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SPINIFEX OFFSHORE WIND FARM PROJECT

EPBC Referral - Offshore Investigations - Significant Impact Assessment

Spinifex Offshore Wind Farm Project
14 June 2024

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1 INTRODUCTION

1.1 Overview

The Spinifex Offshore Wind Farm (the OWF Project) has been in development since 2020.

The initial preferred area identified as requiring further investigation was off the coast of Portland in south-west Victoria. A referral (2022/09359) for this area was submitted in late 2022 for early marine investigations that included geophysical and geotechnical investigations. The outcome of this referral process was a Not a controlled action – particular manner (NCA-PM) decision. Since then, the OWF Project has been redesigned based on feedback from stakeholders and to address the requirements of the Southern Ocean declared area under the *Offshore Electricity Infrastructure Act 2021* process.

The OWF Project is being developed by Spinifex Offshore Wind Farm Pty Ltd as trustee for the Spinifex OWF Trust (Spinifex). The OWF Project is being developed in a partnership between Parkwind and Alinta Energy. Following the Minister for Climate Change and Energy's declaration of the Southern Ocean declared area (SODA) on 6 March 2024 an updated offshore investigation area has been identified as shown in Figure 1-1 below.

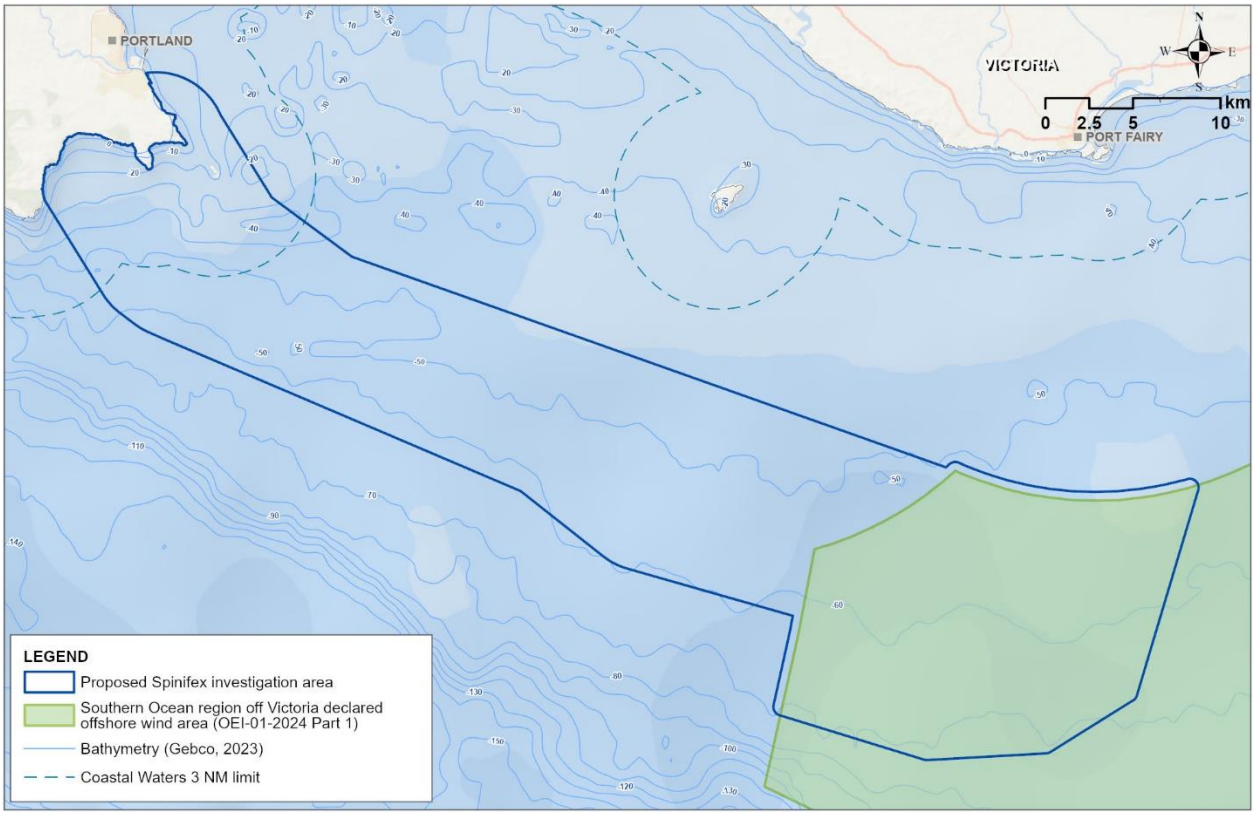

Figure 1-1 Spinifex Offshore Wind Farm offshore investigation area

The OWF Project spans Commonwealth and Victorian jurisdictions and will likely comprise a fixed foundation offshore wind farm of total capacity of 1GW+, at least one offshore substation, and submarine export cables between the offshore wind farm and the proposed onshore connection point near Portland.

Spinifex's primary objectives for the OWF Project are to:

- support the Australian and Victorian Government's to meet renewable energy and offshore wind targets
- deliver a secure, reliable renewable energy supply that provides value-for-money for customers
- aid in developing economic opportunities associated with offshore wind throughout the OWF project lifecycle.

1.2 Proposed action details

The proposed action under this referral is the geophysical and geotechnical investigations that will be carried out to assess the feasibility of the OWF Project. These investigations (action under this referral) will inform basic and detailed level design for the OWF Project. The investigations will gather information on the morphology, geologic makeup, as well as seafloor and oceanic conditions.

The investigations will include:

- Geophysical investigations of the offshore investigation area to gain a preliminary understanding of shallow geology and constraints and hazards from manmade, natural and geological features. The results of this investigation will also inform benthic habitat description and assist with scoping of marine ecological surveys for the environmental impact assessment.
- Geotechnical investigations of the offshore investigation area to inform foundation design and export cable route selection.

These investigations will provide a preliminary, and then detailed understanding of the shallow geology, ground conditions, benthic habitat descriptions and hazards from man-made, natural, and geological features to inform engineering design, the development program, environmental assessments and construction methodologies for the OWF Project.

1.2.1 Geophysical investigations

The objectives of the geophysical investigations(s) are to:

- Collect detailed bathymetric data over the offshore investigation area.
- Develop a ground model of the sub-seabed within the offshore investigation area, including identifying depth and approximate properties of different geological layers.
- Identify potential geo-hazards such as geotechnical anomalies, faults, and very soft areas.
- Identify potential anthropogenic hazards such as Unexploded Ordinance (UXO) and archaeological features.

The main geophysical investigation methods that will be used are shown in Figure 1-2 and their purpose is described below.

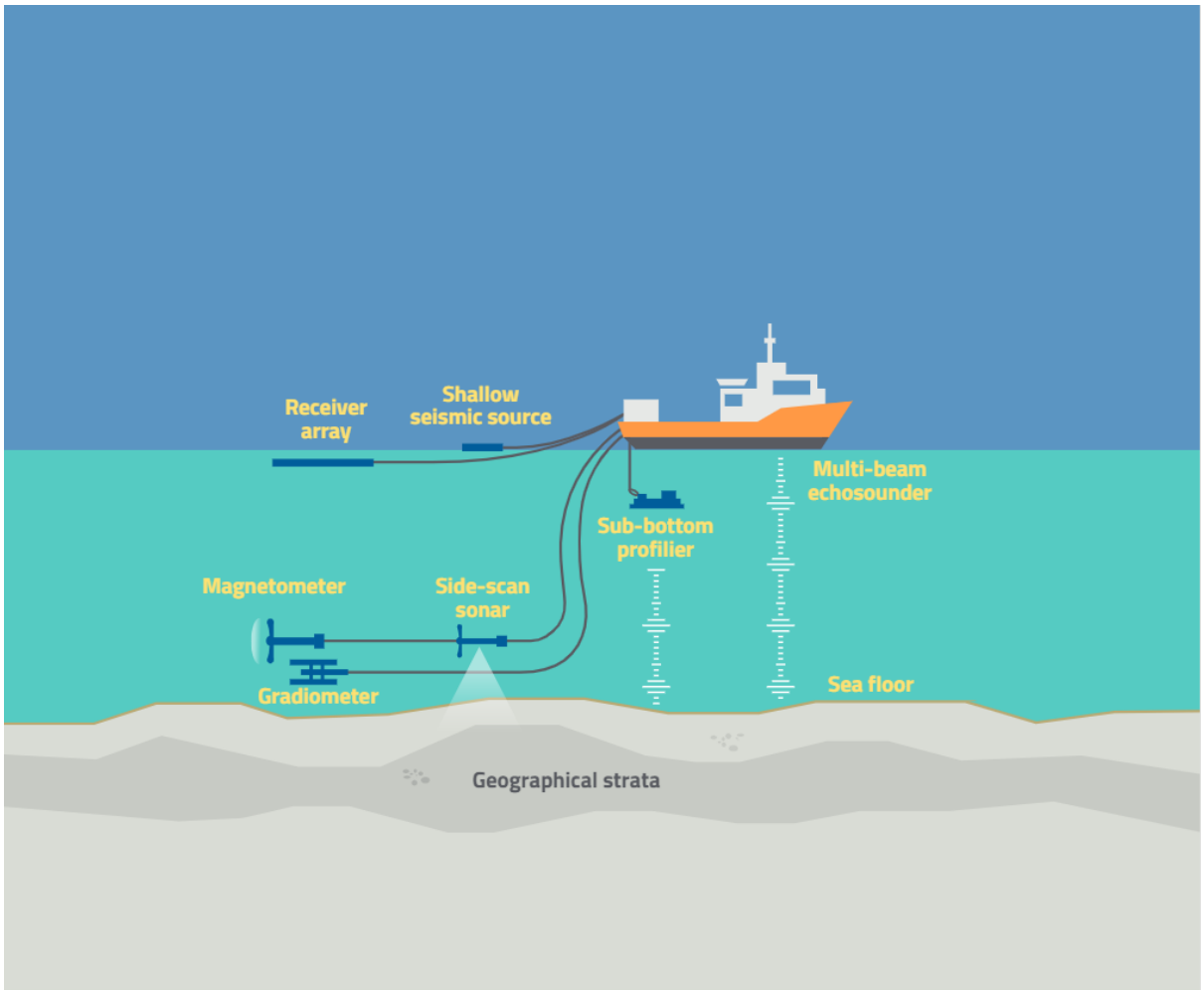

Figure 1-2 Simplified representation of geophysical investigation methods

Geophysical investigation methodologies may include the following:

- Single Beam Echo Sounders (SBES): Determination of water depths
- Multi-beam echo sounder (MBES): Detailed bathymetry measurements
- Side-scan sonar (SSS): Detects hazards (existing pipelines, lost shipping containers, boulders, debris, unmarked wrecks, reefs and craters)
- Sub-bottom profiler (SBP): Measures layers and thickness of seabed sediments (30m+)
- Mini-airgun: Measures layers and thickness of seabed sediments (up to 100m)
- Ultra-short baseline (USBL): allows underwater acoustic positioning to support geophysical and geotechnical activities.
- Magnetometer and Magnetic Gradiometer: Detects metals on or below seabed (missed by sonar)

1.2.2 Geotechnical investigations

The objectives of the geotechnical investigations(s) are to:

- conduct *in-situ* testing to determine physical properties of the seabed at different depths
- collect samples of the seabed at different depths to allow subsequent laboratory testing of physical and chemical properties to inform detailed engineering design parameters.

The main geotechnical investigation methods that will be used are shown in Figure 1-3

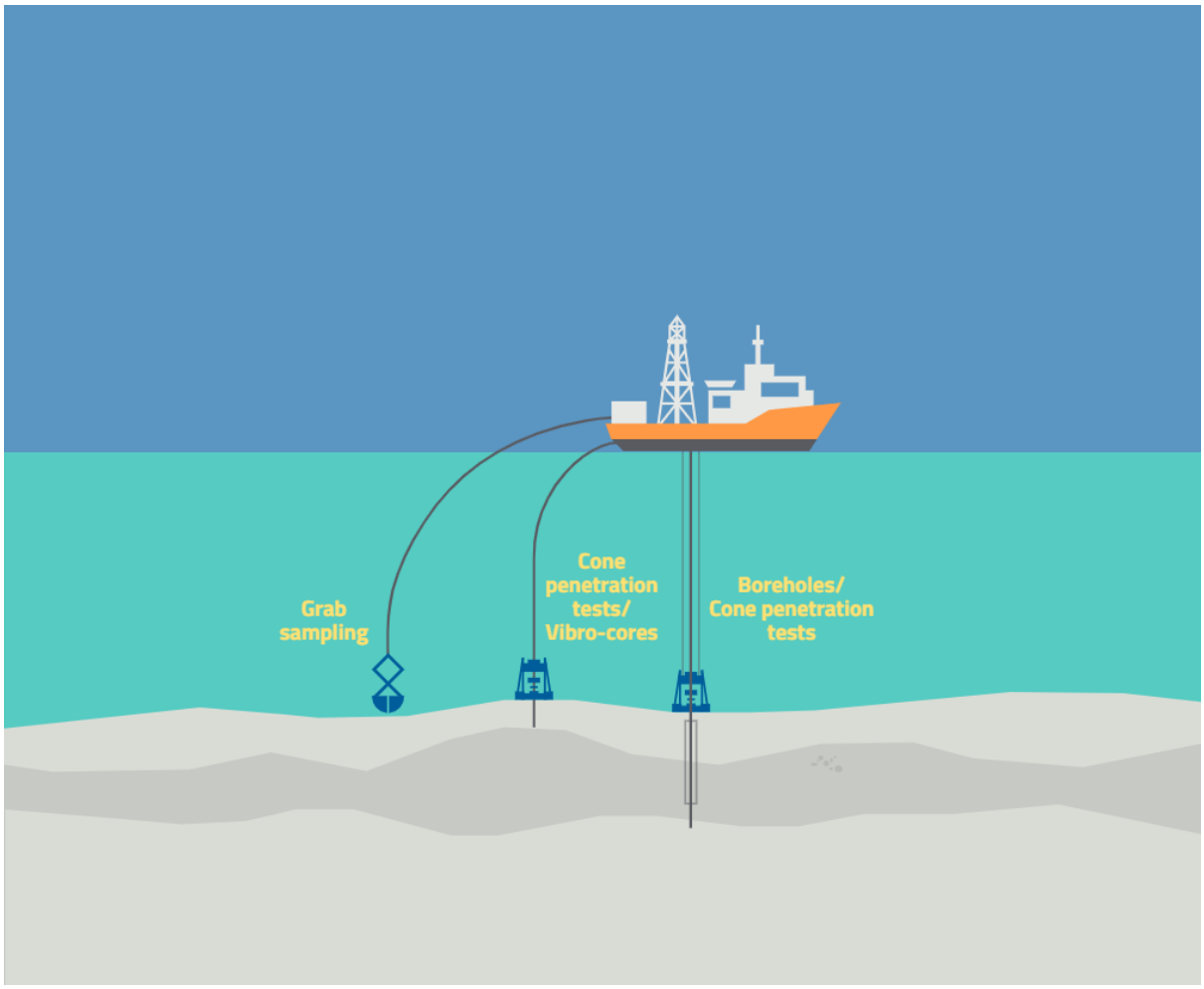

Figure 1-3 Simplified representation of geotechnical investigation methods

Geotechnical investigation methodologies may include the following:

- Seabed grab sampling (SGS): Unconsolidated sediments for analysis
- Seabed coring (SC): Samples for geophysical analysis of formations below the seabed
- Piezo Cone Penetrometer Test (PCPT): Soil strength and stratigraphy

Both the geophysical and geotechnical investigations will be carried out in a staged approach. The initial stage will gather preliminary information at a high-level before more detailed investigations are carried out later in the design stage.

Table 1-1 provides detailed descriptions of each geophysical and geotechnical method that may be used as part of the proposed activity, the associated noise frequency and level, and the methods identified as the most relevant to the assessment of the potential impacts.

Table 1-1 Review of investigation methodology, noise frequency and level and focus of impact assessment

	Description/Methodology	Noise frequency and maximum power output for equipment	Focus of impact assessment
Geophysical Investigation			
Sub-bottom profilers	Acoustic sub-bottom profiling systems are used to determine physical properties of the sub-seabed through seismic reflection and to image and characterise geological information from a few to tens of metres below the seabed. Sub-bottom profilers usually comprise a single channel source that sends sound pulses into shallow sub-seabed sediments. The sound pulses bounce off the seabed and geological layers according to differences in their 'acoustic impedance' (or density). The different times taken for this signal to be returned to and recorded by the sub-bottom profiler indicate how deep the layers are below the seabed. There are five different sub-bottom profiler survey methods/equipment that could be employed during the geophysical investigations. These are compressed high-intensity radar pulses, chirps, pingers, boomers, and sparkers, which can be grouped based on three frequency ranges. Pingers and chirps operate at very high frequencies, boomers at high frequencies and sparkers at medium frequencies. The final selection of the sub-bottom profiler for either of the geophysical investigations will be based on encountered site conditions. The selected sub-bottom profiler must be able to provide imagery down to a minimum depth of 40 m (preferred 80 m) below the seabed. **Chirp** The Chirp system consists of a vessel mounted or towfish that is towed behind or below the vessel, a tow cable, and a topside control unit. Chirp signals typically penetrate the seabed down to approximately 5 to 10 m and provide the best resolution, but lowest penetration of all four options. A Chirp is normally hull-mounted when used for shallow water operations but may also be towed in a similar way to the SSS. The Chirp could be in continuous operation for the duration of the geophysical investigations. The vessel would tow this system at speeds of up to 4 knots. **Pingers** The Pinger system consists of a vessel mounted or towfish that is towed behind or below the vessel, a tow cable, and a topside control unit. Pinger signals typically penetrate the seabed down to 30 m and are particularly good in dense sandy material. If selected as the preferred method, the pinger could be in continuous operation for the duration of the geophysical investigations. **Boomers**	**Underwater Noise - Chirp** Frequency between 0.5 -25 kHz Maximum Power Output - 160 to 215 dB re 1 µPa **Underwater Noise - Pinger** Frequency between 3-18 kHz Maximum Power Output - 120 to 250 dB re 1 µPa	**Underwater Noise** Based on a review of the geophysical equipment to be used for the seabed assessment it was identified that the boomer and mini airgun were most relevant to the assessment of potential impacts to receptors, due to their operating frequencies and source sound levels. An assessment of the potential impacts against the Significant Impact Criteria has been completed in Table Table . **Fauna entanglement in the cables** The risk of fauna entanglement has been assessed in Table .

