Environmental Impact Statement/Environment Effects Statement

Appendix H

Marine ecology and resource use

MARINUS LINK

Marinus Link

Marine Ecology and Resource Use Impact Assessment

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Attachments

Attachment A: EPBC Act PMST Report for offshore Bass Strait, 2023

Attachment B: EPBC Act PMST Report for nearshore Victoria (Waratah Bay), 2023

Attachment C: EPBC Act PMST Report for nearshore Tasmania (Heybridge), 2023

Attachment D: Supplementary information: Underwater noise assessment, EGC 2023

Attachment E: Tioxide sediment analysis, Tetra Tech Coffey 2022

Attachment F: Commercial fisheries data, SETFIA 2022

Attachment G: Underwater Noise Modelling, MDA 2023

Attachment H: Technical Memorandum on additional EMF modelling, Jacobs 2022

Executive Summary

Background

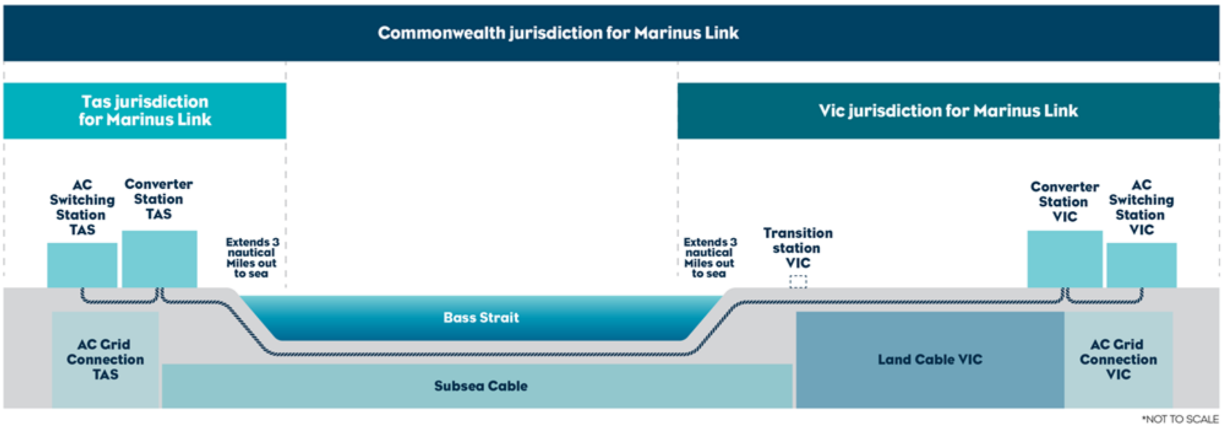
The purpose of this technical study is to describe the existing marine ecology and resource use of Bass Strait and to assess project impacts and propose environmental performance requirements to mitigate the impacts.

This report provides information and data in support of the approvals documents being prepared for the project, which are the Victorian/Commonwealth EIS/EES and the Tasmanian EIS. As such, it covers Victorian state waters, Tasmanian state waters and the Commonwealth waters between them. For clarity, this report will use the term 'EIS/EES' to refer to these approvals.

The report assesses the project's impacts during the construction, operation and decommissioning phases of the project.

Project description

Marinus Link Pty Ltd (MLPL) is proposing to build a high voltage direct current (HVDC) interconnector between Tasmania and Victoria that will be installed across Bass Strait. The HVDC interconnector will link the high voltage alternating current (HVAC) Tasmanian and Victorian electricity grids enabling energy transfer between the regions in the National Electricity Market (NEM). The major components of the interconnector are shown schematically in Figure 0.1.



Source: MLPL (2022).

Figure 0.1: Major components of the proposed Marinus Link

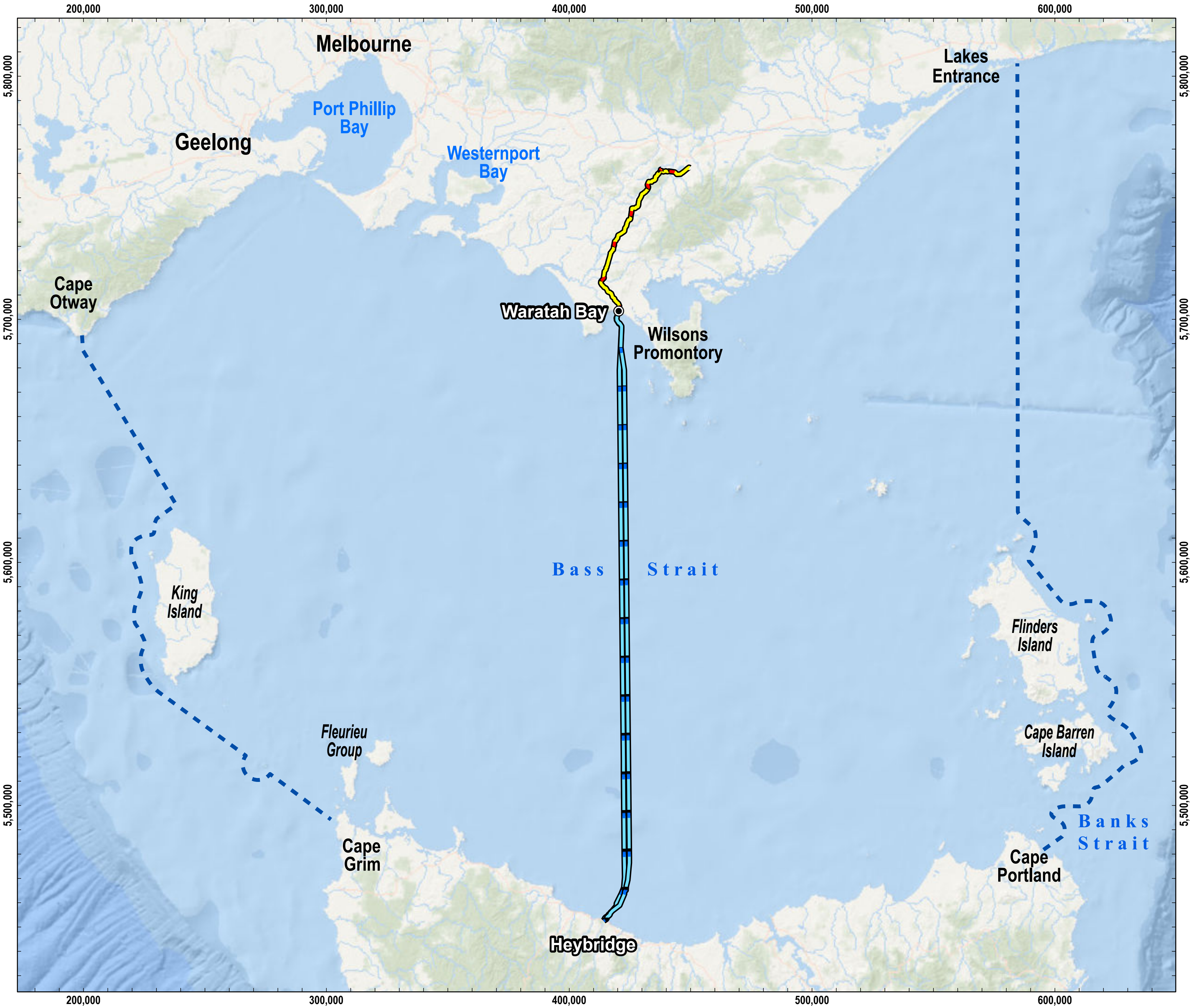
The proposed interconnector will be constructed as two symmetric monopoles, with each monopole having a capacity of 750 MW. Approximately 255 km of subsea HVDC cable is required to cross Bass Strait.

Project location and study area

Figure 0.2 shows the location of the project's proposed cable alignments between Heybridge in Tasmania and Waratah Bay in Victoria. The project area for describing the existing marine environment of Bass Strait is shown in Figure 0.3.

The study area is the total area needed to be able to sufficiently assess impacts to existing marine environmental and social values, within a suitable level of spatial context.

The study area is broader than the project footprint and immediate surrounds so that the regional context of environmental and resource values and impacts can be understood.



MARINUS LINK

LEGEND

Landfall

Proposed route

HVDC subsea cable

Underground HVDC cable

SOURCE
Proposed route from Tetra Tech Coffey.
Bass Strait boundaries indicative only.
Basemap from ESRI Online.

0 25 50 km

SCALE **1:2,250,000**

PAGE SIZE: **A4**

PROJECTION: **GDA2020 MGA Zone 55**

MARINUS LINK PTY LTD

MARINUS LINK
EIS/EES

FIGURE 0.2

Project Area for Bass Strait existing environment

TETRA TECH COFFEY

DATE: 16.05.24 PROJECT: 754-MELEN215878ML FILE: 215878ML_MERU_F002_GIS

EPBC Act Protect Matters Search Tool (PMST) areas

The EPBC Act Protected Matters Search Tool (PMST) was used to assess the presence of EPBC Act threatened species and ecological communities, listed migratory species and listed species within the existing marine environment. The search area was centred on the project's proposed cable alignments in nearshore Tasmania (15-km radius circle), central Bass Strait offshore waters (225 km long by 20 km wide oblong) and nearshore Victoria (10-km radius circle).

Notes: Yellow lines denote proposed alignments of Marinus Link (the project). White dashed lines denote the western and eastern boundaries of the study area within Bass Strait.

Figure 0.3: Study area for Bass Strait existing environment

Consultation

Consultation has been a key part of the project design and development as part of the environmental impact assessment process. Formal EIS/EES scoping requirements were provided by the Commonwealth, Tasmanian and Victorian governments. In addition to the formal scoping process, there have been meetings, communications, and dialogue with the local communities, including key stakeholders such as commercial fisheries. These consultations are continuing and will be reported in the EIS/EES.

Assessment approach

The approach to impact assessment has been based on identifying credible impact sources and impact pathways to sensitive marine biological values, as well as to marine resource use. Identification of impact pathways during construction, operations, and decommissioning were based on scientific literature reviews of the long history and experience gained in the installation, operation, and decommissioning of HVDC power transmission cables within the marine environment.

The assessment of impacts was based mainly on a significance assessment method, which allowed impact significance ratings to be determined based on the sensitivity of an environmental value or receptor and the magnitude of the impact on that environmental value or receptor. In addition, qualitative risk assessments were undertaken to assess the risk of harm from a potential marine invasive species becoming established in the Commonwealth marine area and for project vessel collision risks with other vessels or marine megafauna.

The impact assessment criteria used in this report's significance assessment method and qualitative risk assessment method are consistent with the significant impact criteria for various MNES included in the Matters of National Environmental Significance – Significant impact guidelines 1.1 (DoE 2013).

Key findings

The key findings of this report are presented below for project construction, operation, and decommissioning.

Construction impacts

The principal construction-related potential impacts on marine ecology were found to be associated with seabed disturbance (e.g., impacts on water quality, seabed habitats and associated benthic biological communities), and underwater noise effects on marine fauna (acoustic physiological damage or disturbance impacts, behavioural impacts, and the impacts of acoustic auditory masking of biologically relevant sounds and communications to noise-sensitive marine fauna).

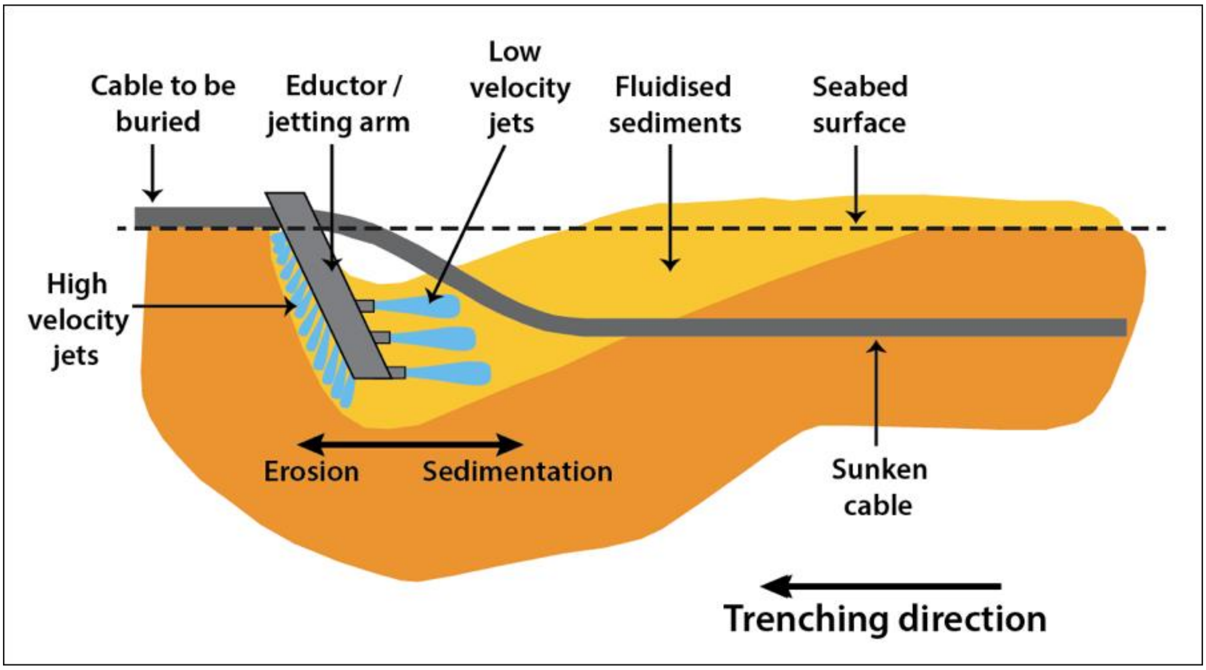
Shore crossing impacts

The cable crossings of the Tasmanian and Victorian coastlines will be achieved using long trajectory horizontal direction drilling (HDD) borehole ducts in which the cables will be pulled to the onshore jointing pits. An environmental performance requirement is proposed to monitor HDD activities for the shore crossing to avoid impacts to the marine environment. Therefore, no impacts are predicted on beach morphology, coastal processes, or beach habitats and associated intertidal flora and fauna.

Seabed disturbance impacts

Seabed disturbance impacts will arise during pre-lay grapnels runs and cable installation and burial operations. The impacts of pre-lay grapnel runs are not significant and generate similar seabed disturbances as bottom trawled fishing gear or scallop dredging scars and are not considered further.

The principal seabed disturbance impacts are associated with the post lay burial of cables laid on the seabed. The method of cable installation burial is based on using a jet trencher fitted with burial tools. Figure 0.4 shows a schematic diagram of the cable installation and burial by jet trencher.



Source: Adapted from Njock et al. (2020).

Figure 0.4: Example of cable installation and burial method

The jet trencher will bury the cable by fluidising the sediment around the cable, which sinks by its own weight to the nominal 1 m burial depth for cable protection against anchor or bottom fishing gear hook-ups. Deeper burial to 1.5 m is not materially relevant in terms of potential impacts to marine ecology, as the width of the footprint is more important than the depth.

Seabed disturbance impacts primarily concern soft seabed sediments, which make up the majority of the project alignment. There are very few areas of hard seabed to be traversed by the cables. However, there a few small areas where the depth of the soft seabed sediment is less than the required nominal cable burial depth of 1 m. In these cases, the cable will be buried to the extent practicable in the sediment and then capped with a rock mattress to provide the required depth of cover for protection against anchors and bottom-trawled fishing gears.

Environmental performance requirements are proposed to locate subsea cables to avoid and minimise impacts on benthic habitats and to complete a pre-lay survey prior to subsea cable installation to minimise seabed disturbance. Measures will be implemented to manage the release of contaminated sediments during construction activities (e.g., wet jetting operations) in the palaeochannels and their sand-gutter extensions in the Tasmanian nearshore and offshore waters where potential seabed contamination exists.

Depending on the final crossing designs for the Telstra and Alcatel telecommunication cables, there might be a slightly increased project footprint on the seabed at these specific locations. This is because articulated concrete mattresses or a similar form of cable protection might be required which, once installed, will occupy an area of seabed equal to the width and length of the concrete mattress/cable protection. This potential increase in footprint is in the order of the tens of metres and therefore considered to be negligible in the context of the project. The exposed surfaces and voids of the concrete mattresses will create a new hard surface substrate on an otherwise soft sediment seabed and provide structure that is important for some benthic species and fish. Residual impacts to water quality and seabed were assessed as ranging from ***Low*** to ***Very low*** due to the project cable crossings of existing seabed infrastructure.

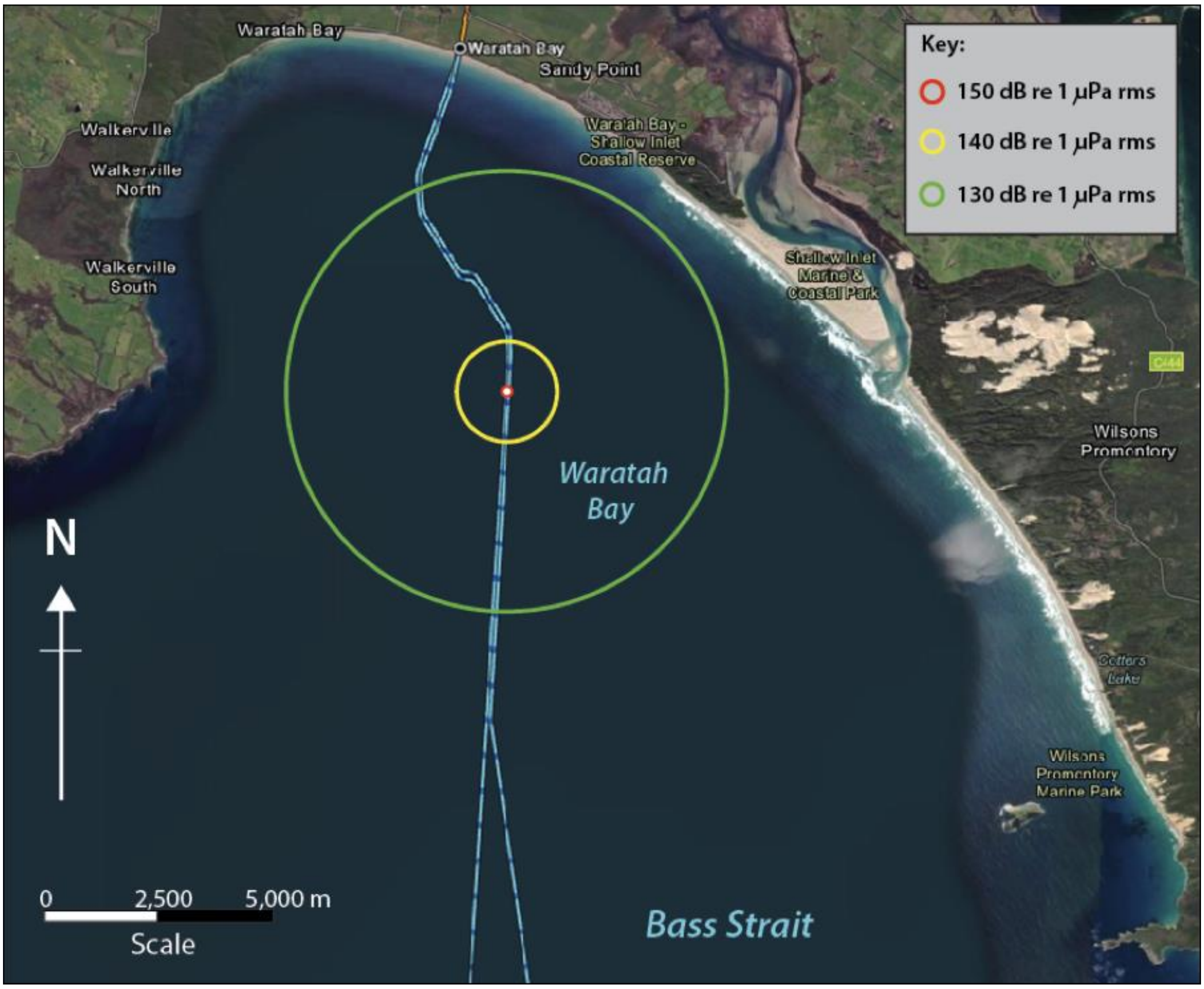
This report has assessed that all seabed disturbance impacts to water and sediment quality, seabed habitats and associated benthic biological communities are short-term and recoverable, with the assessed residual impact significant ratings all being between ***Low*** and ***Very low***. The general findings of low to very low impacts from cable installation and burial agrees with the findings of other HVDC interconnector projects such as the Basslink interconnector (CEE, 2009; Sherwood et al., 2016). Based on the results of a series of environmental monitoring campaigns, observations of impacts from Basslink showed no significant long-term impact on the seabed from the placement of subsea cables across Bass Strait and the authors concluded that the ecological effects of the cable installation and burial on benthic communities have been transient and minor for soft sediments where the cable is buried.

Underwater noise impacts

An underwater noise impact assessment was undertaken to assess underwater noise generated by marine construction activities (e.g., cable installation and burial using jet trencher) and the construction associated vessels (e.g., cable lay ship, tender vessels and offshore supply vessels). Underwater noise modelling was undertaken to calculate the propagation distances to acoustic threshold criteria for noise-sensitive marine fauna.

In this assessment, the loudest identified noise source was the cable lay ship maintaining location using its thrusters under dynamic positioning (DP) control. The cable lay ship has an estimated underwater noise source sound level of 185 dB re 1 microPascal (µPa) at 1 m and was used as a worst-case scenario. The underwater noise modelling allowed calculation of the sizes of zones within which acoustic physiological damage, acoustic disturbance, and behavioural impact could occur.

Figure 0.5 illustrates an example of the acoustic zones surrounding the cable lay ship during cable laying at a location in Waratah Bay.



Notes: Blue dashed lines are the ML1 and ML2 bundled cables. White dot = cable lay ship and underwater noise source level. Coloured rings represent selected isopleths that can be shown at the scale of the map. Dashed blue lines denote the proposed alignments of the western and eastern monopoles of the project.

Figure 0.5: Distance to isopleths around the cable lay ship during cable lay

The report assessed that no mortality of noise-sensitive marine fauna is predicted, which is principally due to the non-impulsive, continuous broadband noise generated during construction in contrast to impulsive noise sources such as marine seismic survey airguns or impact hammer pile driving, which will not be present on this project.

Environmental performance requirements are proposed to implement a marine fauna management plan and measures to minimise impacts on marine fauna due to noise by avoiding and managing interactions with sensitive fauna.

All the predicted underwater noise impacts on noise sensitive fauna such as most cetaceans, pinnipeds (true and eared seals), sea turtles, little penguins, fishes and marine invertebrates were assessed to have impact significance ratings of between ***Low*** and ***Very low***.

Potential permanent hearing damage to high frequency (HF) cetaceans

This report assessed that there is a potential for acoustic damage to high-frequency hearing (HF) cetaceans in the form of permanent and irreversible hearing loss when using the NMFS (2018) non-impulsive noise cumulative sound exposure level (SEL_{cum}) threshold of 173 dB re 1 µPa^2·s for onset of a permanent threshold shift (PTS) in HF cetacean hearing. NMFS recommends a maximum accumulation period of 24 hours for a stationary receptor (e.g., an HF cetacean) that maintains a constant distance from a stationary noise source, which is a most unlikely scenario. In the case of the cable lay ship during cable lay operations, the noise source is classified as a moving source. For example, at the cable lay ship's speed of 1.5 knots (46.3 m/minute), the ship will have moved on by 2.78 km after one hour. Consequently, noise exposure will change location over time with the greatest rate of noise accumulation at closest point of approach. NMFS (2018) acknowledges that there may be specific exposure situations where this accumulation period requires adjustment (e.g., if activity lasts less than 24 hours). This is the case for the present project in that the cable lay ship is a moving noise source, so a shorter cumulative period is more appropriate.

MDA (2023; Attachment G: Underwater Noise Modelling) selected a shorter cumulation period of one hour to assess cumulative sound exposure level impacts on permanent hearing loss of HF cetaceans but which still resulted in an impact significance rating of ***Moderate***. This is a weakness of the above NMFS (2018) acoustic threshold criterion, which requires a receptor (e.g., an HF cetacean) to remain stationary or at a constant distance from the noise source, which is an unlikely scenario. In reality an HF cetacean approaching the cable lay ship will pass through and simultaneously detect the underwater noise gradient surrounding the cable lay ship and, under these conditions, a HF cetacean is unlikely to approach close to the ship.

Overall, while an impact assessment significance rating of ***Moderate*** has been assessed for hearing damage (as measured by permanent threshold shift (PTS) onset) to HF cetaceans, this is most unlikely to occur under the one-hour cumulative exposure period, as an HF cetacean is unlikely to remain stationary or swim at a constant distance from the cable lay ship as it transits Bass Strait. Furthermore, free-ranging and highly mobile HF cetaceans will detect the underwater noise gradient surrounding project marine concentration vessels and, as such, are not expected to closely approach the construction vessels. In the case of a HF cetacean moving away or 'fleeing' from the cable lay ship noise source, rather than remaining stationary or at a constant distance from the cable lay ship, the PTS onset distance is less than 1 metre (Nedwell et al., 2012; Sweeny, 2018; Subacoustech, 2021a,b), which is assessed to have a residual impact significance rating of ***Low*** rather than ***Moderate***.

Artificial lighting impacts

Artificial lighting from project vessels has the potential to affect nighttime light-sensitive marine and terrestrial migratory birds and in-water fauna.

Measures will be implemented to minimise artificial lighting on vessels in alignment with Australia's National Light Pollution Guidelines for Wildlife, Australian and New Zealand Standard AS/NZS 4282:2019 Control the obtrusive effects of outdoor lighting. Measures will recognise the impact of artificial light on living organisms, and EPBC Act Policy Statement 3.21 – Industry Guidelines for avoiding, assessing and mitigating impacts on EPBC Act (Cwlth) listed migratory shorebird species (DoEE, 2017d).

This report assessed that the predicted night-time lighting impacts on marine birds (e.g., nocturnal marine birds or migrating terrestrial birds) and marine fauna all had impact significance ratings of ***Low***.

Impacts of introducing or translocating of invasive marine species

This report has assessed the likelihood of introducing or translocating existing or new invasive marine species (IMS) presents a low risk, given strict adherence to environmental protection requirements and specific mitigation measures that will be put in place to reduce the potential for introduction or spreading of IMS. An environmental performance requirement is proposed to develop and implement a plan to avoid the introduction of invasive marine species that aligns with requirements from Australian and International ballast management and biosecurity requirements and guidelines. This will include a ballast water management plan.

Impacts of marine fauna collision with construction vessels

During movement of construction vessels there is a risk of colliding with marine fauna, resulting in injury or death. This risk was considered to be low. This is because most of the construction vessels move at slow speeds (i.e., less than 2 knots) and construction will not be in high-risk areas such as calving and foraging areas. Further, during typical cable laying there will typically be three vessels present, which is a very small number compared to the existing 50 vessels/day that regularly transit the project area and Bass Strait. Implementation of the fauna management plan and cetacean interaction plan will reduce the risks of collision by conducting visual inspections ahead of vessel movements and maintenance of caution zones.

Marine resource use impacts

Residual impacts on marine resource uses have been assessed to have impact significance ratings of between ***Low*** and ***Very low***. In terms of impacts to navigation and marine traffic, temporary exclusions zones will be required around the cable lay vessel during cable lay operations and around the offshore support vessel during cable installation and burial operations. In general, ships' navigators and the skippers of smaller vessels will adjust their planned routes to deviate around the project's construction vessels that will have restricted movement. The location, timing and duration of the temporary exclusion zones will be presented as 'Notices to Mariners', which alerts other maritime users of the restricted manoeuvrability of project vessels undertaking marine construction or decommissioning activities. At the completion of construction, MLPL will inform the Australian Hydrographic Office (AHO) and DEECA of the locations and coordinates of the project cables. This will enable the AHO to publish Notices to Mariners to inform maritime users of the presence of seabed power cables and mark them on navigation charts. It is anticipated that the project will not require exclusion zones over the project's subsea cables during operations as they will have been buried to a nominal depth of 1 m or more for protection against anchor and trawling gear hook-ups.

During power transmission, the project's HVDC cable magnetic fields have the potential to cause interference with shipboard magnetic compasses. Ships and vessels not equipped with GPS may rely on magnetic compass readings for navigation and localised disturbances in the geomagnetic field can disrupt the accuracy of the compass reading. In general, the deeper the water the lesser the compass deviation effect, and conversely, the shallower the water the greater the compass deviation effect. Therefore, transient magnetic compass deviations are only expected when a vessel with a magnetic compass passes directly over the HVDC cables in nearshore shallow waters. It is expected that any transient magnetic compass deviations on vessels transiting near the shoreline are very unlikely to impact navigation or safety as visual navigation will assist longshore transits.

Commercial fishery resources (e.g., targeted fish, squid, abalone and shellfishes) are not predicted to be impacted, since the project's impacts on marine fauna, which includes targeted fish and shellfish species, were assessed to have residual impact significance ratings of between ***Low*** and ***Very low***. As noted above, commercial fishers can forward plan to avoid the temporary exclusion zones around the cable lay ship during cable laying operations and/or the offshore supply vessel used in cable installation and burial.

Summary of construction impacts

Table 0-1 provides a summary of the residual impact significance ratings associated with construction, along with the sensitivity of value and magnitude of impact used to derive the rating.

Table 0-1: Summary of construction impacts on marine ecology and resource use

Impact assessment descriptor	Sensitivity of value / Likelihood	Magnitude of impact / Consequence	Residual impact risk significance
HDD marine exit hole breakthrough impacts:			
Nearshore seabed habitats (Tas)	Low	Negligible	Very low
Nearshore seabed habitats (Vic)	Low	Negligible	Very low
Nearshore water quality (Tas)	Moderate	Negligible	Low
Nearshore water quality (Vic)	Moderate	Negligible	Low
Nearshore benthic communities (Tas)	Very low	Negligible	Very low
Nearshore benthic communities (Vic)	High	Negligible	Low
Cable installation and burial impacts:			
Nearshore seabed habitats (Tas)	Very low	Negligible	Very low
Nearshore seabed habitats (Vic)	Very low	Negligible	Very low
Nearshore water quality (Tas)	High	Negligible	Low
Nearshore water quality (Vic)	High	Negligible	Low
Wet jetting mobilisation of dissolved metals (Tas)	High	Negligible	Low
Nearshore sediment quality and arsenic (Tas)	Moderate	Minor	Low
Nearshore sediment quality and nickel (Tas)	Moderate	Minor	Low
Nearshore benthic communities (Tas)	Very low	Negligible	Very low
Nearshore benthic invertebrates and fishes (Vic)	Very low	Negligible	Very low
Nearshore endangered Tasman grass-wrack (Vic)	High	Negligible	Low
Impacts of cable installation on hard seabed and third-party crossings:			
Soft-sediment seabed habitat degradation (Tas)	Very low	Negligible	Very low
Soft-sediment seabed habitat degradation (Vic)	Very low	Negligible	Very low
Third-party crossing water quality impacts (Tas)	Moderate	Negligible	Low
Third-party crossing water quality impacts (Vic)	Moderate	Negligible	Low
Third-party crossing benthic communities (Tas)	Low	Negligible	Very low
Third-party crossing benthic communities (Vic)	Low	Minor	Very low
Offshore construction disturbance of seabed impacts:			
Offshore seabed habitat impacts	Low	Negligible	Very low
Offshore bottom water quality impacts	High	Negligible	Low
Offshore seabed fauna and infauna	Low	Negligible	Very low
Offshore seabed benthic with sponge corals patches	Moderate	Negligible	Low
Impacts of cable installation on hard seabed and third-party crossings:			
Soft-sediment seabed habitats (Bass Strait)	Low	Negligible	Very low
Third-party crossing water quality impacts	High	Negligible	Low
Soft-sediment seabed benthic fauna (Bass Strait)	Low	Negligible	Very low
****Underwater noise impacts to marine fauna:***			
LF cetacean disturbance and TTS onset impacts	Low	Moderate	Low
LF cetacean behavioural disturbance impacts	Low	Low to Moderate	Low
LF cetacean communication masking impacts	Low	Low	Low
MF cetacean disturbance and TTS onset impacts	Low	Moderate	Low
MF cetacean behavioural disturbance impacts	Low	Low	Low
MF cetacean communication masking impacts	Low	Low	Low
HF cetacean disturbance and PTS onset impacts	Low	High	Moderate

Impact assessment descriptor	Sensitivity of value / Likelihood	Magnitude of impact / Consequence	Residual impact risk significance
HF cetacean disturbance and TTS onset impacts	Low	Moderate	Low
HF cetacean behavioural disturbance impacts	Low	Low	Low
HF cetacean communication masking impacts	Low	Low	Low
Phocid disturbance and TTS onset impacts	Low	Moderate	Low
Phocid behavioural disturbance impacts	Low	Moderate	Low
Auditory masking impacts to phocids	Low	Low	Low
Otariid acoustic disturbance and TTS onset impacts	Low	Moderate	Low
Otariid acoustic behavioural impacts	Low	Low	Low
Otariid acoustic masking impacts	Low	Low	Low
Sea turtle acoustic behaviour impacts	Low	Low	Low
Sea turtle acoustic auditory masking impacts	Low	Low	Low
Little Penguins acoustic behaviour impacts	Low	Low	Low
Little Penguins acoustic masking impacts	Low	Low	Low
Fish acoustic disturbance and TTS onset impacts	Low	Moderate	Low
Group 3 pelagic fish behaviour impacts	Moderate	Low	Low
Group 3 benthic fish behaviour impacts	Moderate	Negligible	Low
Nearshore fish acoustic auditory masking impacts	Low	Moderate	Low
Cephalopods acoustic behaviour impacts	Very low	Negligible	Very low
Nighttime artificial lighting impacts to fauna:			
Nighttime light-sensitive albatrosses	High	Negligible	Low
Nighttime light-sensitive petrels	Low	Negligible	Very low
Nighttime light-sensitive shorebirds	High	Negligible	Low
Nighttime light-sensitive marine birds	High	Negligible	Low
Near-surface pelagic fish behaviour	Moderate	Negligible	Low
Near-surface zooplankton and micronekton migration	High	Negligible	Low
Construction impacts on marine resource uses:			
Navigation and marine traffic exclusion zone impacts	Low	Negligible	Very low
Temporary exclusion zones and fisheries impacts	Low	Negligible	Very low
Commercial fishery resource direct impacts	High	Negligible	Low
Commercial fisher fish diet indirect impacts	High	Negligible	Low
Recreational fishing temporary exclusion zones	Moderate	Negligible	Low
Recreational fishing boat transit impacts	Moderate	Negligible	Low
Nearshore recreational fishing targeted fish (Tas)	High	Negligible	Low
Nearshore recreational fishing targeted fish (Vic)	High	Negligible	Low
Risks of introducing or spreading Invasive Marine Species (IMS):			
IMS in ballast water discharges	Unlikely	Negligible	Very Low
IMS colonisation of project nearshore hard seabed	Possible	Minor	Low
IMS colonisation of project offshore hard seabed	Unlikely	Negligible	Very Low
Asian date mussel spread in nearshore Tasmania	Unlikely	Negligible	Very Low
NZ screw shell spread in nearshore Tasmania	Unlikely	Moderate	Low
European shore crab spread in nearshore Victoria	Possible	Minor	Low
Risks of project vessel strikes to megafauna:			
Cable lay ship or OSV strike risks to large cetaceans	Rare	Negligible	Very low
Fast-moving vessel strike risks to large cetaceans	Unlikely	Minor	Low

Impact assessment descriptor	Sensitivity of value / Likelihood	Magnitude of impact / Consequence	Residual impact risk significance
Cable lay ship or OSV strike risks to sea turtles	Rare	Negligible	Very low
Fast-moving transit vessel strike risks to sea turtles	Unlikely	Minor	Low

Cetacean hearing groups: LF = Low frequency; MF = Mid-frequency; HF = High frequency.

Operation impacts

The principal impact sources during operations relate to the energized subsea HVDC cables which generate direct current (DC) static magnetic fields around the cables due to current flow and thermal fields due to cable heating.

There are no direct electric fields generated outside of the cables as the cables' insulation and metallic armouring prevents this from occurring. This is due to the HVDC cables' metallic armouring being grounded to earth at the onshore converter stations in Tasmania and Victoria.

The key impact management approach is to adopt a modern HVDC cable design that minimises the electromagnetic fields and heat emitted from the subsea and land cable. The project design will include installation and burial of subsea cables in a manner that reduces the electromagnetic fields emitted from the subsea cables at the seabed and overlying the water column. Bundling of the HVDC cables in each subsea circuit will cancel out or greatly reduce electromagnetic fields. The cable operations impacts were assessed with this context.

Operational impact findings are summarised below for magnetic fields, induced electric fields and thermal fields.

Magnetic field impacts

Magnetic field impacts were assessed for the worst-case scenario, which assumes that one of the monopoles (i.e., bundled HVDC cables) of the project is operating at full power (750 MW). Magnetic field impacts relate to potential effects on magnetosensitive marina fauna and magnetic interference of shipboard magnetic compasses.

The two monopoles across the bulk of Offshore Bass Strait are separated by a distance of 2 km. The magnetic field generated at one monopole during operations reaches background levels (at the microTesla range) within about 20 m. Therefore, the individual mangenic fields generated by the two separate symmetric monopole HVDC cable bundles do not interact. The two symmetric monopoles are also operated independently of one another (i.e., it is not a bipolar system). Thus, the worst-case scenario for assessing magnetic field impacts on magnetosensitive fauna (and magnetic compasses) can be undertaken using only one monopole. The assessment of residual magnetic field impacts of one monopole will also be applicable to the other monopole during operations.

Figure 0.6 shows an example of the combined geomagnetic fields and predicted cable's magnetic at a modelling location south of Waratah Bay.

In Figure 0.6, the background geomagnetic total magnetic flux density strength is 60.87 microTesla (µT), whereas the magnetic increment due to the energised bundled HVDC cables adds a further 35 µT, giving a resultant field of 95.94 µT for a 750 MW power transmission (worst-case scenario).

The findings of the magnetic field impact assessment indicated that predicted impacts to magnetosensitive marine fauna (cetaceans, pinnipeds, sea turtles, migratory bony fish and marine invertebrates) were all assessed as having an impact significance rating of ***Low***.

The above assessed magnetic field impacts on marine fauna concur with the findings of a review of the Basslink Project operations (Sherwood et al. 2016).

Table 0-2 provides a summary of the magnetic field impact significance ratings of marine fauna, along with the sensitivity of value and magnitude of impact used to derive the rating.

Table 0-2 Summary of project magnetic field impacts on marine fauna

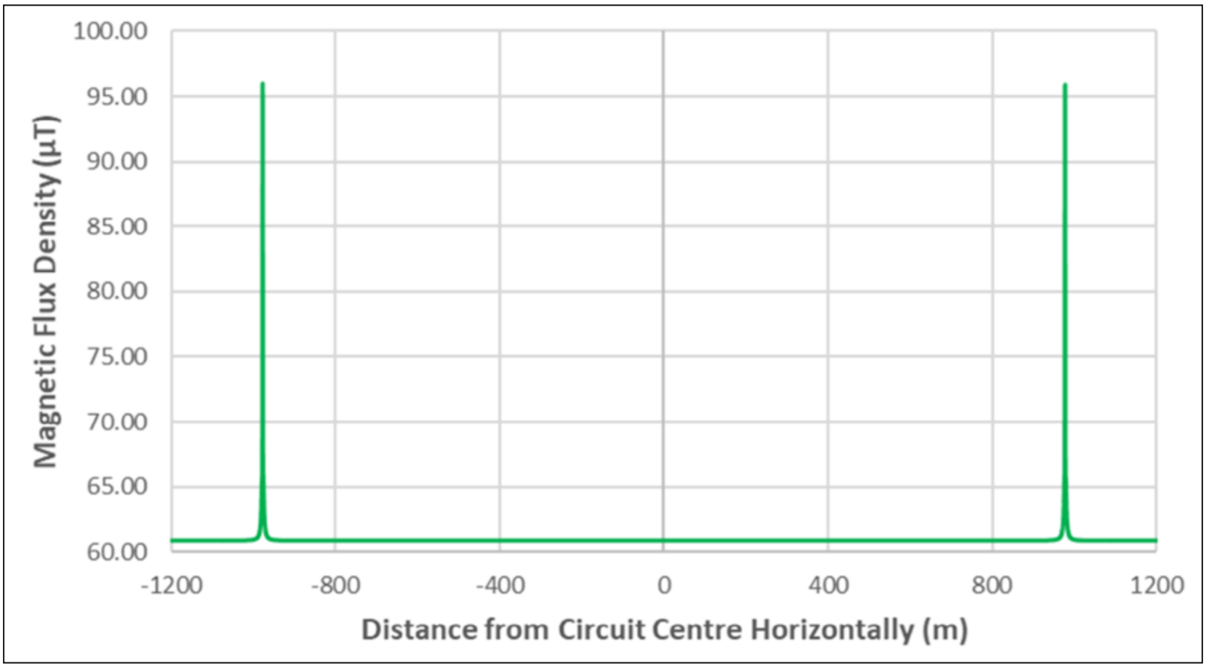
Scientific name	Common name/aspect	Sensitivity	Magnitude	Significance
IMPACTS ON MARINE FAUNA				
Magnetosensitive cetaceans:				
*Humpback whale	*Megaptera novaeangliae*	Low	Negligible	Very low
Sea turtles:				
Migratory sea turtles	As a group	High	Negligible	Low
Otariid (eared) seals:				
*Arctocephalus pusillus**	Australian fur seal	Very low	Negligible	Very Low
Arctocephalus forsteri	Long-nosed fur seal	Very low	Negligible	Very Low
Arctocephalus tropicalis	Sub-Antarctic fur seal	Very low	Negligible	Very Low
Neophoca cinerea	Australian sea lion	Very low	Negligible	Very Low
Phocid (earless) seals:				
Mirounga leonina	Southern elephant seal	Moderate	Negligible	Low
Hydrurga leptonyx	Leopard seal	Very low	Negligible	Very Low
Magnetosensitive bony fishes (Osteichthyes):				
Short-finned eel	*Anguilla australis*	Moderate	Negligible	Low
Long-finned eel	*Anguilla reinhardtii*	Moderate	Negligible	Low
Magnetosensitive cartilaginous fishes (Chondrichthyes –Elasmobranchii)				
#Elasmobranch fishes	As a group	Moderate	Negligible	Low
Marine invertebrates:				
Decapod crustaceans	As a group	Low	Negligible	Very low
All other marine invertebrates	As a group	Very low	Negligible	Very low
Impacts on marine resource use				
Magnetic compass deviation	–	Moderate	Negligible	Low

Notes: * Humpback whale is used as a surrogate for all whales. # Elasmobranchs sense the magnetic field indirectly via induction using their electrosensory system.

Induced electric field impacts

The metal armouring of the Project's HVDC cables is grounded to earth to prevent any direct electric fields being generated outside of the cables during operation (i.e., power transmission). However, seawater flow through the HVDC cable's generated DC static magnetic field will induce a corresponding DC static electric field. The intensity of the induced electric field will depend on the intensity of the HVDC cable's external magnetic field, which itself is directly proportional to the current in the cable and inversely proportional to the radial distance. Therefore, the induced electric field will reduce with distance from the buried HVDC cable.

The principal electrosensitive marine fauna include benthic cartilaginous fishes (Chondrichthyes) represented by elasmobranchs (e.g., sharks, skates, rays and chimaeras), which are all represented and known to occur in Bass Strait.



Source: Jacobs (2023; EIS/EES Technical appendix A: Electromagnetic fields).

Figure 0.6: Predicted resultant magnetic fields at the seabed for offshore Bass Strait

The predicted impacts of the project's induced electric fields on benthic elasmobranchs are assessed to have a residual impact significance rating of ***Very low***. This is based on a sensitivity of *Low* as there are no benthic elasmobranchs listed as threatened in the PMST search reports (refer to Attachments A, B and C, respectively), for offshore Bass Strait, nearshore Victoria and nearshore Tasmania and a magnitude of impact of *Negligible* given that the induced electric fields are localised at the seabed (above background only within a few metres of) and of insufficient strength to cause displacement of elasmobranchs from the general area of the HVDC cables.

Thermal field impacts

During power transmission in the project's HVDC power cables, heat will generate inside the conductor due to the Joule heating effect (i.e., passage of current through a conductor produces heat). Some heat is lost externally of the conductor, leading to an increase in temperature at the cable surface and a subsequent warming of the immediate surrounding seawater (if the cable is exposed) or seabed sediments (if the cable is buried).

Jacobs (2023; EIS/EES Technical appendix A) calculated that the temperature rise predicted at the seabed surface due to the subsea HVDC cables is indistinguishable from the ambient temperature, which is mainly due to constant bottom currents carrying away dissipated heat at the seabed/water interface. Therefore, benthic flora and fauna at the seabed surface are not predicted to be impacted by cable heat generations and dissipation.

Inspection and maintenance impacts

Routine subsea cable inspection and maintenance will occur during operations. This will involve eight events over the 40-year operational life. Inspection and maintenance will involve the use of an ROV and offshore support vessel (OSV). As there will be less vessel movements during this time compared to construction, and the vessels will produce a lower sound level than that assessed for construction, the risks and impacts associated with marine fauna collision and underwater noise are predicted to be no greater than the range (very low to moderate), assessed for construction.

Summary of operations impacts

Table 0-3 provides a summary of the residual impact significance ratings of impacts associated with operations, along with the sensitivity of value and magnitude of impact used to derive the rating.

Table 0-3 Summary of operations impacts on marine ecology and resource use

Impact assessment descriptor	Sensitivity of value or receptor	Magnitude of impact	Residual impact significance
Magnetic field impacts:			
Impacts on cetaceans	High	Negligible	Low
Impacts on sea turtles	High	Negligible	Low
Impacts on pinnipeds – eared seals	Very Low	Negligible	Very Low
Impacts on pinnipeds – true seals	Moderate	Negligible	Low
Impacts on bony fishes	Moderate	Negligible	Low
Impacts on cartilaginous fishes	High	Negligible	Low
Impacts on marine invertebrates	Low	Negligible	Very Low
Impacts on marine resource use	Moderate	Low	Low
Electric field impacts:			
Impacts on benthic elasmobranchs	Low	Negligible	Very low
Thermal field impacts:			
Impacts on benthic and epi-benthic fauna	Low	Negligible	Very low
Impacts on marine resource use			
Magnetic compass deviation	Moderate	Negligible	Low

Decommissioning impacts

The operational lifespan of the project is a minimum 40 years. At this time the project will be either decommissioned or upgraded to extend its operational lifespan.

Requirements at the time will determine the scope of decommissioning activities and impacts. The key objective of decommissioning is to leave a safe, stable and non-polluting environment, and minimise impacts during the removal of infrastructure.

Decommissioning will be planned and carried out in accordance with regulatory and landholder at the time. A decommissioning plan in accordance with approvals conditions will be prepared prior to planned end of service and decommissioning of the project. The decommissioning plan will outline how activities will be undertaken and potential impacts managed.

Decommissioning of project infrastructure will implement the waste management hierarchy principles of avoid, minimise, reuse, recycle and appropriately dispose. Waste management will be in accordance with applicable legislation at the time.

Decommissioning activities may include recovery of subsea cables and removal of rock armouring or mattresses. Alternatively, the subsea cables may be left in-situ. The conduits and shore crossing ducts would be left in-situ as removal would cause significant environmental impact.

Environmental impacts were assessed for two decommissioning options: a) the subsea cables are left in situ and b) the subsea cables are wholly or partially removed.

Impacts of subsea cable retained in situ

If the cables are left in situ, there will be no seabed disturbance, sedimentation or water quality impacts and, therefore, no consequential impacts on seabed habitats and associated benthic flora and fauna communities. The retention of the subsea power cables in situ raises a potential risk of the cables becoming exposed to hook-ups of ships' anchors or bottom trawling fishing gears. This risk is assessed to be low given that the cables are buried to a nominal depth of 1 m below the seabed surface and below the depth of penetration of ship's anchor and bottom trawled fishing gears. The likelihood of seabed scouring processes potentially exposing buried cable is also low. In addition, the absence of decommissioning vessels and seabed cable recovery equipment means that underwater noise impacts will be avoided.

Impacts of subsea cable removal

Cable removal (de-burial) impacts will arise from pulling the cables buried in soft sediment seabed directly to the sea surface by a large vessel with sufficient bollard pull capacity, cutting the retrieved cables on deck, and storing the cut sections for subsequent transport to appropriate disposal or recycling at approved land-based facilities. The environmental impacts will be basically a reverse of the construction impacts associated with cable installation and burial. However, the physical disturbance to the seabed associated with the removal of cables is significantly less than that caused by installation.

Overall, decommissioning impacts of cable removal have been assessed to have residual impact significance ratings of between ***Low*** and ***Very low*** due to reduced seabed disturbance from cable de-burial methods (e.g., absence of the need for wet jetting for shallow buried cables) and the smaller vessels used compared to the large cable lay ship that was required during project construction.

Cumulative impacts

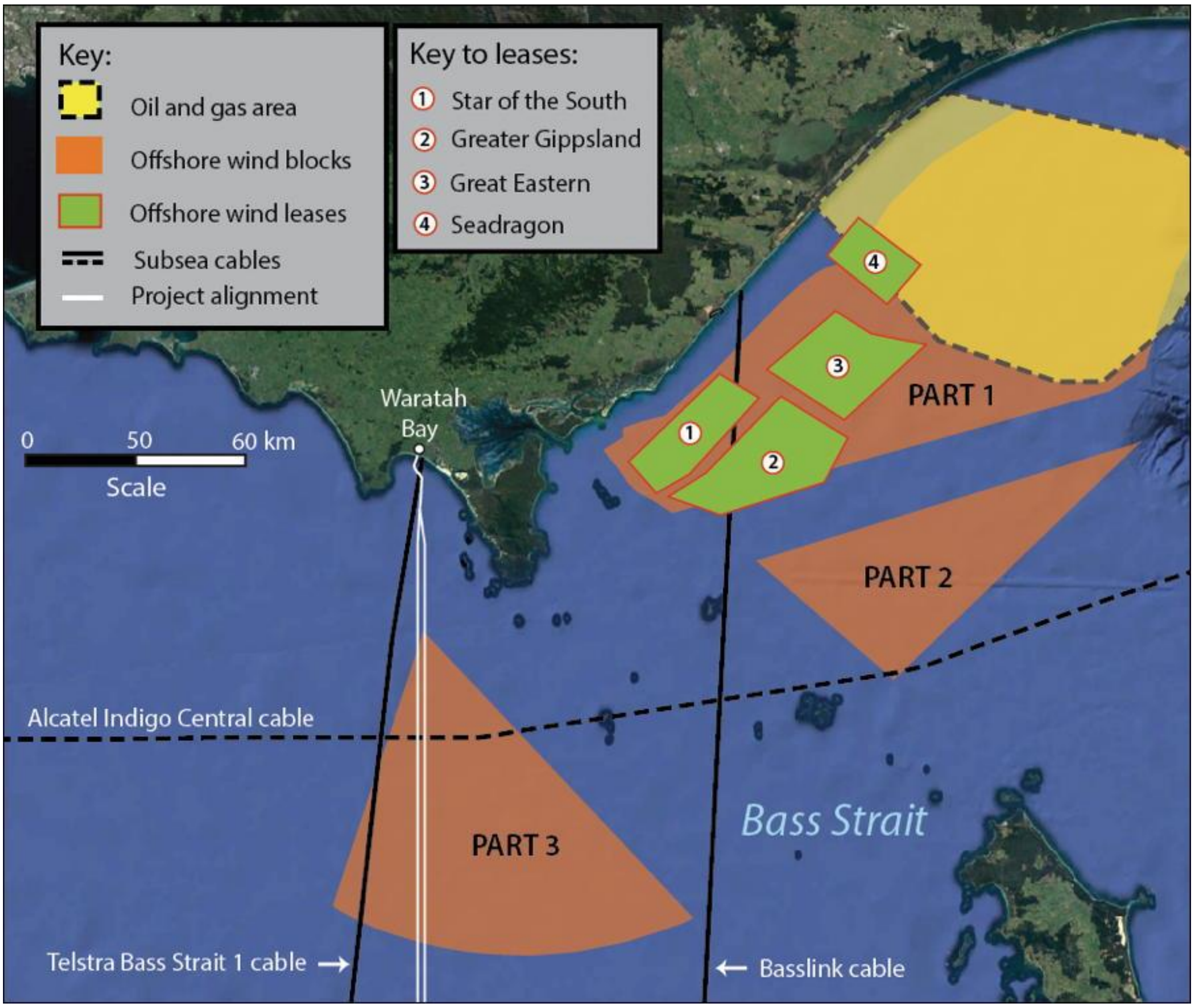
Cumulative impact assessment considers the additive impact of the primary activity (i.e., the current project) and third-party activities. This report assessed the cumulative impacts of the project in relation to existing third-party seabed assets (e.g., pipelines and telecommunication cables) and foreseeable future third-party projects (e.g., currently proposed oil and gas projects and offshore wind farm projects).

The proposed and reasonably foreseeable projects in Bass Strait that could result in cumulative impact with Marinus Link are:

- Star of the South Offshore Wind Project (SOTS).
- Greater Eastern Offshore Wind Project (Corio Generation).
- Greater Gippsland Offshore Wind Project (BlueFloat Energy)
- Seadragon Wind Project (Flotation Energy).
- Yolla Infield Well Project BassGas Project (Beach Energy).

The project alignment will traverse the South Gippsland area declared under the *Offshore Electricity Infrastructure Act* 2021. This includes areas where feasibility license permits have been applied for. Figure 0.7 shows proposed offshore wind farm leases and declared offshore wind blocks and existing third-party infrastructure.

During project construction, cumulative impacts may occur in relation to general maritime traffic (i.e., continuation of existing background traffic) and future third-party offshore wind project vessel traffic (transiting across Marinus Link on the way to those projects) creating a cumulative increase in underwater noise with Marinus Link construction vessels.



Source: Google Earth™, Tetra Tech Coffey Webmap, DCCEEW (2023c). Note map is for illustrative purposes. Widths of the telecommunication cables and HVDC cables are enlarged for visibility. The oil and gas area denotes the 'Area to be Avoided' (DCCEEW, 2022h).

Figure 0.7: Third party subsea infrastructure and proposed offshore electricity areas

Given the large distances of more than 78 km between Marinus Link and these offshore wind projects and the temporary nature of project construction vessel noise overlapping with vessels transiting to those other projects, cumulative low frequency underwater noise impacts to marine fauna are assessed as between ***Low*** and ***Very low***. The numbers of project vessels deployed during the operations phase for ROV surveys, routine maintenance and minor repairs are very low and cumulative interactions with other vessels associated with the reasonably foreseeable offshore wind project vessels, and general marine traffic are predicted to be ***Very Low***.

At third-party cable crossings, the magnetic fields generated by the project's subsea HVDC cables during power transmission have the potential to interact with the magnetic fields generated around existing operating subsea telecommunication cables (i.e., Telstra's Basslink 1 cable and Alcatel's Indigo Central cable).

In general, short length optic fibre cables without repeaters have no associated magnetic field (GNL, 2011). However, long length optic fibre cables with repeaters (which require cable powering) generate weak magnetic fields between 30 to 38 µT at the cable surface (ROD, 2022), which are less than the background geomagnetic field (60.5 µT in Bass Strait). The maximum magnetic field intensity is at the exterior cable surface and decreases inversely with distance from the cable.

At the project cable crossings over third party subsea telecommunication cables, the HVDC cable magnetic fields will mask those of the underlying telecommunication cables, which will be separated from the project's HVDC cable by concrete mattresses by up to one metre. Therefore, it is expected that there will be little interaction between the cables' magnetic fields and no cumulative impacts are predicted on marine magnetosensitive fauna.

The export power cables from any future offshore wind projects operating either to the east or west of the project alignment within declared area Part 3 offshore wind block are not expected to cross the project alignment as the cables from those other projects could run parallel to Marinus Link to the shore crossing. No electromagnetic field interactions between the project's HVDC cables and the inter-array field cables within the offshore wind farms are predicted, given that there will likely be a required separation distance of at least 1 km between the current project and any future wind farm project (as per the separation buffer between Star of the South and Basslink).

Overall, cumulative impacts have been assessed to have residual impact significance ratings ranging from ***Low*** to ***Very low***.

Conclusions

This report has examined the aspects of the project that may cause impacts on the marine environment and marine resource uses.

The assessments undertaken in this report show that marine ecology impacts of the project during construction, operation and decommissioning are mainly restricted to within proximity of the subsea cable alignments and are manageable. No significant negative impacts (i.e., residual impact significance ratings of ***High*** or greater) on marine ecology or marine resource use are predicted during construction, operation or decommissioning of the project.

A high level of confidence can be placed on the findings of the present report based on experience gained at other HVDC interconnector projects and operations, including:

- Basslink HVDC interconnector:
  - Sherwood et al. (2016) undertook a review of cable installation and operational effects of the Basslink interconnector and overseas interconnector studies and concluded that the marine biological effects of cable installation are transient and relatively minor where the cable is buried on soft sediment seabed.
  - The independent Bass Strait Environment Review Committee (BSERC), chaired by Professor John Sherwood of Deakin University, was established to oversee the monitoring of the environmental effects during the installation and operation of the Basslink operation and confirmed that the magnetic fields and induced electrical fields generated by the Basslink HVDC cable were within the range of predicted values and that the ecological impacts were minimal (DAFF, 2009).

- Swepol Link (Sweden to Poland interconnector):
  - A monitoring study by Andrulewicz et al. (2003) one year after cable installation showed that there were no visible changes on the surface of the seabed overlying the HVDC cable buried in soft sediment seabed and confirmed that the measurements of the cable's magnetic fields were as predicted and concluded that the cable's magnetic field did not present an obstacle to migrating fishes.

In conclusion, this report has assessed that, with adherence to EPRs and management measures, project construction, operations and decommissioning are not predicted to significantly impact upon on any threatened species of flora and fauna listed under the Commonwealth EPBC Act's listed threatened species, threatened ecological communities, listed migratory species and listed marine species, or threatened species listed under both the Tasmanian TSP Act and Victorian FFG Act.

Abbreviations and acronyms

Table 0-4 lists the units, abbreviations and acronyms used in this report.

Table 0-4: Units, abbreviations and acronyms used in this report

Units and abbreviations:	
Units	
K	Kelvin
kV	kilovolt (one thousand volts)
kW	kilowatt (one thousand 1,000 watts)
mg	milligram (one thousandth of a gram)
mg/L	Milligrams per litre
mG	milligauss (one thousandth of a gauss)
m/h	metre(s) per hour
m/s	metre(s) per second
MW	Megawatt
µg	micrograms
mg/L	milligrams per litre
µm	Micron or micrometre
µPa	microPascal
µT	microTesla
t	metric ton or tonne
T	Tesla
V	Volt
V/m	Volts per metre
W	Watt
W/m^2	Watts per unit area
Acronyms:	
AFMA	Australian Fisheries Management Authority.
AFZ	Australian Fishing Zone.
AHO	Australian Hydrographic Office, Canberra.
AMSA	Australian Maritime Safety Authority.
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Guidelines
BPL	Basslink Pty Ltd.

Units and abbreviations:	
CAMBA	China-Australia Migratory Bird Agreement.
DAWE	Department of Agriculture, Water and Environment (Cwlth)
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Cwlth)
DEECA	Department of Energy, Environment and Climate Action (Vic)
DEH	Department of Environment and Heritage (Cwlth)
DELWP	Department of Environment, Land, Water and Planning (VIC)*
DNRE	Department of Natural Resources and Environment (Vic)
DNV GL	Det Norske Veritas AS and Germanischer Lloyd SE
DPAC	Department of Premier and Cabinet (Tasmania)
DPIPWE	Department of Primary Industries, Parks, Water and Environment (Tas)
EES	Environmental Effects Statement (Vic)
EGC	EnviroGulf Consulting
EIS	Environmental Impact Statement (Cwlth and Tas)
EMP	Environmental Management Plan
EMPCA	*Environment Management and Pollution Control Act 1994* (Tas)
EMPCS	Environmental Management and Pollution Control System (Tas)
EMS	Environmental Management System
EPA	Environment Protection Authority, Melbourne (Vic) or Hobart (Tas)
ERS	Environment Reference Standard (Vic)
GIS	Geographic Information System
HDD	horizontal directional drilling
HDPE	high-density polyethylene
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
ICPC	International Cable Protection Committee
IMO	International Maritime Organization
IMO	International Maritime Organisation
JAMBA	Japan-Australia Migratory Bird Agreement
MARPOL	International Convention for the Prevention of Pollution from Ships
ML1	Western monopole link of the project (Stage one)
ML2	Eastern monopole link of the project (Stage two)
MLPL	Marinus Link Proprietary Limited
NEM	National Electricity Market
NHMRC	National Health and Medical Research Council
NWTD	North West Transmission Developments (Tas)
RPDC	Resource Planning and Development Commission (Tas)
SEPP	State Environmental Protection Policy (Vic)
SPWQM	State Policy on Water Quality Management 1997 (Tas)
TAC	Total Allowable Catch (fisheries)
TACC	Total Allowable Commercial Catch (fisheries)
VSC	Voltage Source Converter
WHO	World Health Organization
XLPE	Cross-linked polyethylene

* Note: DELWP was renamed DEECA on 1 January 2023. However, references to previous publications by DELWP have been retained.

1 Introduction

The proposed Marinus Link (the project) comprises a high voltage direct current (HVDC) electricity interconnector between Tasmania and Victoria, to allow for the continued trading and distribution of electricity within the National Energy Market (NEM).

The project was referred to the Australian Minister for the Environment on 5 October 2021. On 4 November 2021, a delegate of the Minister for the Environment determined that the proposed action is a controlled action as it has the potential to have a significant impact on the environment and requires assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) before it can proceed. The delegate determined that the appropriate level of assessment under the EPBC Act is an environmental impact statement (EIS).

On 12 December 2021, the former Victorian Minister for Planning under the *Environment Effects Act 1978* (Vic) (EE Act) determined that the project requires an environment effects statement (EES) under the EE Act, to describe the project's effects on the environment to inform statutory decision making.

In July 2022, a delegate of the Director of the Environment Protection Authority Tasmania determined that the project be subject to an environmental impact assessment by the Board of the Environment Protection Authority (the Board) under the *Environmental Management and Pollution Control Act 1994* (Tas) (EMPCA).

As the project is proposed to be located within three jurisdictions, the Victorian Department of Transport and Planning (DTP), Tasmanian Environment Protection Authority (Tasmanian EPA) and Australian Department of Climate Change, Energy, Environment and Water (DCCEEW) have agreed to coordinate the administration and documentation of the three assessment processes. One EIS/EES is being prepared to address the requirements of DTP and DCCEEW. Two EISs are being prepared to address the Tasmanian EPA requirements for the Heybridge converter station and shore crossing.

This report has been prepared by EnviroGulf Consulting ('EGC') to address all jurisdictions as part of the EIS/EES being prepared for the project.

1.1 Purpose of this report

The purpose of this technical study is to describe the existing marine ecology and resource use of Bass Strait and to assess project impacts and environmental performance requirements. This report provides information and data in support of the EIS/EES.

This report assesses the project's impacts during construction, operation and decommissioning, and forms Technical Appendix H of the project's Environmental Impact Statement (EIS)/Environment Effects Statement (EES).

1.2 Project overview

The project is a proposed 1500 megawatt (MW) HVDC electricity interconnector between Heybridge in northwest Tasmania and the Latrobe Valley in Victoria (Figure 1.1). The project is proposed to provide a second link between the Tasmanian renewable energy resources and the Victorian electricity grids enabling efficient energy trade, transmission and distribution from a diverse range of generation sources to where it is most needed, and will increase energy capacity and security across the NEM.

Marinus Link Pty Ltd (MLPL) is the proponent for the project and is a wholly owned subsidiary of Tasmanian Networks Pty Ltd (TasNetworks). TasNetworks is owned by the State of Tasmania and owns, operates and maintains the electricity transmission and distribution network in Tasmania.

Tasmania has significant renewable energy resource potential, particularly hydroelectric power and wind energy. The potential size of the resource exceeds both the Tasmanian demand and the capacity of the existing Basslink interconnector between Tasmania and Victoria. The growth in renewable energy generation in mainland states and territories participating in the NEM, coupled with the retiring of baseload coal-fired generators, is reducing the availability of dispatchable generation that is available on demand.

Tasmania's existing and potential renewable resources are a valuable source of dispatchable generation that could benefit electricity supply in the NEM. The project will allow for the continued trading, transmission, and distribution of electricity within the NEM. It will also manage the risk to Tasmania of a single interconnector across Bass Strait and complement existing and future interconnectors on mainland Australia. The project is expected to facilitate the reduction in greenhouse gas emissions at a state and national level.

Interconnectors are a key feature of the future energy landscape. They allow power to flow between different regions to enable the efficient transfer of electricity from renewable energy zones to where the electricity is needed. Interconnectors can increase the resilience of the NEM and make energy more secure, affordable, and sustainable for customers. Interconnectors are common around the world including in Australia. They play a critical role in supporting Australia's transition to a clean energy future.

The major components of the proposed interconnector are shown schematically in Figure 1.2 and a more detailed description of the interconnector is described in Section 4 (Project description). Both the Tasmanian and Victorian jurisdictions extend 3 nautical miles out to sea from the high-water mark.

Figure 1.3 shows the proposed parallel alignments of the western monopole (Marinus Link 1 or ML1) and the eastern monopole (Marinus Link 2 or ML2), which will be laid about 2-km apart.

Figure 1.4 shows the project alignment within nearshore Tasmania at Heybridge and Figure 1.5 shows the project's alignment within nearshore Victoria (Waratah Bay)

LEGEND

- Landfall
- Converter station
- HVDC subsea cable
- Underground HVDC cable
- Cable option not progressing

MARINUS LINK

SCALE 1:1,500,000

PAGE SIZE: A4

PROJECTION: GDA2020 MGA Zone 55

0 15 30 km

SOURCE
Proposed route from Tetra Tech Coffey.
Imagery from ESRI Online.

MARINUS LINK PTY LTD

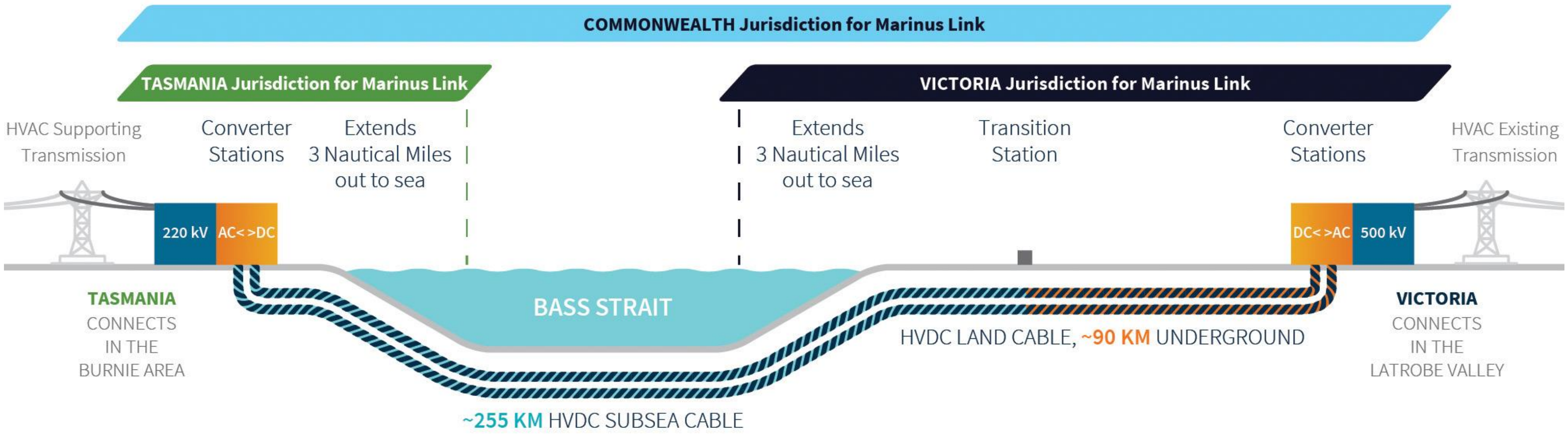
MARINUS LINK
EIS/EES

FIGURE 1-1

Marinus Link Project Overview

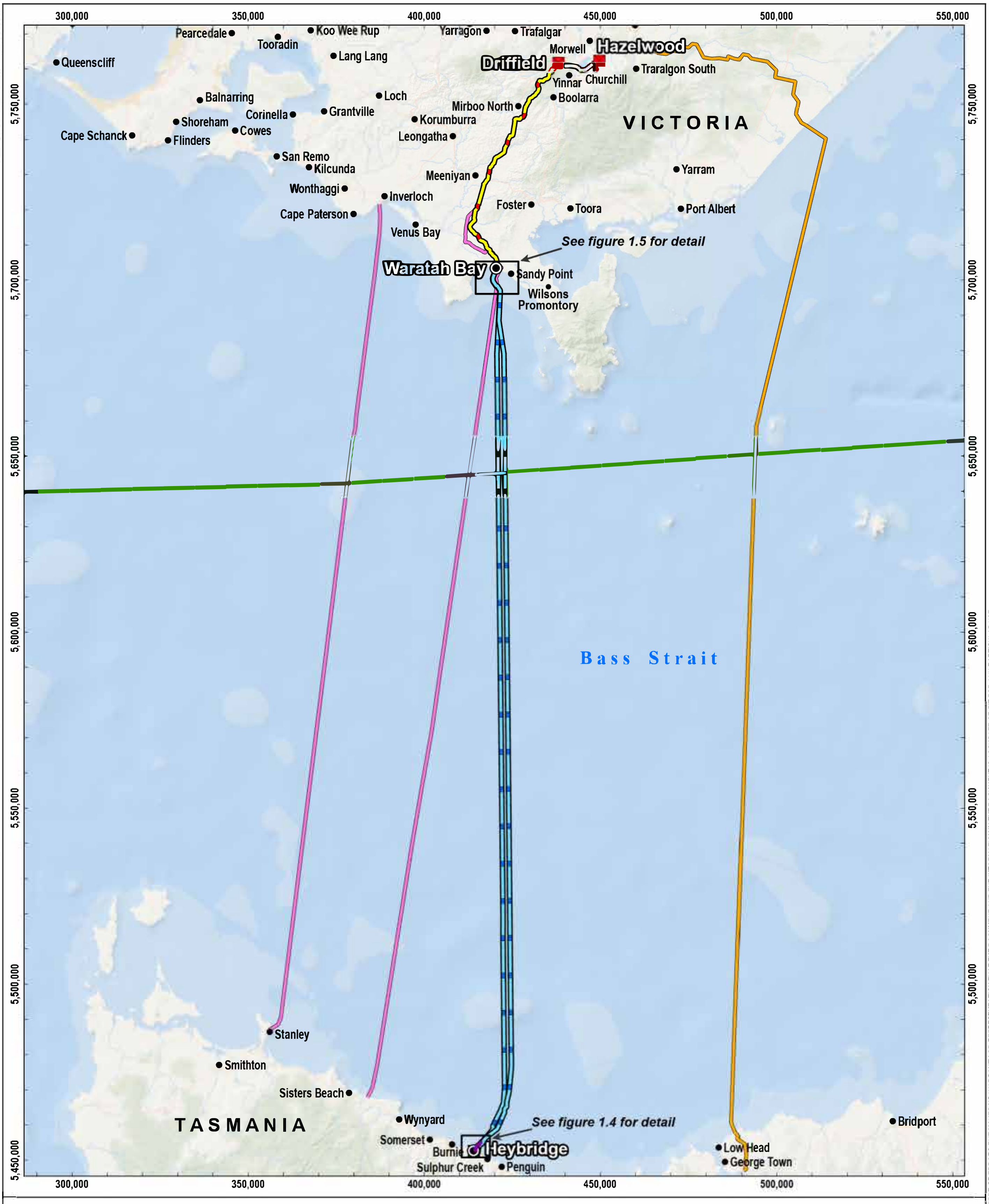
TETRA TECH COFFEY

DATE: 08.05.24 PROJECT: 754-MELEN215878ML FILE: 215878ML_R06_F01-01_GIS



Source: MLPL.

Figure 1.2: Schematic arrangement of the project



LEGEND

- Converter station
- Landfall

Proposed route

- HVDC subsea cable
- Underground HVDC cable
- Basslink Cable
- Alcatel indigo central cable (indicative alignment only)
- Telstra Cable
- Former tioxide plant outfall pipeline

MARINUS LINK

SCALE 1:1,500,000
PAGE SIZE: A4
PROJECTION: GDA2020 MGA Zone 55

SOURCE
Proposed route from Tetra Tech Coffey.
Existing subsea cable alignments indicative only.
Imagery from ESRI Online.

MARINUS LINK PTY LTD

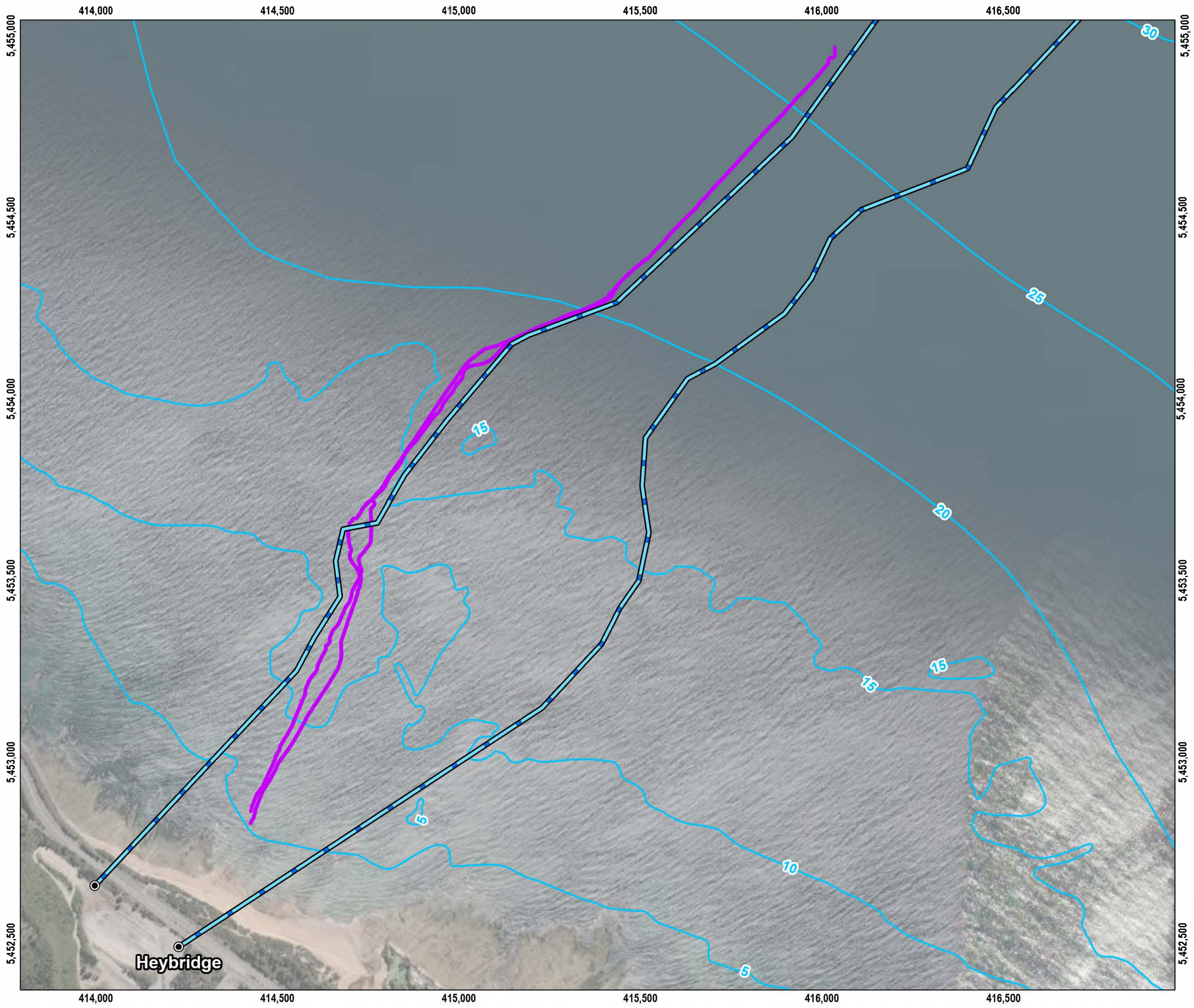
MARINUS LINK
EIS/EES

FIGURE 1.3

Overview of alignment and other seabed infrastructure

TETRA TECH COFFEY

DATE 28.02.23 PROJECT 754-MELEN215878ML FILE 215878ML_MERU_F001.3_GIS



MARINUS LINK

LEGEND

Landfall

Proposed route

HVDC subsea cable

Former tioxide plant outfall pipeline

Bathymetry (m)

SOURCE
Proposed route from Tetra Tech Coffey.
Tioxide pipeline from Fugro.
Imagery from ESRI Online.

0 150 300 m

SCALE 1:15,000
PAGE SIZE: A4
PROJECTION: GDA2020 MGA Zone 55

MARINUS LINK PTY LTD

MARINUS LINK
EIS/EES

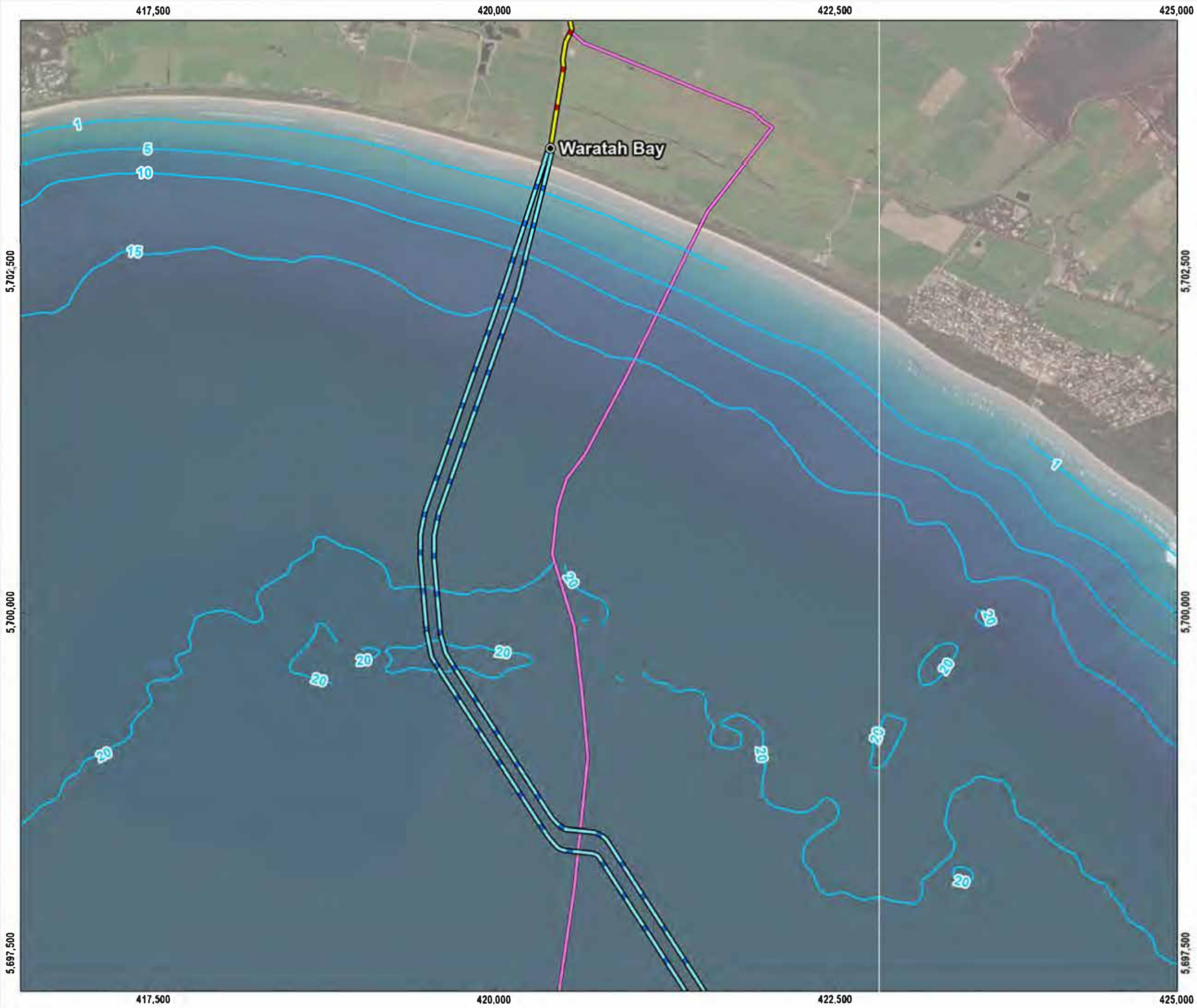
FIGURE 1.4

Nearshore Tasmania

TETRA TECH COFFEY

DATE: 24.02.23 PROJECT: 754-MELEN215878ML FILE: 215878ML_MERU_F001.4_GIS

DOC REFERENCE: \\TT.LOCAL\COFS\772\GIS\215878_MELEN_TASNETWORKS_PROJECT\MARINUSTASNETWORKS\PROJECT\MARINUSGIS\MXD\215878ML_MERU\215878ML_MERU_FIGS_A.APRX LAYOUT: 215878ML_MERU_F001.4_GIS_1 SAVED BY: HELEN.UNKOVICH 24.02.23 12:25 PM



MARINUS LINK

LEGEND

- Landfall

Proposed route

- HVDC subsea cable
- Underground HVDC cable
- Telstra Cable
- Bathymetry (m)

SOURCE
Proposed route from Tetra Tech Coffey.
Tioxide pipeline from GeoNeon.
Imagery from ESRI Online.