	Description/Methodology	Noise frequency and maximum power output for equipment	Focus of impact assessment
	The boomer system emits sound waves through a rubber diaphragm directed vertically downward to the seabed, which are reflected back toward the surface at sea level where they may be received by a streamer receiver. The streamer is typically 5 m long and towed offset to the Boomer sound source. Boomers can penetrate down to depths of up to 100 m below the seabed. Boomers are mostly surface towed but may also be towed below the surface to avoid sea surface wave noise interference and movement. If selected as the preferred method, the boomer could be in continuous operation for the duration of the geophysical investigations. **Sparkers** Sparker systems create an electric arc between electrodes with a small high voltage energy pulse. The arc momentarily vaporises water between the electrodes on the Sparker device, which is towed on the water surface behind the investigation vessel, and the vapour expands, generating a pressure wave. Sparkers can provide low-resolution imagery data to much greater penetration depths than the other 3 methods, typically ensonifying the top 100-150m of seabed. If selected as the preferred method, the sparker could be in continuous operation for the duration of the geophysical investigations. **Mini airgun** A small airgun of between 5 to a maximum of 45 cubic inch volume may be used in the detailed geophysical investigations to measure how impulsive sounds propagate (lose energy with distance travelled) through the offshore investigation area. In-field measurements have shown that a level of 160 dB re 1µPa2.s (SEL) would be reached within 150 m of the airgun.	**Underwater Noise - Boomer** Frequency between 0.2 -8 kHz Maximum Power Output - 180 to 215 dB re 1 µPa at 1m **Underwater Noise - Sparker** Frequency between 100 Hz – 6 kHz Maximum Power Output - 120 to 250 dB re 1 µPa **Underwater Noise – Mini airgun** Frequency between 0 – 30 Hz Maximum Power Output – 225 dB re 1 µPa	
Single Beam Echo Sounders (SBES)	The SBES will be used to determine water depths along the vessel track. SBESs emit a pulse of sound in a narrow cone (2-12°) along the seabed. The sound pressure levels are focused directly downwards in the main beam of the SBES and will be much lower away from the source, so there is a very small horizontal radius of influence for most modern SBESs. Therefore, the zone of influence of most SBESs is limited to a small region immediately below the vessel (SCAR 2002). The equipment will be calibrated at the start and end of the geophysical investigation and will be in operation for the full duration of the geophysical investigations. The echo sounder proposed for use during this investigation is consistent with other vessel echo sounders currently in operation on vessels across the world and is not expected to increase noise levels above ambient.	**Underwater Noise –** Typical frequency of 200 kHz: SBES Sound pressure levels (SPLs) at the source are low, ranging from 190 to 220 dB re 1 µPa.	**Underwater Noise** Based on a review of the geophysical equipment to be used for the seabed assessment it was identified that the boomer and mini airgun were most relevant to the assessment of potential impacts to receptors, due to their operating frequencies

	Description/Methodology	Noise frequency and maximum power output for equipment	Focus of impact assessment
			and source sound levels. No further assessment of noise impacts from SBES has been considered in this assessment.
Multibeam echo-sounder (MBES)	Multibeam echo-sounders perform a similar function to SSS except they use transducers to emit a broad acoustic pulse across the vessel track, which produces a 'fan' of pre-formed narrow beams across the seabed, perpendicular to the vessel track. This allows the MBES to acquire wide swaths (or strips) of bathymetric data perpendicular to the vessel track. The MBES typically ensonifies a broad swath of the seabed perpendicular to the movement of the vessel, but a very narrow swath in the direction of travel of the vessel. The MBES may be hull-mounted (preferred option), over-the-side pole mounted or (where part of the manufacturer's design) installed in a towed body. Multibeam echo-sounder systems operate over a high frequency range between 170 and 700 kHz, with typical maximum source levels of around 190 to 220 dB re 1 µPa. The MBES could be in continuous operation for the duration of the investigation at vessel speeds of <4 knots.	**Underwater Noise -** Frequency between 170 – 700kHZ but may be up to 900kHz; Maximum Power Output - 190 to 220 dB re 1 µPa	**Underwater Noise** Based on a review of the geophysical equipment to be used for the seabed assessment it was identified that the boomer and mini airgun were most relevant to the assessment of potential impacts to receptors, due to their operating frequencies and source sound levels. No further assessment of noise impacts from MBES has been considered in this assessment.
Side Scan Sonar (SSS)	The SSS method of surveying generates oblique acoustic images of the seabed by towing a sonar 'towfish' (i.e. transducer mounted inside in a protective body), approximately 7 to 10 m from the seabed. The towfish is towed from the vessel using a reinforced or armoured tow cable. The tow-fish is equipped with a linear array of transducers that emit and later receive, an acoustic energy pulse in a	**Underwater Noise**	**Underwater Noise** Based on a review of the geophysical equipment to be used for the seabed

	Description/Methodology	Noise frequency and maximum power output for equipment	Focus of impact assessment
	specific frequency range. The received acoustic energy by the towfish (i.e. 'backscatter') provides information as to the general distribution and characteristics of the surficial sediment and outcropping strata. Typically, a dual-channel, dual-frequency SSS will be used. Side scan sonar systems operate with a high frequency range typically between 100 and 400 kHz but may be operated up to 900 kHz. Typical maximum source levels are around 120 to 160 dB re 1 µPa. The SSS could be in continuous operation for the duration of the investigation. The SSS will generally operate at vessel speeds of <4 knots.	Frequency between 100 – 400kHZ but may be up to 900kHz Maximum Power Output - 120 to 160 dB re 1 µPa Side scan sonar operations produce sound at higher frequencies (typically around 100-400 kHz). The SSS is outside of the hearing thresholds of low-frequency cetaceans (baleen whales) that may be present in or in the vicinity of the offshore investigation area (NMFS 2018).	assessment it was identified that the boomer and mini airgun were most relevant to the assessment of potential impacts to receptors, due to their operating frequencies and source sound levels. No further assessment of noise impacts from SSS has been considered in this assessment. **Fauna entanglement in the cable** The risk of fauna entanglement has been assessed in Table 3-2. Equipment will be deployed in a manner that ensures there are no slack lines, substantially reducing entanglement risk. Further to this, the presence of an MMO and trained crew and application of measures within Part 8 of the EPBC Regulations will reduce potential for entanglement.

	Description/Methodology	Noise frequency and maximum power output for equipment	Focus of impact assessment
Ultra-short baseline (USBL)	Ultra-short baseline is a method of underwater acoustic positioning, consisting of a transceiver mounted on a pole under a ship, on a towfish, or on a remotely operated underwater vehicle, and a transponder on the acoustic equipment (i.e. SSS, sub-bottom profiler, or MBES) that is being positioned, often with a gyro compass to indicate direction. An acoustic pulse is transmitted by the transceiver and detected by the transponder on the acoustic equipment, which returns a pulse that is detected by the shipboard transceiver. The time from the transmission of the initial acoustic pulse until the reply is detected is measured by the USBL system and is converted into a distance.	**Underwater Noise USBL** Frequency between approximately 0.5 -25 kHz. Maximum Power Output approximately - 160 to 215 dB re 1 µPa.	**Underwater Noise** Based on a review of the geophysical equipment to be used for the seabed assessment it was identified that the boomer and mini airgun were most relevant to the assessment of potential impacts to receptors, due to their operating frequencies and source sound levels. No further assessment of noise impacts from USBL was considered in this assessment. **Fauna entanglement in the cable** Equipment will be deployed in a manner that ensures there are no slack lines, substantially reducing entanglement risk. Further to this, the presence of an MMO and trained crew and application of measures within Part 8 of the EPBC Regulations will reduce potential for entanglement.

	Description/Methodology	Noise frequency and maximum power output for equipment	Focus of impact assessment
			The risk of fauna entanglement has been assessed in Table 3-2.
Magnetomer and gradiometer	This equipment is used to detect large and small metallic objects on or below the seabed that cannot be identified by acoustic means. The magnetometer sensor will be housed in a towfish that is towed as close to the seabed as possible (typically 2 to 4 m from the seabed) and sufficiently far away from the vessel to isolate the sensor from the magnetic field of the vessel. Gradiometers will typically be mounted in an array on an underwater frame. The magnetometer and gradiometer will be used to detect any ferrous objects and will be towed at sufficient distance from the investigation vessel to minimise magnetic interference from the vessel. This distance is normally at least three times the length of the vessel. The magnetometer will be operational for the full duration of the geophysical investigation. The gradiometer will be in operation for discrete periods during the investigations.	**Not applicable**	Based on a review of the geophysical equipment to be used for the seabed assessment it was identified that the boomer and mini airgun were most relevant to the assessment of potential impacts to receptors, due to their operating frequencies and source sound levels. No further assessment of noise impacts from MBES was considered in this assessment. **Fauna entanglement in the cable** Equipment will be deployed in a manner that ensures there are no slack lines, substantially reducing entanglement risk. Further to this, the presence of an MMO and trained crew and application of measures within Part 8 of the EPBC Regulations will

Description/Methodology	Noise frequency and maximum power output for equipment	Focus of impact assessment
		reduce potential for entanglement. The risk of fauna entanglement has been assessed in Table 3-2.

	Description/Methodology	Key impact(s)	Focus of impact assessment
Geotechnical Investigations			
Shallow seabed sampling/testing	Shallow seabed sampling/testing will be performed to ground truth the geophysical investigation data and for baseline benthic habitat characterisation. The following shallow sampling/testing methods may be employed: Surface grab sampling may be undertaken using a Van Veen or Day grab sampler (maximum footprint of 1 m^2). Samples will be taken down to <1 m and will be sent to onshore laboratories for physical and chemical analyses. Vibro cores, piston cores or similar may be undertaken to collect samples of unconsolidated sediments up to 6 m into the seabed. The shallow Piezo Cone Penetration Test (PCPT) method consists of pushing an instrumented cone, with the tip facing down, into the seabed at a controlled rate to obtain a continuous profile of the physical properties. The exact number of samples/tests will be determined from geophysical data onboard the vessel but is likely to comprise up to one grab sample for every 3-4 km^2 across the offshore investigation area. Each PCPT, vibro-core or	**Localised (1m²) seabed disturbance and vibration impacts from collection of the samples**	The marine habitats that may occur within or near the referral area include: • subtidal nearshore and offshore rocky reefs with kelp and other macroalgae • subtidal soft sediments • water column An assessment of impacts has been carried out in Table 3-2.

	grab sample will require the vessel to remain on location for a short period of time, up to 5-10 minutes. Samples will be sealed in appropriate containers and transported to an onshore laboratory for physical and chemical analyses.		
Seabed Piezo Cone Penetration Tests (PCPTs)	This technique helps to determine soil strength and helps to delineate soil stratigraphy. The process included lowering a frame to the seabed and pushing the PCPT unit into the sediment at a steady penetration rate (usually 2 cm per second). The seabed PCPT unit consists of a rod up to 25 m long (or discrete rod sections to make up a total of 25 m) that has a small cone at its base (with typical cone tips having a cross-sectional area of 2, 5, 10 or 15 cm^2). The PCPT measures resistance to the push and these measurements allow high quality interpretation of ground conditions and pore pressure dissipation testing. A seabed frame is lowered to the seabed with the PCPT unit integrated into it and operated remotely. A PCPT typically takes 2-2.5 hours to complete. When the required penetration depth is reached, all equipment is withdrawn from the seabed. A small hole will remain in the seabed, which will eventually collapse and infill with the movement of seabed sediments.	**Localised seabed disturbance from the PCPT**	The marine habitats that may occur within or near the referral area include: • subtidal nearshore and offshore rocky reefs with kelp and other macroalgae • subtidal soft sediments • water column An assessment of impacts has been carried out in Table 3-2.
Borehole drilling	Deeper geotechnical investigations for soil strength analysis and to ground truth deeper geological sequences will require drilling of boreholes up to a depth of 100 m below the seabed. The drilled boreholes will be of 'composite' type, comprising both the recovery of samples (including rock) and in situ testing using a typical drill sampling and PCPT sequence. Drilling will require positioning of a frame on the seabed with a dimension of approx. 4 x 4 m and boreholes will be drilled with a 120 mm drill pipe. Drilling fluid/mud used during the drilling will be a non-toxic, biodegradable fluid/mud mixed with seawater. No synthetic fluids or muds will be used.	**Underwater noise** **Drilling fluids and rock/sediment cutting discharged to seabed in the vicinity of boreholes** **Localised sediment disturbance (approx. 4 x 4m)**	Assessment of noise impacts has been addressed in Table 3-1 and Table 3-2. The marine habitats that may occur within or near the referral area include: • subtidal nearshore and offshore rocky reefs with kelp and other macroalgae • subtidal soft sediments • water column

	The duration of the drilling for each borehole will be up to 4 days depending on borehole depth, geological conditions encountered, and the extent of downhole testing and sampling required. Therefore, the drilling vessel will need to remain on location during this period. Sampling and PCPT data from boreholes is used to ground truth the geophysical data and provides soil strength data that can be used for geotechnical analysis. The actual depth of penetration will be dependent on the soil conditions. For borehole coring, wireline-deployed hydraulically-operated push or piston samplers may be used to recover high quality samples as a result of the fixed piston that rests on the bottom of the borehole. Drilling fluid will be used during the borehole sampling and PCPT process to lubricate the drill bit, transport cuttings out of the borehole to keep the borehole clean and to prevent the borehole from collapsing during the coring process. Seawater is the primary constituent of geotechnical drilling fluids. Inert drilling fluid additives may be added to the seawater to form a water-based mud (WBM) if challenging boring conditions are encountered. Common WBM additives that may be used during the coring process include guar, bentonite and barite. All drilling fluid additives are to be of low eco-toxicity, with only 'Gold'/'Silver' (CHARM) or 'D'/'E' (non-CHARM) OCNS-rated chemicals to be used. Cuttings are discharged directly to the seabed during borehole sampling. Drill cuttings are inert pieces of rock, sand and other particles removed from the borehole during the sampling process. Cuttings range in size from very coarse to very fine particles.	An assessment of impacts has been carried out in Table 3-2.

Geotechnical Drilling vessels and drilling platforms	All borehole drilling operations will be undertaken using either a seafloor drill deployed from a vessel of opportunity or from a dedicated drilling vessel or platform. The vessels/platforms for geotechnical borehole drilling operations have not been selected but could be mobilised from a local port or from a port outside Australia. There will be no refueling at sea. For vessel-based geotechnical borehole drilling operations, the vessel will be expected to remain stationary at a prescribed location for up to a few days during the geotechnical drilling activities. As such, the vessel will be capable of maintaining station using Dynamic Positioning (DP) or by anchoring.	**Temporary localised disturbance of seabed from anchor** **Temporary localised disturbance of seabed from jack-up legs (1 x5m)** **Underwater noise as a result of use of DP to maintain vessel position.**	Assessment of noise impacts has been addressed in Table 3-1 and Table 3-2. The marine habitats that may occur within or near the referral area include: • subtidal nearshore and offshore rocky reefs with kelp and other macroalgae • subtidal soft sediments • water column An assessment of impacts has been carried out in Table 3-2.

1.2.3 Activity timing

The preliminary geophysical investigations will continue for approximately eight weeks, with an estimated 45 days of geophysical investigation activity over the approximately eight-week period.

Preliminary geotechnical investigations are anticipated to proceed sometime after receiving a feasibility licence, and having in place an approved Management Plan, under the *Offshore Electricity Infrastructure Act 2021*. Once mobilised, the preliminary geotechnical investigations will continue for approximately eight weeks, with an estimated 40 days of geotechnical activity over the approximately eight-week period.

Detailed geophysical and geotechnical investigations will be required to further refine the ground model. For the detailed geophysical investigations, we estimate 45 days over an approximately 8-week period. Detailed geotechnical investigations are estimated to occur over a period of approximately 20 weeks, with an estimated 90 days of geotechnical activity during that period.

The preliminary geophysical investigation would not commence before 1 November 2024. The full program of offshore investigations is targeted to be complete by 30 April 2029, which includes contingency.

Due to the metocean conditions within the offshore investigation area, and in order to avoid potential impacts to southern right whales during the calving period, geophysical and geotechnical site investigations may only be feasibly performed within the summer season each year, which for the purpose of this referral is defined as 1 November to 30 April.

Table 1-2 Approximate timing of the Spinifex Offshore Investigations

Activity	Duration window	Estimated # days of activity	Approximate timing
Preliminary geophysical investigation(s)	Eight weeks (two months)	45 days of geophysical investigation activity	The preliminary geophysical investigation would not commence before 1 November 2024. The full program of offshore investigations is targeted to be complete by 30 April 2029.
Detailed geophysical investigations	Eight weeks (two months)	45 days of geotechnical investigation activity	
Preliminary geotechnical investigations	Eight weeks (two months)	40 days of geotechnical investigation activity	
Detailed geotechnical investigations	Twenty weeks (five months)	90 days of geotechnical investigation activity	

2 EXISTING ENVIRONMENT

2.1 Existing conditions of the Spinifex Offshore Investigation Area

The location of the Spinifex offshore investigation area is approximately 20km off the coast near Port Fairy and 25km from the town of Warrnambool, Victoria, and is situated within the South-east Marine Region. The South-east Marine Region incorporates Commonwealth waters extending from near the far south coast of New South Wales, around Tasmania and as far west as Kangaroo Island in South Australia. It includes the Commonwealth waters of Bass Strait.

The main physical features of this marine region include:

- A narrow continental shelf (i.e., 10 to 25 km) in most parts of the region, except for Bass Strait.
- A shelf break, which includes the edges of the continental shelf and the upper slope, that serves to intensify currents, eddies and upwellings, thereby creating a rich and productive area for biodiversity, including species that are fished commercially and recreationally.
- Several sea floor canyons along the continental margin, which provide habitat for sessile invertebrates, such as corals. These in turn attract other organisms and higher order species.
- Oceanographic complexity, with subtropical influences from the north and subpolar influences from the south and upwelling, which regularly develops from November to late April bringing cold-water plumes to the surface. These plumes provide increased nutrient concentrations that support elevated levels of marine productivity, including protected marine mammals such as *Eubalaena australis* southern right whale and *Balaenoptera musculus* blue whale.

The proposed offshore investigation area is approximately 800 km^2. This captures the area we propose to investigate for the wind turbine generators and offshore substation(s) and an export cable corridor. The mean ocean depth across the offshore investigation area is approximately 51 m. Depths range from 5 m to 75 m across the offshore investigation area. The majority of the investigation area has a depth range of 30 to 75 m and is characterised by relatively flat seafloor that dips gently to the south and southwest; the nearshore portion of the investigation area (lying within circa 5 km of the coast) has more complex and variable bathymetry.

The seabed offshore from Portland and Port Fairy comprises carbonate sediments (biologically derived), with areas of reef formed from sedimentary rock and volcanic rock (DEH, 2006). Much of the offshore investigation area is likely to be unconsolidated sandy seabed. Sediment maps indicate that sediments contain little gravel or mud and are predominantly fine to medium grained sand (Heap *et al*. 2005). Hydrographic charts of the area and data from surrounding areas (Lucieer *et al.* 2017) indicate reef outcrops and large areas of hard seabed may be present throughout the offshore investigation area. Reefs are common offshore from Lawrence Rocks, Julia Reef (Portland Bay) and Deen Maar (Lady Julia Percy Island).

The waters have average surface temperatures ranging from 14°C in winter to 21°C in summer. However, subductions of cooler nutrient-rich water (upwellings) occur along the seafloor during mid to late summer, though this is usually masked in satellite images by a warmer surface layer.

The upwelled water is an extension of the regional Bonney Upwelling system, which affects southern Australia because of south-east winds forcing surface water offshore thus triggering a compensatory subduction along the bottom. If the wind is strong enough the water sometimes shoals against the coast. The water originates from a subsurface water flow called the Flinders current and has the characteristics of reheated Antarctic Intermediate Water (Levings and Gill, 2010).

2.1.1 Protected Matters Search Tool

To inform the referral process, a Protected Matters Species Search was undertaken using the Protected Matter Search Tool (PMST) to identify Matters of National Environmental Significance (MNES) or other matters protected under the EPBC Act that may be impacted by the project. The search covered the offshore investigation area, with an 8km buffer area (refer to Figure 1-1). A copy of the PMST is included in Appendix A. In summary the report concluded the presence/absence of the following MNES:

- World Heritage Properties: None
- National Heritage Places: None
- Wetlands of International Importance (Ramsar): None
- Great Barrier Reef Marine Park: None
- Commonwealth Marine Area: as defined under the EPBC Act
- Listed Threatened Ecological Communities: 3
    - Giant Kelp Marine Forests of South East Australia
    - Grassy Eucalypt Woodland of the Victorian Volcanic Plain
    - Natural Temperate Grassland of the Victorian Volcanic Plain
- Listed Threatened Species: 79 (refer to Table 2-1 for a complete list)
- Listed Migratory Species: 49 (refer to Table for a complete list)

2.1.1.1 Other matters protected by the EPBC Act

Commonwealth Lands: None

Commonwealth Heritage Places: None

Listed Marine Species: 89

Whales and Other Cetaceans: 14

Critical Habitats: None

Commonwealth Reserves Terrestrial: None

Australian Marine Parks: None

Habitat Critical to the Survival of Marine Turtles: None

The Giant Kelp Marine Forests of South East Australia has been identified as a listed threatened ecological communities that 'may occur'. A number of EPBC threatened and listed migratory species have also been identified as potentially occurring within the area. This are discussed in Section 3.2 of this referral.

There is one Key Ecological Feature (KEF) that overlaps the offshore investigation area, the Bonney Upwelling. The Bonney Upwelling is an area of high productivity and aggregations of marine life. It is a predictable, seasonal upwelling which brings cold, nutrient rich water to the sea surface and typically occurs in the summer and autumn along the narrow continental shelf between Robe, South Australia, and Portland, Victoria. The higher primary productivity that attracts baleen whales and other species (including EPBC-listed species) that feed on the plankton swarms (krill) (DoE 2015).

The primary ecological importance of the Bonney Upwelling is as a feeding area for the blue whale. The Bonney Coast Upwelling is one of only two identified seasonal feeding areas for blue whales in Australian coastal waters and is one of 12 known blue whale feeding aggregation areas globally. Sightings of the sei whale in the upwelling indicate this is potentially an important feeding ground for the species (Gill et al., 2015) and also for the fin whale.

There are 18 Biologically Important Areas (BIA) that overlap the Project area. These include:

- Southern Right Whale – Aggregation Area BIA and Known Core Range BIA
- Pygmy Blue Whale – Foraging (annual high use) BIA and Distribution BIA
- Great White Shark – Foraging, Known Distribution and Distribution (low density) BIAs
- Wedge-tailed Shearwater - Foraging BIA
- Wandering Albatross - Foraging BIA
- Antipodean Albatross - Foraging BIA

- Australasian Gannet - Aggregation Area BIA and Foraging BIA
- Common Diving-petrel - Foraging BIA
- Bullers Albatross - Foraging BIA
- Shy Albatross – Likely Foraging BIA
- Indian Yellow-nosed Albatross - Foraging BIA
- Black-browed Albatross - Foraging BIA
- Campbell Albatross - Foraging BIA.

There are no marine protected areas that overlap the offshore investigation area.

Table 2-1 EPBC Act listed species, likelihood of occurrence, migratory status, and BIA overlap with the offshore investigation area

Scientific Name	Common Name	Class	Threatened Category	Likelihood of Occurrence	Migratory Status	BIA Overlap
Ardenna grisea	Sooty Shearwater	Bird	Vulnerable	May	Migratory	
Calidris acuminata	Sharp-tailed Sandpiper	Bird	Vulnerable	May	Migratory	
Calidris canutus	Red Knot, Knot	Bird	Vulnerable	May	Migratory	
Calidris ferruginea	Curlew Sandpiper	Bird	Critically Endangered	May	Migratory	
Charadrius leschenaultia	Great Sand Plover	Bird	Vulnerable	May	Migratory	
Diomedea antipodensis	Antipodean Albatross	Bird	Vulnerable	Likely	Migratory	
Diomedea epomophora	Southern Royal Albatross	Bird	Vulnerable	Likely	Migratory	
Diomedea exulans	Wandering Albatross	Bird	Vulnerable	Likely	Migratory	Foraging
Diomedea sanfordi	Northern Royal Albatross	Bird	Endangered	Likely	Migratory	
Gallinago hardwickii	Latham's Snipe, Japanese Snipe	Bird	Vulnerable	Known	Migratory	
Halobaena caerulea	Blue Petrel	Bird	Vulnerable	May		
Hirundapus caudacutus	White-throated Needletail	Bird	Vulnerable	Known	Migratory	
Lathamus discolor	Swift Parrot	Bird	Critically Endangered	May		
Limosa lapponica baueri	Nunivak Bar-tailed Godwit	Bird	Endangered	May		
Macronectes giganteus	Southern Giant-Petrel	Bird	Endangered	May	Migratory	
Macronectes halli	Northern Giant Petrel	Bird	Vulnerable	Likely	Migratory	
Neophema chrysogaster	Orange-bellied Parrot	Bird	Critically Endangered	Likely		
Neophema chrysostoma	Blue-winged Parrot	Bird	Vulnerable	Known		
Numenius madagascariensis	Eastern Curlew	Bird	Critically Endangered	May	Migratory	
Pachyptila turtur subantarctica	Fairy Prion (southern)	Bird	Vulnerable	Known		
Phoebetria fusca	Sooty Albatross	Bird	Vulnerable	Likely	Migratory	
Pterodroma leucoptera leucoptera	Gould's Petrel	Bird	Endangered	May		
Pterodroma mollis	Soft-plumaged Petrel	Bird	Vulnerable	May		
Rostratula australis	Australian Painted Snipe	Bird	Endangered	Likely		
Stagonopleura guttata	Diamond Firetail	Bird	Vulnerable	May		
Sternula nereis nereis	Australian Fairy Tern	Bird	Vulnerable	Likely		
Thalassarche bulleri	Buller's Albatross, Pacific Albatross	Bird	Vulnerable	Likely	Migratory	Foraging
Thalassarche bulleri platei	Northern Buller's Albatross, Pacific Albatross	Bird	Vulnerable	Likely		

Scientific Name	Common Name	Class	Threatened Category	Likelihood of Occurrence	Migratory Status	BIA Overlap
Thalassarche carteri	Indian Yellow-nosed Albatross	Bird	Vulnerable	Likely	Migratory	
Thalassarche cauta	Shy Albatross	Bird	Endangered	Likely	Migratory	Foraging
Thalassarche chrysostoma	Grey-headed Albatross	Bird	Endangered	May	Migratory	
Thalassarche impavida	Campbell Albatross	Bird	Vulnerable	Likely	Migratory	
Thalassarche melanophris	Black-browed Albatross	Bird	Vulnerable	Likely	Migratory	Foraging
Thalassarche salvini	Salvin's Albatross	Bird	Vulnerable	Likely	Migratory	
Thalassarche steadi	White-capped Albatross	Bird	Vulnerable	Known	Migratory	
Thinornis cucullatus cucullatus	Eastern Hooded Plover, Eastern Hooded Plover	Bird	Vulnerable	Known		
Tringa nebularia	Common Greenshank	Bird	Endangered	Likely	Migratory	
Prototroctes maraena	Australian Grayling	Fish	Vulnerable	Likely		
Seriolella brama	Blue Warehou	Fish	Conservation Dependent	Known		
Thunnus maccoyii	Southern Bluefin Tuna	Fish	Conservation Dependent	Known		
Balaenoptera borealis	Sei Whale	Mammal	Vulnerable	Known	Migratory	
Balaenoptera musculus	Blue Whale	Mammal	Endangered	Known	Migratory	Foraging (annual high use)
Balaenoptera physalus	Fin Whale	Mammal	Vulnerable	Known	Migratory	
Eubalaena australis	Southern Right Whale	Mammal	Endangered	Known	Migratory	Migration; Reproduction
Neophoca cinerea	Australian Sea Lion	Mammal	Endangered	May		
Caretta caretta	Loggerhead Turtle	Reptile	Endangered	Likely	Migratory	
Chelonia mydas	Green Turtle	Reptile	Vulnerable	May	Migratory	
Dermochelys coriacea	Leatherback Turtle	Reptile	Endangered	Likely	Migratory	
Carcharodon carcharias	Great White Shark	Shark	Vulnerable	Known	Migratory	Known Distribution; Foraging
Galeorhinus galeus	Eastern School Shark	Shark	Conservation Dependent	May		
Non-marine species (out of scope)						
Botaurus poiciloptilus	Australasian Bittern	Bird	Endangered	Known		
Callocephalon fimbriatum	Gang-gang Cockatoo	Bird	Endangered	Known		
Falco hypoleucos	Grey Falcon	Bird	Vulnerable	May		
Grantiella picta	Painted Honeyeater	Bird	Vulnerable	May		

Scientific Name	Common Name	Class	Threatened Category	Likelihood of Occurrence	Migratory Status	BIA Overlap
Euastacus bispinosus	Glenelg Spiny Freshwater Crayfish	Crustacean	Endangered	May		
Nannoperca obscura	Yarra Pygmy Perch	Fish	Endangered	May		
Litoria raniformis	Southern Bell Frog	Frog	Vulnerable	Likely		
Antechinus minimus maritimus	Swamp Antechinus (mainland)	Mammal	Vulnerable	Likely		
Dasyurus maculatus maculatus (SE mainland population)	Spot-tailed Quoll	Mammal	Endangered	May		
Isoodon obesulus obesulus	Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern)	Mammal	Endangered	Known		
Miniopterus orianae bassanii	Southern Bent-wing Bat	Mammal	Critically Endangered	Likely		
Petaurus australis australis	Yellow-bellied Glider (south-eastern)	Mammal	Vulnerable	Likely		
Potorous tridactylus trisulcatus	Long-nosed Potoroo (southern mainland)	Mammal	Vulnerable	Likely		
Pseudomys shortridgei	Heath Mouse	Mammal	Endangered	Known		
Pteropus poliocephalus	Grey-headed Flying-fox	Mammal	Vulnerable	May		
Amphibromus fluitans	River Swamp Wallaby-grass	Plant	Vulnerable	May		
Caladenia hastata	Melblom's Spider-orchid	Plant	Endangered	Likely		
Glycine latrobeana	Clover Glycine, Purple Clover	Plant	Vulnerable	May		
Ixodia achillaeoides subsp. arenicola	Sand Ixodia, Ixodia	Plant	Vulnerable	Known		
Lepidium aschersonii	Spiny Peppercress	Plant	Vulnerable	May		
Prasophyllum litorale	Coastal Leek Orchid	Plant	Critically Endangered (listed as *Prasophyllum littorale*)	Likely		
Prasophyllum spicatum	Dense Leek-orchid	Plant	Vulnerable	Likely		
Prasophyllum suaveolens	Fragrant Leek-orchid	Plant	Endangered	May		
Pterostylis chlorogramma	Green-striped Greenhood	Plant	Vulnerable	May		
Pterostylis cucullata	Leafy Greenhood	Plant	Vulnerable	May		
Senecio psilocarpus	Swamp Fireweed, Smooth-fruited Groundsel	Plant	Vulnerable	Likely		
Thelymitra orientalis	Hoary Sun-orchid	Plant	Critically Endangered	May		
Xerochrysum palustre	Swamp Everlasting, Swamp Paper Daisy	Plant	Vulnerable	May		
Lissolepis coventryi	Swamp Skink, Eastern Mourning Skink	Reptile	Endangered	Known		

2.2 Migratory Species

Table 2-2 Non listed migratory species, likelihood of occurrence, and BIA overlap with the offshore investigation area

Scientific Name	Migratory Species	Class	Likelihood of Occurrence	BIA Overlap
Actitis hypoleucos	Common Sandpiper	Bird	Known	No
Apus pacificus	Fork-tailed Swift	Bird	Likely	No
Ardenna carneipes	Flesh-footed Shearwater	Bird	Likely	No
Ardenna tenuirostris	Short-tailed Shearwater	Bird	Known	No
Calidris melanotos	Pectoral Sandpiper	Bird	May	No
Limosa lapponica	Bar-tailed Godwit	Bird	Known	No
Monarcha melanopsis	Black-faced Monarch	Bird	May	No
Motacilla flava	Yellow Wagtail	Bird	May	No
Myiagra cyanoleuca	Satin Flycatcher	Bird	Known	No
Rhipidura rufifrons	Rufous Fantail	Bird	Likely	No
Sternula albifrons	Little Tern	Bird	May	No
Caperea marginata	Pygmy Right Whale	Mammal	Likely	No
Lagenorhynchus obscurus	Dusky Dolphin	Mammal	May	No
Megaptera novaeangliae	Humpback Whale	Mammal	Likely	No
Orcinus orca	Killer Whale, Orca	Mammal	Likely	No
Isurus oxyrinchus	Shortfin Mako Shark	Shark	Likely	No
Lamna nasus	Porbeagle Shark	Shark	Likely	No

3 SIGNIFICANT IMPACT ASSESSMENT

The proposed offshore investigations area is approximately 800 km^2. This captures the area we propose to investigate for the wind turbine generators and offshore substation(s) and an export cable corridor (see Figure 1-1). The activity footprint will be approximately the same as the development area of 800 km^2. However, this footprint is the total area of the project, and is not indicative of the area within which direct impacts associated with this action may occur. For example, geophysical investigations that do not contact the seabed may occur over the entire area, but geotechnical investigations will be limited to representative locations, each with a small, localised disturbance footprint.

A summary of direct and indirect impacts as a result of the proposed activity are summarised below.

Potential DIRECT impacts to protected matters include:

- Underwater sound from geophysical investigation acoustic equipment, drilling (boreholes) and the investigation vessels – localised and temporary behavioural disturbance to noise sensitive marine fauna.
- Underwater sound from geophysical investigation acoustic equipment and drilling (boreholes) – potential for auditory impairment (Permanent Threshold Shift (PTS) or Temporary Threshold Shift (TTS)) in noise sensitive marine fauna in close proximity to the sound source.
- Underwater sound from geotechnical investigations operations, drilling (boreholes) and the investigation vessels – localised and temporary behavioural disturbance to noise sensitive marine fauna.
- Underwater sound from geotechnical investigations operations, drilling (boreholes) – potential for auditory impairment (Permanent Threshold Shift (PTS) or Temporary Threshold Shift (TTS)) in noise sensitive marine fauna in close proximity to the sound source.
- Drilling fluids/muds discharges associated with drilling boreholes – potential localised smothering. However, risk is negligible to low as drilling fluids/muds used will be seawater and non-toxic biodegradable fluid/muds.
- Vessel collision with listed species – potential injury/death of an animal.
- Equipment entanglement (towed equipment) – potential injury of an animal.
- Accidental release of solid objects overboard – potential entanglement and injury of an animal.
- Short-term / localised seabed disturbance resulting from grab sampling, drilling boreholes, coring and anchoring.

Potential INDIRECT impacts to protected matters include:

- Sediment plumes from seabed disturbance resulting from grab sampling, drilling boreholes, coring and anchoring – localised reduced visibility for predators, localised covering of seabed.
- Artificial light emissions from night-time operations – impacts on prey from light attraction.

3.1 Underwater noise estimates and noise criteria

3.1.1 Geophysical investigations

Based on the MNES identified and the activities proposed, underwater noise has been identified as a key impact that required further assessment, particularly in relation to cetacean and fish species, which are vulnerable to low frequency noise.

Table lists the noise effect criteria for geophysical investigation equipment on key sensitive marine fauna receptors. The noise effect criteria levels are based on peer reviewed literature that have been used to support Environmental Plans approved by NOPSEMA for other geophysical and geotechnical seabed assessments completed offshore in Victoria (Otway and Bass Strait).

In terms of applicability of these assessments to the referral area, underwater noise modelling must take into consideration water temperature and salinity (sound travels faster in warm water and in more saline water), water depth (sound propagates further in deep water and depth of the water limits the lowest frequency of noise that can propagate, the deeper the water the lower the cut-off frequency). Because of this, propagated noise levels may be higher in deeper water for the same source and benthic geology (sound propagates further when hard seabed geologies are present). A key source of information used to support the assessment of geophysical noise impacts was a numerical estimation study of underwater sound levels associated with an Otway basin study in 2019 by JASCO Applied Sciences (JASCO) (presented in McPherson & Wood 2019). The results of this modelling are considered relevant to this referral given the similarities in water depth, seabed type, equipment modelled, and fauna groups potentially affected.