0 500 1,000 m

SCALE 1:40,000
PAGE SIZE: A4
PROJECTION: GDA2020 MGA Zone 55

MARINUS LINK PTY LTD

MARINUS LINK
EIS/EES

FIGURE 1.5

Nearshore Victoria

TETRA TECH COFFEY

DATE 24.02.23 PROJECT 754-MELEN215878ML FILE 215878ML_MERU_F001.5_GIS

1.3 Assessment context

Assessments of impacts to marine ecological values and marine resource use are a key consideration at all levels of government in Australia. The purpose of such assessments is to understand the ecological and marine resource values present in a project area and means to avoid and minimise impacts to the natural environment and marine resource use. In particular, close attention has been paid to those values that are considered significant at a local, state or national level.

The key marine ecological values that are considered in this context include:

- Native marine flora and fauna and associated habitats representing ecological communities which are indigenous to the region:
  - marine pelagic habitats and associated flora and fauna
  - benthic and demersal habitats and associated flora and fauna.
- Threatened species that are recognised under state and/or national legislation.
- Threatened ecological communities that are recognised under state and/or national legislation.
- Introduction of marine invasive species.

The key marine resource use values that are considered in this context include:

- Navigation and shipping traffic.
- Commercial fisheries of state and Commonwealth waters.
- Recreational fishing.
- Other recreational activities.

2 Assessment guidelines

This section outlines the assessment guidelines relevant to marine ecology and resource use and the linkages to other EIS/EES technical studies. A single consolidated EIS/EES is being prepared to address the requirements of the Commonwealth and Victorian jurisdictions, including the requirement for an EES. This report will use the term EIS/EES going forward.

2.1 Overview

The project was referred to the Australian Minister for the Environment on 5 October 2021. On 4 November 2021, a delegate of the Minister for the Environment determined that the proposed action is a controlled action as it has the potential to have a significant impact on the environment and requires assessment and approval under the Environment Protection and Biodiversity Conservation Act 1999 (Cwlth) (EPBC Act) before it can proceed. The delegate determined that the appropriate level of assessment under the EPBC Act is an environmental impact statement (EIS).

On 12 December 2021, the former Victorian Minister for Planning under the Environment Effects Act 1978 (Vic) (EE Act) determined that the project requires an environment effects statement (EES) under the EE Act, to describe the project's effects on the environment to inform statutory decision making.

In July 2022, a delegate of the Director of the Environment Protection Authority Tasmania determined that the project be subject to environmental impact assessment by the Board of the Environment Protection Authority (the Board) under the Environmental Management and Pollution Control Act 1994 (Tas) (EMPCA).

As the project is proposed to be located within three jurisdictions, the Victorian Department of Transport and Planning (DTP), Tasmanian Environment Protection Authority (Tasmanian EPA) and Australian Department of Climate Change, Energy, Environment and Water (DCCEEW) have agreed to coordinate the administration and documentation of the three assessment processes. One EIS/EES is being prepared to address the requirements of DTP and DCCEEW. Two EISs are being prepared to address the Tasmanian EPA requirements for the Heybridge converter station and shore crossing, although only the shore crossing guidelines are relevant to the marine ecology and resource use scope.

Assessment guidelines are set out in the following Commonwealth and State documents:

- Commonwealth Government:
  - DCCEEW. 2022b. Guidelines for the content of a draft Environmental Impact Statement. Environment Protection and Biodiversity Conservation Act 1999. Marinus Link underground and subsea electricity interconnector cable (EPBC 2021/9053). Department of Climate Change, Energy, Environment and Water. Australian Government, Canberra, ACT.
- Victorian State Government:
  - DTP. 2023. Scoping requirements. Marinus Link Environmental Effects Statement. Environment Effects Act 1978. Department of Environment, Land, Water and Planning. Victorian State Government, Melbourne, Victoria.
- Tasmanian State Government:
  - EPA Tasmania. 2022a. Environmental Impact Statement Guidelines. Marinus Link Pty Ltd. Converter Station for Marinus Link. Environment Protection Authority, Hobart Tasmania. September 2022.

- EPA Tasmania. 2022b. Environmental Impact Statement Guidelines. Marinus Link Pty Ltd. Heybridge shore crossing for Marinus Link. Environment Protection Authority, State Government of Tasmania, Hobart, Tasmania. September 2022.

The EIS/EES assessment guidelines from each jurisdiction are summarised below with references to where the guidelines are addressed in the report.

2.2 Commonwealth EIS guidelines

DCCEEW have published the following guidelines for the EIS: '*Guidelines for the Content of a Draft Environmental Impact Statement – Environment Protection and Biodiversity Conservation Act 1999* – Marinus Link underground and subsea electricity interconnector cable (EPBC 2021/9053)'.

- Listed threatened species and communities (sections 18 and 18A) Listed migratory species (sections 20 and 20A).
- Commonwealth marine areas (sections 23 and 24A).

2.2.1 Key issues

The main issues raised by the Commonwealth Government's EIS guidelines relate to potential impacts on the following:

- Matters of National Environmental Significance (MNES):
  - World Heritage Properties
  - National Heritage Places
  - Wetlands of International Importance
  - Great Barrier Reef Marine Park
  - Commonwealth Marine Area
  - Listed Threatened Ecological Communities
  - Listed Threatened Species
  - Listed Migratory Species
- Other matters protected by the EPBC Act (Cwlth):
  - Listed Marine Species
  - Whales and Other Cetaceans
  - Critical Habitats
  - Australian Marine Parks
- EPBC Act (Cwlth) extra information:
  - State and Territory Reserves
  - Invasive Marine Species
  - Nationally Important Wetlands
  - Key Ecological Features (Marine)

Table 2.1 lists the Commonwealth EIS guidelines, indicates the source of the requirements, and the sections of this report where the requirements have been addressed. Table 2.1 excludes compliance with Commonwealth and State legislation, polices and guidelines, which are addressed separately in Section 3 (Legislation, policies, regulations, and guidelines).

Table 2-1: Compliance with Commonwealth EIS guidelines (marine)

EIS guideline	Report section
2.2 Relevant legislative and policy context	3 Legislation, policies, regulations, and guidelines
4 Description of the action	4 Project description
4.2 Description of the existing environment	6 Existing conditions
4.3 Description of the protected matters	6.3 Marine biological environment
4.3.1 Listed migratory species and threatened species and ecological communities	6.3 Marine biological environment
4.3.2 Commonwealth Marine Area	6.3 Marine biological environment; 6.4 Existing marine resource use
5 Relevant Impacts	7 Impact assessment
5.1 General Impacts	7 Impact assessment
5.2 Physical seabed disturbance impacts	7.2.2 Seabed disturbance impacts
5.3 Underwater disturbance (noise, heat, vibrations, and electromagnetic fields) impacts	7.2.3 Underwater noise impacts
5.4 Vessel disturbance impacts	7.2 Construction impacts
5.7 Impacts on users of the marine environment	7.2.7 Construction impacts on marine resource use
5.9 Introduced invasive species impacts	7.2.5 Impacts of introducing or translocating invasive marine species
5.10 Consequential and facilitated impacts	7 Impact assessment
5.11 Cumulative impacts	7.5 Cumulative impacts
6 Proposed Avoidance and Mitigation Measures	7.6 Environmental performance requirements

2.3 Tasmanian EIS guidelines

The EPA Tasmania have published two sets of guidelines in September 2022 for the preparation of an EIS for the project converter station (EPA Tasmania 2022a) and the shore crossing (EPA Tasmania, 2022b). The EPA Tasmania (2022b) EIS guidelines document only relates to the Heybridge shore crossing, which was referred to the Board of EPA Tasmania by MLPL on 8 July 2022 under section 27(2) of the *Environmental Management and Pollution Control Act 1994* (Tas) ('EMPC Act'). A separate set of guidelines have been prepared for each of these project components.

The project was determined on 4 November 2021 to be a controlled action under the EPBC Act (EPBC Reference 2021/9053) and will require assessment and approval under the EPBC Act, as well as under Tasmanian State and local government requirements. As the declared controlled action is larger than the scope of the EPA Board's assessment under the EMPC Act, the proposal is not able to be assessed in accordance with the bilateral agreement between the Commonwealth and Tasmanian Governments under *section 45* of the EPBC Act, relating to environmental impact assessment. Notwithstanding, information provided for the purpose of addressing these EIS guidelines must be clearly identified in the document provided for the purpose of the case for assessment under the EMPC Act.

EPA Tasmania states that the EIS should evaluate all potential effects of the proposal and focus on the main objectives identified below:

- Provide information for individuals and groups to gain an understanding of the proposal, the need for the proposal, the alternatives, the environment that it could affect, the positive and negative environmental impacts that may occur and the measures that will be taken to maximise positive outcomes, and minimise any adverse environmental impacts, including specific management measures.
- Provide a basis for public consultation and informed comment on the proposal.
- Provide a framework against which decision makers, particularly the EPA Tasmania Board, and sometimes the relevant Planning Authority, can consider the proposal and determine the conditions under which any approval might be given.
- Provide a demonstration that the proposal is consistent with the objectives of the relevant laws and policies, including the Tasmanian Resource Management and Planning System (RMPS) and the Environmental Management and Pollution Control System (EMPCS).

2.3.1 Key issues

EPA Tasmania (2022b) identified three key issues to be addressed by the EIS for the shore crossing:

- Key issue 1: Potential impacts on terrestrial natural values.
- Key issue 2: Potentially contaminated material and acid sulfate soils.
- Key issue 3: Potential impacts on marine natural values.

It is only key issues 2 and 3 that relate to the marine environment and are therefore considered in this report. The report has defined more detailed issues that relate to key issue 3.

The EPA Tasmania's EIS guidelines relating principally to the marine environment are presented in Table 2.2 along with sections of the present report that that address and comply with the guidelines.

Table 2-2: Compliance with Tasmanian EIS guidelines – shore crossing (relevant to marine values)

Scoping requirement	Report section
2.1 General project details	4 Project description
2.2 Construction	4.2 Construction
9. The Existing Environment	6 Existing conditions
9.2 Environmental aspects - overview	6 Existing conditions
10 Existing conditions	6 Existing conditions
10 Performance requirements	7.6 Environmental performance requirements
10 Potential impacts	7 Impact assessment
10 Avoidance and mitigation measures	7.6 Environmental performance requirements
10 Assessment of residual impacts	8 Conclusion
10.2 Key Issue 2: Potentially contaminated material and acid sulfate soils	7.2.2.1.5 Cable installation and burial impacts on sediment quality and contaminant release
10.3 Key Issue 3: Marine natural values	7 Impact assessment
10.4 Marine water quality	7.2.2.1 Nearshore construction seabed disturbance impacts
10.10 Marine and Coastal	7 Impact assessment
10.16 Cumulative and interactive impacts	7.5 Cumulative impacts
11. Monitoring and Review	7.6 Summary of environmental performance requirements
12. Decommissioning and Rehabilitation	7.4 Decommissioning impacts

2.4 Victorian EES scoping requirements

The EES Scoping Requirements issued by the Minister for Planning (February 2023) outline the specific matters to be assessed across a number of environmental and social disciplines relevant to the project, and to be documented in the EES for the project.

The EES Scoping Requirements inform the scope of the EES technical studies and define the EES evaluation objectives. The EES evaluation objectives identify the desired outcomes to be achieved and provide a framework for an integrated assessment of the environmental effects of a proposed project.

The matters to be investigated and documented within the EES are presented in Table 2.3, and grouped by investigation theme.

2.4.1 EES evaluation objective

The EES evaluation objectives contained in Sections 4.1 and 4.2 of the EES scoping requirements that are relevant to this marine ecology and resource use assessment are:

Avoid, and where avoidance is not possible, minimise adverse effects on terrestrial, aquatic and marine biodiversity and ecology, including native vegetation, listed threatened species and ecological communities, other protected species and habitat for these species, and to address offset requirements consistent with state policies.

Avoid and, where avoidance is not possible, minimise adverse effects on land and water (including groundwater, surface water, waterway, wetland, and marine) quality, movement and availability.

2.4.2 Key issues

Key issues raised in the Victorian EES scoping requirements and relevant to the nearshore marine environment are for:

- Potential adverse effects on coastal and marine ecosystems, including changes to marine and coastal processes arising from project construction, operation and decommissioning of infrastructure.
- Potential direct or indirect loss, disturbance and/or degradation of listed marine species on the FFG Act or other protected marine species on the DEECA advisory lists and nearby habitat that may support listed or other protected flora, fauna, or ecological communities.
- Potential adverse effects on the functions and environmental values of the marine environment such as changed water quality or seabed sediment quality.
- Potential adverse effects from disturbance of the seabed and resuspension of sediments, and formation of down-current subsurface turbidity plumes with delayed settling and deposition of suspended sediments.
- Potential adverse effects on nearby and down-current water environments due to water quality changes including in the context of climate change projections.
- Potential effects to environmental values through spills, disturbance of contaminated materials or the introduction of, or spread of, invasive species.
- Potential for cumulative impacts on listed threatened or other protected fauna species, and their habitats, from the project in combination with other projects that might have similar types of impacts.

Table 2-3: Compliance with Victorian EES scoping requirements (marine)

Scoping requirement	Report section
3.5 Applicable legislation, policies and strategies	3 Legislation, policies, regulations and guidelines
4 Assessment of specific environmental effects – Identify key issues and risks	7 Impact assessment
4 Assessment of specific environmental effects – Characterise the existing environment	6 Existing conditions
4 Assessment of specific environmental effects – Identify the potential effects	7 Impact assessment
4 Assessment of specific environmental effects – Present design refinement and mitigation measures	7.6 Environmental performance requirements
4 Assessment of specific environmental effects – Assess the likely residual effects	7 Impact assessment
4.1 Biodiversity and ecological values – existing environment	6 Existing conditions
4.1 Biodiversity and ecological values – likely effects	7 Impact assessment
4.1 Biodiversity and ecological values – mitigation measures	7.6 Environmental performance requirements
4.2 Marine and catchment values – existing environment	6 Existing conditions
4.2 Marine and catchment values – likely effects	7 Impact assessment
4.2 Marine and catchment values – mitigation	7.6 Environmental performance requirements

2.5 Linkages to other reports

Table 2.4 summarises linkages to other EIS/EES supporting studies that have informed the current Marine Ecology and Resource Use Assessment Study.

Table 2-4: Linkages to other reports

Technical studies	Relevance to this assessment
EIS/EES Technical appendix A – Electromagnetic fields	Electromagnetic field (EMF) data and calculations of the strength and direction of magnetic fields, induced electric fields, and thermal fields.
EIS/EES Technical appendix G – Benthic ecology	Existing seabed environment – marine habitats, flora and fauna, and threatened ecological communities or individual flora and fauna species.
EIS/EES Technical appendix V – Terrestrial ecology	Impacts to terrestrial coastal ecology are assessed in the terrestrial ecology report.

3 Legislation, policies, regulations, and guidelines

This section summarises key Commonwealth, Victorian and Tasmanian legislation, regulations, policies, and guidelines that are relevant to the marine ecology and resource use aspects of the project.

3.1 Commonwealth of Australia

Table 3.1 summarises Commonwealth legislation, regulations, policies and guidelines relevant to the marine ecology and resource use aspects of the project.

Table 3-1: Commonwealth legislation, regulations, and policies relevant to the project

Legislation	Description / Administration	Relevance to the project
Commonwealth Legislation:		
Environment Protection and Biodiversity Conservation Act 1999 (Cwlth) ('EPBC Act')	Protects Matters of National Environmental Significance (MNES) in relation to activities that impact on Commonwealth marine waters. Administered by the Department of Agriculture, Water and the Environment (DAWE)	EIS to address MNES that could be directly or indirectly affected by the project and assessed the potential for significant impacts to MNES.
Biosecurity Act 2015 (Cwlth) ('Biosecurity Act')	The *Biosecurity Act 2015* (Cwlth) establishes the regulatory framework for the management of the risk of pests and diseases associated with vessels entering Commonwealth waters, particularly in preventing invasive marine species associated with ballast water discharges and hull fouling. [Administered by the AMSA]	Project to manage marine invasive species by managing ballast water in accordance with the Australia Ballast Water Management Requirements (DAFF, 2020) and anti-fouling in accordance with the Anti-fouling and In-water Cleaning Guidelines in Commonwealth waters (DoA and DoE, 2015)
Australian Maritime Safety Authority Act 1990 (Cwlth) (AMSA Act)	The AMSA Act established the Australian Maritime Safety Authority (AMSA) as a statutory body, which ensures that ships in Australian waters are appropriately certificated and registered, and that ships' crews have relevant certificates of competency. AMSA also issues Marine Orders, under which various shipping channels are designated including in Bass Strait. AMSA operates a shipping Traffic Separation Scheme within Bass Strait, controlling shipping and reducing the risk of collisions. [Administered by the AMSA]	AMSA is the designated control agency for oil spills from vessels in Commonwealth waters, and response to marine pollution events. The requirements of this act will be relevant in the event of project vessel oil spills, which will be addressed in accordance with AMSA's National Plan for Maritime Emergencies (NATPLAN) of the submission of temporary exclusions zones of marine construction activities to AMSA will occur in line with this act. AMSA would issue Notices to Mariners with details of places, dates and duration.
Navigation Act 2012 (Cwlth) (Navigation Act)	Regulates vessel-related activities in Commonwealth waters and gives effect to relevant international conventions for maritime issues where Australia is a signatory. The act promotes the safety of life at	Project vessels will be subject to the requirements of this act, such as adhering to safe navigation and pilotage practices, having the appropriate pollution prevention certificates and ensuring that

Legislation	Description / Administration	Relevance to the project
	sea, safe navigation, and marine pollution prevention. [Administered by the AMSA]	required navigational aids are in place.
Protection of the Sea (Prevention of Pollution from Ships) Act 1983 (Cwlth) ('PSPPS Act')	The PSPPS Act implements Australia's obligations under the International Convention for the Prevention of Pollution from Ships (MARPOL, 1973/1978). Annexes I-VI of MARPOL 73/78 place controls on operational discharges at sea and prescribe construction and equipment standards. [Administered by the AMSA]	Project vessels will be required to adhere to the discharge standards of MARPOL including Annex I (Oil), Annex II (Noxious liquid substances), Annex III (Harmful packaged substances), Annex IV (Sewage), Annex V (Garbage) and Annex VI (Air emissions). The reporting of marine pollution incidents will also be required for project vessels.
Offshore Electricity Infrastructure Act 2021 (Cwlth) ('OEI Act')	This act includes proposed areas in Bass Strait off Gippsland, Victoria.	This act outlines requirements for potential future conflict and cumulative impact with proposed offshore electricity infrastructure areas that may be intersected by the project.
Commonwealth Regulations:		
Environment Protection and Biodiversity Conservation Regulations 2000	General requirements, assessment approaches and public access and comment. Referral of proposal to take action.	Informs the approach to the impact assessment of Commonwealth matters.
Commonwealth Policies:		
EPBC Act Policy Statement 1.1 (DoE, 2013)	Significant Impact Guidelines – Matters of National Environmental Significance. Administered by DAWE.	The guidelines inform the method for the impact assessment to MNES.
EPBC Act Policy Statement 2.1 (DEWHA, 2008)	Interactions between Offshore Seismic Operations and Whales. Administered by DAWE.	The guidelines are relevant to 'other seismic sources' due to the sub-profiling (SBP) surveys' use of small airguns (e.g., 2- or 5-cubic inch capacity) that generate underwater impulsive noise.
Commonwealth Guidelines:		
Australian and New Zealand guidelines for marine water quality (ANZG, 2018a)	Guidelines for setting water quality targets and for informing assessment of water quality impacts.	Guidelines adopted for assessing potential changes to water quality from project disturbance.
Australian and New Zealand guidelines for sediment quality (ANZG, 2018b)	Guidelines for assessing sediment quality impacts.	Adopted guidelines for assessing potential changes to TSS and metals in the water column arising from disturbance of contaminated seabed sediments.

3.1.1 Environment Protection and Biodiversity Act 1999 (Cwlth)

Additional information is given on the EPBC Act as it is the Commonwealth's primary act relating to conservation and/or protection of the marine environment in Commonwealth waters of Bass Strait. The EPBC Act provides the legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities, and heritage places defined in the EPBC Act as MNES. From time-to-time, amendments are made to the EPBC Act's list of threatened species.

3.1.1.1 EPBC Act Policy Statement 1.1

The EPBC Act Policy Statement 1.1 – Significant Impacts Guidelines – Matters of National Environmental Significance (DoE, 2013) aims to protect MNES. MNES components that are potentially relevant to the project are:

- Section 16 and 17B (wetlands of international importance).
- Section 18 and 18A (listed threatened species and communities).
- Section 20 and 20A (listed migratory species).

MNES values in the project area were investigated using the EPBC Act's online Protected Matters Search Tool (DCCEEW, 2023d). The Protected Matters Search Tools (PMST) results are included in the present report as:

- Attachment A – PMST Report for offshore Bass Strait, 2023
- Attachment B – PMST Report for nearshore Victoria (Waratah Bay), 2023
- Attachment C – PMST Report for nearshore Tasmania (near Heybridge), 2023

There are no wetlands of international importance near the proposed subsea interconnector corridors. The nearest wetland of international importance is the Corner Inlet Ramsar site that is located to the east of Wilsons Promontory and separated from proposed project activities in Waratah Bay by the Yanakie Isthmus, which is a sandy strip of land that connects Wilson Promontory to the Victorian mainland.

3.1.1.2 EPBC Act Policy Statement 2.1

The EPBC Act Policy Statement 2.1–Interaction between offshore seismic exploration and whales (DEWHA, 2008) provides measures and advice to minimise the risk of acoustic injury to whales in the vicinity of marine geophysical seismic surveys. The aim of this policy statement is to:

- Provide practical standards to minimise the risk of acoustic injury to whales in the vicinity of a marine seismic survey.
- Provide 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.

While no large-scale marine seismic surveys are proposed or necessary for the project, the use of sub-bottom profilers represent a source of impulsive noise. Therefore, EPBC Act Policy Statement 2.1 is relevant to the pre-construction and deployment of sub-seabed profiling equipment and methods (e.g., sub-bottom profilers or SBPs).

3.2 Victoria

Victorian State legislation, regulations, and policies relevant to the marine ecology and resource use aspects of the project are summarised in Table 3.2.

Table 3-2: Victorian legislation, regulations, and policies relevant to the project

Legislation/regulation/policy	Description	Relevance to project
Victorian Legislation:		
Environment Effects Act 1978 (Vic) (EE Act) Administered by Department of Transport and Planning (DTP)	The EE Act provides that the proponent of a development can be required by the Minister for Planning to prepare an Environmental Effects Statement (EES). The EE Act establishes a process for assessing the potential environmental effects of a proposed development.	Outlines the requirements for preparing an EES in Victoria and provides scoping requirements relevant to the marine environment issues to be addressed.
Environment Protection Act 2017 (Vic) ('EP Act') Administered by EPA Victoria	The EP Act 2017 replaces the *Environment Protection Act 1970*. The EP Act (Vic) was amended by the *Environment Protection Amendment Act 2018* (Vic) and other Acts and came into force on 1 July 2021. The EP Act gives the Environment Protection Authority (EPA) enhanced powers and tools to prevent and minimise the risks of harm to human health and the environment from pollution and waste.	Outlines the proponent's responsibility to meet the General Environmental Duty that requires all Victorians to manage their activities to minimise the risk of harm to human health or the environment from pollution or waste so far as reasonably practicable.
Flora and Fauna Guarantee Act 1988 (Vic) (FFG Act) and *Flora and Fauna Guarantee Amendment Act 2019* Administered by DEECA	Enables and promotes the conservation of Victoria's native flora and fauna and to provide for a choice of procedures, which can be used for the conservation, management or control of flora and fauna and the management of potentially threatening processes. Requires consideration of biodiversity across State government departments and consider climates change. Gives effect to a consistent national approach to assessing and listing threatened species using the Common Assessment Method (CAM) (DAWE, 2022a) under the CAM Memorandum of Understanding (DoE, 2015a).	Conservation of Victorian marine flora and fauna and management of potentially threatening processes. A list of native marine flora and fauna known or likely to be present in the project is given in Section 6.3 (Marine Biological Environment). Provides updated lists of threatened species of flora and fauna, some of which are in the marine environment. Permits are required to take, remove, or disturb listed and/or protected flora species, listed communities and fish on public land.
Marine and Coastal Act 2018 (Vic) ('MC Act') Administered by DEECA	The MC Act provides an integrated and coordinated approach to planning and managing the marine and coastal environment by enabling protection of the coastline and the ability to address the long-term challenges of climate change, population growth and ageing coastal structures ensuring that partners work together to achieve the	The project will require consent under the Marine and Coastal Act 2018 for any proposed use, development or works that is to be located on marine and coastal Crown land.

Legislation/regulation/policy	Description	Relevance to project
	best outcomes for Victoria's marine and coastal environment. Marine and Coastal Policy 2020 provides direction to decision makers including local councils and landholders on a range of issues relating to the planning, management and sustainable use of coastal and marine environments, including the impacts of climate change, population growth and ageing coastal structures. The policy applies to the planning and management of all private and public land and waters between the outer limits of the Victorian coastal waters (3 nautical miles from the high water mark) and five kilometres inland of the high water mark, including 200 metres below the surface of that land.	
National Environment Protection Council (Victoria) Act 1995 (Vic) (NEPC Act) Administered by NEPC	The NEPC Act establishes the National Environment Protection Council (NEPC). It is made up of a Minister from the Commonwealth and each State and Territory. This is to ensure that people are equally protected from air, water soil and noise pollution, no matter where they live in Australia.	Outlines framework for conservation of biological diversity and integrity, during the environmental impact assessment process for the project.
Pollution of Waters by Oils and Noxious Substances Act 1986 (Vic) (POWBONS Act) Administered jointly by the EPA and Department of Transport	The POWBONS Act aims to protect Victorian sea and other waters from pollution by oil and noxious substances and to implement the MARPOL 1973/1978 Convention.	Outlines pollution management requirements for project vessels, including the implementation of marine pollution requirements in Victorian waters, which gives effect to the MARPOL 1973/1978 International Convention on marine pollution.
Emergency Management Act 2013 (Vic) ('EM Act') Administered by Emergency Management Victoria	The EM Act establishes governance arrangements for emergency management in Victoria.	Provides framework for marine emergency management plans to be integrated with the governance arrangements described in the EM Act (Vic).
Fisheries Act 1995 (Vic) (Fisheries Act) and *Fisheries Amendment Act 2015* (Vic). Administered by the Victorian Fisheries Authority (VFA)	The Fisheries Act provides a legislative framework for the regulating, managing, and conserving Victoria's marine fisheries including fishery habitats.	Provides framework for assessing effects on target fish species listed under the Fisheries Act, including those Protected Aquatic Biota listed under the FFG Act. Provides framework for informing the AMSA (Notices to Mariners) and the Victorian Fisheries Authority of any temporary fishing exclusion

Legislation/regulation/policy	Description	Relevance to project
		zones around the project's construction (cable installation) activities or operations (e.g., non-anchoring areas)
Environmental Protection Regulations:		
Wildlife (Marine Mammals) Regulations 2019 (Made under sections 85A and 87 of the *Wildlife Management Act 1975* (Vic) Administered by Conservation Regulator Victoria	Provides for long-term protection of marine mammals by prescribing minimum approach distances for marine mammals, prohibiting, or regulating activities in the vicinity of marine mammals, and prescribing conditions for marine mammal watching.	Relevant in respect of the project's vessel approach distances, prohibiting or regulating the project's activities in the vicinity of whales and seals.
Fisheries Regulations 2019 Administered by the Victorian Fisheries Authority (VFA)	The Fisheries regulations set out the management arrangements for commercial and recreational fishing. Provide for matters prescribed under the Fisheries Act.	Relevant to marine resource use components such as commercial fisheries, and recreational fishing and boating. Sources of information on catch limits and minimum sizes of marine fish and macroinvertebrates.
Environment Protection Regulations 2021 Administered by EPA Victoria and local councils	The regulations further the purposes of, and give effect to, the EP Act, such as by imposing obligations in relation to environmental protection, pollution incidents, and contaminated land and waste.	Part 5.4–Discharge or deposit of waste from vessels into marine water environment. Note that Commonwealth acts or regulations may also apply to the disposal of waste from vessels

Source: Various Victorian Government legislation web sites.

3.2.1 Environment Effects Act 1978 (VIC)

The EE Act provides for assessment of proposed projects that may have a significant effect on the environment. This is achieved by enabling the Minster administering the EE Act to decide whether an EES should be prepared or not.

In general, the Minister may typically require a proponent to prepare an EES when:

- There is a likelihood of regionally or State significant adverse effects on the environment.
- There is a need for integrated assessment of potential environmental effects (including economic and social effects) of a project and relevant alternatives.
- Normal statutory processes will not provide a sufficiently comprehensive, integrated, and transparent assessment.

The EES process provides for the analysis of potential effects on environmental assets and the means of avoiding, minimising, and managing adverse effects. It also includes public involvement and the opportunity for an integrated response to a proposal.

3.2.2 Environment Protection Act 2017 (Vic)

Under the EP Act the State environment protection policies (SEPPs) and Waste Management Policies (WMPs) no longer have a formal legal role since 1 July 2021. However, the EP Act introduces new duties such as the general environmental duty (GED) and new subordinate instruments.

Some of the content of former SEPPs and WMPs have been translated into more fit-for-purpose subordinate instruments, as follows:

- The Environment Reference Standard 2022 (ERS) includes environmental values, indicators, and objectives, which equate to the beneficial uses, indicators, and objectives in SEPPs.
- Clauses that are intended to be enforceable are included (with changes) in the Environment Protection Regulations 2021 (for example, where they set a clear requirement on a type of industry activity).
- Clauses that contain decision-making rules are included (with some changes) in the Environment Protection Regulations 2021 (for example, rules that EPA Victoria must follow when assessing a permission application).

3.3 Tasmania

Tasmanian State legislation, regulations, and policies relevant to the project are summarised in Table 3.3.

Table 3-3: Tasmanian legislation, regulations, and policies relevant to the project

Legislation/Regulations/Policies	Description	Relevance to the project
Legislation:		
Living Marine Resources Management Act 1995 (Tas) (LMRM Act) Administered DNRE Tasmania	The LMRM Act is the principal act that promotes the sustainable management of living marine resources in Tasmania, which enables protected areas to be declared. This act protects vulnerable fish species and their habitats and allows the establishment of scientific reference areas and public education in the resources, protection and use of the marine environment.	Outlines LMRM Act's protection of vulnerable fish species and their habitats, and any protected areas of scientific interest, to be considered when assessing the impacts of the project.
Environment Management and Pollution Control Act 1994 (Tas) (EMPCA) Administered by the Tasmania EPA	The EMPCA is the primary environmental protection legislation in Tasmania. The basis of the EMPCA is prevention, reduction and remediation of environmental harm. In Tasmania, the responsibility for environmental management is shared by the EPA and local councils under the EMPCA.	Requires the EPA to provide guidance to the proponent on what should be included in the EIS.
Resource Management and Planning System (RMPS)	(RMPS) was established in 1994 and is an integrated framework that is supported by several acts. Schedule 1 of EMPCA lists the RMPS objectives. The objectives of the RMPS are to: • Promote the sustainable development of natural and physical resources and the maintenance of ecological processes and genetic diversity. • Provide for the fair, orderly and sustainable use and development of air, land and water. • Encourage public involvement in resource management and planning.	The four acts that support the RMPS and are relevant to this EIS/EES are: • *Land Use Planning and Approvals Act 1993* (Tas) • *State Policies and Projects Act 1993* (Tas) • *Environmental Management and Pollution Control Act 1994* (Tas)

Legislation/Regulations/Policies	Description	Relevance to the project
	• Facilitate economic development in accordance with the RMPS objectives. • Promote the sharing of responsibility for resource management and planning between the different spheres of government, the community and industry in the State.	• *Historic Cultural Heritage Act 1995* (Tas)
Threatened Species Protection Act 1995 (Tas) (TSP Act) Administered by DNRE Tasmania	The TSP Act provides for the protection and management of threatened native terrestrial and aquatic plant and animals. Several marine species are listed including whales, seals, seabirds, fishes, and invertebrates.	Outlines Tasmanian threatened species of native marine plants and animals, in addition to those identified by EPBC Act MNES PMST Results Report for nearshore Tasmania (PMST, 2023; Attachment C), to be considered in the impact assessment
Nature Conservation Act 2002 (Tas) (NC Act) Administered by DNRE Tasmania	The NC Act provides for the conservation and protection of all native coastal and marine wildlife (excluding "fish", as defined in the LMRM Act), and the creation of marine reserves.	Regulates the protection and conservation of fauna, flora and geological diversity within Tasmania and establishes values and objectives for management of reserved lands.
Marine-related Incidents (MARPOL Implementation) Act 2020 (Tas) (MIMI Act) Administered by DNRE Tasmania	The MIMI Act deals specifically with discharges of oil and other pollutants from ships within Tasmanian waters, giving effect to the MARPOL international convention on marine pollution.	Adherence of project vessels or contracted vessels to marine pollution requirements in Tasmanian waters, which gives effect to the MARPOL 1973/1978 International Convention on marine pollution.
State Coastal Policy Validation Act 2003 (Tas) (SCPV Act) Administered by Department of Premier and Cabinet (DPAC)	The SCPV Act validates the State Coastal Policy 1996 (see below) and amends the coastal zone to include State waters and all land to a distance of one kilometre inland from the high-water mark.	Outlines State Coastal Policy provisions within nearshore waters.
Biosecurity Act (Tas) Administered by DNRE Tasmania	The Biosecurity Act provides a legal framework and creates a General Biosecurity Duty (GBD) for the management of pests, diseases and invasive species, and biosecurity emergencies.	Outlines requirements for a proponent to maintain its statutory duty of care (GBD) in the avoidance or management of biosecurity risks.
Regulations:		
Fisheries (General and Fees) Regulations 2006 (FGF Regulations)	The FGF Regulations prohibits the taking or possession of certain protected marine fauna.	• The FGF Regulations outlines protected species, which may be

Legislation/Regulations/Policies	Description	Relevance to the project
Administered by DNRE Tasmania		present in the study area
Policies:		
State Coastal Policy 1996 (Tas) (Revised 16 April 2003) in accordance with the *State Coastal Policy Validation Act 2003* (Tas).) Administered by EPA Tasmania	Main principles are to protect natural and cultural values of the coast, sustainable development of the coast, and integrated management and protection of the coastal zone.	Relevant to interconnector landfalls and shore crossing aspects of the project.
State Policy on Water Quality Management 1997 (SPWQM) Administered by EPA Tasmania	The SPWQM aims to protect marine ecosystem water quality and recreational water quality and aesthetics. The State Policy on Water Quality Management (1997) provides a framework to manage water quality for all Tasmanian surface waters. Section 7.1 of the policy states that "Water quality objectives may be set for surface waters and groundwaters in Tasmania by determining which protected environmental values (PEVs) should apply to each body of water".	Assessment of water quality impacts to consider the state water quality policy, which is based on the Australian Water Quality Guidelines for Fresh and Marine Waters (ANZG, 2000, 2018), and Section 41 (Waste from ships) and Section 43 (Discharge of Ballast Water) in Tasmanian waters.

Tasmania's Resource Management and Planning System provides the overarching framework for the management of natural resources. The planning system's primary objectives include sustainable development while ensuring the maintenance of ecological processes and genetic diversity.

The State Government recognised the need for a policy direction to guide the management of the State's coastal resources on a sustainable basis. As a result, the Government initiated coastal management reforms including the *Living Marine Resources Management Act 1995* (Tas), and the introduction of a State Coastal Policy.

3.3.1 Tasmanian Regulations

Two Tasmanian regulations are relevant to threatened species legislation and are described below.

3.3.1.1 Fisheries (General and Fees) Regulations 2006

Fisheries (General and Fees) Regulations 2006 under the LMRM Act prohibits the taking or possession of certain protected marine fauna, which are outlined below.

Protected marine fishes include:

- Any species of pipehorse, pipefish, seahorse or seadragon of the family *Syngnathidae*.
- Handfish of the family *Brachionichthyidae*:
    - spotted handfish (*Brachionichthys hirsutus*)
    - red handfish (*Thymichthys politus*)
    - Ziebell's handfish (*Brachiopsilus ziebelli*)
- Threefin blennies of the genus *Forsterygion*.
- Five species of shark:
    - great white shark (*Carcharodon carcharias*)
    - basking shark (*Cetorhinus maximus*)

  - grey nurse shark (*Carcharias* taurus)
  - megamouth shark (*Megachasma pelagios*)
  - whale shark (*Rhincodon typus*)

Protected marine invertebrates include:

- Elephant snail (*Scutus antipodes*)
- Limpets belonging to the superfamilies *Fissurellacea*, *Patellacea* and *Siphonariacea*
- Gunn's screw shell (*Gazameda gunnii*)

3.3.2 Environment Protection Authority Tasmania

A review of the above Tasmanian legislation revealed that all references to noise pollution related to airborne noise and its potential effects on people. Explicit mention of waterborne or underwater noise was absent. However, the Board of EPA Tasmania can ensure that environmental issues (including underwater noise and vibration) are considered and accounted for in relation to the development of an EIS, draft management controls and planning and development processes. For example, EPA Tasmania's EIS guidelines in Section 2.3 (Tasmanian EIS/EES guidelines) includes the requirement to assess the impacts of underwater noise and vibration to marine fauna (pelagic and benthic).

3.4 International conventions, treaties, protocols, and obligations

Australia is a signatory to numerous international conventions and agreements that obligate the Commonwealth Government to take action to prevent pollution and to protect specified habitats, flora, and fauna. The following international conventions, protocols, and agreements have been considered and legislative provisions observed to the degree required in preparing this EIS appendix.

3.4.1 Maritime conventions

Relevant maritime conventions include:

- United Nations Convention on the Law of the Sea (1982).
- London Convention (1972), and 1996 Protocol, formerly London (Dumping) Convention (1972).
- International Convention for the Protection of Pollution from Ships, 1973 as modified by the Protocol of 1978 (MARPOL 73/78).
- International Convention on Oil Pollution Preparedness, Response and Co-operation (1990).
- International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties (1969).
- International Convention on Civil Liability for Oil Pollution Damage (1969).

3.4.2 Conservation conventions and agreements

Relevant conservation conventions and agreements:

- Convention on Biological Diversity (the Rio Convention, 1992).
- Convention on Wetlands of International Importance Especially as Wildfowl Habitat ('Ramsar Convention', 1971).
- Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention, 1979).
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1973.
- Convention on Conservation of Nature in the South Pacific (the Apia Convention, 1976).

- Bilateral Agreements on the Protection of Migratory Birds:
  - Japanese/Australian Agreement on the Protection of Migratory Birds (JAMBA).
  - Chinese/Australian Agreement on the Protection of Migratory Birds (CAMBA).
  - Republic of Korea–Australia Migratory Bird Agreement (ROKAMBA).
- Agreement on the Conservation of Albatrosses and Petrels (ACAP).
- Convention for the Protection of the Natural Resources and Environment of the South Pacific. United Nations Environment Programme (UNEP) and Secretariat of the Pacific Regional Environment Programme (SPREP) (the Noumea Convention, 1986).

3.4.3 Climate change conventions and protocols

Relevant climate change conventions and agreements include:

- United Nations Framework Convention on Climate Change (1992).
- Kyoto Protocol to the United Nations Framework Convention on Climate Change (1997).
- Montreal Protocol on Substances that Deplete the Ozone Layer (‘Montreal Protocol, 1987).
- Vienna Convention on the Protection of the Ozone Layer and the Montreal Protocol; on Substances that Deplete the Ozone Layer.
- UN Climate Change Conference (COP26) in Glasgow (‘The Glasgow Climate Pact’, 2021).

The agreement arising from the Glasgow COP26 conference, although not binding, will set the global agenda on climate change for the next decade. It was agreed that countries will meet next year to pledge further cuts to emissions of carbon dioxide (CO_2) – a greenhouse gas that causes climate change.

3.4.4 Industry codes of practice and guidelines

Installation and operation of electric transmission interconnectors in the marine environment are undertaken within the following industry codes of practice, guidelines, or policies:

- IAGC Environmental Guidelines for Worldwide Geophysical Operations (IAGC, 2001).
- Diving Medical Advisory Committee (DMAC). Report DMAC 12. Safe diving distance from seismic surveying operations. London, November 1979.
- Regulations to reduce ship-whale collision risks (IMO, 2009).
- Guidelines for the reduction of underwater noise from commercial shipping to address adverse impacts on marine life (IMO, 2014).
- International Cable Protection Committee (ICPC) is the body responsible for the management of the submarine cable industry and its mandate includes the protection, security, and safe interaction of international submarine cables with seabed and ocean users.
- Det Norske Veritas AS and Germanischer Lloyd SE (DNV GL) recommended practice for subsea power cables in shallow water (DNV GL, 2016).

4 Project description

4.1 Overview

The project is proposed to be implemented as two 750 MW circuits to meet transmission network operation requirements in Tasmania and Victoria. Each 750 MW circuit will comprise two power cables and a fibre-optic communications cable bundled together in Bass Strait and laid in a horizontal arrangement on land. The two 750 MW circuits will be installed in two stages with the western circuit being laid first as part of stage one, and the eastern cable in stage two.

The key project components for each 750 MW circuit, from south to north, are:

- HVAC switching station and HVAC-HVDC converter station at Heybridge in Tasmania. This is where the project will connect to the northwest Tasmania transmission network being augmented and upgraded by the North West Transmission Developments (NWTD).
- Shore crossing in Tasmania adjacent to the converter station.
- Subsea cable across Bass Strait from Heybridge in Tasmania to Waratah Bay in Victoria.
- Shore crossing at Waratah Bay approximately 3 km west of Sandy Point.
- Land-sea cable joint where the subsea cables will connect to the land cables in Victoria.
- Land cables in Victoria from the land-sea joint to the converter station site in the Driffield or Hazelwood areas.
- HVAC switching station and HVAC-HVDC converter station at Driffield or at Hazelwood, where the project will connect to the existing Victorian transmission network.

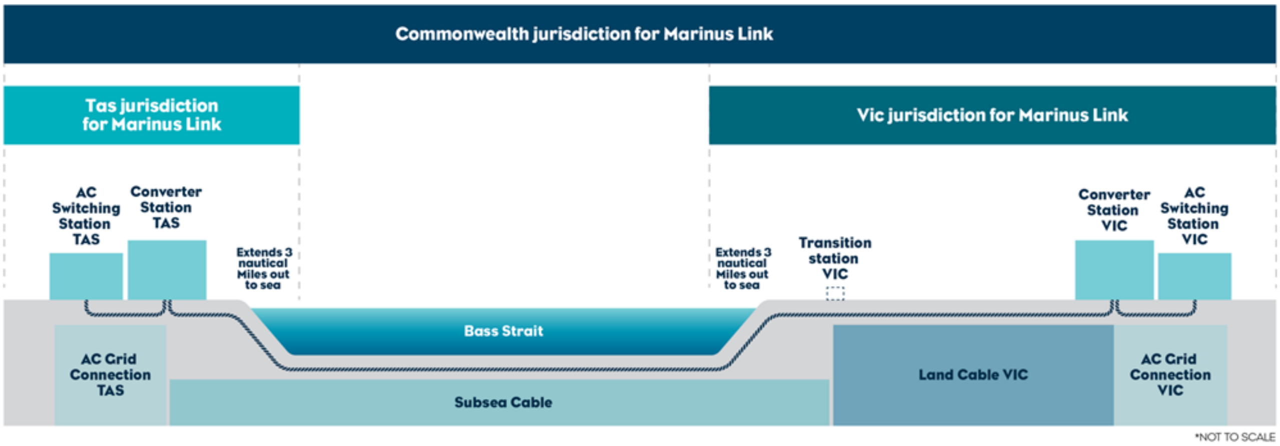
A transition station at Waratah Bay may also be required if there are different cable manufactures or substantially different cable technologies adopted for the land and subsea cables. The location of the transition station will also house the fibre optic terminal station in Victoria. However, regardless of whether a transition station is needed, a fibre optic terminal station will still be required in the same location. The key project components are shown in Figure 4.1.

In Tasmania, a converter station is proposed to be located at Heybridge near Burnie. The converter station will facilitate the connection of the project to the Tasmanian transmission network. There will be two subsea cable landfalls at Heybridge with the cables extending from the converter station across Bass Strait to Waratah Bay in Victoria. The preferred option for shore crossings is horizontal directional drilling (HDD) to about 10 m water depth where the cables will then be trenched, where geotechnical conditions permit.

Approximately 255 kilometres (km) of subsea HVDC cable will be laid across Bass Strait. The preferred technology for the project is two 750 megawatt symmetrical monopoles using ±320 kV, cross-linked polyethylene insulated cables and voltage source converter technology. Each symmetrical monopole is proposed to comprise two identical sized power cables and a fibre optic communications cable bundled together. The cable bundles for each circuit will transition from approximately 300 m apart at the HDD (offshore) exit to 2 km apart in offshore waters.

In Victoria, the shore crossing is proposed to be located at Waratah Bay with the route crossing at the Waratah Bay–Shallow Inlet Coastal Reserve.

The assessment is focused on the Victorian / Tasmanian / marine section of the project. The present report has focused on the marine components of the project. This report will inform the Tasmanian, Victorian and Commonwealth approvals being prepared to assess the project's potential environmental effects in its entirety across each jurisdiction in accordance with the legislative requirements of the Commonwealth, Tasmanian and Victorian governments (see Figure 4.1). Both the Tasmanian and Victorian jurisdictions extend 3 nautical miles out to sea from the high-water mark.



Source: MLPL (2022).

Figure 4.1 Project components considered under applicable jurisdictions

The project is proposed to be constructed in two stages over approximately five years following the award of works contracts to construct the project. On this basis, stage 1 of the project is expected to be operational by 2030, with Stage 2 to follow, with final timing to be determined by market demand. The project will be designed for an operational life of at least 40 years.

4.2 Construction

This section describes the construction methods applicable to the offshore, nearshore, and shore crossings of the project. Different construction methods will be used to prepare the seabed for cable installation within Bass Strait.

Pre-construction (early works) activities for the project have already been undertaken and included:

- Geophysical surveys of the seabed and subsea environment.
- Geotechnical surveys and seabed sampling.
- Seismic refraction surveys.

While the abovementioned geophysical surveys and geotechnical investigations have already been carried out and are not part of the current EIS impact assessment, some of the geophysical instruments (e.g., multibeam echosounders and side scan sonar) will also be used during the construction, operation, and decommissioning phases of the project. Underwater noise generated by these geophysical instruments and an assessment of their potential impacts on marine fauna are addressed in Section 7 (Impact assessment) and Attachment D (Supplementary Information: Underwater Noise Impact Assessment).

4.2.1 Pre-lay grapnel runs and route

The project alignment across Bass Strait and the Victorian and Tasmania nearshores need to be cleared of any obstacles that could interfere with the installation and burial of the cable bundles, or that could cause post-installation damage to the cable. Route clearance will be undertaken by a series of pre-lay grapnel runs (PLGRs) immediately prior to cable lay operations. The purpose of the PLGR operation is to clear any uncharted debris from the project alignment that were not detected during the 2019 marine survey or that have been deposited since that survey. Typical seabed obstacles or marine debris will typically include discarded fishing nets, anchor chains, and out-of-service cables.

The PLGR method involves towing a grapnel along the seabed within the planned project alignment, which is typically undertaken at a towing speed of between 1 and 1.5 knots. The grapnel will be deployed using a winch wire and be capable of penetrating a depth of up to 0.5 m and a width of 20 cm in soft seabed, but will depend on the changing seabed conditions along the route. During towing, the actual towing line passes over a sensitive dynamometer so that tension on the winch wire is constantly monitored onboard the tow vessel. If seabed debris is detected by tension increases in the towing winch wire, the grapnel will be recovered (i.e., winched in) and the attached debris stored on deck for subsequent appropriate disposal onshore including recycling of anchor chains or wire ropes. Stubborn marine debris (e.g., wire ropes) may need to be cut in-situ by a separate grapnel tool fitted with a cutting device.

In proximity to third party in-service cables (e.g., Telstra 1 and Alcatel's Indigo Central telecommunication cables) or out-of-service pipelines (e.g., the disused marine outfall pipelines of the former Tioxide Australia plant at Heybridge) that will need to be crossed by the project's subsea cables, the PLGR operation will be halted within 250 m either side of the crossing point. This mitigative measure ensures that the PLGR operation does not interfere with existing third-party seabed infrastructure in Bass Strait. The 250 m buffer either side of the crossing point is based on the ICPC (2023a) recommendation that, where a cable or pipeline to be crossed has been positively identified by sensors during a survey of the project alignment, then a nominal 500 m separation can be reduced to 250 m with agreement from the owner of the crossed cable or pipeline.

Prior to cable lay operations, shore-end construction activities will be undertaken at the Tasmanian and Victorian landfalls. The principal shore-end construction activity proposed for the project's subsea cables at landfall involves horizontal direction drilling (HDD).

4.2.1.1 Tasmanian shore-end construction activities

Due to the presence of a main road (i.e., the Bass Highway) and disused railway line (i.e., the Western Line) between the Heybridge converter site and the foreshore, MLPL has proposed that the Tasmanian shore crossing will be achieved using HDD. In general, HDD is a trenchless method that does not disturb the overlying dunes, roads, railways, or shore crossing vegetation.

HDD installations comprise a three-stage process involving drilling a pilot hole, reaming (hole opening), and followed by inserting a high-density polyethylene (HDPE) pipe (duct) that will be pulled to shore through the reamed hole by a winch cable. The individual HDD ducts will be spaced about 50 m apart.

Up to 10,000 m^2 of land is required for each of the two HDD drill pads (dimensions 100 m by 100 m) that are required for stage 1 construction (western monopole (ML1) cables) and stage 2 construction (eastern monopole (ML2 cables). Both HDD drill pads will be located within the Heybridge converter station site, which will be temporary as they are only required for construction purposes. Three boreholes will be drilled from each of the two proposed drill pads. The HDD shore crossings will be drilled continuously over 24 hours and 7 days per week to ensure borehole stability. It is anticipated that the total HDD process will take approximately 8 months for both stage 1 and stage 2 construction phases, which includes activities from site establishment to demobilisation of the HDD drill rigs.

However, 12 months has been allowed to take into consideration weather and other unforeseen circumstances.

The onshore HDD rigs will bore through competent rock with their seaward exit holes located within the sand-filled palaeochannels in the rock platform that extends offshore from the beach at Heybridge. At this juncture, the HDD trajectories from the onshore HDD rigs to the western palaeochannel for ML1 cables are expected be about 800 m long and about 1,200 m long to the eastern palaeochannel for ML2 cables. Figure 4.2 shows a schematic diagram of a typical long trajectory HDD proposed for the Tasmanian shore crossing.

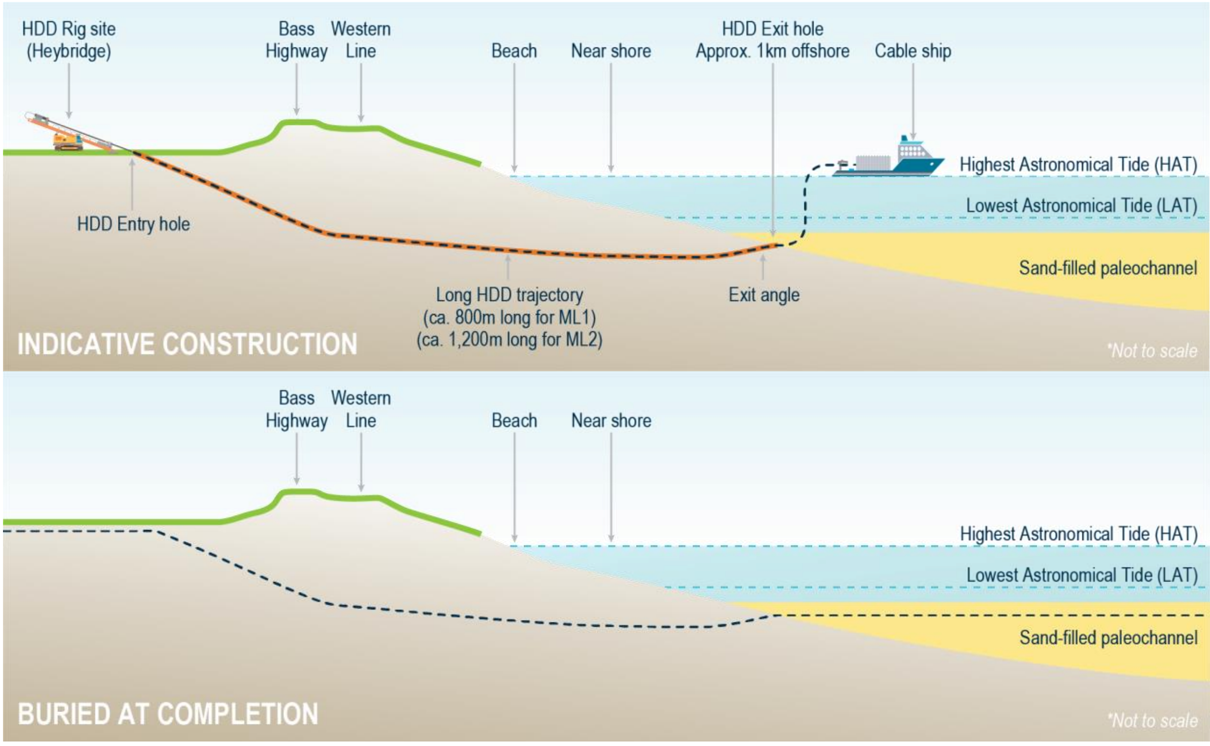


Figure 4.2: Long trajectory HDD proposed for the Tasmanian shore crossing

4.2.1.2 Victorian shore-end construction activities

The Victorian shore crossing is environmentally more sensitive than the Tasmanian shore crossing due to the presence of the Waratah Bay Foreshore Reserve, which is an extension of the Shallow Inlet Marine and Coastal Park (see Section 6.3.2.4, Victorian marine reserves and coastal parks). Figure 4.3 shows a schematic diagram of a typical long trajectory HDD proposed for the Victorian shore crossing.

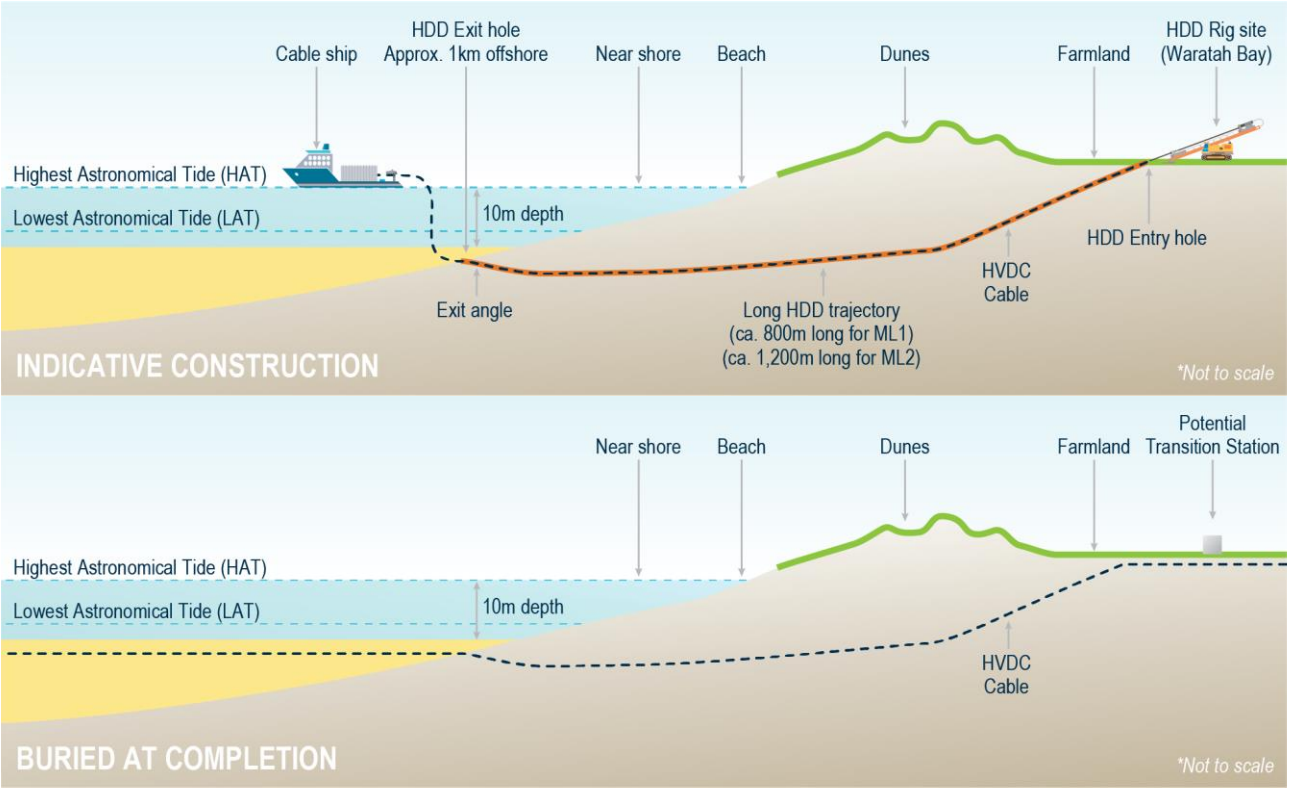


Figure 4.3: Long trajectory HDD proposed for Victorian shore crossing

4.2.2 Cable lay installation, burial, and protection

This section describes the cable lay vessels, cable lay operation, and methods of cable installation, burial and protection.

4.2.2.1 Cable lay vessel

The marine-rated cross-linked polyethylene (XLPE) HVDC power cables are expected to be manufactured in 125-km long sections, pre-tested in the factory of manufacture, and then loaded onto an appropriately sized cable lay ship. The cable lay ship (yet to be selected) will transport the cable lengths from a port in either northern Europe or Japan to the Port of Melbourne, Port Burnie, or Devonport in advance of cable lay operations.

Plate 4.1 shows an example of a large capacity cable lay ship, namely the Prysmian Group's cable lay ship C/S *Giulio Verne*, which was used to lay the subsea cables for the Basslink interconnector across Bass Strait in 2005.

Source: Prysmian Group (2022).

Plate 4.1: Example of a large cable lay ship, the CS *Giulio Verne*

The cable lay ship used for the installation of each circuit will need to have two turntables, one for each power cable, and a separate turntable (also known as a 'tank') for the optical fibre cable. Plate 4.2 shows the presence of two HVDC cable turntables and an optical fibre cable tank, which are of sufficient capacity to lay the cables in two phases with only one offshore subsea joint per cable in central Bass Strait.

Prior to the shore-end cable lay, installation and burial at the Tasmanian or Victorian landfalls, the loaded cable lay ship will position itself immediately offshore at about the 15-m water depth and pay out the cables for pulling shoreward to the HDD marine exit hole ducts as required. The process of cable laying, installation and burial is similar for both the Tasmanian and Victorian landfalls.

4.2.2.2 Shore-end cable lay and installation

The cable lay ship will approach nearshore waters in both Tasmania and Victoria and maintain station using dynamic positioning (DP) over a water depth of 15 m to allow clearance of the ship's draught (about 6 m) and for safety reasons. No anchor spread, spuds or other devices in contact with the seabed will be used as the cable lay ship can readily maintain its position using its thrusters in DP mode.

The first HVDC cable will be conveyed over one of the cable chutes at the stern of the cable lay ship and shipboard operatives will attach buoyant floats as the cable is payed out. An example is shown in Plate 4.3 (a). As the buoyant cable is payed out and floats at the water surface, a fleet of around five to seven small, outboard motor-driven or shaft-driven boats or tenders will be used to configure the floating cable out into an 'omega' shape (i.e., to reduce the risk of cable kinks or twists during the pull operation), which also facilitates the subsequent cable pull to shore. Plate 4.3 (b) shows an example of a fleet of small boats maneuvering a floated HVDC cable to shore. This is a common shore-end practice as the floated cable can be pulled to shore faster from a floating omega configuration than would be the case if the cable was pulled directly from the cable lay ship, since the cable pay out rate from the cable lay ship is slower, due partly to the need to periodically attach flotation devices (e.g., air bags) to the cable.

Source: Prysmian Group (2022).

Plate 4.2: C/S *Giulio Verne* with HVDC cable turntables and an optical fibre cable tank

In addition, the slack afforded by forming the 'omega' configuration allows flexibility in the floated cable such as site-specific manoeuvring of the floating the cable over sand-filled channels (or other soft seabed areas among areas of hard seabed) for subsequent burial by wet jetting.

(a) Boat operatives attaching floats to cable	(b) Small boat fleet manoeuvring floated cable

Source: Plate (a) The Diving Co. (2022); Plate (b) Europacable (2012)

Plate 4.3: Cable float installation and floated cable manoeuvring to shore

The long trajectory HDD duct exit hole will be within the sublittoral zone at about 10 m water depth, which obviates the need for any beach trenching. The submerged end of the HDD duct exit hole is normally sealed until cable insertion time is near. Typically, divers will remove the seal plate and the

duct is flushed with water to clean out any accumulate sediments in the duct. The same divers will place a bellmouth[1] in the HDD duct exit hole, which is typically used to guide the cable being winched through the HDD duct. Plate 4.4 shows an example of a bellmouth and an HVDC cable being winched through the exit hole of a subsea HDD duct.

	
(a) Bellmouth being attached to HDD duct	(b) Cable inserted into HDD duct to be winched

Source: The Diving Company (2022).

Plate 4.4: Example of subsea HDD duct exit hole and HVDC cable insertion

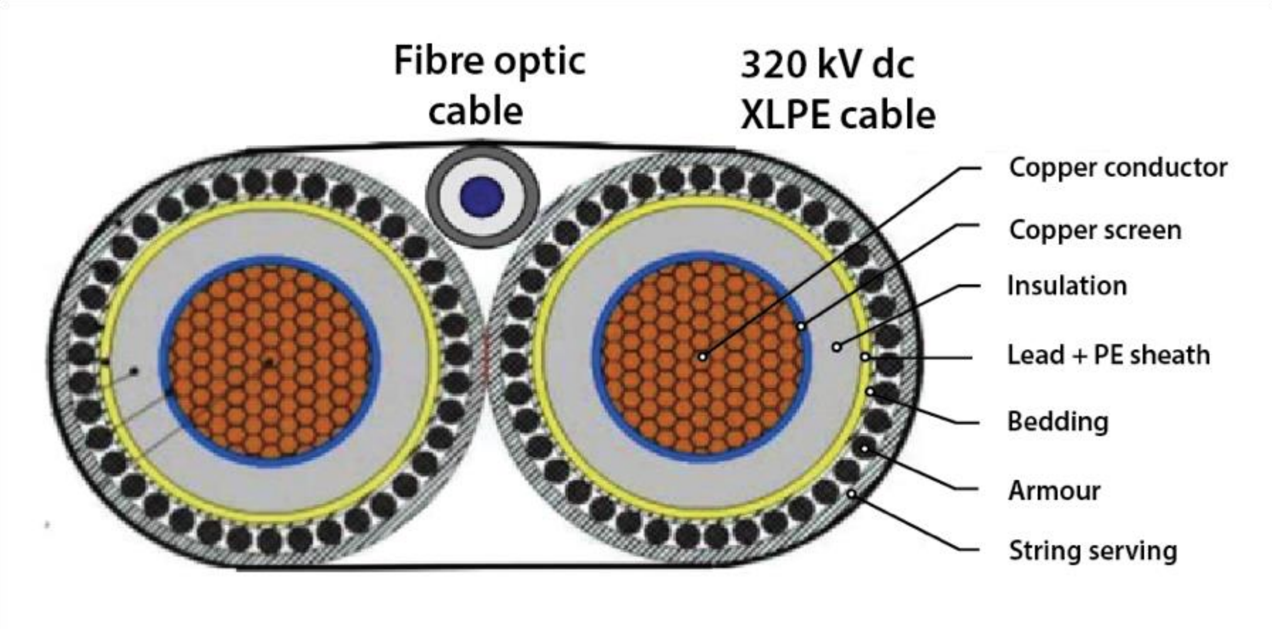
The onshore winch cable is pulled through the HDD duct and connected to the end of the floated cable from the cable lay ship, and the cable is then pulled through the HDD duct to the onshore jointing pit for subsequent connection to its equivalent land cable.

4.2.2.3 Offshore cable lay installation and burial

For the purposes of the present report, it is assumed that offshore cable lay will commence from the 20 m water depth within the Tasmanian nearshore to the 20 m water depth within the Victorian nearshore, which covers 98% of the Bass Strait traverse.

Offshore cable laying may commence once the individual HVDC cables and optical fibre cable have been landed and connected to the Tasmanian onshore joint pit. The cable lay ship will commence travelling northwards while onboard machinery will bundle the cables together with straps and pay out the bundled cable over one of its stern chutes. A schematic diagram of the bundled cable horizontal configuration is shown in Figure 4.4.

[1] A bellmouth is a bell-shaped extension fitted to the flange of an HDD duct exit hole, which aids cable guidance of a subsea cable as it is winched into the HDD duct.



Source: Tetra Tech Coffey (2022).

Figure 4.4: Proposed horizontal configuration of the bundled cables

The subsea cables will be laid in two campaigns, with the cable lay ship re-supplied either from the factory or with cable from a cable transport vessel. Re-supply of the cable lay vessel will occur in port. Cable laying can occur all year round. However, during late spring to summer months there is less impact from weather conditions. Overall, it is expected that only one offshore subsea cable joint will be required for each stage (i.e., ML1 and ML2) of the 255-km long Bass Strait crossing. An example of a large cable lay ship with the capacity to accommodate two HVDC power cable turntables and an optical fibre cable tank is the cable lay ship CS *Giulio Verne* (see Plate 4.1 above), which was used for the first HVDC interconnector installation across Bass Strait in 2003 and 2004 by Basslink Pty Limited (NSR, 2002).

The cable lay ship will be used for the installation of the first stage western ML1 monopole and the second stage eastern ML2 monopole. The HVDC power cables and optical fibre cable for each stage will be bundled and tied together using polypropylene rope and cable ties as the cables are unspooled and lowered over the back of the vessel to the seabed.

Plate 4.5 shows an example of a bundled cable in the process of being paid out at the stern of a cable lay ship. The proposed bundled cable configuration will comprise two HVDC cables and an optical fibre cable.

Source: Basslink (2004).

Plate 4.5: Example of bundled cables being laid offshore

The cable lay ship will lay the bundled cables on the seabed at a speed of about 1.5 knots in a northerly direction for about 125 km, which will take approximately 3 days to lay the first cable length. The end of the first cable length will be encased in waterproof sealants and lowered to the seabed with an attached rope or steel wire rope connected to marker buoy at the sea surface. The cable lay ship will then travel to the European or Japanese port used by the cable manufacturers, to reload its carrousels with the next 125 km lengths of new cable. On return, the cable lay ship operator will retrieve the bundled cables from the seabed and splice the new cables to the existing cables, and then continue its offshore cable laying operation.

Once the individual cables have been laid and installed in nearshore Victoria and connected to the land cables in the jointing pit, the second offshore campaign bundled cable burial may commence. It is assumed that during the first cable laying campaign, the cable on the seabed will have been buried by a tracked wet jetting trenching machine (see below). The environmental and marine resource use impacts of offshore cable lay activities are assessed in Section 7.2.7 (Construction impacts on marine resource use).

4.2.2.3.1 Offshore cable burial and protection

MLPL propose a post-lay burial of the offshore bundled cables using a remotely operated vehicle (ROV) trencher with umbilical to an offshore supply vessel (OSV), and one or two smaller vessels assisting post-lay cable burial operations such as guard vessels to alert any approaching ships or other vessels.

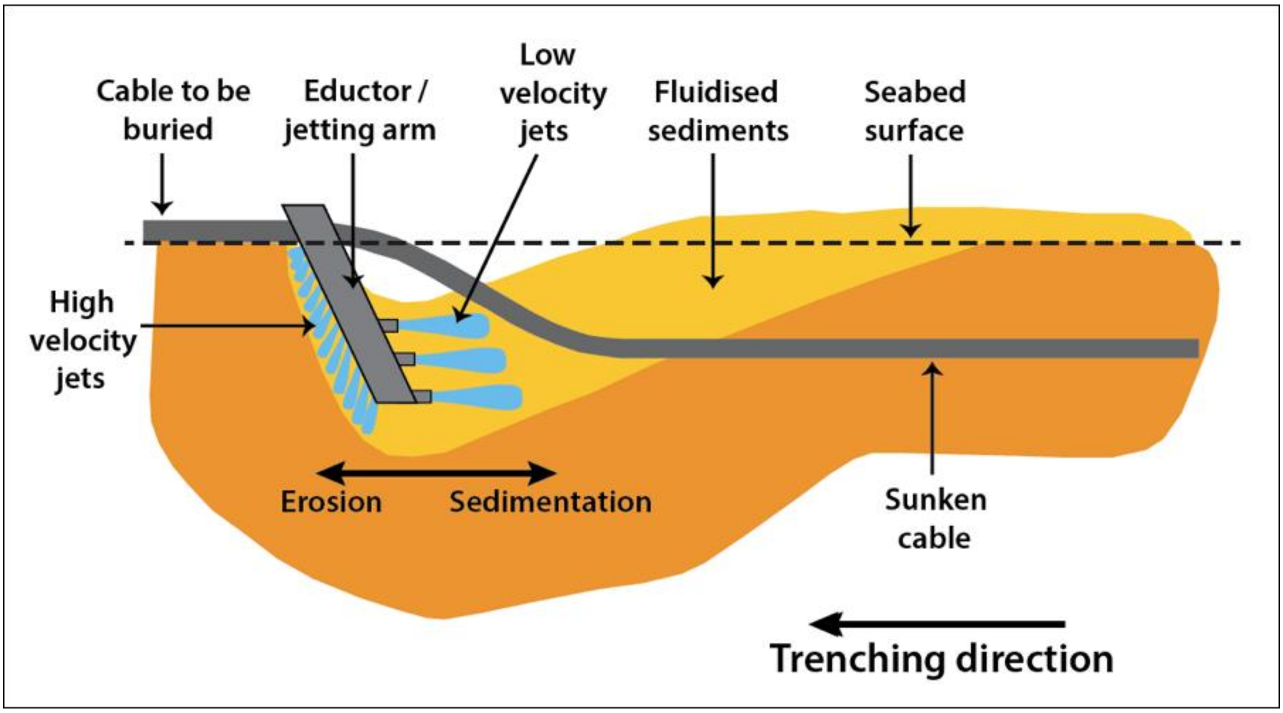
Jet trenchers are large machines of variable dimensions, depending on the manufacturers and the requirements of operators. For example, a typical ROV jet trencher is the Helix T-1200 ROV Trencher (Helix, 2022), which has a width over tracks of 5.60 m, a length of 9.15 m and a height of 5.16 m. Plate 4.6 shows the Helix T-1200 Trencher but another jet trencher model or other type of jet trenching machine may be adopted by the MLPL's subsea engineering contractor.

Source: Helix (2022).

Plate 4.6: Example of a cable trencher – the Helix T-1200 Trencher™

The trencher is equipped with two jetting "swords", each comprising an eductor fitted with high- and low-velocity water jet nozzles. Figure 4.5 shows a schematic longitudinal section of the wet jetting process to sink and bury an individual cable or bundled cables. At the start of the cable burial operation, the high-pressure water jets of the twin swords are turned on and the swords are lowered simultaneously into the seabed sediment. Adjustable jetting nozzles distributed on the jetting swords to fluidise in front and between the swords. The twin swords straddle the as-laid cable bundle and fluidises the sediment, which allows the bundled cable to sink into the seabed under its own weight. The low-pressure water jets maintain the fluidisation and suspension of sediments for an extended duration to ensure that the cable bundle continues to sink under its own weight to the designed depth of burial, which is a nominal 1 m, but may vary between 0.75 and 1.5 m depending on the nature and particle size distribution of the seabed sediments.

Trenching speeds of the Helix T-1200 Trencher can vary depending on mode (tracked or skid), seabed sediment conditions, diameter of the individual cable or bundled cables, and the required depth of trench required. However, speeds of 400 m/h can be attained in sandy seabed whereas speeds of 80–150 m/h are achievable for conditions where seabed sediments are stiffer and harder to penetrate.



Source: Adapted from Njock et al. (2020).

Figure 4.5 Schematic of cable burial by a trencher

4.2.2.3.2 Non-buried cable protection

In the case of either short or long HDD ducting being employed at the Tasmanian or Victorian landfalls, the HVDC and optical fibre cables will be protected within the HDD ducts. In those cases where beach trenching is proposed, the cables will be protected by burial within the backfilled trenches. However, there several areas in nearshore or offshore Bass Strait where it Is not possible to install and bury the cable using the jet trencher:

- Areas where the cables are laid over hard seabed.
- Areas where the individual or bundled cables cross existing seabed infrastructure.

Cable protection methods are described below.

Tasmanian nearshore

In the Tasmanian nearshore, the cables will be buried within the sand-filled palaeochannels until the rock platform or hard substrata (e.g., rock platforms, low- or high-profile reefs or cobble and rock rubble) are encountered seawards of the palaeochannels. There are areas of seabed with hard substrata between the seaward extent of the sand-filled palaeochannels and deeper water at around 10 m depth. Given the anticipated short lengths of cable traversing across hard substratum, cable protection may be secured by loose rock dumping over seabed-exposed cable or by covering with concrete mattress, or a combination of both, to achieve a burial depth of a minimum of 1 m. Plate 4.7 shows an example of a concrete mattress (SPS, 2022).

Source: SPS International (2022).

Plate 4.7: Example of a concrete mattress

These hard seabed post-lay burial and protection methods serve to prevent movement and provide greater stability of the protected individual cables or bundled cables.

Victorian nearshore

Hydrographic surveys of the nearshore seabed in Victoria by Fugro (2021) and subsequent benthic habitat surveys by CEE (2019 and 2021) did not reveal the presence of hard seabed that will preclude wet trenching. However, if the subsea cable trencher cannot excavate the seabed in small areas of hard seabed, rock dumping or cable mattresses may be used to protect exposed cable length over hard seabed. However, the proposed alignment of the project's bundled cables crosses over the existing Telstra communications cable. Crossing methods over third-party seabed infrastructure are described separately below.

Offshore Bass Strait

Most of the seabed of offshore central Bass Strait is comprised of soft sediments within which wet trenching for cable installation and burial is readily achievable. However, both the western monopole (ML1) and eastern monopole (ML2) will have to cross Alcatel Indigo Central telecommunications cable in north central Bass Strait. The method of crossing third party seabed infrastructure is described in the following section.

4.2.2.3.3 Third party seabed infrastructure crossings

In those cases where the project alignment crosses out-of-service telecommunication cables (if present), the latter can be retrieved at the crossing points and cut on board a cable retrieval vessel. The cut sections of telecommunication cables will be transported offsite to appropriate waste disposal or recycling. In contrast, in those areas where in-service telecommunication cables are present, such cables will be protected by either targeted rock dumping of placement of rock mattresses or a combination both, and over which the project interconnector cable bundles will pass.

There are two existing in-service cables in Bass Strait that require crossing:

- Telstra's Bass Strait 1 cable within Waratah Bay (4.4 km from shoreline):
  - Western Link (ML1) crossing at -38.861° S and 146.085° E.
  - Eastern Link (ML2) crossing at -38.860° S and 146.086° E.
- Alcatel Submarine Networks' Central Indigo cable (57.5 km south of Waratah Bay shoreline):
  - Western Link (ML1) crossing at -39.339° S and 146.084° E.
  - Eastern Link (ML2) crossing at -39.339° S and 146.107° E.

MLPL will negotiate separate crossing agreements with Telstra and Alcatel Submarine Networks.

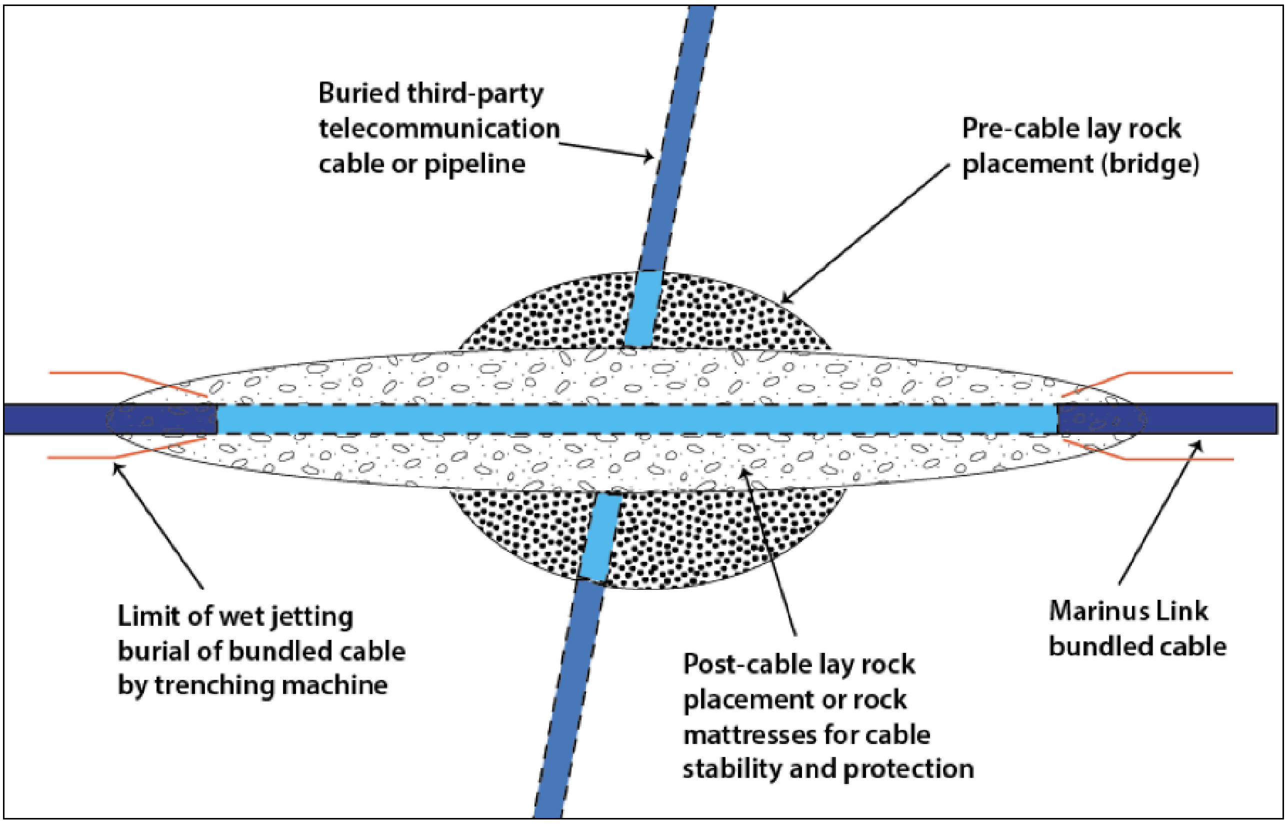
The offshore cable lay will avoid the above telecommunication cable locations by terminating 250 m from the cable crossing locations and then recommencing 250 m at the other side of the cable crossing locations. The final buffer zones will be decided by the project's subsea engineering contractor.