In terms of equipment, boomer and mini airguns were identified as most relevant to the assessment of potential noise impacts to receptors, due to their operating frequencies and sound source levels (Table Table 1-1). These devices were selected as they emit lower frequency sound than sparker, pinger, single-beam echo sounder (SBES) or multi-beam echo sounder (MBES) units and lower frequency sounds propagate further in seawater than higher frequency sounds of an equivalent power. As a result, it is expected that the effect ranges for sparker, pinger and echo sounder sources will be similar to those presented for the boomer and sub-bottom profiler (SBP) and well within the effect ranges for the mini-airgun. The effect ranges for the mini-airgun are the largest of all the sound sources and will be used as the basis for the design of control measures to ensure a conservative approach is applied.

3.1.1.1 Underwater noise modelling for representative geophysical investigations

In 2019 JASCO Applied Sciences (JASCO) performed a numerical estimation study of underwater sound levels associated with the Otway Basin Geophysical Operations proposed by Lattice Energy in the Otway Basin (presented in McPherson & Wood (2019)). The acoustic modelling evaluated the effects of sounds produced by three sources on marine fauna. The three sources considered in the modelling were a representative boomer and sub-bottom profiler (SBP) both towed at 3 m, along with a 450 in^3 airgun array (referred to as a vertical seismic profiler or VSP in McPherson & Wood 2019) operated at a centroid depth of 6 m.

The modelling approach taken by McPherson & Wood (2019) accounted for the acoustic emission characteristics of a representative boomer (AP3000) and SBP (Edgetech X-star system) both towed at 3 m depth and an array of 3 x Bolt 1900 LLX 150 in 3 airguns towed at a centroid 6 m depth. The boomer, SBP and airgun geophysical investigation sources planned for use had not been decided at the time of the modelling study, therefore JASCO chose commonly used representative systems for each source, with levels derived from previous JASCO field measurement campaigns of such sources.

As outlined above, sound propagation in the marine environment is influenced by temperature and salinity. For the study described by McPherson & Wood (2019) sound speed profiles were reviewed across all months of the year and September was selected as it represented conditions of maximum sound propagation.

3.1.1.2 Relevance of noise modelling to Spinifex Geophysical Investigations

Equipment selection

Due to the uncertainty associated with which investigation vessel will be contracted it is not possible for Spinifex to confirm the exact equipment that will be used during geophysical investigations for the Spinifex Offshore Investigations. This is a common issue in marine geophysical investigations due to the need for proponents to obtain regulatory approvals prior to contracting investigation vessels. A similar issue was encountered by Lattice Energy for the work described in McPherson & Wood (2019) and for that reason the noise modelling applied a representative sound source for modelling that would produce a similar sound profile to the eventual equipment used for the investigation. This is an industry standard approach in this situation (e.g. see also Beach Energy Environment Plan T-5200-75- RP-0009[1]).

McPherson & Wood (2019) modelled noise emissions from boomer and SBP units and a 450 in^3 airgun. These devices were selected as they emit lower frequency sound than sparker, pinger, SBES or MBES units and lower frequency sounds propagate further in seawater than higher frequency sounds of an equivalent power.

For this reason, the equipment modelled by McPherson & Wood (2019) represents a maximum impact scenario for the proposed Spinifex Offshore Investigations Project and is appropriate to inform the impact assessment given the similar equipment proposed.

Source levels

Source levels for the modelled equipment is expected to be representative of the source levels for the boomer, SBP, SBES and MBES equipment for the Spinifex Offshore Investigations. However, the source level for the mini airgun is considered to be very conservative given that the Spinifex offshore investigations would use a much smaller airgun (I.e. less than 45 in^3) compared to the much larger airgun modelled by McPherson & Wood (2019).

Environmental relevance

The propagation of noise through seawater is dependent upon a number of environmental factors as described above. The results of the McPherson & Wood (2019) modelling can be applied to the activity with confidence as the sound levels modelled by McPherson & Wood were:

- in deeper water and hence more likely to be an over-estimate in distance to noise effect criteria.
- based on a worst-case sound speed profile for the month of September.
- over similar seabed geologies (hard caprock and a shallow sand layer over increasingly consolidated calcarenite).

3.1.2 Geotechnical investigations

Underwater noise generated during the geotechnical investigations can be attributed to two sources

- underwater noise from geotechnical drilling and standard penetration testing; and
- vessel noise, in particular the use of Dynamic Positioning (DP), which is a system used to maintain a vessel's position by using its propulsion system.

3.1.2.1 Equipment selection

Due to the uncertainty associated with which investigation vessel will be contracted it is not possible for Spinifex to confirm the exact equipment or vessel that will be used during geotechnical investigations for the Spinifex Offshore Investigations.

Based on current market availability, vessel specifications have been assumed to be similar to the Fugro Mariner specific purpose DP2/Four Point Mooring 76m length geotechnical and scientific drilling vessel for deeper water geotechnical activities, or a smaller vessel for shallow geotechnical activities. Geotechnical

borehole drilling will require drilling via a frame (approximately 4m x 4m) positioned on the seabed. Borehole drilling proposed for the purposes of these geotechnical investigations is of a much smaller scale than typically undertaken for oil production and exploration well drilling.

3.1.2.2 Drilling Noise

Erbe and McPherson (2017) reported that "underwater noise from geotechnical site investigations was up to 35 dB above ambient levels at certain frequencies and hence likely detectable by various taxa of marine fauna." However, they also concluded that noise "levels were tens of dB less than those from production or construction operations and below levels commonly considered in marine noise regulations" and that "even small support boats with outboard engines can have broadband levels exceeding those of geotechnical drilling operations reported here".

The assessment considered underwater noise from geotechnical drilling and standard penetration testing measured broadband (30 Hz–2 kHz) geotechnical drilling noise and source levels of 145 dB re 1 µPa @ 1m for the Sideson II geotechnical vessel at Geraldton and 142 dB re 1 µPa @ 1m at James Price Point. The broadband (20Hz–24 kHz) Standard Penetration Test (SPT) source levels were 160 and 151 dB re 1 µPa @ 1m at Geraldton and James Price Point, respectively.

Expected Sound Exposure Levels (SEL) for the drilling documented in Erbe and McPherson (2017) were 128 dB re 1 µPa2s at 20m and between 131 and 140 dB re 1 µPa2s at 10 m range at James Price Point and Geraldton respectively. These levels are well below the accepted injury threshold criteria for low frequency cetaceans (refer to Table 3-1)

Based on the results outlined by Erbe and McPherson (2017), and given the greater size and depth of the drilling assessed in that study, it is expected that noise levels for the geotechnical drilling proposed for the Spinifex Offshore Investigations Project would be below 120 dB re 1 µPa (acoustic threshold at which continuous noise is predicted to cause behavioural disturbance to low frequency cetaceans (such as humpback whales, pygmy blue, sei and fin whales, per Southall et al. 2019) at a distance of 100 m from the source.

The sound emitted from the proposed geotechnical activities at the seabed (penetration tests and sampling boreholes) may be at levels that result in very localised behavioural effects to animals that are exposed within 100 m of the activity. However, these sound levels are well below those that may result in injury to marine fauna and are not expected to be significant or cause behavioural disturbance at a scale that could have any significant ecological effect.

It is also highly unlikely that Temporary Threshold Shift (TTS) effects to protected species of cetaceans will occur as individual animals are unlikely to remain within range of the investigation activities (i.e. within 100 m of the investigation vessel) for durations long enough for the relevant sound exposure threshold to be exceeded. The sound levels from the proposed geotechnical sampling drilling are typically not detailed in underwater noise assessments, as the noise level is relatively low compared to the continuous noise generated by an operating vessel (e.g. Beach Energy Offshore Gas Victoria Geophysical and Geotechnical Survey Environment Plan (EP) accepted by NOPSEMA 21 Dec 2023, EOG Beehive Pre-Drill Geotechnical Assessment EP accepted by NOPSEMA 30 Jan 2024).

Noise generated from the proposed geotechnical investigation activities will be minimized by implementing control measures in relation to vessel noise outlined below.

3.1.2.3 Vessel Noise

Vessel noise varies with the size, speed, and engine type. The sound characteristics and level from vessels can vary and are influenced by the activity being conducted by the vessel, for example, if it is idle, holding position using bow thrusters, or accelerating. However, the main source of underwater noise from a vessel (as a continuous noise source) is when using dynamic positioning (DP) thrusters to maintain position. The Spinifex Offshore Investigations referral area is in water depths of up to 75m. The vessel will utilize DP to remain stationary while drilling as a more effective and safer means of remaining stationary whilst conducting the geotechnical sampling/testing, versus anchoring.

Relevant noise threshold guideline values and their references are found in Table 3-1.

McCauley (1998) measured underwater sound levels while an offshore support vessel (OSV), similar to the Fugro Mariner, was transiting at 11 knots, and found the distance from the vessel to thresholds understood

to cause behavioural disturbance to LF-cetaceans (120 dB re 1 µPa, (Root Mean Square Sound Pressure Level or RMS SPL)) was approximately 1 km. However, when the OSV was holding its position using bow thrusters the 120 dB re 1 µPa noise level was exceeded out to approximately 3-5 km from the source (measured in 25 Hz to 10 kHz range). Source levels used for this study were 182 dB re 1 µPa at 1 m (RMS SPL) and 137 dB re 1 µPa at 405 m (RMS SPL).

McPherson et al. (2019) conducted the JASCO Browse to North West Shelf Noise Modelling Study which reports noise at thresholds thought to cause behavioural disturbance at 2.25 and 2.39 km from an OSV on DP in water 463 and 515 m deep. Distances to these same thresholds were assessed at 2.21 to 3.14 km in JASCO Woodside Browse to NWS Vessel Noise (Green et al. 2022) and at 2.29 km in JASCO Woodside Browse to NWS Vessel Noise Acoustic Modelling Phase 2 (Green et al. 2022) for similar activities.

Santos WA-437-P Geotechnical and Geophysical Survey Environment Plan estimated vessel noise using DP for a geotechnical study in north-west Western Australia in water depths of 86-94 m. For low frequency cetaceans, noise reached Sound Exposure Level (SEL_{cum}) thresholds for Permanent Threshold Shift (PTS) at 80 m, Temporary Threshold Shift (TTS) at 1.7 km, and Sound Pressure Level (RMS SPL) thresholds for behavioural disturbance at 7.5 km.

Beach Energy Offshore Gas Victoria Geophysical and Geotechnical Seabed Survey Environment Plan applied the results from JASCO modelling of DP vessels under various scenarios (Koessler and McPherson 2021 Appendix D and Stroot et al. 2022 Appendix E) to estimate noise impacts from their proposed survey. The modelling scenarios included stationary vessels on DP which would be equivalent or larger than the type of vessel that is proposed to be used to take the geotechnical samples proposed for the Spinifex Offshore Investigations Project.

Stroot et al. (2022) modelled underwater sound levels associated with the Yolla Drilling Program off Wilson's Promontory in Victoria (water depth 80m). The modelling scenarios included a stationary vessel on DP while undertaking re-supply activities to a platform. The results used in the assessment included underwater sound levels associated with the vessel on DP as well as noise sources from the platform itself, so was likely to be an overestimate of a standalone vessel on DP. Frequency weighted LF-cetacean SEL_{24h} PTS thresholds were reached at 110m, TTS thresholds at 350m, and the threshold for behavioural disturbance at 5.94 km from the activity. Koessler and McPherson (2021) modelled noise for an OSV under DP at the Thylacine location in the Otway basin in Victoria at ~100m water depth and found PTS thresholds were reached at 90m, TTS at 950m and behavioural disturbance at 7.1 km.

Encounters with marine fauna are possible during the geotechnical investigation, however the duration of the preliminary investigation is up to 8 weeks in a summer season and up to 20 weeks for detailed investigations in a subsequent summer season. These investigation durations will only overlap a small portion of biologically important periods for whales and the behavioural disturbance range of 2 - 7 km (based on representative modelling studies summarised above) for geotechnical vessel operations is small relative to the large areas available for feeding and migration. These temporal and spatial scales are relatively small when viewed in the context of the MNES Significant Impact Guidelines. For example, the criteria for a significant impact on migratory species would include seriously disrupting the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species. The noise range is generally within the observation range during clear conditions and when the observer is elevated, such as in the wheelhouse of a vessel (e.g., the human eye can see approximately 4.8 km for a person of average height at sea level), and binoculars will also assist.

Blue whales and southern right whales were the focus for the noise thresholds investigated above (i.e., LF cetaceans) as they are the most sensitive to noise disturbance, as reflected in the specific conservation actions identified in their recovery plans. Any potential impacts to LF cetaceans within the offshore investigation area are likely to be restricted to avoidance behaviour as the vessel moves through an area. Any injury to LF cetaceans is unlikely due to the small distance (<1 km) within which noise levels reach the noise effect criteria for PTS/TTS. Temporary avoidance constitutes no greater effect than the avoidance of other similar sized vessels that already operate in the Southern Ocean marine environment.

In order to manage the potential for behavioural disturbance from the vessel while using DP, in the event whales are present during the geotechnical investigation, further precautionary control measures will be implemented.

- An MMO will be on-board, and the MMO or a designated vessel crew member, trained in the environmental management for the project (EPBC Policy Statement 2.1 A.2) will maintain a watch for any whale on approach to the location at which geotechnical sampling is intended and a pre-start visual check for 30 minutes will also apply.
- If a whale is detected within the limits of visibility (as per PS 2.1 B.4), the vessel will change course and move to sample in a direction away from the cetacean so as not to encroach within the area that behavioural disturbance could occur.
- Night-time and low visibility controls will also be implemented (as per PS 2.1 A.3.6) whereby DP operations can only commence at night if operations were previously underway during the preceding 24 hours, the vessel has been in the vicinity (approximately 10 km) of the proposed start up position for at least 2 hours (under good visibility conditions) within the preceding 24 hour period, and no whales have been sighted.

Refer to Table 4-2 for an assessment of how the mitigation measures proposed align with the management procedures outlined in EPBC Act Policy Statement 2.1 – *Interaction between offshore seismic exploration and whales.* It is considered that the management measures proposed are sufficient to also minimize impacts to Medium Frequency (MF-) and High Frequency (HF-) cetaceans, fish, marine turtles and pinnipeds in the context of the MNES Significant Impact Guideline.

Table 3-1 Noise effect criteria and distances for investigation equipment on the identified sensitive receivers[1]

Receptor	Noise Effect Criteria Reference	Noise Effect Criteria Impulsive	Noise Effect Criteria Continuous	Mini airgun Maximum R_{max} Distance (m) [2]	Boomer Maximum R_{max} Distance (m)	SBP Maximum R_{max} Distance (m)	Vessel on DP Maximum R_{max} Distance (m)[3]
Fish (swim bladder): mortality/potential mortal injury	Popper *et al*. 2014	>207 dB PK[4] or 207 dB SELcum[1]	N/A	Not reached <40	1.6 Not reached	0.3 Not reached	N/A
Fish (swim bladder): recoverable injury	Popper *et al*. 2014	>213 dB PK or >216 dB SELcum[1]	170 dB rms (48HR)	Not reached <40	0.6 Not reached	0.1 Not reached	30
Fish (no swim bladder): mortality/potential mortal injury	Popper *et al*. 2014	>213 dB PK or >219 dB SELcum[1]	N/A	Not reached <40	0.6 Not reached	0.1 Not reached	N/A N/A

[1] Adapted from - EP reference: https://docs.nopsema.gov.au/A815062 Table 6-5, pg. 76- Impulsive acoustic noise effect criteria

[2] Adapted from - EP reference: https://docs.nopsema.gov.au/A672343 for cetaceans (based on exposure to 25 impulses of a much larger airgun array). The maximum distances for injury to fish for the mini airgun are based on modelled SPL PK levels.

Note: Very high frequency cetaceans have been removed from the table as they do not occur within the region. Continuous noise effect criteria are not available for turtle but given the likelihood of occurrence and management measures in place for LFC, the risk is considered low.

[4]dbPK relates to an instantaneous sound source

Section 5.2 pg. 35 – note that a 450 in^3 airgun array was modelled, vs the maximum of 45 in^3 mini airgun proposed for use during the Spinifex Offshore Investigations Project. The significantly larger modelled airgun would be much more powerful than the one proposed for use and would consequently represent a maximum impact scenario well in excess of actual expected effects.