Figure 4.6 shows a schematic of a typical method for crossing third party seabed infrastructure, using a telecommunications cable or pipeline as an example.

In the Tasmanian nearshore, the Western Link (ML1) alignment intersects two out-of-service non-buried (exposed) effluent outfall pipelines of the former Tioxide Australia plant that operated at Heybridge. One out-of-service pipeline is 2.84 km long, while the other pipeline is 1.83 km long, and will be intersected at the following crossing locations:

- Western Link (ML1) crossing at -39.340° S and 146.083° E.
- Eastern Link (ML1) crossing at -39.339° S and 146.106° E.

Sections of these two pipelines may be cut either side of the Western Link (ML1) route and removed offsite for appropriate disposal or recycling. Alternatively, these disused out-of-service pipelines may be crossed using either targeted rock placement or concrete mattresses, or a combination of both.



Source: Adapted from PMSS (2017).

Figure 4.6: Example of method for crossing a third-party seabed infrastructure

4.3 Operation

The project's subsea interconnector will ideally operate 24 hours per day, 365 days per year over an anticipated minimum 40-year operational lifespan. However, servicing, testing and repairs includes scheduled minor outages or potential major outages.

During the project's operations, the maintenance activities proposed are:

- Mid-life refurbishment in years 10, 20 and 30.
- Seabed ROV inspection surveys in year two, year four and then every six years over the 40-year operational life.
- Remedial work every six years or as required.

No permanent exclusion zones will be established over either of the two monopoles (ML1 and ML2), which have a separation distance of 2 km.

The environmental and resource use impacts during operation are assessed separately in Section 7.3 (Operation impacts).

4.4 Decommissioning

The operational lifespan of the project is a minimum 40 years. At this time the project will be either decommissioned or upgraded to extend its operational lifespan.

Requirements at the time will determine the scope of decommissioning activities and impacts. The key objective of decommissioning is to leave a safe, stable, and non-polluting environment.

Decommissioning will be planned and carried out in accordance with regulatory and landholder requirements at the time. A decommissioning plan in accordance with approvals conditions will be prepared prior to planned end of service and decommissioning of the project. The decommissioning plan will outline how activities will be undertaken and potential impacts managed.

Decommissioning activities may include recovery of subsea cables and removal of land cable joint pits. The conduits and shore crossing ducts would be left in-situ as removal would cause significant environmental impact. Subsea cables would be recovered by water jetting or removal of rock mattresses or armouring to free the cables from the seabed.

MLPL will prepare a subsea cable Decommissioning Plan near the end of the project's life. According to DNV and GL (2016), a decommissioning evaluation should include a review of leaving the cables in situ and removal options including aspects such as:

- Relevant national and international regulations.
- Natural environment (benefits of not disturbing the seabed, possible pollution, future effects)
- Obstruction for surface navigation, also in comparison to existing installations, wrecks and debris
- Impact on fishing activities.
- Mobility of sediments and change of the cable presenting a hazard over time.
- Future management of an out-of-service cables.
- Technical feasibility and socio-economic benefits of cable removal.

For the purposes of the present report the abandonment and removal options are described below.

4.4.1 Decommissioning with power cables retained in situ

In general, it is considered less impactful to leave submarine infrastructure in place rather than remove it. Some components of the project could be retained in-situ such as the underground HDD ducts between land and the nearshore.

The main issues relating to subsea power cables retained in situ is the potential exposure on the seabed by bottom currents, which may result in anchor hook ups. The out-of-service cables also pose a risk to future subsea infrastructure projects, which may require to cross the disused cable alignments.

A secondary issue in the very long term is the slow release of trace metals released into seabed sediments and overlying seawater via corrosion of the disused cables over the centuries or millennia. The environmental and marine resource use impacts of cable retention in-situ are assessed in Section 7.4 (Decommissioning impacts).

4.4.2 Decommissioning involving subsea cable removal

In general, practical experience in removing decommissioned power cables is very limited.

DNV and GL (2016) recommended that subsea power cable removal should consider the following aspects:

- Relevant national and international regulations
- Minimisation of environmental impact.
- Competence, experience and insurance cover of salvage party.
- Health and safety of personnel.
- Scrap value of materials, in particular metals.
- Treatment and documentation of cable segments left in the seabed.

Partial removal of cable should not leave the remaining cable system in a more hazardous condition than prior to removal. Disused cable ends may require specific considerations such as weighing down (e.g., rock mattress or rock dumping) or burial may be required (e.g., by an ROV jetting machine). For the purposes of the present report, total removal of the decommissioned subsea cables has been assumed and is described below in order that decommissioning impacts of this option can be assessed (see Section 7.4, Decommissioning impacts).

In general, the removal of the project's subsea cables is a reverse of the cables' installation during construction. A similar spread of vessels is required for the removal process. Instead of a cable lay ship, a large cable removal vessel such as an offshore supply vessel (OSV) will be used as a cable recovery vessel to retrieve the bundled cable from the seabed and bring it to the surface. Onboard the cable recovery vessel, the cables will be cut into lengths of between 15 and 30 m for ease of handling, while also taking account of the vessel's deck length and width, as well as storage capacity.

The cable recovery vessel will undertake several campaigns as there will be a need to regularly offload cut cable lengths at a nearby port for appropriate disposal or recycling. It is likely that the cost of the salvaged materials (e.g., copper and other scrap metals) will surpass the costs of cable recovery operation, given the likely price of salvaged metals in 40 years' time. An alternative option may be to use a sea-going barge to the receive cut lengths of cable transferred by a davit or crane onboard the cable recovery vessel.

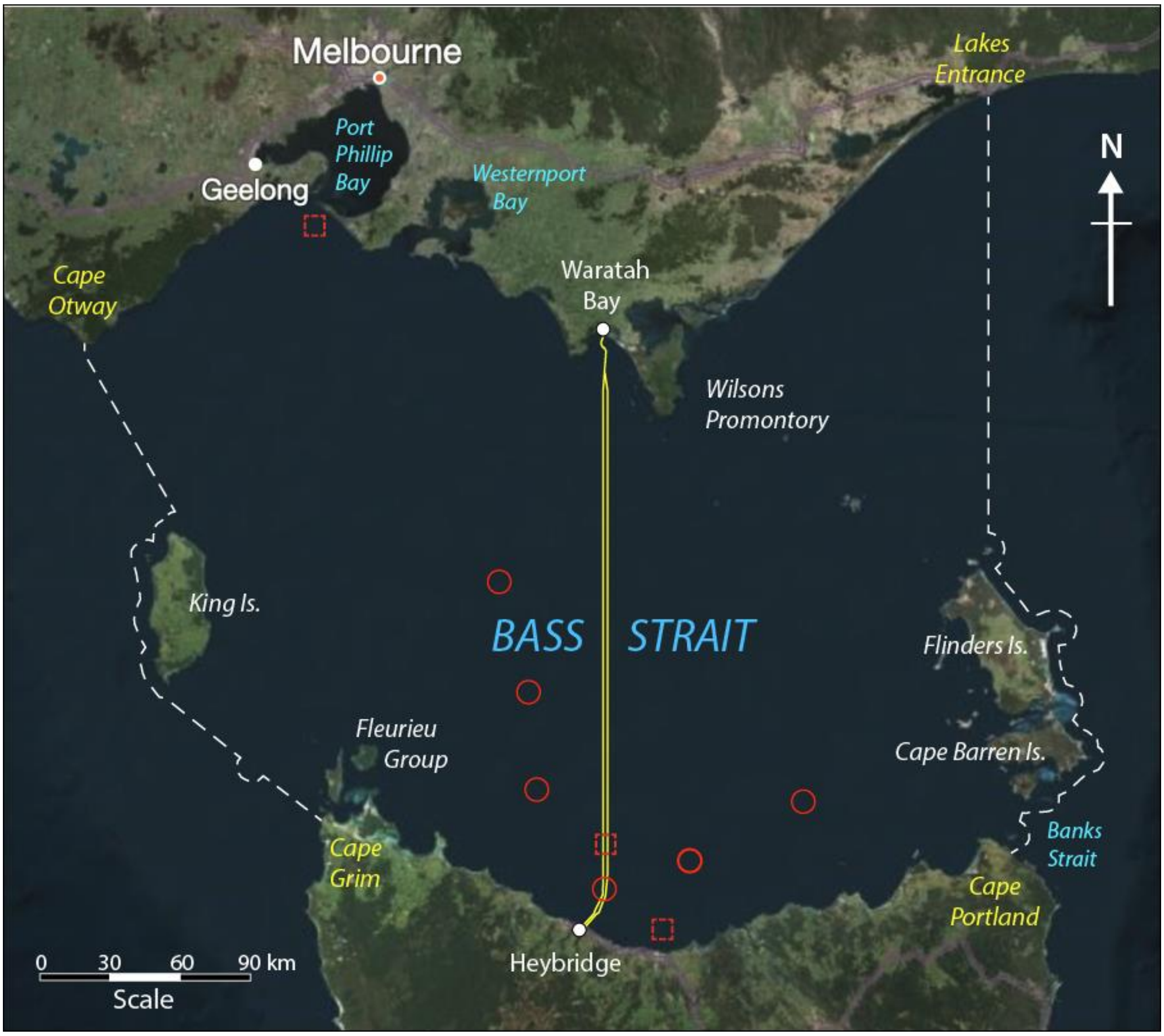
The cable recovery vessel will include one or two guard vessels, which will alert other third-party vessels and maritime users (e.g., fishing trawlers) uses of the restricted maneuverability of the cable recovery vessel and the suspended underwater cable bundle catenary between the vessel and sea floor.

The environmental and marine resource use impacts of cable removal are assessed in Section 7.4 (Decommissioning impacts).

5 Assessment methods

5.1 Study area

The study area encompasses the shallow-water environment of Bass Strait but excludes the continental shelves to the west and east of the strait. Figure 5.1 shows the study area for collating baseline information and data relevant to describing the existing environment.



Notes: Yellow lines denote the project's proposed alignment. Dashed white lines denote the western and eastern boundaries of the designated Bass Strait study area. Red boxes denote areas of water quality sampling data collected by the MV Spirit of Tasmania I (see Section 6.2.3, Marine water quality). Red circles denote sponge bed sampling points of Butler et al. (2002).

Figure 5.1: Bass Strait study area for description of existing marine environment

In Figure 5.1 the study area may be defined as that portion of Bass Strait that is enclosed by the following impact assessment boundaries:

- The Victorian mainland nearshore between Cape Otway and Lakes Entrance
- The Tasmanian mainland nearshore between Cape Grim and Cape Portland
- Lines between King Island and Cape Otway and Cape Grim
- Lines between the Furneaux Group to Lakes Entrance and Cape Portland.

In describing parts of the study area, the term 'nearshore' denotes state waters within the three nautical mile (NM) limits and the term 'offshore' denotes Commonwealth waters outside the State 3 NM limits.

In Figure 5.1, the study area has been selected for the description of the existing shallow water environment of Bass Strait and within which the impact assessment boundaries of varying dimensions will be considered for different impact assessment pathways. For example, the project area for cable lay operation is 2-km wide either side of the proposed project alignment, whereas the project area adopted by SETFIA (2022) for commercial fisheries is a polygon with a total width of 16 km, centered on the proposed alignment of the project, or 8 km either side of the alignment.

In terms of the propagation of low frequency underwater noise from project construction activities and construction vessels, the acoustic field will extend westwards to King Island and eastwards to Flinders Island, as will be the case for non-project vessels and marine traffic in Bass Strait.

5.2 Study methods

5.2.1 Information and data sources

Descriptions of the existing environment of Bass Strait and project area (see Section 6, Existing conditions) have been informed by a literature review of publicly available data sources and a review of several marine field investigation reports.

Desktop reviews were undertaken of the following sources:

- EIS scoping requirements from Commonwealth, Tasmanian, and Victorian governments:
    - Commonwealth EIS scoping requirements (DCCEEW, 2022b).
    - Victorian EES/EIS scoping requirements (DTP, 2023).
    - Tasmanian EIS guidelines (EPA Tasmania, 2022a ; EPA Tasmania, 2022b).
- Online public access databases, including:
    - EPBC Act Protected Matters Search Tool (PMST) (DCCEEW, 2023d).
    - Species Profile and Threats Database (DCCEEW, 2022c).
    - Atlas of Living Australia (CSIRO, 2022).
    - Victorian Biodiversity Atlas (DELWP, 2022b).
    - National Conservation Values Atlas (DCCEEW, 2022a).
    - Tasmanian Natural Values Atlas (DNRE, 2022).
    - Victorian State Wide Integrated Flora and Fauna Teams (SWIFFT, 2022).
    - Southern Australian Sea Turtles (SAST) Project (Deakin University, 2022).
- Peer reviewed scientific papers and studies, including key reports relevant to Bass Strait:
    - Basslink Integrated Impact Assessment Study (IIAS) (NSR, 2002).
    - BassGas Project Environment Effects Statement (Origin Energy, 2002).
    - Basslink. Marine biological Monitoring. (Chidgey et al., 2006).
    - Basslink. Supplementary Marine Biological Monitoring (CEE, 2009),
    - Installation and operational effects of a submarine cable in a continental shelf setting (Sherwood et al., 2016).
- Publications from relevant organisations, including but not limited to:
    - Australian Maritime and Safety Organisation (AMSA).
    - Australian Fisheries Management Authority (AFMA).
    - Southern and Eastern Scalefish and Shark Fishery (SESSF) – Commonwealth Trawl sector.

  - Southern and Eastern Scalefish and Shark Fishery (SESSF) – Shark Gillnet and Shark Hook sectors.
  - South East Trawl Fishing Industry Association (SETFIA, 2022).
  - SESSF – Shark Gillnet and Shark Hook sectors.
  - Bass Strait Central Zone Scallop Fishery (BSCZSF).
  - Tasmanian Seafood Industry Council (TSIC, 2022).
  - Seafood Industry Australia (SIA).
- Marinus Link EIS/EES Appendices:
  - Technical appendix A: Electromagnetic fields (Jacobs, 2023).
  - Technical appendix G: Benthic ecology assessment (CEE, 2023).
- Technical studies (attached to this report):
  - Attachment D: Supplementary Information – Underwater noise impact assessment (EGC, 2023).
  - Attachment E: Tioxide sediment analysis report (Tetra Tech Coffey, 2022).
  - Attachment F: Commercial fisheries data (SETFIA, 2022).
  - Attachment G: Underwater noise modelling (MDA, 2022).
  - Attachment H: Technical Memorandum on additional EMF modelling (Jacobs, 2022).
- Technical studies (not attached to this report):
  - Marine engineering geophysical survey (Fugro, 2020).
  - Marine traffic impact assessment (Stantec, 2023).

5.2.2 Likelihood of occurrence of marine fauna

A likelihood of occurrence rating was used to categorise both EPBC Act listed species as well as non-listed species potentially occurring within Bass Strait and the project's EPBC Act Protected Matters Search Tool (PMST) search areas. The assessment of a likelihood of occurrence rating was based on a literature review of selected marine fauna species and their preferred habitats and foraging areas. In addition, species records of online databases such as the Atlas of Living Australia (CSIRO, 2022), Victorian Biodiversity Atlas (DELWP, 2022b) and the Tasmanian Natural Values Atlas (DNRE, 2022) were examined.

Table 5.1 presents a summary of the likelihood of occurrence ratings used in the present report.

Table 5-1: Likelihood of occurrence of marine fauna in Bass Strait and project PMST areas

Likelihood rating	Description
Remote	No prior known occurrence and/or is not anticipated to occur
Rare	Occurs rarely and/or is unlikely to occur
Possible	Possible but does not commonly occur and/or may occur at some time
Likely	Has occurred before and will again and/or is likely to occur
Very likely	Occurs frequently and/or is expected to occur

In Section 6 (Existing conditions), the likelihood of occurrence of various marine flora and fauna, including invasive species includes the likelihood ratings in Table 5.1. These likelihood ratings are presented in bold and italicised font to denote their special meaning in this report.

5.3 Impact assessment

This section provides a description of the framework used to assess the direct and indirect environmental and resource use impacts of the project and in particular, the use of the significance assessment method to predict the residual biophysical impacts. Those impacts associated with specific project activities such as marine water quality, wastewater discharges, and underwater noise levels can be readily evaluated by comparing measured or predicted quantities to objective, quantitative criteria, guidelines or standards.

Impacts arising from accidental events (e.g., vessel fuel or oil spills) or from natural hazards (e.g., cyclones) are not addressed in this report.

5.3.1 Approach

The approach to impact assessment has been based on identifying credible impact sources and impact pathways to sensitive marine biological flora and fauna with a focus on threatened ecological communities and threatened flora and fauna species, as well as to marine resource use.

The marine impact assessment approach applied in this report identifies the sources of positive (beneficial) and negative (potentially adverse) environmental impacts of the project and predicts their effects on environmental values (e.g., a site, receptor or marine resource use). A receptor is any environmental component (e.g., a whale, fish or sea turtle) that is sensitive to or has the potential to be impacted by the project, whereas a resource is any environmental component (e.g., a marine habitat, fishery resource (e.g., targeted fish), or conservation area) that has the potential to be impacted by the project.

Identification of impact pathways during construction, operations, and decommissioning are based on scientific literature reviews of the long history and experience gained in the installation, operation and decommissioning of HVDC power transmission cables within the marine environment. Relevant lessons learnt during the construction and operation of the Basslink interconnector across Bass Strait and other international HVDC cable projects provide background information for identifying credible impact sources and pathways. Impact pathways specific to the project have also been identified, and for which the residual impacts on the marine ecology and resource uses of Bass Strait are assessed. The Basslink interconnector is used as a reference point (i.e., a comparative analogue) for the project because both projects adopt similar approaches including the following factors in common (NSR, 2001):

- Both projects utilise a large cable lay ship fitted with long lengths of HVDC and fibre optic cables and consequently similar underwater noise generation.
- Both projects utilise similar sized HVDC cables and consequently similar EMF emissions depending on cable configuration.
- Both projects have similar methods of cable burial in soft seabed sediments including similar cable burial depth. The nominal burial depth was between 0.4 to 1.2 m for Basslink and 0.5 to 1.5 m for Marinus Link.
- Both projects are in a similar location (central Bass Strait) and are consequently of similar water depth, distance, and environmental conditions.

This marine ecology and resource use impact assessment approach primarily adopts the significance assessment method. The risk assessment method (see Section 5.3.4) was adopted in the assessment of invasive marine species and construction vessel-marine megafauna collision. In addition, those impacts or impact sources with the potential to cause changes to marine water and sediment quality or wastewater discharges can be evaluated by comparing measured or predicted quantities to objective, quantitative criteria, guidelines or standards.

5.3.2 Significance assessment method

The significance assessment method has been adopted where a qualitative assessment is required. This approach assumes the identified impacts will occur, as this conservative method enables a more comprehensive understanding and assessment of the likely impacts of a project. It focuses attention on the mitigation and management of potential impacts through the identification and development of effective design responses and environmental controls.

The significance assessment method is based on determining significance through a combination of the sensitivity (of a marine environmental value or receptor) and the magnitude (of an impact). The descriptors used to categorise the sensitivity of receptors and magnitude of impacts are described below.

5.3.2.1 Sensitivity criteria

The sensitivity of an environmental value is determined with respect to its protection status, intactness, uniqueness or rarity, resilience to change and replacement potential.

Table 5.2 presents criteria for assessing the sensitivity of a marine environmental value, or receptor, which are met if one or more of the definitions apply.

Table 5-2: Sensitivity criteria

Sensitivity level	Descriptor
Very high	• The value is listed on a recognised or statutory state, national or international register, or is protected under legislation, regulations or guidelines as being of very high significance (e.g., critically endangered). • The value is intact and retains its intrinsic value. • It is unique. It is isolated to the affected system/area which is poorly represented in the broader region, territory, country or the world. • It is fragile and predominantly unaffected by existing threatening processes. Small changes will lead to substantial changes to the prescribed value. • It is not widely distributed throughout the system/area and consequently will be difficult or impossible to replace.
High	• The value is listed on a recognised or statutory state, national or international register, or is protected under legislation, regulations or guidelines as being of high significance (e.g., endangered). • The value is relatively intact and retains most of its intrinsic value. • It is locally unique to the environment or community in which it occurs, with few regionally available alternatives. • It is predominantly unaffected by existing threatening processes. Small changes will lead to changes to the prescribed value. • It is not widely distributed throughout the system/area and consequently recovery potential will be limited.
Moderate	• The value is listed on a recognised or statutory state, national or international register, or is protected under legislation, regulations or guidelines as being of moderate significance (e.g., vulnerable). • The environmental value is in a moderate to good condition despite it being exposed to threatening processes. It retains many of its intrinsic characteristics and structural elements. • It is relatively well represented in the systems/areas in which it occurs, but its abundance and distribution are limited by threatening processes.

Sensitivity level	Descriptor
	• Threatening processes have reduced the environmental or social value's resilience to change. Consequently, changes resulting from project activities may lead to degradation of the prescribed value. • Replacement of unavoidable losses is possible due to its abundance and distribution.
Low	• The value is not listed on a recognised or statutory state, national or international register, or is protected under legislation, regulations or guidelines as being of significance. • It is in a poor to moderate condition as a result of existing threatening processes which have degraded its intrinsic value. • It is not unique or rare and numerous representative examples exist throughout the system/area. • It is less widely distributed throughout the host systems/areas. • There is slight detectable response to change of the value but can quickly recover. • The abundance and wide distribution of the value ensures replacement of unavoidable losses is assured.
Very low	• The value is not listed on any recognised or statutory register. It is not recognised locally by relevant suitably qualified experts or organisations e.g., historical societies. • It is in a poor condition due to existing threatening processes, which have degraded its intrinsic value. • It is not unique or rare and representative examples exist abundantly throughout the system/area. • It is abundant and widely distributed throughout the host systems/areas. • There is no detectable response to change, or change does not result in further degradation of the value.

5.3.2.2 Magnitude of impact criteria

The criteria for assessing the magnitude of a potential impact due to the project considers three different aspects of the impact as follows:

- **Spatial (geographical extent)** is an assessment of the spatial extent of the impact where the extent is defined as site, local, regional, or widespread (meaning state-wide or national or international).
- **Duration** is the timescale of the effect i.e., if it is short, medium or long term.
- **Severity** is an assessment of the scale or degree of change from the existing condition from the impact. This could be positive or negative.

The magnitude of impact will be assessed for all credible impact pathways (i.e., where a project activity may lead to an impact on a value).

Table 5.3 presents criteria for the magnitude of impact to a marine environmental value, which are met if one or more of the definitions apply.

Table 5-3: Magnitude of impact criteria

Magnitude level	Descriptor
Severe	• An impact that causes permanent changes to the physical, ecological, or social environment and irreversible harm to values or consequences of the impact are unknown and management controls are untested. • Total loss of, or severe alteration to a marine ecological value, and/or loss of a high proportion of the known population or range of the value with a strong likelihood that the viability of the value will be severely reduced. • Avoidance through appropriate design responses is required to address the impact.
Major	• Major loss of or alteration to a marine ecological value and/or loss of a significant proportion of the known population or range of the value, with the viability of the biological value/resource reduced. • Significant effect to marine ecosystem functions or other relevant environmental values. • An impact that is widespread, long lasting and results in substantial change to the value either temporary or permanent. • Can only be partially rehabilitated or uncertain if it can successfully be rehabilitated. • Receives widespread local community complaints and lasting effects on the social fabric of a community.
Moderate	• Moderate changes to a marine ecological value that is readily detectible with respect to natural variability. • Moderate effect to ecosystem functions or other relevant environmental or marine environmental values. • An impact that extends beyond the operational area to the surrounding area but is contained within the region where the project is being developed. • The impacts are short term and result in changes that can be ameliorated with specific management controls. • May receive local community complaint.
Minor	• Minor effect compared to existing baseline conditions. • Effects unlikely to reduce the overall viability of a marine environmental value or receptor. • Effect barely detectable with respect to natural variability. • A localised impact that is short term and could be effectively mitigated through standard management controls. • Remediation work and follow-up required.
Negligible	• A temporary impact likely to be very low and highly localised. • Either unlikely to be detectable or could be effectively mitigated through standard management controls. • Impacts within statutory limits or guideline values and no detectable change to the existing environment beyond natural variability. • Reduction in the viability of a marine environmental value is highly unlikely. • Full recovery expected.

5.3.2.3 Significance assessment of impacts

The significance of an impact on an environmental value or receptor is determined by combining the sensitivity of the environmental value or receptor (Table 5.2) and the magnitude of the impact (Table 5.3) on that environmental value or receptor via the significance assessment matrix presented in Table 5.4.

Table 5-4: Significance of impacts matrix

Magnitude of impact	Sensitivity of environmental value				
	Very high	**High**	**Moderate**	**Low**	**Very low**
Severe	Major	Major	Major	High	Moderate
Major	Major	Major	High	Moderate	Low
Moderate	High	High	Moderate	Low	Low
Minor	Moderate	Moderate	Low	Low	Very low
Negligible	Low	Low	Low	Very low	Very low

The significance of impact classifications (major, high, moderate, low, and very low) in Table 5.4 are defined as follows:

- **Major:** when an impact will potentially cause widespread or irreversible harm to an environmental value that is irreplaceable because of its rarity or uniqueness. Avoidance of the value/impact through appropriate design responses is the only effective mitigation.
- **High:** when proposed activities are likely to exacerbate threatening processes affecting the core characteristics or structural elements of an environmental value. Although replacement of unavoidable losses is possible, avoidance through appropriate design responses is preferred to preserve the environmental value's conservation status or intactness.
- **Moderate:** where an environmental value is somewhat resilient to change but will be further degraded due to the scale of the impact or its susceptibility to further change. The abundance and/or distribution of the environmental value ensures that it is adequately represented in the region, and that replacement, if required, is achievable.
- **Low:** where an environmental value is of local importance and temporary changes will not negatively affect its viability, provided that standard mitigation and environmental management controls are implemented.
- **Very low:** where impact to an environmental value will not result in any noticeable change in its intrinsic value, and as such, the proposed activities will have negligible effect on its viability.

In some cases, a project activity may have a beneficial impact on an environmental value that enhances its resilience to change. Where this occurs, explanatory text is provided.

5.3.2.4 Summary of environmental values and sensitivities

The sensitivity of an environmental value is determined with respect to its protection status, intactness, uniqueness or rarity, resilience to change and replacement potential. These contributing factors are described below.

- **Protection status** is assigned to a value by governments (including statutory and regulatory authorities) or international organisations (e.g., UNESCO) through legislation, regulations, and international conventions.
- **Intactness** is an assessment of how intact a value is. It is a measure (with respect to its characteristics or properties) of its existing condition, particularly its representativeness.
- **Uniqueness** or **rarity** of a value is an assessment of its occurrence, abundance and distribution within and beyond its reference area (e.g., bioregion/biosphere).

- **Resilience to change** is determined by the extent to which a value can cope with change including that posed by threatening processes. This factor is an assessment of the ability of a value to adapt to change without negatively affecting its conservation status, intactness, uniqueness, or rarity.
- **Replacement potential** is the potential for a representative or equivalent example of the environmental value to be found to replace any losses.

Identification of the nearshore and offshore marine environmental values ('sites', or 'receptors') that require protection is a key step in assessing potential impacts of the project on marine ecology and resource use.

The environmental values of the marine environment reflect the interaction of the physical and biological environment, local communities, and other marine stakeholders. The generic sensitivities of the environmental values of the marine pelagic and benthic environment are given in Table 5.5.

The environmental values and sensitivities in Table 5.5 are representative of 'elements or segments of the marine environment' such as pelagic and benthic zonation, which are relevant to the assessment of the residual impacts of the project (Section 7, Impact assessment) in the context of the existing nearshore and offshore environment of Bass Strait.

Table 5-5: Summary of marine environmental values and sensitivities

Environmental value	Description	Sensitivity
Marine pelagic environment:		
Depth range 0 m to lowest astronomical tide (intertidal zone) (Vic and Tas) *Key receptors:* Phytoplankton. Zooplankton, nekton (fishes and water column invertebrates)	• Low biodiversity and low abundances of threatened or sensitive species/communities • Low primary and secondary productivity. • Elevated nutrient levels from riverine inputs and land runoff (particulate and dissolved nutrients). • High-energy hydrodynamics (intertidal seabed disturbance by waves, surf, swash and backswash) resulting in lower water quality (increased suspended sediment concentrations and associated turbidity).	**Low**
Depth range 0 to ~50 m (Euphotic zone within epipelagic zone 0 to 100 m*) (Vic, Tas and Cwlth)** *Key environmental receptors:* Phytoplankton, zooplankton, micronekton, nekton (near surface water macroinvertebrates (e.g., jellyfishes, squid and fishes)	• High biological diversity and productivity in which primary producers (e.g., phytoplankton) within the euphotic zone provide the basis of the food web for secondary producers (e.g., zooplankton and micronekton), which in turn are consumed by fish and pelagic macroinvertebrates. • High primary productivity and secondary productivity but limited by nutrient supply, as nutrient concentrations in Bass Strait are low. • Depth of the euphotic zone varies in turbidity, colour, hue and density of plankton in the water column. • Presence of apex and high trophic level secondary consumers, such as marine mammals, (e.g., whales, dolphins, seals), near-surface fishes (e.g., yellowtail kingfish, southern bluefin tuna and Australian salmon), and Little Penguins.	**High**
Depth range 50 to 80 m (zone below the euphotic zone to the seabed) (Cwlth) *Key receptors:* Mid-water zooplankton and micronekton (salps, crustaceans, larval fish), pelagic macroinvertebrates such as squid and jellyfishes, and mid- to deep-water adult and juvenile fishes (e.g., gummy and school	• A zone of lower primary productivity and secondary productivity limited by nutrient supply and reduction in penetration of photosynthetically active light. • Presence of apex and higher trophic level secondary consumer, such as foraging marine mammals, (e.g., whales, dolphins, seals), sharks (e.g., gummy and school sharks), and Little Penguins.	**Moderate**

Environmental value	Description	Sensitivity
sharks), and foraging marine mammals such as whales, dolphins, and seals.		
Marine benthic environment:		
Seabed depth zone (0 to Lowest Astronomical tide (Intertidal zone)) (Vic and Tas) *Key receptors:* Beach infauna including amphipod and isopod crustaceans, *polychaete* worms, and bivalve molluscs.	• A zone of intertidal beach sand habitat. • Very low primary productivity due to frequent sand mobilisation (e.g., tidal flows, surf, swash and backswash) and lack of hard substrate attachments for benthic algae and macroalgae. • A zone characterised by low biodiversity and abundances of benthic infauna.	**Low**
Seabed depth zone (5 to 20 m) (subtidal nearshore zone – sandy seabed) (Vic and Tas) *Key receptors:* Mixed macroalgae, seagrass (Victoria only), epibenthic macroinvertebrates, benthic and demersal fishes, foraging seals, Little Penguins, dolphins etc.	• Frequent physical disturbance of seabed sediments (sands and gravels) by wave action (ripples) and lower bottom-water quality of sandy seabed habitats. • Low primary productivity due to low diversity and abundance of benthic algae (e.g., encrusting or filamentous algae) and macroalgae, and absence of seagrass. • Low secondary productivity due to low diversity and abundance of epibenthic macroinvertebrates and sediment infauna.	**Low**
Seabed depth zone (5 to 20 m) (subtidal nearshore zone – low-profile reefs) (Vic and Tas) *Key receptors:* Mixed macroalgae and encrusting coralline red algae, encrusting invertebrates and solitary sponges and *ascidians*, epibenthic macroinvertebrates (e.g., starfishes, sea urchins and decapod crustaceans), benthic reef-attached fishes.	• Low-profile reefs, and rock platform and cobbles intermixed with patches of sand with low vertical profile and structural diversity. • Moderate primary productivity due to higher diversity and abundance of benthic algae (e.g., encrusting or filamentous algae), macroalgae and seagrasses (Victoria only). • Mixed macroalgae and epibenthic macroinvertebrates, sponges, corals and *ascidians*.	**Moderate**
Seabed depth zone (5 to 20 m) (subtidal nearshore zone – high-profile reefs) (Tas) *Key receptors:* Mixed macroalgae and encrusting coralline red algae, encrusting invertebrates and solitary sponges and *ascidians*, epibenthic macroinvertebrates (e.g., starfishes, sea urchins and decapod crustaceans), benthic reef-attached and reef-associated fishes.	• High-profile reef habitat with high vertical structural diversity offering niches and microhabitats. • High primary productivity due to higher diversity and abundance of benthic algae (e.g., encrusting or filamentous algae) and mixed red, green and brown macroalgae. • High secondary productivity due to presence of diverse and abundant herbivorous and omnivorous epibenthic macroinvertebrates including sponges, corals and *ascidians*. • Higher abundance of reef-attached and reef-associated fishes and foraging predators (e.g., carnivorous fish, seals, Little Penguins.	**High**
Depth range 10 to 15 m (Nearshore endangered seagrass zone) (Vic) *Key receptor:* Tasman grass-wrack	• A restricted narrow zone of seabed habitat suitable for the FFG Act endangered Tasman grass-wrack (*Heterozostera tasmanica*) in nearshore Victoria. • Low to moderate density of Tasman grass-wrack, which occurs in patches in this zone (CEE, 2022).	**High**
Depth zone 65 to 75 m (Offshore sponge bed zone) (Cwlth) *Key receptors*: Mesophotic ‘sponge beds’ of conservation interest comprising communities of sessile, filter feeding fauna containing habitat-forming organisms.	• A narrow zone of seabed in silt-clay seabed where large catches of sponges were undertaken by the Museum of Victoria (Butler et al., 2002). • The high diversity sponge bed communities comprise sponges (Porifera), *gorgonians* (octocorals), *bryozoans*, and *ascidians*, which flourish in low light conditions.	**High**

Environmental value	Description	Sensitivity
	• The sponge beds are described as largely unexplored but are likely to be extremely species rich, high in endemism and likely to include many species new to science (Butler et al., 2002). • The sponge beds have a patchy distribution where the 65 to 75 m depth zone is intercepted by the project's alignment.	
Marine resource use:		
Pelagic commercial fisheries within 16-km wide study area of project alignment (Vic, Tas and Cwlth) *Key receptors*: Southern Jig Fishery: Arrow. Victorian Ocean General Fishery: Gummy and school sharks, Australian salmon, and pink snapper. Tasmanian Scalefish Fishery: southern garfish, bastard trumpeter, silver warehou, silver trevally, striped trumpeter, southern calamari, Arrow squid, and banded morwong	• Commonwealth managed Southern Squid Jig Fishery and SESSF Commercial Trawl Sector (pelagic and mid-water otter-board trawl subsector). • Victorian Ocean General Fishery. • Tasmanian Scalefish Fishery. • The fishery resources in the 16-km wide study area straddling the project's alignment (SETFIA ,2022) represent a small fraction of the total fishery resource area.	**Moderate**
Demersal commercial fisheries within 16-km wide study area of project alignment (Vic, Tas and Cwlth) *Key receptors*: Danish Seine: Tiger flathead and eastern school whiting. SGSHS: Gummy and school sharks. Abalone and Sea Urchin: abalone and sea urchins. Abalone Fishery and Rock lobster Fishery: abalone and rock lobsters. Victorian (Ocean) Fishery: gummy and school sharks, Australian salmon, pink snapper, flatheads, sardines, and pilchards. Wrasse (Ocean) fishery: bluethroat, purple and other wrasses. Tasmanian Scalefish Fishery: Tiger flathead, wrasses, silver trevally, redfish, jackass morwong and striped trumpeter	• Commonwealth managed fisheries: SESSF Commercial Trawl Sector, CTS (otter-board demersal or bottom-trawling subsector), SESSF Shark Gillnet and Shark Hook Sector (SGSHS), Bass Strait Central Zone Scallop Fishery (BSCZSS), and Danish Seine. • Tasmanian managed fisheries: Abalone and Sea Urchin diving fishery, Rock Lobster Fishery, Scalefish Fishery, and Wrasse (Ocean) fishery. • Victorian managed fisheries: Abalone Fishery and Rock Lobster Fishery, Ocean General Fishery: Demersal longline and demersal gillnet subsectors. Wrasse (Ocean) Fishery Central subsector.	**Moderate**
Pelagic commercial fisheries outside 16-km wide study area of project alignment (Vic, Tas and Cwlth) *Key receptors*: Deepwater blue grenadier, pink ling and mirror dory. Giant Crab Fishery: giant crabs. Purse Seine Fishery: southern bluefin tuna, Australian sardine, blue mackerel, and jack mackerel (see Attachment F, SETFIA (2022) for other receptors).	• Commonwealth managed fisheries: SESSF Commercial Trawl Sector (deep water), CTS (deep water otter-board demersal or bottom-trawling subsector). • Tasmanian managed fisheries: Giant Crab Fishery, Commercial Dive Fishery, Mackerel Fishery, Shellfish Fishery and Seaweed Fishery. • Victorian managed fisheries: Giant Crab Fishery, Bait (General) Fishery, Sea Urchin Fishery (Central Zone, Purse Seine (Ocean) Fishery, Scallop (Ocean) Fishery, Trawl (Inshore) Fishery. • These fisheries have a much-reduced sensitivity as they are not present in the 16-km wide study area straddling the project's alignment	**Low**

* The whole of central Bass Strait (i.e., the Study Area) with a maximum depth of 80 m is within the epipelagic zone (0 to 200 m).
** Euphotic zone is a useful index of the penetration of diffuse sunlight into the sea and represents the depth at which photosynthetically active radiation (PAR) is reduced to about 1% of the level at the water surface

5.3.2.5 Consistency with EPBC MNES Significant impact assessment guidelines

The significance assessment detailed in the above sections is consistent with the Matters of National Environmental Significance – Significant impact guidelines 1.1 (DoE 2013).

This assessment has addressed the relevant MNES as outlined in the Matters of National Environmental Significance – Significant impact guidelines 1.1 (DoE 2013).

The Matters of National Environmental Significance – Significant impact guidelines 1.1 (DoE 2013) defines a 'significant impact' as an impact "which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts". As detailed in section 5.3.2, this assessment has adopted a similar approach, whereby the sensitivity of values (section 5.3.2.1) are identified with appropriate context in their sensitivity criteria (protection status, condition, resilience, replacement potential), and the magnitude of impact (section 5.3.2.2) considers the impact intensity, duration and extent.

The criteria used in this significance impact assessment are consistent with the significant impact criteria for various MNES included in the Matters of National Environmental Significance – Significant impact guidelines 1.1 (DoE 2013), which include:

- Reduction of population or reduced viability of ecological communities
- Reduction in extent or quality of habitat
- Exacerbation of threatening processes (such as invasive species and disease)
- Substantial changes to ecosystem function
- Interference with recovery of species/communities/populations.

These considerations are included in the sensitivity and magnitude and significance criteria in section 5.3.2.1 to section 5.3.2.4.

The criteria used in this significance impact assessment are also consistent with the significant impact criteria for the environment within a Commonwealth marine area, which are outlined in the Matters of National Environmental Significance – Significant impact guidelines 1.1 (DoE 2013).

The MNES-Significant impact guidelines 9DoE, 2013) state that "an action is likely to have a significant impact on the environment in a Commonwealth marine area if there is a real chance or possibility that the action will:

- Result in a known or potential pest species becoming established in the Commonwealth marine area
- Modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results
- Have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution
- Result in a substantial change in air quality or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity, social amenity, or human health
- Result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity, or human health may be adversely affected, or
- Have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck. "

In the abovementioned list of significant impact criteria applicable to the environment within a Commonwealth marine area, the MNES significance impact criteria relating to heritage values including historic shipwrecks in a Commonwealth marine area do not apply to this Marine Resource and Ecology Impact Assessment Report, as they are assessed in EIS/EES Technical Appendix I: Underwater cultural heritage.

In the current impact assessment, a residual impact significance rating of ***Major*** or ***High*** (see Table 5-4, Significance impacts matrix for derivation) would equate to a significant impact under the Matters of National Environmental Significance – Significant impact guidelines 1.1 (DoE 2013), which also includes any MNES of the environment within a Commonwealth marine area.

5.3.3 Comparison with environmental guidelines

Those impacts or impact sources with the potential to cause changes to marine water and/or sediment quality, or wastewater discharges can be readily evaluated by comparing measured or predicted quantities to objective quantitative criteria, guidelines, or standards.

This section addresses consistency with the following assessment criteria:

- Comparison with ambient water quality guidelines.
- Comparison with sediment quality guidelines.
- Compliance with end of pipe discharge guidelines.

The above assessment criteria are discussed in more detail below.

5.3.3.1 Comparison with ambient water quality guidelines

The Australian and New Zealand guidelines for marine water quality and the protection of marine ecosystems (ANZG, 2018a) were adopted to allow comparisons of existing or predicted water quality measurements to the guidelines.

Table 5.6 presents a list of water quality parameters and corresponding ANZG (2018a) ambient water quality guidelines for the protection of 99% of marine species. This protection level is commonly assigned to largely unmodified aquatic ecosystems under the EPA's Environment Reference Standard (ERS) (EPA Victoria, 2017).

Under the ERS, Bass Strait is classified as a 'largely unmodified' ecosystem, which is defined as one in which marine biological diversity may have been negatively affected to a relatively small but measurable degree by human activity. Therefore, the marine water guidelines for the 99% species protection applies to Bass Strait waters.

Table 5-6: Marine water quality guidelines

Metal or metalloid	Units	99% species protection
General water quality parameters:		
Temperature	°C	N/A
Dissolved Oxygen (DO)	mg/L	N/A
Total Suspended Solids (TSS)	mg/L	N/A
Turbidity	NTU	N/A
pH	Log pH units	N/A
Electrical conductance (EC)	µS/cm	N/A
Ammonia	µg/L	500
Nitrate (as NO_3^- + NO_2^-)	µg/L	N/A

Metal or metalloid	Units	99% species protection
Sulphate (SO_4^-)	µg/L	N/A
Cyanide (CN)	µg/L	2
Dissolved metals and metalloids:		
Aluminium (Al)	µg/L	N/A
Silver (Ag)	µg/L	0.8
Arsenic (As)	µg/L	N/A
Cadmium (Cd)	µg/L	0.7
Chromium (Cr III)	µg/L	7.7
Chromium (Cr VI)	µg/L	0.14
Cobalt (Co)	µg/L	0.005
Copper (Cu)	µg/L	0.3
Manganese (Mn)	µg/L	80*
Mercury (Hg inorganic)	µg/L	0.1
Nickel (Ni)	µg/L	7
Lead (Pb)	µg/L	2.2
Antimony (Sb)	µg/L	N/A
Zinc (Zn)	µg/L	3.3
Tin (Sn tributyl)	µg/L	0.0004
Thallium	µg/L	17*
Vanadium (V)	µg/L	50

*Low reliability trigger level to be used as an indicative, interim working level (ANZG, 2018a). Relevant parameters and species protection levels from EPA Victoria (2017) and guideline values from ANZG, 2018a).

5.3.3.2 Comparison with marine sediment quality guidelines

For the purposes of this section, the existing sediment contaminants of potential environmental concern are metals and metalloids that are associated with legacy discharges of effluent from the Tioxide Australia plant at Heybridge to the Tasmanian nearshore waters. The Tioxide Australia plant at Heybridge ceased operations 28 years ago in July 1996. Other potential contaminants such as organometallics (e.g., tributyl tin) or organics such as polyaromatic hydrocarbons, polychlorinated biphenyls, and insecticides are not anticipated to be present and have been excluded from further consideration.

Sediment quality data for baseline sediment sampling sites across Bass Strait have been compared to the ANZG (2018b) sediment quality guidelines, which have the following format and definitions:

- Default Guideline Value (DGV): The threshold concentration level below which there is a low probability that biological effects could occur.
- Guideline Value-High (GV-High): The threshold concentration level above which there is a high probability that biological effects could occur.

At contaminant concentrations between the DGV and GV-high, ecotoxicity effects may occur but further investigation will be needed to confirm. Table 5.7 presents a list of metals and metalloids for which ANZG (2018b) guideline values are available.

Table 5-7: Marine sediment quality guidelines (ANZG, 2018b)

Metal or metalloid	Units (dry weight)	Default Guideline Value (DGV)	Guideline Value-High (GV-High)
Silver (Ag)	mg/kg	1	4
Arsenic (As)	mg/kg	20	70
Cadmium (Cd)	mg/kg	1.5	10
Chromium (Cr)	mg/kg	80	370
Copper (Cu)	mg/kg	65	270
Mercury (Hg)	mg/kg	0.15	1
Nickel (Ni)	mg/kg	21	52
Lead (Pb)	mg/kg	50	220
Antimony (Sb)	mg/kg	2	25
Zinc (Zn)	mg/kg	200	410

Source: ANZG (2018b).

5.3.3.3 Comparison with end-of-pipe discharge guidelines

The project has no proposed direct discharges of treated or untreated wastewater to the marine environment. Clean stormwater runoff and overflow from the Heybridge converter station site will be discharged via an existing drainage culvert to the marine environment (Entura, 2023). This will be done in accordance with EPA Tasmanian policy requirements.

Potential marine discharges from the project's contracted cable lay ship, offshore support vessels, dive boats, and various small boats have been considered in this report.

Australia is a signatory to two conventions that are relevant to the project:

- International Convention for the Prevention of Pollution from Ships 1973 (as modified by the London Protocol of 1978) (MARPOL) (1994) and Annex IV of MARPOL, Regulations for the Prevention of Pollution by Sewage from Ships.
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (1975) and Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (2006) (London Protocol).

The implications of these two conventions to the project are discussed below.

5.3.3.3.1 Marine pollution from contractors' vessels

Accidental contamination of the marine environment confers a risk to the project; however, with good practice and observation of the MARPOL regulations by contractors, this risk should be managed to be as low as reasonably practical during the construction, operations, and decommissioning phases of the project. Therefore, potential marine pollution from contractors' vessels is not described further but is noted here to provide completeness of consideration.

5.3.3.3.2 Dumping of wastes and other matter

During the construction, operations, or decommissioning phases, there are no proposals to dump wastes or other materials in contravention of the prevention of marine pollution under the London protocol. Note that targeted rock dumping to protect project cable(s) laid over hard seabed or the emplacement of rock mattresses are outside the meaning of waste dumping and other matter defined in the convention. Therefore, there will be no dumping of waste or other matter by the project.

5.3.4 Risk assessment method

The risk assessment method, which is an essential component of implementing a risk management system, was adopted for the assessment of invasive marine species and project vessel collisions with marine megafauna (e.g., whales and sea turtles). The risk assessment method involves three steps: risk identification, risk analysis and risk evaluation. Risk analysis is an iterative process that involves the examination of the identified risks, the potential consequences (impacts) associated with each risk and the likelihood (probability) of that consequence occurring (ISO, 2018).

The assessment of risk of harm to identified values (prior to implementation of proposed standard mitigation measures to avoid, minimise, offset, and manage impacts) is conducted by examining the likelihood of harm occurring and the potential consequences (i.e., a measure of severity of environmental impact) should the harm occur.

5.3.4.1 Qualitative criteria for likelihood

Table 5-8 describes qualitative criteria developed to rank the likelihood of potential impacts.

Table 5-8: Qualitative criteria for likelihood

Descriptor	Description
Almost certain	A hazard, event and/or pathway exists, and harm has occurred in similar environments and circumstances elsewhere and is **expected to occur** more than once over the duration of the project activity, project phase or project life.
Likely	A hazard, event and/or pathway exists, and harm has occurred in similar environments and circumstances elsewhere and is **likely to occur** at least once over the duration of the project activity, project phase or project life.
Possible	A hazard, event and/or pathway exists, and harm has occurred in similar environments and circumstances elsewhere and **may occur** over the duration of the project activity, project phase or project life.
Unlikely	A hazard, event and/or pathway exists, and harm has occurred in similar environments and circumstances elsewhere but is **unlikely to occur** over the duration of the project activity, project phase or project life.
Rare	A hazard, event and/or pathway is theoretically possible for the project and has occurred once elsewhere but is **not anticipated to occur** over the duration of the project activity, project phase or project life.

5.3.4.2 Qualitative criteria for consequence

Table 5-9 describes qualitative criteria developed to rank the consequence of potential impacts.

Table 5-9: Qualitative criteria for consequence

Descriptor	Description
Severe	An effect that causes permanent changes to the environment and irreversible harm to physical, ecological, or social environmental values or consequences of the impact are unknown and management controls are untested. Causes major public outrage, sustained widespread community complaints. Prosecution by regulatory authorities. Avoidance through appropriate design responses is required to address the impact.
Major	An effect that is widespread, long lasting and results in substantial change to the value either temporary or permanent. Can only be partially rehabilitated or uncertain if it can successfully be rehabilitated. Appropriate design responses are required to address the impact. Causes major public outrage, possible prosecution by regulatory authorities. Receives widespread local community complaints.

Descriptor	Description
Moderate	An effect that extends beyond the operational area to the surrounding area but is contained within the region where the project is being developed. The harm is short term and result in changes that can be ameliorated with specific management controls.
Minor	A localised effect that is short term and could be effectively mitigated through standard management controls. Remediation work and follow-up required.
Negligible	A localised effect that is temporary and does not extend beyond operational area. Either unlikely to be detectable or could be effectively mitigated through standard management controls. Full recovery expected.

5.3.4.3 Qualitative risk assessment matrix

The risk of harm is determined by combining the likelihood (Table 5-8) and consequence (Table 5-9) using the resultant matrix in Table 5-10.

Table 5-10: Qualitative risk assessment matrix

Consequence	Likelihood				
	Almost certain	**Likely**	**Possible**	**Unlikely**	**Rare**
Severe	Major	Major	Major	High	Moderate
Major	Major	Major	High	Moderate	Low
Moderate	High	High	Moderate	Low	Low
Minor	Moderate	Moderate	Low	Low	Very low
Negligible	Low	Low	Low	Very low	Very low

Low risks are considered minor and acceptable and will be managed by the project's standard operating procedures and managing for continual improvement.

Where the risk level is higher than low, additional management and mitigation measures are required to be considered and implemented to reduce the risk to as low as reasonably practicable (ALARP) and tolerable levels.

Risk evaluation involves making decisions, based on the outcomes of the risk analysis, about which risks need treatment and the priority for treatment implementation. For the purposes of the preset project, potential incidental or unplanned events that require a risk assessment include:

- Incidental events:
  - project vessel collision risks with other vessels.
  - project vessel collision risk with large migratory cetaceans.
  - commercial trawling entanglement with exposed (non-buried) project structures.
- Unplanned events:
  - introduction of marine invasive species
  - spread of existing invasive species

In the current qualitative risk assessment, a residual risk rating of ***Major*** or ***High*** (see Table 5 10, Qualitative risk assessment matrix for derivation) would equate to a 'significant impact' for Matters of National Environmental Significance – Significant impact guidelines 1.1 (DoE 2013), which includes consideration of the adverse risk of a marine invasive species becoming established in the Commonwealth marine area or adverse event risks such as project vessel collisions with other vessels or project vessel collision risks to MNES migrating marine megafauna.

5.3.5 Cumulative impact assessment

The EIS guidelines and EES scoping requirements both include requirements for the assessment of cumulative impacts. Cumulative impacts result from incremental impacts caused by multiple projects occurring at similar times and within proximity to each other.

To identify possible projects that could result in cumulative impacts, the International Finance Corporation (IFC) guidelines on cumulative impacts have been adopted. The IFC guidelines (IFC, 2013) define cumulative impacts as those that 'result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones.'

The approach for identifying projects for assessment of cumulative impacts considers:

- Temporal boundary: the timing of the relative construction, operation and decommissioning of other existing developments and/or approved developments that coincides (partially or entirely) with Marinus Link.
- Spatial boundary: the location, scale and nature of the other approved or committed projects expected to occur in the same area of influence as Marinus Link. The area of influence is defined as the spatial extent of the impacts a project is expected to have.

Proposed and reasonably foreseeable projects were identified based on their potential to credibly contribute to cumulative impacts due to their temporal and spatial boundaries. Projects were identified based on publicly available information at the time of assessment. The projects considered for cumulative impact assessment in Bass Strait are:

- Star of the South Offshore Wind farm
- Offshore wind development zone in Gippsland including Greater Gippsland Offshore Wind Project (BlueFloat Energy), Seadragon Project (Floatation Energy), and Greater Eastern Offshore Wind (Corio Generation).

The projects relevant to this assessment have been determined based on the potential for cumulative impacts to marine ecology and resource use values. Projects assessed as relevant to this assessment are:

- Offshore Victorian wind development declared areas in Gippsland including:
  - Star of the South Offshore Wind Project (SOTS).
  - Greater Eastern Offshore Wind (Corio Generation).
  - Greater Gippsland Offshore Wind Project (BlueFloat Energy)
  - Seadragon Project (Flotation Energy).

5.4 Stakeholder engagement

Consultation has been a key part of the project design and development as part of the environmental impact assessment process. There have been meetings, communications and dialogue with the local communities, including key stakeholders such as Traditional Owners and commercial fisheries. These consultations are continuing and will be reported in the EIS/EES.

5.5 Assumptions and limitations

Key assumptions and limitations of the impact assessment process are summarised below while specific assumptions and/or limitations are outlined in the relevant impact sections of this report.

5.5.1 General

This marine ecology and resource impact assessment has been based on a knowledge of the existing marine environment of the project and observed marine environmental impacts associated with similar subsea interconnector projects (e.g., Basslink Project and operations), as well as more recently observed marine environmental impacts associated with from marine renewable energy projects and operations (e.g., offshore wind farms). Since the marine impact assessment process deals with the future there is, inevitably, some uncertainty about what will realistically happen.

As with most proposed marine development projects, the impact assessment process is based on defining representative scenarios reflecting typical conditions likely to be experienced during construction, operation, and decommissioning of the project. This report presents adopted scenarios and outlines any assumptions and limitations of the scenarios within the relevant impact assessment sections.

The present report has adopted a precautionary approach to the identification and assessment of impacts. Wherever possible, impact predictions have been made based on the results of field surveys and using the best available data, methods and the scientific knowledge available at this juncture. Where predictive ability is lacking or where uncertainty remains, this is acknowledged and commented upon, and greater emphasis will be placed on subsequent monitoring.

5.5.2 Key assumptions and limitations

Key assumptions and limitations are outlined in the following sections.

5.5.2.1 Baseline marine ecology

The nearshore video and drop camera surveys of Waratah Bay were based on the 2021 alignment of the project's subsea cables. However, the 2022 re-alignment, which is a maximum of 535 m west of the 2021 alignment, was not surveyed in detail by CEE (2022). The key assumption here is that the seabed biological communities of the 2022 project re-alignment will mirror those of the 2021 alignment at similar depths and distances from the shore. It is expected that the character of any marine communities associated with habitat on the 2022 alignment in Waratah Bay will be the same as those documented on similar habitats in the 2018 and 2021 surveys about 2 km to the east.

Additional species lists of fauna inhabiting nearshore sandy seabed have been derived from regional data (e.g., nearshore Tasmania at Five Mile Bluff for the Basslink Project (Chidgey et al., 2006) and the Tasmanian Natural Values Atlas (DNRE, 2020).

5.5.2.2 Underwater noise sources and impacts

In common with most marine construction projects, the types and number of construction vessels required is not yet known. Therefore, assumptions had to be made about the required types, size, and capacity of vessels likely to be involved in the project construction, operations and decommissioning were derived from literature reviews of similar subsea interconnector projects or operations. The present report is therefore based on 'typical' noise source levels impacts for different categories of project vessels.

In a similar manner, the prediction of noise impacts of project construction equipment (e.g., a jet trencher or targeted rock placement) involves unknown underwater noise source level characteristics for construction equipment that will be used on site. Therefore, a literature review was undertaken of similar types of equipment used in cable installation and burial. The present report is therefore based on ‘typical’ underwater noise source levels for different categories of marine construction equipment.

6 Existing conditions

6.1 Overview

This section outlines the existing physical, biological, and resource use aspects of the marine environment of the study area and project area within Bass Strait. Natural magnetic fields and electric fields in Bass Strait are described separately and in context within impact assessment Section 7.3.1 (Magnetic field impacts) and Section 7.3.2 (Electric field impacts), respectively.

6.2 Physical environment

6.2.1 Climate

Bass Strait is located within a cool temperate region with cold, wet winters and warm, dry summers. The regional climate is dominated by subtropical high-pressure systems in summer and sub-polar low-pressure systems in winter. The conditions are primarily influenced by weather patterns originating in the Southern Ocean.

6.2.1.1 Rainfall

Table 6.1 presents mean and median annual rainfall at four weather stations across Bass Strait, comprising one in Victoria (Wilsons Promontory Lighthouse), and three in Tasmania with two located offshore at Hogan Island and King Island Airport and one located onshore at Burnie. Figure 6.1 shows the locations of weather stations across Bass Strait.

Table 6-1: Monthly and annual rainfall across project area in Bass Strait

Site	Monthly rainfall (mm)												Total (mm)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Victoria – Wilsons Promontory Lighthouse:													
Mean	52.0	46.7	69.8	84.5	114.6	119.3	123.0	123.7	98.6	91.7	70.6	64.2	1057.7
Median	46.4	38.1	58.6	80.9	102.9	114.7	110.2	116.2	96.2	84.8	67.9	57.2	1075.2
Tasmania – Hogan Island:													
Mean	39.6	36.5	46.2	52.9	59.1	61.0	72.2	74.9	53.2	43.6	43.7	42.5	638.5
Median	36.0	27.4	40.4	48.0	63.5	63.0	73.6	67.0	49.1	39.8	46.4	40.1	667.6
Tasmania – Burnie (Park Grove):													
Mean	44.9	43.2	51.6	73.0	94.5	101.4	123.8	110.2	88.7	84.4	68.5	63.2	958.2
Median	39.2	39.1	45.2	62.8	89.6	89.2	113.7	105.6	81.8	76.0	69.7	57.4	946.7
Tasmania – King Island Airport:													
Mean	39.7	31.5	51.0	56.1	89.5	98.3	116.2	114.7	84.9	74.5	55.3	47.1	858.7
Median	32.4	27.0	47.4	48.6	80.2	98.4	117.8	111.2	77.2	69.6	54.2	40.0	852.0

Source: BOM (2021).

Mean annual rainfall across Bass Strait, in the vicinity of the proposed northern alignment of the project, decreases from 1,057.7 mm at Wilson Promontory in Victoria to 638.5 mm at Hogan Island in central Bass Strait and increases to 958.2 mm at Burnie in Tasmania. In general, the wetter months are May through August, and the drier months are November to February.

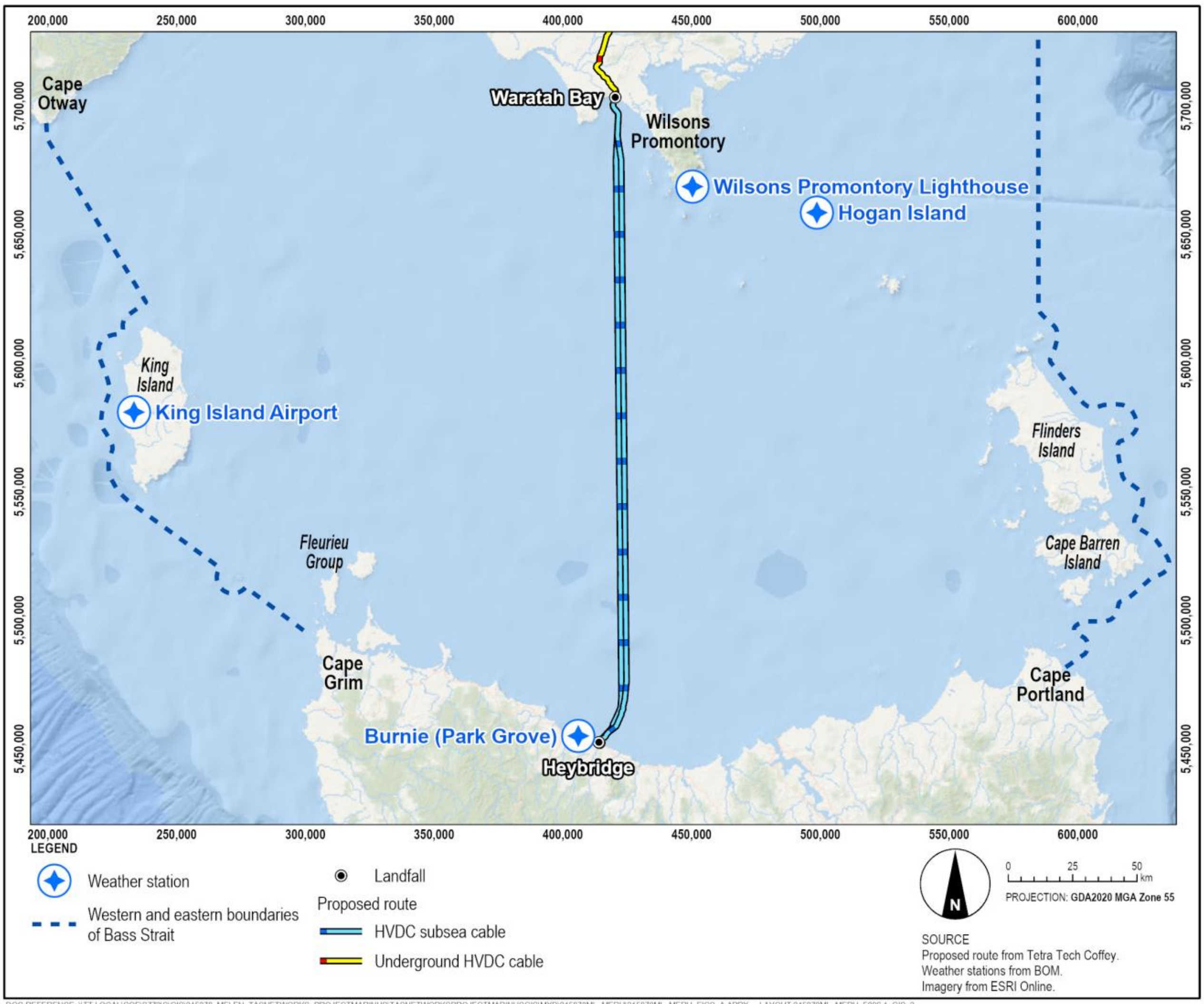


Figure 6.1 Weather station locations across Bass Strait

The relatively low annual rainfall at Hogan Island (75 km east of the project's proposed alignment) was comparable to the nearest western weather station on King Island (190 km west of the project), which had a mean annual rainfall of 858.2 mm, confirming lower levels in central Bass Strait.

6.2.1.2 Winds

The project area across Bass Strait is exposed to winds that vary and depend on the season. In the winter months, a regular succession of depressions passes to the south of Tasmania and strong to gale-force westerlies may persist for weeks at a time with only brief intermissions. These depressions are a principal source of unsettled weather in Bass Strait. In the spring the winds are mostly northerly through west to south-westerly. During the summer months, westerly winds prevail whilst in the autumn the winds are northerly through west to south-westerly.

Low-pressure systems are accompanied by strong westerly winds and rain-bearing cold fronts that move from west to east across the Strait, producing strong winds from the west, northwest and southwest.

6.2.2 Oceanography

The region of Bass Strait is characterised as oceanic, with weak nearshore tidal currents, complex large-scale ocean currents, high wave climate and a wide spatial and temporal range in water temperature (NSR, 2001). Approximately 255-km wide and with an average depth of 50 metres, Bass Strait features numerous islands, deep ocean drop-offs at its western and eastern margins, and a meeting point of currents created by the merging of the Pacific Ocean and Southern Ocean. Bass Strait current and wave conditions are described below.

6.2.2.1 Currents and wave conditions

Bass Strait is influenced by three very different water masses: northern Bass Strait, south Tasman Sea and the East Australia Current (Fandry et al., 1985; Gibbs et al., 1986). In winter, surface water from the Great Australian Bight moves eastwards through Bass Strait, transforming under the prevailing atmospheric conditions into the locally formed Bass Strait water, which reaches its minimum temperature near Flinders Island. A northward flow at the eastern shelf break of Bass Strait carries Bass Strait water and, from east of Tasmania, sub-Antarctic surface water towards the coast of Victoria. The low-salinity water in eastern Bass Strait and westwards along the north Tasmanian coast during November may indicate penetration of sub-Antarctic surface water (Gibbs et al., 1999). The strength of each of these water masses influences in Bass Strait is in turn influenced by seasonal and regional wind patterns. The effects of these water masses may influence Bass Strait water quality (e.g., temperature, nutrients and phytoplankton).

Bass Strait is a high-energy environment, and storms are frequent. In central Bass Strait, the wave climate is dominated by westerly and southwesterly swells. The median significant wave height can range from 1 to 2 m in the northern and central parts of Bass Strait and to about 1 m in the southern part (NSR, 2001). Wave climate in shallow waters can induce near-seabed orbital velocities, which can initiate bed sediment transport and resuspension of fine-grained seabed sediments.

Significant differences in sea state intensity can exist in Bass Strait during large storms with wind and waves from the southeast, with maximum significant wave heights during large storms reaching 9.7 m (Silbert et al, 1980). On the night of 3rd February 2005, the 194-m long passenger ship *MV Spirit of Tasmania I*, with 623 passengers aboard, was hit by high seas in Bass Strait while sailing from Melbourne to Devonport in Tasmania, damaging the starboard bow and some cabins up to deck seven (uppermost deck). The damage to the ship was appraised to be from waves reaching a maximum 19.8 m and the storm caused considerable damage to local beaches, parks and piers, with Middle Park beach almost being completely washed away (CSW Network, 2005). The ship's location at the time of the damage was 38 km south of Cape Liptrap and about 14 km west of the proposed alignment of the project's western monopole (ML1), which implies that storm damage was also likely to have occurred within Waratah Bay and the western coastline and islands of Wilsons Promontory.

6.2.2.2 Bathymetry

In general, the average depth of central Bass Strait is around 75 m with a maximum depth of 80.6 m (Fugro, 2020). Water depths within 10 km of the proposed Tasmanian and Victorian nearshore interconnector landfalls were measured by Fugro (2020) at select locations, which are summarised below.

6.2.2.2.1 Nearshore Tasmania

In nearshore Tasmania, the seabed sloped at a gradually decreasing gradient from the coastline to the 40 m depth contour. Sharp changes in depth occurred at intervals from the coastline to 3 km offshore that indicate the presence of high relief reef habitat. Beyond 32 m depth and 3.5 km offshore, the profile is relatively smooth and flat, reaching 40 m depth at approximately 6.5 km offshore. Figure 6.2 shows the bathymetry in nearshore Tasmania.

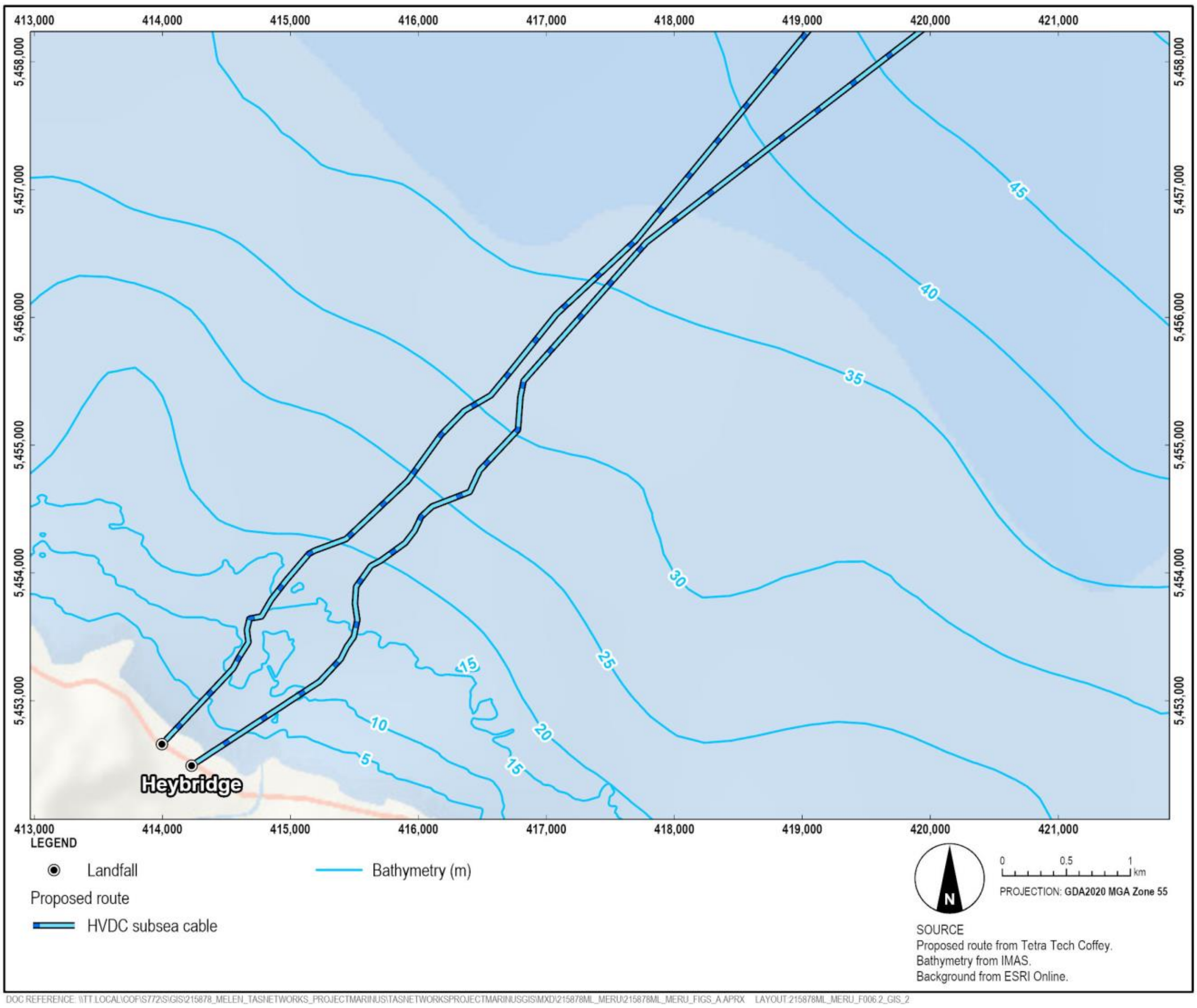
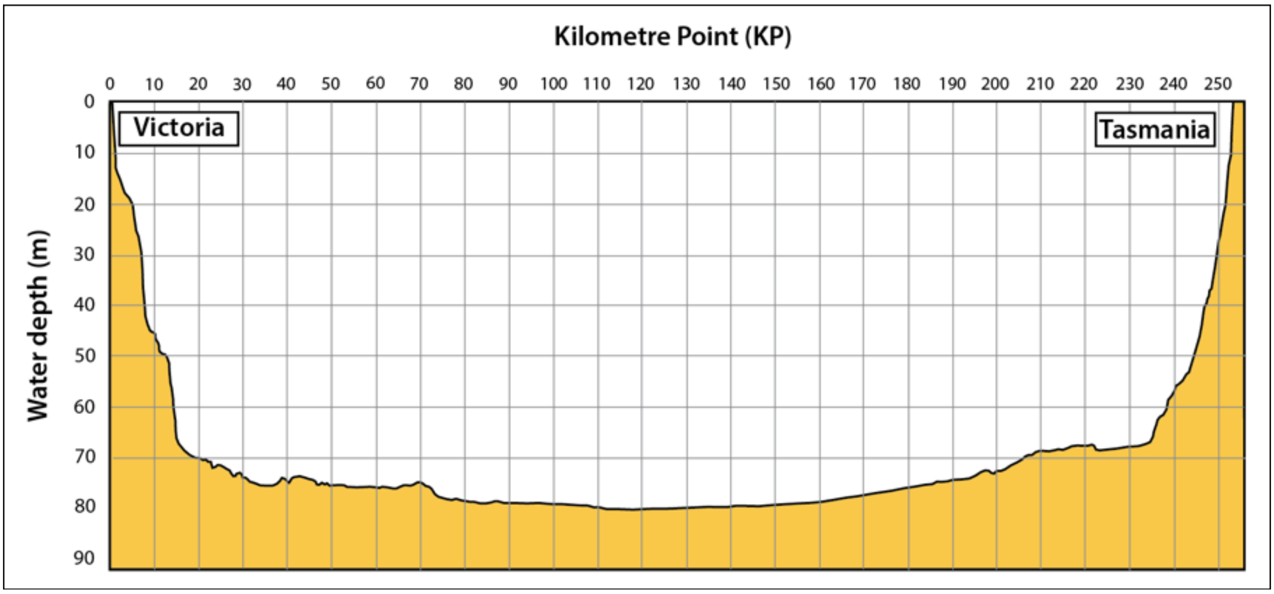


Figure 6.2: Bathymetry in nearshore Tasmania off Heybridge

6.2.2.2.2 Offshore waters (Central Bass Strait)

While CEE (2023) measured water depths within 10 km of the Victorian and Tasmanian nearshore zones, similar measurements for the 200-km long intervening section of offshore Bass Strait were undertaken during a geophysical survey by Fugro (2020). A schematic cross-section of Bass Strait along the project's proposed route corridor from shoreline to shoreline is shown in Figure 6.3.

The descending seabed in nearshore Victoria levels off at around Kilometre Point (KP) 14 (65 m water depth) and continues to be relatively flat until rising again at KP 237 (63 m water depth) in nearshore Tasmania. The deepest point of 80.6 m was measured at KP 127 in central Bass Strait. The average water depth across most of offshore Bass Strait is around 75 m.



Source: Fugro (2020).

Figure 6.3: Water depths along the project alignment in Bass Strait

6.2.2.2.3 Nearshore Victoria

In the Victorian nearshore within Waratah Bay, the water depth at 560 m from shore was 7 m and increased to 42 m at 7.7 km from the shore. The depth profile shows an initial steep increase in depth from 6 m to 15 m over the first 500 to 600 m of the section (gradient 1:70), followed by gently-sloping, flat seabed from 15 m to 25 m over approximately 4 km (gradient of 1 in 400), a longshore trough 5.8 to 5.9 km offshore followed by a relatively steep increase in depth from 30 m to 42 m over the last offshore 1,000 m of the section (gradient of 1 in 80). Figure 6.4 shows the bathymetry in nearshore Victoria.

6.2.3 Marine water quality

This section provides a brief overview of existing water quality in Bass Strait including the study area. The following summaries are mainly based on water quality data described by Gibbs et al. (1986) and Gibbs et al. (1999).

Additional information on Bass Strait water quality data was obtained from an analysis of water quality data collected daily by the passenger ship MV *Spirit of Tasmania I* as it traverses Bass Strait between its homeport of Devonport and the Port of Geelong (IMOS, 2022). Water samples are taken from the ship's sea chest water intake at about 6 m depth (Lee et al., 2011). The water quality data has been summarised for the period 2020 to 2021 for three locations that are representative of nearshore Victoria, nearshore Tasmania and offshore Bass Strait waters (see Figure 5.1).

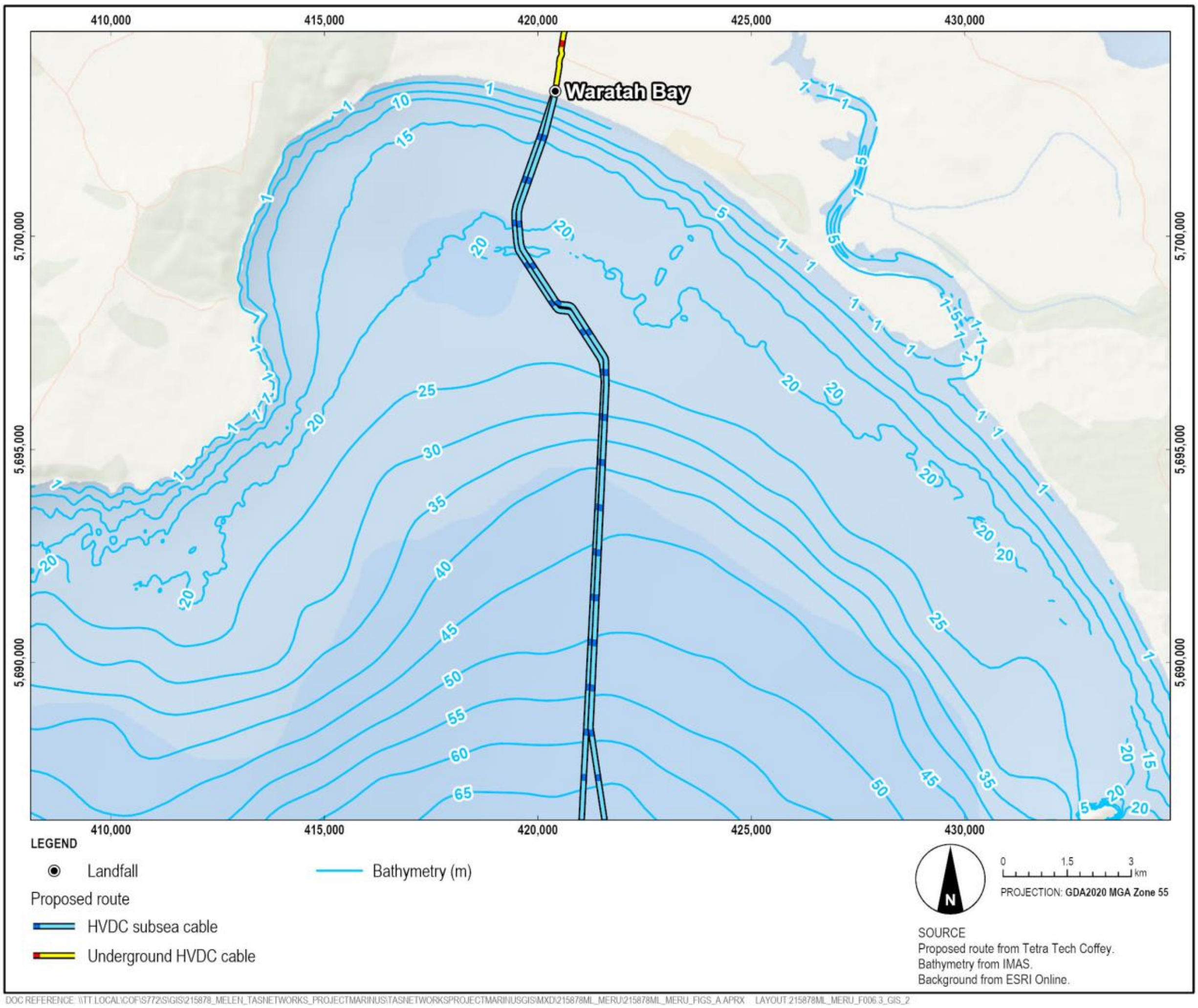


Figure 6.4: Bathymetry in nearshore Victoria

6.2.3.1 Nearshore Tasmania water quality

Table 6.2 presents a summary of water quality at the point where the outbound and inbound transits of the MV *Spirit of Tasmania I* cross the Tasmanian nearshore west of Mersey Estuary entrance for the quadrilateral area bounded by Lat/Long -41.14° S, 146.31° E to Lat/Long -41.114° S, 146.364° E (see Figure 5.1 for location). Surface water quality at the transit points is assumed for the purpose of the present report to be representative of nearshore water quality along the Tasmanian coast including Heybridge nearshore waters.

Table 6-2: Water quality summary nearshore Tasmania (MV *Spirit of Tasmania I* data)

Statistics	Temperature (°C)	Turbidity (NTU)	Salinity (PSU)	Chlorophyll (mg/m^3)
Winter (1 June to 31 August 2021):				
No. of samples	51,191	51,191	51,191	51,191
Average	13.705	1.136	33.260	0.400
Standard deviation	2.695	2.255	1.728	0.080
5-percentile	11.731	0.018	29.265	0.283
10-percentile	11.837	0.234	31.444	0.295
50-percentile (median)	12.353	0.462	33.826	0.394

90-percentile	18.844	1.152	35.156	0.492
95-percentile	19.267	6.474	35.246	0.529
Summer (1 December 2020 to 28 February 2021):				
No. of samples	71,219	71,219	71,219	71,219
Average	17.532	0.521	35.073	0.295
Standard deviation	1.582	0.276	0.638	0.017
5-percentile	14.666	0.210	33.932	0.271
10-percentile	15.326	0.264	34.546	0.271
50-percentile	17.527	0.516	35.266	0.295
90-percentile	19.477	0.714	35.417	0.320
95-percentile	19.871	0.77	35.441	0.320

Source: MV *Spirit of Tasmania I* water quality data (AODN, 2021). NTU=Nephelometric Turbidity Units. PSU=Practical Salinity Units.

6.2.3.1.1 Surface water temperatures

In Table 6.2, the average temperatures for nearshore Tasmania were 13.71° C in winter (1 June to 31 August 2021) and 17.53° C in summer (1 December 2021 to 28 February 2021). The temperature difference between winter and summer in nearshore Tasmania was 3.82° C. The average surface water temperatures in nearshore Tasmania were about 0.65° C cooler than in nearshore Victoria.

6.2.3.1.2 Surface water turbidity

In Table 6.2, average surface turbidity for nearshore Tasmania were 1.14 NTU in winter (1 June to 31 August 2021) and 0.52 NTU in summer (1 December 2021 to 28 February 2021). These low surface turbidity values indicate high water clarity and low TSS concentrations in nearshore Tasmania. Average turbidity values in both Victorian and Tasmanian nearshore surface waters were of the same magnitude.

6.2.3.1.3 Surface water salinity

In Table 6.2, average surface salinities for nearshore Tasmania were 33.26 PSU in winter (1 June to 31 August 2021) and 35.07 PSU in summer (1 December 2021 to 28 February 2021). The lower surface salinity in winter may be caused by lower salinity water discharging from Port Phillip Bay, owing to higher reiver flows to the bay.

6.2.3.1.4 Surface water chlorophyll-*a* concentrations

In Table 6.2, average surface chlorophyll concentrations for nearshore Tasmania were 0.40 mg/m^3 in winter (1 June to 31 August 2021) and 0.30 mg/m^3 in summer (1 December 2021 to 28 February 2021). In general, chlorophyll concentrations were higher in winter than summer.

6.2.3.2 Offshore Bass Strait water quality

Table 6.3 presents a summary of offshore water quality where the outbound and inbound transits of MV *Spirit of Tasmania I* cross the project alignment for the quadrilateral area bounded by the northwest point at Lat/Long -41.7515° S, 146.0718° E to southeast point at Lat/Long -40.7717° S, 146.1158° E (see Figure 5.1 for location). Surface water quality at these transit crossings have been assumed to be representative of general water quality in offshore Bass Strait for the purpose of the present report.

6.2.3.2.1 Surface water temperature

Based on measurements taken during research cruises in 1980 within Bass Strait, Gibbs et al. (1986) observed that in summer (January), surface water temperatures showed a gradual increase from south-west to north-east within Bass Strait. In early winter (June), surface water temperatures showed little variation in the east-west direction through Bass Strait. Average seasonal variation of water temperatures of Bass Strait is 16.3° C in summer (January) to 13.2° C in winter (July).

In Table 6.3, average temperatures for nearshore Victoria, Bass Strait and nearshore Tasmania were 14.35, 14.28 and 13.71 °C in winter (1 June to 31 August 2021) respectively; and 18.02, 16.91 and 17.53 °C (1 December 2021 to 28 February 2021). The temperature difference between winter and summer in Bass Strait was not as great as those measured in the nearshore locations.

Table 6-3: Water quality summary for offshore Bass Strait (MV *Spirit of Tasmania I* data)

Statistics	Temperature (°C)	Turbidity (NTU)	Salinity (PSU)	Chlorophyll (mg/m^3)
Winter (1 June 2020 to 31 August 2021):				
No. of samples	174,330	174,330	174,330	174,330
Average	14.282	1.194	33.764	0.395
Standard deviation	2.442	2.350	1.397	0.082
5-percentile	12.490	0.018	30.236	0.283
10-percentile	12.694*	0.306	32.287	0.295
50-percentile	13.030	0.492	34.146	0.381
90-percentile	19.060	1.254	35.245	0.504
95-percentile	19.396	8.454	35.321	0.529
Summer (1 December 2020 to 28 February 2021):				
No. of samples	210,913	210,913	210,913	210,913
Average	16.909	0.440	35.435	0.296
Standard deviation	1.089	0.170	0.141	0.023
5-percentile	15.222	0.198	35.276	0.258
10-percentile	15.497	0.222	35.318	0.271
50-percentile	17.143	0.456	35.443	0.295
90-percentile	18.297	0.636	35.570	0.332
95-percentile	18.640	0.666	35.582	0.344

Source: MV *Spirit of Tasmania I* water quality data (AODN, 2021).

6.2.3.2.2 Surface water turbidity

In Table 6.3, average surface turbidity for offshore Bass Strait were 1.19 NTU in winter (1 June to 31 August 2021) and 0.44 NTU in summer (1 December 2021 to 28 February 2021). These low surface turbidity values indicate high water clarity and low TSS concentrations in the offshore waters of Bass Strait. Average turbidity values in both Victorian and Tasmanian nearshore surface waters were of the same magnitude during the winter and summer monitoring periods.

6.2.3.2.3 Surface water salinity

In Table 6.3, surface salinity for offshore Bass Strait were 33.76 PSU in winter (1 June to 31 August 2021) and 35.44 PSU in summer (1 December 2021 to 28 February 2021).

Surface water salinities can vary due to the interaction of east-moving Bass Strait water with warm saline water to the northeast and cold, low salinity sub-Antarctic water from the southeast. In general, the surface salinities in offshore waters are consistent with eastward flow in winter and weak or westward flow in summer (Gibbs et al., 1986).

6.2.3.2.4 Surface water chlorophyl-*a* concentrations

In Table 6.3, average surface chlorophyll concentrations for offshore Bass Strait were 0.40 mg/m^3 in winter (1 June to 31 August 2021) and 0.30 mg/m^3 in summer (1 December 2021 to 28 February 2021). In general, chlorophyll concentrations were higher in winter than summer.

Chlorophyll a is a commonly used indicator of phytoplankton abundance and biomass in the marine environment, an effective measure of trophic status and potential indicator of maximum photosynthetic rate.

6.2.3.2.5 Surface water nutrient concentrations

Additional existing water quality data for the offshore surface waters of Bass Strait are nutrient concentrations provided by Gibbs et al. (1986). Typical nutrient concentrations routinely measured in near surface waters across central Bass Strait include nitrogen-based nutrients (e.g., ammonia, nitrate plus nitrite), silicate and phosphorus (total and inorganic reactive phosphate). Measured nutrient concentrations are summarised below.

Ammonia and combined nitrate and nitrite

Average seasonal variation of near-surface water ammonia concentrations of Bass Strait ranged from 0.12 µg/L in summer (January) to 0.32 µg/L in winter (July), and combined nitrate and nitrite concentrations of Bass Strait ranged from 0.15 µg/L in summer (January) to 1.1 µg/L in winter (July).

Silicate

Average seasonal variation of near-surface water silicate concentrations of Bass Strait ranged from 0.55 µg/L in summer (January) to 0.78 µg/L in winter (July).

Phosphorus and phosphate

Average seasonal variation of near-surface water total phosphorus concentrations of Bass Strait ranged from 0.28 µg/L in summer (January) to 0.39 µg/L in winter (July), whereas inorganic reactive phosphate concentrations ranged from 0.14 µg/L in summer (January) to 0.27 µg/L in winter (July),

Total organic carbon

Average seasonal variation of near-surface water total organic carbon concentrations of Bass Strait ranged from 1.6 mg/L in summer (January) to 0.6 mg/L in winter (July). Total organic carbon did not show any consistent geographical pattern; however, its seasonal variation indicated the reverse of the nutrient case, with the highest concentrations being observed in summer and the lowest in winter.

6.2.3.3 Nearshore Victoria water quality

Table 6.4 presents a summary of water quality at the point where the transit of MV *Spirit of Tasmania I* crosses Victorian nearshore just east of Port Philip entrance for the quadrilateral area bounded by Lat/Long -38.3534° S and 144.6090° E to Lat/Long -38.4049° S to 144.6857° E (see Figure 5.1 for location), which is assumed to be representative of nearshore water quality along the Victorian south coast including Waratah Bay, for the purposes of the present report.

Table 6-4: Water quality summary for nearshore Victoria (MV Spirit of Tasmania I data)

Statistics	Temperature (°C)	Turbidity (NTU)	Salinity (PSU)	Chlorophyll (mg/m^3)
Winter (1 June to 31 August 2021):				
No. of samples	80,129	80,129	80,129	80,129
Average	14.352	1.063	33.949	0.380
Standard deviation	2.424	2.037	1.112	0.069
5-percentile	12.533	0.042	31.990	0.283
10-percentile	12.591	0.240	32.385	0.295
50-percentile	13.233	0.456	34.178	0.381
90-percentile	19.319	1.488	35.367	0.467
95-percentile	19.573	6.432	35.390	0.492
Summer (1 December 2020 to 28 February 2021):				
No. of samples	99,423	99,423	99,423	99,423
Average	18.202	0.487	35.450	0.303
Standard deviation	0.793	0.152	0.113	0.023
5-percentile	16.807	0.246	35.313	0.271
10-percentile	17.184	0.288	35.360	0.271
50-percentile	18.202	0.498	35.457	0.295
90-percentile	19.239	0.672	35.550	0.332
95-percentile	19.493	0.720	35.572	0.344

Source: MV *Spirit of Tasmania I* water quality data (AODN, 2021). NTU=Nephelometric Turbidity Units. PSU=Practical Salinity Units.

6.2.3.3.1 Surface water temperature

In Table 6.4, the average temperatures for nearshore Victoria were 14.35° C in winter (1 June to 31 August 2021) and 18.02 °C in summer (1 December 2021 to 28 February 2021), equating to a 3.67° C difference across the two seasons.

6.2.3.3.2 Surface water turbidity

In Table 6.4, average surface turbidity for nearshore Victoria were 1.06 NTU in winter (1 June to 31 August 2021) and 0.49 NTU in summer (1 December 2021 to 28 February 2021). These low surface turbidity values indicate surface waters of high clarity and low concentrations of total suspended solids (TSS) since turbidity is often used as a surrogate for TSS concentrations.

6.2.3.3.3 Surface water salinity

In Table 6.4, average surface salinities for nearshore Victoria were 33.95 PSU in winter (1 June to 31 August 2021) and 35.45 PSU in summer (1 December 2021 to 28 February 2021). The lower surface salinity in winter may be caused by lower salinity water discharging from Port Phillip Bay, owing to higher reiver flows to the bay.

6.2.3.3.4 Surface water chlorophyll-*a* concentration

In Table 6.4, average surface chlorophyll concentrations for nearshore Victoria were 0.38 mg/m^3 in winter (1 June to 31 August 2021) and 0.30 mg/m^3 in summer (1 December 2021 to 28 February 2021). In general, chlorophyll concentrations were higher in winter than summer.

6.2.4 Seabed sediment characteristics

The nature of the seabed and bedforms of Bass Strait along the proposed project alignment of were surveyed and described by Fugro (2020). In addition, Fugro (2020) undertook targeted sampling of soft seabed sediments using a Van Veen grab for subsequent analysis of carbonate content and sediment particle sizing. CoreMarine on behalf of Tetra Tech Coffey (2022; Attachment E) undertook trace metal analysis in surface sediment samples collected in the vicinity of the marine outfalls of the former Tioxide Australia plant at Heybridge. The objective of the sediment sampling at Heybridge was to characterise the sediment contaminant concentrations along the proposed subsea project alignment in nearshore Tasmania and the potential occurrence of coastal acid sulfate soils (CASS) in the intertidal zone and nearshore subtidal sediments and to determine whether disturbance during cable installation, maintenance, or decommissioning will suspend and disperse sediments that may have negative environmental effects.

6.2.4.1 Particle size distribution

Seabed sediment grain size varies in relation to current velocity, with fine materials (silt and clay) in the central basin of Bass Strait and coarser sands around the coastal margins, where wave and current action is stronger (AMOG, 2000; Li et al., 2011a, b and c). Table 6.5 presents the Wentworth (1922) scale for the size classes of the various sediment types that are discussed in subsequent sections.

The Victorian nearshore comprises mainly coarse and fine sands along the interconnector route within Waratah Bay however, the seabed will be subject to pre-construction geophysical surveys and geotechnical in-situ sampling with measurements to map (swath bathymetry) and characterise the size grading of the seabed sediments. In the Tasmania nearshore, both soft seabed sediments and hard seabed (cobble, bedrock, submerged platforms, and reefs) are known to be present from the CEE 2019 survey (CEE, 2021). This will be investigated in more detail during the geophysical surveys and geotechnical investigations.

The seabed of the central Bass Strait is anticipated to be predominantly fine sands and coarse to very coarse silts based on previous sampling (NSR, 2001; Li et al., 2011a).

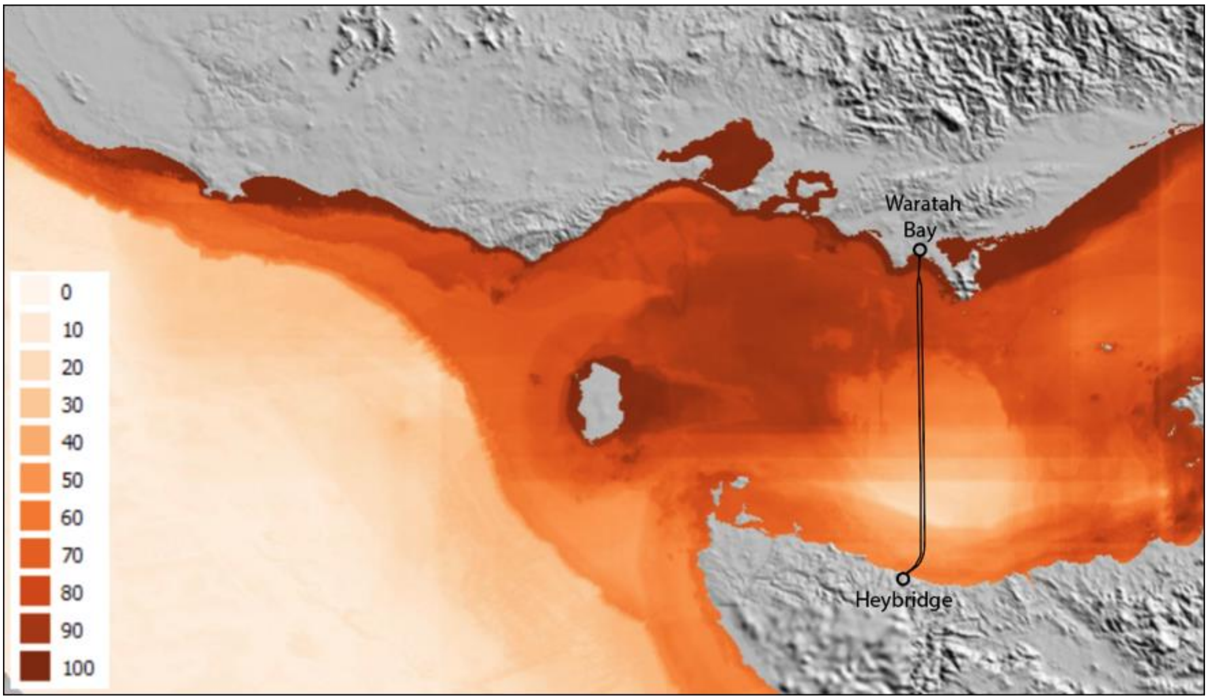
Table 6-5: Wentworth (1922) scale for seabed sediment size classes

Seabed material	Minimum	Maximum
Cobbles	64 mm	128 mm
Pebbles	2.0 mm	64 mm
Very coarse sand	1 mm	2 mm
Coarse sand	500 µm	1,000 µm
Medium sand	250 µm	500 µm
Fine sand	125 µm	250 µm
Very fine sand	62 µm	125 µm
Coarse silt	31 µm	62 µm
Medium silt	16 µm	31 µm
Fine silt	8 µm	16 µm
Very fine silt	4 µm	8 µm
Clay	1 µm	4 µm

Source: Wentworth (1922).

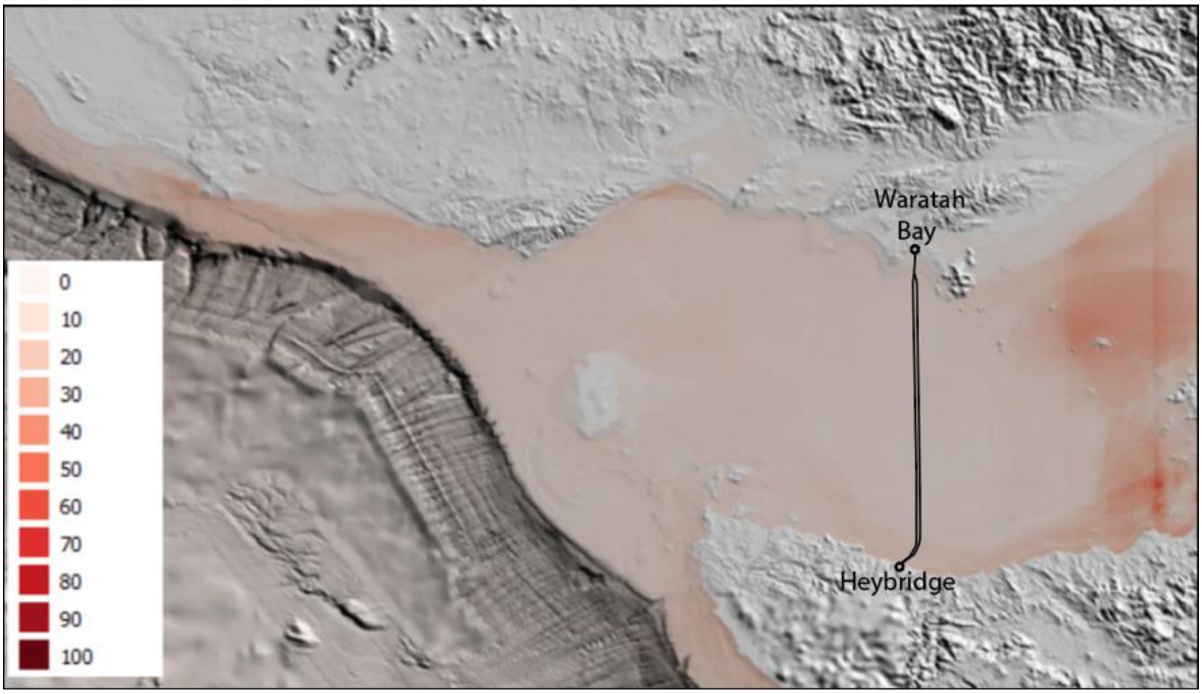
Figure 6.5 gives the percentage distribution of sand in Bass Strait, which shows higher percentages of sand near the Victorian nearshore and adjoining offshore seabed along favourable interconnector route corridor. Figure 6.6 gives the distribution of gravels across Bass Strait, which shows a general uniformity in percentage of gravels (between 0 and 10%).

Figure 6.7 shows the percentage distribution of mud (silts and clays) in Bass Strait, which shows fine-grained sediments (e.g., very coarse to coarse silts and clays) in the southern section of the central basin of Bass Strait. This represents an area in which the projects' subsea cables may be laid on the seabed and allowed to self-bury.



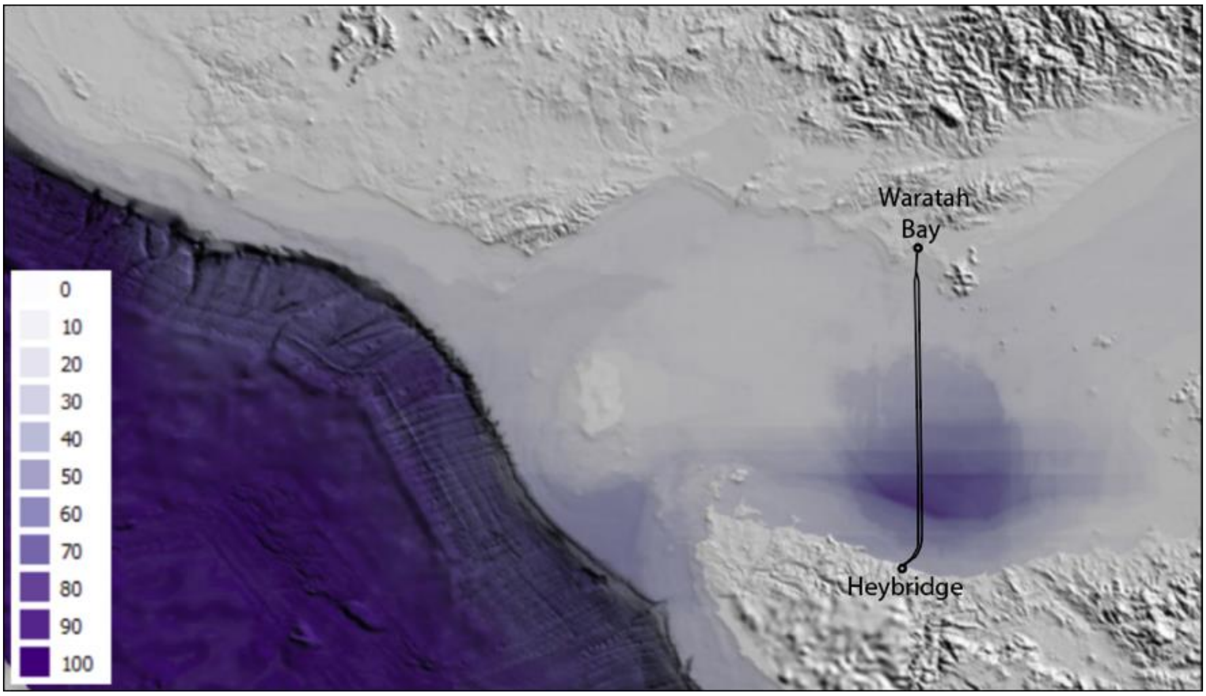
Source: Li et al. (2011a). Legend units are per cent.

Figure 6.5: Bass Strait – percentage sands



Source: Li et al. (2011b). Legend units are per cent.

Figure 6.6: Bass Strait - percentage gravels



Source: Li et al. (2011c). Legend units are per cent.

Figure 6.7: Bass Strait - percentage muds (silts and clays)

6.2.4.2 Seabed sediment quality

In general, most seabed sediments along the project's proposed alignment are anticipated to be of good quality with metals concentrations being typical of uncontaminated seabeds and below sediment quality guidelines and, as such, a program of sampling bed sediments across Bass Strait was considered unnecessary.

For nearshore Victoria, a literature review did not reveal any industrial discharges or marine outfalls (current or historical) to Waratah Bay. In addition, a survey of acid sulphate soils (ASS) (EIS/EES Technical Appendix N – Contaminated land and acid sulfate soils) concluded that the survey results "*did not identify any potential sources of contamination within the coastal fringe along Waratah Bay (or within 2 km of the coast) that have had the potential to result in contamination of sediments on the seabed that may be disturbed during construction, operation or decommissioning of the cable. Consequently, no specific testing of seabed sediments for contamination is considered warranted*." Given the general absence of contaminants and ASS, seabed sampling to characterise background sediment quality of nearshore Victoria was not required.

Potential impacts associated with the mobilisation of acid sulfate soils in the Tasmanian nearshore zone are not discussed in this report. This is because although testing and analysis showed there are potential acid sulfate soils in the nearshore sediments in this area, the measured neutralising capacity of the sediments is high enough to neutralise any acid that may be generated and consequently no management measures are required for the sediments (refer to Attachment E: Tioxide sediment analysis report).

However, within the Tasmanian nearshore environment at the project's approach to landfall, historic discharges of treated wastewater from the former Tioxide Australia Plant at Heybridge occurred through two marine outfalls, which has influenced sediment quality.

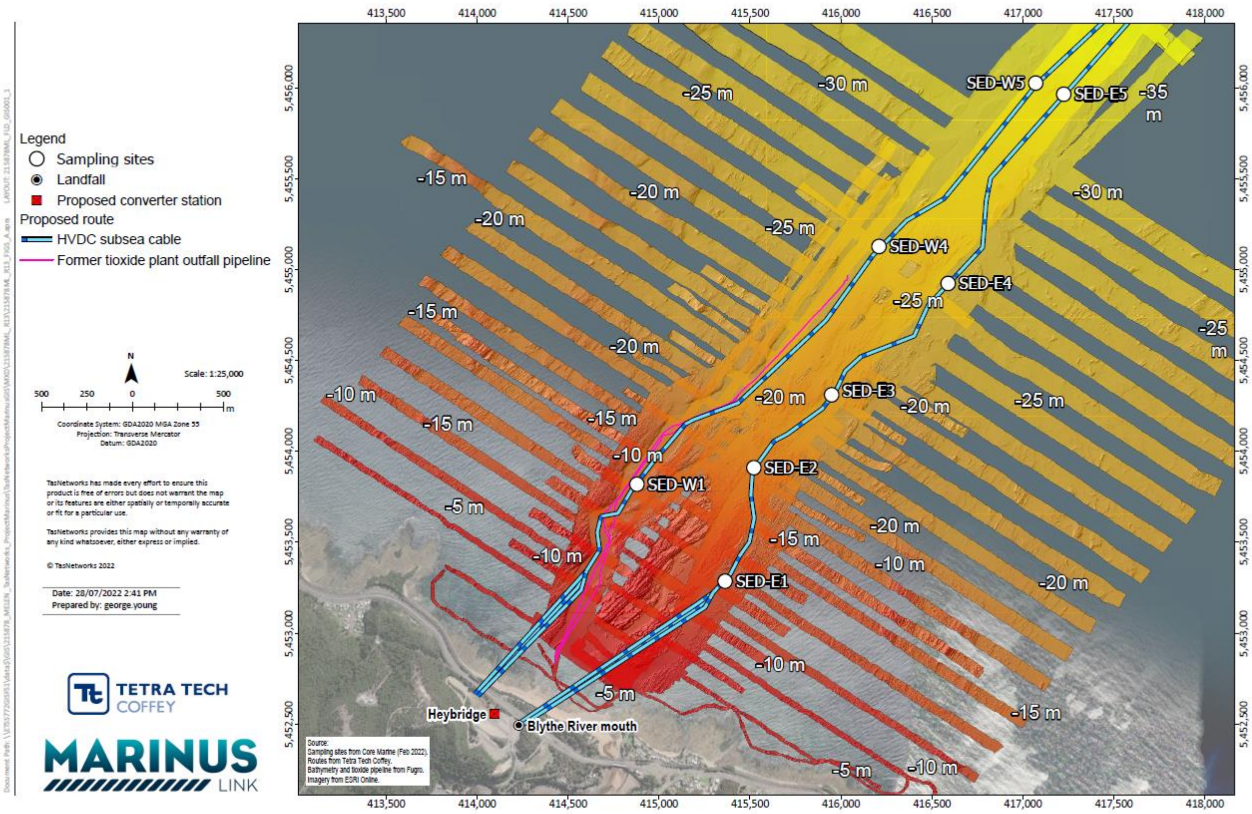
The existing quality of nearshore sediments adjacent to nearshore Tasmania at Heybridge is described below.

6.2.4.2.1 Existing sediment quality in nearshore Tasmania

The operational discharges of treated wastewaters from the Tioxide Australia plant at Heybridge occurred during the period 1948 to 1996. Residual contamination of seabed sediments may still be evident today, even after almost 25 years since the Tioxide Australia plant ceased operation.

Figure 6.8 shows the pipelines and locations of the marine outfalls of the former Tioxide Australia plant. The outfall of shorter pipeline (Tioxide 1) is located at -41.058° S and 145.994° E, while the longer pipeline's marine outfall is located at -41.052° S and 146.001° E. Both pipelines and their marine outfalls are located within the western sand-filled palaeochannel, which is the same palaeochannel where the project' western monopole (ML1) will be constructed.

Tetra Tech Coffey (2022) commissioned a seabed sediment sampling program to assess existing sediment quality and the presence of residual historic contaminants. The resulting Tioxide Sediment Analysis Report by Tetra Tech Coffey (2022) is presented as Attachment E: Tioxide analysis of the report.



Source: Tetra Tech Coffey, 2022; Attachment E, Tioxide sediment analysis report.

Figure 6.8: Sediment sampling sites in relation to Tioxide pipeline and outfalls

Metal and metalloid contaminants

Table 6.6 presents the results of surficial sediment sample analysis for a suite of potential metals and metalloids of general environmental concern; namely, mercury (Hg), arsenic (As), cadmium (Cd), chromium (Cr), Copper (Cu), lead (Pb), nickel (Ni), and zinc (Zn). In order to compare the total concentrations of metals and metalloids in sediment samples with sediment quality guidelines, the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018) have been adopted, which are based on metal and metalloid concentrations in the less than 2,000-µm sediment size fraction.

Table 6-6: Surficial sediment metal/metalloid concentrations (<2,000-μm size fraction)

Site	Depth (cm)	Metal/metalloid concentration (mg/kg dry weight)							
		Hg	As	Cd	Cr	Cu	Pb	Ni	Zn
DGV*	–	0.15	20	1.5	80	65	50	21	200
GV-High#	–	1.0	70	10	370	270	220	52	410
Eastern palaeochannel:									
SED-E1	0–10	<0.1	17	<1	9	<5	<5	3	8
SED-E2	0–25	<0.1	**27**	<1	11	<5	<5	3	10
SED-E3	0–20	<0.1	**29**	<1	23	14	30	10	30
SED-E4	0–20	<0.1	**49**	<1	33	15	7	41	31
SED-E5	0–20	<0.1	**43**	<1	35	<5	<5	**27**	21
Western palaeochannel:									
SED-W1	10-25	<0.1	**34**	<1	10	<5	8	3	32
SED-W4	0–20	<0.1	**43**	<1	19	<5	<5	7	16
SED-W5	0–20	<0.1	**21**	<1	25	<5	6	15	23

Source: Tetra Tech Coffey, 2022; Attachment E: Tioxide analysis. Australia and New Zealand Sediment Quality Guidelines (ANZG, 2018b). *DGV = Default Guideline Value. #GV-high = Upper Guideline Value. Bold font values denote exceedance of the DGV. In instances where duplicate samples were collected at sediment sampling sites, the duplicate showing the more conservative result has been adopted for this report. The full extent of testing and results is available in Attachment E: Tioxide analysis.

The ANZG (2018) sediment quality guidelines provide:

- Default guideline value (DGV), which indicates the concentration below which there is a low risk of biological effects occurring.
- Upper guideline value (GV-high), which provides an indication of the concentration above which toxicity related effects are expected.

At concentrations between the DGV and GV-high, toxicity related effects may occur, but further investigations will typically be recommended to investigate the risks of biological effects occurring.

The key points of Table 6.6 are summarised as:

- Surficial sediment concentrations of mercury, cadmium, chromium copper, lead and zinc concentrations for every sample were less than their respective DGVs at all sites.
- Surficial sediment concentrations of arsenic exceeded its DGV at most sampling depths across all sites, except for SED-E1 and SED-E3.
- Surficial sediment concentrations of nickel for most sites were below its DGV, except for site SED-E5. At site SED-E5 the concentration of nickel was 27 mg/kg (dry weight), which is slightly higher than the DGV of 21 mg/kg.

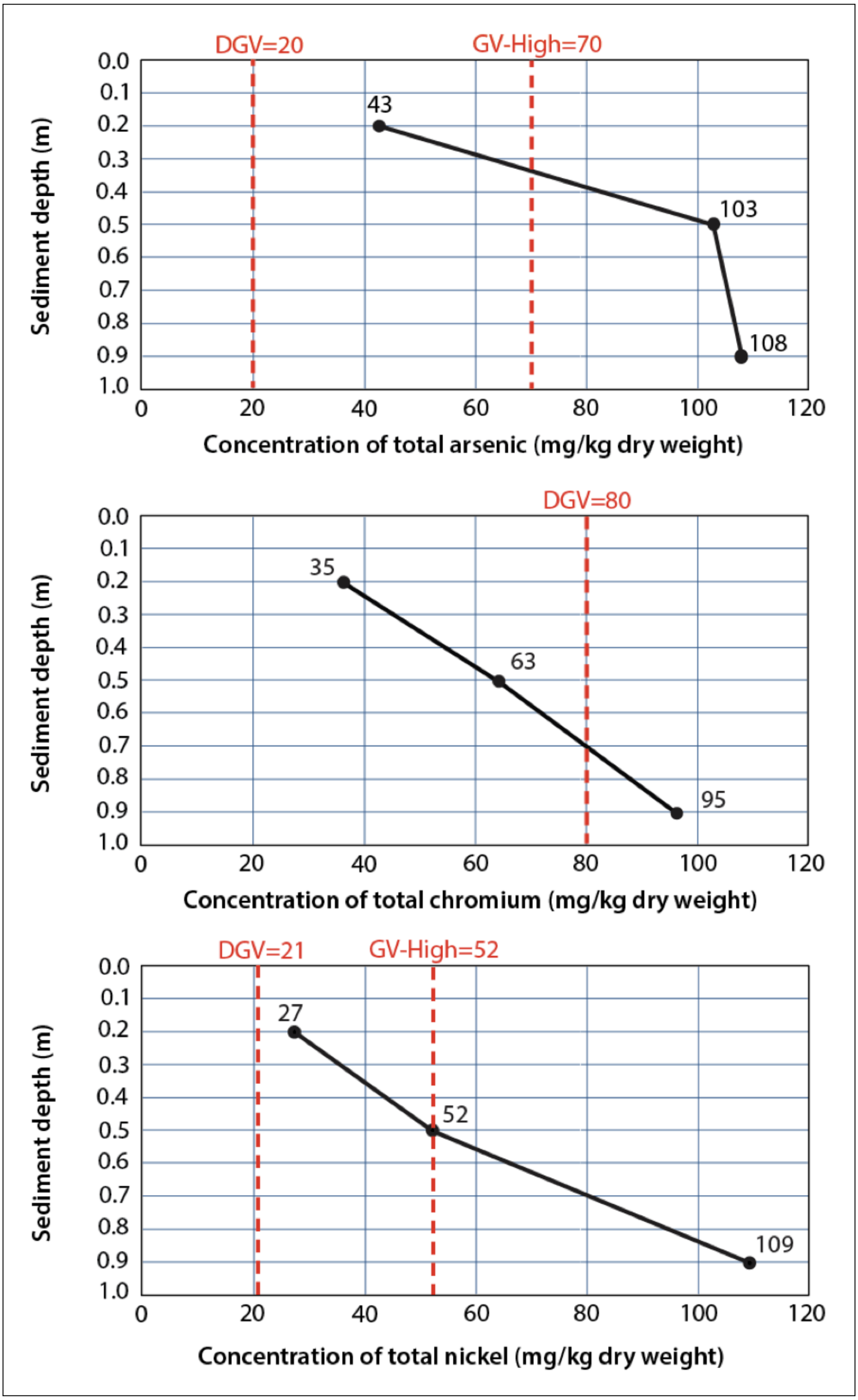
Most surficial sediments have concentrations of metals and metalloids below their respective DGVs, except for arsenic and nickel. Tetra Tech Coffey (2020) also determined metal and metalloid concentrations in sediments at different depths below the seabed of the western palaeochannel. Table 6.7 presents metal and metalloid concentrations with the depth at which the sediment was sampled. Values exceeding the DGV are highlighted in bold font, whereas the cells containing values that exceed the GV-high are highlighted in grey shading.

Figure 6.9 presents the trends of arsenic, chromium, and nickel with depth at the most contaminated sampling site (SED-E5) compared to ANZG (2018) sediment quality criteria.

Table 6-7: Sediment depth and metal/metalloid concentrations (<2,000-µm size fraction)

Site	Depth (cm)	Metal/metalloid concentration (mg/kg dry weight)							
		Hg	As	Cd	Cr	Cu	Pb	Ni	Zn
DGV*	–	0.15	20	1.5	80	65	50	21	200
GV-High#	–	1.0	70	10	370	270	220	52	410
Eastern palaeochannel:									
SED-E3	0–20	<0.1	**29**	<1	23	14	30	10	30
	20–32	<0.1	19	<1	27	<5	<5	8	10
SED-E4	0–20	<0.1	**49**	<1	33	15	7	41	31
	40–60	<0.1	**34**	<1	26	12	<5	31	23
	70–90	<0.1	26	<1	35	20	<5	51	31
SED-E5	0–20	<0.1	**43**	<1	35	<5	<5	**27**	21
	40–60	<0.1	103	1	63	8	<5	**52**	27
	80–100	<0.1	108	1	**95**	23	<5	109	26
Western palaeochannel:									
SED-W1	10–25	<0.1	**34**	<1	10	<5	8	3	32
	10–60	<0.1	**24**	<1	10	<5	<5	2	10
	65–72	<0.1	14	<1	9	<5	<5	2	<5
SED-W4	0–20	<0.1	**43**	<1	19	<5	<5	7	16
	40–60	<0.1	**25**	<1	13	<5	<5	5	6
	80–100	<0.1	**24**	<1	16	<5	<5	9	9
SED-W5	0–20	<0.1	**21**	<1	25	<5	6	15	23
	40–60	<0.1	17	<1	**124**	39	5	147	84

Source: Tetra Tech Coffey, 2022; Attachment E: Tioxide analysis. Australia and New Zealand Sediment Quality Guidelines (ANZG, 2018b). *DGV = Default Guideline Value. #GV-high = Upper Guideline Value. Bold values denote exceedance of DGV and orange-shaded cells denote exceedance of GV-high. In instances where duplicate samples were collected at sediment sampling sites, the duplicate showing the more conservative result has been adopted for this report. The full extent of testing and results is available in Attachment E: Tioxide analysis.



Source: Extracted from Tetra Tech Coffey, 2022; Attachment E: Tioxide analysis.

Figure 6.9: Sediment depth profile of arsenic, chromium, and nickel concentrations

The key points of Table 6.7 and Figure 6.9 may be summarised as:

- Arsenic concentrations decreased with sediment depth at sites SED-E3, SED-E4, SED-W1, SED-W4 and SED-W5, but increased with depth at site SED-E5.
- Chromium concentrations increased with sediment depth at site SED-E5 with its GV-High guidelines value of 70 mg/kg (d.w.) exceeded within both the 40-60 cm and 800-100 cm depth zones. These exceedances of the chromium GV-High value indicate that toxicity related effects are expected in these deeper sediment layers.
- Nickel concentration increased with sediment depth at site SED-E5 with its GV-High guidelines value of 52 mg/kg (d.w.) exceeded within the 80-100 cm sediment depth zone. This exceedance of the nickel GV-High value indicates that toxicity related effects are expected in the deepest sediment layer sampled.

Based on the above findings of the sediment depth profile at site SED-E5, Figure 6.9 graphically presents the concentrations of arsenic, chromium and nickel with depth using mid-point of the sediment depth ranges in Table 6.7.

The implications of construction disturbance of metal or metalloid contaminated sediments in nearshore Tasmania are addressed in Section 7 (Impact assessment).

6.2.5 Coastal environment and coastal processes

The physical coastal environment described in this section is defined by the extent of the nearshore Victoria (Waratah Bay) and nearshore Tasmania (tioxide beach and the Blythe River mouth), where the project's proposed landfalls are located. In additional, coastal processes of the Tasmanian and Victorian coast have been characterised.

6.2.5.1 Tasmanian coast at or near the project's proposed landfall

An assessment of the stability of the shoreline at the project's proposed landfall at tioxide beach adjacent to Heybridge and west of the Blythe River mouth was undertaken by examining the position of the shoreline from historical imagery using Google Earth™. Figure 6.10 shows coastline changes over a 13-year period.

In Figure 6.10, the project's proposed landfall shore crossings at the project's proposed landfalls of both the western monopole (ML1) and eastern monopole (ML2) appear to be stable, as indicated by non- variability of the seaward edge of coastal vegetation (green line) using historical satellite images over a 13-year period. However, the mouth of the Blythe River is more dynamic in terms of hydrodynamics and sedimentology, with occasional changes in the accumulated coastal sediments and direction of river flow to the sea.

Tioxide beach and Blythe River mouth	**Year /Comment**
	June 2007 (Low tide) Exit direction of Blythe River is to the north-north-west (NNW).
	October 2011 (Low tide) Exit direction of Blythe River is to the north-north-west (NNW).
	November 2017 (Low tide) Exit direction of Blythe River is to the west (W).
	February 2018 (Low tide) Exit flow of the Blythe River is to the north (N).
	August 2020 (very low tide) Exit flow from the Blythe River is to the north-west (NW).

Source: EGC and Google Earth™ (2022) – June 2007 to December 2020. Red outline is coastline at mean tide in December 2020. Left blue line is the project's proposed western monopole (ML1) and the right blue line is the proposed eastern monopole (ML2).

Figure 6.10: Changes in shoreline of the project's proposed Tasmanian landfall over 13 years

In Figure 6.10, the satellite photograph of October 2011 at low tide, there is a tongue of deposited sediments in close proximity (~110 m) to the proposed alignment of the project's eastern monopole (ML2), which indicates that sediments accumulating at or near the mouth of the Blythe River have the potential to reach this eastern alignment, with the potential to temporarily bury the subsea cable.

About five and a half years' later in November 2017, the Blythe River flow is westwards and alongshore towards the proposed alignment of the eastern monopole (ML2). While it is acknowledged that changes in the shoreline of the lower foreshore may occur from storms due to elevated mean water levels and storm waves (Dean and Maurmeyer, 1983), successive storm events are anticipated to redistribute coastal sediment deposits derived from the Blythe River as well as resuspending settled sediments within the lower foreshore.

Overall and based on historical satellite imagery, coastal processes operating at the project's proposed landfall area in nearshore Tasmania are not anticipated to cause erosion of the nearshore project alignments. However, the potential for occasional but temporary sediment deposition at the project's proposed alignment of the eastern monopole (ML2) is possible. In terms of potential impacts of climate change-induced higher sea levels in nearshore Tasmania in the longer term, changes to the stability of the coastline in a way that interacts with the cables is not anticipated over the 40-year life of the project. This evidenced by the 13 years of stability observed in Figure 6.10.Therefore, modelling of coastal processes including numerical modelling of waves and sand transport processes, and further assessments of shoreline behaviour at the project's proposed Tasmanian landfall are not required nor considered further

6.2.5.2 Victorian coast at or near the project's proposed landfall

The 16-km long stretch of the coastline straddling the project's proposed landfall in northern Waratah Bay is comprised entirely of sandy beaches and dune systems that extend from Waratah Bay township in the northwest to the mouth of the sea channel (i.e., southeastern limit of the bay) from Shallow Inlet.

On the west coast of Waratah Bay, the 9-km long stretch of coastline between Waratah Bay township and Bell Point (i.e., the southwestern limit of the bay) is comprised of sandy beaches interspersed with patches of rocky shoreline and rocky headlands (e.g., Bell Point).

Overall, sand is the dominant intertidal substrate in Waratah Bay that will be intercepted by the project's proposed nearshore approach to landfall east of the Waratah Bay township.

6.2.5.2.1 Coastal processes within Waratah Bay

Figure 6.11 shows coastline changes over a 36-year period (Google Earth™ historical imagery).

Waratah Bay	Shallow Inlet mouth	Year/Comment
		December 1986 Shallow Inlet exit flows west (W)
		December 1996 Shallow Inlet exit flows west-south-west (WSW)
		December 2006 Shallow Inlet exit flows west (W)
		December 2016 Shallow Inlet exit flows south-south-west (SSW)
		December 2020 Shallow Inlet exit flows south-west (SW)

Source: Google Earth™ (2022). Blue line =project's alignment. Red line = coastline (December 2020).

Figure 6.11: Changes in shoreline at project's proposed Victorian landfall over 36 years

The historical satellite imagery of Waratah Bay coastline in Figure 6.11 also includes close-up images of the more dynamic coastline at the mouth of the sea channel from Shallow Inlet.

Based on Figure 6.11, the shoreline at the project's proposed landfall east of Waratah Bay township in Waratah Bay and the proposed crossing point of the coastal dunes have not changed over the 36-year period of satellite imagery. Therefore, modelling of coastal processes including numerical modelling of waves and sand transport processes, and further assessments of shoreline behaviour at the project's proposed Victorian landfall are not required nor considered further. In terms of potential impacts of climate change-induced higher sea levels within Waratah Bay in the longer term, changes to the stability of the bay's northern coastline (sandy beaches and sand dunes) and in a way that interacts with the cables is not anticipated over the 40-year life of the project.

The main changes in shoreline history are located at the mouth of the sea channel that drains Shallow Inlet. In Figure 6.11, the mouth of the sea channel has moved 2 km further south as indicated by the December 2020 shoreline location, which is shown as a redline. Since the sea entrance of Shallow Inlet is located 12 km by land (via shoreline) from the project's proposed dune crossing by HDD and 8.5 km by sea from the project's nearest proposed alignment in Waratah Bay, coastal processes at Shallow Inlet are unlikely to influence the project and are not considered further.

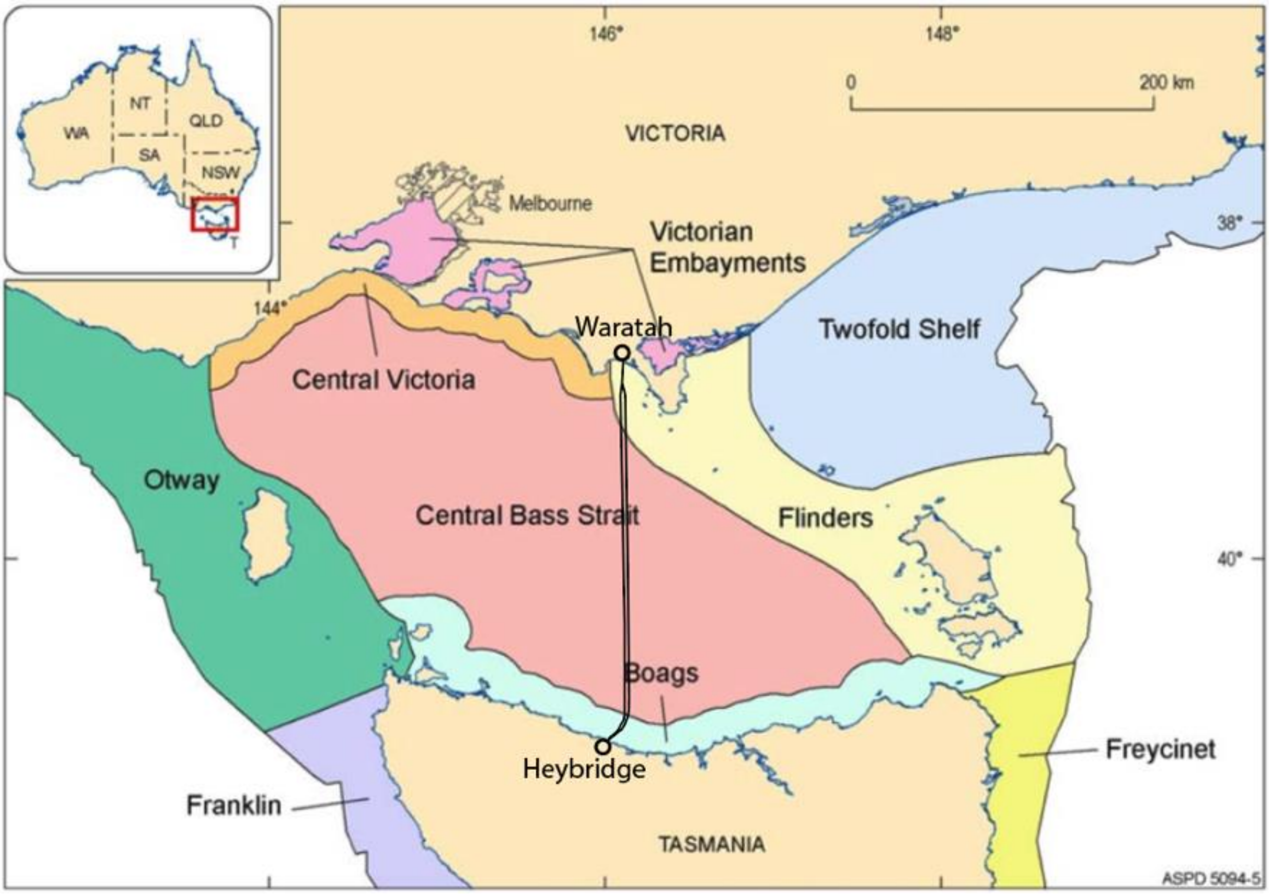
6.3 Marine biological environment

This section describes the existing marine biological environment including EPBC Act MNES. The search of online data sources for conservation listed species within the study area was conducted in September 2023 and is a basis for this technical study. Subsequent changes to species' listing status have not been considered in this study.

6.3.1 Bioregional setting

The Integrated Marine and Coastal Regionalisation of Australia (IMCRA version 4.0) is a spatial framework for classifying Australia's marine environment into ecological bioregions, which are at a scale useful for regional planning (DEH, 2006). Under the current IMCRA (version 4.0), bioregionalisation is based on a synthesis of a) divergent state-based analyses of coastal waters, combined with b) an offshore analysis of oceanographic/geomorphological surrogates and a single (but extensive) marine biological dataset (demersal fish). However, a future IMCRA (version 5.0) is likely to alter the areas of bioregions of Bass Strait (O'Hara et al., 2016) given that the Central Victorian and Boags (northern Tasmania) bioregions are currently restricted artificially to the 3-nautical mile (nm) limits of each state and being separated by an equally artificial Central Bass Strait bioregion.

While the project's proposed alignment across Bass Strait will lie wholly within the Bass Strait Shelf Province of the South-east Marine Region, sections of the project will pass through three bioregions: namely, the Boags, Central Bass Strait and Flinders bioregions (Figure 6.12).



Source: DEH (2006). The project's proposed alignment is shown as black bold line(s).

Figure 6.12: Bioregions of Bass Strait crossed by the project.

6.3.2 EPBC Act Matters of National Environmental Significance

Under the EPBC Act, actions that have, or are likely to have, a significant impact on a MNES require approval from the Commonwealth Government's Minister for the Environment (the Minister).

The presence of MNES within selected nearshore and offshore areas of the project's proposed alignment across Bass Strait was assessed by using the EPBC Act PMST, which generates a PMST report on MNES for a given search area (DCCEEW 2023d). The PMST search reports are attached to the present report as:

- Attachment A – Offshore Bass Strait (Commonwealth marine area), 2023.
- Attachment B – Nearshore Victoria (Waratah Bay), 2023.
- Attachment C – Nearshore Tasmanian (Heybridge), 2023.

Table 6.8 presents a summary of the relevant EPBC Act MNES, 'other matters protected by the EPBC Act', and 'EPBC Act extra information' for the PMST search areas of offshore Bass Strait, nearshore Victoria, and nearshore Tasmania.

Table 6-8: EPBC Act Protected Matters Search Tool (PMST) report results

Category	Tasmania nearshore (Heybridge)	Offshore waters (Bass Strait)	Victorian nearshore (Waratah Bay)
Matters of National Environmental Significance (MNES):			
World Heritage Properties	NONE	NONE	NONE
National Heritage Places	NONE	NONE	NONE
Wetlands of International Importance	NONE	1	1
Great Barrier Reef Marine Park	N/A	N/A	N/A
Commonwealth Marine Area	2	2	1
Listed Threatened Ecological Communities	4	NONE	3
Listed Threatened Species	58	39	78
Listed Migratory Species	42	38	61
Other matters protected by the EPBC Act:			
Listed Marine Species	72	66	101
Whales and Other Cetaceans	14	15	13
Critical Habitats	NONE	NONE	NONE
Australian Marine Parks	NONE	NONE	NONE
EPBC Act extra information:			
State and Territory Reserves	8	NONE	4
Invasive Marine Species	NONE	NONE	NONE
Nationally Important Wetlands	NONE	NONE	1
Key Ecological Features (Marine)	NONE	NONE	NONE

Source: EPBC Act PMST results reports, 2023: Attachment A (Offshore waters Bass Strait); Attachment B (Nearshore Victoria, Waratah Bay); Attachment C (Nearshore Tasmania, off Heybridge). N/A = Not Applicable.

Based on a list of eight spatially or non-spatially defined Key Ecological Features (KEFs) in the South-east Marine Region (DCCEEW, 2023c), two non-spatially defined KEFs may be within the study area, including the Bass Cascade, and Shelf rocky reefs and hard substrate. The Bass Cascade KEF is mainly relevant to the continental shelf and drop-off (Bass Canyon group area) that is located well to the east of the project area, in central Bass Strait, and is therefore not relevant and does not need to be addressed in this report. The main rocky reef areas in nearshore Victoria are on the east coast of the Cape Liptrap peninsula and on the west coast of Wilsons Promontory, which are well outside the project area in nearshore Victoria and therefore not further assessed in this report. In the project area, along the Tasmanian coast, there are examples of rocky reefs and hard substrate that may constitute a KEF. However, because these KEFs aren't spatially defined, it cannot be determined whether those in the project area are KEFs. Regardless, due to the nature of the reefs and hard substrate in the project area combined with project design aspects, they are not further assessed in this report.

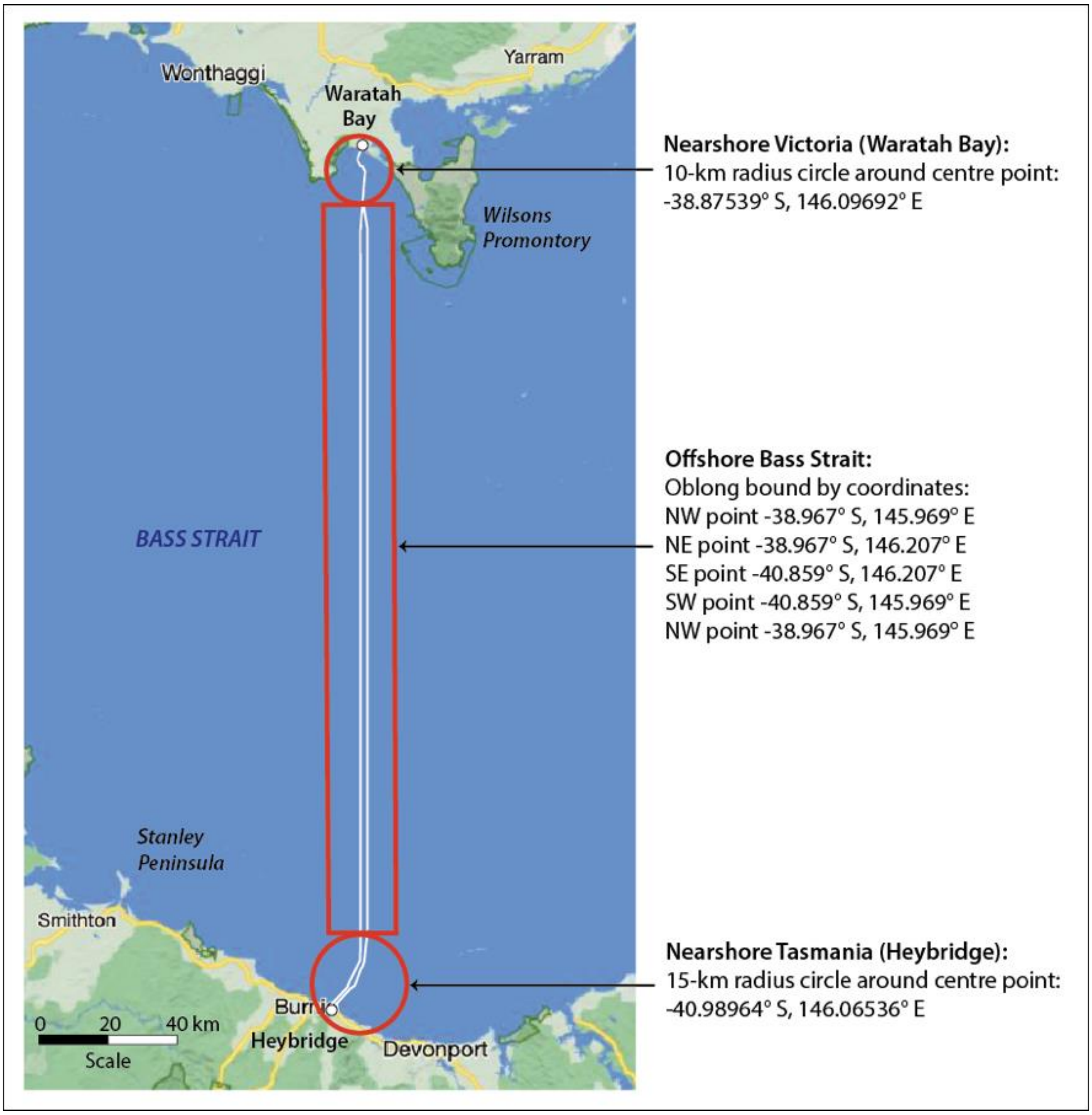
Figure 6.13 shows the PMST search areas in nearshore Victoria, offshore Bass Strait and nearshore Tasmania along with their coordinates.

In Figure 6.13, the PMST search areas are contiguous so that the whole of the project area along the proposed alignment is captured by the three PMST search areas.

6.3.2.1 EPBC Act Wetlands of International Importance (Ramsar)

In terms of wetlands of international importance listed under the EPBC Act, the nearest Ramsar site is the Corner Inlet Marine and Coastal Park, which is located 11 km overland from the project's alignment in Waratah Bay (see Figure 6.14).

The Corner Inlet Marine and Coastal Park is located on the eastern side of Wilsons Promontory in southeast Victoria and, as such, the land isthmus forms a natural physical barrier between the project's proposed approach to landfall in Waratah Bay and this Ramsar site. Therefore, summary descriptions of the flora and fauna of this Ramsar site are not presented in the present report.



Source: EPBC Act PMST search reports, 2023: Attachment A (Offshore waters Bass Strait); Attachment B (Nearshore Victoria, Waratah Bay); Attachment C (Nearshore Tasmania, off Heybridge).

Figure 6.13: PMST search areas along the project's proposed alignment across Bass Strait

6.3.2.2 EPBC Act Nationally Important Wetlands

The only EPBC Act Nationally Important Wetland within the project's area of influence is Shallow Inlet Marine and Coastal Park (23.77 km^2), which is a large tidal embayment with a single channel to the sea and is located on the northwest coast of Wilsons Promontory in Victoria.

6.3.2.2.1 Shallow Inlet Marine and Coastal Reserve

The Shallow Inlet and Marine Coastal Park also includes the eastern section of the 'Waratah Bay Shallow Inlet Coastal Reserve' (also known as 'Waratah Bay Foreshore Reserve' within Waratah Bay), the 'Shallow Inlet Saltmarsh Flora and Fauna Reserve' to the east of the inlet, and the 'Flora and Fauna Reserve' to the west. Shallow Inlet is a large, wave-dominated tidal embayment (DSE, 2004).

The inlet has an intertidal area of 7.05 km^2, a water area of 5.03 km^2, and a tidal range of 2.1 m (Stafford-Bell et al., 2019). Hirst (2004) indicates that the average depth of Shallow Inlet is 5 m, surface salinity is 32.1 parts per thousand (‰), bed sediments are mainly comprised of sand (69.1%) and silts (30.3%), with an organic carbon content of 6.5% and a REDOX of 37.5 mV.

This wetland system provides a wide range of habitats for various terrestrial and aquatic bird species, as well as aquatic habitat for marine, brackish water and freshwater fauna (e.g., fishes and invertebrates). The coastal habitat of the inlet is characterised by its shallow estuarine waters, extensive mudflats and sandy intertidal areas.

Shallow Inlet aquatic flora

The marine and brackish water intertidal areas of Shallow Inlet are characterised by extensive areas of seagrasses. The most abundant species is the eelgrass (*Zostera muelleri*) that is widespread on the tidal flats, usually above the low tide mark but also extending below (DCFL, 1990). Seagrass beds of another species of eelgrass, the FFG Act *Endangered* Tasman grass-wrack (*Heterozostera tasmanica*) (FFG Act Threatened List of October 2021 (DELWP, 2021)) are restricted to deeper water adjacent to the main channels (DCFL, 1990).

Shallow Inlet fishes and invertebrates

The marine and brackish water intertidal areas of Shallow Inlet are characterised by extensive areas of seagrass that are important nursery areas for some marine fish species and other marine life such as molluscs, crustaceans, and other invertebrates (DSE, 2004). Several marine species within Waratah Bay and west coast of Wilson Promontory are likely to use nursery areas in Shallow Inlet.

Common fish species targeted by fishers are: Australian salmon (Arripis spp.), Australasian snapper (Chrysophrys auratus), white trevally (Pseudocaranx dentex), dusky flathead (Platycephalus fuscus), bartail flathead (Platycephalus australis), sand sillago (Sillago ciliata), King George whiting (Sillaginodes punctata), and gummy shark (Mustelus antarcticus).

The intertidal flats support large beds of bivalve molluscs and large congregations of soldier crabs (*Mictyris platycheles*), which are regularly sighted (DSE, 2004).

Shallow Inlet avifauna

Shallow Inlet Marine and Coastal Park forms an Important Bird Area (IBA) for wetland, wading and shore bird species. In 2004, about 180 species of birds at Shallow Inlet were recorded by DSE (2004) with 19 bird species listed under the Japan-Australia Migratory Birds Agreement (JAMBA) and 16 species listed under the China-Australia Migratory Birds Agreement (CAMBA).

Shallow Inlet Marine and Coastal Park has also been identified by BirdLife International (2022) as an IBA because it supports over 1% of the world populations of migratory wetland bird species such as Double-banded Plovers (*Charadrius bicinctus*) and Red-necked Stints (*Calidris ruficollis*). This wetland also supports Eastern Curlews (*Numenius madagascariensis*), Curlew Sandpipers (*Calidris ferruginea*), and potentially Orange-bellied Parrots[2] (*Neophema chrysogaster*), all of which are classified as critically endangered under the EPBC Act. Other birds recorded as using the wetland in significant numbers include migratory wetland species such as Pacific Golden Plovers (*Pluvialis fulva*) and Sanderlings (*Calidris alba*), as well as the critically endangered Curlew sandpipers (*Calidris ferruginea*). There is one instance of albatrosses using Shallow Inlet with the Grey-headed Albatross (*Thalassarche chrysostoma*) recorded by Cooper (1975) (as reported in Norris et al. 1979).

Many of the birds associated with Shallow Inlet Marine and Coastal Park are terrestrial or wetland birds and as such are not expected to be affected by the project's marine construction activities within Waratah Bay. However, those bird species that forage over the open waters of Bass Strait including Waratah Bay have the potential to interact with the project during its construction and decommissioning phases. The mouth of the tidal channel that drains Shallow Inlet lies within southeast portion of Waratah Bay and is located 8.6 km from the project's proposed alignment.

6.3.2.3 Commonwealth marine reserves in Bass Strait

Commonwealth marine protected areas or reserves are matters of national environmental significance under the EPBC Act. Within Bass Strait, the Commonwealth marine area extends from the 3-nm limits of Victoria and Tasmania seawards to the 200-nm limit, which is located farther offshore of the western and eastern margins of Bass Strait.

There are no Commonwealth marine reserves in the vicinity of the project. Notwithstanding, the nearest Commonwealth marine reserves are Beagle Commonwealth Marine Reserve (northern Bass Strait) and the Boags Rock Commonwealth Marine Reserve (northwest Tasmania). Both these marine reserves are classified as Multiple Use Zone with a Category VI (Protected area with sustainable use of natural resources) by the International Union for the Conservation of Nature (IUCN, 2008). In general, the following activities do not require authorisation within these Category VI Commonwealth marine reserves: general use and access, commercial shipping, recreational fishing and national security and emergency response. However, authorisation is required for commercial fishing, commercial tourism, mining, research and monitoring, structures and works, and commercial media (DoNP, 2013).

The above Commonwealth marine reserves are described briefly below.

6.3.2.3.1 Beagle Commonwealth Marine Reserve

The Beagle Marine Reserve has an area of 2,928 km^2 and extends across Bass Strait from a point southeast of Wilson's Promontory to a point north-west of Flinders Island. This marine reserve surrounds the Kent Group Marine Reserve (Erith, Dover, and Deal islands) and the Hogan and Curtis Island groups, which are both located in Tasmanian waters. This marine reserve is located 31.5 km east of the project's proposed alignment and is therefore outside the project's area of direct influence.

[2] An orange-bellied parrot was last observed in Shallow Inlet in 2007 (BirdLife International, 2022).

Beagle Marine Park has a shallow water depth (50 to 70 m depth) and is characterised by the presence of rocky reefs and diverse, colourful sponge gardens, and is an important foraging area for seabirds that breed on the islands, including little penguins that have a breeding colony on Curtis Island.

6.3.2.3.2 Boags Rock Commonwealth Marine Reserve

Boags Rock Marine Reserve has an area of 537 km^2 with an average water depth of 52 m (range 15–70 m) and is located 80 km west of the project's proposed alignment. The seabed of Boags Rock Marine Reserve comprises diverse soft sediment communities dominated by crustaceans, *polychaete* worms and molluscs. Such habitats are typical of the Bass Strait Shelf Province and offshore seabed. The marine reserve also provides important foraging grounds for nearby breeding colonies of seabirds (e.g., the endemic Shy Albatross, *Thalassarche cauta*), and open-water habitat for migrating humpback, southern right and pygmy blue whales. The Boags Rock Commonwealth Marine Reserve is located 80 km west of the project's proposed alignment in Bass Strait and is outside the project's area of direct influence.

6.3.2.4 Victorian marine reserves and coastal parks

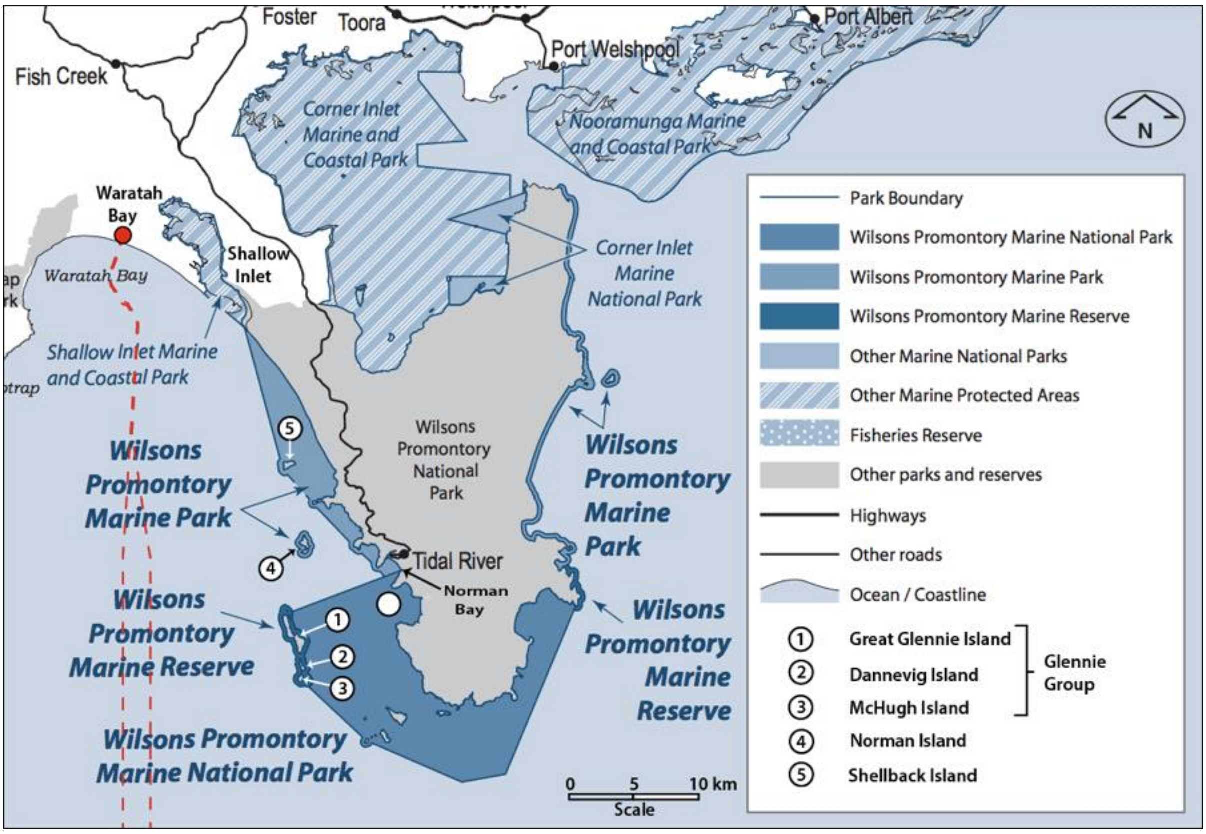
In Victoria, the nearest coastal parks and marine reserves are:

- Cape Liptrap Coastal Park (41.75 km^2)
- Shallow Inlet Marine and Coastal Park (23.77 km^2)
- Waratah Bay Foreshore Reserve (~1.40 km^2)
- Corner Inlet Marine and Coastal Park (285 km^2)
- Nooramunga Marine and Coastal Park (301.79 km^2)
- Wilsons Promontory Marine National Park (504.6 km^2)
- Wilsons Promontory Marine Park (53.90 km^2)
- Wilsons Promontory Marine Reserve (11.85 km^2)
- Seal Islands Wildlife Reserve (~0.33 km^2)

As indicated in Section 6.3.2.2 (EPBC Act Nationally Important Wetlands), the narrow coastal strip of northern Waratah Bay east of Waratah town is also known as the Waratah Bay Foreshore Reserve (approximately 1.40 km^2), which is the western extension of the Shallow Inlet Marine and Coastal Park (23.77 km^2). This foreshore reserve is the only Victorian marine or coastal reserve that needs to be crossed by the project's cables at landfall.

Two additional marine reserves or parks are Corner Inlet Marine and Coastal Park (285 km^2) and Nooramunga Marine Reserve and Coastal Park (301.79 km^2). These two marine reserves are located to the east of Wilsons Promontory and, therefore, lie outside the project's proposed areas for marine construction or decommissioning activities in Waratah Bay and are not considered further. Notwithstanding, some species of birds from these two marine reserves may potentially forage within Waratah Bay open waters and coastline.

The nearest Victorian national park or marine reserve to the proposed interconnector route is Wilsons Promontory Marine Reserve, which is shown in Figure 6.14.



Source: Adapted from Parks Victoria (2006). Red-dashed lines are the proposed project alignments.

Figure 6.14: Subsea interconnector corridor in relation to conservation areas

The Wilson Promontory Marine National Park surrounds the southern tip of Wilsons Promontory from Norman Bay in the west to Cape Wellington in the east. The nearest proclaimed conservation area to the project's proposed alignment is Wilsons Promontory Marine Reserve, which lies 10 km to the east of the western monopole (ML2). Wilsons Promontory Marine Reserve comprises the Glennie Group, which is a chain of islands formed by the Great Glennie, Dannevig and McHugh islands. This island chain has significant habitats including breeding areas for seabirds and Australian fur seals, which forage within the open waters intersected by the project's proposed alignments.

6.3.2.5 Tasmanian nearshore and offshore Bass Strait marine reserves

In the Tasmanian nearshore marine environment, there are no marine protected areas within the vicinity of the project's proposed alignments near the Heybridge landfall. The nearest national parks with coastlines adjoining Bass Strait are Narawntapu National Park (44 km^2) and Rocky Cape National Park (30.6 km^2) (PWST, 2019). Narawntapu NP is located between Port Sorell and West Head and lies 45 km east of the proposed Tasmanian landfall at Heybridge and Rocky Cape NP is located between Rocky Cape and Walkers Cove and lies 38 km to the west of the proposed Tasmanian landfall at Heybridge. These two national parks are of interest from an aesthetic viewpoint and include natural beaches and sea caves, as well as onshore Aboriginal cultural heritage sites. Fish and recreation are permitted along the shoreline. The shorelines of these two national parks lie outside the project's area of influence.

In offshore Bass Strait, the nearest Tasmanian marine reserve is the Kent Group Marine Reserve (23.74 km^2), which is situated halfway between Wilsons Promontory in Victoria and Flinders Island in Tasmania. This isolated marine reserve comprises three main islands of Erith, Dover and Deal, and two smaller islands (North East Isle and South West Isle). Altogether, the islands cover a land area of 23.74 km^2 and the marine (water) component of the reserve covers over 290 km^2. The westernmost island (Dover Island) of the Kent Group Marine Reserve is located 98.6 km from the project's proposed alignment.

Three major ocean currents meet at the Kent Group and this convergence brings nutrient-rich water that supports a unique diversity of marine life. The rocky outcrops of the islands of the Kent Group are a breeding sanctuary for Australian fur seals (*Arctocephalus pusillus doriferus*). Tasmania's largest breeding colony of Australian fur seals is located nearby at Judgement Rocks, which lies 11.5 km to the west of the Kent Group.

The islands of the Kent Group are also an important refuge for sea birds. Seabirds find sanctuary on the Kent Group's smaller islands of North East Isle and South West Isle, including Common Diving Petrels (*Pelecanoides urinatrix*), Fairy Prions (*Pachyptila turtur*), Short-tailed Shearwaters (*Puffinus tenuirostris*), Little Penguins (*Eudyptula minor*), Sooty Oystercatchers (*Haematopus fuliginosus*), cormorants (*Phalacrocoracidae*) and terns (*Laridae*).

The marine waters of the Kent Group display a diverse array of kelps, and a very high number and diversity of fish species, which is a result of the convergence of three ocean currents.

6.3.2.6 EPBC Act Threatened Ecological Communities

In terms of EPBC Act MNES category of Threatened Ecological Communities, the EPBC Act PMST report listed three and four threatened ecological communities in Victoria and Tasmanian PMST search areas, respectively. However, for both Victoria and Tasmania, there are only two threatened ecological communities that relate to the aquatic environment: the 'Giant Kelp Marine Forests of South East Australia' and 'Subtropical and Temperate Coastal Saltmarshes', which are summarised below.

6.3.2.6.1 Giant Kelp Marine Forests of South East Australia

The Giant Kelp Marine Forests of South East Australia ecological community is listed as endangered (EN) under the EPBC Act. The giant kelp (*Macrocystis pyrifera*) forms the foundation species of the Giant Kelp Marine Forests of South East Australia ecological community. Also known as string kelp, the giant kelp is a large brown alga that grows on rocky reefs from the sea floor 8 m below sea level and deeper, and its fronds grow vertically toward the sea surface (DSEWPaC, 2012a).

DSEWPaC (2012b) published a map of the Giant Kelp Marine Forests of South East Australia ecological community, which presents areas within southeast Australia where this ecological community is likely to be found or may occur based on suitable hard seabed and water depths. Based on this map, known areas or potential areas suitable for the giant kelp ecological community in Bass Strait are described below.

Offshore Bass Strait

The distribution map of giant kelp marine forest of southeast Australia ecological community (DSEWPaC, 2012b) indicates that this ecological community may occur, based on hard seabed substrate and suitable water depths. The only areas of suitable hard seabed and water depths for the giant kelp ecological community are the offshore islands of Bass Strait of which there are none along the project's proposed alignment. The nearest offshore islands with the hard seabed and water depths suitable for giant kelp colonisation are those in Tasmanian waters such as the Kent Group of which Dover Island is the nearest but is located 98 km east of the project's proposed alignment.

Victorian waters

The giant kelp distribution map of DSEWPaC (2012b) identified possible sites with rocky seabed where physical conditions and environmental factors are favourable for its growth. These sites included Norman Island and the cluster of islands centred on Kanowna Island (including Anser Island and the adjacent Anderson Isles and Skull Rock), which lie to the west of Wilsons Promontory. Norman Island and Kanowna Island are located 11.4 km and 17.3 km east of the proposed alignment of the eastern symmetric monopole (Link 2). The sandy seabed of Waratah Bay in Victoria is not suitable substrate for giant kelp attachment.

Overall, the likelihood of giant kelp forest occurring within Waratah Bay is considered most unlikely, given the predominance of a sandy seabed, which does not provide suitable substrate for giant kelp colonisation or thallus attachment. The baseline marine benthic habitat surveys of the Victorian nearshore in 2019 and 2021 (CEE, 2023; EIS/EES Technical appendix G: Benthic ecology) did not report the presence of giant kelp.

Tasmanian waters

The giant kelp distribution map of DSEWPaC (2012b) indicates that patches of the giant kelp ecological community are predominantly found in sheltered embayments associated with rocky reefs on the south and east coasts of Tasmania. Most of the northern coast of Tasmania is classified as sheltered open or moderately exposed coastal habitats (Edgar et al., 1995), which may exclude the likelihood of giant kelp forests developing. The northern coast has predominantly sandy substrate at depths greater than 8 m below sea level and, therefore, is not typically exposed to sufficient water motion to support the development of the giant kelp forest community. This is confirmed by Edyvane (2003) who noted that while patches of giant kelp have been recorded on the north coast of Tasmania in the past, they are no longer likely to occur. The baseline marine benthic habitat surveys of the Tasmanian nearshore and landfall did not report the presence of giant kelp (CEE, 2023; EIS/EES Technical appendix G: Benthic ecology).

Overall, there is a regional decline in the extent of dense beds of giant kelp around Tasmania's coasts. A dramatic decline of giant kelp beds along the east coast Tasmania has been attributed to climate change and the extension of the East Australian Current (EAC) southwards with stronger incursions of warmer water along eastern Tasmania (Johnson et al., 2011).

6.3.2.6.2 Subtropical and Temperate Coastal Saltmarshes

The Subtropical and Temperate Coastal Saltmarsh ecological community is listed as vulnerable (VU) under the EPBC Act and consists mainly of salt-tolerant vegetation (halophytes) including grasses, herbs, sedges, rushes and shrubs, which are found mainly in tidally influenced, sheltered embayments and estuaries. Only temperate saltmarshes are expected to be present within the cooler Victorian and Tasmanian coastal environments of Bass Strait.

Victorian coastal saltmarshes

In Victoria, temperate saltmarsh is mainly found in the Corner Inlet Marine and Coastal Park (A Ramsar site) and Nooramunga Marine and Coastal Park, both of which lie to the east of Wilsons Promontory (Boon et al., 2015) and therefore well outside of the proposed subsea interconnector route within Waratah Bay.

The nearest areas of saltmarsh are found within Shallow Inlet, which have been mapped by (Roy, 2015) as shown in Figure 6.15. The nearest saltmarsh area above the upper intertidal zone boundary in Shallow Inlet is approximately 17 km via the Shallow Inlet channel to its mouth and then to the nearest of the project's proposed alignments (ML2). Therefore, a summary description of the Shallow Inlet saltmarsh community is not warranted and could only be influenced by project-induced changes in water quality within Waratah Bay and tidal inflows into the Shallow Inlet channel.