[3] Adapted from offshore support vessel DP noise modelling from EP references: Upstream Controlled Document - General Template Aus (nopsema.gov.au) and https://docs.nopsema.gov.au/A1044228

Receptor	Noise Effect Criteria Reference	Noise Effect Criteria Impulsive	Noise Effect Criteria Continuous	Mini airgun Maximum R_{max} Distance (m) [2]	Boomer Maximum R_{max} Distance (m)	SBP Maximum R_{max} Distance (m)	Vessel on DP Maximum R_{max} Distance (m)[3]
Fish (no swim bladder): recoverable injury	Popper *et al*. 2014	>213 dB PK or >216 dB SELcum[1]	N/A	Not reached <40	0.6 Not reached	0.1 Not reached	N/A
Fish (swim bladder or no swim bladder); Temporary Threshold Shift (TTS)	Popper *et al*. 2014	>186 dB SELcum[1]	158 dB rms (12HR)	<738	Not reached	Not reached	110 - 130
Turtle: behavioural	NSF 2011 McCauley et al. (2000)	166 dB SPL 175dB SPL	N/A	1550 <900	36	Not reached	N/A
Turtle: mortality/potential mortal injury	Finneran et al. (2017)	>207 dB PK or 210 dB SELcum[1]	N/A	Not reached Not modelled	1.6 Not reached	Not reached 0.3	N/A
Marine mammals: behavioural	NMFS 2013 Stroot et al. 2022 Koessler and McPherson 2021	160 dB SPLrms	120 dB SPLrms	<2560	145	2	>1000 - 7100
Low-frequency cetaceans: Permanent Threshold Shift (PTS) (humpback, southern right, pygmy blue	NMFS 2018 Southall et al. 2019 Wood and McPherson 2019	219 dB PK 183 dB SEL_{24h}	199 dB SEL_{24h}	Not reached 72	Not reached Not reached	Not reached Not reached	90 - 110

Receptor	Noise Effect Criteria Reference	Noise Effect Criteria Impulsive	Noise Effect Criteria Continuous	Mini airgun Maximum R_{max} Distance (m) [2]	Boomer Maximum R_{max} Distance (m)	SBP Maximum R_{max} Distance (m)	Vessel on DP Maximum R_{max} Distance (m)[3]
whales, sei and fin whales)							
Low-frequency cetaceans: TTS (humpback, southern right, pygmy blue whales, sei and fin whales)	NMFS 2018 Southall et al. 2019 Wood and McPherson 2019	213 dB PK 168 dB SEL_{24h}	179 dB SEL_{24h}	No reached 1227	Not reached 10	Not reached 10	350 - 950
High-frequency cetaceans: PTS (dolphins)	NMFS 2018; Southall et al. 2019 Stroot et al. 2022	230 dB PK 185 dB SEL_{24h}	198 dB SEL_{24h}	Not reached <10	Not reached Not reached	Not reached Not reached	60 - 110
High-frequency cetaceans: TTS (dolphins)	Southall *et al*. 2019 NMFS 2018 Wood and McPherson (2019)	224 dB PK 170 dB SEL_{24h}	178 dB SEL_{24h}	Not reached <51	Not reached Not reached	Not reached Not reached	120 - 470
Phocid pinnipeds: PTS (seals)	NMFS 2018 Wood and McPherson (2019)	218 dB PK 185 dB SEL_{24h}	201 dB SEL_{24h}	Not reached <10	Not reached Not reached	Not reached Not reached	30
Phocid pinnipeds: TTS (seals)	NMFS 2018 Wood and McPherson (2019)	212 dB PK 170 dB SEL_{24h}	181 dB SEL_{24h}	Not reached 55	Not reached Not reached	Not reached Not reached	280

Receptor	Noise Effect Criteria Reference	Noise Effect Criteria Impulsive	Noise Effect Criteria Continuous	Mini airgun Maximum R_{max} Distance (m) [2]	Boomer Maximum R_{max} Distance (m)	SBP Maximum R_{max} Distance (m)	Vessel on DP Maximum R_{max} Distance (m)[3]
Otariid pinnipeds: PTS (seals)	NMFS 2018	232 dB PK	219 dB SEL_{24h}	Not reached	Not reached	Not reached	Not reached
	Wood and McPherson (2019)	203 dB SEL_{24h}		Not reached	Not reached	Not reached	
Otariid pinnipeds: TTS (seals)	NMFS 2018	226 dB PK	199 dB SEL_{24h}	Not reached	Not reached	Not reached	40 - 110
	Wood and McPherson (2019)	188 dB SEL_{24h}		Not reached	Not reached	Not reached	

3.2 Assessment and mitigation of noise against MNES with BIAs

Three marine species that may be directly impacted by underwater noise have a BIA that overlaps with the offshore investigation area; southern right whales (SRW) (*Eubalaena australis*); pygmy blue whales (PBW) (*Balaenoptera musculus brevicauda*) (a subspecies of the blue whale (*Balaenoptera musculus*)); and white sharks (*Carcharodon carcharias*).

Due to the metocean conditions within the offshore investigation area, site investigations may only be feasibly performed within the summer season each year from 1 November to 30 April inclusive. These investigations are not expected to overlap with the presence of southern right whales in the offshore investigation area but may overlap with the presence of pygmy blue whales and white sharks. Figure 3-1 details the timing, locations and type of behaviour demonstrated by the pygmy blue whale, southern right whale, and white shark, when the species are present within the offshore investigation area.

Common Name	Likelihood of occurrence	Behaviour	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Seasonal window for site investigations	N/A	N/A												
Eastern Indian Ocean pygmy blue whale	High	Possible foraging & Migration		Peak									Early	
Southern right whale	High	Aggregation/ Migration/ resting on migration			Early			Peak				Late		
White shark	Medium	Feeding	Possible					Less likely					Possible	

Figure 3-1 Timing, location and behaviour of MNES with overlapping BIAs

3.2.1 Southern Right Whale

Southern right whales (SRW) (*Eubalaena australis*) migrate annually from southern feeding areas in the sub-tropical front (below 40° S) to occupy calving areas along the southern Australian coast between mid-May and October (DSEWPAC, 2012). SRWs are thought to be solitary during migration or accompanied by a dependent calf or occasionally a yearling offspring (DSEWPAC, 2012). There is substantial movement along the coast indicating that connectivity of coastal habitat is important (Pirzl, 2008). The winter distribution of non-calving SRWs is unknown but may include offshore habitat where mating occurs.

Sightings of SRWs off the Victorian coast have been documented since 1985 by the Department of Environment, Land, Water and Planning (DELWP) and the State Wide Integrated Flora and Fauna Teams (SWIFFT) network as a part of the SRW South East Australia monitoring program (SWIFFT, 2022). Anecdotal sightings of SRWs have also been collated in the ALA and VBA databases, which collect and verify sightings made by third parties. There have been 4,129 records of SRWs in the ALA database (1942-2021) and 3,933 records in the VBA database (1970-2021). In southern Australian coastal waters, SRWs generally occur within 2 km of the coast (Kemper et al., 1997) and tend to aggregate in areas associated with suitable calving habitat (DSEWPAC, 2012; Ward et al., 2014). Emerging aggregation areas comprising small but growing numbers of non-calving whales that regularly aggregate for short periods of time have been identified in coastal waters off Peterborough, Port Campbell, Port Fairy, and Portland in Victoria. Off Portland, SRWs are typically sighted from May to September, however, the earliest sighting on record was 22 April 2006 and the latest sighting was 27 October 2010 (SWIFFT, 2022). There have been over 3,250 verified recorded sightings of SRWs along the Portland coastline since 1966 according to the ALA sightings database. Other incidental sightings in the Portland area through citizen science submissions over the previous two years recorded the first sightings as early as May and the last sightings for the season in late September. Most of the incidental sightings of SRWs occur from shore-based observers and sightings recorded tend to be within 500 m of the shoreline. SRWs may traverse the offshore investigation area as

they migrate into and out of the coastal zone, but due to the sighting data being predominately shore-based, this is currently unknown.

Increasing levels of anthropogenic noise at low frequencies (<1 kHz) may result in masking of marine mammal communication, echolocation and the sounds of predators, prey and the environment (Stone & Tasker 2006; Weilgart 2007; Clark et al. 2009; Erbe 2013; Rice et al. 2014). The risk of masking is especially acute for baleen whales, including southern right whales which specialise in low frequency calls (Clark et al. 2009).

It is very unlikely that the proposed investigations will overlap with presence of SRW as all investigations will be completed by the end of April at latest in every calendar year and the earliest arrival of SRWs yet recorded is 22 April, dating back to 2006. However, in the very unlikely event of temporal overlap, noise from the investigation- activities could lead to disturbance of mother/calf pairs. This could affect predator detection and mother/calf communication, two critical components of calf survival. In order to mitigate this, a suite of effective control measures will be in place to ensure any potential impacts to SRWs are minimised as far as practicable (Table 4-1).

3.2.2 Pygmy Blue Whale

The Bonney Upwelling is an upwelling region which forms off southern Australia from approximately Robe in SA to Portland in Victoria each year. The seasonal upwelling attracts a feeding aggregation of pygmy blue whales (PBW) (*Balaenoptera musculus brevicauda*) (a subspecies of the blue whale (*Balaenoptera musculus*)) which occupy the western area of the Bonney Upwelling from November/December each year and move towards Victoria during January to May (Gill et al., 2011; Gill, 2002). PBWs have been shown to prefer water depths of between 50 and 150 m within the Bonney Upwelling, with Gill et al. (2011) recording 78% of sightings within this range. However, sightings in Australia have been recorded in waters as deep as 1,548 metres (Gill et al., 2011). A PBW foraging BIA encompasses the offshore investigation area.

Classical upwelling plumes are regularly observed along the Bonney Coast between November/December and March/April. This is not the only upwelling in southeast Australia driven by the prevailing southeasterly winds, but it is the most prominent. The area is highly productive as a result of the upwelling and it is this productivity and the associated krill swarms that attract PBWs. Gill (2002) recorded 261 Blue Whale sightings from dedicated surveys, reports from fishermen and incidental records in the Bonney Upwelling, between 1998 and 2001. Whales were observed between December and May, and they were associated with surface swarms of coastal krill in 48% and feeding on krill in 36% of all sightings (Gill 2002).

Krill have on occasion been spotted in Portland Bay (Butler et al. 2002), with high densities of the species generally being associated with onshore surface currents and wind stress – when appropriate depth, bottom rugosity and upwelling conditions are present (Cimino et. al. 2020). Opportunistic sightings of blue whales are recorded in the SWIFFT database. Two blue whales were sighted at Cape Nelson on 4 May 2017, and a solitary blue whale was sighted off Portland on 4 May 2018 (SWIFFT, 2022). Anecdotal sightings of blue whales have also been collated in the ALA and VBA databases, which collect and verify sightings made by third parties. There are 112 records of blue whales in the ALA database (1977-2021) and 107 records in the VBA database (1970-2021).

Thirteen adult PBW were satellite tagged in the Bonney Upwelling region between January to March 2015 (Möller et al., 2020). Satellite tracking of these animals showed that four tagged whales travelled through the offshore investigation area throughout their migration (whales tagged in January and March), and a further two whales travelled in proximity to the offshore investigation area (whales tagged in January and February) (Möller et al., 2020). PBWs that travelled through, or in proximity to, the offshore investigation area did so during February to May, with an estimated time spent in the area of approximately 10 days (Möller et al., 2020).

McCauley et al. (2018) analysed acoustic data from underwater noise recordings off Portland from 2009 to early-2017 for blue whale presence. The logger that was used for the Portland site in this study was situated near the shelf, relatively close to the Bonney Upwelling approximately 40km south-west of the offshore investigation area, in water depth of 165m. The Portland region consistently had relatively high numbers of calling PBWs from January to July, with a peak presence between February and June (McCauley et al., 2018). In 2010 and 2011, PBWs arrived in November to December, while in other years they did not arrive until January or February. Some whales remained in the area till mid-June. The listening ranges for PBW calls at the Portland logger were estimated to span a maximum range of 353 km along the continental shelf from 139.0°E to 142.3°E, and a minimum of 88 km along the shelf from 140.7°E to 141.5°E.

The summary of available data above indicates that PBW are likely to be present within or adjacent to the offshore investigation area during at least part of the annual investigation window from November to April. In any case, there is a probability of disturbing foraging animals, in particular as a result of DP use during the geotechnical investigations unless control measures are implemented, as outlined in Section 3.1.2.3. A commitment to implement a suite of effective control measures that are aligned with EPBC Act Policy Statement 2.1 (Table 4-2) mean that the probability of disturbing foraging PBWs in the BIA is considered low.

3.2.3 White Shark

The white shark (*Carcharodon carcharias*) is listed as vulnerable under the EPBC Act and endangered under the FFG Act. The offshore investigation area overlaps two Biologically Important Areas (BIA) for this species, one each for distribution and foraging. The white shark is globally distributed in temperate and sub-tropical coastal pelagic waters. In Australian waters white sharks occur in coastal, shelf, and continental slope waters from the Montebello Islands in Western Australia, south around the coast to central Queensland (CSIRO, 2021). The main threats to white sharks are capture by fisheries and shark control programs, and evidence indicates a decline in the species' abundance in Australian and international waters (CoA, 2020).

Tracking data suggest that white sharks may spend extended periods in one area when food resources are available, but when these disperse, they make relatively rapid and directed movement away from such areas—presumably in search of other prey sources (Bruce 2006). Snapper (*Pagrus auratus*) are a common prey species for white sharks in southern Australia (Malcolm *et al*. 2001). Bruce (2006) described white sharks remaining in an area of eastern Victoria where snapper seasonally aggregate to spawn on coastal reefs and then leaving that area in autumn when the snapper were dispersing. In Australian waters, white sharks are reported to first start feeding on pinnipeds at approximately 2.7–3.0 m total length, although they continue to target elasmobranchs and finfish at all sizes (Malcolm *et al*. 2001).

Taylor et. al (2016) describe satellite tracking reported by Bruce *et al*. (2006) and Bruce and Bradford (2012) which suggests that, in general, white sharks appear to move north along the east coast from autumn to spring and return south during summer. This pattern is supported by the capture of white sharks by shark control programs in New South Wales and Queensland. Historical catches (1950–1993) show highest catch rates occur in New South Wales from May to November with a peak from September to November (Reid & Krogh 1992). Of the 100 white sharks caught by the NSW shark control program since 1990/91, 57 were caught in September and October (Green *et al*. 2009). Catches similarly peak in the Queensland program during September and October (Paterson 1990).It is presumed that the presence of white sharks in the offshore investigation area correlates with the presence of key prey species (being schooling finfish and Australian and New Zealand fur seal colonies). As a highly mobile, migratory predator impacts due to temporary disturbance while hunting would be expected to be easily offset by utilisation of another important nearby feeding ground at the Bonney Upwelling or other feeding grounds along the Victorian coast.

It should also be noted that white sharks do not have a swim bladder and primarily detect particle motion and not sound pressure, therefore white sharks are considered less sensitive to impacts from underwater noise (Popper *et al.* 2014). This is evidenced by the small effect ranges (< 40 m) for fish (no swim bladder) in Table .

Table 3-2 Assessment of impacts against Significant Impact Criteria

Significant Impact Criteria	Impact Assessment and Criteria Trigger
Wetlands of International Importance	
Areas of the wetland being destroyed or substantially modified.	***No impact*** There are no Ramsar wetland areas within or adjacent to the offshore investigation area.
A substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland.	***No impact*** There are no Ramsar wetland areas within or adjacent to the offshore investigation area.
The habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected.	***No impact*** There are no Ramsar wetland areas within or adjacent to the offshore investigation area.
A substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health	***No impact*** There are no Ramsar wetland areas within or adjacent to the offshore investigation area.
An invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland.	***No impact*** There are no Ramsar wetland areas within or adjacent to the offshore investigation area.
Critically endangered and endangered ecological communities	
Areas of the Giant Kelp Marine Forests of South East Australia ecological community being destroyed or substantially modified.	***Unlikely*** The Protected Matters Search Tool (PMST) identified that the Giant Kelp Marine Forests of South East Australia may occur within the offshore investigation area. Information from the Species Profile and Threats Database indicates that the potential for this ecological community to overlap the offshore investigation area is limited to shallow waters of the inshore section of the export cable route near Portland. It is not known to occur in this region but may occur based on potential presence of suitable substrate. Direct impacts from benthic habitat disturbance (e.g., drilling, coring, grab sampling) will be limited to small and defined areas of the seabed, and the introduction and establishment of IMS via marine growth or ballast water discharge is very unlikely as the investigation vessels will adhere to government biosecurity guidelines and management requirements (Table 4-1).
Areas of the Grassy Eucalypt Woodland of the Victorian Volcanic Plain ecological community being destroyed or substantially modified.	***No impact*** The Grassy Eucalypt Woodlands of the Victoria Volcanic Plain ecological community is terrestrial and the proposed geophysical and geotechnical investigations are marine-based.

Significant Impact Criteria	Impact Assessment and Criteria Trigger
Areas of the Natural Temperate Grassland of the Victorian Volcanic Plain ecological community being destroyed or substantially modified.	***No impact*** The Natural Temperate Grassland of the Victorian Volcanic Plain ecological community is terrestrial and the proposed geophysical and geotechnical investigations are marine-based.
Critically endangered and endangered species	
Lead to a long-term decrease in the size of a population	**Cetaceans** ***Unlikely*** The Protected Matters Search Tool (PMST) identified 14 cetacean species to potentially occur within the offshore investigation area, of which two are classified as endangered and two as vulnerable (see Table 2-1 and Table 2-2). These endangered species are the southern right whale (*Eubalaena australis*) which has an aggregation and known core range Biologically Important Area (BIA) overlapping the offshore investigation area, and the blue whale, more specifically the pygmy blue whale subspecies (*Balaenoptera musculus brevicauda*) which has an overlapping distribution and high use foraging BIA. The timing of the proposed action means there is a very low likelihood of encountering southern right whales or having any impact on this species. The vulnerable cetacean species are the fin whale (*Balaenoptera physalus*) and the sei whale (*Balaenoptera borealis*). These species do not have defined BIAs within or adjacent to the offshore investigation area but are known to occur in the area. The assessment below is focused on the two endangered species but the control measures set out in Table 4-1 will apply to all whale species. The risk of vessel collision with cetaceans is low due to the requirement of the investigation vessel to follow Part 8 of the EPBC regulations, which include requirements for: trained crew members to maintain watch for cetaceans, investigation vessel to maintain slow speeds less than 6 knots within the 300 m caution zone, and the investigation vessel to maintain minimum distance from any marine mammals (50 m for dolphin and 100 m for whales). The risk of entanglement for cetaceans is also considered low because the operation of the gear will employ best-practise environmental methods, including making sure that the equipment will not be used with slack lines and will always be tended. The impact from potential auditory masking from geophysical vessel noise is considered low, being temporary and localised as the vessels will be almost constantly moving during the activities and only stationary for short periods. The investigation vessel noise is not expected to be any higher than existing noise from shipping traffic within the region. There is inherent risk for cetaceans from the noise generated from the equipment used during investigation operations. However, previous modelling of acoustic survey equipment (Boomer, Sub-bottom Profiler) similar to that proposed to be used for the proposed geophysical surveys was carried out for a geophysical survey in the Otway Basin (McPherson et al. 2019). The study predicted for the Sub Bottom Profiler a temporary threshold shift (TTS; temporary reduction to hearing sensitivity) and permanent threshold shift (PTS; physical injury) range of less than 10 m horizontally from the noise source for marine mammals, and behavioural impact range of 2 m horizontally and 145 m for the boomer (McPherson et al. 2019). The model was accepted by the regulatory governing body the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) in July 2019. The source levels for the profiler are in the same range as proposed for this investigation. If a mini airgun is used these effect ranges will extend to approximately 2.5 km for behavioural disturbance but this distance is based on a much larger airgun and is well within effective visual detection ranges allowing for implementation of control measures in accordance with EPBC Policy Statement 2.1. Due to the very small noise impacted distances (less than 10 m up to 1.2