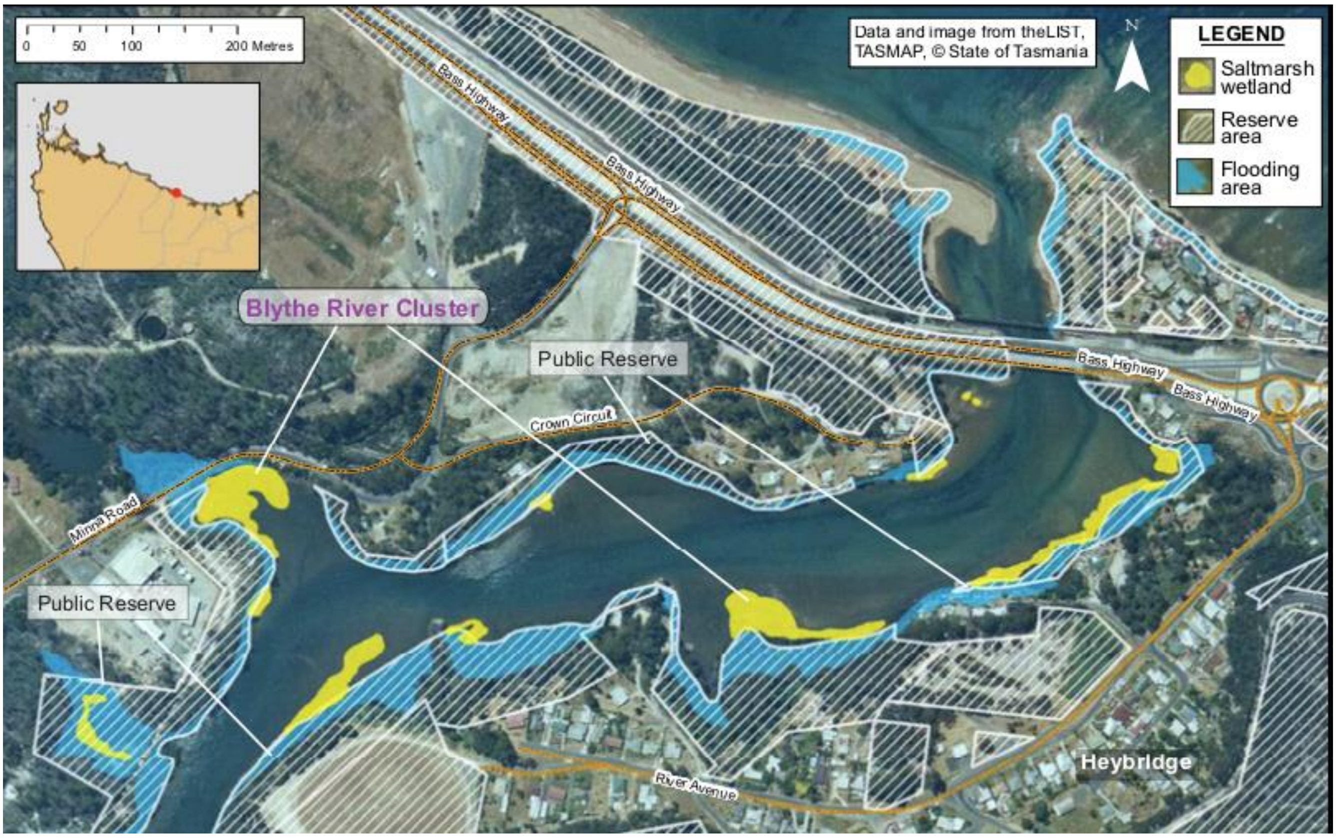
Source Roy (2015). Light green areas denote saltmarsh and brown areas denotes intertidal flats.

Figure 6.15: Areas of saltmarsh within Shallow Inlet

Tasmanian coastal saltmarshes

Based on the atlas of coastal saltmarsh wetlands in the Cradle Coast Natural Resource Management (NRM) region of Tasmania (Prahalad and Helman, 2016), coastal saltmarshes in the vicinity of the HVDC cable landfalls include the Blythe River Cluster located within the Blythe River estuary. Figure 6.16 shows the distribution of saltmarsh areas within the Blythe River estuary which, together, cover a total area of 10,000 m^2 (Prahalad and Helman, 2016). The dominant saltmarsh vegetation consists of mostly grassy saltmarsh dominated by juncus rush (*Juncus* spp.), speargrass (*Austrostipa* spp.) and sawsedge (*Gahnia* spp.), with one small patch of creeping brookweed (*Samolus repens*). The nearest patch of saltmarsh is the Blythe River Complex, which is located about 500 m south of the nearest HVDC cable shore crossing.

The saltmarshes within the Blythe River estuary are located outside of the project's proposed alignment within nearshore Tasmania at Heybridge, but may be influenced by project-induced changes in water quality, with impacted marine waters being carried by tidal inflows to the estuary. Potential impacts of the project on water quality within the Blythe River estuary are addressed in Section 7.2.2.1.



Source: Prahalad and Helman (2016).

Figure 6.16: Saltmarsh areas within the Blythe River estuary

6.3.3 Biologically Important Areas

Biologically important areas (BIAs) of regionally significant marine species are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, resting or migration. BIAs have been created for regionally significant marine species that are protected under the EPBC Act, which may include listed threatened species (critically endangered, endangered, vulnerable, conservation dependent), listed marine species and migratory species. An individual species may be listed under more than one category.

Bass Strait BIAs for those marine species that have been assessed by DAWE (2021b), and which are intercepted by the project's proposed alignment, include:

- Cetaceans:
  - Southern right whale (*Eubalaena australis*).
  - Pygmy blue whale (*Balaenoptera musculus brevicauda*).
  - Humpback whale (*Megaptera novaeangliae*).
- Fishes:
  - Great white shark (*Carcharodon carcharias*).

- Marine Birds:
  - Short-tailed shearwater (*Puffinus tenuirostris*).
  - Shy albatross (Thalassarche cauta).

Subsequent sections of this baseline existing environment refer to the above BIAs for cetaceans (see Section 6.3.6, Cetaceans), Fishes (see Section 6.3.10, Marine fishes) and marine birds (see Section 6.3.9, Marine birds).

6.3.4 Marine seabed habitats and ecological communities

This section presents an overview and brief descriptions of key marine benthic habitats and ecological communities of offshore Bass Strait and the Tasmanian and Victorian nearshore environments at the project's proposed landfalls. Key information and data were collated from the nearshore marine benthic characterisation underwater camera surveys by CEE (2023); presented in EIS/EES Technical appendix G: Benthic ecology).

Non-project information sources for benthic habitat and ecological communities included mapped seabed habitats presented in Seamap Australia (Lucieer et al., 2017), CoastKit (DELWP, 2022a), and Google Earth™, as well as other Bass Strait investigations and such as those conducted in support of the Draft Integrated Impact Assessment Statement (IIAS) for the Basslink Project (NSR, 2002). Additional information and data on marine species were extracted from online searches of the Victorian Biodiversity Atlas (DELWP, 2022b) and the Tasmanian Natural Values Atlas (DNRE, 2022).

The key marine habitats of the project area include the seabed habitats (benthic environment) and overlying water column (pelagic environment), which are described in the following sections.

6.3.4.1 Seabed habitats and benthic communities of nearshore Victoria

The 2019 and 2021 marine biological habitat surveys (2023; EIS/EES Technical appendix G: Benthic ecology) together with the results of the 2020 geophysical surveys by Fugro (2020) showed that the seabed along the subsea alignment in Waratah Bay is predominantly fine mobile sand, with patches of gravel and small patches of isolated low-profile reef.

Table 6.9 presents a summary of the key characteristics of seabed habitats and dominant biological communities within the Victorian nearshore (10 m and 30 m water depth) survey for the project's 2019 alignment in Waratah Bay.

Table 6-9: Summary of seabed habitat characteristics of nearshore Victoria

Seabed zone	Water depth	Kilometre Point	Description
1	5 to 17 m	KP 1.1 to KP 3.5	• Seabed was characterised by fine to medium sands with patches of rock reef, with several small patches of reef and broken reef of cobble were detected within 2 km of shore. • Sand ripples were most pronounced on the seabed from 5 m to 15 m water depth. • Sparse to moderate seagrass cover and sparse drift algae. • There were no obvious visible epifauna and bioturbation was either absent or sparse. • Sea pens were scarce.

Seabed zone	Water depth	Kilometre Point	Description
2	17 to 21 m	KP 3.5 to KP 5.0	• Seabed was characterised by sand and cobbles with patchy reef. • Sparse seagrass patches. • Moderate macroalgal cover. • Bioturbation absent or sparse, and invertebrates (inferred) were sparse.
3	21 to 25 m	KP 5.0 to KP 7.0	• Seabed was characterised by sand with ripples and patches of rock reef. • Sparse macroalgae. • Sparse to moderate visible infauna. Sea pens were sparse. A spider crab (*Leptomithrax gaimardii*) was sighted.
4	25 to 30 m	KP 7.0 to KP 8.0	• Seabed was fine sand. • Irregular flat plates of consolidated sand scattered irregularly across the seabed with visible flora or fauna. • Sparse visible infauna (inferred)

Source: Fugro (2020); CEE (2022). The Kilometre Points (KPs) in the table vary slightly from those given in Fugro (2020) and CEE (2019, 2022) due to the changes in the project's proposed alignment of the western and eastern monopoles within the Victorian nearshore (see Table 7-4 in Section 7.2.2.1.4).

Fugro (2020) have shown that the seabed along project's proposed alignment in Waratah Bay is predominantly fine mobile sand, with patches of gravel and small patches of isolated low relief reef. Most species are widely distributed within Central Victoria, Flinders and Two Shelf marine bioregions. The sandy seabed environment is generally bare of epibiota except for patches of low to moderate densities of soft corals such as sea pens (mainly *Pseudogorgia godeffroyi*) between 14 m and 30 m depth and the eelgrass Tasman grass-wrack (*Heterozostera tasmanica*) between 10 m and 15 m water depth. The Tasman grass-wrack also occurs between 8 to 10 m and 15 to 34 m depth as individuals or sparse patches. Since Tasman grass-wrack is the only FFG Act listed species present within Waratah Bay, the total area of its potential habitat has been estimated below to compare with the potential area of residual impacts to this species. Due to the sparsity of Tasman grass-wrack outside this range, only the area at 10 to 15 m water depth has been assessed.

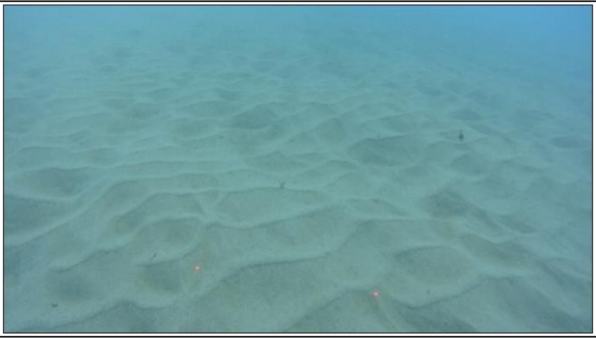
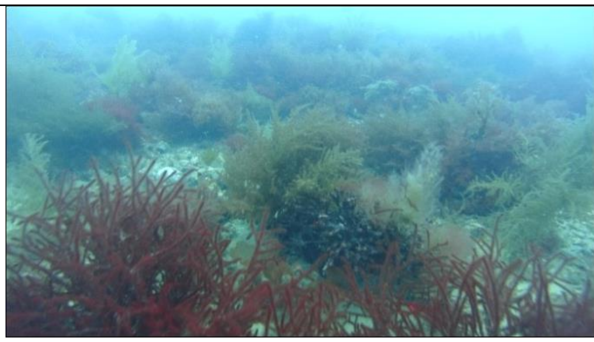
The length of the subtidal zone between the 10 and 15 m depth contours (i.e., Tasman grass-wrack potential habitat) was based on considering a 12-km-long zone adjacent to the sandy beaches (i.e., 4 km to the west and 8 km to the east of the project alignment). The width of this subtidal zone varies, having an average width 1.18 km within the 4-km western section (i.e., 4.7 km^2) and an average width of 0.787 km in the 8-km-long eastern section (i.e., 6.3 km^2). Adding both areas, the total area of potential Tasman grass-wrack habitat between 10 to 15 m depth is therefore 11 km^2 within Waratah Bay.

CEE (2023) noted that rubble and reef seabed habitat in Waratah Bay occurred mainly between the 14 m and 19 m depth zone. This flora seabed habitat was characterised by macroalgae with patches of seagrasses such as wire weed (*Amphibolis antarctica*) and the FFG Act threatened Tasman grass-wrack, and the invertebrate fauna characterised by sponges of various sizes.

Plate 6.1 shows example photographs of the seabed within nearshore Victoria:

- Photograph (a) shows fine sand seabed at 8 m water depth with a few drift macroalgae and little evidence of benthic invertebrates for Site C09.
- Photograph (b) shows fine sand seabed at 14 m with Tasman grass-wrack (*Zostera tasmanica*), drift macroalgae and mixed infauna (inferred) at Site C08.

- Photograph (c) shows sand/shell/cobble seabed at 22 m water depth with mixed macroalgae for Site C03.
- Photograph (d) shows cobble/sand/shell seabed at 17 m water depth with mixed macroalgae for Site W07.

	
(a) Site C09: Sand with drift macroalgae (8 m)	(b) Site C08: eelgrass (*Zostera tasmanica*) (14 m)
	
(c) Site C03: Macroalgae on sand/shell seabed (22 m)	(d) Site W07: Macroalgae on cobble and shell (17 m)

Source: CEE (2023).

Plate 6.1: Examples seabed types within nearshore Victoria (Waratah Bay)

Full details of the seabed physical and marine biological characteristics in nearshore Victoria (Waratah Bay) are given in Fugro (2020) and CEE (2023; EIS/EES Technical appendix G: Benthic ecology).

6.3.4.2 Offshore seabed habitats and benthic communities of Bass Strait

Table 6.10 presents a summary of the key characteristics of the seabed of offshore Bass Strait.

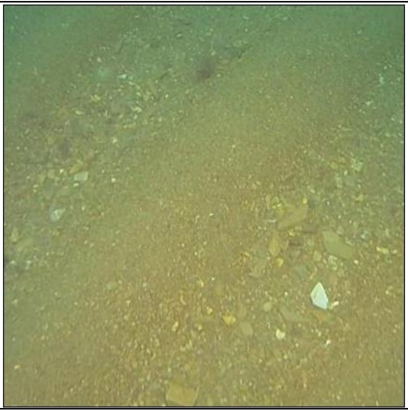
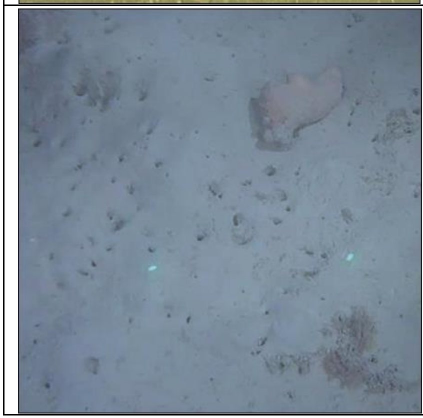
For the purposes of this report, the seabed has been divided into four offshore zones (i.e., Zones 1, 2, 3 and 4). The seabed and benthic habitats of the two nearshore zones, Waratah Bay and Heybridge, are described separately in Section 6.3.4.1 and Section 6.3.4.3, respectively.

Underwater videos and drop camera photographs of the offshore seabed were extracted from Fugro (2020) to provide examples of offshore seabed types and to describe the deep-water marine benthic habitats. Plate 6.2 gives some examples of seabed photographs taken at deep-water sites in central Bass Strait. The explanatory text adjacent to the photographs are based on descriptions provided by Fugro (2020).

Table 6-10: Summary of seabed characteristics of offshore Bass Strait

Zone	Water depth	Kilometre Point	Description
1	25 to 65 m	KP 5.5 to KP 15	Seabed surface classified as 'SAND' in this 9.5-km-long offshore zone.
2	65 to 79 m	KP 15 to KP 88	Seabed surface sediments in this 73-km long zone are classified as 'silty SAND'. Colonial eunicid worm tubes stalks protrude as sparsely distributed erect solitary 40-cm-high stalks from the seabed at depths between around 40 m and 70 m.
Transition	79 to 80 m	KP 88 to KP 125	This 37-km long zone is characterised by a seabed characterised by progressive fining of sediments and include the transition from 'silty SAND' to 'sandy SILT, with sand and silt/clay layers. Colonial eunicid worm tubes stalks protrude as sparsely distributed erect solitary 40-cm-high stalks from the seabed at depths between around 40 m and 70 m. The seabed was relatively flat from KP 70 (75 m depth) to KP 80 (78 m depth) and became dimpled with burrowing biota activity.
3	80 to 62 m	KP 125 to KP 237	This 112-km long seabed zone is described as SILT/CLAY with sandy silt/silty sand and sand layers. Seabed surface sediments are predominantly silts and eventually clay towards the central and southern, deepest part of Bass Strait. grab samples within this zone comprise 81.7 % to 89.3 % fines. seabed surface flattened from KP 230 to KP 237 km (55 m depth) and patches of entwining sponge, *bryozoan* and *ascidians*. Eunicid worm tube stalks and solitary sponges became sparsely distributed over the seabed. Sub-seabed biological activity was pronounced as abundant mounds up to around 8 cm high from KP 180 to KP 230 (~75 m depth)
4	62 to 10 m	KP 237 to 249.5	This 12.5-km long seabed zone is described as 'SAND and ROCK' with sandy sediments, occurrence of coarser fractions (e.g., cobbles) and outcropping rock approaching the nearshore zone. At KP 249.5 (33 m water depth), the seabed showed strong medium- to coarse-grained sand waves. Shell and other organic material including living and empty doughboy scallops had accumulated in the sand wave troughs. Eleven-arm seastars (*Coscinasterias muricata*) were observed feeding on the scallops.

Source: Physical seabed characteristics based on Fugro (2020); and biological characteristics based on CEE (2022). The Kilometre Points (KPs) in the table vary slightly from those given in Fugro (2020) and CEE (2019, 2022) due to the changes in the proposed alignments of the project's western and eastern monopoles within the Victorian nearshore.

	• Location: Just north of KP 80. • Water depth: 75 m. • Seabed type: Silty SAND, fine to medium, silt proportion ranging from traces to 30 %, local traces of gravel. • Topography: No or very low relief, ripples. • Marine growth: Mixed but sparse macroalgae; some isolated seagrass
	• Location: Between KP 80 to KP 125 • Water depth range: 75 m to 80.5 m. • Seabed type: Sandy SILT. The sand is mainly fine to medium grained. Some clay (up to 15 %). • Topography: No relief, flat though some ripples. • Marine growth: No macroalgae visible. No benthic macroinvertebrates or their burrows or mounds visible. Infauna inferred.
	• Location: South-central Bass Strait south of KP 202. • Water depth: 72 m. • Seabed type: predominantly CLAY (MUD) and SILT with little sand. • Topography: No relief except for occasional isolated very low-profile patches. • Marine growth: None to light growths. Some macroalgae present. Sponges (Porifera) visible. Infauna inferred.

Source: Fugro (2020)

Plate 6.2: Example deep-water seabed habitats in offshore Bass Strait

In the deeper waters of southern Bass Strait, soft seabed sediments between 65 and 75 m water depth within an arc of southern Bass Strait are also known to provide habitat suitable for mesophotic coral-sponge communities or 'sponge beds' (Butler et al., 2002). Soft silty-sand seabed areas offshore of both Victoria and Tasmania also provide habitat suitable to commercially important scallops (see Section 6.4, Existing marine resource use).

6.3.4.3 Marine seabed habitats of nearshore Tasmania

Table 6.11 presents a summary of the key characteristics of the seabed and dominant biological communities within the Tasmanian nearshore (10 m and 30 m water depth) survey, which is adjacent to the project's landfall at Heybridge.

Table 6-11: Summary of seabed habitats of nearshore Tasmania (Heybridge)

Zone	Water depth	Kilometre Point	Description
3	62 to 43 m	KP 237 to KP 246	Seabed is flatter and sandier with greater development of sand waves and decreasing epibiota. Seabed was characterised by sparsely distributed stalked *bryozoans Lanceopora smeatoni*, the green alga (feather caulerpa, *Caulerpa longifolia*), with doughboy scallops (*Mimachlamys asperrima*) and commercial scallops (*Pecten fumatus*) scarce.
2	43 to 35 m	KP 246 to KP 249	Seabed showed some wave created undulations and progressively more shell fragments. Small burrow mounds were visible. *Lanceopora smeatoni* and *Caulerpa longifolia* were less abundant. Doughboy scallops were sparsely scattered over the seabed, while commercial scallops were present but scarce
1	35 to 10 m	KP 249 to KP 250	At around KP 249.6 sand gutters weave through the extensive rocky outcrops; that characterise the nearshore seabed on this part of central northern Tasmanian coast. Sandy seabed at sites shallower than 30 m depth comprises relatively bare, mobile medium to coarse sand and shell, with no associated biota visible. Filamentous ephemeral green and red macroalgae (seaweeds) dominated the reefs in summer from the shoreline to 30 m depth. Larger long-lived brown algae (*Cystophora* and *Ecklonia*) were restricted to depths less than around 5 m. In winter, when most filamentous algae were absent and the reefs were characterised by bare rock with some encrusting coralline red algae, encrusting invertebrates and solitary *ascidians*.

Source: CEE (2023). The Kilometre Points (KPs) in the table vary slightly from those given in CEE (2022) due to the changes in the proposed alignments of the project's western and eastern monopoles within the Victorian nearshore. The zones are in reverse order, as the KPs increase, and water depths decrease, towards the proposed Tasmanian landfall of the project's subsea cables.

Plate 6.3 shows photographs of examples of the different seabed habitats in nearshore Tasmania.

Descriptions of the example seabed photographs in Plate 6.3 are summarised below:

- Photograph (a) shows sandy seabed habitat at 7 m water depth (below LAT[3]) within the western sand-filled palaeochannel within which the project's proposed western monopole (ML1) will be buried. There is an absence of bottom-attached macroalgae though occasional drift macroalgae may be present. There is little evidence of benthic macroinvertebrates, but a mixed infauna is inferred. The sand waves indicate that bottom currents are relatively strong, which regularly mobilise surface sands by wave-induced orbital velocities and alongshore current-induced velocities.
- Photograph (b) shows an example of cobble, pebble and sand seabed habitat at 13 m water depth. Sand ripples are present with the troughs occupied by larger cobbles and pebbles with bottom-attached mixed macroalgae. Benthic macroinvertebrates are inferred.

[3] LAT is Lowest Astronomical Tide, which is the lowest tide level that can be predicted to occur under average meteorological conditions and any combination of astronomical conditions.

- Photograph (c) shows and example of cobble and high-profile reef seabed habitat at 18 m water depth. Dense and diverse mixed macroalgae are present, but seagrasses are absent. Obvious benthic macroinvertebrates present include sponges (Porifera). Diverse mixed assemblages of benthic macroinvertebrates are inferred.
- Photograph (d) shows an example of sand and cobble seabed habitat at 24 m water depth. Mixed macroalgae are present along with sponges (Porifera). Mixed assemblages of other benthic macroinvertebrates are inferred.
- Photograph (e) shows an example of sand and shell fragments seabed habitat at 33 m water depth. Bottom-attached mixed macroalgae such as red macroalgae (Rhodophyta) are present in troughs, as sponges and other macroinvertebrates (inferred). The presence of sand ripples and troughs indicates the presence of bottom currents at 33 m depth and sufficient to mobilise these soft sediments at the seabed.
- Photograph (f) shows an example of boulder and cobble seabed habitat at 33 m water depth. Sparse cover of mixed macroalgae present mainly as bottom-attached red macroalgae (Rhodophyta). Benthic macroinvertebrates include sponges (Porifera) and other are inferred.

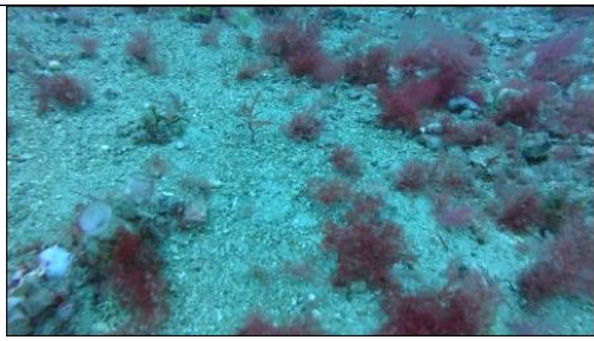
(a) Site W11: Palaeochannel sand seabed (7 m)

(b) Site C09: Cobble/pebble and sand seabed (13 m)

(c) Site C08: High-profile reef and cobble seabed (18 m)

(d) Site C06: Sand and cobble seabed (24 m)

e) C04: Sand and shell fragments seabed (33 m)



f) Site E03: Boulder and cobble seabed (33 m)

Source: CEE (2019).

Plate 6.3: Examples seabed types within nearshore Tasmania (Heybridge)

The hard seabed habitats of the project's proposed corridor across Bass Strait are found mainly within the Tasmanian nearshore and comprise rocky platforms and low- and high-profile rocky reefs which provide vertical structural diversity. Hard seabed habitats are more structurally diverse and offer a range of microhabitats that are colonised by a larger diversity and abundance of benthic flora, benthic and epibenthic macroinvertebrates, and benthic and epibenthic fish. The Tasmanian nearshore rocky platform and reefs provide habitat for benthic algae and other marine plants, which are a preferred habitat of EPBC Act listed pipefishes, sea dragons and seahorses.

6.3.5 Marine pelagic habitats, plankton and micronekton

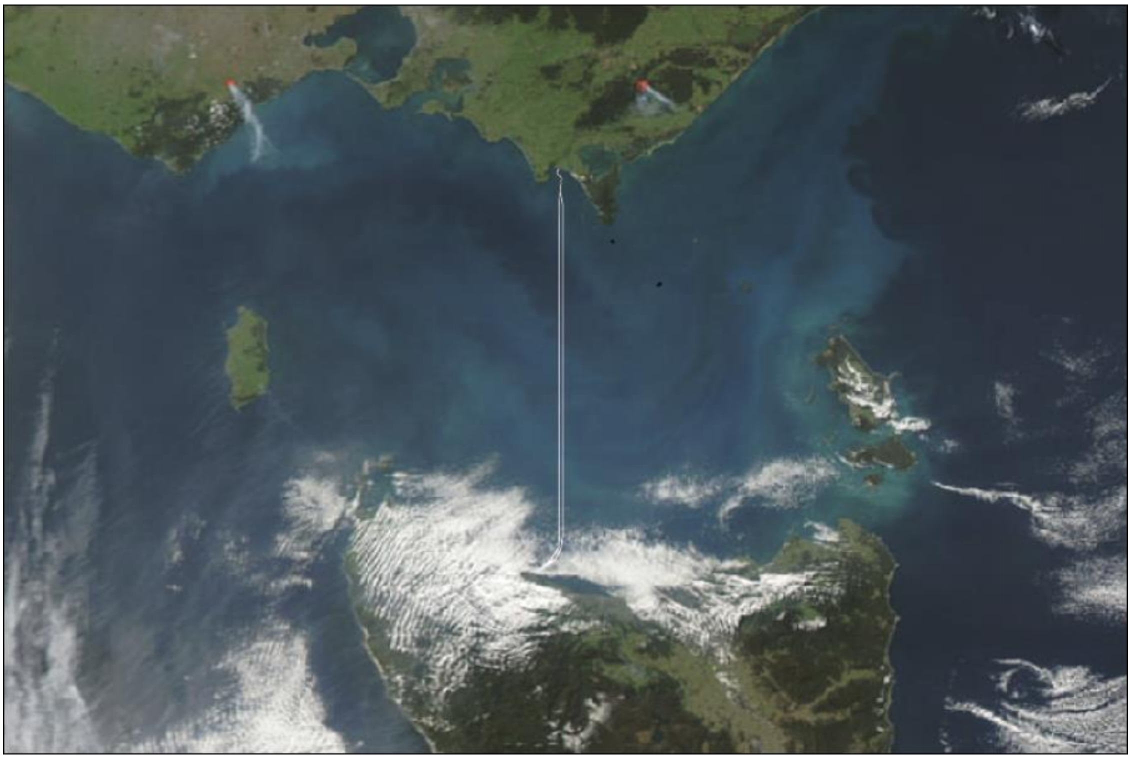
The water column of Bass Strait lies within the epipelagic zone (waters less than 200 m deep). The euphotic zone is the upper water layer where most photosynthesis by phytoplankton occurs, and is therefore, the zone of primary productivity. The euphotic zone also has a high secondary productivity based on zooplankton and micronekton. The much larger mobile megafauna (e.g., cetaceans, pinnipeds, sea turtles, adult fishes, penguins, etc.) of the Bass Strait water column are described separately in later sections of this report.

6.3.5.1 Phytoplankton

In the shallow nearshore and offshore waters of Bass Strait, the water column is comprised mainly of phytoplankton. Phytoplankton biomass and productivity is generally low in Bass Strait as exemplified by the very low chlorophyl-*a* measurements (all less than 0.5 mg/m^3) reported in Section 6.2.3 (Marine water quality).

However, phytoplankton can bloom profusely in Bass Strait when conditions are favourable. For example, satellite photographs by MODIS (2015) captured a phytoplankton bloom during mid-May in 2015 as shown in Figure 6.17 and in which, the phytoplankton biomass density is represented by the swirls of aqua and peacock-coloured water areas of Bass Strait.

Gibbs et al. (1986) measured average nitrate-nitrogen concentrations in offshore Bass Strait surface waters, which ranged from 0.15 ug/L in summer (January) to 1.1 ug/L in winter (July). Local increases are likely to occur when flows of nutrient-rich waters enter Bass Strait. For example, Wear et al (2006) measured nitrate-nitrogen concentrations in the Bonney Coast upwelling near Beachport, South Australia and showed average values of 4 µg/L in spring and elevated values of 20–25 µg/L in the autumn. The Bonney Coast upwelling is a predictable, seasonal upwelling bringing cold nutrient rich water to the sea surface and supporting regionally high productivity and high species biodiversity. Each season, from November to May, deep water is funnelled toward the surface through a series of submarine canyons (ERG, 2018).



Source MODIS (2015). Satellite photo credit Jeff Schmaltz (MODIS). White lines denote the project alignments.

Figure 6.17: Phytoplankton bloom in Bass Strait on 22 May 2015

During eastward extension of the South Australian Current Water (SACW) between November to May, nutrient-rich waters from the Bonney Coast upwelling will enter the northwest of Bass Strait and spread across Bass Strait, since the main pathway of currents is generally eastward (Sandery and Kämpf, 2007).

During the winter, nutrient-rich sub-Antarctic Surface Water (SASW) is found widely present in Bass Strait as it enters the strait via Cape Grim in northwest Tasmania and via Banks Strait in northeastern Tasmania strait (Gibbs et al., 1986). Evans and Middleton (1998) found that upon relaxation of a constant westerly wind-stress a gyre developed off the western shelf-break leading to a plume of deeper water upwelled and advected into the strait.

Overall, experience from other undersea cable projects indicates that potential direct or indirect effects on phytoplankton in the water column are not considered an issue of concern by regulatory authorities nor specific requirement in the EIS scoping guidelines of the Commonwealth Government (DCCEEW, 2022b), Victorian State Government (DTP, 2023) or the Tasmanian State Government (EPA Tasmania, 2022a ; EPA Tasmania, 2022b). Therefore, for the purposes of the present report, phytoplankton species lists, diversity, biomass densities in the water column are not provided nor required.

6.3.5.2 Zooplankton

Zooplankton can be divided into three sizes classes: a) microplankton that are 2-20 µm in size and include some copepods and other small zooplankton species; b) mesoplankton that are 200 µm–2 mm in size and includes larval crustaceans; and c) macroplankton that are 2-20 mm in size and include euphausiids (e.g., krill). Krill is an important food source for many higher trophic organisms including whales that feed on krill during the Bonney Upwelling along the coasts of southwestern Victoria and southeast South Australia.

Zooplankton can further be divided into a) holoplankton that comprises pelagic forms that spend their entire life in the water column such as copepods and b) meroplankton that comprises those forms that only spend part of their life cycle in the plankton such as the eggs and larvae (young stages) of fishes, crabs, lobsters, prawns, sea stars, mussels and oysters (Richardson et al., 2017). In general, meroplankton spend part of their life cycle in the benthic zone.

The low primary productivity of phytoplankton in Bass Strait means that zooplankton secondary productivity will also be correspondingly low. However, occasional increases in phytoplankton productivity are mirrored by increased secondary productivity (i.e., zooplankton consuming phytoplankton and micronekton feeding on zooplankton).

Overall, experience from other undersea cable projects indicates that potential effects on zooplankton in the water column are not considered an issue of concern by regulatory authorities nor a specific requirement in the EIS scoping guidelines of the Commonwealth Government (DCCEEW, 2022b), Victorian State Government (DTP, 2023) or the Tasmanian State Government (EPA Tasmania, 2022a; EPA Tasmania, 2022b). Therefore, for the purposes of the present report, zooplankton species lists, diversity, biomass densities in the water column are not provided nor required. Notwithstanding, a qualitative assessment of the generic impacts arising from project-induced water quality changes are addressed in Section 7 (Impact assessment).

6.3.5.3 Micronekton

Micronekton are classified as organisms between 20 and 200 mm in size and includes the larger larval stages of both marine invertebrates and fishes.

Neira (2005) documented the species composition and abundance of larval and early juvenile fishes in plankton sampled around oil production platforms in Bass Strait, which is in an area east of Wilson Promontory off the Gippsland coast and 170 km from the project's proposed alignment. The samples were collected during plankton net surveys undertaken in February 1998 and 1999 (summer), and August 1998 (winter). The plankton surveys yielded a taxonomically diverse fish assemblage containing 55 taxa from 45 families. The summer-winter assemblages differed markedly in terms of family and taxa richness: 42 families occurred in both summers combined compared to only six in winter (Neira, 2005). This marked seasonal difference reflects the fact that fishes in temperate coastal waters of Australia, including enclosed bays and estuary entrances, spawn primarily during spring/summer (Gaughan et al., 1990; Neira et al., 2000).

Table 6.12 presents a summary of the dominant families and taxa of larval fishes arranged in descending order of contribution (per cent) and includes only those taxa that individually contributed more than one per cent of the total. Eight families accounted for about 88.8% of the total caught during the study (numbers adjusted to 100 m^3), with *Carangidae* (35.1%) and *Myctophidae* (31.5%) dominating the summer and winter catches, respectively. Individuals of one or more species of the *Bovicthidae*, *Scomberesocidae*, *Berycidae*, *Triglidae*, *Arripidae*, *Bothidae* and *Monacanthidae* made up the other 22.2%. A total of 47 other taxa that individually contributed less than 1% of the total are not included, but cumulatively accounted for 12.2%.

Table 6-12: Dominant micronekton community organisms in Bass Strait

Family/taxa	Species/group	Common name	Nos./ 100 m^3	% Total
Carangidae	*Trachurus declivis*	Common Jack mackerel	848	35.1
Myctophidae	Myctophids	Lanternfishes	267	31.5
Bovicthidae	*Bovichtus angustifrons*	Dragonet	45	8.7
Scomberesocidae	*Scomberesox saurus*	King gar	91	3.7
Berycidae	*Centroberyx affinis*	Redfish	43	3.0
Triglidae	*Lepidotrigla mulhalli*	Roundsnout gurnard	22	2.7
Arripidae	*Arripis trutta*	Eastern Australian salmon	26	1.7
Bothidae	*Arnoglou muelleri*	Mueller's flounder	19	1.3
Monacanthidae	Monacanthids	Leatherjackets	11	1.1

Source: Neira (2005).

Based on the findings of Neira (2005), a similar species matrix of larval fishes may be expected to occur in Victorian offshore waters south of Waratah Bay and west of Wilsons Promontory.

For the purposes of the present report, micronekton species lists, diversity, biomass densities in the water column are not provided and are not a specific requirement in the EIS scoping guidelines of the Commonwealth Government (DCCEEW, 2022b), Victorian State Government (DTP, 2023) or the Tasmanian State Government (EPA Tasmania, 2022a; EPA Tasmania, 2022b). Notwithstanding, a qualitative assessment of the generic impacts arising from project-induced water quality changes and potential acoustic impacts are addressed (see Section 7, Impact assessment).

6.3.5.4 Megaloplankton

Megaloplankton plankton are classified as planktonic organisms greater than 200 mm in size, which includes jellyfish, comb jellies (ctenophores), salps, and the juvenile stages of cephalopods such as arrow squid (*Nototodarus gouldi*) and southern calamari (*Sepioteuthis australis*). An extensive list of megaloplankton is not presented. Notwithstanding, potential project-induced changes in water quality and potential acoustic effects on cephalopods are assessed in Section 7 (Impact assessment).

6.3.6 Cetaceans

The EPBC Act PMST results for offshore Bass Strait (PMST, 2023; Attachment A), nearshore Victoria (PMST, 2023; Attachment B) and nearshore Tasmania (PMST, 2023; Attachment C) identified 16 cetaceans (whales and dolphins) that are known or likely to be present in the project's area of influence. Table 6.13 provides a list of cetaceans of conservation significance that includes species within the EPBC Act's categories of 'Listed Threatened Species', 'Listed Marine Species' and 'Listed Migratory Species', as well as non-listed species.

The characterisation of cetaceans present in the study area was based on literature review using online databases such as the Victorian Biodiversity Atlas (DELWP, 2022b), Atlas of Living Australia (CSIRO, 2022), National Conservation Values Atlas (DCCEEW, 2022a) and the Tasmanian Natural Values Atlas (DNRE, 2022). Additional cetacean presence and distributional data were gleaned from scientific papers and the grey literature. No project field surveys were completed for this project on cetacean presence.

6.3.6.1 Cetaceans of conservation significance

In Table 6.13, there are six EPBC Act listed threatened species of whale, three of which are classified as endangered (i.e., the Antarctic blue, pygmy blue, and southern right whales), and two of which are classified as vulnerable (i.e., sei and fin whales). In addition, 10 cetaceans are classified as listed marine species under the EPBC Act.

The Commonwealth Government and all states and territories in Australia have agreed to establish a Common Assessment Method for the assessment and listing of threatened species (DCCEEW, 2023e). However, this method has not yet been adopted by the Tasmanian Government and the species listing categories and status of these cetacean species in Table 6-13 may be different in Tasmania under the TSP Act compared to those under the EPBC Act and the IUCN. In terms of conservation status, the TSP Act has the same status categories as those listed under the EPBC Act in Table 6-13 except for the humpback whale (*Megaptera novaeangliae*), which is listed by the TSP Act as endangered in the current List of Tasmanian threatened species (DNRE, 2023a).

The migratory whales in Table 6.13 are listed under the Convention on the Conservation of Migratory Species of Wild Animals (the Bonn Convention), to which Australia is a party, with accession on 1st September 1991. Australia's obligations include protecting migratory whales, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them.

In Table 6.13, the listed IUCN Red List of Threatened Species criteria are designed for global taxon assessments and some species that are classified as 'least concern' globally might be endangered or vulnerable within a particular region where numbers are very small or declining. The latter is the case for the subpopulation of southern right whales in southeast Australian waters, where the population is growing at a lower rate than the Western Australian and South Atlantic (e.g., Argentina) southern right whale subpopulations. The IUCN regularly reviews its Red List of Threatened Species and in the case of the Chile-Peru subpopulation of southern right whales, the IUCN has listed this subpopulation as critically endangered (IUCN, 2022).

The principal cetaceans identified in the EPBC Act PMST reports (see Attachments A, B and C) and their distribution within Bass Strait and the project's area of influence are described below.

Table 6-13: List of cetaceans in project area and central Bass Strait according to the PMST search

Species	Common name	Conservation status		Occurrence in project search areas			Migratory
		IUCN	EPBC Act	Victorian nearshore	Bass Strait offshore	Tasmanian nearshore	
Baleen whales (*Mysticeti*):							
Megaptera novaeangliae	Humpback whale*	LC	–	SK	SK	SK	Yes
Eubalaena australis	Southern right whale	LC	EN	SK	SK	SK	Yes
Balaenoptera borealis	Sei whale	EN	VU	FL	FL	FL	Yes
Balaenoptera musculus intermedia	Antarctic blue whale	EN	EN	SL	SL	SL	Yes
Balaenoptera musculus brevicauda	Pygmy blue whale	EN	EN	SL	SL	SL	Yes
Balaenoptera physalus	Fin whale	VU	VU	FL	FL	FL	Yes
Caperea marginata	Pygmy right whale	LC	–	FM	FM	FM	Yes
Balaenoptera acutorostrata	Minke whale	LC	–	SM	SM	SM	No
Toothed whales (*Odontoceti*):							
Orcinus orca	Killer whale	DD	–	SL	SL	SL	Yes
Pseudorca crassidens	False killer whale	NT	–	–	SL	SL	No
Globicephala macrorhynchus	Short-finned pilot whale	LC	–	–	SM	SM	No
Lagenorhynchus obscurus	Dusky dolphin	LC	–	SM	SM	SM	Yes
Delphinus delphis	Common dolphin	LC	–	SM	SM	SM	No
Grampus griseus	Risso's dolphin	LC	–	SM	SM	SM	No
Tursiops aduncus	Indo-Pacific bottlenose dolphin	NT	–	SL	SL	–	Yes
Tursiops truncatus s. str.	Common bottlenose dolphin	LC	–	SM	SM	SM	No

Notes: EN – Endangered; VU – Vulnerable; LC – Least Concern; NT – Near Threatened; Dash (–) denotes not listed. EPBC Protected Matters Search Tool (PMST) Report species occurrence in area: FK – Foraging, feeding or related behaviour known to occur; FL = Foraging, feeding or related behaviour likely to occur; FM - Foraging, feeding or related behaviour may occur; SK = Species or species habitat known to occur; SL = Species or species habitat likely to occur; SM = Species or species habitat may occur; NL – Not likely to occur.
*The humpback whale (formerly listed as vulnerable) was delisted on 26 February 2022 (TSSC, 2022).

6.3.6.2 Baleen whales (*Mysticeti*)

6.3.6.2.1 Humpback whale

The humpback whale (*Megaptera novaeangliae*) is listed as migratory under the EPBC Act and listed under the TSP Act as endangered (DNRE, 2023a). However, under the FFG Act Threatened List (DELWP, 2021), a subspecies of humpback whale, the southern humpback whale (*Megaptera novaeangliae australis*) is listed as critically endangered. This subspecies appears to be based on the revision of humpback whales into three oceanic subspecies as proposed by Jackson et al. (2014). However, Perrin (2021) states that the subspecies name has been rejected as there is no fixed holotype. For the purposes of this report, the humpback whale (reported as *Megaptera novaeangliae*) in Victorian waters is assumed to be endangered as was originally listed under FFG Act in 1995.

DCCEEW (2022c) states that a recovery plan for the humpback whale is not required as this species was deleted from the EPBC Act list of threatened species on 26 February 2022. The EPBC Act PMST reports (Attachments A, B and C) indicate that foraging, feeding or related behaviour of humpback whale is known to occur in all the project's PMST search areas.

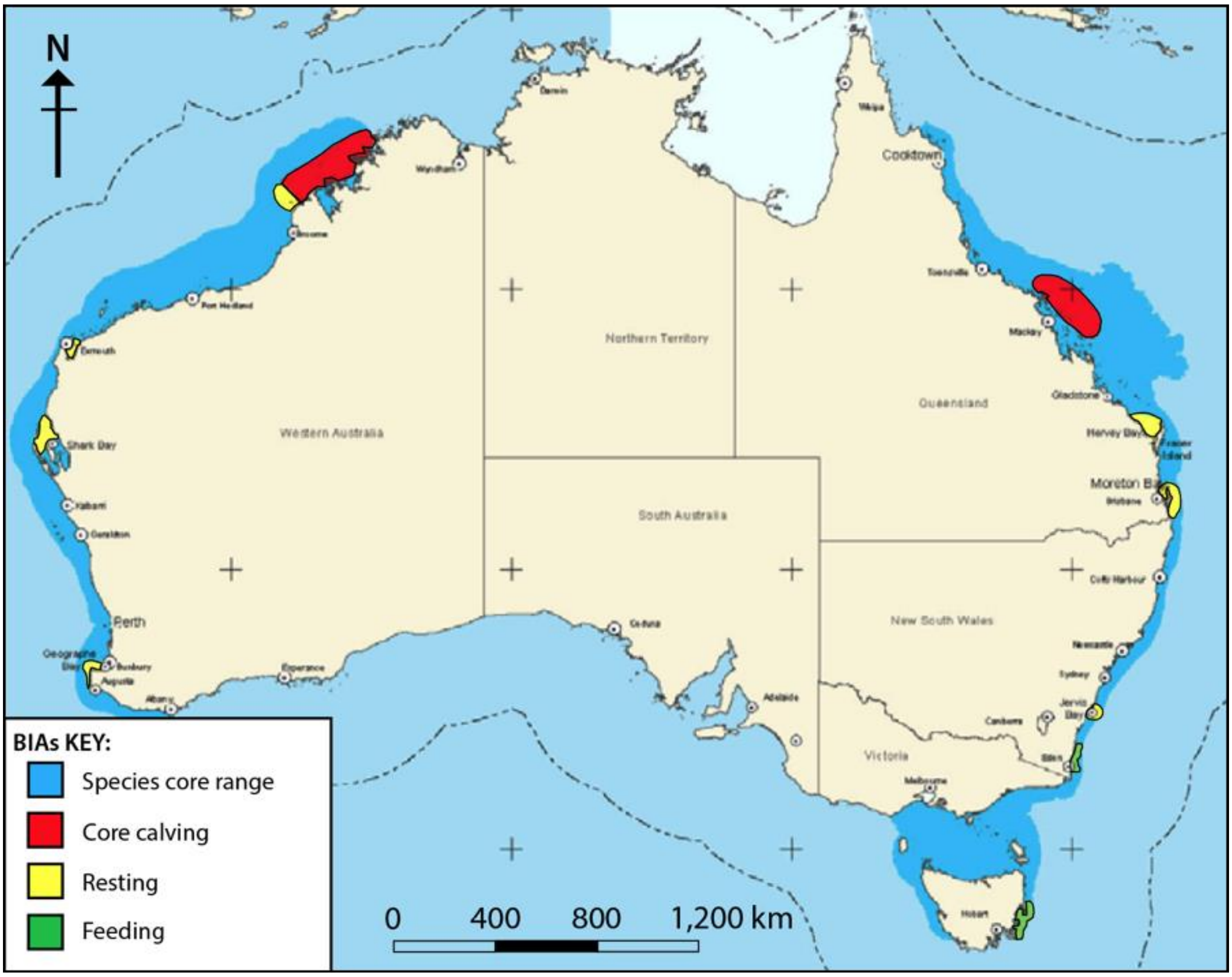
The humpback whale is a moderately large baleen whale having a maximum recorded length of 17.4 m, and females are generally 1.0 to 1.5 m longer than males (Chittleborough, 1965). Humpback whales regularly pass through or rest within Bass Strait during their seasonal migrations, to and from breeding grounds in tropical waters in eastern Australia, in autumn and spring (NSR, 2002).

The International Whaling Commission (IWC) currently recognises seven distinct breeding stocks (Groups A-G) of humpback whales in the Southern Hemisphere. The Australian populations are designated as Group D (western Australian coast) and Group E1 (eastern Australian coast). Individuals of another subpopulation of the E group (E2) pass through Australian waters adjacent to Norfolk Island on their way to breeding grounds around New Caledonia (Schmitt et al., 2014); however, due to their transitory presence in Australian waters (mainly offshore of the coast of NSW) and their absence in Bass Strait, this subpopulation is not considered further.

Both the western and the eastern Australian populations are recovering, and the rate of population increase for these two populations is thought to be between 10.9% and 11% per year for the eastern Australian population and between 9.7-13% for the western Australian population (DoEE, 2015). Western Australian (Group D) humpback whales are unlikely to be present in Bass Strait.

Biologically important areas

Biologically Important Areas (BIAs) are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, calving, resting or migration (DCCEEW, 2021). Figure 6.18 shows the BIAs for humpback whales in Australia (TSSC, 2015).



Source: Adapted from TSSC (2015).

Figure 6.18: Humpback whale Biological Important Areas (BIAs)

Core calving area

The core calving area of the eastern humpback whale E1 subpopulation lies within the warm nearshore and coastal waters off Mackay in Queensland (see Figure 6.18). In general, humpback whales are present off the Queensland coast between late autumn and late spring, prior to migrating south in July and August (DES, 2019).

Migration south from the Queensland core calving area occurs from mid-August through to mid-October, with females in early pregnancy heading south first, followed by immature whales then mature males/resting females, and lastly by lactating females with suckling calves (Dawbin, 1966).

Resting areas

From late September to late November, sheltered coastal embayments are used as resting areas by humpback whale cow-calf pairs and attendant males, during their southern migration. Two main resting areas are known at Hervey Bay and Moreton Bay in Queensland, while two smaller resting areas are known at Jervis Bay and Twofold Bay in New South Wales. The nearest resting area is Twofold Bay (near Eden), which is located approximately 460 km from the project's proposed alignment in Bass Strait.

Some southern migrating humpback whale mothers and calves that pass westwards through Bass Strait are known to undertake short resting periods before migrating south along the west coast of Tasmania to Southern Ocean feeding grounds. These short-term rest areas are typically in sheltered waters within Bass Strait including east of Wilsons Promontory near Corner Inlet Marine National Park in Victoria and the sheltered Perkins Bay to the west of the Stanley Peninsula and Godfreys Beach Bay east of the peninsula in Tasmania.

Feeding areas

Besides their summer Southern Ocean main feeding grounds, humpback whales have been observed feeding along the coast of eastern and southeastern Australia during their southern migration. From late September to late November, humpback whale mothers accompanied by new season calves migrate down the coast and stop over to undertake feeding at two core feeding areas en-route. Figure 6.18 shows the core feeding areas (i.e., green shaded areas) of the Sapphire Coast (New South Wales) and southeast Tasmania.

Foraging behaviour in humpback whales continues while migrating south after leaving the Sapphire Coast in the waters off southeastern Tasmania based on satellite tracking data by Andrews-Goff et al. (2018). Humpback whale 'super-groups' have been observed bubble-net feeding and lunge feeding at Fortescue Bay and bubble-net feeding only at Waterfall Bay on the east coast of the Tasman Peninsula in southeast Tasmania (Pirotta et al., 2021). At both locations the prey species targeted were euphausiids (krill).

When fewer whales are present in the core feeding areas, their foraging behaviour uses methods such as horizontal or vertical lunge feeding that involves a whale swimming at speed with their mouths wide open towards a high-density patch of prey, then closing their mouths around the prey thus engulfing large volumes of prey-laden water and then allowing water to pass out through the baleen plates, and finally consuming (swallowing) the captured prey.

Humpback whale 'super-groups' and bubble-feeding behaviour have not been observed within Bass Strait. However, during their northern migration, humpback whales have been observed surface or shallow-water lunge feeding on baitfish (e.g., Australian sardines) off Wilsons Promontory and Phillip Island, as well as to the west of Bass Strait off Portland (Pirotta et al., 2021). Supplemental feeding by humpback whales within Bass Strait during their southern migration has been shown by satellite tracking of three humpback whales that spent more than 30 days within the strait (Andrews-Goff et al., 2018).

Migration

Humpback whales migrate annually between their summer feeding grounds in Antarctica to their tropical breeding grounds in winter. Most of the eastern Australian population (E1) humpback whales follow a migration route from Antarctic waters that passes the east coast of Tasmania and along the New South Wales and Queensland coasts to and from the tropics. However, early season (autumn) sightings along the Victorian coast indicate that some northbound whales follow a migration route that passes the west coast of Tasmania and then traverses Bass Strait to join the main northward bound migration stream passing by Cape Howe at the Victoria-New South Wales border (Warneke, 2001).

The peak northern and southern migration periods of humpback whales in Bass Strait are given in Table 6.14.

Table 6-14: Peak migration periods of humpback whales in Bass Strait

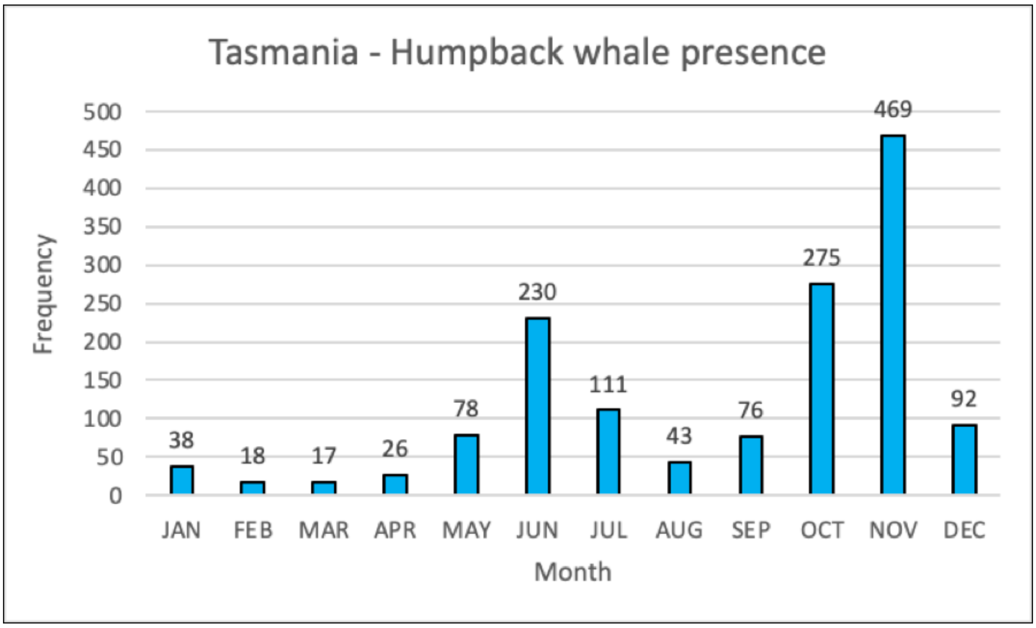
	Migration periods – humpback whales											
	Spring			Summer			Autumn			Winter		
Peak migration	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**
Northward												
Southward												

Source: Reviews of the literature (e.g., DSE, 2009; TSSC, 2015). Dark blue represents the peak month for the presence of humpback whales.

Humpback whale migration in Tasmania

During their southern migration, eastern Australian breeding stock (Group E1) humpback whales are sighted closer to shore, which provides additional protection to mothers and calves from potential predators (e.g., killer whales and great white sharks). The main southern migration route is east of Tasmania; however, satellite tracking has shown that some humpback whales travel westwards through Bass Strait before heading south along the west coast of Tasmania to their summer feeding grounds in sub-Antarctic waters (Andrews-Goff et al., 2018).

A frequency analysis of confirmed sightings of humpback whales in Tasmanian waters over the last 20 years, as reported in the Tasmanian Natural Value Atlas database (DNRE, 2022), is shown Figure 6.19. This figure confirms that the peak northern migration period was June, and that the peak southern migration period was November, as shown in Table 6.14.



Source: Based on frequency analysis of confirmed humpback whale sightings in Tasmanian waters (DNRE, 2022).

Figure 6.19: Monthly frequency analysis of all humpback whale sightings in Tasmania

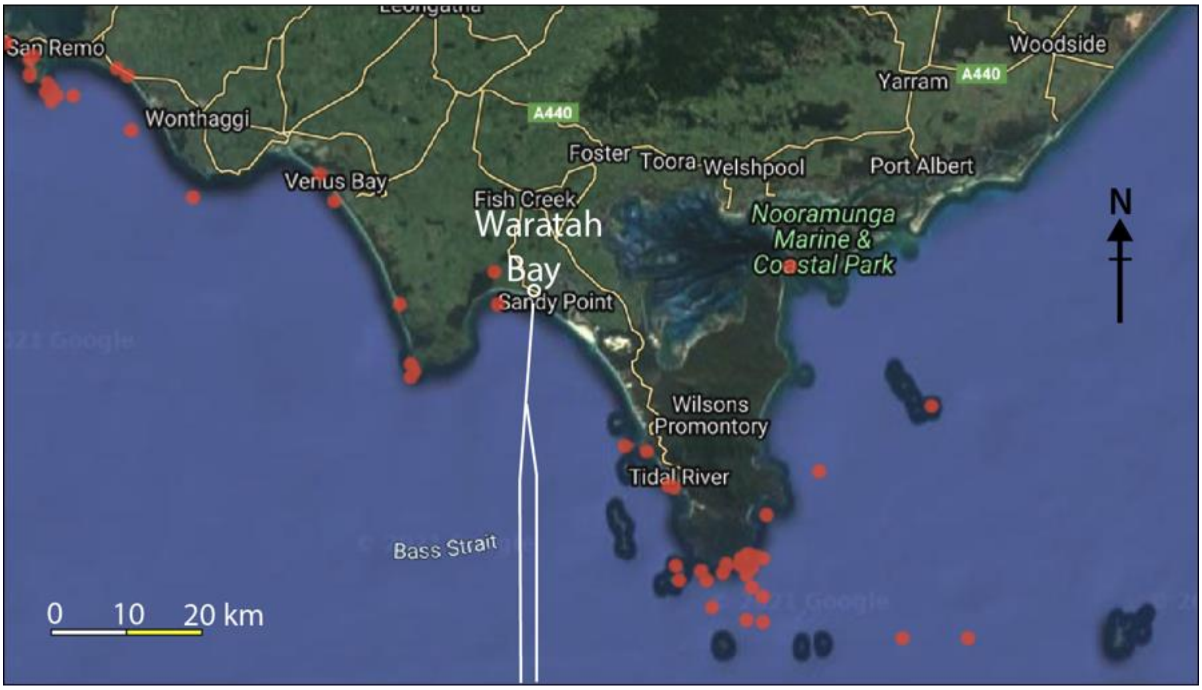
Figure 6.19 also reveals the presence low numbers of sightings during February through April and indicates that humpback whales may be present all year round in Tasmanian waters.

The likelihood of occurrence of humpback whales in Bass Strait and the project's PMST search areas and potential interaction with the project's proposed marine activities is assessed as ***Very likely***[4] during their northern peak migratory period of between May and July, and ***Very likely*** during their southern peak migration period between October and December. However, according to DSE (2009), the northward and southward migrations span longer periods May to August and September to November, respectively, which do not coincide with the peak periods in Bass Strait.

In northwest Tasmania, there is an annual peak migration presence of mothers and calves near the Stanley Peninsula between November and December, which confirms the presence of southern migrating humpback whales passing westerly through Bass Strait before turning southwards along the west coast of Tasmania towards their Southern Ocean feeding grounds.

Distribution of humpback whales in Victorian waters

Based on analysis of confirmed humpback whale sightings presented in the Atlas of Living Australia database (CSIRO, 2022), Figure 6.20 shows the accumulated distribution of humpback whales in Bass Strait waters under Victorian jurisdiction.



Source: Atlas of Living Australia (CSIRO, 2022) and Victorian Biodiversity Atlas (DELWP, 2022b)

Figure 6.20: Observed distribution of humpback whales in Bass Strait (Victorian waters)

In Figure 6.20 most humpback whale sightings (total of 26 records) are located off Wilsons Promontory with fewer sightings to the west of the promontory until Phillip Island where large numbers of confirmed humpback whale sightings have been recorded. Two confirmed sightings of humpback whales have been recorded within Waratah Bay, which suggests that humpback whales rarely use this bay despite the presence of potential observers in coastal villages, boats and smaller watercraft, and holidaymakers visiting the bay.

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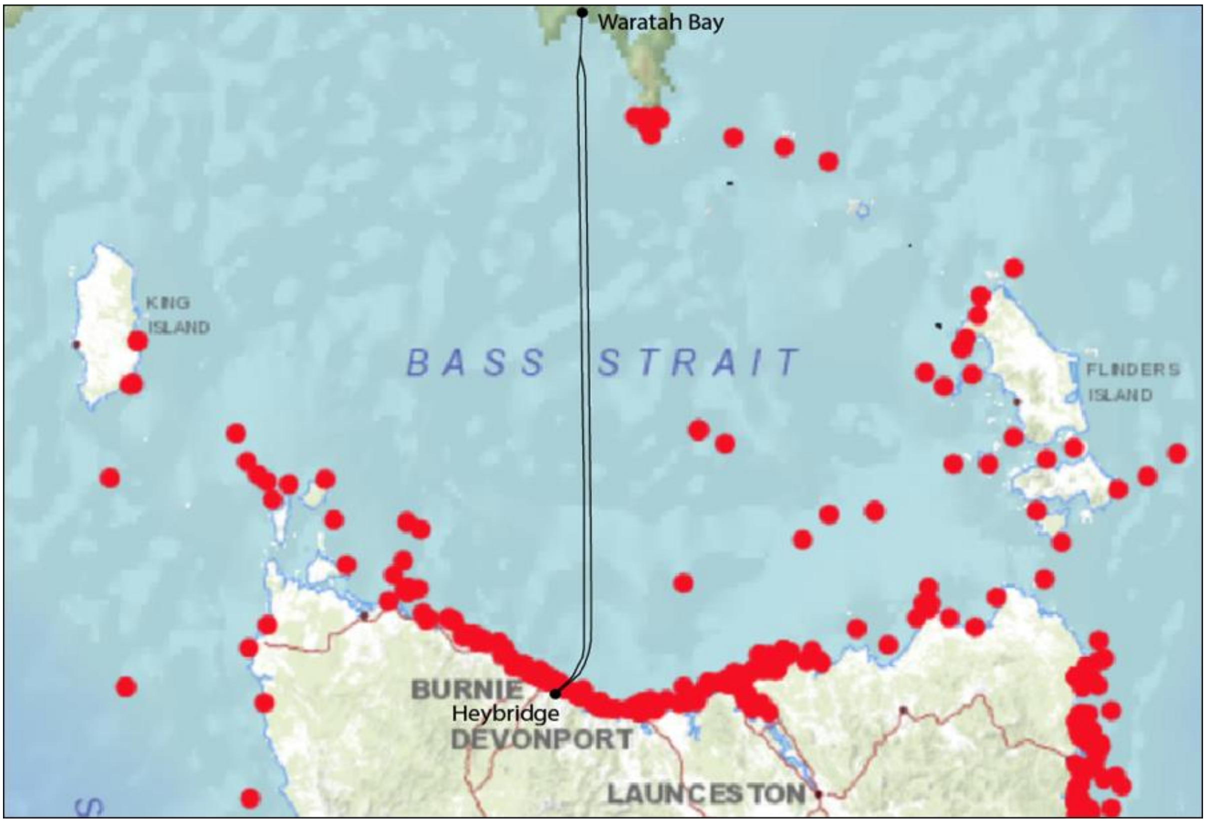
[4] Likelihood of occurrence categories are those described in Table 5.1.

Distribution of humpback whales in Tasmanian waters

Inspection of the Tasmanian Natural Values Atlas (DNRE, 2022) indicates that humpback whales are frequently found in Tasmanian waters, including Bass Strait. Figure 6.21 shows the distribution of observations of humpback whales in Bass Strait waters under Tasmanian jurisdiction.

Large numbers of confirmed humpback whale sightings have been recorded along the north coast of Tasmania, as well as within the Furneaux Group (Flinders, Cape Barren and Clarke islands) and Fleurieu Group (Three Hummock, Hunter and Walker islands). Along the northern coast of Tasmania, humpback whales have been regularly recorded, including the nearshore area and approach to the project's proposed landfall at Heybridge.



Source: Tasmanian Natural Values Atlas (DNRE, 2022). Black lines denote the project's proposed alignment.

Figure 6.21: Observed distribution of humpback whales in Bass Strait (Tasmania waters)

6.3.6.2.2 Southern right whale

The southern right whale (*Eubalaena australis*) is listed as endangered and migratory under the EPBC Act and listed as endangered under both the FFG Act and the TSP Act. A Draft National Recovery Plan for Southern Right Whales (SRW) was published by DCCEEW (2022e), and this report assesses and addresses the key threats listed in the plan in Section 7.2.3.5. Foraging, feeding or related behaviour of southern right whale is known to occur within the offshore Bass Strait, nearshore Victoria, and nearshore Tasmania PMST search areas (Attachments A, B and C, respectively).

The southern right whale is a medium to large baleen whale and grows to a maximum length of 17.5 m and weight of 80 t, with mature females often slightly larger than males (Bannister et al. 1996). The southern right whale has its own conservation management or recovery plan (DSEWPaC, 2012c). The conservation management plan recognises two Australian southern right whale subpopulations: the southwest Australian (SWA) population and the southeast Australian (SEA) subpopulation.

Detailed individual-based information collected from populations of southern right whales in Australia, New Zealand, Argentina and Southern Africa suggest the global population in 2012 exceeded 12,000 individuals (DSEWPaC, 2012c). In the 1990s, the Australian population was thought to number about 600-800 (Bannister et al. 1996). While there were no reliable estimates for the SEA subpopulation, the total Australian population (i.e., the combined SWA and SEA subpopulations) in 2012 was estimated at 3,500 individuals by DSEWPaC (2012c). In more recent studies, Smith et al. (2021) estimated the SWA subpopulation at 2,585 individuals in 2020 and increasing at a rate of 6% per annum. In a study by Smith et al. (2022), the most recent population estimate of the SWA subpopulation is 2,549 whales (1993 – 2021) and is increasing at a rate of about 4.3% (confidence interval of 2.8 – 5.8%) per annum for all whales observed and about 5.4% (confidence interval of 3.6 – 7.2%) for mother and calf pairs observed. (DCCEEW, 2022e). Stamation et al. (2020) estimated the SEA subpopulation at 268 individuals increasing at a rate of 4.7% per annum.

In general, the southern right whale is restricted to the Southern Hemisphere, where it has a circumpolar distribution and occurs mainly between 20° S and 55° S, although it has also been observed as far south as 63° S (Jefferson et al., 1993). Southern right whales have been recorded in all coastal Australian waters, except the Northern Territory (Bannister et al. 1996).

Southern right whale Biologically Important Areas

Southern right whale BIAs within southeast Australia have been identified and mapped in the Commonwealth's National Conservation Values Atlas (DCCEEW, 2022a). Figure 6.22 shows BIAs for southern right whales in southeast Australia, including Bass Strait.

The main BIAs for southern right whales are:

Resting on migration areas.

- Breeding or potential breeding areas.
- Calving and nursery areas.
- Coastal connecting habitat.

Resting on migration areas

In Victoria, the coastal waters within the 3-nm limit include a southern right whale BIA for 'migration or resting on migration' habitat, with seaward extensions at two specific areas:

- Wilsons Promontory general area that includes:
    - Wilsons Promontory Marine Park
    - Wilsons Promontory Marine Reserve
    - Wilsons Promontory Marine National Park
    - Corner Inlet marine and Coastal Park
    - Nooramunga Marine and Coastal Park
    - Westernport Bay and Phillip Island

Source: National Conservation Values Atlas (DCCEEW, 2022a). Note that core calving habitat is not present in Bass Strait and the nearest intermittent calving habitat area is Port Campbell in southwest Victoria.

Figure 6.22: Biologically Important Areas (BIAs) for southern right whales

- Phillip Island general area that includes:
  - Southern half Western Port Bay
  - Phillip Island nearshore waters between Cape Schanck and Cape Paterson

In Victoria, the above extended 'migration or resting on migration' habitat BIAs are shown as pink areas in Figure 6.22.

Breeding or potential breeding areas

Watson et al. (2021) stated that there is an absence of information on where and when conception occurs for southern right whales of the southeast Australia (SEA) subpopulation. However, a region on the east coast of Tasmania centred on Great Oyster Bay and extending southwards to the Tasman Peninsula has been designated as a 'breeding or potential breeding' BIA (see dark blue area in Figure 6.22) by DAWE (2022b). At this location, numerous male southern right whales attempt to attract females with potential underwater mating taking place in deeper nearshore or offshore waters.

Calving and nursery areas

Calving takes place very close to the coast in Australia, typically within water depths of less than 10 m and nursery grounds are occupied from May to October. Southern right whales have a single calf every 3 years and female-calf pairs generally stay within the calving area for 2 to 3 months. Gestation lasts 12 months, lactation at least 7–8 months with weaning complete within 12 months. In addition, female southern right whales show calving site fidelity, generally returning to the same location to give birth and nurse offspring (DSEWPaC, 2012c).

In Victoria, the main BIA for calving and nursery areas (based on observations of mothers with very young calves in multiple years) are along the southeast Australian coast includes nearshore waters at Logans Beach near Warrnambool, which is located 330 km to the west of the project's proposed alignment across Bass Strait. In addition, areas that have been used intermittently as calving areas or by small numbers of mothers with very young calves include nearshore coastal waters at Port Campbell, Port Fairy and Portland in southwest Victoria. The nearest intermittent calving area (i.e., Port Campbell) is located 270 km from the project's proposed alignment across Bass Strait.

The mean calving interval for southern right whales observed at Logans Beach is 4.2 ± 0.3 years long, with some calving intervals up to seven or nine years. However, between 2007 and 2018, the mean calving interval was 3.9 ± 0.2 years for southern right whales at Logans Beach near Warrnambool in southwestern Victoria (Watson et al., 2021).

Coastal connecting habitat in Tasmania

In Tasmania, waters within the state's 3-nm limit of the mainland, King Island and the Furneaux Group (Flinders, Cape Barren and Clarke islands) are classified as connecting habitat BIAs for southern right whales (see light blue areas in Figure 6.22). In the updated National Conservation Values Atlas (DCCEEW, 2022a), the southern right whale BIA for "connecting habitat" has been renamed as "Reproduction (approx. May – September)".

Information on the distribution or movements of southern right whales and the whales' preferred water depth ranges and other environmental variables within connecting habitat is poorly described. A review of the literature revealed preferred depth range data for the southwest Atlantic subpopulation of southern right whales, which is assumed to be applicable to the eastern Australian subpopulations. A detailed study from Argentina (Svendsen, 2013) has revealed key environmental variables that characterise Southern Right Whale distribution in connecting habitat. Table 6.15 gives southwest Atlantic southern right whale subpopulation distribution data by distance from the shore, water depth and bottom slope in connecting habitat and breeding areas.

In Table 6.15, the water depths of southwestern Atlantic southern right whales in coastal habitats averaged 10 m for all whales but a shallower water depth of 7.2 m was preferred by mother-calf pairs. Breeding behaviour was observed in deeper water further offshore with an average depth of 37.4 m. A similar spatial occurrence and distribution of the southeastern Australian (SEA) subpopulation of southern right whales in Tasmanian mainland and island connecting habitat BIAs.

Table 6-15: Nearshore distribution of SW Atlantic southern right whales and ambient variables

	No. of whale records*		Area under the curve#		Important ambient variable modelled			
Grouping	Model run	Model test	Model run	Model test	Distance from shore (m)	Water depth (m)	Bottom slope (°)	*Mean surface temperature (°C ±SD)
All	370	160	0.943	0.936	86.9	10.0	1.6	0.5±1.0
Breeding	96	41	0.968	0.973	57.1	37.4	3.8	0.1±1.5
Mothers/calves	160	68	0.980	0.970	86.4	7.2	5.3	0.7±0.4

Source: Svendsen (2013). Model runs using 70% of whale records and model tests using 30% of SW Atlantic southern right whale records. * Modelling by Svendsen (2013) uses either annual or seasonal averages. # Area under the curves relates to an output of the Maxent software model for species niches and distributions (AMNH, 2018).

Feeding areas

The location of the summer sub-Antarctic feeding grounds of the southeast Australian (SEA) subpopulation of southern right whales is not known (Watson et al., 2021). However, historical whaling data show southern right whales were captured in the region of the Subtropical Front (STF) south of Australia during the austral summer months (December-February). The STF typically occurs between latitudes 39° S and 42° S and is a continuous feature that lies within the Southern Tropical Convergence (STC), which is characterised by elevated primary productivity (Moore and Abbott, 2000; Tomczak et al., 2004) and is an area where southern right whales have been tracked (Mackay et al., 2020).

Migration

Southern right whales migrate from their summer feeding grounds in the Southern Ocean to calve and breed in warmer temperate coastal waters. It is not clear where southern right whales approach the Australian coast from offshore areas (Kemper et al., 1997; Burnell, 2001). In the updated National Conservation Values Atlas, all the waters surrounding Tasmania and the whole of Bass Strait are now classified as migratory habitat and classified by DCCEEW (2022a) as a southern right whale BIA for "Migration (approx. May – September)".

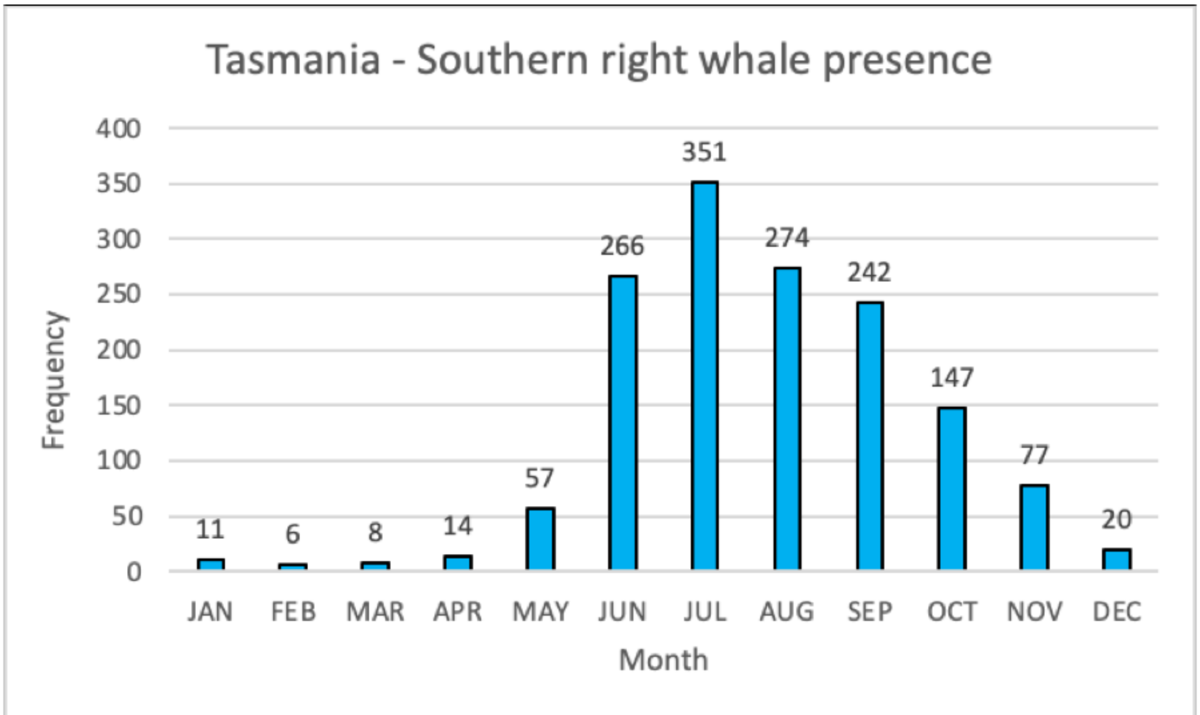
Table 6.16 indicates that southern right whales are seasonally present along the southeast Australian coast between late April and early November, with their peak northern migration period in Tasmanian waters including Bass Strait is between May and July, and their peak southern migration between September and November.

Table 6-16: Peak migration periods of southern right whales in Bass Strait

	Migration periods – southern right whale											
	Spring			Summer			Autumn			Winter		
Peak migration	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
Northern												
Southern												

Source: Based on frequency analysis of confirmed southern right whale sightings in Tasmanian waters (DNRE, 2022).

Figure 6.23 shows the temporal distribution of confirmed sightings of southern right whales in Tasmanian waters based on a frequency analysis of observation records of the Tasmanian Natural Values Atlas database (DNRE, 2022). In Figure 6.23, the main months of the northern migration in Tasmania and Bass Strait waters are from May to August and returning during the months of September through November. Note that there can be interannual variability in the peak months when southern right whales may be observed at specific locations or BIAs.



Source: Histograms based on confirmed southern right whale sightings (1974 – 2023) in Tasmanian waters (DNRE, 2022).

Figure 6.23: Monthly frequency analysis of southern right whales in Tasmanian waters

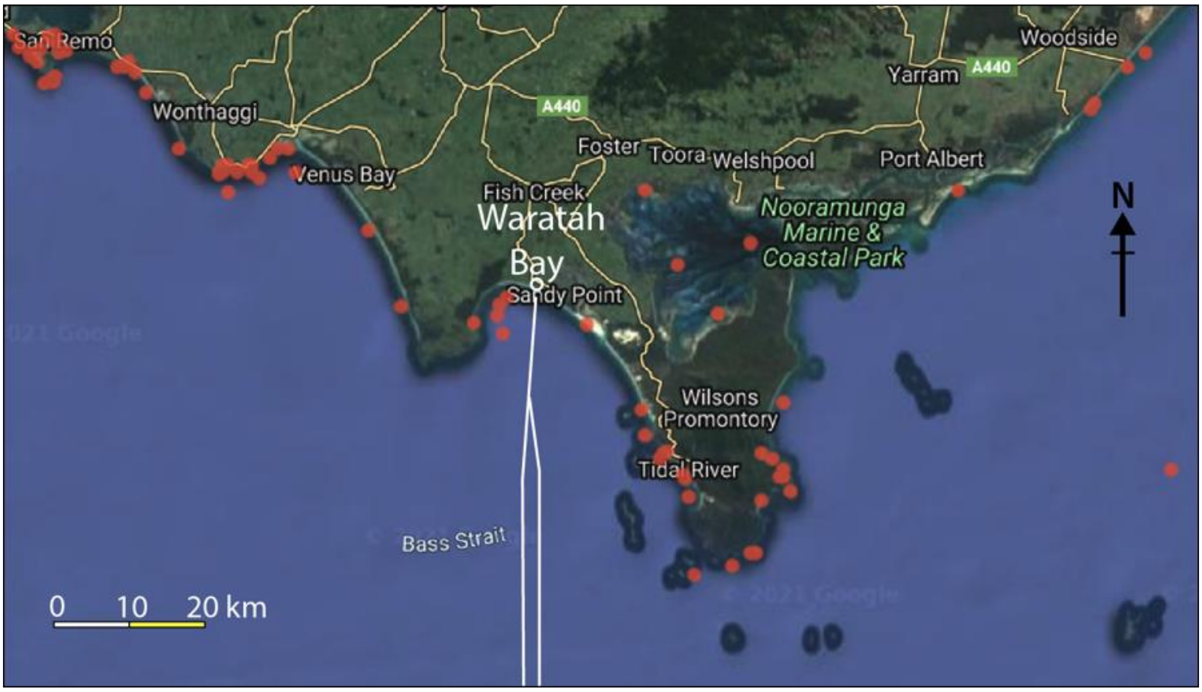
Southern right whales that migrate north along the east coast of Tasmania move in a north-easterly direction up the coast of Victoria and New South Wales, while those that migrate north along the west coast of Tasmania move from east to west along the southern coasts of South Australia and Western Australia. This east to west migratory pattern has been termed the 'counter-clockwise' migratory pattern (Kemper et al. 1997).

Distribution in Victorian waters

Figure 6.24 shows the distribution of southern whale sightings in Victorian nearshore waters between Phillip Island and Lakes Entrance. Most sightings of southern right whales along the Victorian southeast coast occur during their peak presence between June and September, with fewest sighting during the period December through April when the whales are in their summer feeding grounds in the Southern Ocean.

There have been six confirmed sightings between July to November within Waratah Bay, which is the project's proposed landfall location in Victoria. A total of 27 confirmed sightings along the coastal connecting habitats of Wilsons Promontory, with many sightings recorded in the various embayments of Wilsons Promontory Marine Park.

Larger counts of southern right whales are also frequently observed in Venus Bay (Bunurong Marine National Park) and off Phillip Island (see Figure 6.24), which are located about 50 m and 87 km, respectively, to the northwest from the project's proposed alignment in Bass Strait.



Source: Atlas of Living Australia (CSIRO, 2022) and Victorian Biodiversity Atlas (DELWP, 2022b).

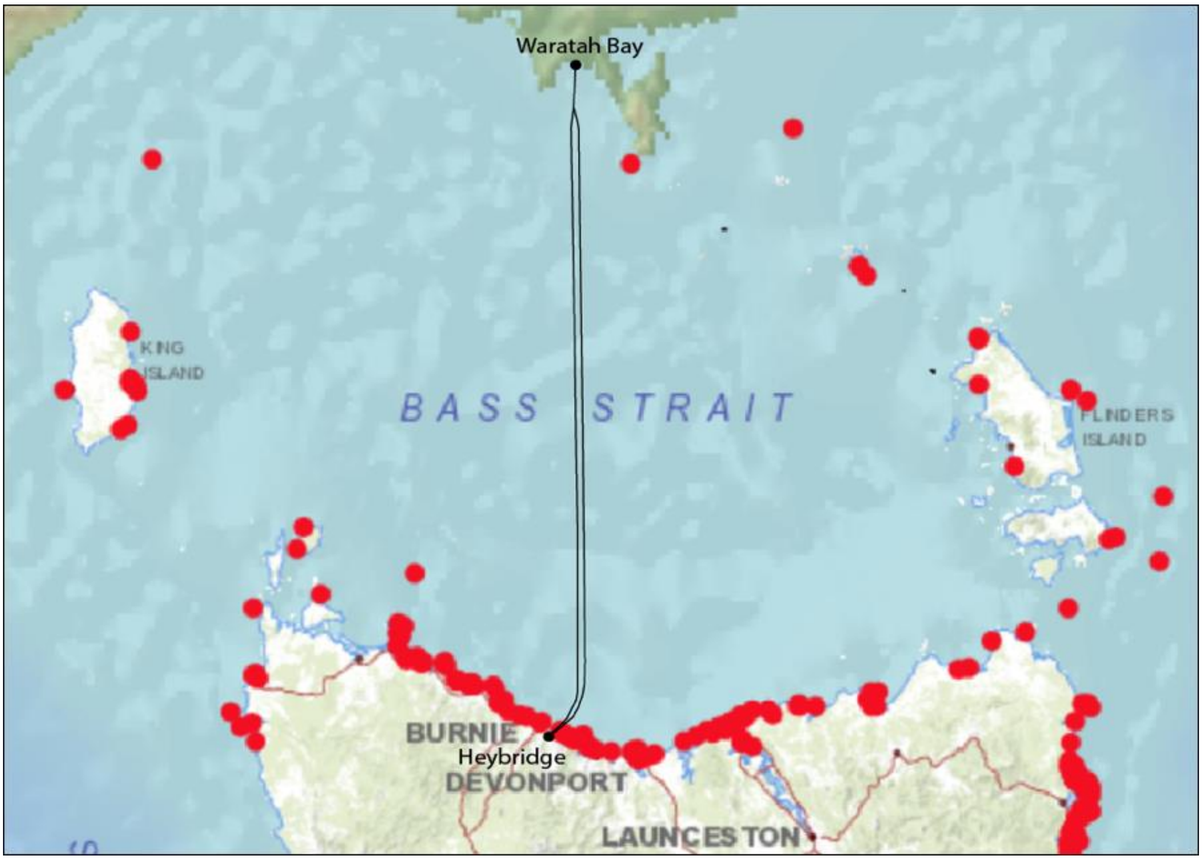
Figure 6.24: Distribution of southern right whale sightings in Victorian waters

The likelihood of occurrence of southern right whales in Victorian nearshore waters is determined to be ***Very likely*** during the whales' peak presence along coast (May to August) but absent in December and April when they are at their summer feeding grounds in the Southern Ocean.

Distribution in Tasmanian waters

Figure 6.25 shows the distribution of southern right whales in Bass Strait waters under Tasmanian jurisdiction. The distribution of confirmed sightings is mainly concentrated along the northern coast of Tasmania and amongst the Furneaux Group (Flinders, Cape Barren and Clarke islands), the Fleurieu Group (Three Hummock, Hunter and Walker islands) and King Island. Fewer sightings of southern right whales in the offshore waters of Bass Strait may be expected given that observations will have to be made by observers on passing ships or offshore oil and gas platforms, with few sightings being reported.

The likelihood of occurrence of southern right whales in Tasmanian waters of Bass Strait is assessed as ***Very likely*** during their peak presence in (May and July), but generally will be absent during their peak southern migration period (September to November), and very low during December through April when they are feeding in the Southern Ocean (see Figure 6.23). Note that southern right whales may be observed all year round in Tasmanian waters including Bass Strait.



Source: Tasmanian Natural Values Atlas (DNRE, 2022). Black lines denote the project's proposed alignment.

Figure 6.25: Distribution of southern right whale sightings in Bass Strait (Tasmanian waters)

6.3.6.2.3 Sei whale

The conservation status of the sei whale (*Balaenoptera borealis*) is classified as vulnerable and listed as migratory under the EPBC Act. Sei whales are not listed under the FFG Act or the TSP ACT. The EPBC Act PMST reports indicate that foraging, feeding or related behaviour of sei whale is likely to occur in Bass Strait and the project's PMST search areas (Attachments A, B and C). The Threatened Species Scientific Committee has issued conservation advice for the sei whale (DoE, 2015d).

The sei whale is the third largest whale in the family *Balaenopteridae*, after the blue and fin whales. Sei whales are approximately 12 to 16 m long at sexual maturity, although they can reach lengths of 17.7 m in males and 21 m in females (Gambell, 1985). Adult females are about 0.5 to 0.6 m longer than males and sei whales of the Southern Hemisphere are larger than those of the Northern Hemisphere (Horwood, 1987).

The Southern Hemisphere population was originally estimated to be around 100,000 individuals but decreased to around 24,000 individuals in 1980 (Horwood, 2009). However, the total abundance and latest population trends of sei whales in Australian waters are unknown.

Sei whales are primarily found in deep-water oceanic habitats and their distribution, abundance and latitudinal migrations are largely determined by seasonal feeding and breeding cycles (DoE, 2015d). In their Antarctic feeding grounds, sei whales feed especially on copepods when available (mainly *Calanus* spp.) or feed on euphausiids (krill) such as *Euphausia superba* and *E. vallentini* (Mizroch et al., 2004). Sei whales are rarely seen in Australian coastal waters, but they have been sighted 20 to 60 km offshore over the continental shelf (Miller et al., 2012) and have also been observed feeding on krill at the Bonney Upwelling (Gill, 2002).

Sei whales tend to be restricted to more temperate waters, and consequently are generally found within a smaller range of latitudes. In summer, sei whales do not venture into higher latitude waters near the Antarctic continent as much as some other baleen whales such as humpback and southern right whales (Horwood, 1987). The majority of the sei whale population occurs between 40° S and 60° S, usually north of the Antarctic Convergence, and juveniles are found further north than mature individuals (Matsuoka and Hakamada, 2018). Since latitude 40° S passes through King Island in the west and Flinders Island in the east of Bass Strait, sei whales at this northern limit may be expected to be predominantly juveniles.

The similarity in appearance of sei whales and Bryde's whales (*Balaenoptera edeni*) has resulted in confusion about sei whale distributional limits and frequency of occurrence, particularly in warmer waters (greater than 20°C) where Bryde's whales are more common (DAWE, 2022b).

Occurrence in low latitude wintering grounds has been recorded from March to December, with abundance peaks from June/July to August/September (Horwood, 1987). In late spring and summer, abundance peaks in November between 30° S and 50° S. As the season progresses relatively more whales are observed south of 40° S and abundance between 50° S and 60° S increases consistently until March (Horwood, 1987).

Biologically Important Areas

The sei whale is not listed in the current list of regionally significant marine species for which BIAs have been identified (DAWE, 2021b). However, the Threatened Species Scientific Committee (DoE, 2015d) has issued conservation advice for the sei whale.

Distribution in Victorian Waters

The Atlas of Living Australia (CSIRO, 2022) and Victorian Biodiversity Atlas (DELWP, 2022b) show two confirmed sightings (1983 and 2003) of sei whales in Victorian waters but both records are from the continental slope edge to the east and west of Bass Strait, respectively. This species is mainly found on the continental slope, which is confirmed by their mapping distribution. There were no sightings of sei whales in Victorian waters of Bass Strait.

The likelihood of occurrence in Bass Strait waters under Victorian jurisdiction is determined to be ***Rare***, and potential interaction with the project’s proposed marine construction activities or operations in Victorian waters is not anticipated.

Distribution in Tasmanian waters

The Tasmanian Natural Values Atlas (DNRE, 2022) shows six confirmed sei whale sightings distributed along the east coast of Tasmania and three sightings off the Tasman Peninsula in southeast Tasmania, with no records for Bass Strait. The Tasmanian sightings were recorded in two time periods, February to April and September to October, which may represent a northern and southern migration within southeast Australia waters.

The likelihood of occurrence in Bass Strait waters under Tasmanian jurisdiction is determined to be ***Rare***, and potential interaction with the project’s proposed marine construction activities, operations or decommissioning activities in Tasmanian waters is not anticipated.

6.3.6.2.4 Antarctic blue whale

The conservation status of the Antarctic blue whale (*Balaenoptera musculus intermedia*) is classified as endangered and listed as migratory under the EPBC Act. This species is also listed as endangered under both the FFG Act and the TSP Act. The EPBC Act PMST reports (Attachments A, B and C) indicate that the Antarctic blue whale or its habitat is likely to occur in Bass Strait.

Antarctic blue whales live to about 80 to 90 years, weigh up to 130 t, and are slow to mature, with a low reproductive rate of one calf every 2 to 3 years (Sears, 2002; Yochem et al., 1985).

There is limited information on the distribution of Antarctic blue whales in Australian waters, including Bass Strait. A recovery plan, the Blue Whale Conservation Management Plan, has been made under s.269A(2) of the EPBC Act (DoE, 2015f).

Visual observations of 'blue whales' near the Bonney Upwelling in southwestern Victoria were previously thought to be pygmy blue whales (*Balaenoptera musculus brevicauda*) (Gill et al., 2011), while recent genetic studies (Attard et al., 2012) and passive acoustic monitoring studies (Tripovich et al., 2015) have shown that both Antarctic and pygmy blue whales are present. In the acoustic studies by Tripovich et al. (2015), a total of 29,053 blue whale calls were confirmed of which 52% were attributed to Antarctic blue whales and 48% were attributed to pygmy blue whales.

Tripovich et al. (2015) observed that the peak presence of Antarctic blue whales off Portland, in southwestern Victoria, was between July and October in 2009 and between June and July in 2010, which corresponded with the suspected breeding season (Small, 1971). During the austral summer (December to February), there were no Antarctic blue whales in December or low numbers in February at the Bonney Upwelling area, which is to be expected given that it is at this time of year the whales are presumed to have returned to Antarctic waters to forage (Attard et al. 2012). No acoustic data for Antarctic blue whales were recorded during January, due to high currents impeding the exchange of acoustic recorders (Tripovich et al. 2015).

Biologically Important Areas

The Antarctic blue whale is not listed in the current list of regionally significant marine species, for which BIAs have been identified (DAWE, 2021b). However, there is a conservation management plan and a recovery plan in place for the blue whale (DOE, 2015c).

Migration

Antarctic blue whales migrate to circumpolar Antarctic waters during the summer months, feeding mainly on krill (*Euphausia superba*) from the ice pack to the Antarctic Convergence. The Antarctic Convergence (or Antarctic Polar Front) is a boundary line that separates the Antarctic and sub-Antarctic regions, and where the cold Antarctic waters meet, mingle, and sink beneath the warmer sub-Antarctic waters (Chepkemoi, 2017).

Antarctic blue whale calls were detected more often during July to October 2009 and June to July 2010 (Tripovich et al. 2015), which coincides with the literature suggestion that whales move to warmer waters in winter to breed (Small, 1971).

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2022) and the Victorian Biodiversity Atlas (DELWP, 2022b) do not show any confirmed Antarctic blue whale sightings in Victorian waters of Bass Strait.

The likelihood of occurrence of Antarctic blue whales in Bass Strait waters under Victorian jurisdiction is determined to be ***Remote***, and potential interaction with the project's proposed marine construction activities or operations in Victorian waters is not anticipated.

Distribution in Tasmanian waters

The Tasmanian Natural Values Atlas (DNRE, 2022) only reports confirmed sightings of 'blue whales' as *Balaenoptera musculus,* but not as the Antarctic blue whale subspecies (*Balaenoptera musculus intermedia*). Most of the confirmed 'blue whale' sightings are along the east and southeast coast of Tasmania.

In Bass Strait there are five confirmed sightings, all within far northwest Tasmania, with three records at King Island (one on the west coast and two offshore to the north), and two sightings at Table Cape on the north coast west of Burnie. One of the Antarctic blue whales was recorded by video[5] from a circling light aircraft in January 2012 as it passed along the north coast of Tasmania near Table Cape and was calculated to be 24.3 m long (Maurice and McArthur, 2012). While Table Cape lies 26 km west of the project's proposed alignment, the eastward direction of travel of the observed whale along the northern Tasmanian coast would have taken it past Heybridge nearshore and the project's proposed approach to landfall.

The likelihood of occurrence of Antarctic blue whales in Bass Strait waters under Tasmanian jurisdiction is determined to be ***Remote***, and interaction with the project's proposed marine construction activities or operations is not anticipated.

6.3.6.2.5 Pygmy blue whale

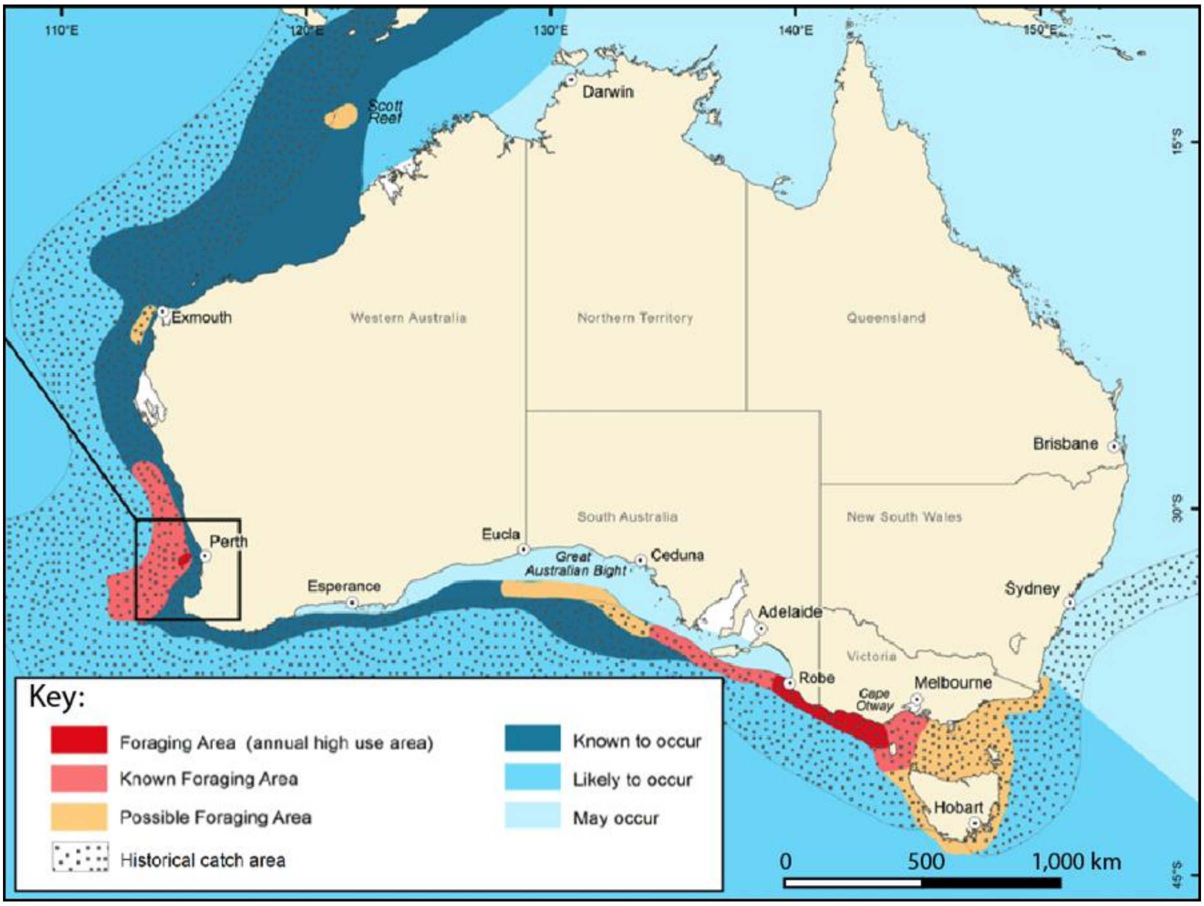
The conservation status of the pygmy blue whale (*Balaenoptera musculus brevicauda*) is classified as endangered and is listed as a migratory species under the EPBC Act. In Victoria only the blue whale as '*Balaenoptera musculus*' is listed as endangered under the FFG Act and in Tasmania, the blue whale as '*Balaenoptera musculus*' is also listed and classified as endangered under the TSP Act (DNRE, 2023a). The blue whale Conservation Management Plan and Recovery Plan (DoE, 2015f) includes information on pygmy blue whales (DoE, 2015f). There is no conservation listing advice for this subspecies.

Pygmy blue whales are shorter (≤24.2 m) and generally found north of 55° S in summer, while Antarctic blue whales generally exceed 30.5 m and are found in more southerly waters (IWC, 2018).

Biologically Important Areas

Figure 6.26 shows BIAs for pygmy blue whales in Australian nearshore and offshore waters.

[5] The 2012 sighting of an Antarctic blue whale is available at https://www.youtube.com/watch?v=5SEOJN3dBYM.



Source: Adapted from the Conservation Management Plan for the Blue Whale 2015-2025 (DoE, 2015f)

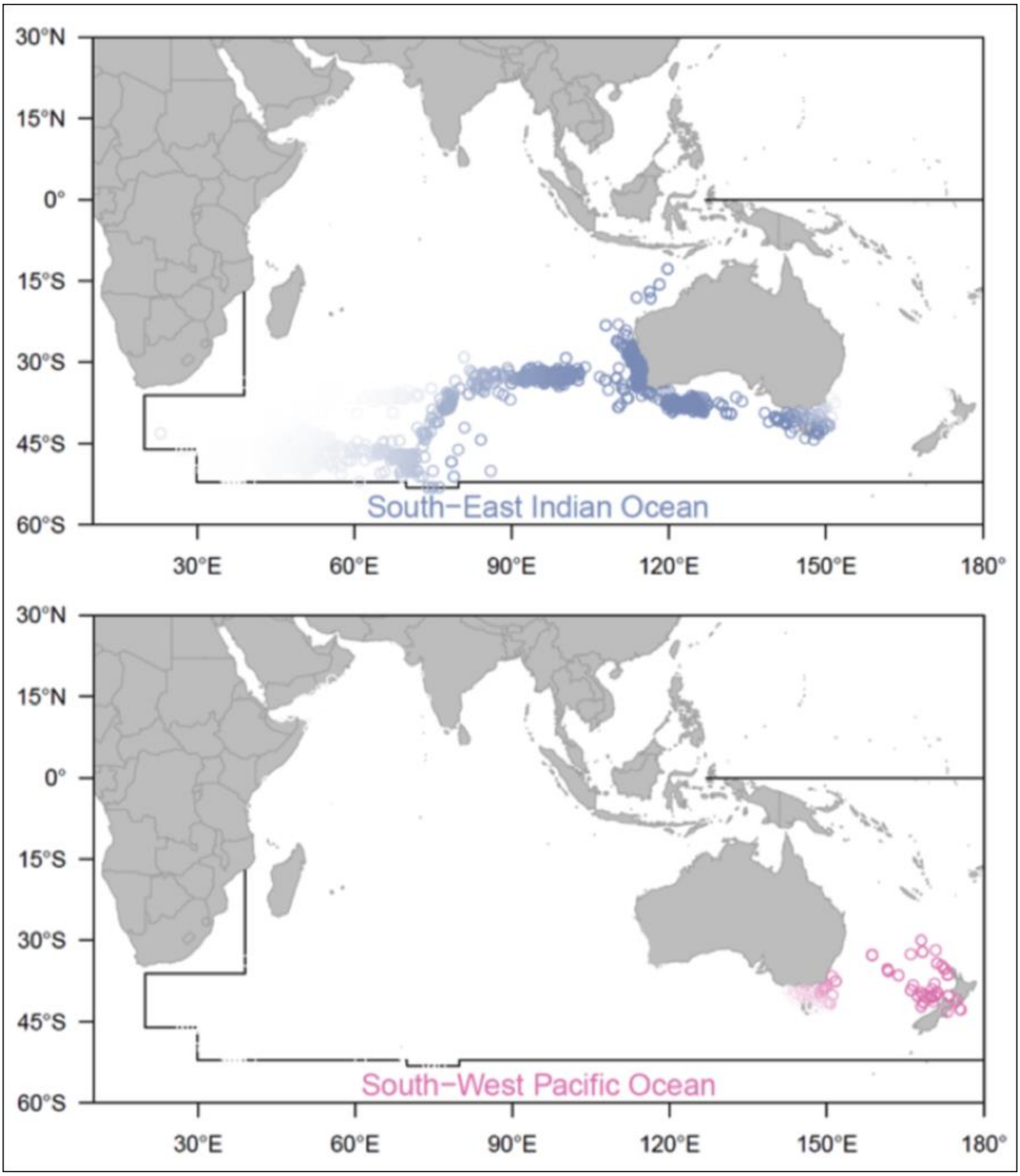
Figure 6.26: Biologically Important Areas (BIAs) for pygmy blue whales

In Figure 6.26, most of the central and eastern parts of Bass Strait are classified as a possible foraging area for pygmy blue whales, while the western section is a known foraging area. The latter is an extension of the high annual use foraging area along the coasts of southeast South Australia and southwest Victoria (i.e., from Robe to Cape Otway), which is with the Bonney Upwelling and its high productivity of zooplankton preyed upon by pygmy blue whales. The project's proposed alignment intercepts the possible foraging area of pygmy blue whales in central Bass Strait.

Pygmy blue whales inhabit a zone generally north of the Antarctic convergence (Ichihara, 1966; Kato et al., 1995). The pygmy blue whale was first described and named by Ichihara (1966); however, since then, five vocally distinct pygmy blue whale subpopulations separated by song types have been identified in the Southern Hemisphere, all within discrete geographical ranges (Beck, 2019).

There are two subpopulations of the pygmy blue whale that occur in Australian waters, and which are characterised by differences in morphology, geographical distribution, genetics and vocal behaviour. The two subpopulations occurring in Australia as described by the IWC (2018) are the 'South Eastern Indian Ocean (SEIO) pygmy blue whale subpopulation and the South West Pacific Ocean (SWPO) pygmy blue whale subpopulation.

Figure 6.27 shows the distribution of the SEIO and SWPO pygmy blue whales (IWC, 2018; Branch et al., 2018), which shows a general clear distinction between the SEIO and SWPO subpopulations. However, there is an area of overlap between these two subpopulations in Bass Strait as pygmy blue whales from both the SEIO and SWPO subpopulations may be present.



Source: International Whaling Commission (IWC, 2018). High colour intensities represent high probabilities of being assigned to a particular population, while low and faded colour intensities represent low probabilities.

Figure 6.27: Acoustic-derived distribution of pygmy blue whales in Australia and New Zealand

Migration

DoE (2015) provides a description of the Australian pygmy blue whales' northern and southern migration. The approach paths of pygmy blue whales in the SEIO subpopulation from their high-latitude summer feeding grounds in the Southern Ocean and the southern coast of Australia are not well defined but appear to follow direct south to north trajectories. One migration path from the Southern Ocean passes along the west coast of Tasmania.

In Western Australia, the northern migration starts at Cape Leeuwin and Perth area around March and April and then reach their low-latitude wintering grounds in the Banda and Molucca seas in Indonesia between June and September. During the southern migration, pygmy whales are found off the northwest coast of Western Australia during September and December, and off Perth and Cape Leeuwin in October through late December. Thums et al. (2022) provides updated details on pygmy blue whale distribution during their northern and southern migrations, and their results showed extensive use of slope habitat off Western Australia and only minimal use of shelf habitat, compared to southern Australia where use of the continental shelf and shelf break predominates.

Pygmy blue whale calls of the SWPO subpopulation were recorded mainly around New Zealand (Taranaki) and the eastern Australian waters of the Tasman Sea (including eastern Bass Strait), with a northern migration to Tongan waters (Miller et al., 2014; Balcazar et al., 2015; Barlow et al., 2018). One 20.3-m long sexually mature female pygmy blue whale captured on 11 June 1954 at Tangalooma on Moreton Island near Brisbane was assigned as belonging to the New Zealand subpopulation (Branch et al, 2018). In the case of migrating pygmy blue whales of the SWPO subpopulation, their low latitude overwintering grounds are located near Tonga and Samoa (Balcazar et al., 2015).

General Australian Distribution

Pygmy blue whale calls of the SEIO subpopulation were recorded throughout north-western, western and southern Australian waters, with occasional calls on the east coast of Australia. Double et al. (2014) used satellite tags and showed that SEIO pygmy blue whales had consistent movements along western Australia and Indonesia, and the region south of Perth Canyon. Peak migration to low latitude overwintering grounds in the Banda and Molucca seas in the Indonesian archipelago occurred between May and July.

McCauley et al. (2018) undertook long term passive acoustic monitoring (PAM) of the calls of Antarctic blue whales and pygmy blue whales across western and southern Australia. They found that pygmy blue whale calls from the SWPO subpopulation occurred predominantly eastward of longitude 145.8° E in Bass Strait (i.e., an approximate line from Table Cape (Tasmania) to Cape Riprap (Victoria). This longitude lies about 23 km west of the project's proposed alignment. However, numerous SWPO pygmy blue whale calls have been acoustically detected within western Bass Strait (see Figure 6.27) and at the Bonney Upwelling near Portland (Balcazar et al. 2015).

Balcazar et al. (2015) analysed the distribution of pygmy blue whales of the SEIO and SWPO subpopulations in Bass Strait based on their 'Bass Strait' passive acoustic monitoring (PAM) site; however, this PAM site was located at Portland near the Bonney Upwelling and not within Bass Strait). At the Bonney Upwelling PAM site, only three out of 12,765 calls were SWPO pygmy blue whales (0.02%), while the rest were SEIO pygmy blue whales. All the calls were only detected across one day in March 2010 during an 8-month sampling period (Balcazar et al., 2015).

Overall, pygmy blue whales of the SWPO subpopulation may be found in the east of Bass Strait and farther offshore but are rarer in western and central Bass Strait. Given the large number pygmy blue whales of the SEIO subpopulation occurring at the Bonney Upwelling and the presence of the eastward flowing South Australian Current, the pygmy blue whales from the SEIO subpopulation are the most likely to occur in western and central Bass Strait, and therefore the project area.

Distribution in Victorian waters

Pygmy blue whales occur in the southwest of Victoria on the continental shelf between Cape Otway to Robe in South Australia. Sightings occur from November through to May and are associated with feeding on krill (*Nyctiphanes australis*) which form surface swarms in response to the predictable wind-forced upwelling of cool nutrient-rich water of the Bonney Upwelling (Gill, 2002).

The likelihood of occurrence of pygmy blue whales of the SEIO subpopulation in Bass Strait waters under Victorian jurisdiction is assessed as ***Possible***. Similarly, the likelihood of occurrence of New Zealand pygmy blue whales in Bass Strait waters under Victorian jurisdiction is determined to be possible.

Distribution in Tasmanian waters

The Tasmanian Natural Values Atlas (DNRE, 2022) only has entries for 'blue whales' reported as '*Balaenoptera musculus'* and does not distinguish between Antarctic and pygmy blue whales. Notwithstanding, the likelihood of occurrence of pygmy blue whales from the SEIO and SWPO subpopulations is assessed as ***Possible***.

6.3.6.2.6 Fin whale

The conservation status of the fin whale (*Balaenoptera physalis*) is classified as vulnerable and listed as migratory under the EPBC Act. The fin whale is not listed under the FFG Act but is listed and classified as vulnerable under the TSP Act. Fin whales are also listed as vulnerable on the IUCN Red List of Threatened Species (IUCN, 2021). The Threatened Species Scientific Committee (DoE, 2015e) has issued conservation advice for the fin whale.

The EPBC Act Protected Matters Reports (Attachments A, B and C) indicate that fin whale foraging, feeding or related behaviour is likely to occur in the central Bass Strait and the project area. However, fin whales are rarely seen in Australian coastal waters, but they have been observed feeding at the Bonney Upwelling (Gill, 2002).

The Society of Marine Mammalogy recognises three subspecies: the northern fin whale (*Balaenoptera physalus physalus*), found in the Northern Hemisphere, and both the southern fin whale (*Balaenoptera physalus quoyi*) and the pygmy fin whale (*Balaenoptera physalus patachonica*), found in the Southern Hemisphere (Archer et al., 2013). The pygmy fin whale was described by Clarke (2004), based on a type specimen sourced from a fin whale stranding in the River Plate estuary in Argentina; however, limited studies are available to identify and confirm the subspecies (Aulich et al., 2019). Therefore, for the purposes of this report, fin whale subspecies are ignored and the original terminology (i.e., the fin whale as *Balaenoptera physalis*) has been adopted.

The fin whale is the second largest baleen whale reaching 22 m in length and has a world-wide distribution (Bose and Lien, 1989). In general, fin whales prefer oceanic waters where their low frequency calls, which are typically between 15 and 40 Hz (Aulich et al., 2019), can readily travel great distances in oceanic environment, that propagate low frequency sounds (Bass and Clark, 2003). Fin whales' ability to communicate over long distances enables congregation in areas of high productivity (e.g., Perth Canyon and to a lesser extent the Bonney Upwelling) in an otherwise vast ocean, containing widely distributed prey (Payne and Webb, 1971).

Aulich et al. (2019) used passive acoustic monitoring as a tool to identify the migratory movements of fin whales in Australian waters, and their observations provided evidence of fin whale migration through Australian waters. The earliest arrivals of fin whales were recorded in April at Cape Leeuwin, Western Australia, which then migrated northwards along the Western Australian coast to the Perth Canyon (May to October), which likely acts as a way station for feeding. Some whales continued migrating as far north as Dampier (19° S). On Australia's east coast, at Tuncurry (100 km northeast of Newcastle, NSW), fin whale seasonal presence each year occurred later, between June and late September/October.

Fin whale call recordings near Portland (Victoria) indicated the presence of small numbers of fin whale calls in southeast Australia at the Bonney Upwelling, which might also include coastal waters to the east where sub-surface upwelling is also thought to occur (Gill, 2002) and potentially affect western waters in Bass Strait. However, analysis of the Tasmanian Natural Values Atlas (DNRE, 2020) indicates that there are no fin whale sightings in Bass Strait.

The likelihood of occurrence of fin whales in central Bass Strait and the project's PMST search areas is assessed to be ***Rare***, but they are most likely to be present during the main migratory months of June to late September/October.

6.3.6.2.7 Pygmy right whale

The pygmy right whale (*Caperea marginata*) is not listed as a threatened species but is listed as a migratory species under the EPBC Act. This species is not listed under the FFG Act or the TSP Act.

The pygmy right whale is the smallest of the baleen whales and are physically mature at around 6-m long, with maximum length of 6.5 m and maximum weight 3.430 kg. Pygmy right whales are about 2-m long at birth and wean when they are between 3- and 3.5-m long (DAWE, 2022c). The females are slightly longer than males (Kemper, 2002a).

Pygmy right whales are found in temperate and sub-Antarctic waters where surface temperatures are between 5 and 20° Celsius (Kemper at al., 2013). Pygmy right whales are thought to have a circumpolar distribution in the Southern Hemisphere, approximately between latitudes 30° S and 55° S (DAWE, 2022c).

Pygmy right whale Biologically Important Areas

The EPBC Act current list of species for which BIAs have been identified (DAWE, 2021b) does not include the pygmy right whale; therefore, there are no BIAs for this species within Bass Strait or the project's PMST search areas.

Migration

Pygmy right whales were once thought to be non-migratory (Bannister et al., 1996); however, the pygmy right whale is now listed as a migratory species under the EPBC Act. Pygmy right whale sightings in far offshore deep waters indicate that it is an oceanic species, but other sightings over the Australian continental shelf and the many live and dead strandings suggest that individuals commonly venture shoreward from the shelf edge.

Pygmy right whale distribution

Outside Bass Strait, concentrations of pygmy right whales have primarily recorded in the west near Portland, Warrnambool and Port Campbell in southwestern Victoria, which indicates that they may be associated with the Bonney Upwelling and its seasonal high abundances of euphausiids (krill) and copepods, which are their primary prey (Sekiguchi et al., 1992; Kemper, 2002b). Most sightings of pygmy right whales at Portland were sighted between June and November.

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2022) and the Victorian Biodiversity Atlas (DELWP, 2022b) reveal that most sightings of pygmy right whales are at Portland (nine records), Warrnambool (two records) and Port Campbell (two records), which indicates that the southwestern Victorian coastal waters at or near the Bonney Upwelling may be an important feeding area.

Along the Victorian coast between Cape Otway and Lakes Entrance, five confirmed sightings of pygmy right whales on with two records at Apollo Bay, two records at Phillip Island and one record at the east coast of Wilsons Promontory. There are no records of this whale species in Waratah Bay.

The likelihood of occurrence of pygmy right whales in Victorian waters of Bass Strait is assessed as ***Rare***, and potential interaction with the project's proposed nearshore and offshore marine activities in Waratah Bay and south of the Victorian and Tasmanian sea borders is not anticipated.

Distribution in Tasmanian waters

The Tasmanian Natural Values Atlas (DNRE, 2022) shows that most pygmy right whales have been observed along the east and southeast coasts of Tasmania with only four sightings in Bass Strait. Two observations were at Three Hummock Island in southwestern Bass Strait and two observations were on the west coast of Flinders Island in eastern Bass Strait. No sightings of pygmy right whales were recorded along the north coast of Tasmania.

Warneke (2001) reported that pygmy right whales have stranded in Tasmania in all months, with a peak in the period November to January (20 of 42 dated events). A major cluster of five live stranding events and 15 carcass events were recorded in Perkins Bay near Stanley Peninsula (Kemper et al., 2013). These whales are clearly at risk when venturing into areas of topographical complexity, and into shallow bays and over tidal flats subject to rapid ebb tides.

The likelihood of occurrence of pygmy right whales in the nearshore and offshore areas of Bass Strait under Tasmanian jurisdiction is assessed as ***Rare***.

6.3.6.2.8 Minke whales

There are two species and one subspecies of minke whale in Australian waters: the Antarctic minke whale (*Balaenoptera bonaerensis*) and the common minke whale (*Balaenoptera acutorostrata*), and the dwarf minke whale (*Balaenoptera acutorostrata* subsp.) that is an unnamed subspecies. The dwarf minke whale is regarded as a subspecies of the common minke whale (Ramirez-Flores et al., 2019). These three species and their likelihood of occurrence in Bass Strait and the project's PMST search areas are summarised below.

Antarctic Minke Whale

The Antarctic minke whale (*Balaenoptera bonaerensis*) or southern minke whale is listed as a migratory species under the EPBC Act. This small baleen whale is found throughout Antarctic waters and mainly in higher southern latitudes below 60° S, where it is associated with pack ice and generally found within 160 km of the edge of pack ice (ADW, 2020).

From November through January, Antarctic minke whales are found in large numbers in Antarctic waters before they disperse and migrate north to temperate and tropical waters of Australia. The Antarctic minke whale is found around Tasmania and along the east coast of Australia as far north as the Great Barrier Reef. For example, Arnold et al. (2005) observed a juvenile Antarctic whale that briefly joined with four dwarf minke whales in a reef area 56 km east of Cooktown.

Distribution in Victoria

The Atlas of Living Australia (CSIRO, 2020) shows only one record of the Antarctic minke whale Bass Strait waters with a sighting at Aireys Inlet near Lorne in Victoria (1980).

The likelihood of occurrence of Antarctic minke whales at the nearshore Victorian PMST search area (PMST, 2023; Attachment B) and adjacent offshore water of Bass Strait under Victorian jurisdiction (PMST, 2023; Attachment A) is assessed to be ***Remote***.

Distribution in Tasmania

The Tasmanian Natural Values Atlas (DNRE, 2020) has four records of the Antarctic minke whale in Tasmanian waters, with three sightings in the southeast of Tasmania (2014-2015) and one sighting in Bass Strait (1998), at Isabella Island Nature Reserve, which lies to the west of Flinders Island in Tasmania.

The likelihood of occurrence of Antarctic minke whales at the nearshore Tasmanian PMST search area (PMST, 2023; Attachment C) and adjacent offshore water of Bass Strait under Tasmanian jurisdiction (PMST, 2023; Attachment A) is assessed to be ***Remote***.

Common Minke whale

Common minke whales (*Balaenoptera acutorostrata*) are known to occur in southeast Australian waters, including Bass Strait. The PMST reports (PMST, 2023; Attachments A, B and C) indicate that the common minke whale or its habitat may occur within the three PMST search areas.

Adult minke whales reach just over 9 m in length (some females may rarely reach a maximum of 10.7 m) with a length at birth between 2.4 and 2.8 m, and a maximum body weight of about 14 t (FAO, 2021).

Distribution in Victoria

The Atlas of Living Australia (CSIRO, 2022) shows eight records of common minke whales in Bass Strait, with three recorded at Lakes Entrance (1966 – 2017), three recorded near Westernport Bay (1976 – 2016), one recorded at Port Phillip Bay entrance (1999), and one recorded near Lorne (1980).

The likelihood of occurrence of common minke whales in the nearshore Victorian PMST search area (PMST, 2023; Attachment B) and adjacent offshore waters of Bass Strait under Victorian jurisdiction (PMST, 2023; Attachment A) is assessed to be ***Possible***.

Distribution in Tasmania

The Atlas of Living Australia (CSIRO, 2022) shows three common minke whale records in northwest Tasmania with one at King Island (date not provided) and two at Anthony Beach west of the Stanley Peninsula (1999, 2008). The Tasmanian Natural Values Atlas (DNRE, 2022) shows most sightings of the common minke whale along the east and southeast coast of Tasmania with only three sightings in Bass Strait. In Bass Strait, one observation was at Three Hummock Island (1995), one offshore of Penguin Point (2014) and one offshore of Mersey Bluff near Devonport (2017).

The likelihood of occurrence of common minke whales in the nearshore Tasmanian PMST search area (PMST, 2023; Attachment C) and adjacent offshore waters of Bass Strait under Tasmanian jurisdiction (PMST, 2023; Attachment A) is assessed to be ***Possible***.

Dwarf Minke Whale

The dwarf Minke whale (*Balaenoptera acutorostrata* subsp.) is not listed as threatened or listed as migratory under the EPBC Act. There is no conservation advice for this subspecies (DCCEEW, 2022f) and this subspecies is not listed in the FFG Act or the TSP Act. The EPBC Act Protected Matters Reports (PMST, 2023; Attachments A, B and C) do not list the dwarf minke whale as present.

The dwarf minke whale is the second smallest baleen whale reaching a maximum recorded length of 7.8 m (Best, 1985). Dwarf minke whales are highly manoeuvrable. They can jump from the water like dolphins and can swim in bursts at 12 knots (23.4 m/s) but cannot maintain this speed. They have also been seen repeatedly circling a vessel that was cruising at 8.5 knots (CRC Reef, 2002).

A predictable aggregation of dwarf minke whales occurs in the northern Great Barrier Reef in June and July each year (Arnold et al., 2005), where they regularly interact with vessels and swimmers (Mangott et al., 2011). Since the mid-1990s, a tourism industry has established around this aggregation, providing swim-interactions for dive tourists, as well as a means for cetacean researchers to collect various data, including underwater images of individual whales (Curnock et al., 2013).

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2021) does not list dwarf minke whales in Australian waters, as only common minke whales are listed and mapped. Therefore, the likelihood of occurrence of this subspecies in Bass Strait waters under Victorian jurisdiction is unknown.

Distribution in Tasmania waters

The Tasmanian Natural Values Atlas (DNRE, 2022) does not list dwarf minke whales in Tasmanian waters, as only common minke whales are listed and mapped. However, a review of dwarf minke whale live strandings by Warneke (2001) indicated the presence and frequency of occurrence of these whales in Tasmanian waters.

Warneke (2001) found that dwarf minke strandings in Tasmania had a seasonal distribution, occurring mostly between May and November, with 80% of the strandings occurring between June and October, which represents a pattern that corresponds with the known migration schedule of this species that overwinters in temperate to tropical waters.

The likelihood of occurrence of dwarf minke whales in the nearshore Tasmanian PMST search area (PMST, 2023; Attachment C) and adjacent offshore waters of Bass Strait under Tasmanian jurisdiction is assessed to be ***Rare***, with the most likely period of their presence anticipated to be between June and October each year.

6.3.6.3 Toothed whales (*Odontoceti*)

6.3.6.3.1 Killer whale

The killer whale (*Orcinus orca*), also known as an orca, is not listed as a threatened species but is listed as a migratory species under the EPBC Act. This species is not listed under the Victorian FFG Act or the TSP Act. The EPBC Act Protected Matters reports (PMST, 2023: Attachment A: Offshore Bass Strait, Attachment B: Nearshore Victoria and Attachment C: Nearshore Tasmania) indicate that the killer whale or its habitat is likely to occur in Bass Strait and the project's PMST search areas.

The killer whale is a cosmopolitan species, often grouped in pods of three to five individuals (Travers et al., 2018). Unlike some other migratory cetacean species, killer whales do not migrate to specific calving or breeding regions distant from their feeding grounds (Wellard, 2018). Notwithstanding, the EPBC Act list the killer whale as a migratory.

In Antarctic waters, five ecotypes have been described, each displaying distinct differences in morphological features, foraging behaviours, habitat and diet preferences, and genetic structure (Wellard et al., 2013). One ecotype is the Antarctic Type C killer whale, which has not been recorded previously in Bass Strait until a pod of orcas was sighted on 14 July 2022 offshore of Kilcunda on the Gippsland Coast by Captain John Dickie of Wildlife Coast Cruises (Thomas and Fistric, 2022). Mr. David Donnelly of the Dolphin Research Institute noted that the Type C orcas are the smallest orcas in world that ate fish but no other marine mammals (Thomas and Fistric, 2022).

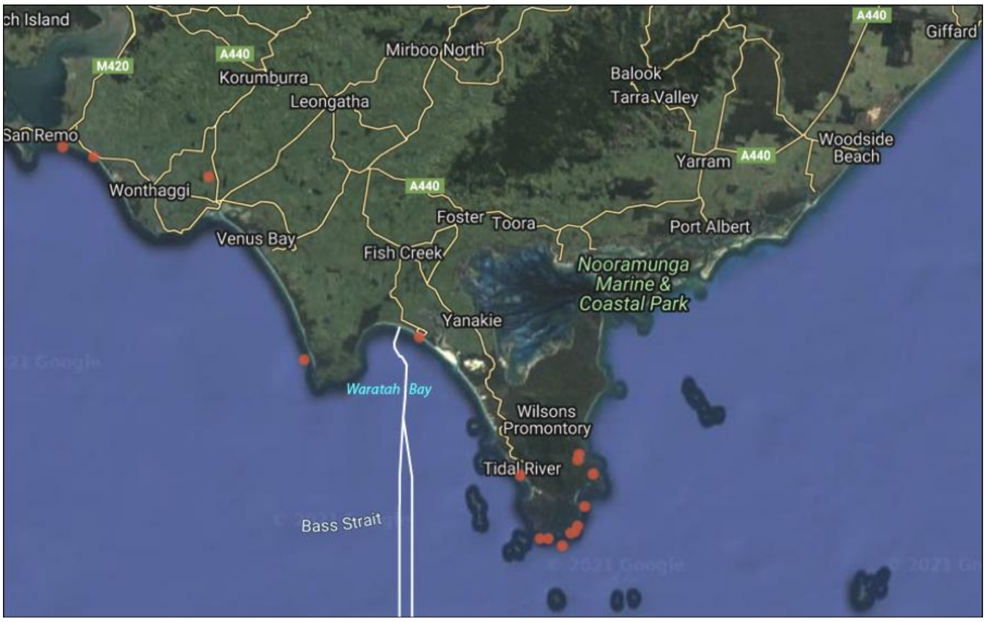
Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2022) and Victorian Biodiversity Atlas (DELWP, 2022b) show a total of 65 sightings of killer whales in Victorian coastal and offshore waters.

Figure 6.28 shows the distribution of 16 killer whale sighting in southeast Victoria around Wilsons Promontory including Waratah Bay, which is the location of the project's proposed landfall at Waratah Bay.

The cluster of killer whale sightings around Wilsons Promontory may be expected given that the coastal area and nearby islands provide breeding habitats, haul-outs and foraging areas for key prey items of killer whales such as Australian fur seals (*Arctocephalus pusillus doriferus*) and Little Penguins (*Eudyptula minor*).

The likelihood of occurrence of killer whales in the Victorian PMST search area is assessed as ***Likely***.



Source: Atlas of Living Australia (CSIRO, 2022a). White lines denote the project's proposed alignment.

Figure 6.28: Distribution of killer whale sightings in Bass Strait (Victorian waters)

Distribution in Tasmanian waters

The Tasmanian Natural Values Atlas (DNRE, 2020) shows 611 records of killer whales around Tasmania, mostly along the east and southeast coast but also along the north coast.

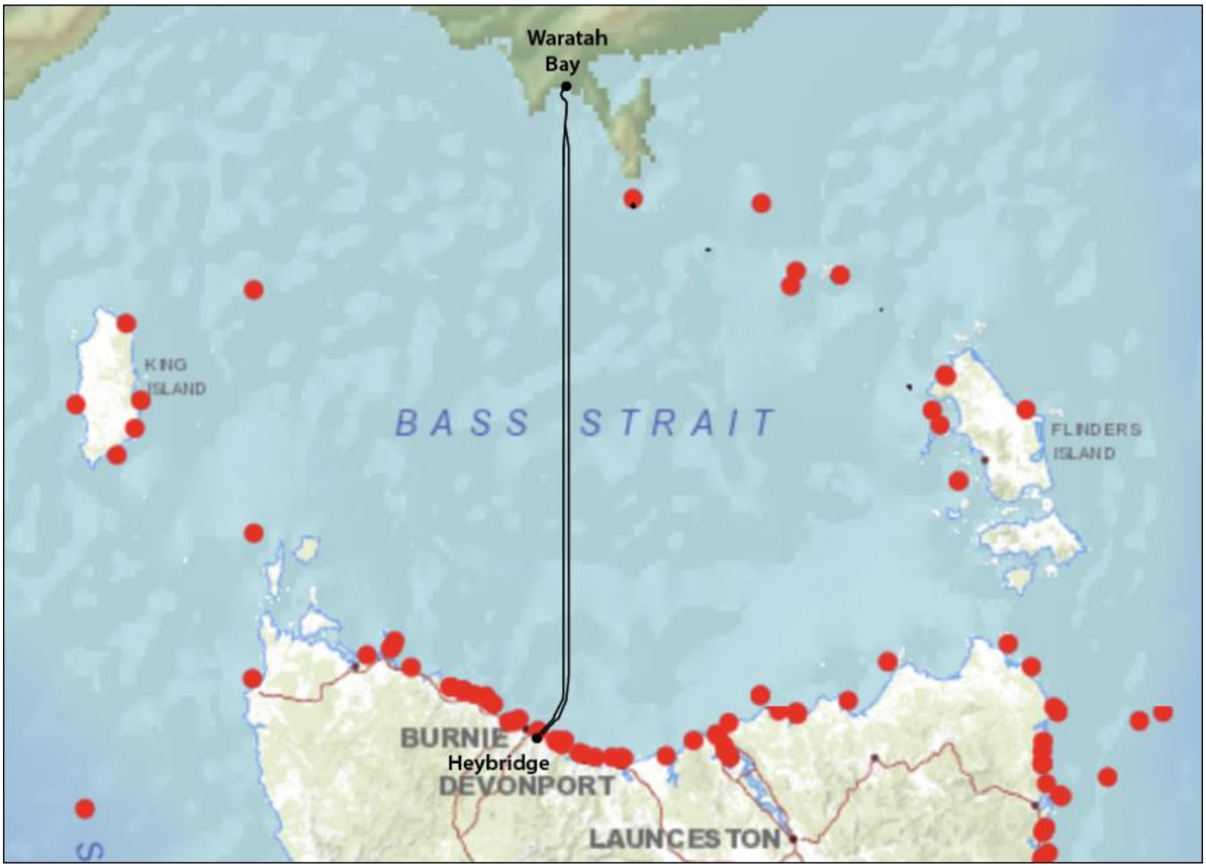
Figure 6.29 shows the distribution of around 55 killer whales in Bass Strait waters under Tasmanian jurisdiction. A total of 49 sightings were made along the north coast of Tasmania including nine sightings between Burnie and Penguin, which straddle the proposed Heybridge landfall of the project.

The likelihood of occurrence of killer whales in southwestern Bass Strait and the project's PMST search areas is assessed as ***Likely***.

6.3.6.3.2 False killer whale

The false killer whale (*Pseudorca crassidens*) is a listed marine species and cetacean under the EPBC Act but is not listed in the FFG Act Threatened List (DELWP, 2022b) or the TSP Act.

Adult males reach lengths of up to 6 m, while females can reach up to 5 m in length (Baird, 2002; Stacey et al., 1994). The false killer whale is a highly social species with an extensive and wide distribution within tropical and warm temperate waters.



Source: Tasmanian Natural Values Atlas (DNRE, 2022).

Figure 6.29: Distribution of killer whale sightings in Bass Strait (Tasmanian waters)

The false killer whale is typically found in areas of deep-water and in the open ocean away from land. However, they are commonly found on the continental shelf where they are sometimes involved in mass stranding that can wipe out whole schools involving hundreds of individuals. Their tendency to mass strand seems to support the existence of strong social affiliations within and between groups (Australian Museum, 2019a). False killer whales are efficient pack hunters, and their diet includes squid and a large range of fish species.

Distribution in Victoria

The Atlas of Living Australia (CSIRO, 2022) records 10 sightings of false killer whales along the Victorian coastline with four sightings at Corner Inlet and east of Wilsons Promontory, but none in Waratah Bay or the west coast of Wilson Promontory.

The likelihood of occurrence false killer whales within Waratah Bay and the project's nearshore PMST search area for Victoria (PMST, 2023; Attachment B) and adjoining offshore Bass Strait waters under Victorian jurisdiction is assessed to be ***Rare***.

Distribution in Tasmania

The Tasmanian Natural Values Atlas (DNRE, 2020) shows 11 records of false killer whales around Tasmania with only two sightings on the north coast: one at Three Hummock Island and one a Sawyers Bay to the east of the Stanley Peninsula (see Figure 6.29).

The Tasmanian stranding records for false killer whales (e.g., Guiler, 1978) includes several mass strandings near the Stanley Peninsula (100 individuals on 30 May 1936), Perkins Island (43 individuals on 18 June 1974), and Seal Bay, on King Island (50 individuals in September 1958). Warneke (2001) reviewed false killer whale strandings and noted a cluster of five mass strandings around the region of Stanley Peninsula and sandy islands to the west (e.g., Perkins Island) and noted that all the mass strandings occurred between May and July.

The likelihood of occurrence of false killer whales in central Bass Strait or along the central north coast of Tasmania and within the project's PMST report search areas for central Bass Strait (PMST, 2023; Attachment A) and nearshore Tasmania (PMST, 2023; Attachment C) is assessed as ***Rare***.

6.3.6.3.3 Short-finned pilot whale

The short-finned pilot whale (*Globicephala macrorhynchus*) is a widespread and common species that occurs in tropical and warm-temperate waters world-wide (between 41° S and 45° N), and their distribution extends into cold-temperate waters in the North Pacific (Bernard and Reilly, 1999).

The short-finned pilot whale (*Globicephala macrorhynchus*) is a listed marine species under the EPBC Act. This species is not listed for the nearshore Victorian PMST search area (PMST, 2023; Attachment B) but this species or its habitat may occur within offshore Bass Strait (PMST, 2023; Attachment A) and the nearshore Tasmanian PMST search area (PMST, 2023; Attachment C).

In Australia, short-finned pilot whales occur in tropical (22 to 32°C) to temperate (10 to 22 °C) oceanic waters and coastal seas (Ross, 2006). There appear to be no BIAs for this species such as calving and foraging areas, or other key localities where short-finned pilot whales are commonly observed (Bannister et al., 1996). Short-finned pilot whales are socially cohesive, forming small groups of between 10 to 30 individuals, but may also be seen in groups of several hundred animals and often accompanied by dolphins, especially bottlenose dolphins (Bannister et al. 1996). In these mixed groups, male short-finned pilot whales and the dolphins tend to remain at the perimeter of the herd, and sub-adult male short-finned pilot whales appear to protect creches of young whales (Bannister et al. 1996).

Short-finned pilot whales appear to be generally nomadic, with no known migration patterns. However, the SPRAT (Species Profile and Threats Database) profile for this species (DoAWE, 2020b) indicates that while short-finned pilot whales are usually found offshore, the inshore occurrence of spawning squid results in pronounced inshore-offshore movements. These inshore-offshore movements are probably determined by the timing of squid spawning, as outside the squid season short-finned pilot whales are usually found offshore (Culik, 2004). Short-finned pilot whales feed mainly on squid, cuttlefish, octopus, and some fish.

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 202) records four sightings of short-finned pilot whales in Victorian waters including one recorded in Corner Inlet, which lies overland to the east of Waratah Bay.

The likelihood of occurrence of short-finned pilot whales in the Victorian nearshore and offshore waters of Bass Strait in the vicinity of the project is assessed as ***Rare***.

Distribution in Tasmanian waters

The Atlas of Living Australia (CSIRO, 2020) revealed only one sighting record of a short-finned pilot whale in Tasmania that was far offshore (150 km) to the south of Tasmania.

The likelihood of occurrence of short-finned pilot whales in Bass Strait and the project's three PMST search areas is assessed as ***Remote***.

6.3.6.3.4 Dusky dolphin

The conservation status of the dusky dolphin (*Lagenorhynchus obscurus*) is classified threatened and is also listed as migratory and as a listed marine species under the EPBC Act. This species is not listed as threatened under the Victorian FFG Act (DEECA, 2023b) or the Tasmanian TSP Act (DNRE, 2023a). The EPBC Act PMST reports (Attachments A, B and C) indicate that the dusky dolphin or its habitat may occur in the project's PMST search areas.

In general, where dusky dolphins are known to be present in coastal areas, they have been observed move offshore in the late afternoon to primarily feed on deep-water mesopelagic fishes and squid within the deep scattering layer that rises vertically to shallower water during night-time hours (Benoit-Bird et al., 2004). In the following day, dusky dolphins reform groups in the early morning as overnight deep-water foraging individuals move back to shallow, nearshore waters. A period of low activity then occurs from late morning to midday, as indicated by elevated levels of rest (Lundquist et al. 2012). During the day, small travelling groups of dusky dolphins have been observed to forage for small schooling fish (e.g., baitfish such as sardines and anchovies).

Distribution in Victoria

The Atlas of Living Australia (CSIRO, 2022) and Victorian Biodiversity Atlas (DELWP, 2022b) do not list the presence of dusky dolphins in Bass Strait.

The likelihood of occurrence of dusky dolphins in Bass Strait waters under Victorian jurisdiction and the project's offshore PMST search area (PMST, 2023; Attachment A) and nearshore PMST search area (PMST, 2023; Attachment B) is assessed as ***Rare***.

Distribution in Tasmania

The Tasmanian Natural Values Atlas (DNRE, 2022) shows 16 records, with most sightings in southeast Tasmania. Only one observation has been made in Bass Strait to the west of Cape Barren Island, with no sightings along the north coast of Tasmania or central Bass Strait including the project area.

The likelihood of occurrence dusky dolphins within central Bass Strait and the project's Tasmanian PMST search area (PMST, 2023; Attachment C) is assessed as ***Rare***.

6.3.6.3.5 Common dolphin

The EPBC Act categories the common dolphin (*Delphinus delphis*) as a listed marine species but is not listed under either the FFG Act or the TSP Act. The PMST reports (PMST, 2023; Attachments A, B, and C) and Table 6.13 indicate that the common dolphin or its habitat may occur in the project's PMST search areas.

The common dolphin in Australian waters has been confirmed by Mason et al. (2016) to be the short-beaked common dolphin, while the long-beaked common dolphin (*Delphinus capensis*) is found mostly in the northern Pacific Ocean in the Northern Hemisphere, although a subspecies of the long-beaked dolphin (*D. c. tropicalis*) is found in the Southern Hemisphere, with populations along the east coast of South America and west coast of Africa, but not within Australia.

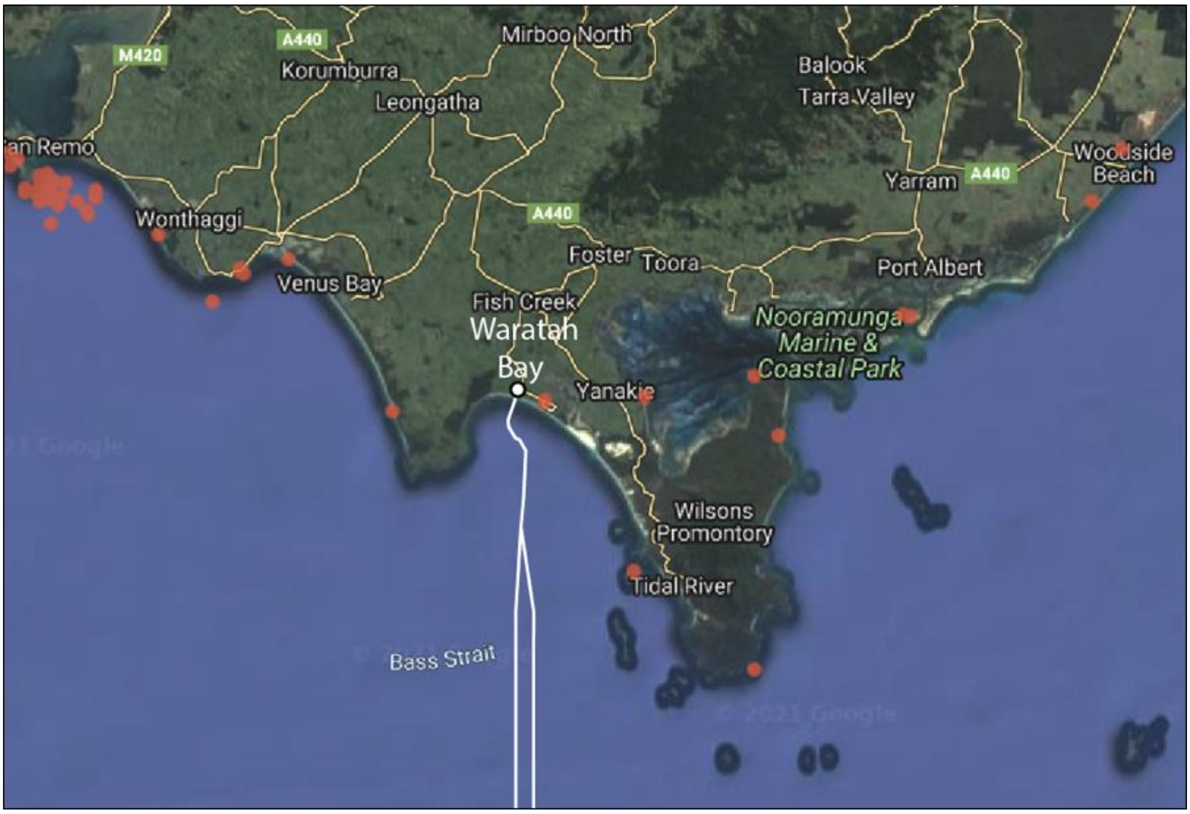
The common dolphin is a highly social dolphin that is often found in groups ranging from less than 30 to hundreds or thousands of individuals (Perrin, 2009). Common dolphins are often found in association with schools of pilot whales (*Globicephala* spp.) and other dolphins such as dusky dolphins (*Lagenorhynchus obscurus*) and Risso's dolphins (*Grampus griseus*) and have also been observed 'bow-riding' in front of large baleen whales as well as vessels (Evans, 2003).

Common dolphins are mainly an oceanic species but are known to strand in nearshore waters of Tasmania, and mass strandings are common on the central east coast and south coast (Storm Bay) regions (Warneke, 2001). One potential reason for mass stranding of common dolphins is their pursuit of prey into shallow water (Simpson, 1968).

The habitats of common dolphins include the open ocean environment (Jefferson et al., 2011) or continental shelf (neritic) coastal waters (Bilgmann et al., 2008) and are often found in regions with high productivity where they feed on bait fish species. The main prey of the common dolphins are squid (e.g., Gould's squid and southern calamari) and small school fish such as sardines (*Sardinops sagax*) and anchovies (*Engraulis australis*), which are seasonally abundant around Australia's shelf waters, including Bass Strait (Australian Museum, 2019b).

Distribution in Victorian waters

Figure 6.30 shows the distribution of common dolphin observations in Bass Strait waters under Victorian jurisdiction.



Source: Atlas of Living Australia (CSIRO, 2022). White lines denote the project's proposed alignment.

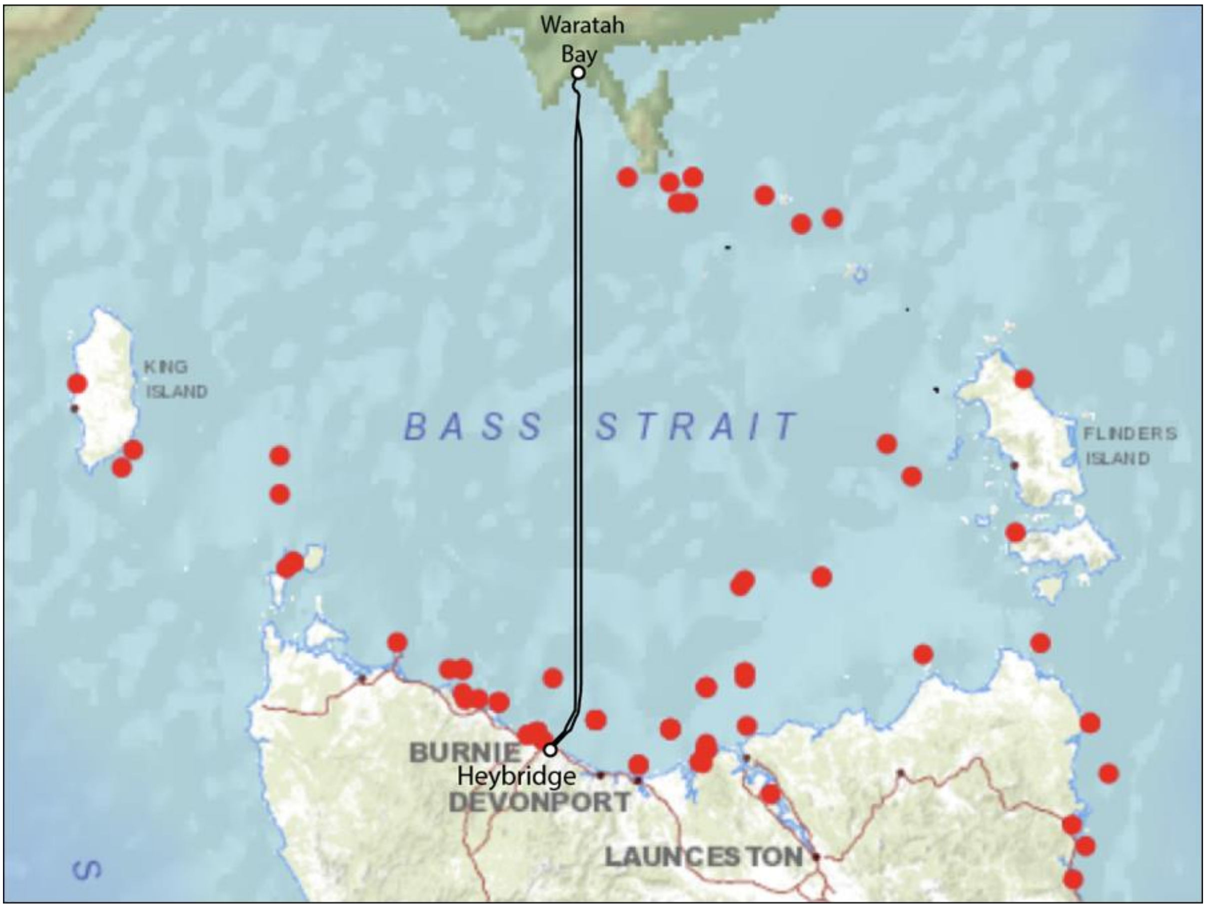
Figure 6.30: Distribution of common dolphin sightings in Bass Strait (Victorian waters)

In Figure 6.30, about 38 common dolphin records are shown along the southeast coast of Victoria, with six sightings around Wilsons Promontory and one sighting in Waratah Bay.

The likelihood of occurrence of common dolphins in the nearshore and offshore waters of Bass Strait under Victorian jurisdiction including the Victorian PMST search area (PMST, 2023; Attachment B), is assessed as ***Very likely***.

Distribution in Tasmanian waters

The Tasmanian Natural Values Atlas (DNRE, 2020) indicates a total of 42 confirmed sightings of common dolphins in Bass Strait waters under Tasmanian jurisdiction, and their distribution is shown in Figure 6.31. About 25 of these sightings are along the Tasmanian northern coastline. Five sightings are in the vicinity (25 km distance) of the project's proposed landfall at Heybridge.



Source: DNRE (2022).

Figure 6.31: Distribution of common dolphin sightings in Bass Strait (Tasmanian waters)

Based on the distribution of common dolphin sightings in Figure 6.31, the likelihood of occurrence of common dolphins in offshore Bass Strait (PMST, 2023; Attachment A) under Tasmanian jurisdiction and the nearshore Tasmanian PMST search area (PMST, 2023; Attachment C) is assessed as ***Very likely***.

6.3.6.3.6 Risso's dolphin

Risso's dolphin (*Grampus griseus*) is a listed marine species under the EPBC Act but is not listed under either the FFG Act or the TSP Act. The EPBC Act PMST reports (PMST, 2023; Attachments A, B, and C) for offshore Bass Strait and the Victorian and Tasmanian nearshores indicates that this species or its habitat may occur in the project's PMST search areas.

Risso's dolphin is a highly social cetacean and usually forms groups varying from 10 to 50 individuals, with an average of 30 individuals (Animalia, 2018). The global range of this dolphin species is not well known, and there has been confusion in the literature as to whether the species has a broad, circum-global range or only occurs along continental margins (Jefferson et al., 2014). Risso's dolphins are sometimes found in association with pilot whales and other dolphins such as bottlenose dolphins (Sibyline Oceans, 2014) and common dolphins (Evans, 1994).

Risso's dolphins consume large amounts of fish, krill, crustaceans, and cephalopods. When diving, Risso's dolphins normally remain submerged for 1 to 2 minutes at a time. However, they are capable of diving to a depth of more than 300 m, staying there for up to 30 minutes, while hunting deep-water cephalopods and fish, before they come to the surface (Animalia, 2018).

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2022a) indicates 10 sightings of Risso's dolphins in Bass Strait waters under Victorian jurisdiction, with two recorded at Zeally Bay near Torquay, four recorded within Nooramunga Marine and Coastal Park, and four recorded at the Gippsland Lakes Coastal Park. No sightings were recorded for Waratah Bay or the west coast of Wilsons Promontory and its associated islands.

The likelihood of occurrence of Risso's dolphins in the Victorian nearshore PMST search area (PMST, 2023; Attachment B) or offshore waters under Victorian jurisdiction (PMST, 2023; Attachment A) is assessed as ***Rare***.

Distribution in Tasmanian waters

The Tasmania Natural Values Atlas (DNRE, 2022) shows three sightings with two recorded in southern Tasmania (one at Bruny Island and one 90 km offshore) and one recorded at Lillico Beach near Devonport in Bass Strait. The Lillico Beach Risso's dolphin site is approximately 26 km to the east of the project's proposed alignment and indicates that Risso's dolphins may be found occasionally along the northern coast of Tasmania.

Between November 2014 and November 2015, there have been 12 stranding events, involving 13 animals on Tasmania's shores (Tasmanian Parks and Wildlife Service, 2015). The observed strandings included one stranding at Cooee Beach, near Burnie. At about the same time, another eight Risso's dolphins were stranded between Gippsland, in Victoria, through to northern New South Wales (Sibyline Oceans, 2014). The reason for Risso's dolphins moving into cooler Tasmanian waters is not known; however, in recent decades, the East Australian Current has extended further southwards, which may allow a southward extension of this species.

The likelihood of occurrence of Risso's dolphins in the Tasmanian nearshore PMST search area (PMST, 2023; Attachment C) or offshore Bass Strait waters under Tasmanian jurisdiction (PMST, 2023; Attachment A) is assessed as ***Rare***.

6.3.6.3.7 Indo-Pacific bottlenose dolphin

The Indo-Pacific bottlenose dolphin (*Tursiops aduncus*) is listed under 'Whales and Cetaceans' under the EPBC Act but is not listed in the FFG Act or the TSP Act. This species or its habitat is likely to occur in the Bass Strait offshore PMST search area (PMST, 2023; Attachment A) and nearshore Victorian PMST search area (PMST, 2023; Attachment B) but is not listed as likely to be present in the Tasmanian PMST search area (PMST, 2023; Attachment C).

Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) prefer continental shelf waters near shore and in areas with rocky and coral reefs, sandy bottom, or sea grass bed (Yang and Chu, 2009). In southern Australia, this species appears to prefer shallow coastal waters including in and around estuaries (WDC, 2022). One particular group of this species occupies the heavily urbanised Port River in Adelaide and Barker Inlet areas which was designated as a sanctuary in 2005 under the South Australian State Government's *Adelaide Dolphin Sanctuary Act 2005* (SA). Most groups of Indo-Pacific bottlenose dolphins include five to 15 individuals, but sometimes numbering in their dozens (WDC, 2022).

The Indo-Pacific bottlenose dolphin is generally smaller than the common bottlenose dolphin (*Tursiops truncatus*), reaching a maximum total length of about 2.7 m and about 200 kg in weight (Yang and Chu, 2009).

Distribution in Victoria

The Atlas of Living Australia (CSIRO, 2022) gives records of six Indo-Pacific bottlenose dolphin sightings with three sighted within Port Phillip Bay, one sighting near Anglesea southwest of Melbourne and two sightings at the Victoria-New South Wales border.

The likelihood of occurrence of Indo-Pacific bottlenose dolphins within the Bass Strait offshore PMST search area (PMST, 2023; Attachment A) and the nearshore PMST search area of Victoria (PMST, 2023; Attachment B) is assessed as ***Rare***.

Distribution in Tasmania

The Natural Values Atlas (DNRE, 2022) does not record any Indo-Pacific bottlenose dolphins in Tasmanian waters. Therefore, the likelihood occurrence of Indo-Pacific bottlenose dolphins within the offshore Bass Strait waters under Tasmanian jurisdiction (PMST, 2023; Attachment A) and nearshore waters (PMST, 2023; Attachment C) is assessed as ***Remote***.

6.3.6.3.8 Common bottlenose dolphin

The common bottlenose dolphin (*Tursiops truncatus)* is a listed marine species under the EPBC Act. This species is not listed in the FFG Act or the TSP Act. The EPBC Act Protected Matters report (PMST, 2023; Attachment A) states that this or its habitat may occur within project's PMST search areas of offshore Bass Strait (PMST, 2023; Attachment A), nearshore Victoria (PMST, 2023; Attachment B) and nearshore Tasmania (PMST, 2023; Attachment C).

Common bottlenose dolphins occur mainly in tropical and subtropical Australian waters and are usually found in coastal and offshore shallow areas. They are commonly observed in groups or pods, containing as few as two or three individuals to more than a thousand. There are two forms of bottlenose dolphins: a 'nearshore and an 'offshore' form (Australian Museum, 2019c).

Bottlenose dolphins feed on a wide variety of prey such as various species of fish, squid and sometimes crustaceans, depending on the habitat they occupy. The nearshore form feeds mainly on benthic fish, while the offshore form feeds mainly on schooling fish (IWC, 2018b).

Distribution in Victoria

The Talas of Living Australia (CSIRO, 2022) shows 13 sightings of common bottlenose dolphins were recorded around Wilsons Promontory, with six sightings to the west of this promontory including one sighting in Waratah Bay. Figure 6.32 shows the distribution of common bottlenose sightings in southeast Victoria.

Source: Atlas of Living Australia (CSIRO, 2022). Black lines denote the project's proposed alignment.

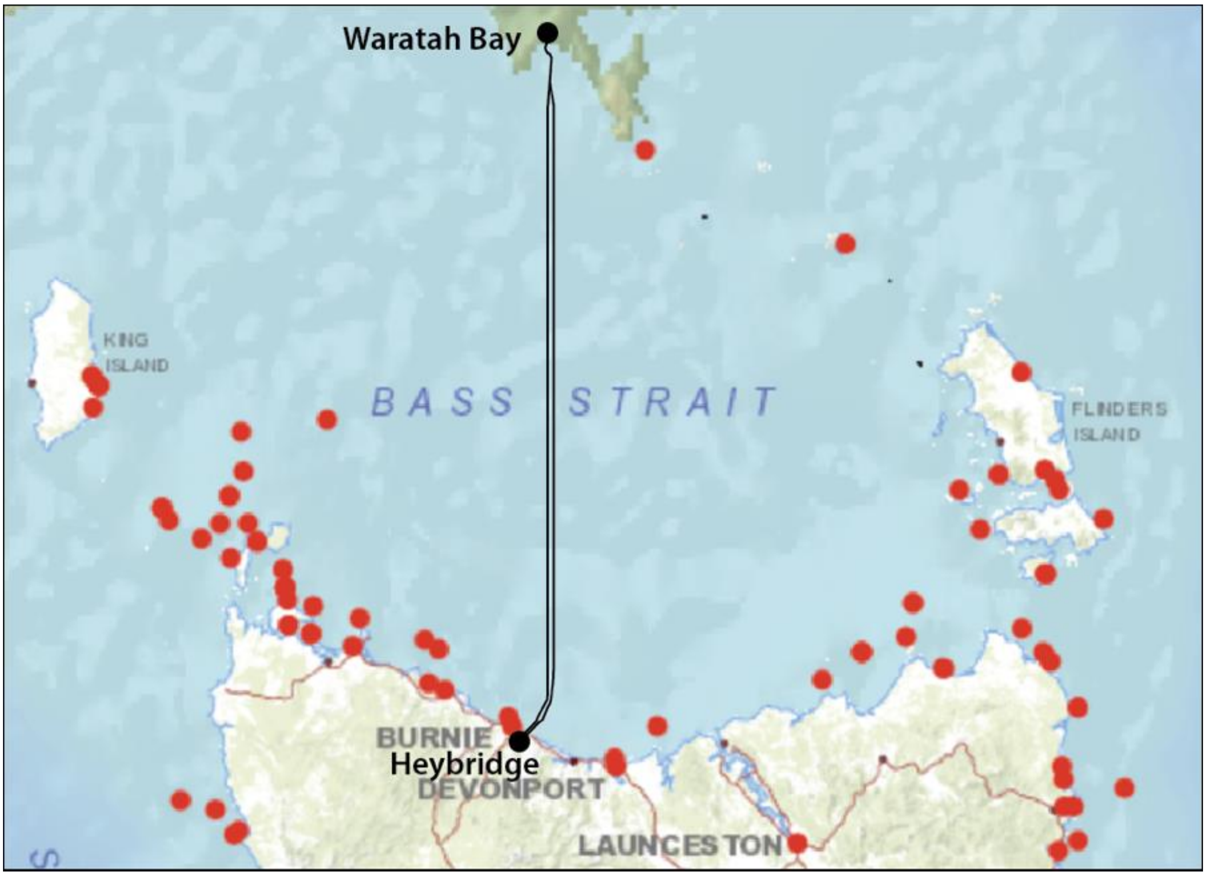
Figure 6.32: Distribution of Victorian common bottlenose dolphin sightings in Bass Strait

The likelihood of occurrence of common bottlenose dolphins in the EPBC Act PMST search areas of nearshore Victoria (PMST, 2023; Attachment B) and adjacent offshore Bass Strait within Victorian jurisdiction (PMST, 2023; Attachment A) is assessed as ***Very likely***.

Distribution in Tasmania

The Tasmanian Natural Values Atlas (DNRE, 2020) records 251 sightings of common bottlenose dolphins in Tasmanian waters with most sightings recorded along the east and southeast coastline of Tasmania. Around 45 sightings were recorded in Bass Strait waters under Tasmanian jurisdiction, including four common bottlenose dolphin sightings that were recorded in the nearshore between Burnie and Devonport. Figure 6.33 shows the distribution of Tasmanian common bottlenose dolphin sightings in Bass Strait.

The likelihood of occurrence of common bottlenose dolphins in the EPBC Act PMST search areas of nearshore Tasmania (PMST, 2023; Attachment C) and adjacent offshore Bass Strait within Tasmanian jurisdiction (PMST, 2023; Attachment A) is assessed as ***Very likely***.



Source: Tasmanian Natural Values Atlas (DNRE, 2022).

Figure 6.33: Distribution of Tasmanian common bottlenose dolphin sightings in Bass Strait

6.3.6.3.9 Burrunan dolphin

The Burrunan dolphin (*Tursiops australis*) is yet to be listed or classified under the EPBC Act or IUCN Red List, due to data deficiencies. However, it is classified as critically endangered under the updated FFG Act Threatened List – August 2021 (DELWP, 2021).

The Burrunan dolphin is endemic to a small geographic region of southern and south-eastern Australia, with only two small resident populations known and in proximity to major urban and agricultural centres are known, giving them a high conservation value and making them susceptible to numerous anthropogenic threats (Charlton-Robb et al., 2011).

Distribution in Victoria

The two resident Burrunan dolphin populations include one in Port Phillip Bay and the other in the Gippsland Lakes. The Port Phillip Bay is estimated at 120 individuals (Charlton-Robb et al., 2011), while the Gippsland Lakes population is estimated at 65 individuals (Charlton-Robb et al., 2015). The species is vulnerable to extinction due to several different factors relating to exposure to threats, data deficiency, low genetic diversity and low population sizes, high mercury levels, and increased risk from pathogens and contaminants (Puszka et al., 2021).

The two endemic populations in Port Phillip Bay and the Gippsland Lakes are isolated, which indicates that the Burrunan dolphins do not intermingle according to the genomic studies of Charlton-Robb et al, (2015) and are therefore not likely to pass along the south coast of Victoria between Port Phillip Bay and the Gippsland Lakes. However, two of the Burrunan dolphins sampled by Charlton-Robb et al. (2015) were located off Cotters Beach on the west coast of Wilsons Promontory, which is 11 km from the project's nearest proposed alignment. The close genetic similarities of these two dolphins with those of the Gippsland Lakes population, suggests that they were from the latter's population and indicates that there are coastal movements of Burrunan dolphins between Wilsons Promontory and the Gippsland Lakes.

The close genetic similarities of the Gippsland Lakes population and that of the southeast Tasmanian population suggests intermingling. Recent surveys have indicated that male Burrunan dolphins migrate between the Gippsland Lakes and southeast Tasmania (Freycinet Peninsula). These males breed with the Tasmanian females during the summer and then breed with the Gippsland Lakes females during the winter (Asher, 2017). The migration route from the Gippsland Lakes across eastern Bass Strait and along the east coast of Tasmania is located 150 km from the nearest project alignment in central Bass Strait.

The likelihood of occurrence of critically endangered Burrunan dolphins in the offshore waters of Bass Strait under Victorian jurisdiction (PMST, 2023; Attachment A) or the nearshore Victoria PMST search area (PMST, 2023; Attachment B) is assessed as ***Rare***, given only the two known occurrences near Cotters Beach on the west coast of Wilsons Promontory.

6.3.6.3.10 Sperm whales

The sperm whale (*Physeter macrocephalus*) is listed as vulnerable and migratory under the EPBC Act and listed as endangered under the TSP Act. The EPBC Act PMST results (PMST, 2023; Attachments A, B and C) do not include the sperm whale as present in the project's PMST search areas. The distribution map in the SPRAT profile for the sperm whale (DCCEEW, 2022c) does not include Bass Strait but does include the western and eastern edges of Bass Strait overlying the edge of the continental shelf where the deeper water and forms suitable foraging habitat for diving sperm whales.

In general, sperm whales tend to concentrate where the shelf slope is steep or dissected by submarine canyons, where the upwellings of nutrient-rich waters occur, which support concentrations of the whales' favoured prey of deep-sea cephalopods such as squids (Warneke, 2001).