Significant Impact Criteria	Impact Assessment and Criteria Trigger
	km for TTS/PTS) and proposed control measures (Table 4-1), potential impacts to cetaceans within the offshore investigation area are likely to be restricted to vessel avoidance behaviour, without having a significant physical impact on either individuals or populations. Indirect impacts from benthic habitat disturbance (e.g., drilling, coring, grab sampling) will be limited to small and defined areas of the seabed, and the introduction and establishment of IMS via marine growth or ballast water discharge affecting cetaceans is highly unlikely as the investigation vessels will adhere to government biosecurity guidelines and management requirements (Table 4-1). The timing of the action avoids the main calving and aggregation period for the southern right whale and the BIA of the pygmy blue whale cover large spatial extents in comparison to the very small disturbance area (up to 2.5 km around the vessel). Considering the short duration of the offshore investigation (potentially approx. 7 months total across four investigations), any potential impacts are considered temporary and very localised to the area the vessels will be operating in. Cetaceans can immediately re-utilise the given area after the investigation vessel has moved on and so there is considered to be no long-lasting impact from the proposed investigation to the health of either individuals or the threatened species population, or their recovery. Behavioural impacts would also be very localised and temporary, unlikely to have a significant impact that would lead to a long-term decrease to the size of the population. **Pinnipeds** ***Unlikely*** The Protected Matters Search Tool (PMST) identified 3 pinniped species to potentially occur within the offshore investigation area, of which one is classified as endangered (Table 2-1). The endangered pinniped species is the Australian sea lion and although this species may occur in the offshore investigation area, the area is beyond the breeding range for this species, reducing the potential for impact. Considering the short duration of the offshore investigation (potentially approx. 7 months total across four investigations), any potential impacts are considered temporary and very localised to the area the vessels operating in. Pinnipeds can immediately re-utilise the given area after the investigation vessel has moved on and so there is considered to be no long-lasting impact from the proposed investigation to the health of either individuals or the threatened species population, or their recovery. Behavioural impacts would also be very localised and temporary, unlikely to have a significant impact that would lead to a long-term decrease to the size of the population. **Marine turtles** ***Unlikely*** There are three marine turtle species identified in the EPBC Act PMST as potentially occurring in the offshore investigation area, with two species classified as endangered (loggerhead turtle, *Caretta caretta*, and the leatherback turtle, *Dermochelys coriacea*). There are however no BIAs of important turtle breeding, foraging, nesting, or migration areas within the offshore investigation area as it is outside the foraging range for leatherback turtles and loggerhead foraging is opportunistic with no defined area - they are likely to forage anywhere in the Bass Strait. In terms of potential noise impacts from the investigation, the modelling study previously cited (McPherson et al. 2019) predicted TTS or PTS ranges of 1.6 m for turtles, and behavioural disturbance impact ranges for the boomer of 36 m. Vessel interactions and noise impacts have been identified as threats in the Recovery Plan for marine turtles in Australia (DoEE, 2017). However, given the extent of the investigation and its duration, these impacts are considered to be short-term, localised, and restricted to behavioural impacts (i.e.,

Significant Impact Criteria	Impact Assessment and Criteria Trigger
	avoidance behaviour) for individuals that may transit the offshore investigation area in close proximity (less than 40 m) to the acoustic source. Given that the offshore investigation area does not provide critical habitat for these endangered turtle species, the likelihood of encountering turtles is very low and likely to be transiting individuals, and the management measures to reduce potential impacts on cetaceans will likely benefit other marine species and reduce the magnitude of the impact, the risk of the proposed action leading to a long-term decrease in the size of the populations is considered low. **Fish** ***Unlikely*** There is one endangered fish species, the Yarra pygmy perch (*Nannoperca obscura*) identified in the EPBC Act PMST that may occur within the offshore investigation area. The Yarra pygmy perch is restricted to slow-moving freshwater areas for the entirety of its life cycle, so this species is not found within the offshore investigation area and would not experience any impacts. **Seabirds** ***Unlikely*** Five species of endangered seabirds have been identified as potentially occurring and/or foraging in the offshore investigation area: shy albatross (*Thalassarche cauta*), northern royal albatross (*Diomedea sanfordi*), grey-headed albatross (*Thalassarche chrysostoma*), southern giant-petrel (*Macronectes giganteus*) and Gould's petrel (*Pterodroma leucoptera leucoptera*) (Table 2-1). The offshore investigation area also fully overlaps the foraging biologically important area (BIA) of the shy albatross. Albatross and petrels can travel extremely long distances and cover large oceanic areas of the Southern Ocean, spending majority of their time at sea, especially during their non-breeding periods, generally coming back to land only to breed (ASOC, 2022). Their large ranges and high spatial and temporal availability of their prey make their distribution within their ranges extremely patchy (Green et al. 2020). While there are no breeding sites identified within, or in close proximity to the offshore investigation area, approximately 3 endangered albatross and petrel species have been reported on Julia Percy Island, likely roosting or foraging (Avibase, 2021). Due to the large range of the identified endangered seabird species and lack of breeding sites within the offshore investigation area, it is likely that the presence of these endangered seabirds within the offshore investigation area will only occur during the migration period and for short periods. Given that the direct impacts from the geophysical and geotechnical impacts are generally linked to underwater noise and seabed disturbance, the risk to these endangered species from investigation vessel operations is low, and hence unlikely to impact long-term population dynamics. Seabirds may be directly affected by vessel lights at night, however possible impact will be short term on an individual basis and standard controls will be implemented to reduce unnecessary exposure (Table 4-1). Indirect impacts to prey species that these species may be reliant upon are also considered to be unlikely, as seabed disturbance and changes in water quality are expected to be negligible. Therefore, the proposed investigation action or activities associated with the action will not lead to a long-term decrease in the size of an important population of endangered seabird species. **Shorebirds**

Significant Impact Criteria	Impact Assessment and Criteria Trigger
	Unlikely Two species of critically endangered shorebirds (the curlew sandpiper and the eastern curlew) and three species of endangered shorebirds (the Australian painted snipe, the Australasian bittern and the common greenshank) were identified as potentially occurring in the offshore investigation area. The threatened listed shorebirds (excluding the Australian painted snipe, Australasian bittern and the common greenshank) are migratory waterbirds who travel long distances along the East Asian-Australasian flyway, running between Australia and New Zealand up north towards Asia and the western parts of North America to forage and winter in Australia during the non-breeding season. It is possible that individuals may pass through the offshore investigation area on this migration, transiting across the Bass Strait between Tasmania and mainland Australia, or across the Tasman Sea between Australia and New Zealand to reach their wintering grounds (Bamford et al. 2008). Areas of wetlands and waterways, onshore from the offshore investigation area provide rocky intertidal shores, sandy beaches and mudflats, and are important coastal foraging and wintering habitats for shorebirds, with no known shorebird breeding sites within the offshore investigation area. Movements of these vulnerable shorebirds foraging along the coast are likely to be confined to inshore areas of the coast and the nearby sheltered wetlands. It is considered given the magnitude of the investigation activities and the lack of breeding sites in the area, vessel operations are unlikely to impact shorebird species. Prey resources are also unlikely to be impacted. Therefore, activities associated with the investigation action are not expected to lead to a long-term decrease in shorebird populations.
Reduce the area of occupancy of the species	***Unlikely*** It is unlikely that the proposed action will reduce the occupancy of critically endangered and endangered species given the duration and localised extent of the impacts predicted. The timing of the proposed action is outside of the primary calving period for the southern right whale and as a result interactions with this endangered whale species are very unlikely. Potential impacts to the endangered pygmy blue whale may include localised disturbance within their foraging BIA during the investigation due to vessel activity and noise impacts from the geophysical and geotechnical investigation methods. However, given the timing of the investigations, the small disturbance ranges predicted, the large area over which blue whales forage and the control measures adopted it is unlikely that this investigation will cause any reduced occupancy for these endangered species. The potential for impacts to endangered seabirds and shorebirds that could affect occupancy are not considered to be significant given the magnitude and duration of the impacts.
Fragment an existing population into two or more populations	***No impact*** The proposed action is of a short-term duration and as discussed earlier is unlikely to have a significant impact on either critical habitat or the population dynamics of the endangered species identified in this assessment. As such, no risk has been identified that would result in fragmentation of an endangered species population.
Adversely affect habitat critical to the survival of a species	The action does not overlap with any designated habitat critical to the survival of any species potentially affected.

Significant Impact Criteria	Impact Assessment and Criteria Trigger
Disrupt the breeding cycle of a population	***Unlikely*** There is an important calving area for southern right whales inshore of the offshore investigation area. However, the timing of the action has been designed to avoid overlap with the calving season. There are no known significant breeding areas or sites known within the offshore investigation area for any other critically endangered and endangered species identified. In addition, the disturbance from the investigation activities is temporary with recovery expected for such species. It is thus unlikely that the proposed investigations will disrupt the breeding cycle of these populations.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	***Unlikely*** As described above, the investigation will cause disturbance (from grab sampling, coring, and drilling) to a small, localised area of the seafloor at each proposed site. Given the vast spatial scale of the endangered species critical habitat, the investigation will not have a significant impact on critical habitat health to the extent to cause the threatened species 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	***Unlikely*** Vessels utilised during the proposed investigation action will: • Abide by the ballast water exchange guidelines defined by DAWR in the Australian Ballast Water Management requirements (DAWE, 2020), with no discharge of ballast water within 12 nautical miles of land. • Adhere to the requirements of the Australian biofouling management requirements (DAFF 2023) regarding the management of biofouling risks. Therefore, the introduction and establishment of invasive marine species through biofouling or ballast water discharge that results in impacts to endangered species is extremely unlikely.
Introduce disease that may cause the species to decline	***Unlikely*** The likelihood of introducing disease/s that may cause the identified critically endangered or endangered species to decline is considered highly unlikely given the magnitude of the investigations and the fact the vessels utilised by the investigation will be required to follow strict guidelines for IMS management, including in relation to ballast water and biofouling risk pathways.
Interfere with the recovery of the species.	***Unlikely*** The recovery plan for southern right whale identifies seismic surveys as a high risk for the recovery objectives for the species in the absence of mitigation. Given the proposed action is being undertaken outside of the known calving periods for the species, will not involve a high-volume airgun array and will be undertaken in line with Policy Statement 2.1, it is unlikely that the action will interfere with the recovery of the species. Although the southern right whale and pygmy blue whale may experience momentary disturbance from potential noise interference, their complete recovery is expected. Other potential risks, such as vessel collision with cetaceans, is considered low due to the requirement of the investigation vessel to follow EPBC and any other relevant government regulations to avoid close interactions with cetaceans. There is negligible threat concern for other MNES and therefore no considered interference with the recovery of the mentioned threatened species.
Vulnerable species	

Significant Impact Criteria	Impact Assessment and Criteria Trigger
Lead to a long-term decrease in the size of a population	**Cetaceans** ***Unlikely*** Two vulnerable cetacean species, Sei Whale (*Balaenoptera borealis*) and Fin Whale (*Balaenoptera physalus*), were identified in the EPBC PMST to potentially occur within the offshore investigation area. However, there are no known important populations off the coast of Portland, including the offshore investigation area, so it is unlikely that the investigations will lead to any long-term decrease in size of their populations. In addition, marine mammal observations will detect fin and sei whales if present and control measures aligned with Part A of EPBC Act Policy Statement 2.1 will apply to these species. **Marine turtles** ***Unlikely*** One vulnerable marine turtle species (Green Turtle, *Chelonia mydas*) was identified in the EPBC PMST to potentially occur within the offshore investigation area. There are no known important populations within the offshore investigation area, and it is likely to be a transitory species. Vessel interactions and noise impacts have been identified as a threat in the recovery plan for marine turtles in Australia (DoEE, 2017). However, given the extent of the investigation and its duration, these impacts are considered to be short-term, localised, and restricted to behavioural impacts (i.e., avoidance behaviour) for individuals that may transit the offshore investigation area in close proximity (less than 40 m) to the acoustic source. Given that the offshore investigation area does not provide critical habitat for this vulnerable turtle species and is well outside of nesting locations, the likelihood of encountering turtles is very low and likely to be transiting individuals. Further to this, the management measures to reduce potential impacts on cetaceans (e.g. soft starts) will likely benefit other marine species and reduce the magnitude of the impact, the risk of the proposed action leading to a long-term decrease in the size of the populations is considered low. **Fish** ***No Impact*** Two species of vulnerable fish were identified as potentially occurring in the offshore investigation area, the white shark (*Carcharodon carcharias*) and the Australian grayling (*Prototroctes maraena*). The Australian grayling spend most of their life within freshwater habitat, unlikely to be significantly impacted by the proposed action and therefore a significant impact on the population resulting in a long-term decrease is unlikely (DoE, 2014; DoE, 2022a). The white shark foraging BIA and three distribution BIAs overlap with the offshore investigation area. Within the BIA, white sharks may potentially experience localised temporary disturbance in close proximity to the investigation vessel from acoustic activities. However, noise is not identified as a key threat to their populations in the Recovery Plan for white sharks (DSEWPaC 2013). Additionally, the modelling study previously cited predicted a TTS (temporary reduction to hearing sensitivity) range of < 750 m and an injury range for fish with/without swim bladders of < 40 m (McPherson *et al.* 2019). However, these ranges are based on a much larger airgun than proposed for this action and actual ranges are expected to be substantially smaller. White sharks can reutilise the area immediately after the

Significant Impact Criteria	Impact Assessment and Criteria Trigger
	investigation vessel has moved on and any noise impacts as discussed are temporary and localised, therefore unlikely to lead to a long-term decrease in the size of a population or the breeding success. In terms of potential indirect impacts, benthic habitat disturbance will be minimal, only limited to small areas of seabed within the offshore investigation area. Vessels will be required to follow strict guidelines for ballast water and IMS management so the potential impact of IMS is unlikely. In summary, the investigation will not lead to a long-term decrease in the size of a population of the two identified vulnerable fish species in the offshore investigation area. **Seabirds** ***Unlikely*** Sixteen species of vulnerable seabirds have been identified as potentially occurring and/or foraging in the offshore investigation area, including eleven species of albatross, three species of petrel, the fairy prion and the Australian fairy tern (Table 2-1). Six of these species have large foraging BIAs covering the Portland region and overlapping the offshore investigation area. Albatross and petrels can travel extremely long distances and cover large oceanic areas of the Southern Ocean, spending majority of their time at sea, with no breeding sites identified within or in proximity to the proposed action site, though approximately 8 endangered albatross and petrel species have been reported on Julia Percy Island, likely roosting or foraging (Avibase, 2021). Fairy prions are known to nest and breed on Lawrence Rocks, (situated within the offshore investigation area) and Lady Julia Percy Island, (north of the offshore investigation area, however, due to the range, and migratory nature of these species, it is likely presence will only in small numbers and for short periods, off shelf edge areas where prey density is higher, and foraging is more likely to occur (Harris and Norman, 1981). Australian fairy terns exploit a range of coastal habitats (wetlands, beaches, islands) and nest on sandy substrates above the high-water mark (DoEE, 2022) and are likely to be confined to inshore areas of the coast and the nearby sheltered wetlands, though may traverse the offshore investigation area along the coast. As the proposed action is short-term (potentially approx. 7 months total across four investigations), the risk of exposure to the seabirds from investigation vessel operations is low. Seabirds may be directly affected by vessel lights at night, however possible impact will be short term on an individual basis and standard controls will be implemented to reduce unnecessary exposure (Table 4-1). Indirect impacts to prey species that these species may be reliant upon are also considered to be unlikely, as seabed disturbance and changes in water quality are expected to be negligible. Therefore, the proposed investigation action or activities associated with the action will not lead to a long-term decrease in the size of an important population of vulnerable seabird species. **Shorebirds** ***Unlikely***

Significant Impact Criteria	Impact Assessment and Criteria Trigger
	Five species of vulnerable shorebirds were identified as potentially occurring in the offshore investigation area, the Latham's snipe, the sharp-tailed sandpiper, the red knot, the great sand plover and the Eastern hooded plover. Areas of Lady Julia Percy Island lying adjacent to the offshore investigation area, and Portland Bay, Narrawong Coastal Reserve and the Yambuk Coastal Reserve, onshore from the offshore investigation area provide important intertidal and coastal foraging and nesting habitats for shorebirds. There are no known shorebird breeding sites within the offshore investigation area, though shorebirds foraging, nesting or breeding along the coastline may traverse the offshore investigation area. However, due to the short timeframe of the investigation and the lack of breeding sites in the area, vessel operations are unlikely to impact shorebird species. Prey resources are also unlikely to be impacted. Therefore, activities associated with the investigation action are not expected to lead to a long-term decrease in vulnerable shorebird populations. Shorebirds may be directly affected by vessel lights at night, however possible impact will be short term on an individual basis and standard controls will be implemented to reduce unnecessary exposure (Table 4-1).
Reduce the area of occupancy of the species	***Unlikely*** Six species of albatross (black-browed albatross, Antipodean albatross, Campbell albatross, Buller's albatross, wandering albatross and Indian yellow-nosed albatross) have overlapping BIAs (foraging) and the white shark has an overlapping foraging and three distribution BIAs with the offshore investigation area. However, the BIAs cover a large spatial extent, across the continental shelf waters of Victoria and Tasmania, with no identified aggregation sites within the offshore investigation area. Due to the large distribution ranges and lack of aggregation sites in association with the short duration of the proposed investigation actions and the lack of any permanent infrastructure, reduction in the area of occupancy of these vulnerable species and their BIAs is unlikely.
Fragment an existing population into two or more populations	***No impact*** Any potential disturbance/s from the investigation vessels and activities are temporary, localised and short-term, so the vulnerable species will completely recover and be able to re-utilise the area after the vessels have moved on. In addition, considering there is no fixed infrastructure being installed, the investigation will not permanently damage any critical habitat to vulnerable species and therefore is unlikely to advance fragmentation of existing populations.
Adversely affect habitat critical to the survival of a species	The action does not overlap with any designated Critical Habitat to the survival of any species potentially affected.
Disrupt the breeding cycle of a population	***Unlikely*** The offshore investigation area overlaps three distribution BIAs and one foraging BIA for the vulnerable white shark, however the Portland region is reportedly visited by juvenile white sharks, though the presence of a nursery area has not been confirmed (DCCEEW SPRAT database, accessed 15/4/24). CSIRO tracking of the movements of white sharks in southern Australian waters has not identified any nursery areas for the south-western Vic population (Bruce 2016). The Recovery Plan for white sharks (DSEWPaC 2013) does not identify noise as a key threat to their populations and the lack of a swim bladder or specialised hearing organs reduces their sensitivity to noise.