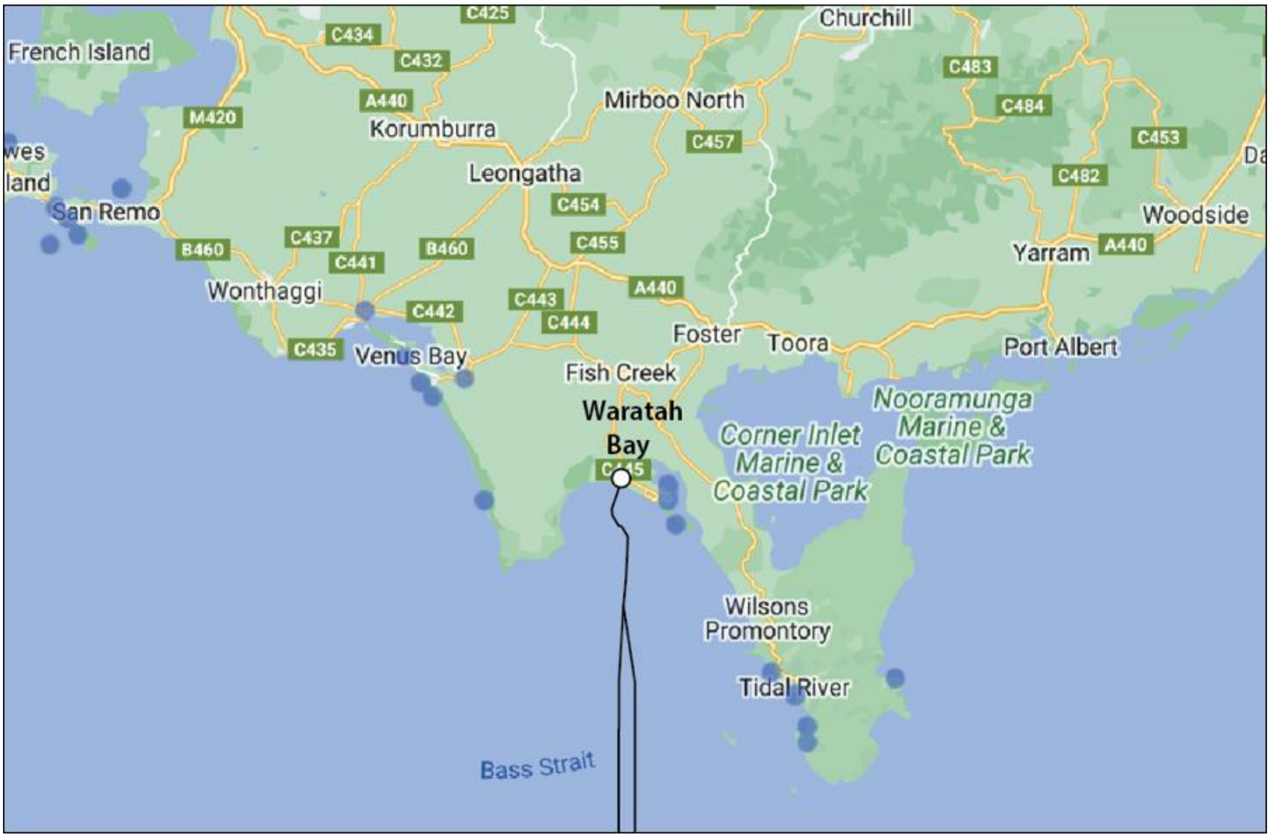
The sperm whale's diet consists almost exclusively of cephalopods (squid and octopus), especially deep-water and ocean bed species, and for this prey, sperm whales will sometimes make deep prolonged dives. They have been recorded at depths exceeding 1 km and can stay submerged for up to 90 minutes (Australian Museum, 2019d).

Migration

Sperm whales migrate seasonally between warmer and colder seas, and in the Southern Hemisphere, sperm whales breed in temperate and tropical regions from July through March, with a peak between September and December, and their calving season falls between November and March (Rice, 1989).

Distribution in Victorian waters

Figure 6.34 shows the distribution of sperm whales in southeast Victorian waters of Bass Strait with 12 sightings around Wilsons Promontory including five sightings in Waratah Bay near Shallow Inlet. The likelihood of occurrence of sperm whales in the nearshore Victorian PMST search area (PMST, 2023; Attachment B) and adjacent offshore waters of Bass Strait (PMST, 2023; Attachment A), under Victorian jurisdiction, is assessed as ***Likely***, as sperm whales have occurred in the past and are anticipated to occur again.



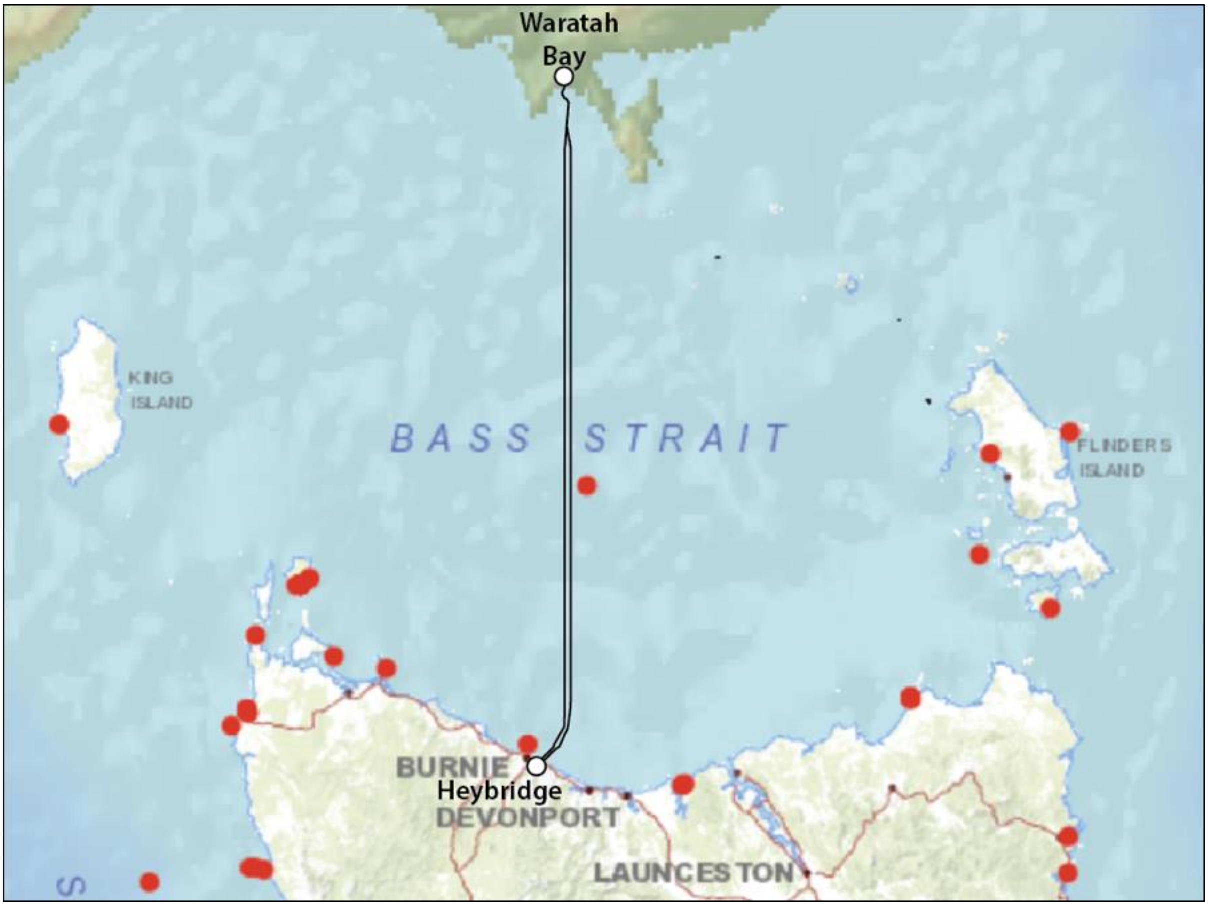
Source: Atlas of Living Australia (CSIRO, 2022). Black lines denote the project's proposed alignment.

Figure 6.34: Distribution of sperm whale sightings in southeast Victoria

Distribution in Tasmanian Waters

The Tasmanian Natural Values Atlas (DNRE, 2022) shows 301 records of sperm whales in Tasmanian waters with 14 sightings in Bass Strait including one sighting between Burnie and Devonport. Most sperm whale sightings are along the west and east coasts of Tasmania, especially over the continental shelf and slope, where the whales deep dive for prey.

Figure 6.35 shows the distributions of sperm whale sightings in Bass Strait waters under Tasmanian jurisdiction.



Source: Tasmanian Natural Values Atlas (DNRE, 2020). Black lines denote the project's proposed alignment.

Figure 6.35: Distribution of sperm whale sightings in Bass Strait

Sperm whale strandings in Tasmania

Warneke (2001) reported 51 single and 16 mass strandings in Tasmania. Mass strandings of sperm whales in Tasmania are highly clustered, with six events in the vicinity of Stanley. For example, 37 sperm whales mass stranded at Perkins Island in February 1911, and 32 sperm whales mass stranded at the Stanley Peninsula in March 1971 (Guiler, 1978).

The Stanley Peninsula is a typical example of a spit-bay or headland-bay configuration with shallow sandy bays either side of its isthmus (Perkins Bay to the west and Sawyers Bay to the east) and within which some species of toothed whales (e.g., sperm whales and long-finned pilot whales) are known to regularly mass strand. In general, mass strandings at spit-bay or headland-bay configurations are attributed to shallow bathymetry (slopes less than 1°), sandy seabeds, and fast-flowing ebb tides (Hamilton and Lindsay, 2014; Hamilton, 2017).

Overall, based on sperm whale sightings and stranding records, the likelihood of occurrence of sperm whales in central Bass Strait and the project's PMST search areas is assessed as between ***Rare*** and ***Likely***, given their preferred offshore deep-water habitat overlying the continental shelf and submarine canyons.

6.3.6.3.11 Long-finned Pilot Whales

The long-finned pilot whale (*Globicephala melas*) is not listed as threatened or migratory under the EPBC Act; however, all cetaceans are protected under this act. The PMST search reports (Attachments A, B and C) do not list the presence of long-finned pilot whales in the PMST search areas.

In the Southern Hemisphere, long-finned pilot whales are recognised as the subspecies *Globicephala melas edwardii;* whereas in the Northern Hemisphere the subspecies is *Globicephala melas melas* (Bannister et al. 1996; Kraft et al., 2020).

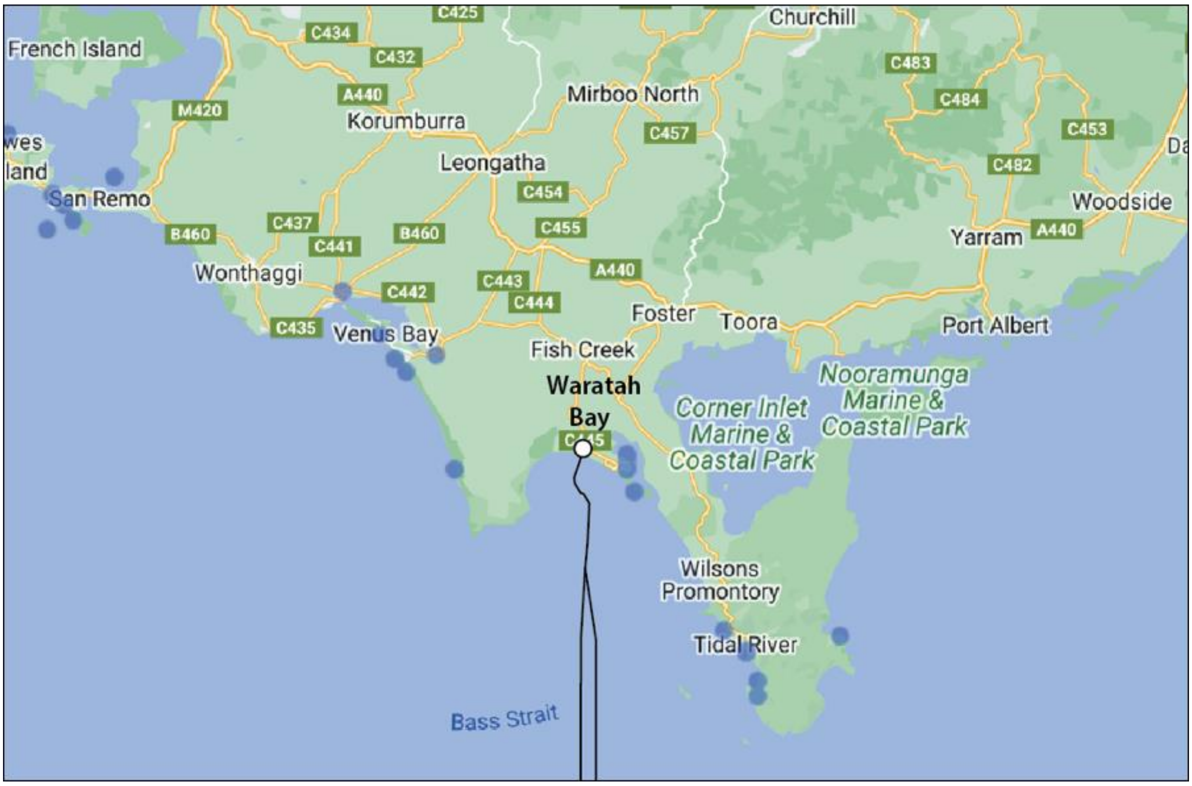
The long-finned pilot whale is a large species of oceanic dolphin that is widely distributed and apparently common, but no population assessments are available for Southern Hemisphere populations (Ross, 2006). Long-finned pilot whales are very social in nature and are usually seen in groups, which range in size from a couple of individuals to aggregations of over a thousand; however, groups of 20 to 150 individuals are more commonly observed (Bloch et al., 1993). Studies have shown that this species often forms small, long-term social units made up of around 8 to 12 individuals (Ottensmeyer and Whitehead, 2003).

The maximum recorded length of the long-finned pilot whale is 7.2 m for males (Tasmania) and 6.0 m for females, both measured in Tasmania (Bannister et al., 1996). The maximum weight is approximately 3 tonnes in males and around 1.8 tonnes in females (Ross, 2006).

While the long-finned pilot whale is not listed as migratory under the EPBC Act, nor under the Bonn Convention, this species undertakes offshore to continental shelf movements, apparently in relation to the seasonal abundance of its favoured prey species, particularly cephalopods such as Gould's squid, that spawns throughput the year with two or three peaks (AFMA, 2020a), or the southern calamari that forms large aggregations during spawning in spring and summer (Lyle et al., 2019).

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2022) indicates that eight long-finned pilot whale sightings around Wilsons Promontory with three in Waratah Bay and another three on the west coast of the promontory.



Source: Atlas of Living Australia (CSIRO, 2022). Black lines denote the project's proposed alignment.

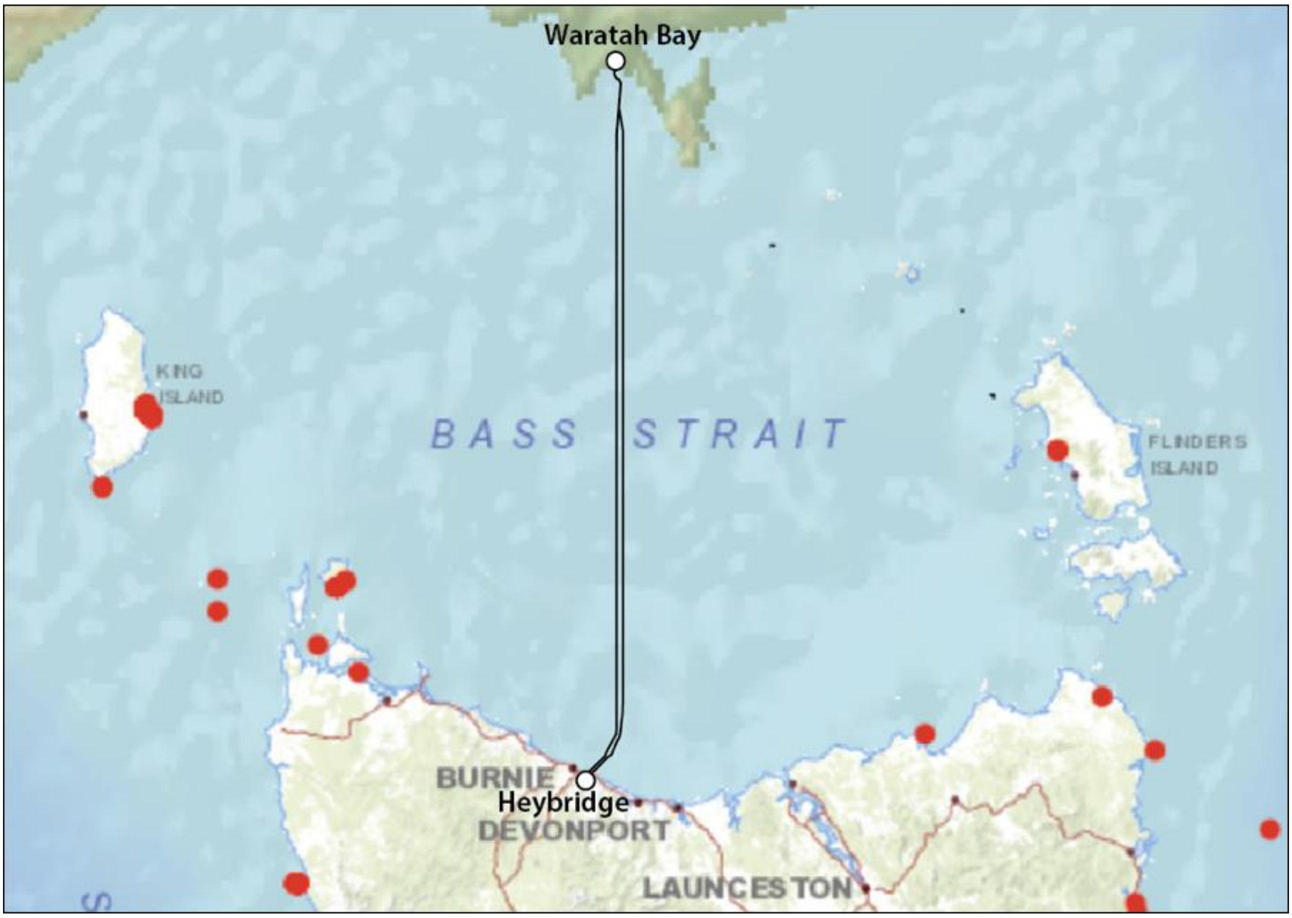
Figure 6.36: Distribution of long-finned pilot whales in southeast Victoria

The likelihood of occurrence of long-finned pilot whales in the nearshore Victorian PMST search area (PMST, 2023; Attachment B) and adjacent offshore waters under Victorian jurisdiction (PMST, 2023; Attachment A) is assessed as ***Likely***, as they have occurred before and are anticipated to occur again.

Distribution in Tasmania

The Tasmanian Natural Values Atlas (DNRE, 2020) lists 686 sightings of long-finned pilot whales around Tasmania with about 15 sightings in Bass Strait. Only two sightings were observed along the north coast of Tasmania, with one sighting at Robbins Bay in far northwest Tasmania and one sighting at Andersons Bay near Bridport in the east. There were no sightings between Burnie and Devonport, and within which the Tasmanian nearshore PMST search area (PMST, 2023; Attachment C) is located.

Figure 6.37 shows the distribution of long-finned pilot whale sightings in Bass Strait waters under Tasmanian jurisdiction.



Source: Tasmanian Natural Values Atlas (DNRE, 2022). Black lines denote the project's proposed alignment.

Figure 6.37: Distribution of long-finned pilot whale sightings in Bass Strait

Strandings in Tasmania

The long-finned pilot whale is a notorious species for strandings and exhibits the largest number of reported live mass strandings worldwide (Alvarado-Rybak et al., 2019) and, in some cases, involve what appear to be healthy individuals (Olson, 2018). In Tasmania, mass stranding events involving long-finned pilot whales are quite common and perhaps even more frequent than in other places around Australia (Rudolph and Smeenk, 2009). In Bass Strait, live strandings have occurred at Sellars Point, Flinders Island, with two strandings on either side. Sellars Point is a sand-spit that forms the eastern-most extremity of the island and is connected to rocky Babel Island by a sand bar that may be exposed at low tide.

The high proportion of mass strandings is strong evidence that long-finned pilot whales are at risk whenever they venture into unfamiliar waters close inshore, and the dense clustering of events at some Tasmanian sites indicates that they are particularly hazardous (Warneke, 2001). Known mass strandings within Bass Strait have occurred in the far northwest of Tasmania and include:

- King Island (200 mass stranded in 2009 at Naracoopa Beach on the east coast).
- Anthony's Beach in Perkins Bay (65 mass stranded in November 2008).

However, the mass strandings in far northwestern Tasmania, particularly at Perkins Bay west of the Stanley Peninsula, are likely to result from long-finned pilot whale entering Bass Strait from the western continental shelf, rather than from the eastern shelf, which will require transiting westwards across Bass Strait and less likely to occur.

Overall, based on sightings records for the northern coast of Tasmania, the likelihood of occurrence of long-finned pilot whales in nearshore Tasmanian PMST search area (PMST, 2023; Attachment C) and adjacent offshore waters of Bass Strait under Tasmanian jurisdiction (PMST, 2023 Attachment A) is assessed as ***Likely***, as tagged long-finned pilot whales have been observed by Gales et al. (2012) along the Tasmanian north coast between Stanley Peninsula to west of Flinders Island in both nearshore and offshore waters.

6.3.6.4 Cetacean summary and likelihood of occurrence

Table 6.17 summarises the likelihood of occurrence of cetaceans in Bass Strait and the project's study area.

Table 6-17: Summary of cetacean likelihood of occurrence in Bass Strait

Latin name	Common name	Offshore	VIC	TAS
Megaptera novaeangliae	Humpback whale	Very likely	Very likely	Very likely
Eubalaena australis	Southern right whale	Very likely	Very likely	Very likely
Balaenoptera borealis	Sei whale	Rare	Rare	Rare
Balaenoptera musculus intermedia	Antarctic blue whale	Remote	Remote	Remote
Balaenoptera musculus brevicauda	Pygmy blue whale	Possible	Possible	Possible
Balaenoptera physalus	Fin whale	Rare	Rare	Rare
Caperea marginata	Pygmy right whale	Rare	Rare	Rare
Balaenoptera bonaerensis	Antarctic minke whale	Remote	Remote	Remote
Balaenoptera acutorostrata	Common minke whale	Possible	Possible	Possible
Balaenoptera acutorostrata subsp.	Dwarf minke whale	Rare	Rare	Rare
Orcinus orca	Killer whale (or orca)	Rare	Likely	Rare
Pseudorca crassidens	False killer whale	Rare	Rare	Rare
Globicephala macrorhynchus	Short-finned pilot whale	Rare	Rare	Remote

Latin name	Common name	Offshore	VIC	TAS
Globicephala melas	Long-finned pilot whale	Likely	Likely	Likely
Lagenorhynchus obscurus	Dusky dolphin	Rare	Rare	Rare
Delphinus delphis	Common dolphin	Very likely	Very likely	Very likely
Grampus griseus	Risso's dolphin	Rare	Rare	Rare
Tursiops australis	Burrunan dolphin	Rare	Rare	Rare
Tursiops aduncus	Spotted bottlenose dolphin	Rare	Rare	Remote
Tursiops truncatus	Common bottlenose dolphin	Very likely	Very likely	Very likely
Physeter macrocephalus	Sperm whale	Likely	Likely	Rare

Notes: O/S denotes offshore Bass Strait. VIC denotes nearshore Victoria. TAS denotes nearshore Tasmanian waters of Bass Strait. Dash (–) denotes not listed (unknown). Spotted bottlenose dolphin is an alternative name to the Indo-Pacific bottlenose dolphin discussed in text.

6.3.7 Pinnipeds

All pinnipeds in the family *Otariidae* (eared seals) and the family *Phocidae* (true seals) in Australian waters are listed marine species under the EPBC Act.

Otariid seals comprise Australian and long-nosed fur seals and the sub-Antarctic seal, whereas phocid seals include the southern elephant seal, Australia sea lion and leopard seal, which are occasionally found on Victorian and Tasmanian shorelines.

Table 6.18 lists pinnipeds that are known to occur, or may occur in the project’s area of influence, and wider southwestern Bass Strait, including those species that are of conservation significance.

Table 6-18: List of pinnipeds in central Bass Strait

Family/Species	Conservation		Occurrence in PMST search areas		
	IUCN	EPBC Act	Victorian nearshore	O/S Bass Strait	Tasmanian nearshore
Otariidae (eared seals):					
Australian fur seal (*Arctocephalus pusillus doriferus*)	LC	–	SL	SM	SM
Long-nosed fur seal (*Arctocephalus forsteri*)	LC	–	SM	SM	SM
Sub-Antarctic seal (*Arctocephalus tropicalis*)	LC	EN	–	–	–
Phocidae (earless seals):					
Australian sea lion (*Neophoca cinerea*)	EN	EN	–	–	–
Southern elephant seal (*Mirounga leonina*)	LC	VU	–	–	–
Leopard seal (*Hydrurga leptonyx*)	LC	–	–	–	–

Source: EPBC Act, SPRAT (DCCEEW, 2022c) and International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (IUCN, 2022) key: EN – Endangered; VU – Vulnerable; LC – Least Concern. Dash (–) denotes not listed. O/S Bass Strait denotes offshore Bass Strait.
EPBC Act PMST Report species or species habitat presence in PMST search areas key: SL = Species or species habitat likely to occur; SM = Species or species habitat may occur; dash (–) denotes not likely to be present.

6.3.7.1 Eared seals (*Otariidae*)

There are two *Otariid* seals are present in Bass Strait and may occur in the project's area of influence.

6.3.7.1.1 Australian fur seal

The Australian fur seal (*Arctocephalus pusillus doriferus*) is a listed marine species under the EPBC Act. The EPBC Act Protected Matter Reports (PMST, 2023: Attachment A: Offshore Bass Strait, Attachment B: Nearshore Victoria and Attachment C: Nearshore Tasmania) indicate that this species or its habitat may occur in all the project's PMST search areas.

There are ten established breeding colonies of Australian fur seals in Bass Strait, which are restricted to the islands of the strait with four located off the coast of Victoria and six located off the coast of Tasmania (Kirkwood et al., 2010; Warneke 1995). However, an updated review of the scientific literature revealed the presence of six and seven colonies in Victorian and Tasmanian sections of Bass Strait, respectively.

Biologically Important Areas

The principal BIAs for Australian fur seals are breeding colonies and haul-out sites. Table 6.19 lists the known breeding and haul-out sites of Australian fur seals in Bass Strait.

In Table 6.19, there are 12 breeding colonies or sites of Australian fur seals that are relatively restricted to the islands of Bass Strait with five sites in Victoria and seven sites in Tasmania.

Table 6-19: Australian fur seal Biologically Important Areas in Bass Strait

Site	Coordinates	State	Distance to the project (km)
Breeding colonies or sites:			
Cape Bridgewater	38°23'16.03"S, 141°24'19.39"E	Victoria	426.0
Lady Julia Percy Island	38°25'3.89"S, 142°0'11.33"E	Victoria	374.0
The Skerries	37°45'16.17"S, 149°31'4.71"E	Victoria	345.0
Seal Rocks	38°31'33.59"S, 145°5'57.92"E	Victoria	98.0
Kanowna Island	39°9'16.71"S, 146°18'39.13"E	Victoria	11.3
Rag Island	38°57'16.71"S, 146°40'50.71"E	Victoria	60.0
Reid Rocks	40°14'43.44"S, 144°10'5.52"E	Tasmania	163.0
West Moncoeur Island	39°13'55.43"S, 146°30'21.11"E	Tasmania	35.0
Tenth Island	40°56'19.45"S, 146°59'7.89"E	Tasmania	74.5
Judgement Rocks	39°30'29.11"S, 147°7'31.72"E	Tasmania	87.5
Wright Rock	39°35'33.98"S, 147°32'18.78"E	Tasmania	122.3
Moriarty Rocks	40°34'48"S, 148°16'12"E	Tasmania	184.5
Bull Rocks	40°44'22.51"S, 145°17'52.32"E	Tasmania	66.0
Haul-out sites			
Cape Bridgewater	38°23'16.03"S, 141°24'19.39"E	Victoria	426.0
White Rock	38°54'19.23"S, 146°38'50.06"E	Victoria	62.0
Norman Island	39°1'20.78"S, 146°14'30.99"E	Victoria	11.4
Bass Pyramid	39°49'11.69"S, 147°14'39.58"E	Tasmania	97.5
East Moncoeur Island	39°13'40.28"S, 146°32'23.31"E	Tasmania	37.5
Forty Foot Rocks	39°12'3.15"S, 146°25'16.70"E	Tasmania	27.0

Source: CEE (2001). Distances to project's proposed alignment by sea. Shaded rows denote sites lying outside this report's definition of Bass Strait (see Figure 5.1).

Diet of Australian fur seals

In Victorian waters and based on the dietary survey results of Meyers et al. (2021), for 23 female Australian fur seals, Table 6-20 presents a breakdown of key prey items. The fur seals eat mainly fishes (68.8% of prey items), unidentified benthic prey comprising a mixture of fishes, cephalopods, and decapods (total 28.3% of prey items) and cephalopods (2.9% of prey items). For the purposes of the present report, the dietary composition of prey items for female fur seals is anticipated to be similar for both sexes and adult Australian fur seals.

Table 6-20: Prey capture of Australian fur seals in northern Bass Strait

Prey species of group	*Enc. (n)	#Cap. (n)	Percent
Invertebrates:			
Cephalopoda: Octopuses (*Octopus* spp.)	30	30	2.38
Cephalopoda: Squids (*Teuthida*)	5	5	0.40
Cephalopoda: Giant cuttlefish (*Sepia apama*)	1	1	0.08
Decapoda: Spiny rock lobster (*Jasus edwardsii*)	1	1	0.08
	Sub-total		**2.9**
Fishes:			
Scorpaeniformes: Gurnards (*Triglidae*)	334	301	23.83
Tetraodontiformes: Leatherjackets (*Monacanthidae*)	246	225	17.81
Scorpaeniformes: Other lionfishes and sculpins	160	119	9.42
Carangiformes: Jack mackerel (*Trachurus* spp.)	280	85	6.73
Scorpaeniformes: Gurnard perches (*Neosebastidae*)	83	75	5.94
Zeiformes: Silver dory (*Cyttus australis*)	24	18	1.43
Carangiformes: Ray-finned fish (other *Carangidae*)	21	11	0.87
Elasmobranchii: Stingrays (*Myliobatiformes*)	8	8	0.63
Scorpaeniformes: Flatheads (*Platycephalidae*)	6	5	0.40
Gadiformes: Codling (*Moridae*)	6	4	0.32
Carangiformes: Trevally (*Pseudocaranx* spp.)	5	3	0.24
Perciformes: Redbait (*Emmelichthys nitidus*)	4	3	0.24
Ophidiiformes: Pink Ling (*Genypterus blacodes*)	3	3	0.24
Scombriformes: Barracouta (*Thyrsites atun*)	3	3	0.24
Tetraodontiformes: Slender-spined porcupine fish (*Diodon nichthemerus*)	3	3	0.24
Beloniformes: Garfish (*Hyporhamphus* spp.)	2	2	0.16
Perciformes: Knifejaw (*Oplegnathus* spp.)	1	1	0.08
	Sub-total		**68.8**
Unidentified:			
Unidentified benthic prey	793	357	28.27
	Sub-total		**28.3**
	Total		**100.0**

Source: Adapted from Meyers et al. (2021). * Enc. denotes number of encounters; # Cap. denotes number of captures.

Table 6.21 presents the success rate of capture of prey items by 23 female Australian fur seals, with 100% success rates for solitary pelagic fishes and benthic cephalopods (mainly octopuses). Successful capture rates for both demersal baitfish (39.4%) and pelagic baitfish (32.9%), which emphasises the effectiveness of baitfish shoaling tactics towards predators.

Australian fur seals eat mainly fish and cephalopods (squid, octopus and cuttlefish) and over 40 species of fish and over 10 cephalopod species have been identified as being eaten by these fur seals (MMIC, 2002). The fish species known to be consumed, Jack mackerel (*Trachurus declivis*), Redbait (*Emmelichthys nitidus*) and leatherjackets (*Monacanthidae*) form the main prey items.

Table 6-21: Prey capture success rates by Australian fur seals in northern Bass Strait

Prey type	Pursuit initiation (n)	Captures (n)	Success rate (%)
Pelagic solitary fish	85	85	100.0
Benthic cephalopods	34	34	100.0
Benthic solitary fish	786	674	85.8
Benthic elasmobranchs	16	10	62.5
Benthic unknown	783	351	44.8
Demersal baitfish	66	26	39.4
Pelagic baitfish	234	77	32.9

Source: Adapted from Meyers et al. (2021).

Of the 11 known cephalopod species eaten, the most frequently consumed is the arrow or Gould's Squid (*Nototodarus gouldi*). Table 6.22 lists the major prey species of the Australian fur seal in Tasmania.

Table 6-22: Major prey species for Australian fur seals in Tasmania

Prey items	1989–1990	1994–2000
Number of Samples	357	1,106
Prey remains	1,496	4,013
Fish species:		
No. species	25	34
Prey item numerical abundance:		
Redbait (*Emmelichthys nitidus*)	43%	25%
Leatherjackets (*Monacanthidae*)	12%	19%
Jack mackerel (*Trachurus declivis*)	1%	9%
Arrow squid (*Nototodarus gouldi*)	57%	41%
Sepia (unidentified 1)	4%	10%
Octopods	13%	40%

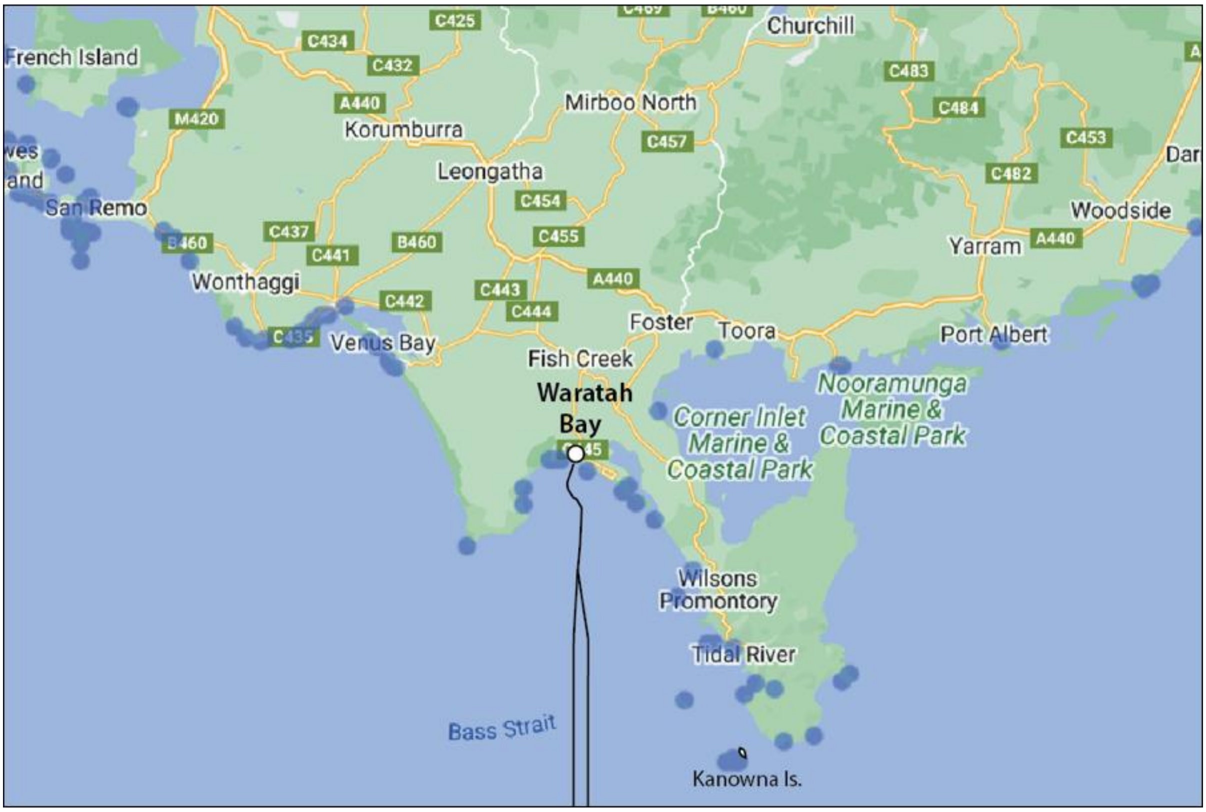
Source: Adapted from MMIC (2002).

Another study by Gales and Pemberton (1994) revealed that fishes were the most prevalent prey in the diet, with cephalopods occurring less frequently. Occurrences of crustaceans and birds were negligible. Twenty-five species of fish were identified from faecal and regurgitate samples, with redbait (*Emmelichthys nitidus*), jack mackerel (*Trachurus declivis*) and leatherjackets (*Monacanthidae*) constituting the main prey species. The same study identified that fish in the diet predominated in winter, whereas cephalopods predominated in summer, and most samples.

Distribution in Victoria

Table 6.19 above lists the Australian fur seal breeding and haul-out sites in Bass Strait under Victorian jurisdiction. Two Victorian Australian fur breeding sites at Cape Bridgewater and Lady Julia Percy Island in southwestern Victoria and one site at The Skerries near the Victorian-New South Wales border are not included in the project's study area as defined in the present report (see Figure 5.1).

Based on the Atlas of Living Australia (CSIRO, 2022), Figure 6.38 shows the distribution of Australian fur seals in northern Bass Strait, including the nearshore waters of Waratah Bay.



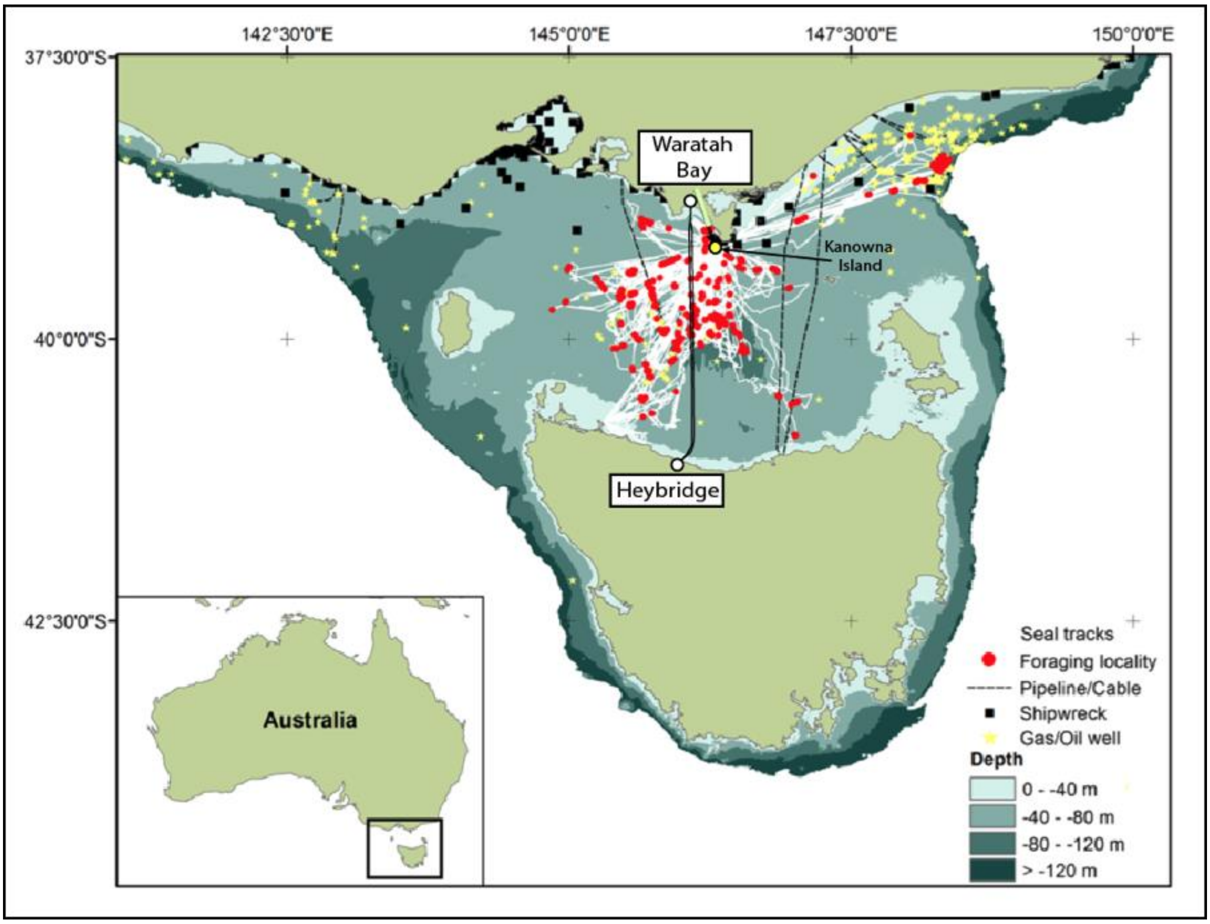
Source: Australian Living Atlas (CSIRO, 2022). Black lines denote the project's proposed alignment.

Figure 6.38: Distribution of Australian fur seals in northern Bass Strait (Victoria)

In Figure 6.38, most sighting records of Australian fur seals are found along the rocky coast of Cape Liptrap, in the west of Waratah Bay, and along the western and southern coast of Wilson Promontory. The Kanowna Island breeding site is located at the southwest tip of Wilsons Promontory (see Figure 6.38).

The Australian fur seal is the most common seal in Victorian waters and breeds between the end of October to mid-December/January (PINP, 2022) on small islands (e.g., Kanowna Island in the Anser Group) and isolated rocks (e.g., Seal Rocks near Philip Island and Rag Island, within the Seal Rocks Wildlife Reserve, that lies to the east of Wilson Promontory). Seal Rocks lies 1.8 km off Phillip Island and provides an important breeding area and nursery for around 30,000 Australian fur seals (approximately 25% of the total population) and at any given time, there will be between 5,000 to 8,000 seals at this breeding colony (PINP, 2022). However, the Seals Rock breeding colony is located about 98 km west of the project's proposed alignment across Bass Strait.

The most important breeding site of the Australian fur seal in Victorian waters is Kanowna Island (see Figure 6.38 which had a breeding colony of around 15,000 fur seals in 2010 (Kirkwood et al., 2010), which had increased from its estimated population of between 5,600 and 7,200 individuals observed in 2000 (Arnould and Littnan, 2000). While Kanowna Island is located about 11.3 km east of the project's proposed alignment within Victorian waters, Australian fur seal foraging areas include the waters surrounding the numerous islands to the west of Wilson Promontory and southeast of Waratah Bay, as well as Victorian and Tasmanian waters of central Bass Strait. For example, Figure 6.39 shows at-sea movements of adult female Australian fur seals from the Kanowna Island colony, which are representative of their key foraging area.



Source: Adapted from Arnould et al. (2015). Black solid lines denote the project's proposed alignment.

Figure 6.39: At-sea movements of adult female Australian fur seals from Kanowna Island

The project's proposed alignment in northern Bass Strait and the Victorian nearshore will intersect the foraging area of the Australian fur seals from Kanowna Island.

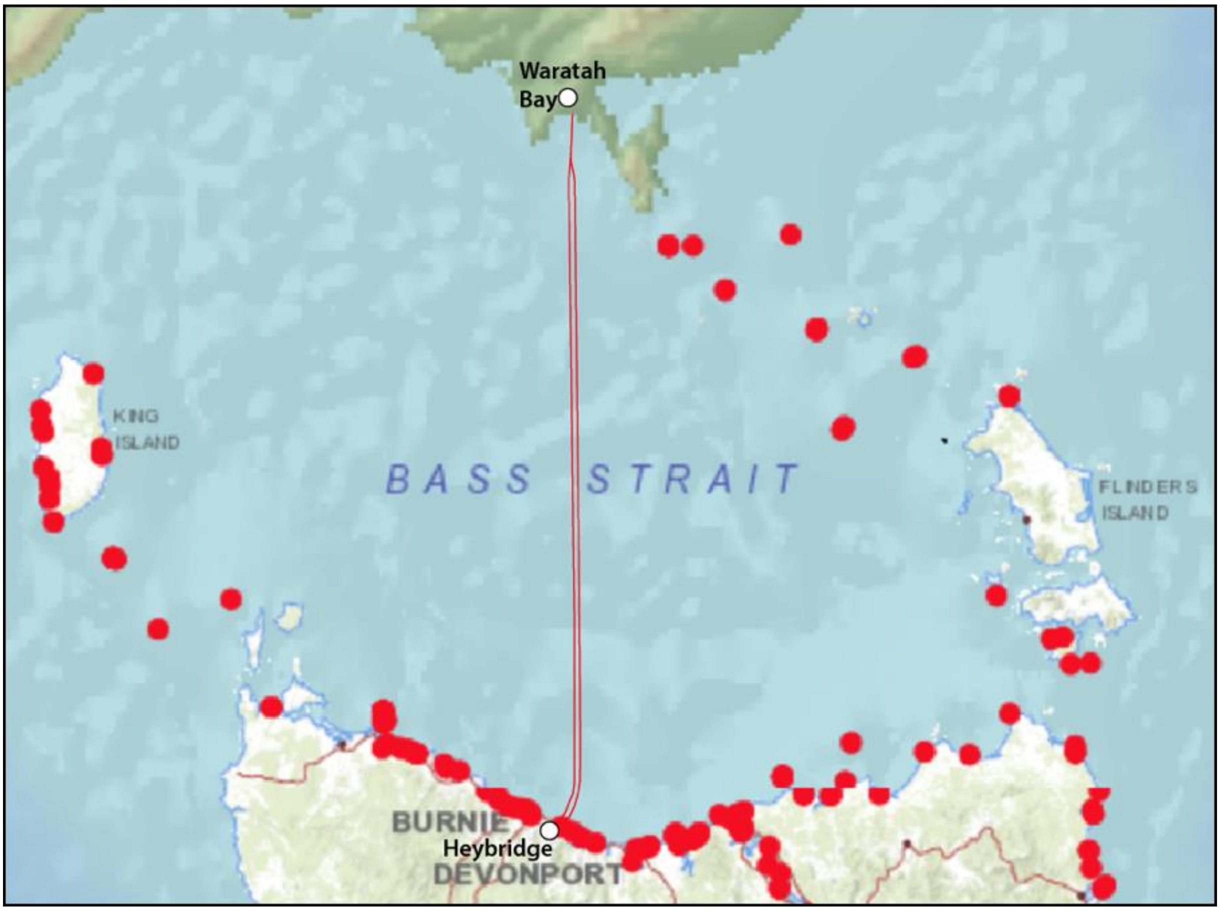
Arnould et al. (2015) found that the duration of foraging trips at sea for Australian fur seals from Kanowna Island was within the range of between 3 and 7 days. In addition, Australia fur seals spent time in the vicinity of anthropogenic seabed structures and, of the fur seals spending time in the vicinity of anthropogenic structures, 96% visited pipelines and cable routes, 42% visited oil/gas wells and 23% visited shipwrecks. While the results of the study by Arnould et al. (2015) do not indicate direct specific use of such structures as forage sites, they suggested a spatial link between the presence of anthropogenic structures and potential foraging habitat.

The likelihood of occurrence of Australian fur seals in the nearshore Victorian PMST search area (PMST, 2023; Attachment B) and adjacent offshore Bass Strait waters under Victorian jurisdiction (PMST, 2023; Attachment A) is assessed as ***Very likely***.

Distribution in Tasmania

Table 6.19 also lists the Australian fur seal breeding and haul-out sites in Bass Strait under Tasmanian jurisdiction. The Australian fur seal is the most common seal in Tasmanian waters and breeds between October and January on small islands (e.g., Tenth Island) and isolated rocks (e.g., Reid Rocks, Judgement rocks and Moriarty Rocks). The nearest breeding colony at Tenth Island is approximately 74.5 km east of the project's proposed alignment across Bass Strait.

The distribution of Australian fur seal sightings in the Tasmanian Natural Values Atlas (DNRE, 2022) shows frequent sightings along the north coast of Tasmania and the Tasmanian islands of Bass Strait. Figure 6.40 shows the distribution of Australian fur seal records in Bass Strait waters under Tasmanian jurisdiction.



Source: DNRE (2022).

Figure 6.40: Distribution of Australian fur seals in Bass Strait (Tasmanian waters)

Few observations are made in central Bass Strait, as most observers live along the coast. Notwithstanding, the project's proposed alignment intercepts foraging areas used by Australian fur seals in nearshore Tasmania at Heybridge and most likely the adjacent offshore Bass Strait waters to the north.

The likelihood of occurrence of Australian fur seals in the nearshore Tasmanian PMST search area (PMST, 2023; Attachment C) and adjacent offshore Bass Strait waters under Tasmanian jurisdiction is assessed as ***Very likely***.

6.3.7.1.2 Long-nosed fur seals

The long-nosed seal (*Arctocephalus forsteri*) is a listed marine species under the EPBC Act. This species is classified as endangered by the IUCN (2022). The EPBC Act PMST results for Tasmanian offshore Bass strait (PMST, 2023; Attachment A) and nearshore Tasmania (PMST, 2023; Attachment C) indicate that this species or its habitat may occur, while the nearshore Victoria PMST area (PMST, 2023; Attachment B) indicates that this species or its habitat are likely to occur.

Most occurrences of long-nosed fur seals are in South Australian coastal waters such as Kangaroo Island (Shaughnessy, 1999).

Biological Important Areas

Table 6.23 lists long-nosed seal BIAs in the Victorian or Tasmanian waters of Bass Strait.

Table 6-23: Long-nosed seal Biologically Important Areas in Bass Strait

Site	Coordinates	State	Distance from the project (km)
Breeding colonies or sites:			
Kanowna Island	39°9'16.71"S, 146°18'39.13"E	Victoria	11.3
Rag Island	38°57'14.59"S, 146°40'51.83"E	Victoria	61.4
The Skerries	37°45'16.17"S, 149°31'4.71"E	Victoria	345.0
Lady Julia Percy Island	38°25'3.89"S, 142° 0'11.33"E	Victoria	365.0
Haul-out sites:			
Kanowna Island	39°9'16.71"S, 146°18'39.13"E	Victoria	11.3
West Moncoeur Island	39°13'55.43"S, 146°30'21.11"E	Tasmania	35.0
Hogan Group	39°12'49.91"S, 146°59'18.57"E	Tasmania	75.0
Reid Rocks	40°14'43.44"S, 144°10'5.52"E	Tasmania	163.0
Tenth Island	40°56'19.45"S, 146°59'7.89"E	Tasmania	74.5
Judgement Rocks	39°30'29.11"S, 147°7'31.72"E	Tasmania	87.5
Wright Rock	39°35'33.98"S, 147°32'18.78"E	Tasmania	122.3
Moriarty Rocks	40°34'48"S, 148°16'12"E	Tasmania	184.5
Cape Bridgewater	38°23'34.23"S, 141°24'8.27"E	Victoria	426.0
Norman Island	39°1'20.78"S, 146°14'30.99"E	Victoria	11.4
White Rock	38°54'19.23"S, 146°38'50.06"E	Victoria	62.0
East Moncoeur	39°13'40.28"S, 146°32'23.31"E	Tasmania	37.5
Bass Pyramid	39°49'11.69"S, 147°14'39.58"E	Tasmania	97.5

Source: Shaughnessy (1999); Barton et al. (2012); Kirkwood et al. (2009); Blue shaded rows indicate areas well outside the project's study area (see Figure 5.1).

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2022) indicates that only three sightings of long-nosed seals have been recorded at the nearshore Victorian PMST search area (PMST, 2023; Attachment B), with one sighting within Waratah Bay, one sighting at the southern tip of Wilsons Promontory, and one sighting at Kanowna Island.

In Victoria, long-nosed fur seal breeding is known to occur at Kanowna Island to the southwest of Wilsons Promontory (Arnould and Littnan, 2000). While the breeding area of long-nosed fur seals on Kanowna Island is located about 11.3 km east of the project's proposed alignment, the foraging area of the long-nosed fur seal may be intersected by the project.

The likelihood of occurrence of long-nosed fur seals in the nearshore Victorian PMST search area (PMST, 2023; Attachment B) and adjacent offshore waters (PMST, 2023; Attachment A) is assessed as ***Rare***.

Distribution in Tasmanian waters

The Tasmanian Natural Values Atlas (DNRE, 2022) indicates a total of 249 records of long-nosed seals in Tasmania, which are found mainly along the south and east coasts. A total of nine sightings were recorded in Bass Strait, with three sightings at King Island, but only three sightings along the north coast of Tasmania. The north coast records reveal one sighting at Stanley Peninsula, two sightings at Wynyard, and one at Port Sorrell. However, there were no sightings between Burnie and Devonport, which includes the proposed Heybridge landfall of the project.

The likelihood of occurrence of long-nosed seals in nearshore Tasmanian PMST search area (PMST, 2023; Attachment C) and adjacent PMST offshore waters of Bass Strait under Tasmanian jurisdiction (PMST, 2023; Attachment A) is assessed as ***Rare***.

6.3.7.1.3 Sub-Antarctic fur seal

The sub-Antarctic fur seal (*Arctocephalus tropicalis*) is listed as endangered under the EPBC Act. It is not listed under the FFG Act threatened species list but is listed as endangered under the TSP Act. Threatened Species Scientific Committee conservation advice is available for this species (TSSC, 2016) and a recovery plan is also in place (DEH, 2004).

Sub-Antarctic fur seals breed and pup from late October to early January, with a peak in mid-December. Seals also are ashore for the annual moult between February and April, with a peak in March and April. Little is known of their behaviour while at sea. Except for cows with pups, most of the population spends much of the winter and spring (June-September) at sea (FAO, 2022).

Adult males are up to 1.8 m long and weigh 70 to 165 kg, females 1.4 m and 25 to 55 kg, and newborns are about 60 cm and 4 to 4.4 kg (FAO, 2022).

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2022) indicates that there are seven records of sub-Antarctic fur seals in Victorian waters with most sightings to the west of Cape Patterson nears Wonthaggi, which is located about 55 km northwest of the proposed alignment of the project.

The likelihood of occurrence of sub-Antarctic fur seals in the nearshore Victorian PMST search area (PMST, 2023; Attachment B) and adjacent offshore Bass Strait waters (PMST, 2023; Attachment A) under Victorian jurisdiction) is assessed as ***Remote***.

Distribution in Tasmanian waters

The Tasmanian Natural Values Atlas (DNRE, 2022) list a total of 95 records of sub-Antarctic fur seals in Tasmanian waters, with most sightings located along the south and southeast coastline of Tasmania. In Bass Strait, there were 11 records of which five were located at King Island, one at Flinders Island, and one at Albatross Island. Along the north coast of Tasmania there were four sightings with one each at Sawyers Bay, Sisters Beach, Wynyard and George Town. There were no sightings between Burnie and Devonport, which encompasses the project's proposed landfall at Heybridge. The nearest sighting from the project's proposed alignment was the sighting at Wynyard, which is 25 km to the west.

The likelihood of occurrence of sub-Antarctic fur seals in the nearshore Tasmanian PMST search area (PMST, 2023; Attachment C) and adjacent Bass Strait waters (PMST, 2023; Attachment A) under Tasmanian jurisdiction is assessed as ***Remote***.

6.3.7.2 Earless seals (*Phocidae*)

Earless seals include the Australian sea lion, southern elephant seal, and leopard seal.

6.3.7.2.1 Australian sea lion

The Australian sea lion (*Neophoca cinerea)* is endemic and classified as endangered under the EPBC Act. It is not listed under the FFG Act threatened list or the TSP Act threatened list. Conservation advice is available for this species (TSSC, 2016) and a recovery plan is also in place (DSEWPaC, 2013b). None of the PMST search areas (Attachments A, B and C) list the Australian sea lion as present.

Australian sea lions show high fidelity of female sea lions to their natal sites, which indicates that sea lions lost from a small colony are unlikely to be replaced by immigrants from other colonies (DSEWPaC, 2013b).

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2022) lists 29 records for the Australian sea lion in Victorian waters, with 29 records along the Victorian southwest coast (Warrnambool area) to west of Cape Otway. East of Cape Otway, there is one recorded at Port Phillip Bay and three recorded at Phillip Island, the nearest of which is 90 km from the project's proposed alignment.

The likelihood of occurrence of Australian sea lions in the nearshore Victorian PMST search Area (PMST, 2023; Attachment B) and adjacent offshore waters of Bass Strait within Victorian jurisdiction (PMST, 2023; Attachment A) is assessed as ***Remote***.

Distribution in Tasmanian waters

Records of Australian sea lions in Tasmanian Natural Values Atlas (DNRE, 2022) indicates a total of 25 sightings of Australian sea lions around Tasmania, with nine sightings in Bass Strait. The records in Bass Strait include four sightings at King Island, one at Cape Barren Island, and four sightings along the north coast of Tasmania. The north coast records include two sightings at Stanley Peninsula, one at Ulverstone and one at Stony Head, to the east of Georgetown. Another Australian sea lion sighting is located at Ulverstone, about 11 km from the project's proposed alignment, near its landfall at Heybridge.

The likelihood of occurrence of Australia sea lions in nearshore Tasmania at the Heybridge landfall (PMST, 2023; Attachment C) and adjacent offshore waters of Bass Strait under Tasmanian jurisdiction is assessed as ***Rare***.

6.3.7.2.2 Southern elephant seal

The southern elephant seal (*Mirounga leonina*) is listed as vulnerable under the EPBC Act, and vulnerable under the TSP Act Threatened Species List but is not listed under the FFG Act Threatened List. Conservation advice is available for this species (TSSC, 2016b) but a recovery plan is also required to be put in place (DCCEEW, 2022c). None of the PMST search areas (Attachments A, B and C) list the southern elephant seal as present.

Southern elephant seals are distributed across sub-Antarctic waters north of the pack ice and up to up to 1,500 m depth (McConnell et al., 1992) and ranges from Macquarie Island, in Australia, to the tip of the Antarctic continent (McMahon et al., 2003).

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2022) indicates a total of around 70 southern elephant seals along the Victorian coast with most sightings in the southwest of the state. Nine sightings were east of Wilson Promontory, and eight sightings were between Westernport Bay and Wonthaggi. The project's proposed alignment is 65 km away from the Wonthaggi sighting in the northwest. There were no sightings between Cape Patterson and Woodside, which includes both Waratah Bay and Wilsons Promontory.

The likelihood of occurrence of southern elephant seals in the nearshore Victorian PMST are (PMST, 2023; Attachment B) and adjacent offshore waters of Bass Strait (PMST, 2023; Attachment A) under Victorian jurisdiction is assessed as ***Remote***.

Distribution in Tasmanian waters

The Tasmanian Natural Values Atlas (DNRE, 2020) lists a total of 266 records of southern elephant seals around Tasmanian, mainly along the western, eastern, and southern coastline. A total of 17 sightings of southern elephant seals were recorded for King Island with six sightings along the north coast of Tasmania. The north coast sightings were one each at Stanley Peninsula, Sisters Beach, Wynyard and Heybridge.

The likelihood of occurrence of southern elephant seals in the nearshore Tasmanian PMST search area (PMST, 2023; Attachment C) encompassing the project's landfall is assessed as ***Possible***, given the one sighting at this location.

6.3.7.3 Leopard Seal

The leopard seal (*Hydrurga leptonyx*) is not listed as a threatened species but is listed as a marine species under the EPBC Act. This species is not listed as a threatened species under the FFG Act or the TSP Act. There is no listing advice or specific recovery plan for this species (DCCEEW, 2022c).

The leopard seal is a frequent visitor mainly in the winter months to the coasts and islands of Bass Strait. Leopard seals breed on the outer fringes of the circumpolar pack ice (50° S to 80° S) and range from the coast of Antarctica to the sub-Antarctic and subtropical seas (e.g., coast of New South Wales). Sea-ice is used by leopard seals as a haul-out platform for pupping during late spring and early summer (Southwell et al., 2003), moulting (mid to late summer) and resting throughout the year (Rogers et al., 2013). Morris et al. (2018) stated that leopard seals in Australian waters are non-breeding.

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2022) shows an estimates total of 85 records of leopard seal sightings along Victorian coastline, and their distribution appears to be equally spread out. Five sightings were located on the west coast of Wilson Promontory at Tidal River, with one sighting in Waratah Bay.

The likelihood of occurrence of leopard seals in the Victorian nearshore PMST search area of Waratah Bay (PMST, 2023; Attachment B) and the adjacent offshore waters of Bass Strait (PMST, 2023; Attachment A) under Victorian jurisdiction is assessed as ***Possible***.

Distribution in Tasmanian waters

Leopard seals occur annually in Tasmania waters between July and November each year, probably resulting from their northward movements from the Antarctic pack ice zone (Rounsevell and Pemberton, 1994). These northward movements are not classified as migratory but simply as 'extralimital' sightings, that is, at the limit of their range (Riedman, 1990). Similarly, leopard seal sightings in South Australia peaked during the period from August to October (Shaughnessy et al., 2012).

The Tasmanian Natural Values Atlas (DNRE, 2022) shows a total 656 records of leopard seals in Tasmanian coastal waters, with sightings distributed mainly along the north, east and south coasts. The lack of leopard seal sightings along the west coast may be reflected in the lower human population density along this coast (i.e., potential observers) and leopard seals using remote haul-out beaches.

On the Bass Strait islands, 12 sightings have been made at King Island and 16 sightings at Flinders Island. A further 55 sightings of leopard seals have been made along the north coast with 15 sightings between Burnie and Devonport, a stretch of coastline that includes the project's landfall at Heybridge. The nearest sighting near Sulphur Creek Point is located 3 km from the project's proposed alignment.

The likelihood of occurrence of leopard seals in the nearshore Tasmanian PMST search area (PMST, 2023; Attachment C) and the adjacent offshore waters of Bass Strait (PMST, 2023; Attachment A) under Tasmanian jurisdiction is assessed as ***Possible***, with their potential presence likely to be between July and December.

6.3.8 Sea turtles

All sea turtle species occurring in Australian waters are managed under the Recovery Plan for Marine Turtles in Australia (DoEE, 2017a), which is a national plan which aims to aid in the recovery of six of the world's seven species of sea turtles. While six species of marine turtles are known from Australia, only five species are known to occur in Bass Strait. Three of these occur in Bass Strait only as rare vagrants, outside their usual range and include loggerhead (*Caretta caretta*), green (*Chelonia mydas*) and olive ridley (*Lepidochelys olivacea*) turtles. The leatherback turtle (*Dermochelys coriacea*) is a regular visitor to Bass Strait and is mostly a pelagic species that is away from its breeding grounds in New Guinea and Indonesia. The flatback turtle (*Natator depressus*) does not occur in Victorian or Tasmanian waters.

6.3.8.1 Sea turtle species of conservation significance in Bass Strait

Table 6.24 lists the five sea turtle species that are known to occur in Bass Strait and migrate through the study area (see Figure 5.1) and the project's area of influence.

Table 6-24: Sea turtles likely to or may occur in Bass Strait

Species	Conservation status		Presence in PMST search areas		
	IUCN	EPBC Act	Victorian nearshore	O/S Bass Strait	Tasmanian nearshore
Loggerhead turtle (*Caretta caretta*)	VU	EN	FK	SK	–
Green turtle (*Chelonia mydas*)	EN	VU	SM	SM	SM
Leatherback turtle (*Dermochelys coriacea*)	VU	EN	FK	SK	–

Olive Ridley turtle (*Lepidochelys olivacea*)	VU	EN	–	–	–
Hawksbill turtle (*Eretmochelys imbricata*)	CR	VU	–	–	–

Source: EPBC Act and the IUCN Red List of Threatened Species. Codes: CR – Critically endangered; EN – Endangered; VU – Vulnerable. Dash (–) denotes not listed; O/S is offshore. EPBC Act Protected Matters Report species occurrence in area: FK – Foraging, feeding or related behaviour known to occur; SK = Species or species habitat known to occur; SM = Species or species habitat may occur.

Leatherback, loggerhead and olive ridley turtles are listed as endangered under the EPBC Act, whereas green and hawksbill turtles are listed as vulnerable under the EPBC Act.

6.3.8.2 Sea turtle Biologically Important Areas

In the current list of marine species for which BIAs have been identified as regionally significant in the National Conservation Values Atlas (DCCEEW, 2022a), no sea turtle BIAs are located within southeast Australia. Notwithstanding, the few species that do pass through Bass Strait are known to forage for squid and jellyfish in the case of leatherback sea turtles and seagrasses and algae for green sea turtles.

6.3.8.3 Loggerhead turtle

The loggerhead turtle (*Caretta caretta*) is listed as endangered and a listed migratory species under the EPBC Act, as well as a listed marine species, under the EPBC Act. This species is also listed as endangered under the FFG Act and the TSP Act. There is no Commonwealth approved conservation advice or listing advice for this species (DCCEEW, 2022c); however, conservation information is presented in the generic Recovery Plan for Marine Turtles in Australia (DoEE, 2017a)

The EPBC Act Protected Matters reports indicates that foraging, feeding or related behaviour of is known to occur in the nearshore Victorian PMST search area (PMST, 2023; Attachment B) and that this species or its habitat may occur in offshore Bass Strait (PMST, 2023; Attachment A). However, loggerhead turtles are not listed in the nearshore Tasmanian PMST search area (PMST, 2023; Attachment C).

The loggerhead turtle is the second most observed sea turtle in Bass Strait after the leatherback sea turtle.

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2022) indicates that there are a total of 17 loggerhead turtle records along the Victorian coastline, with 10 sightings west of Cape Patterson. East of Cape Patterson, the is one sighting in Venus Bay, three on the west coast of Wilsons Promontory between Cotters Beach and Darby Beach. There were a further three sightings with one at the Gippsland Lakes and two near the VIC/NSW border. There were no records of loggerhead turtles in Waratah Bay.

The likelihood of occurrence of loggerhead turtles in the nearshore Victorian PMST search area (PMST, 2023; Attachment B) and adjacent offshore waters of Bass Strait (PMST, 2023; Attachment A) is assessed as ***Rare***.

Distribution in Tasmanian waters

The Tasmanian Natural Values Atlas (DNRE, 2022) indicates a total of 18 records of loggerhead turtles in Tasmanian waters with five sightings in Bass Strait: two at King Island and three at Flinders Island. There were no sightings along the north coast of Tasmania including the project's landfall at Heybridge.

The likelihood of occurrence of loggerhead turtles in the nearshore Tasmanian PMST search area (PMST, 2023; Attachment C) and the adjacent offshore waters of Bass Strait (PMST, 2023; Attachment A) is assessed as ***Remote***, with no prior occurrences.

6.3.8.4 Green turtle

The green turtle (*Chelonia mydas*) is classified as vulnerable and listed as migratory, as well as a listed marine species, under the EPBC Act. There is no approved conservation advice or listing advice for this species (DCCEEW, 2022c). The EPBC Act Protected Matters Reports indicated that the green turtle or its habitat may be present in all the PMST search areas (PMST, 2023: Attachment A: Offshore Bass Strait, Attachment B: Nearshore Victoria and Attachment C: Nearshore Tasmania).

Green turtles are found in tropical and subtropical waters throughout the world (Limpus, 2008). They usually remain within the 20° C isotherms (Márquez, 1990) but below which the turtles' mobility and foraging generally decreases (Robson et al., 2017), although individuals may also stray into temperate waters (Cogger et al., 1993).

The green turtle is primarily herbivorous, foraging on algae, seagrass and mangroves. In their pelagic juvenile stage, they feed on algae, pelagic crustaceans and molluscs (DCCEEW, 2022c).

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2022) records a total of 16 green turtle sightings along the Victorian coastline, including nine sightings within Port Phillip Bay and two sightings at Westernport Bay. The nearest sightings to the project's proposed alignment are on the west coast of Wilsons Promontory with one at Norman Beach and the other at Little Oberon Beach, which are both around 18 km east of the project's proposed alignment, in Victorian waters. A further two sightings have been recorded in Corner Inlet, and there is only one further sighting near Cap Howe at the VIC/NSW border.

The likelihood of occurrence of green turtles at the nearshore PMST search area (PMST, 2023; Attachment B) and adjacent offshore waters of Bass Strait (PMST, 2023; Attachment A) is assessed as ***Rare***.

Distribution in Tasmanian waters

The Tasmanian Natural Values Atlas (DNRE, 2022) has only two records of green turtles in Tasmanian waters and both sightings are in Bass Strait with one sighting at Burnie and the other at Arthur Bay on the west coast of Flinders Island, The Burnie sighting location is 8.5 km from the project's proposed alignment, in its approach to landfall at Heybridge. Given the higher numbers of green sea turtles observed (12 records) along the south coast of Victoria, the waters along the north coast of Tasmania (one record) appear to be too far south and near the southern limit of this migratory species.

The likelihood of occurrence of green turtles in the nearshore Tasmanian PMST search area (PMST, 2023; Attachment C) and the adjacent offshore waters of Bass Strait (PMST, 2023; Attachment A) under Tasmanian jurisdiction is assessed as ***Remote***.

6.3.8.5 Leatherback turtle

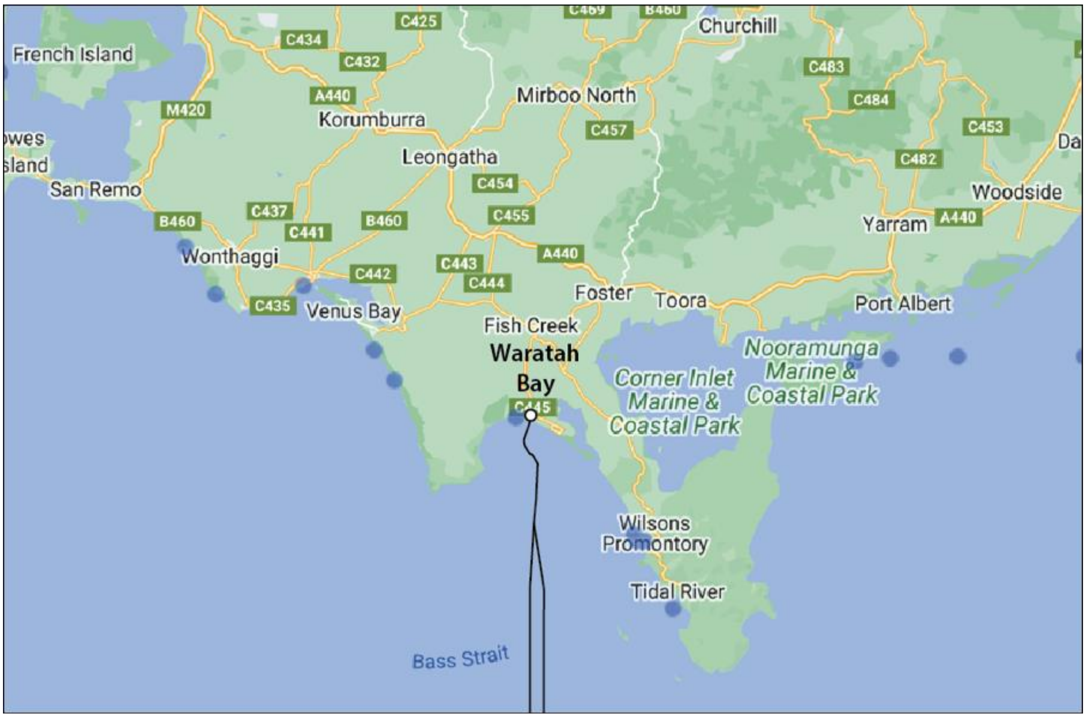
The leatherback turtle (*Dermochelys coriacea*) is classified as endangered and listed as migratory, and as a listed marine species under the EPBC Act. Under Victorian legislation, this species is listed as critically endangered under the FFG Act Threatened List and is classified as vulnerable under the TSP Act list of threatened species. TSSC (2009) provides Commonwealth listing advice for the leatherback turtle. However, there is no approved specific recovery plan for this species, though the need for one is being considered (DCCEEW, 2022c).

This species has a circum-global distribution and occurs in tropical, sub-tropical and temperate waters (Limpus, 2009). The southern waters of Australia including Bass Strait are one of five identified foraging sites (where area restricted behaviour occurs) for leatherback turtles and mainly during the summer months from November to February (Bailey et al., 2012). These leatherback turtles are likely from the western Pacific genetic stock that nests in northwest Papua (Irian Jaya), northern Papua New Guinea, the Solomon Islands and Vanuatu (Benson et al, 2012).

The leatherback turtle is predominantly a pelagic species and does not take up residency in continental shelf waters of southern Australia, although at the southern limit of their global roaming and foraging range they pass through Bass Strait and are likely to feed opportunistically on jellyfish and other megaloplankton such as *ascidians*.

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2022) has around 53 records of leatherback turtles along Victoria's coastline and inshore waters. In proximity to the project's landfall in Victoria, there is one sighting within Waratah Bay and four sightings along the west coast of Wilsons Promontory. Figure 6.41 shows the distribution of leatherback turtle sightings along the Victorian southeast coast near Wilsons Promontory.



Source: Atlas of Living Australia (CSIRO, 2022). Black lines denote the project's proposed alignment.

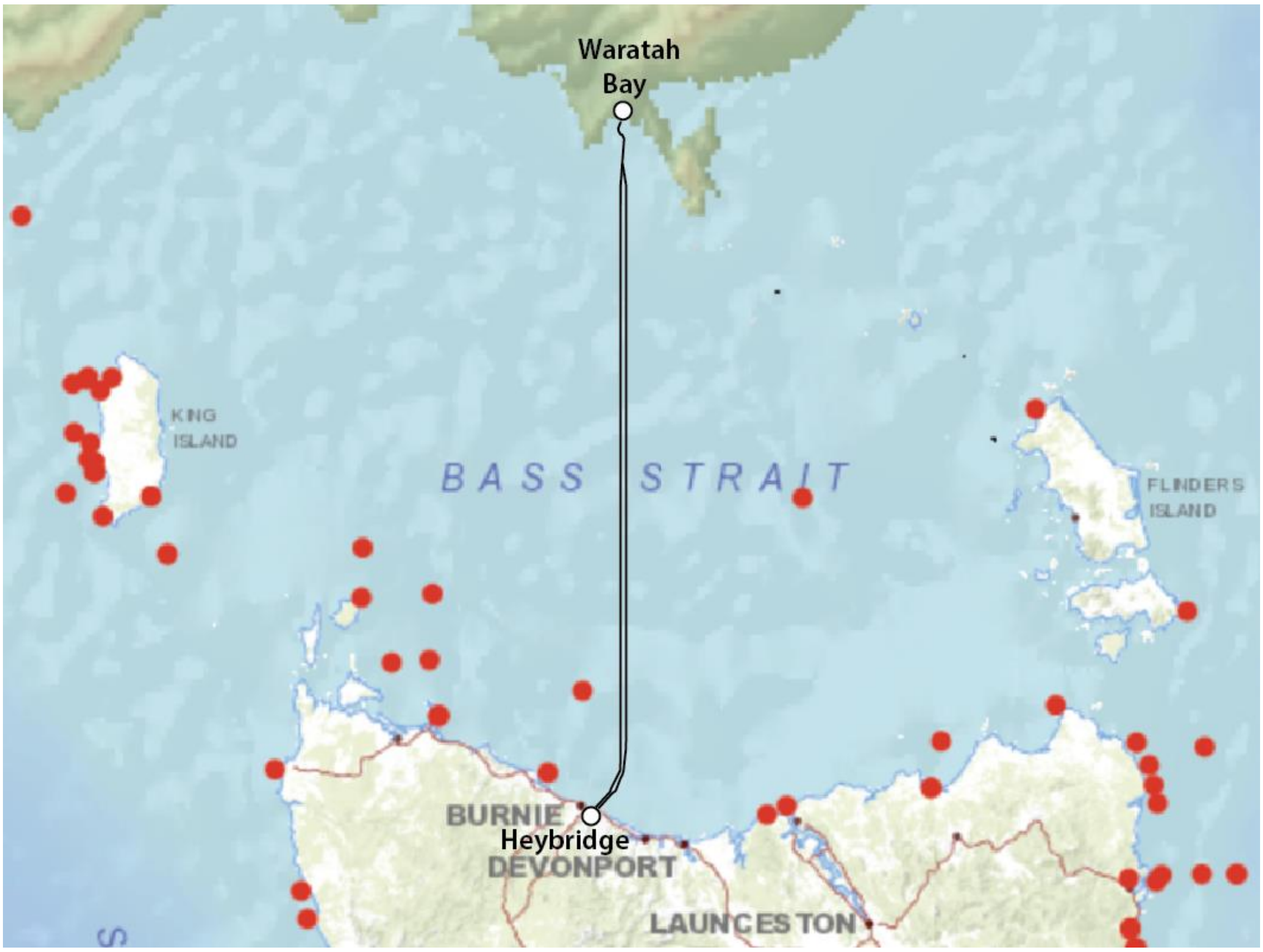
Figure 6.41: Distribution of sightings of leatherback turtles in Victoria waters

The likelihood of occurrence of leatherback turtles in the nearshore PMST area (PMST, 2023; Attachment B) and adjacent offshore waters of Bass Strait (PMST, 2023; Attachment A) is assessed as ***Likely***, based on confirmed sightings along the Victorian coastline.

Distribution in Tasmanian waters

The Tasmanian Natural Values Atlas (DNRE, 2022) indicates that there are 67 records for leatherback turtles in Tasmanian waters with a cluster of 15 sightings around King Island in western Bass Strait but only two sightings in the Furneaux Group (one at Flinders Island and one at Cape Barren Island). This difference may indicate that leatherback turtles pass through Bass Strait from west to east during their migration. Along the north coast of Tasmania, seven sightings were in inshore waters while six sightings were further offshore. The nearest sighting off Table Cape near Wynyard is about 25 km from the project's proposed alignment.

Figure 6.42 shows the distribution of leatherback turtle observations in the Tasmanian waters of Bass Strait.



Source: Tasmanian Natural Values Atlas (DNRE, 2022). Black lines denote the project's proposed alignment.

Figure 6.42: Leatherback turtle distribution in Tasmanian waters

There have been no sightings of leatherback sea turtles in the Tasmanian nearshore waters between Burnie and Devonport, which encompasses the project's proposed landfall at Heybridge, despite the numerous coastal towns (and opportunities for such sightings) along this section of coastline.

The likelihood of occurrence of leatherback turtles in the nearshore Tasmanian PMST search area (PMST, 2023; Attachment C) and adjacent offshore waters of Bass Strait (PMST, 2023; Attachment A) under Tasmanian jurisdiction waters is assessed as ***Possible***.

6.3.8.6 Olive ridley turtle

The olive ridley sea turtle (*Lepidochelys olivacea*) is classified as endangered and listed as migratory, as well as a listed marine species, under the EPBC Act. This sea turtle species is not present in either the FFG Act Threatened List or TSP Act threatened species list. There is no approved conservation advice or listing advice for this species (DCCEEW, 2022c). The EPBC Act Protected Matters Reports indicate that the olive ridley turtle is not listed as present in any of the PMST search areas (PMST, 2023: Attachment A, Attachment B, and Attachment C).

The olive ridley turtle, also known as the Pacific ridley is the second smallest and most abundant of the world's sea turtles (Plotkin, 2007). Most observations are typically within 15 km of mainland shores in protected, relatively shallow marine waters between 22 and 55 m deep (Ernst et al., 1994). In both Victorian and Tasmanian waters of Bass Strait, olive ridley turtles have been recorded to occur irregularly as vagrants outside their normal range (Bauer, 2011).

Conway (1994) conducted a feeding study of olive ridley turtles in Australia and found mostly gastropod and bivalve molluscs from the stomachs of 36 adults (Conway, 1994). Outside of Australia, the olive ridley turtle diet includes crabs, shrimps, tunicates, jellyfish, salps and algae (Mortimer, 1982; Bjorndal, 1997).

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2022) indicates a total of four records of olive ridley turtles in Victorian waters, with one each at Guvvos Beach (Anglesea) and Barwon Head, and two records in Corio Bay within Port Phillip Bay. There are no records along the Victorian coast to the east of the mouth (The Heads) of Port Phillip Bay.

Given the absence of prior sightings olive ridley turtles along the southeast coast of Victoria, the likelihood of occurrence of this species is assessed as ***Remote***.

Distribution in Tasmanian waters

The Tasmanian Natural Values Atlas (DNRE, 2022) indicates a total of four olive ridley turtles' records in Tasmanian waters with two sightings at Phoques Bay on the northwest coast of King Island and one each at Three Hummock Island and West Inlet (Stanley Peninsula). There were no sightings along the north coast nearshore or offshore waters east of the Stanley Peninsula.

Given the absence of prior sightings olive ridley turtles along the north coast of Tasmania, the likelihood of occurrence of this species is assessed as ***Remote***.