Significant Impact Criteria	Impact Assessment and Criteria Trigger
	Although they may experience some form of disturbance from the acoustic activities during operation, sharks can re-utilise the area immediately after the investigation vessel has moved on, so a full recovery is expected. Since the investigations are temporary and localised, of short duration, it is unlikely to significantly disrupt the breeding cycle of their population. There are no known breeding areas or nursery BIAs for any other vulnerable species within or near the offshore investigation area.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	***Unlikely*** As described previously, the investigation will cause disturbance (from grab sampling, coring, and drilling) to a small, localised area of the seafloor at each proposed site. Given the vast spatial scale of the identified vulnerable species habitat, the survey will not have a significant impact on critical habitat health to the extent to cause vulnerable species 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	***Unlikely*** Vessels utilised during the proposed investigation action will: • Abide by the ballast water exchange guidelines defined by DAWR in the Australian Ballast Water Management requirements (DAWR 2020), with no discharge of ballast water within 12 nautical miles of land • Adhere to the requirements of the Australian biofouling management requirements (DAFF 2023) regarding the management biofouling risks Therefore, the introduction and establishment of invasive marine species through biofouling or ballast water discharge that results in impacts to migratory species is extremely unlikely.
Introduce disease that may cause the species to decline, or	***Unlikely*** The likelihood of introducing disease/s that may cause the identified vulnerable species to decline is considered highly unlikely given the magnitude of the investigations and the fact the vessels utilised by the investigation will be required to follow strict guidelines for ballast water and IMS management.
Interfere with the recovery of the species.	***Unlikely*** The offshore investigation area overlaps two distribution BIAs and one foraging BIA for the vulnerable white shark and the Portland region is reportedly visited by juvenile Great White Sharks, though the presence of a nursery area has not been confirmed (DAWE 2010). CSIRO tracking of the movements of white sharks in southern Australian waters has identified no nursery areas associated with the south-western Vic population (Bruce & Bradford 2012). Noise impacts are not considered a threat to their populations (DSEWPaC 2013), and any impacts are going to only be localised to the immediate waters around the vessel and temporary. The investigation will not reduce the reproductive success and hence interfere with the recovery plans for this species. The negligible threat to other MNES means that there are no threats to the recovery of any other threatened species.
Migratory Species	
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	***Unlikely*** The PMST search of the offshore investigation area listed the following number of marine migratory species: • 20 seabirds, 10 shorebird species • Three shark species • Eight cetacean species • Three marine turtle species.

Significant Impact Criteria	Impact Assessment and Criteria Trigger
	For the migratory species not listed in the previous sections, there is no known critical habitat in the offshore investigation area. It is therefore highly unlikely the investigation will substantially modify, destroy or isolate an area of important habitat for any of these 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	***Unlikely*** Vessels utilised during the proposed investigation action will: • Abide by the ballast water exchange guidelines defined by DAWR in the Australian Ballast Water Management requirements (DAWE 2020), with no discharge of ballast water within 12 nautical miles of land • Adhere to the requirements of the Australian biofouling management requirements (DAFF 2023) regarding the management biofouling risks Therefore, the introduction and establishment of invasive marine species through biofouling or ballast water discharge that results in impacts to migratory species is extremely unlikely.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	**Cetaceans** ***Unlikely*** Eight cetacean species were identified as potentially occurring in the offshore investigation area, which was made up of six baleen whales, one odontocete whale and one dolphin species. Humpback whales (*Megaptera novaeangliae*), pygmy right whales (*Caperea marginata*), killer whales (*Orcinus orca*) and dusky dolphins (*Lagenorhynchus obscurus*) have not previously discussed in the above sections. These species may experience temporary disturbance during acoustic activities; however, recovery is expected following cessation of each investigation. The entanglement and collision risk between an individual cetacean and the investigation vessel is unlikely due to the temporary short-term nature of the investigation and the protocols that will be implemented if a whale is spotted (see above sections for further details). Therefore, it is highly unlikely this investigation will seriously disrupt the lifecycle of an ecologically significant proportion of the population of these migratory species. **Marine turtles** ***Unlikely*** There are no BIAs or habitat critical to the survival of migratory turtle species, which are unlikely to be encountered in the offshore investigation area. Therefore, it is highly unlikely this investigation will seriously disrupt the lifecycle of an ecologically significant proportion of their populations. **Fish** ***Unlikely*** Three species of migratory sharks were identified as potentially occurring in the offshore investigation area, including the shortfin mako (*Isurus oxyrinchus*), the white shark (*Carcharodon carcharias*), and the porbeagle (*Lamna nasus*). Beside the previously discussed white shark, the other two migratory species, the shortfin mako and porbeagle are both pelagic species with no defined BIA within the offshore investigation area. **Pinnipeds** ***No impact*** No pinniped species were listed as migratory in the offshore investigation area. **Seabirds and shorebirds** ***Unlikely***

Significant Impact Criteria	Impact Assessment and Criteria Trigger
	Ten species of migratory shorebirds were identified as potentially occurring in the offshore investigation area, including four sandpiper species, the Latham's snipe, the bar-tailed godwit, the far eastern curlew, the great sand plover, the common greenshank and the red knot. Twenty species of migratory seabird were identified as potentially occurring in the offshore investigation area, including thirteen species of albatross, two petrel species, three shearwater species, one swift species and one tern species. As the investigation is short-term (potentially approx. 7 months total across four investigations) and seabed disturbance will be localised, it is unlikely the prey resources of these species will be affected and have no impact on foraging ability.
Commonwealth Marine Areas	
Result in a known or potential pest species becoming established in the Commonwealth marine area	The offshore investigation area lies within both Victorian State and Commonwealth waters, extending from the shoreline offshore approximately 35 km, within the Otway region. The offshore investigation area sits within the South-east Marine Region which incorporates Commonwealth waters extending from near the far south coast of New South Wales, around Tasmania and as far west as Kangaroo Island in South Australia. It is probable that investigation vessels will transit to the offshore investigation area from the Port of {Portland. Introduction and establishment of marine pests has the potential to occur through marine biofouling on vessels or investigation equipment transiting between port and the offshore investigation area, and transport through ballast water discharge. Vessels utilised during the proposed investigation action will: • Abide by the ballast water exchange guidelines defined by DAWR in the Australian Ballast Water Management requirements (DAWE 2020), with no discharge of ballast water within 12 nautical miles of land. • Adhere to the requirements of the Australian biofouling management requirements (DAFF 2023) and Biosecurity Act 2015 regarding the management biofouling risks Therefore, the establishment of invasive marine species through biofouling or ballast water discharge in the Commonwealth marine area is extremely unlikely.
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	Direct physical impacts to habitats will be limited to localised seabed disturbance because of sediment sampling and boring; as (grab sampling coring drilling). - Anchoring and spudding of jack up rig. Avoid sites of significance to threatened species, no modification, destruction, removal isolation or decrease in availability or quality of habitat to the extent that a species is likely to decline.
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	***Unlikely*** The magnitude and duration of the proposed action is unlikely to have a substantial adverse effect on a population of a marine species or cetacean within the Commonwealth marine area.
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	***Unlikely*** Potential indirect effects from the proposed action include water quality impacts (e.g., vessel discharges, drilling operations – fluids/muds, incidental vessel spills) however these are short-term and localised. Possible effects would be localised to the vessel (discharge point; ballast water > 12 NM and routine dischargers > 3 NM) and the discharge would mix rapidly into the immediate waters.

Significant Impact Criteria	Impact Assessment and Criteria Trigger
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	***Unlikely*** The geotechnical investigations may require the use of drilling mud additives if conditions are difficult. Seawater is the primary constituent of geotechnical drilling fluids. Inert drilling fluid additives may be added to the seawater to form a water-based mud (WBM) if challenging boring conditions are encountered. Common WBM additives that may be used during the coring process include guar, bentonite and barite. VEA will specify that all drilling fluid additives are of low eco-toxicity, with only 'Gold'/'Silver' (CHARM) or 'D'/'E' (non-CHARM) OCNS-rated chemicals to be used. As such, the risk of persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment is considered unlikely.
Have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck.	***No Impact*** No known World Heritage Properties, National Heritage Places or Commonwealth Heritage Places were identified through the PMST within the offshore investigation area. One of the objectives of the geophysical investigations will be to identify unknown wreck sites, the location of which will feed into the planned locations for the geotechnical sampling point. Should a wreck or potential wreck be identified, geotechnical sampling points will avoid this area. Given the scope and magnitude of the proposed action, a substantial adverse impact on the heritage values of the Commonwealth marine area is not expected.

4 GEOPHYSICAL AND GEOTECHNICAL CONTROL MEASURES

This section sets out the proposed control measures for geophysical and geotechnical activities (Table 4-1) as well as an assessment of how the proposed mitigation and management measures for underwater noise align with the requirements of EPBC Act Policy Statement 2.1 (Table 4-2).

Geophysical equipment operates at significantly lower source levels than seismic arrays commonly used for petroleum exploration, and thus the resulting sound levels are proportionally lower at comparable distances. EPBC Act Policy Statement 2.1 was developed for seismic surveys with the aim of the policy to provide:

- Practical standards to minimise the risk of acoustic injury to whales in the vicinity of seismic survey operations.
- A framework that minimises the risk of biological consequences from acoustic disturbance from seismic survey sources to whales in biologically important habitat areas or during critical behaviours.
- Provide guidance to both proponents of seismic surveys and operators conducting seismic surveys about their legal responsibilities under the EPBC Act.

The geophysical investigation equipment with the greatest noise effect ranges is the mini airgun. Modelling adopted for the Spinifex Offshore Investigations referral was for an airgun volume of 450 in^3 and this is highly conservative given the highest volume that will be used for the Spinifex Offshore Investigations Project is 45 in^3. Despite this, modelling has shown that received noise levels and distances to noise effect criteria for geophysical investigations will be significantly lower than those for seismic surveys. In particular, modelling for a 450 in^3 airgun array resulted in a behavioural disturbance range for marine mammals of approximately 2.5 km and an approximately 1.2 km range for temporary threshold shift (TTS) in hearing for low frequency cetaceans (Table 4-2). The actual effect ranges for the 45 in^3 are expected to be smaller than these conservative estimates. In comparison, the TTS effect range for a seismic survey in the Otway Basin with a much larger airgun array was estimated to be 48 km[4].

Policy Statement 2.1 applies a sound exposure level of 160 dB re 1µPa2·s as a benchmark for determining the appropriate size of a low power zone, with surveys that can demonstrate this level will not be exceeded at 1 km from the source able to apply a smaller low power zone of 1 km. A low power zone is not relevant to the Spinifex Offshore Investigations as the entire investigation will be conducted at low power, i.e. single small airgun.

Despite the low power of the investigation equipment and the very small effect ranges relative to the seismic surveys that Policy Statement 2.1 typically applies to, Spinifex have committed to apply relevant standard Part A management measures as well as some Part B measures due to the overlap with biologically important areas for listed threatened whales (Table 4-1 and Table 4-2),

With regard to geotechnical noise, this assessment has found the sound emitted from the proposed geotechnical activities (e.g. borehole drilling) may be at levels that result in very localised behavioural effects to animals that are exposed within 100m of the activity. However, these sound levels are well below those that may result in injury to marine fauna and are not expected to be significant or cause behavioural disturbance at a scale that could have any significant ecological effect.

With reference to DP noise, encounters with marine fauna are possible during the geotechnical investigation, however the duration of the investigation is limited and the noise footprint according to the distance to behavioural disturbance thresholds reported from the modelling studies above can be predicted to be between 2 and 7 km from the geotechnical drilling/sampling. These temporal and spatial scales are relatively small when viewed in the context of the MNES Significant Impact Guidelines and the large areas over which noise sensitive species such as whales undertake biologically important behaviours. For example, the criteria for a significant impact on migratory species would include seriously disrupting the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species. The noise range is generally within the observation range during clear conditions and when the observer is elevated, such as in the wheelhouse of a vessel (e.g., the human eye can see approximately 4.8 km for a person of average height at sea level), and binoculars will also assist.

[4] https://docs.nopsema.gov.au/A700128

In order to manage the potential for behavioural disturbance that results from the vessel while using DP, in the event whales are present during the geotechnical investigation, further precautionary control measures will be implemented (Table 4-1).

Table 4-1 Proposed control measures for activities

Environmental Aspect	Potential environmental impact	Proposed management measures
Acoustic disturbance to cetaceans from geophysical investigation techniques	Potential physiological injury (temporary or permanent hearing threshold shift) or disruption to behaviour patterns of cetaceans	At least one dedicated Marine Mammal Observer (MMO) supported by sufficiently trained crew to maintain a watch for whales and implement standard management measures. A pre-start visual observation period of 30 mins will be applied out to 3 km with a particular focus on the 500 m shut-down zone prior to the start of the sub-bottom profiler (SBP) activity. A 500 m shutdown zone will be maintained around SBP once operational. This is consistent with Australian EPBC Act Policy Statement 2.1, “Interaction Between Offshore Seismic Exploration and Whales (2008)”. Policy Statement 2.1 also includes criteria for determining the appropriate size of a low power zone but this is not applicable to this action as the mini airgun (if used) will only be operated at low power, i.e. a single airgun. This is considered a conservative measure in reducing potential impacts from noise on marine fauna as geophysical investigations have much less of an impact on marine fauna than Oil & Gas seismic surveys, because the radiated power generated from an Oil & Gas seismic survey is significantly higher than what is generated from a geophysical investigation. Start-up delay procedure if whales are sighted within the 3 km observation zone. Night-time and low visibility controls will also be implemented (as per PS 2.1 A.3.6) whereby DP operations can only commence at night if operations were previously underway during the preceding 24 hours, the vessel has been in the vicinity (approximately 10 km) of the proposed start up position for at least 2 hours (under good visibility conditions) within the preceding 24 hour period, and no whales have been sighted. A recorded log of activities will be utilised to capture correct procedures, and to log sightings and actions.
Acoustic disturbance to cetaceans from geotechnical investigation techniques	Potential physiological injury (temporary or permanent hearing threshold shift) or disruption to behaviour patterns of cetaceans	An MMO will be on-board, and the MMO or a designated vessel crew member, trained in the environmental management for the project (EPBC Policy Statement 2.1 A.2) will maintain a watch for any whale on approach to the location at which geotechnical sampling is intended. A pre-start visual check for 30 minutes will also apply. If a whale is detected within the limits of visibility (as per PS 2.1 B.4), the vessel will change course and move to sample in a direction away from the cetacean so as not to encroach within the area that behavioural disturbance could occur. Night-time and low visibility controls will also be implemented (as per PS 2.1 A.3.6) whereby DP operations can only commence at night if operations were previously underway during the preceding 24 hours, the vessel has been in the vicinity (approximately 10 km) of the proposed start up position for at least 2 hours (under good visibility conditions) within the preceding 24 hour period, and no whales have been sighted. A recorded log of activities will be utilised to capture correct procedures, and to log sightings and actions.

Environmental Aspect	Potential environmental impact	Proposed management measures
Collision with marine fauna or entanglement	Injury or death of MNES marine fauna	Geophysical investigations and support vessels will not travel at greater than 6 knots within 300 m of a cetacean (caution zone). Geophysical investigation and support vessels will not approach closer than 50 m for a dolphin and/or 100 m for a whale (with the exception of animals bow riding). Watch maintained for marine fauna prior to deployment of wet equipment, with deployment delayed if entanglement risk is considered high. Buoys (including GPS transponder, lights) and automatic recovery devices will be attached to the SBP streamer (if used) to facilitate recovery in the event of loss and reduce entanglement risk. Recording installations will be maintained in a good state of repair, working order and condition, and no part of them will impede, interfere with or become a danger to marine fauna. All vessel strike incidents are reported in the National Ship Strike Database at https://data.marinemammals.gov.au/report/shipstrike All known or suspected cetacean injuries or death will be reported to the DCCEEW within 2 hours of the incident.

Vessel or equipment interference with, or displacement of, other marine users, including commercial and recreational fishing	Reduced access to commercial fishing grounds
	
	Displacement of commercially targeted fish species away from fishing grounds
	
	Reduced access for recreational interests/activities
	
	Entanglement of investigation equipment with fishing vessels
	
	Increased collision risk with other marine users
		Navigation:
		
		• Investigation vessel to maintain appropriate lighting, navigation and communication at all times to inform other users of the position and intentions of the investigation vessel, in compliance with the *Navigation Act 2012*, the International Regulations for Preventing Collisions at Sea 1972 (COLREGS), Chapter IV (Radio communications) and Chapter V (Safety of Navigation) of the International Convention on the Safety of Life at Sea 1974 (SOLAS).
		• Vessel navigational lighting and communication system managed in accordance with AMSA Marine Orders Part 30: Prevention of collisions, Part 21: Safety and emergency arrangements and Part 27 (Safety of navigation and radio equipment).
		• Continuous (24 hour) operations with trained crew (STCW95/Elements of Shipboard Safety), and monitoring of vessel position (radar) and depth at all times.
		• Investigation vessels will be equipped with Automatic Radar Plotting Aid (ARPA) and active Automatic Identification System (AIS) for detection of vessels, speed and heading.
		• Offshore structures, including any buoys or other floating installations, will be marked in accordance with guidance produced by the International Association of Marine Aids to Navigation and Lighthouse Authorities.
		
		Engagement and consultation:
		
		• A Consultation Plan will be developed by Spinifex and updated as required throughout the investigations. The Consultation Plan must include:
		  • The identification of key stakeholders and other affected parties
		  • Stakeholder and other affected party details

Environmental Aspect	Potential environmental impact	Proposed management measures

- Stakeholders and other affected party issues
- Action plans for dealing with issues raised
- Responsibilities for dealing with issues raised
- the Client's complaint management procedure
- actions taken for issue resolution of issues resolved
- outstanding issues for resolution.

- Conduct consultation and communication with local communities and stakeholders, e.g. fishing industry and undertake the investigations in a way that is respectful of local communities and the environment, and resolve community issues where possible.
- Participate in relevant community sessions, forums or meetings and support and facilitate site visits for media and stakeholders.

Notifications:

- Key stakeholders, including fishers and petroleum operators, will be notified four weeks prior to the start (or re-start) of the investigations, and will be notified on completion of the investigations.
- The following information will be submitted to the Australian Hydrographic Office (AHO) three weeks and three days prior to the commencement of an investigation, to support the Notice to Mariners. The notification shall include:
  - the estimated start and end dates of any works
  - the type of work to be carried out
  - location (latitude/longitude) along with any exclusion zones in force
  - details of vessels involved in operations
  - if installing buoys/lights, the positions, colour, shape and rhythm of the buoys/lights.

- AMSA's Joint Rescue Coordination Centre (JRCC) will be advised at the start and/or re-start (after suspension for the season) of the investigation vessel's details (including vessel name, call-sign and Maritime Mobile Service Identity (MMSI)), satellite communications details (including INMARSAT-C and satellite telephone), area of operation and requested clearance from other vessels. This information will be notified to AMSA JRCC 24 to 48 hours before operations commence via email address (rccaus@amsa.gov.au) or phone (1800 641 792 or +61 2 6230 6811)
- Vessel to provide daily investigation reports to AMSA JRCC unless fitted with suitable Automatic Identification System (AIS), where position tracking is automated and continuously monitored by AMSA.
- AMSA and AHO will be advised of the loss of large items of buoyant waste and lost equipment (potential navigational hazards).
- AMSA JRCC will be notified at the end of the investigation when operations have been completed and/or suspended (via email address (rccaus@amsa.gov.au) or phone: 1800 641 792 or +61 2 6230 6811).
- Upon completion of the investigations, notify the AHO of the positions of any installed equipment, so the AHO can update its charts.

Environmental Aspect	Potential environmental impact	Proposed management measures
Anchoring, positioning of drilling rig or lost equipment overboard results in seabed disturbance or impacts to shipwrecks or other infrastructure	Temporary smothering of a small area of seabed habitat Impacts on unmarked shipwrecks or other infrastructure creating navigation hazards for other vessels Providing “rafting” opportunities for marine species (including potential IMS).	• If anchoring is required, the location of anchoring and positioning of the drill rig will be selected to avoid significant habitat. • Known shipwrecks and infrastructure in the offshore investigation area will be marked on vessel navigation systems and actively avoided. • Develop and implement a pre-seabed disturbance inspection protocol to minimise the risk of impacting shipwrecks on the seabed. • Operational procedures will be in place onboard the vessel for deployment and retrieval of towed equipment on board. • A single short streamer (approx. 125 m in length) may be used as part of the SBP survey which will be equipped with a Streamer Recovery Device (SRD) designed to bring it to the surface if lost accidentally. • A lost streamer recovery procedure (including shallow water recovery e.g. by grappling) will be implemented onboard investigation vessel. • Lost equipment will be retrieved where possible. • Details of all items lost overboard will be recorded and reported to the Vessel Master. • Equipment brought onto the site will be removed on completion of the investigations.
Drilling boreholes results in seabed disturbance, impacts on water quality	Temporary smothering of a small area of seabed habitat Temporary effects of drilling fluids on water quality	Where practicable, drilling locations will be located to minimise the potential impact on significant habitats. Seawater is the primary constituent of geotechnical drilling fluids. Inert drilling fluid additives may be added to the seawater to form a water-based mud (WBM) if challenging boring conditions are encountered. Common WBM additives that may be used during the coring process include guar, bentonite and barite. Spinifex will specify that all drilling fluid additives are of low eco-toxicity, with only ‘Gold’/’Silver’ (CHARM) or ‘D’/’E’ (non-CHARM) OCNS-rated chemicals to be used.
Routine vessel discharges (sewage, grey water, putrescibles, deck drainage	Potential localised reduction in water quality through nutrient enrichment Secondary effects on marine life due to reduction of water quality (e.g. nutrient enrichment) Disturbance of marine habitats	Sewage/grey water: • Vessels will use compliant Sewage Treatment Plants (STP) in accordance with MARPOL 73/78 Annex IV (sewage): • Treated sewage discharged >3 NM from land or untreated sewage discharge >12 NM from land and at a speed of greater than 4 knots; OR • Retain all sewage for onshore disposal. • STPs will be maintained in line with manufacturers' specifications • Biodegradable wash down detergents will be used.

Environmental Aspect	Potential environmental impact	Proposed management measures
		Putrescibles: • All food scraps and other putrescible wastes to be handled, stored and disposed of in accordance with the vessel Garbage Management Plan (GMP), compliant with MARPOL 73/78 Annex V, and AMSA Marine Order 95: Marine Pollution Prevention – Garbage. • Vessels will use an organic waste macerator compliant with MARPOL Annex V. • Macerators will be maintained in line with manufacturers' specifications. • Food scraps macerated to particle size <25 mm and all putrescible wastes discharged >3 NM from nearest land and at a speed of >4 knots. • Unmacerated food scraps and other putrescibles wastes may be discharged >12 NM from nearest land and at a speed of >4 knots. • All non-food galley wastes will be bagged and transported ashore for recycling or disposal in accordance with the GMP. • All cooking oils and greases will be collected, stored appropriately onboard and transported to an onshore registered facility for disposal. • Each vessel to maintain a log of the mass of putrescible food waste discharged during each investigation. Deck drainage: • Drainage and discharge overboard managed in accordance with MARPOL 73/78 Annex I. • Drainage water from areas that may be contaminated with traces of oil (e.g. bilge and machinery spaces) will be treated in an Oil in Water (OIW) separator. • OIW separator shut off valve activates when concentration exceeds 15 parts per million (ppm). • Regular maintenance of OIW separator. • Recovered oil from the OIW separator will be returned to shore for disposal at a registered facility. • Bilge and machinery water with oil content of <15 ppm may be discharged via deck drainage anywhere at sea (except within port limits) as per MARPOL 73/78 Annex I. • Main deck drain scuppers will be closed in the event of a spill on deck. • Daily inspections to ensure deck areas are clean of spillages and accumulations of oil, grease and chemicals. Minor oil/lubricant spills will be mopped up immediately with absorbent materials that will be disposed of onshore as hazardous waste in accordance with the Shipboard Oil Pollution Emergency Plan (SOPEP). • All spills and leaks will be recorded and reported in Daily Report.
Disposal of solid and liquid hazardous and non-hazardous waste	Potential localised reduction in water quality through nutrient enrichment Minor, temporary effects on marine life due to reduction	Compliance with MARPOL 73/78 Annex V and have a vessel Waste Management Plan (WMP). • A WMP will be in place detailing wastes generated, waste storage requirements, and waste disposal requirements. • Solid and liquid hazardous and non-hazardous wastes will be collected and stored onboard prior to transfer onshore for recycling, disposal or treatment. • Waste handling equipment, waste storage containers, and closed bins appropriate to the type and volume of waste will be provided at waste storage areas. • Large, bulky items are securely fastened for the voyage intended to prevent loss at sea.

Environmental Aspect	Potential environmental impact	Proposed management measures
	of water quality Temporary disturbance or smothering of marine habitats	
Atmospheric emissions	Localised and temporary decrease in air quality due to emission of gaseous and particulate matter from marine gas oil or diesel combustion Contribution to the global greenhouse gas (GHG) effect.	Compliance with MARPOL 73/78 Annex VI and AMSA Marine Order Part 97: Marine Pollution Prevention – Air Pollution, where applicable to vessel class including: • investigation vessel will hold a valid International Air Pollution Prevention (IAPP) Certificate • only fuel that contains less than 3.5% m/m sulphur will be bunkered • investigation vessels only use Marine Gas Oil (MGO) or Marine Diesel Oil (MDO) grade fuel • vessels >400 gross tonnes must ensure that firefighting and refrigeration systems are managed to minimise Ozone Depleting Substances (ODS). • Incineration is only conducted when the vessel is >12 NM from the shore. • Oil and other noxious liquids and solids will not be incinerated. • Engines maintained according to maintenance schedule, to minimise emissions. • All refrigeration equipment will be maintained in accordance with maintenance procedures and no release of an ODS will be permitted during the investigations.
Artificial light emissions from vessels	Disorientation, attraction or repulsion of sensitive marine fauna (e.g. juvenile seabirds) Disruption to natural behavioural patterns and cycles, e.g. enabling nocturnal foraging and increased predation compared to unlit areas	• Vessel to maintain appropriate lighting, navigation and communication at all times to inform other users of the position and intentions of the investigation vessel, in compliance with the *Navigation Act* 2012 and Chapter 5 of the SOLAS Convention. • As per the National Light Pollution Guidelines for Wildlife (DCCEEW, 2023), non-essential lighting will be switched off when not in use and options to reduce unnecessary outdoor deck lighting on vessels (e.g. restrict lighting to those necessary for navigation and human safety) considered. • External lighting will be directed onto the deck, reducing light spill to the environment where practicable for safe operations.
Vessel operations result in the introduction and establishment of Invasive Marine Species (IMS)	Biofouling or ballast water discharge results in potential effects to seabed habitat and marine ecosystems due to:	Ballast Water: • Adherence to Australian Ballast Water Management Requirements (DAWR 2017) to meet the requirements of the Commonwealth *Biosecurity Act* 2015. • No discharge of ballast water from investigation and support vessels within 12 NM of land without prior authorisation from the Department of Agriculture, Fisheries and Forestry (DAFF).

Environmental Aspect	Potential environmental impact	Proposed management measures
	• competition with native species for resources, reducing native species diversity and abundance • habitat modification • predation on local species.	• Ballast water discharges recorded as >12 NM from land in Ballast Water Management Summary Sheet. • The vessel(s) (if arriving from international waters) will submit a Quarantine Pre-Arrival Report (QPAR) form to the DAFF between 12 and 96 hours prior to arriving and ballast water management summary logs will be confirmed by the DAFF prior to entry. • Maintenance of ballast water system in accordance with manufacturer's specifications. Marine Biofouling: Vessel compliance with Australian biofouling management requirements (DAFF 2023) including a biofouling management plan (BFMP) that meets the minimum standards of: •Most recent and next scheduled dry-docking dates •An operating profile (typical operating speed, in-service period, and typical trading routes and operating areas) •Description of hull and niche areas where biofouling is most likely to accumulate •A diagram of areas of potential biofouling accumulation on the vessel (i.e. general arrangement, docking plan, and internal seawater systems schematics) •Description and installation of anti-fouling systems (AFS) including the type of anti-fouling coatings and marine growth prevention systems •Inspection schedule including areas to be inspected, inspection frequency, and management actions •Cleaning schedule including methods, areas to be cleaned, and cleaning frequency •Monitoring of biofouling risk parameters and contingency plans •Capture of disposal of biofouling waste •Safety procedures for the vessel and crew •Crew training and familiarisation including a training register Furthermore, a biofouling record book (BFRB) will be maintained that meets the minimum standards including items of: •Cleaning activities •Inspections •Information regarding operations outside of expected operating profile specified in BFMP •Maintenance/service or damage to anti-fouling coating •Maintenance/service or downtime/malfunction of marine growth prevention systems Marine Order Part 98 (Anti-fouling systems). • Routine cleaning and inspection of submersible equipment (airgun array, streamers, tail buoys), consistent with the Australian biofouling management requirements (DAFF 2023).
Unplanned discharge of oils and chemicals to	Potential localised reduction in water quality resulting in	Compliance with MARPOL 73/78 Annex I and AMSA Marine Order

Environmental Aspect	Potential environmental impact	Proposed management measures
the marine environment from deck spills	potential localised chronic/acute toxic effects on marine fauna and flora	Part 91: Marine Pollution Prevention – Oil, including: • Investigation vessel holds a valid IOPP certificate, where required, under vessel class. • Vessel will have an approved and tested Shipboard Oil Pollution Emergency Plan (SOPEP), with crew to be trained in implementation of the SOPEP and use of clean up equipment. • Chemicals/oil wastes handling, storage and use carried out in accordance with the vessel SOPEP and WMP. • No refuelling undertaken at-sea. • All liquid chemicals and oils to be stored in bunded containers or areas and in accordance with MSDS. • MSDS' for all chemicals on-board vessel are available to all crew. • If used in the geophysical investigation, the SBP streamer will be solid or gel filled (not fluid filled). • Maintenance of hydraulic equipment in accordance with manufacturer's specifications. • Only small volumes of oil and chemicals will be kept on board. • High risk areas of deck (e.g. hydraulics) to be bunded or have some form of containment. • Oil content of any discharged water to be <15 ppm in accordance with MARPOL 73/78 Annex I. Appropriate spill response materials located in the vicinity of chemical stores/oily wastes and hydraulic deck equipment with crew instructed on their use. • Daily inspection of bunded areas and spill kits undertaken on all vessels. • Scupper plugs and drip trays available in the event of a deck spill. • Used absorbents contained onboard for onshore disposal.

Table 4-2 Assessment of how mitigation and management measures align with the management procedures outlined in EPBC Act Policy Statement 2.1

Policy 2.1 Management Measures	Compliance against Policy 2.1 Management Measures	Reference to Referral text
A.1.0 – Pre-Survey planning	Should it be necessary to conduct seismic surveys in areas where and when whales are known, or are likely to be migrating, then additional measures (see Part B Additional Management Procedures) to ensure that impacts and interference are avoided and/or minimised are necessary. Data collected from ongoing Visual Aerial Surveys will be used to inform planning for the investigation.	See Part B Additional Measures below. B.1.0 – B.6.0
A.2.0 – Trained crew	Sufficiently trained crew to implement standard management measures - using trained crew to maintain a watch for whales. In addition to trained crew, MMOs will be used – refer to B 1.0.	**Already adopted** see p. 61 and B.1.0 below
A.3.0 During Surveys	A 500 m shutdown zone will be maintained around SBP once operational.	**Already adopted** see p. 61 and Referral text Section 4.1.4.10
A.3.1 – Pre Start-up Visual Observations	A pre-start visual observation period of 30 mins will be applied out to 3 km with a particular focus on the 500 m shutdown zone prior to the start of the sub-bottom profiler (SBP) activity.	**Already adopted** see Referral text, Section 4.1.4.10
A.3.2 – Soft Start Procedure	Soft start procedures may not be applicable in this action because the total power output from the planned activities will not exceed the 'lowest power' of normal seismic survey activity. Policy 2.1 suggests that *... " Soft start procedures should be used each time the acoustic sources are initiated, gradually increasing power over a 30-minute period. Initiate soft start procedures by firing a single airgun. The preferred airgun to begin with should be the smallest airgun, in terms of energy output and volume. Additional acoustic source components should gradually be added in sequence until operating level is achieved."* It is not feasible to initiate a soft start procedure, as the action will be using the lowest setting possible that would usually be used for the Soft-start procedure.	**Not Applicable**
A.3.3 – Start-up Delay Procedure	Start-up delay procedure if whales are sighted within the 3 km observation zone.	**Already adopted** see Referral text, Section 4.1.4.10
A.3.4 – Operational Procedure	Operational procedures outlined in A 3.4. will be implemented. This includes a 500 m shutdown zone that will be maintained around Sub-bottom profiler (SBP) once operational. As set out in Table 4-1 above a low power zone is not relevant to this action as the sources are always operated at low power relative to a seismic survey with a large airgun array (typically greater than 2000 in^3).	**Already adopted** see pp. 61-62

Policy 2.1 Management Measures	Compliance against Policy 2.1 Management Measures	Reference to Referral text
A.3.5 – Stop work procedure	A 500 m shutdown zone will be maintained around SBP once operational as per the requirements in A 3.5.	**Already adopted** see p. 61 and Referral text, Section 4.1.4.10
A.3.6 – Night time and Low visibility	Investigation operations will only proceed at night if there have not been 3 or more whale instigated shut-down situations during the preceding 24 hour period. Investigation operations will only start up at night if: • there have not been 3 or more whale instigated shut-down situations during the preceding 24 hour period; or • if operations were not previously underway during the preceding 24 hours, the vessel (and/or a spotter vessel or aircraft) has been in the vicinity (approximately 10km) of the proposed start up position for at least 2 hours (under good visibility conditions) within the preceding 24 hour period, and no whales have been sighted.	**Night time procedures to be adopted**
A.4.0 – Compliance and Sighting reports	A recorded log of activities will be utilised to capture correct procedures, and to log sightings and actions.	**Logging of sightings and actions to be adopted**
B.1.0 – Marine Mammal Observers	The use of MMOs will be used if investigation timing coincides with a 'moderate to high likelihood' of encountering whales.	**Use of a dedicated MMO to be adopted**
B.2.0 – Night-time/ poor visibility	Adaptive measures, such as moving the vessel away from areas of high presence, will be considered should higher than expected levels of whale numbers be encountered. Consideration will be given to the use of technology, including but not limited to the use of infrared technology, to detect whales at night.	**Appropriate technology to detect whales during period of low visibility to be considered**
B.3.0 – Spotter Vessel and Aircraft	Due to the equipment that is planned to be used and the lower power output of the investigation methodologies, the maximum disturbance footprint from the acoustic survey activities for marine mammals is expected to be ~1km distance, therefore the use of MMOs will be able to identify any whales that may come into the vicinity of the disturbance zone without the use of aerial spotters or separate spotter vessels.	**Not applicable**
B.4.0 – Increased precaution zones and Buffer zones	The equipment and methodologies that will be used for this acoustic survey activity will be operating within a relatively low power setting, compared to seismic surveys, so an increased precaution zone or buffer zone which would include an increased low power zone (e.g. 3km) is not relevant to this type of investigation. The equipment and methodologies utilised are not anticipated to breach a disturbance zone outside of 1km from the investigation vessel.	**Not applicable**

Policy 2.1 Management Measures	Compliance against Policy 2.1 Management Measures	Reference to Referral text
B.5.0 – Passive Acoustic Monitoring	As a cetacean detection method, PAM has been used to detect whales that vocalise at high frequencies/intensities such as mid-frequency cetaceans (MFC) and high-frequency cetaceans (HFC) (e.g., sperm whales) and, in conjunction with visual monitoring, can enhance cetacean detection effectiveness. Passive Acoustic Monitoring (PAM) has the advantage of potentially detecting cetaceans during night hours and during periods of poor visibility when they cannot be visually detected. Although PAM can be a valuable tool in identifying the presence of cetaceans, the following factors limit its effectiveness: • Most suitable for MFC and HFC, which are generally of lower concern in this region compared to low-frequency cetaceans (LFC). It is difficult for PAM to pick up vocalisations of LFC such as pygmy blue whales and southern right whales. • Bearing accuracy and range estimation is limited because it is not as accurate as visual observations. The use of an experienced MMO negates the need for using PAM given that LFC (which surface to breath more regularly than deeper-water MFC and HFC) will generally be able to be easily detected. Night time and low visibility procedures will ensure that night time operations only occur when there has not been 3 or more whale instigated shut-downs in the preceding 24 hours.	**The use of MMOs to be adopted in lieu of PAM**
B.6.0 – Adaptive Management	If whale sightings are greater than expected such that the pre-start procedures have delayed investigation activities three times within a 24 hr period or the vessel has moved away from a whale or pod of whales three times within a 24hr period, then a review of the controls in place will be undertaken by the Activity Project Manager and Environment Advisor. This is to ensure that the implementation of an adaptive management process to continue to manage risks and impacts during the proposed activity.	**Adaptive management to be adopted**

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