6.3.8.7 Hawksbill turtle

The hawksbill sea turtle (*Eretmochelys imbricata*) is classified as vulnerable and listed as migratory, and as a listed marine species under the EPBC Act. This species is not listed in the FFG Act Threatened List but is listed as vulnerable in the TSP Act's list of threatened species. There is no Commonwealth approved conservation advice or listing advice for this species. There is no specific conservation plan for this species except for conservation information in the generic Recovery Plan for Marine Turtles in Australia (DoEE, 2017a)

The EPBC Act Protected Matters Reports indicate that hawksbill turtles are not listed as being present in the PMST search areas (Attachments A, B, and C).

Hawksbill turtles are omnivorous, eating a variety of animals and plants including sponges, hydroids, cephalopods (octopus and squid), gastropods (marine snails), cnidarians (jellyfish), seagrass and algae (Carr and Stancyk 1975). In Australia the main foraging area for hawksbill turtles extends along the east coast, including the Great Barrier Reef, where sponges make up a major part of the diet of hawksbill turtles, although they also feed on seagrasses, algae, soft corals and shellfish (Weatherstone and Consterdine, 2022). Similar prey and dietary items may be expected in Bass Strait migratory foraging areas.

In both Victorian and Tasmanian waters of Bass Strait, hawksbill turtles have been recorded to occur irregularly as vagrants outside their normal range (Bauer, 2011).

Distribution in Victorian waters

The Atlas of Living Australia (CSIRO, 2022) indicates the presence of three sightings of the hawksbill sea turtle in Victorian nearshore waters of Bass Strait, with one sighting at Blythe Point near Andersons Inlet and Inverloch, and two confirmed sightings within Waratah Bay.

Given the low number of sightings over a 20-year period of records, the likelihood of occurrence of hawksbill sea turtles in Victorian waters of Bass Strait is assessed as ***Remote***.

Distribution in Tasmanian waters

The Tasmanian Natural Values Atlas (DNRE, 2022) indicates a total of eight records of hawksbill turtles in Tasmanian waters, including five records for Bass Strait with two sightings on King Island and three sightings at Flinders Island. There were no sightings along the north coast of Tasmania.

The likelihood of occurrence of hawksbill sea turtles in Tasmanian waters of central Bass Strait and the nearshore project area at Heybridge is assessed as ***Remote***.

6.3.9 Marine birds

Marine birds pertinent to the project are mainly pelagic seabirds that forage and feed over open waters of Bass Strait and which may be affected by the project's proposed marine activities and operations. This section concentrates on those seabirds (e.g., the Little Penguin, albatrosses, petrels, and shearwaters) that may be expected to forage within Bass Strait including nearshore and offshore water through which the project's proposed alignment will be located.

6.3.9.1 Marine birds of conservation significance

Pelagic and other marine birds include species of conservation significance (e.g., as classified under the EPBC Act, FFG Act or TSP Act) as well as non-threatened EPBC Act Listed Marine Species, some of which may have Biologically Important Areas for foraging in offshore and/or nearshore Bass Strait waters.

Table 6.25 presents a list of marine birds of conservation significance known or potentially occurring in Bass Strait, which has been compiled from the EPBC Act Protected Matters Reports (PMST, 2023: Attachment A: Offshore Bass Strait, Attachment B: Nearshore Victoria and Attachment C: Nearshore Tasmania).

The EPBC Act PMST reports include five pelagic seabirds that are endangered including the Northern Royal Albatross[6] (*Diomedea sanfordi*), Southern Giant Petrel (*Macronectes giganteus*), Gould's Petrel (*Pterodroma leucoptera leucoptera*), shy albatross (*Thalassarche cauta*), and Grey-headed Albatross (*Thalassarche chrysostoma*). In addition, eighteen pelagic seabird species in Table 6.25 are classified as vulnerable under the EPBC Act.

Australian breeding and/or foraging populations of albatrosses and petrels generally represent a small proportion of global populations, except the shy albatross (*Thalassarche cauta*), which is endemic (DCCEEW, 2022g).

6.3.9.2 Biologically Important Areas

Biologically Important Areas (BIAs) are defined by DCCEEW (2021) as spatially defined areas where aggregations of individuals of a regionally significant species are known to display biologically important behaviours such as breeding, foraging, resting, or migration.

Table 6.26 lists those marine pelagic birds that have foraging BIAs within Bass Strait and which will be intercepted by the project’s proposed alignment. The foraging BIAs are based on those published in the Commonwealth’s National Conservation Values Atlas (DCCEEW, 2022a).

[6] By convention, the common names of all bird common names have initial capital letters to distinguish a taxonomic species from a general description of a bird (Gill et al., 2022).

Table 6-25: List of pelagic seabirds and presence in the project PMST areas

Species	Common name	Conservation status		Occurrence in PMST area			Migratory
		IUCN	EPBC Act	Victorian nearshore	Offshore Bass Strait	Tasmanian nearshore	
Procellariiformes (albatrosses and petrels):							
Diomedea antipodensis	Antipodean Albatross	EN	VU	FL	FL	FL	Yes
Diomedea antipodensis gibsoni	Gibson's Albatross	EN	VU	FL	FL	FL	No
Diomedea epomophora	Southern Royal Albatross	VU	VU	FL	FL	FL	Yes
Diomedea exulans	Wandering Albatross	VU	VU	FL	FL	FL	Yes
Diomedea sanfordi	Northern Royal Albatross	EN	EN	FL	FL	FL	Yes
Fregetta grallaria grallaria	White-bellied Storm-petrel	LC	VU	SL	SL	SL	No
Halobaena caerulea	Blue Petrel	LC	VU	SM	SM	SM	No
Macronectes giganteus	Southern Giant Petrel	LC	EN	SM	FL	FL	Yes
Macronectes halli	Northern Giant Petrel	LC	VU	SM	SM	SM	Yes
Pelagodroma marina	White-faced Storm-petrel	LC	–	–	–	–	
Phoebetria fusca	Sooty Albatross	LC	VU	SL	SL	SL	Yes
Pterodroma leucoptera leucoptera	Gould's Petrel	VU	EN	SM	SM	SM	No
Pterodroma mollis	Soft-plumaged Petrel	LC	VU	SM	SM	SM	No
Thalassarche bulleri	Buller's Albatross	NT	VU	SM	SM	SM	Yes
Thalassarche bulleri platei	Northern Buller's Albatross	NE	VU	SM	SM	SM	No
Thalassarche cauta	Shy Albatross	NT	EN	FL	FL	FL	Yes
Thalassarche carteri	Indian Yellow-nose Albatross	EN	VU	SL	SL	SL	Yes
Thalassarche chrysostoma	Grey-headed Albatross	EN	EN	SM	SM	SM	Yes
Thalassarche impavida	Campbell Albatross	VU	VU	FL	FL	FL	Yes
Thalassarche melanophris	Black-browed Albatross	LC	VU	SM	FL	FL	Yes
Thalassarche salvini	Salvin's Albatross	VU	VU	FL	FL	FL	Yes
Thalassarche steadi	White-capped Albatross	NT	VU	FL	FL	FL	Yes
Charadriiformes (gulls, terns, skuas):							

Species	Common name	Conservation status		Occurrence in PMST area			Migratory
		IUCN	EPBC Act	Victorian nearshore	Offshore Bass Strait	Tasmanian nearshore	
Sternula nereis nereis	Australian Fairy Tern	VU	VU	SK	FL	SK	
Charadriiformes (gulls, terns, skuas):							
Stercorarius (Catharacta) skua	Great Skua	LC	–	SM	SM	SM	Yes
Sternula albifrons sinensis	Little Tern (western Pacific)	LC	–	SM	–	SM	Yes
Sternula albifrons	Little Tern	LC	–	SM	–	SM	Yes
Thalasseus bergii	Crested Tern	LC	–	BK	–	–	Yes
Hydroprogne caspia	Caspian Tern	LC	–	BK	–	–	Yes
Onychoprion fuscata	Sooty Tern	LC	–	BK	–	–	Yes
Accipitriformes:							
Haliaeetus leucogaster	White-bellied sea-eagle	LC	–	SK	–	BK	Yes
Procellariiformes (shearwaters, prions and skuas):							
Ardenna carneipes	Flesh-footed Shearwater	NT	–	FL	FL	FL	Yes
Ardenna griseus	Sooty Shearwater	NT	–	SM	SM	SM	Yes
Ardenna tenuirostris	Short-tailed Shearwater	LC	–	SM	SM	SM	Yes
Pachyptila turtur	Fairy Prion	LC	–	SK	SK	SK	Yes
Pachyptila turtur subantarctica	Southern Fairy Prion	–	–	SK	SK	SK	Yes
Sphenisciformes (penguins):							
Eudyptula minor	Little Penguin	LC	–	SK/FL	SK/FL	*SK/FL	No

Notes: EPBC Act: EN – Endangered; VU – Vulnerable; LC – Least Concern; NT – Near threatened; Dash (–) denotes not listed. EPBC Protected Matters Search Reports' species occurrence in area: FK – Foraging, feeding or related behaviour known to occur; FL = Foraging, feeding or related behaviour likely to occur; FM - Foraging, feeding or related behaviour may occur; SK = Species or species habitat known to occur; SL = Species or species habitat likely to occur; SM = Species or species habitat may occur; BK – Breeding known to take place.

In Table 6.26, 14 marine birds with foraging BIAs in Bass Strait includes both threatened species and listed marine species under the EPBC Act.

Table 6-26: Threatened or listed marine birds with foraging BIAs within Bass Strait

Common name	EPBC Act Status	Presence in PMST search area	Biologically Important Area F= foraging; B=Breeding
Wandering Albatross	VU	FO	B.S. excl. 3-nm limits (F)
Buller's Albatross	VU	MO	B.S. excl. 3-nm limits (F)
Shy Albatross	EN	FO	B.S. incl. 3-nm limits (F)
Campbell Albatross	VU	FO	B.S. excl. 3-nm limits (F)
Black-browed Albatross	VU	FO	B.S. excl. 3-nm limits (F)
Antipodean Albatross	VU	FO	B.S. excl. 3-nm limits (F)
Indian, Yellow-nosed Albatross	–	–	B.S. excl. 3-nm limits (F)
Soft-plumaged Petrel	EN	MO	B.S. incl. 3-nm limits* (F and B)
White-faced Storm Petrel	–	–	B.S. incl. 3-nm limits* (F and B)
Common Diving Petrel	–	–	B.S. incl. 3-nm limits (F and B)
Short-tailed Shearwater	–	–	B.S. incl. 3-nm limits (F)
Australasian gannet	–	–	Port Phillip Bay/Pyramid Rock (F)
Black-faced Cormorant	–	MO	B.S. incl. 3-nm limits (F and B)
Little Penguin	–	KO	Numerous (see Section 6.3.9.2.5, Little Penguin) (F and B)

Source: EPBC Act PMST reports (PMST, 2023; Attachment A: Offshore Bass Strait, Attachment B: Nearshore Victoria and Attachment C: Nearshore Tasmania). B.S. = Bass Strait. *Foraging BIA does not include Waratah Bay or Wilsons Promontory. EPBC Act codes: EN = Endangered; VU = Vulnerable; Occurrence in area codes: FO = Foraging, feeding or related behaviour likely to occur; LO = Species or species habitat likely to occur; MO = Species or species habitat may occur; KO = Species or species habitat known to occur. Dash (–) under EPBC Act status denotes not threatened and dash (–) under presence in PMST search area denotes absence.

6.3.9.2.1 Marine bird breeding sites and foraging BIA sites

In Table 6.26, only the endemic Shy Albatross (*Thalassarche cauta*) is known to have a breeding site in Bass Strait (Albatross Island) as listed in the National Conservation Values Atlas (DCCEEW, 2022a). The other five albatrosses in Table 6.26 breed outside Australian waters and are mainly ocean-wide species with a very large foraging area, which includes Bass Strait and most of or the whole of the South-east Marine Region (DoE, 2015b).

The Shy Albatross has been selected as a representative of the EPBC Act threatened albatross species and is listed in Table 6-27 along with other non-threatened listed marine birds with foraging BIAs in Bass Strait.

Table 6-27: Selected marine birds with breeding BIAs in Bass Strait

Common name	EPBC	Presence	Breeding BIA	Location	Distance (km)
Shy Albatross	EN	FO	Yes	Albatross Island (TAS)	122
Common Diving Petrel	–	–	Yes	Kanowna Island (VIC)	17
Short-tailed Shearwater	–	–	Yes	Kanowna Island (VIC)	17
Australasian gannet	–	–	Yes	Port Phillip Bay (VIC) Pyramid Rock (TAS)	153 95
Little Penguin	–	KO	Yes	Kanowna Island (VIC) Curtis Group (TAS)	17 42

Source: National Conservation Values Atlas (DCCEEW, 2022a) and Google Earth™.

Descriptions of the marine bird species in Table 6.27 are summarised below.

Shy Albatross

The Shy Albatross (*Thalassarche cauta*) is listed as endangered and migratory, and as a listed marine species under the EPBC Act. This species is managed under the National Recovery Plan for threatened Albatrosses and Giant Petrels 2022 (DSEWPaC, 2011)

The main Shy Albatross breeding colony is on Albatross Island that lies between Hunter Island (Fleurieu Group) and King Island in far northwest Tasmania. This breeding colony is located 122 km from the project's proposed alignment, which is well outside the project's area of influence. Albatross Island (0.33 km^2) is very rocky, with a coastline of eroded boulders, gulches and caves and a short cover of grasses and herbs across the interior and holds approximately 30% of the global breeding population (Mason et al., 2018). Shy Albatrosses also breed on the rocky islets of the Mewstone and Pedra Branca, which are located to the south of Tasmania. Juveniles from Mewstone and Pedra Branca travel further west, sometimes to South Africa, where they forage over shelf waters (Mason et al. 2018).

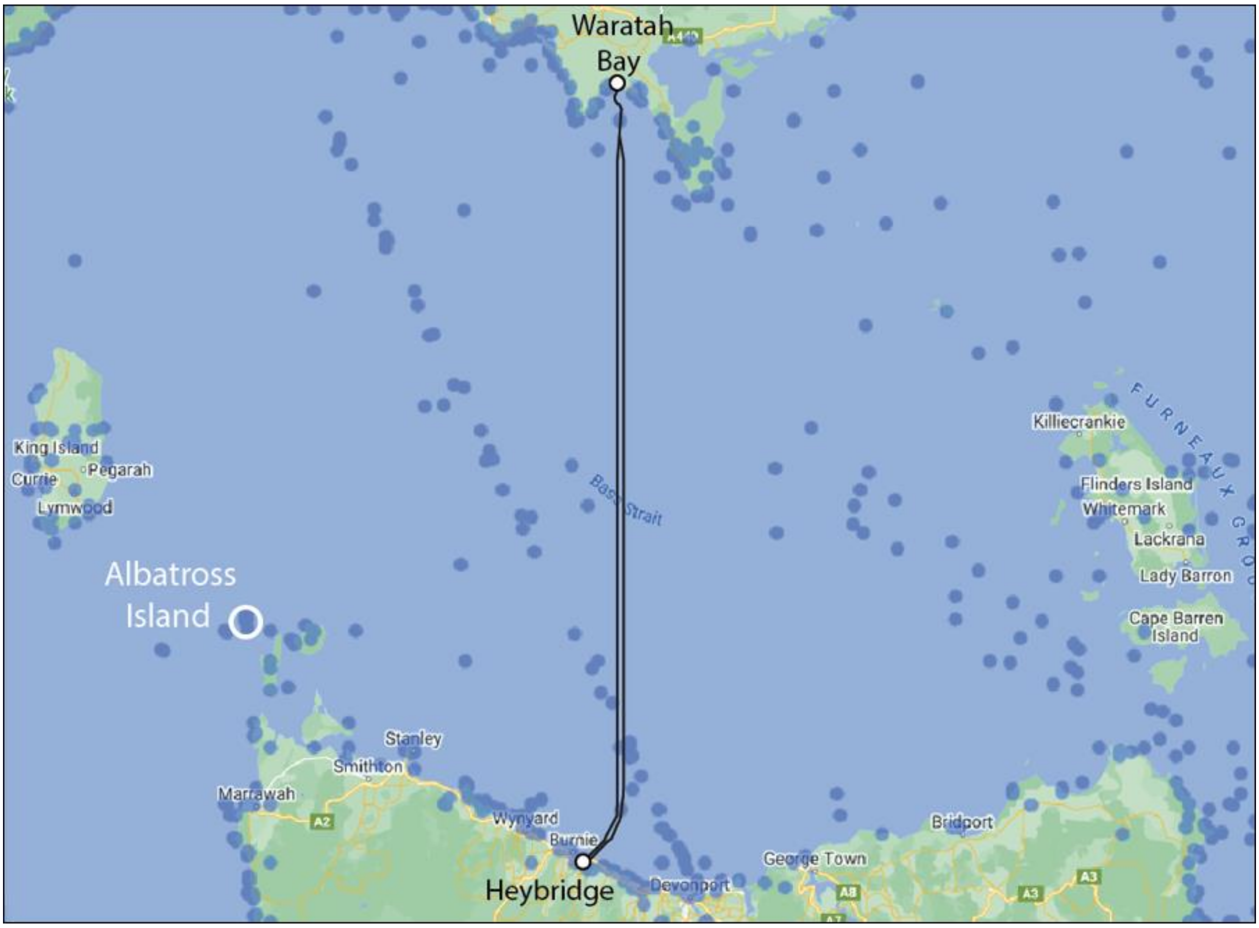
Unlike most albatrosses that are highly mobile during the non-breeding season and utilise expansive foraging areas across ocean basins, the shy albatross typically feeds within 300 km of the colony and maintains a year-round presence (Mason et al., 2018). At sea, adults largely remain in Australian waters, mostly remaining near nesting islands, as do juveniles from Albatross Island (Alderman et al., 2011). The foraging BIA for the Shy Albatross is the whole of Bass Strait including Victorian and Tasmanian waters within the 3-nm limit (see Table 6.26). BIA foraging areas are also located in southern New South Wales, eastern Victoria (Mallacoota) and along the east coast of Tasmania.

Based on a research study by McInnes et al. (2020), the diet of the Shy Albatross consisted predominantly of fish (93%) and cephalopods (38%), with a total of 84 fish and 11 cephalopod species identified. Most prey items were sourced naturally; however, at least 13% of the Shy Albatross population studied was sourcing fishery discard species with up to 29% during some breeding stages.

The Atlas of Living Australia (CSIRO, 2022) records over 100 records of the Shy Albatross in Bass Strait. Figure 6.43 shows the distribution of sightings of this species along the coastline, offshore islands and offshore open waters of Bass Strait.

Distribution in Victorian waters

Figure 6.43 indicates that sightings of the Shy Albatross are common along the southern coastline around Wilson Promontory and Waratah Bay. The northeast-southwest linear track of sightings represents observations taken by passengers and bird naturalists on the transits of the MV *Spirit of Tasmania I* and MV *Spirit of Tasmania II* during transits between Melbourne and Devonport.



Source: Atlas of Living Australia (CSIRO, 2022). Albatross Island is a breeding BIA for the Shy Albatross. Black lines denote the project's proposed alignment. All marine waters represent foraging BIA of this species.

Figure 6.43: Shy Albatross distribution of sightings in Bass Strait

The likelihood of occurrence of Shy Albatrosses in nearshore Victorian waters and adjacent offshore Bass Strait waters under Victorian jurisdiction and nearshore Victorian waters (PMST, 2023; Attachment B) is assessed as ***Very likely***.

Distribution in Tasmanian waters

Figure 6.43 indicates that sightings of the Shy Albatross are common along the northern coastline of Tasmania as well as concentrations of sightings around King Island and the Fleurieu Group (Three Hummock Island, Hunter Island and Robbins Island) including Albatross Island, the Furneaux Group (Flinders Island, Cape Barren Island and Clarke Island), as well as numerous sightings in the open waters of Bass Strait under Tasmanian jurisdiction.

The Commonwealth marine reserves of Boags Rock Marine Reserve and Franklin Marine Reserve both provide important foraging grounds for nearby breeding colonies of seabirds (e.g., Shy Albatross colonies on Albatross Island).

The likelihood of occurrence of Shy Albatrosses in nearshore Tasmanian waters at Heybridge and adjacent offshore Bass Strait waters is assessed as ***Very likely***.

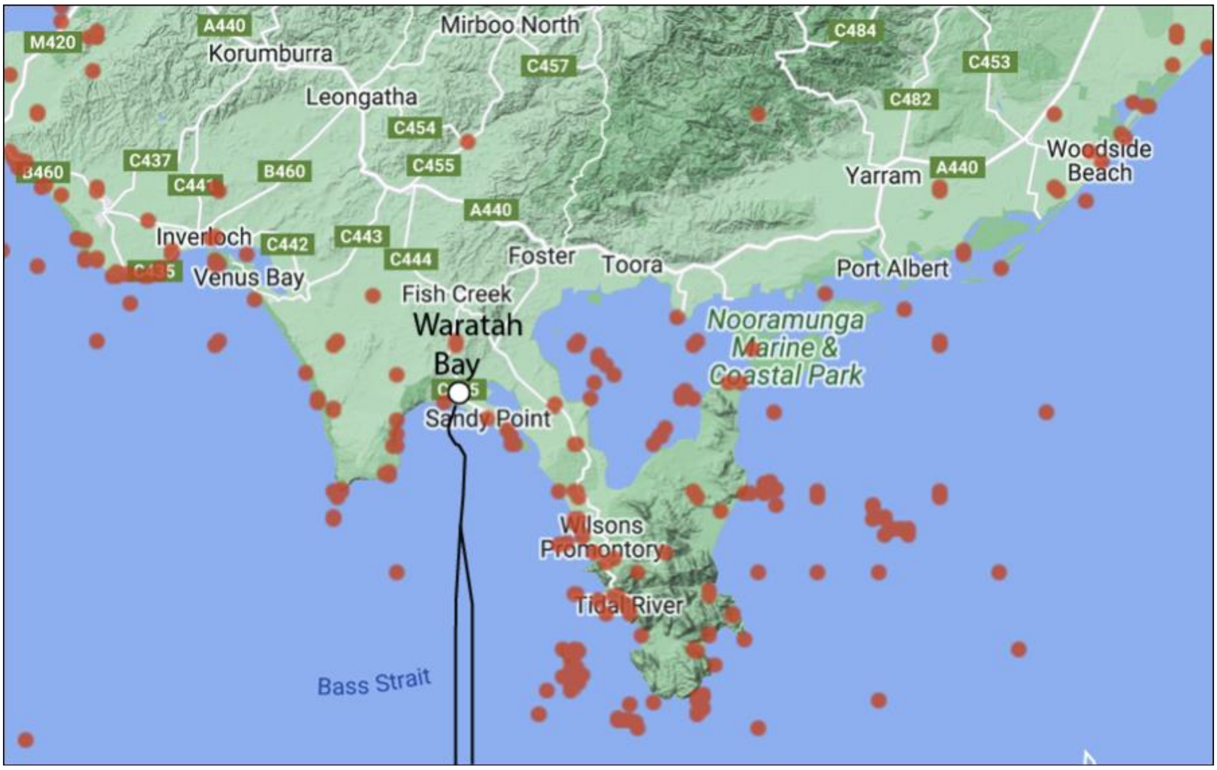
6.3.9.2.2 Short-tailed Shearwater

The Short-tailed Shearwater (*Ardenna tenuirostris*[7]*)*, also known as the Tasmanian muttonbird, is not listed as threatened but is listed as migratory and as a marine species under the EPBC Act. The National Conservation Values Atlas (DCCEEW, 2022a) indicates that numerous islands within Waratah Bay and around Wilsons Promontory are breeding BIAs for this species.

The Short-tailed Shearwater is a circum-Pacific migrant ranging to 65° S in the Antarctic zone in the breeding season (Kerry et al., 1983) and to the far North Pacific Ocean in the non-breeding season (Serventy, 1974). The Short-tailed Shearwater breeds on islands and mainland headlands and promontories. It burrows where soft soil of at least 30 cm depth occurs, usually stabilised by vegetation in native and modified grasslands, bracken fern, scrubland and open forest. (Skira et al., 1996).

Distribution in Victoria

Figure 6.44 shows the distribution of Short-tailed Shearwaters in nearshore Victorian waters as far as the Victorian-Tasmanian maritime border (39° 11’ 53.44" S), which lies 6.9 km south of South Point at the southern tip of Wilsons Promontory.



Source: Atlas of Living Australia (CSIRO, 2022). Black lines denote the project’s proposed alignments.

Figure 6.44: Distribution of Short-tailed Shearwaters in nearshore Victoria

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[7] *Ardenna tenuirostris* was formerly known as *Puffinus tenuirostris*.

In Figure 6.44, numerous Short-tailed Shearwaters have been observed in Waratah Bay and the west coast and associated islands of Wilsons Promontory. Given the presence of numerous breeding sites (see below) in this nearshore region,

The likelihood of occurrence of Short-tailed Shearwaters in the Victorian nearshore and adjacent offshore waters is assessed as ***Very likely***.

Breeding sites in Victorian nearshore waters

Reviews of the SPRAT database (DCCEEW, 2022c) and the scientific literature indicates that numerous islands within Waratah Bay and around Wilsons Promontory are breeding sites for Short-tailed Shearwaters. Figure 6.45 shows the breeding sites of Short-tailed Shearwaters in Victorian nearshore waters and Table 6.28 presents a summary of the breeding sites in Victorian waters and their proximity (distance) to the nearest proposed alignment of the project.

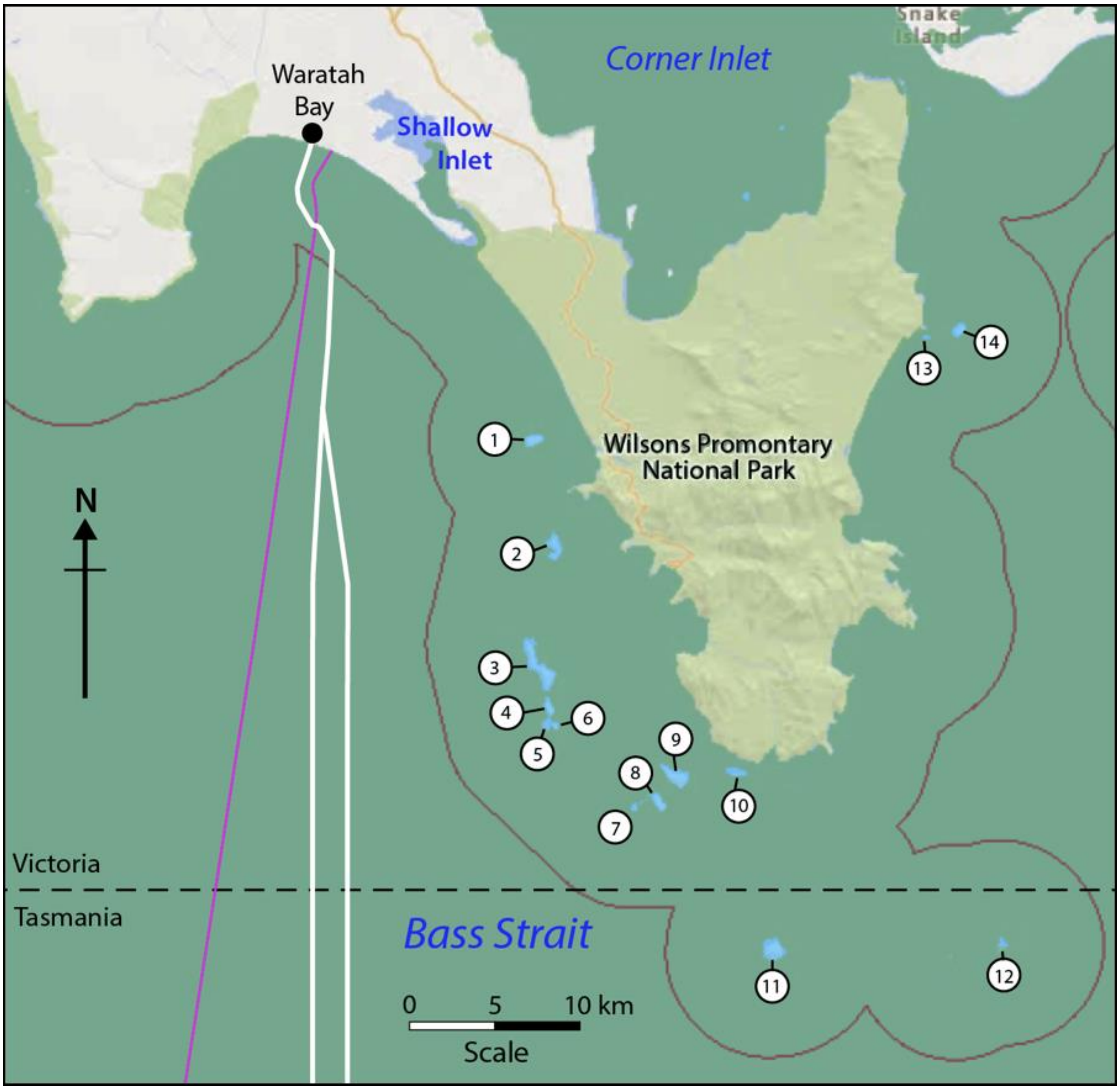
Table 6-28: Breeding sites of Short-tailed Shearwaters in nearshore Victorian waters

Name of colony	Coordinates	Number of borrows	Distance to project (km)
Waratah Bay and Wilsons Promontory			
Shellback Island	38° 58' 6.54" S, 146° 13' 41.26" E	61,339	11.2
Norman Island	39° 1' 21.12 "S, 146° 14' 31.10" E	86,592	11.4
Great Glennie Island	39° 5' 1.49" S, 146° 13' 43.00" E	262,315	9.9
Dannevig Island	39° 6' 22.36" S, 146° 14' 15.11" E	2,832	11.1
Citadel Island	39° 6' 52.10" S, 146° 14' 13.24" E	631	10.9
McHugh Island	39° 6' 55.97" S, 146° 14' 31.38" E	6,845	11.6
Kanowna Island	39° 9' 14.36" S, 146° 18' 38.38" E	53,808	17.3
Anser Island	39° 8' 29.51" S, 146° 19' 21.70" E	120,564	17.8
Wattle Island	39° 8' 21.37" S, 146° 21' 41.78" E	62,370	21.5
Rabbit Rock	38° 54' 54.25" S, 146° 29' 22.76" E	1,019	34.3
Rabbit Island	38° 54' 43.45" S, 146° 30' 40.24" E	82,966	36.2

Source: Schuman et al. (2014). Blue shaded rows denote Short-tailed Shearwater breeding sites to the east of Wilsons Promontory, which are not considered further. Breeding sites based on the Species Profile and Threats Database (DCCEEW, 2022c). Distance to project is direct given that short-tailed shearwaters fly.

In Figure 6.45, there are 12 islands either within Waratah Bay or around off the coast of Wilsons Promontory that are breeding sites for the Short-tailed Shearwater. An additional two breeding sites (rookeries) found on Rodondo Island and East Moncoeur Island are located within Tasmanian waters of northern Bass Strait. A short literature search did not reveal the numbers of birds nesting on these islands; however, an indication of overall numbers may be interpreted from the number of active burrows at the breeding sites.

Schumann et al. (2014) estimated the total number of breeding burrows of Short-tailed Shearwaters in the northern-central Bass Strait region in 2008–2011 was 755,300 ± 32,400 (standard error). Based on active burrows, the number of breeding Short-tailed Shearwaters in the region was estimated to have decreased by 35% between 1978–1980 and 2008–2011, which is equivalent to a decrease of 1.4% per annum between 1980 and 2011.



Source: National Conservation Values Atlas (DCCEEW, 2022a); Schumann et al. (2014). Islands: 1 = Shellback, 2 = Norman, 3 = Great Glennie, 4 = Dunnevig, 5 = Citadel, 6 = McHugh, 7 = Anderson Islets, 8 = Kanowna, 9 = Anser, 10 = Wattle, 11 = Rodondo, 12 = East Moncoeur, 13 = Rabbit Rock and 14 = Rabbit Island. Green shading denotes BIA foraging area. Blue shaded islands = breeding sites of short-tailed shearwaters. White lines = the project. Red line is Telstra's Bass Strait 1 cable. Brown line is the 5 nautical mile limit.

Figure 6.45: Breeding sites of Short-tailed Shearwaters in nearshore Victoria

Based on the studies of Schumann et al. (2014), the five largest Short-tailed Shearwater colonies in nearshore Victorian waters are located at Great Glennie Island (262,315 burrows), Anser Island (120,564 burrows), Norman Island (86,592 burrows), Rabbit Island (82,966 burrows) and Wattle Island (62,370 burrows). Most of these islands are within 20 km of the nearest proposed alignment of the project. The most important breeding site is Great Glennie Island, which has 262,312 burrows and is also the closest breeding site (9.9 km) to the project.

Foraging BIAs in Victorian waters

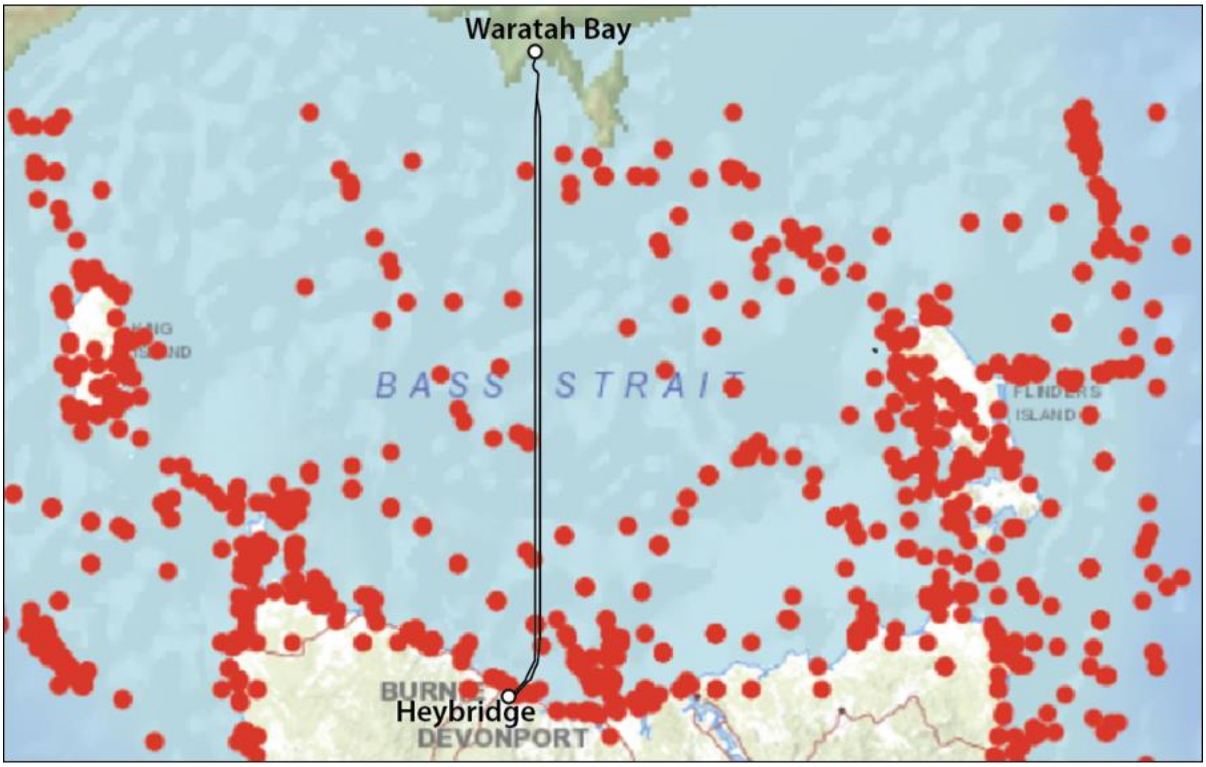
In Figure 6.45, the foraging BIA for Short-tailed Shearwaters (shown as green shading) includes the whole of Bass Strait including 3-nm limit zones of both Victoria and Tasmania. In addition, the tidal reach of Shallow Inlet is also included in the foraging BIA for this species. Therefore, the foraging BIA for this species includes the nearshore Victorian waters and adjacent offshore Bass Strait waters under Victorian jurisdiction and through which the project's proposed alignment passes.

Distribution in Tasmania

Based on the Tasmanian Natural Values Atlas (DNRE, 2022), Figure 6.46 shows the distribution of sighting records of Short-tailed Shearwaters in Bass Strait waters under Tasmanian jurisdiction.

Concentrations of sightings have been recorded at King Island in the west and the Furneaux Group (Flinders, Cape Barren and Clarke islands) in the east. Many sightings are across the smaller offshore islands of Bass Strait, which are under Tasmanian jurisdiction.

The likelihood of occurrence of Short-tailed Shearwaters in nearshore Tasmanian waters and offshore waters of Bass Strait under Tasmanian jurisdiction through which the project intercepts is assessed as ***Very likely***.



Source: Tasmanian Natural Value Atlas (DNRE, 2022). Black lines denote the project's alignment.

Figure 6.46: Short-tailed Shearwaters in Tasmanian Waters of Bass Strait

Breeding sites in Tasmanian waters

Table 6.29 lists Short-tailed Shearwater breeding sites (colonies) in the northwest and north-central coast of Tasmania, as well as offshore islands in northern Bass Strait (Skira et al., 1998). There are many other mainland- and island-based colonies within Bass Strait; however, Table 6.29 lists only those colonies within 80 kms of the project's proposed alignment.

Table 6-29: Short-tailed Shearwater colonies in Tasmanian waters of Bass Strait

Name of colony	Coordinates	Number borrows	Distance from the project
Northwest Tasmania (land):			
Stanley Nut	40° 47' S, 145° 19' E	13,276	68
Black River	40° 48 'S, 145° 19' E	100	64
Rocky Cape, Forwards Beach	40° 53' S, 145° 28' E	100	48
Sisters Island	40° 54' S, 145° 35' E	15	42
Table Cape	40° 57' S, 145° 43' E	100	27
North coast Tasmania (land):			
Lillico Beach	41° 10' S, 146° 18' E	500	26
Don Heads	41° 10' S, 146° 20' E	1,000	27
Point Sorell	41° 08' S, 146° 32' E	7,050	41
Northern Bass Strait (islands):			
Hogan Group, Hogan Island	39° 14' S, 146° 59' E	14,820	75
Hogan Group, Long Islet	39° 12' S, 147° 99' E	3,700	78
Hogan Group, East Islet	39° 13' S, 147° 01' E	4,515	79
Hogan Group, Round Islet	39° 13' S, 146° 59' E	175	77
Hogan Group, Twin Islets	39° 12' S, 146° 59' E	55	75
Cone Islet	39° 30' S, 146° 40' E	85	47
Devils Tower	39° 23' S, 146° 45' E	400	55
Curtis Island	39° 28' S, 146° 39' E	390,000	47
East Moncoeur Island	39° 14' S, 146° 32' E	41,290	37
West Moncoeur Island	39° 14' S, 146° 32' E	100	35
Rodondo Island	39° 14' S, 146° 23' E	77,000	24

Source: Skira et al. (1996).

The five largest Short-tailed Shearwater colonies are located at Curtis Island (390,000 burrows), Rodondo Island (77,000 burrows), East Moncoeur Island (41,290 burrows), Hogan Island (14,820 burrows) and The Nut at Stanley (13,276 burrows). The closest colony to the project's proposed alignment is at Sisters Island, which is located 42 km to the west of the nearest proposed alignment of the project.

6.3.9.2.3 Australasian gannet

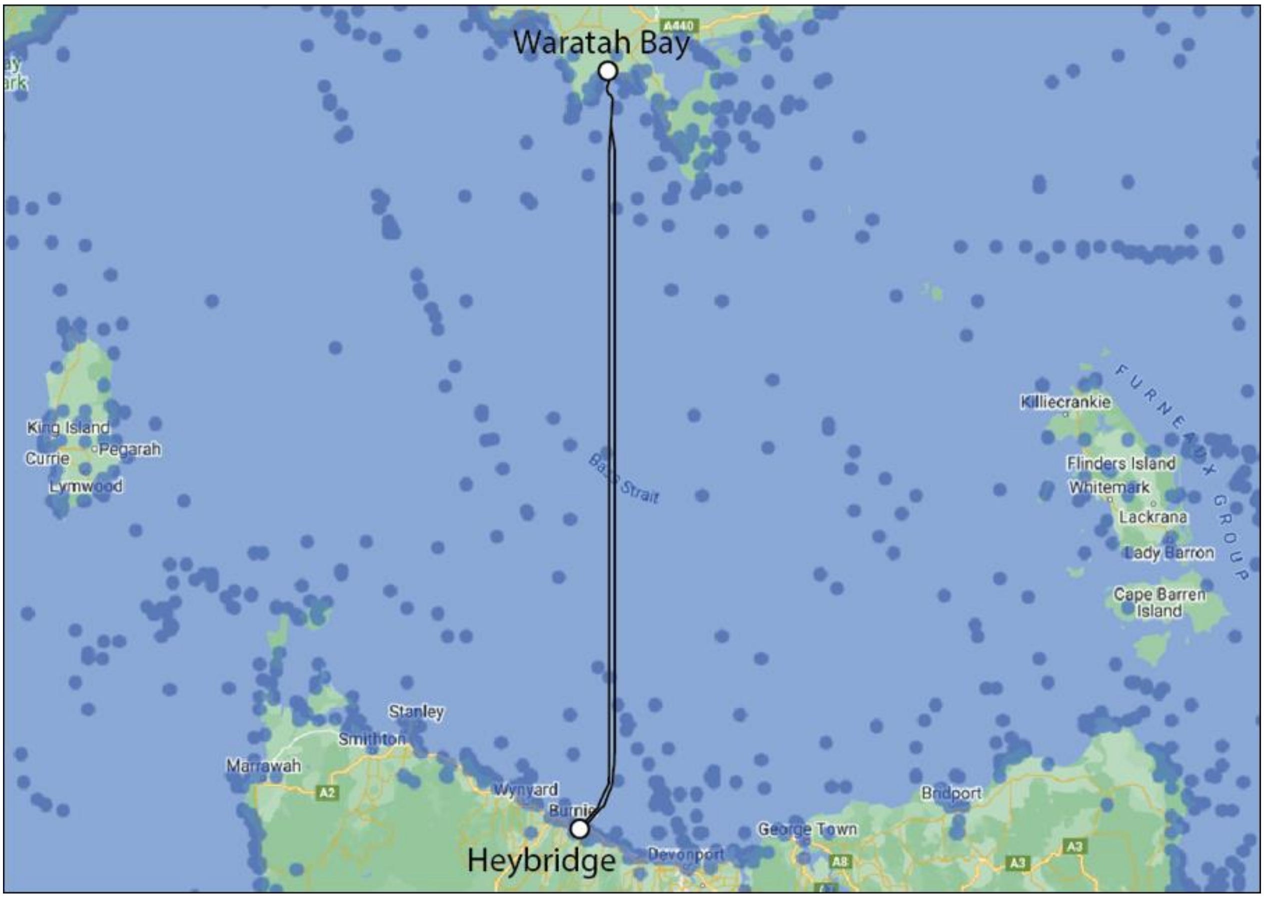
The Australasian gannet (*Morus serrator*) is not listed as threatened or migratory but is a listed marine species under the EPBC Act. The Atlas of Living Australia (CSIRO, 2022) indicates that this species is widely distributed along both the Victorian and Tasmanian coasts and offshore islands and the open waters of Bass Strait.

The Australasian gannet's main foraging strategy is vertical plunge-diving, a highly specialised technique (Machovsky-Capuska, et al., 2013) and is often associated with small baitfish also visited upon by Australian fur seals, dolphins, sharks and other seabirds, which has been proven beneficial to find and capture prey (Wells et al., 2016).

Distribution in Victorian waters

Figure 6.47 shows the distribution of sighting records of the Australasian gannet in Victorian nearshore and adjacent offshore waters. There are around 31 sightings of this species in Waratah Bay and a further 36 sightings along the mainland and islands of the west coast of Wilsons Promontory.

The likelihood of occurrence of Australasian gannets in nearshore and adjacent offshore water of Bass Strait waters under Victorian jurisdiction and through which the project passes is assessed as ***Very likely***.



Source: National Conservation Values Atlas (DCCEEW, 2022a). Black lines denote proposed alignment of the project.

Figure 6.47: Distribution of sightings of Australasian gannets in Bass Strait

Victorian breeding sites

The SPRAT database (DCCEEW, 2022c) indicates that there are two breeding sites for the Australasian gannet (*Morus serrator*) within Victoria, which include Port Phillip Bay and the combined Lawrence Rocks and Point Danger breeding sites near Portland in the southwest.

In Port Phillip Bay, Australasian gannet breeding sites are generally present on isolated artificial structures (e.g., the Pope's Eye) near the bay's entrance (Rodríguez-Malagón, 2018), which is located 150 km northwest of the project's proposed alignment. In 2016, there was an estimated 310 breeding pairs in Port Phillip Bay (Angel et al., 2016). A second Australasian gannet breeding site in Victoria is located at the Lawrence Rocks southeast of Point Danger near Portland; however, this breeding site is located 395 km northwest of the project's proposed alignment and lies outside the definition of Bass Strait study area given in Figure 5.1 and is therefore not considered further.

Victorian foraging BIA

The National Conservation Values Atlas (DCCEEW, 2022a) indicates that the foraging BIA for Australasian gannets from Port Phillip Bay includes the waters of Port Phillip Bay and out to about 35 km of northern Bass Strait. This outer limit of this seaward buffer zone is about 130 km from the nearest proposed alignment of the project. However, while the breeding sites and the foraging BIA for the Australasian gannet in Victorian waters of Port Phillip Bay and adjacent waters of Bass Strait are located well away from the nearest proposed alignment of the project, any project-related vessels using the Port of Melbourne or other ports within Port Phillip Bay will intercept with the foraging BIA of this species.

Distribution in Tasmanian waters

Figure 6.47 shows the distribution of sighting records of the Australasian gannet in Tasmanian nearshore and adjacent offshore waters. There are around 40 sightings of this species along the Tasmanian north coast between Burnie and Devonport, which include the proposed nearshore landfall of the project at Heybridge. The Australasian gannet is widely spread in Tasmanian waters of Bass Strait with concentrations of sightings in the far northwest of Tasmania (e.g., King Island and the Fleurieu Group (Three Hummock, Robbins and Hunter islands) and the Furneaux Group (Flinders, Cape Barren and Clarke islands).

The likelihood of occurrence of Australasian gannets in nearshore and adjacent offshore waters of Bass Strait under Tasmanian jurisdiction and through which the project passes is assessed as ***Very likely***.

Tasmanian breeding sites

In Tasmania, the Australasian gannet breeding site is located on Black Pyramid Rock, which is located to the west of Hunter Island in the Fleurieu Group of islands in far northwest Tasmania. This breeding site is protected by the Black Pyramid Rock Nature Reserve. Black Pyramid Rock (0.40 km^2) is a spectacular basaltic rock surrounded by steep cliffs, steep grassy slopes and a small central plateau. Black Pyramid Rock is located 147 km from the nearest proposed alignment of the project.

Tasmanian foraging BIA

The National Conservation Values Atlas (DCCEEW, 2022a) indicates that that the Australasian gannet's foraging BIA forms a radius of about 30 km around Black Pyramid Rock. The eastern edge of this buffer zone is located 117 km west of the nearest proposed alignment of the project. Overall, the foraging BIA of the Australasian gannet at Black Pyramid Rock in Tasmanian waters of Bass Strait lie well outside the project's proposed alignment and outside the project's area of influence and are therefore not considered further.

6.3.9.2.4 Common Diving Petrel

The Common Diving Petrel (*Pelecanoides urinatrix*) is not listed as threatened or migratory but is a listed marine species under the EPBC Act. Common Diving Petrels are managed under the National Recovery Plan for Albatrosses and Petrels (DCCEEW (2022g).

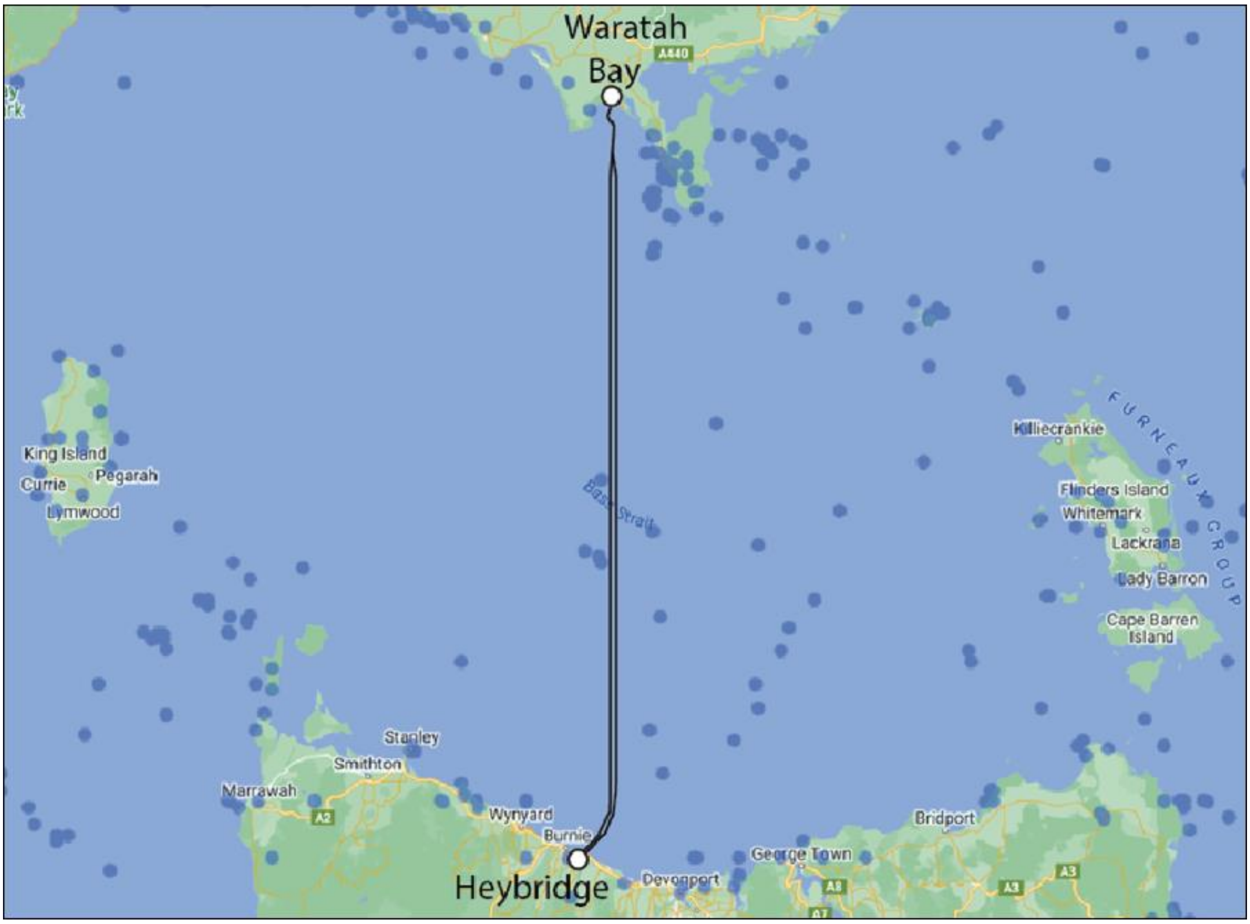
Common Diving Petrels have been recorded from waters ranging from the subtropics to the Sub-Antarctic, usually between 35° and 55° S, and they are widely distributed over southern Australian and New Zealand waters. It is the only diving petrel species known to breed in south-eastern Australia, near the northern limit of its breeding distribution (Schumann et al., 2008). This species nests on coastal plains and slopes on cliff edges and behind stable dunes, where their active burrows or tunnels are 25 cm to 150 cm long, 0.2 m to 1.0 m deep and with an entrance 5 cm to 8 cm in diameter (DCCEEW, 2022g).

The diet of Common Diving Petrels is mostly marine crustaceans, particularly euphausiids and copepods while rearing chicks. For example, Schumann et al. (2008) examined the gut contents of Common Diving Petrels that had died in a fire at Seal Island (east of Wilsons Promontory) and observed that their prey items were comprised mainly of krill (euphausiids) such as *Nyctiphanes australis* (87%) and *Themisto australis* (12.5%) and lesser quantities of copepods (0.3%), crab megalopa (0.1%) and mantis shrimp larvae (0.01%).

Common diving petrels are known to have a mean diving depth of 7.8 m with a mean range of between 6.9 and 22.2 m (Taylor, 2008). The dive depth may be dependent on local food sources and on the depth of the sea floor near the colonies, especially as the species stays quite close to the colonies during chick-rearing when both parents feed the chick each night (Miskelly and Taylor, 2004).

Distribution in Victorian waters

Figure 6.48 shows the distribution of Common Diving Petrel sighting records in Bass Strait for both Victoria and Tasmania. In Victoria, there was only one sighting within Waratah Bay and around 23 sightings along the west coast and islands of Wilson Promontory, which included a cluster of 24 sightings at the Glennie Group (Great Glennie, Dannevig, Citadel and McHugh islands). Another cluster of 25 sightings was around Seal Island (a breeding colony) and surrounding offshore waters to the east of Wilsons Promontory.



Source: Atlas of Living Australia (CSIRO, 2022). Black lines denote proposed alignment of the project.

Figure 6.48: Distribution of sighting records of Common Diving Petrels in Bass Strait

The likelihood of occurrence of Common Diving Petrels in Waratah Bay is assessed as possible. However, in offshore waters of Bass Strait and west of Wilson Promontory, the likelihood of occurrence of Common Diving Petrels is assessed as ***Very likely***, which is confirmed by the presence of numerous Common Diving Petrel breeding sites at Kanowna Island and other islands of the west and south coasts of Wilson s Promontory (see below).

Victorian breeding sites

The main breeding site for the Common Diving Petrel in Victoria is Phillip Island around which there is a foraging BIA is based on the National Conservation Values Atlas (DCCEEW, 2022a). However, there are numerous smaller breeding sites in Victoria as shown in Table 6.30.

Table 6-30: Victorian Common Diving Petrel breeding sites and distances to the project

Name of breeding site	Coordinates	Distance to the project (km)
*Phillip Island	38° 28' 58.08" S, 145° 16' 4.93" E	82.0
Great Glennie Island	39° 5' 1.49" S, 146° 13' 43.00" E	9.9
Shellback Island	38° 58 '6.54" S, 146° 13' 41.26" E	10.9
Citadel Island	39° 6 '52.10" S, 146° 14' 13.24" E	11.0
Dannevig Island	39° 6' 22.36" S, 146° 14' 15.11" E	11.2
Norman Island	39° 1' 21.12" S, 146° 14' 31.10" E	11.4
McHugh Island	39° 6' 55.97" S, 146° 14' 31.38" E	11.7
Kanowna Island	39° 9' 14.36" S, 146° 18' 38.38" E	17.0
Anser Island	39° 8' 29.51" S, 146° 19' 21.70" E	17.8
Wattle Island	39° 8' 21.37" S, 146° 21' 41.78" E	21.5
Rag Island	38° 57' 16.61" S, 146° 40' 50.71" E	53.9
Seal Island	38° 55' 32.02" S, 146° 39' 41.11" E	54.0
Notch Island	38° 56' 28.65" S, 146° 40' 34.70" E	54.5
Cliffy Island	38° 57' 1.24" S, 146° 42' 19.51" E	56.5
St Kilda Pier (Port Phillip Bay)	37° 51' 53.19" S, 144° 57' 56.91" E	205
Lady Julia Percy Island	38° 25' 4.35" S, 142° 0' 12.69" E	318
Lawrence Rocks	38° 24' 25.69" S, 141° 40' 11.42" E	401

Source: * National Conservation Values Atlas (DCCEEW, 2022a) foraging BIA site; other sites by Marchant and Higgins (1990). Blue shaded rows denote BIA breeding sites exceeding 100 km distance from the nearest proposed alignment of the project, and which have not been conserved further.

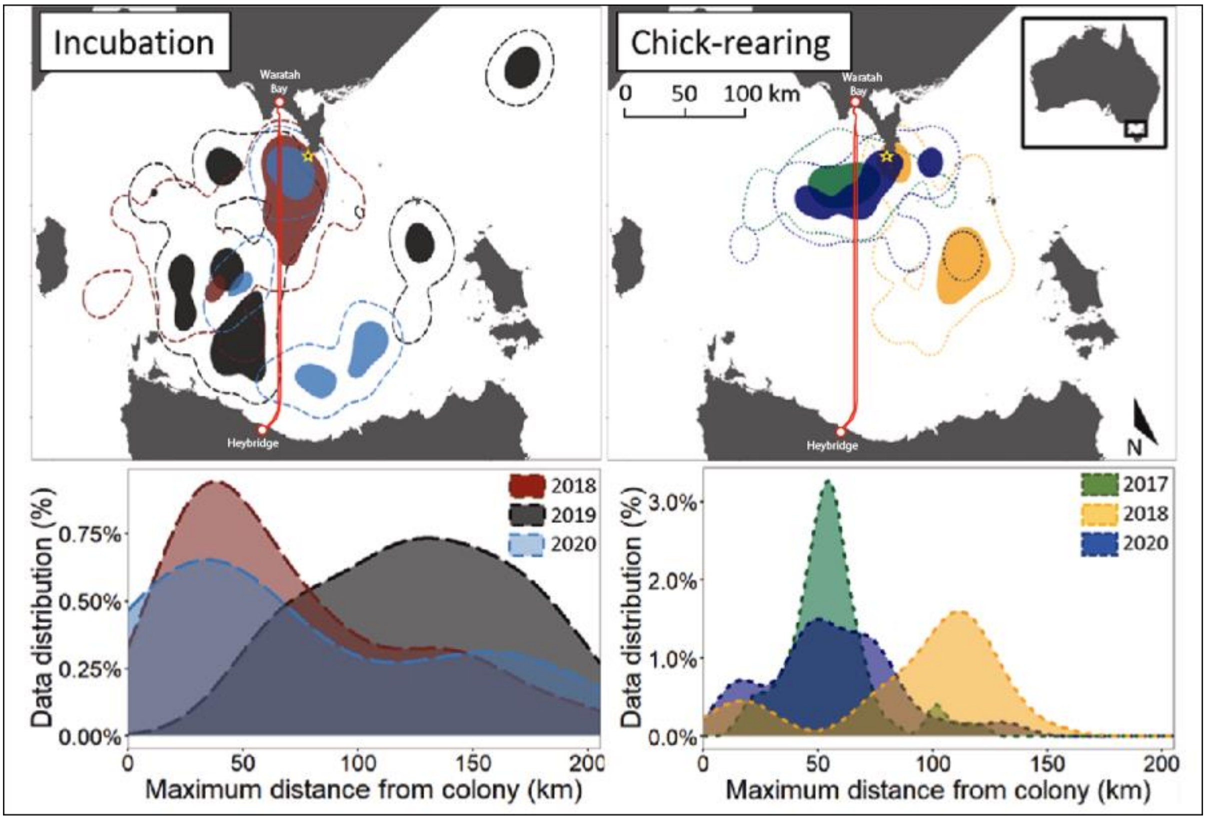
The closest breeding site of the Common Diving Petrel is on Greater Glennie Island, which is located 9.9 km from the nearest proposed alignment of the project. Besides Greet Glennie Island, other Glennie Group islands with breeding habitats are Citadel, Dannevig and McHugh islands. Common Diving Petrel breeding sites to the east of Wilson Promontory (e.g., Rag, Seal, Notch and Cliffy islands) are greater than 50 km from the project and are thus outside the project’s area of influence on these eastern breeding sites.

Schumann et al. (2014) observed that the dominant breeding sites Common Diving Petrels on the west of Wilson Promontory (and close to the project’s proposed alignment) were Shellback Island (3,119 active burrows), Anser Island (1,954 burrows), Norman Island (1.863 burrows), Wattle Island (1,733 burrows), and Kanowna Island (227 burrows).

Victorian foraging BIAs

The National Conservation Values Atlas (DCCEEW, 2022a) indicates that all marine waters under Victorian jurisdiction in Bass Strait including the coastal zone within the state’s 3-nm limit is a foraging BIA for the Common Diving Petrel, which also includes the tidal reach of Shallow Inlet. Part of the whole-of-Bass Strait foraging BIA of the Common Diving Petrel includes the Victorian nearshore waters of Waratah Bay and adjacent offshore waters of Bass Strait to the south, and within which the project will be located.

Figure 6.49 shows the key local foraging areas for Common Diving Petrels from the Kanowna Island colony during incubation and chick-rearing phases (Fromant et al., 2021). Fromant et al. (2021) conducted a study of foraging activities of Common Diving Petrels from a colony on Kanowna Island during the incubation and chick-rearing periods over four consecutive years (2017-2020). The purpose of Figure 6.49 is simply to show that the project's proposed alignment passes through a local foraging BIA of the Common Diving Petrol. More detailed descriptions of the foraging areas of this species are given in Fromant et al. (2021.)



Source: Fromant et al. (2021). Red linear lines denote the project's proposed alignment. Star denotes location of Kanowna Island, southwest of Wilsons Promontory. Top panels: solid colours and dashed lines of the same colour denote core and larger foraging areas, respectively, during incubation and chick-rearing phase. Bottom panels: Colours denote study years and distribution density for maximum distance from colony to foraging locations per foraging trip of common diving petrel in incubation (lower left) and chick-rearing (lower right) periods.

Figure 6.49: Common Diving Petrel BIA foraging areas near Kanowna Island

Distribution in Tasmanian waters

Figure 6.48 also shows the distribution of Common Diving Petrel sighting records in Bass Strait under Tasmanian jurisdiction. There are clusters of sighting records around King Island (13 sightings) and the offshore waters (33 sightings) between King Island and Hunter Island (Fleurieu Group), as well as the Furneaux Group (Flinders, Cape Barren and Clarke islands) with 24 sightings.

Along the north coast of Tasmania, there is a total of around 35 sightings of Common Diving Petrels, with five sightings along the stretch of coast between Burnie and Devonport, which includes the project's landfall at Heybridge. Coastal waters along the north coast of Tasmania are a foraging area for Common Diving Petrels.

The likelihood of occurrence of Common Diving Petrels in Tasmanian nearshore waters at Heybridge and the adjacent offshore waters of Bass Strait is assessed as ***Very likely***.

Tasmanian breeding sites

The main breeding sites of the Common Diving Petrel in Tasmania are the numerous rocky islands of the Kent Group and the Hogan Group. However, there are other smaller breeding sites within Tasmanian Bass Strait as listed in Table 6.31.

Table 6-31: Tasmanian Common Diving Petrel breeding sites and distances to the project

Name of breeding site	Coordinates	Distance to the project (km)
Curtis Island	39° 28' 20.19" S, 146° 38' 46.34" E	45
Hogan Island	39° 13' 19.37" S, 146° 59' 9.61" E	75.8
Twin Islets (North)	39° 12' 3.36" S, 146° 59' 0.07" E	75.8
Twin Islets (South)	39° 12' 14.47" S, 146° 59' 9.26" E	75.8
Long Island	39° 12' 27.21" S, 146° 59' 57.32" E	77.1
East Island	39° 12' 53.57" S, 147° 1' 19.79" E	77.8
Round Island	39° 13' 44.37" S, 146° 59' 51.62" E	76.8
North East Islet	39° 11' 54.88" S, 147° 1' 17.61" E	79.2
South West Isle	39° 31' 18.84" S, 147° 7' 40.52" E	87.7
Judgement Rocks	39° 30' 28.75" S, 147 7' 31.05" E	87.5
Big Rock	39° 30' 17.79" S, 147° 7' 47.84" E	87.9
Ninth Island	40° 50' 5.46" S, 147° 16' 12.49" E	98.5

Source: DPIPWE (2011).

The nearest breeding site of the Common Diving Petrel is Curtis Island, which is located about 45 km from the nearest proposed alignment of the project. All other breeding sites exceed distances of 75 km from the Link and, as such, lie outside the project's area of direct potential influence.

Tasmanian foraging BIA

The National Conservation Values Atlas (DCCEEW, 2022a) indicates that all marine waters under Tasmanian jurisdiction in Bass Strait including the coastal zone within the state's 3-nm limit is a BIA foraging area for the Common Diving Petrel. This includes the central north coast of Tasmania and the nearshore waters of the project's landfall at Heybridge.

6.3.9.2.5 Little Penguin

The Little Penguin (*Eudyptula minor*), also known as the Fairy Penguin, is not listed as threatened or migratory but is a listed marine species under the EPBC Act. This species is also not listed as threatened under either the FFG Act or the TSP Act.

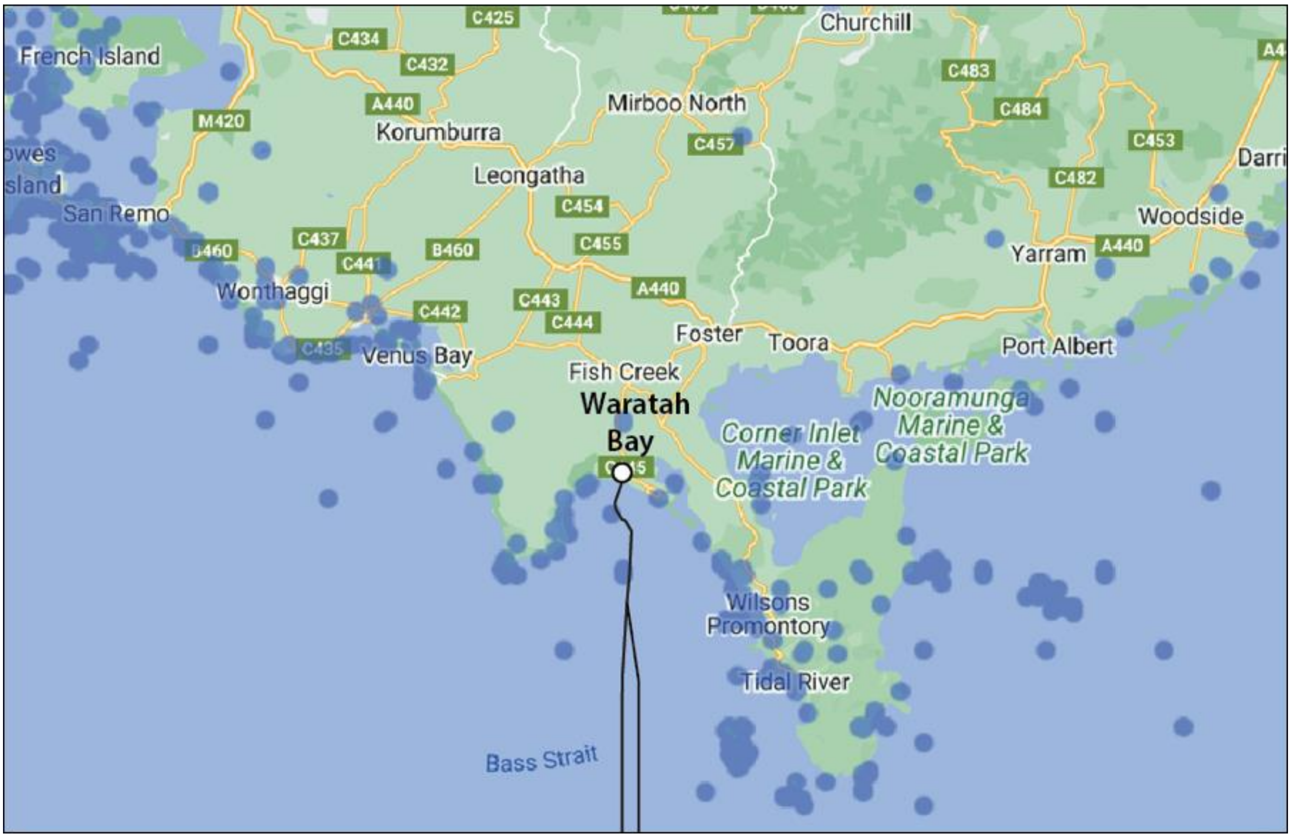
Little Penguins usually breed on offshore islands or, less commonly, along parts of the mainland coast (often talus and screes at the base of cliffs) that are inaccessible to mammalian predators. Most breeding sites are adjacent to the sea with burrows in sand or soil or under vegetation but may also nest in caves or crevices in rock falls (Dann et al., 1996). At the end of the breeding season, adult penguins come ashore to moult (replace all their feathers), often in the same burrows where they nested (Reilly and Cullen, 1983).

Population estimates made in Victoria between 1978 and 1980 suggested that 30% of the state's population bred on Phillip Island, 30% on Gabo Island and 30% the islands off Wilsons Promontory, with the remaining 10% at sites in southwest Victoria (Dann et al., 1996). Relatively little is known of their foraging areas at sea, either during the breeding season when they return daily, or every few days to the breeding colony, but may still range more than 100 km from their burrows. Outside the breeding season, they can travel farther but existing evidence from radio-tracking suggests they remain within 20 km of the coast (Weavers, 1992). The Little Penguin is considered an inshore generalist forager relying chiefly on small pelagic prey such as clupeid fishes such as pilchards

(*Sardinops neopilchardus*), Australian sardine (*Sardinops sagax*), Australian anchovies (*Engraulis australis*), sandy sprat (*Hyperlophus vittatus*), jack mackerel (*Trichurus declivus*) and other small baitfish species (Cullen et al., 1992; Cavallo et al., 2020).

Distribution in Victorian waters

Figure 6.50 shows the distribution of Little Penguin sighting records in Victoria near the proposed landfall of the project. In this figure, a cluster of 21 sightings around Little Penguin breeding sites on islands of the Glennie Group (Great Glennie, Dannevig, Citadel, McHugh islands) and a cluster of nine sightings around the Anser and Kanowna islands. About 12 sightings are recorded for Waratah Bay and a further 65 sightings along the west coast of Wilsons Promontory, which indicates a ubiquitous presence along this stretch of coastline.



Source: Atlas of Living Australia (CSIRO, 2022). Black lines denote the project's proposed alignments.

Figure 6.50: Distribution of Little Penguin sightings in the Victorian project area

The likelihood of occurrence of Little Penguins in the nearshore and adjacent offshore waters near the proposed landfall of the project at Waratah Bay is assessed as ***Very likely***.

Victorian breeding sites

Table 6.32 lists breeding sites of Little Penguins in Victoria and their distances to the nearest proposed alignment of the project. The largest Little Penguin breeding sites are located at Gabo Island (near the VIC–NSW border) and Phillip Island at Western Port Bay. The closest breeding sites to the project are the Glennie Group of islands (range 9.9 to 11.2 km) and Shellback Island (10.9 km distance).

Table 6-32: BIA breeding sites of Little Penguins in Victoria

Name of breeding site	Coordinates	Distance to the project (km)
Great Glennie Island	39° 5' 1.49" S, 146° 13' 43.00" E	9.9
Shellback Island	38° 58 '6.54" S, 146° 13' 41.26" E	10.9
Citadel Island	39° 6 '52.10" S, 146° 14' 13.24" E	11.0
Dannevig Island	39° 6' 22.36" S, 146° 14' 15.11" E	11.2
Norman Island	39° 1' 21.12" S, 146° 14' 31.10" E	11.4
McHugh Island	39° 6' 55.97" S, 146° 14' 31.38" E	11.7
Kanowna Island	39° 9' 14.36" S, 146° 18' 38.38" E	17.0
Anser Island	39° 8' 29.51" S, 146° 19' 21.70" E	17.8
Wattle Island	39° 8' 21.37" S, 146° 21' 41.78" E	22.0
Rabbit Rock	38° 54' 54.25" S, 146° 29' 22.76" E	57.2
Rabbit Island	38° 54' 43.45" S, 146° 30' 40.24" E	58.4
Rag Island	38° 57' 16.61" S, 146° 40' 50.71" E	53.9
Seal Island	38° 55' 32.02" S, 146° 39' 41.11" E	54.0
Notch Island	38° 56' 28.65" S, 146° 40' 34.70" E	54.5
Cliffy Island	38° 57' 1.24" S, 146° 42' 19.51" E	56.5
Phillip Island	38° 28' 58.08" S, 145° 16' 4.93" E	82.0
St Kilda Pier (Port Phillip Bay)	37° 51' 53.19" S, 144° 57' 56.91" E	205
Lady Julia Percy Island	38° 25' 4.35" S, 142° 0' 12.69" E	318
Lawrence Rocks	38° 24' 25.69" S, 141° 40' 11.42" E	401
Gabo Island	37° 33' 48.47" S, 149° 54' 40.96" E	388
Tullaburga Island	37° 33' 25.74" S, 149° 50' 42.41" E	380
The Skerries	37° 45' 16.53" S, 149° 31' 5.76" E	344

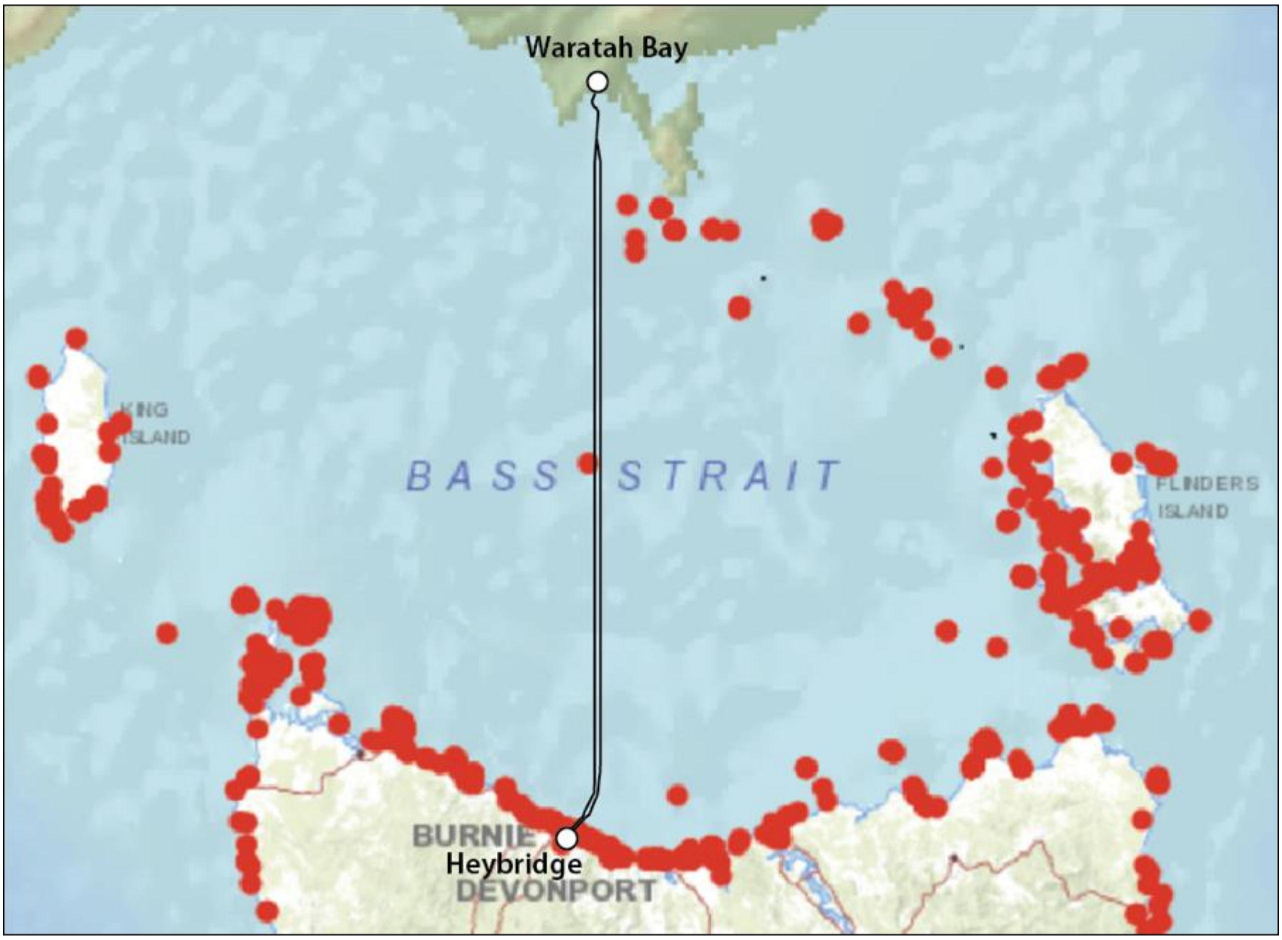
Source: Dann (1996). Blue shading denotes that BIA breeding sites greater than 50 km distance from the nearest proposed alignment of the project and outside of the project's area of direct influence. Distance to project is based on sea route and not by direct route as Little Penguins swim and do not fly.

Biologically Important Areas

The only foraging BIA for the Little penguin listed in Victoria listed the National Conservation Values Atlas is a buffer zone (radius range 8 to 10 km) around Phillip Island, which is located 134 km northwest from the nearest proposed alignment of the project. This Phillip Island foraging BIA is considered to lie outside the projects' area of potential direct influence.

Distribution in Tasmania

Figure 6.51 shows the distribution of Little Penguin sighting records in Bass Strait under Tasmanian jurisdiction. Little Penguin sighting clusters are evident at King Island and the Fleurieu Group (Three Hummock, Hunter, Walker and Robbins islands) in the far northwest of Tasmanian, at the Furneaux Group (Flinders, Cape Barren and Clarke islands) in the east of Bass Strait, and at the numerous offshore islands of northern Bass Strait. A total of 78 Little Penguin sightings were recorded along the central North Coast between Burnie and Devonport, which includes the proposed landfall of the project at Heybridge.



Source: Natural Values Atlas (DNRE, 2022). Black lines denote the project's proposed alignment.

Figure 6.51: Distribution of Little Penguins in Bass Strait Tasmanian waters

The likelihood of occurrence of Little Penguins in the nearshore waters and adjacent offshore waters near the proposed landfall of the project at Heybridge is assessed as ***Very likely***.

Tasmanian breeding sites

Table 6-33 lists the known breeding sites of Little Penguins in Bass Strait under Tasmanian jurisdiction. BirdLife International (2022) indicated that the key breeding sites were Bird Island (3,000 breeding pairs), Steep Island (2,000–3,000 breeding pairs), Three Hummock Island (2,059 breeding pairs) and Trefoil Island (500 breeding pairs). However, these islands are greater than 50 km distance from the nearest proposed alignment of the project and are therefore well outside the project's area of potential direct influence.

Table 6-33 Tasmanian breeding sites of Little Penguins

Name of colony	Coordinates	Distance to the project (km)
Wright and Egg islands	41° 8' 57.49" S, 146° 25' 27.75" E	34
Sisters Island	40° 54' 13.14" S, 145° 34' 46.68" E	42
Curtis Group	39° 28' 13.80" S, 146° 38' 50.09" E	46
Three Hummock Island	40° 25' 47.51" S, 144° 55 '9.75" E	95
Petrel Island	40° 34' 1.32" S, 144° 55'2 7.50" E	97
Ninth Island	40° 50' 1.97" S, 147° 16' 12.29" E	98
Councillor Island (King Island)	39° 49' 48.53" S, 144° 9' 40.53" E	164
Albatross Island	40° 22' 30.77" S, 144°39' 12.38" E	121
Stack Island	40° 36'18.65" S, 144° 46' 36.71" E	108
Seacrow Islets	40° 37'9.72" S, 144° 44' 17.97" E	112
Henderson Islet	40° 37' 24.99" S, 144° 44' 13.79" E	112
Harbour Islets	40° 38' 23.08" S, 144° 44' 1.59" E	113
Bird Island	40° 36' 10.52" S, 144° 43' 9.80" E	115
Trefoil Island	40° 37' 55.50" S, 144° 41' 23.12" E	116
Little Trefoil Island	40° 38' 41.13" S, 144° 42' 9.44" E	116
Steep Island	40° 33' 50.30" S, 144° 41' 5.65" E	118
Doughboys Nature Reserve	40° 40' 17.25" S, 144° 40' 46.30" E	120
Black Pyramid Rock	40° 28' 19.37" S, 144° 20' 32.29" E	159

Source: SPRAT Little Penguin profile (DCCEEW, 2022c); Dann (1996); Blue shading denotes that breeding sites greater than 50 km distance from the nearest proposed alignment of the project are considered outside of the project's area of direct influence.

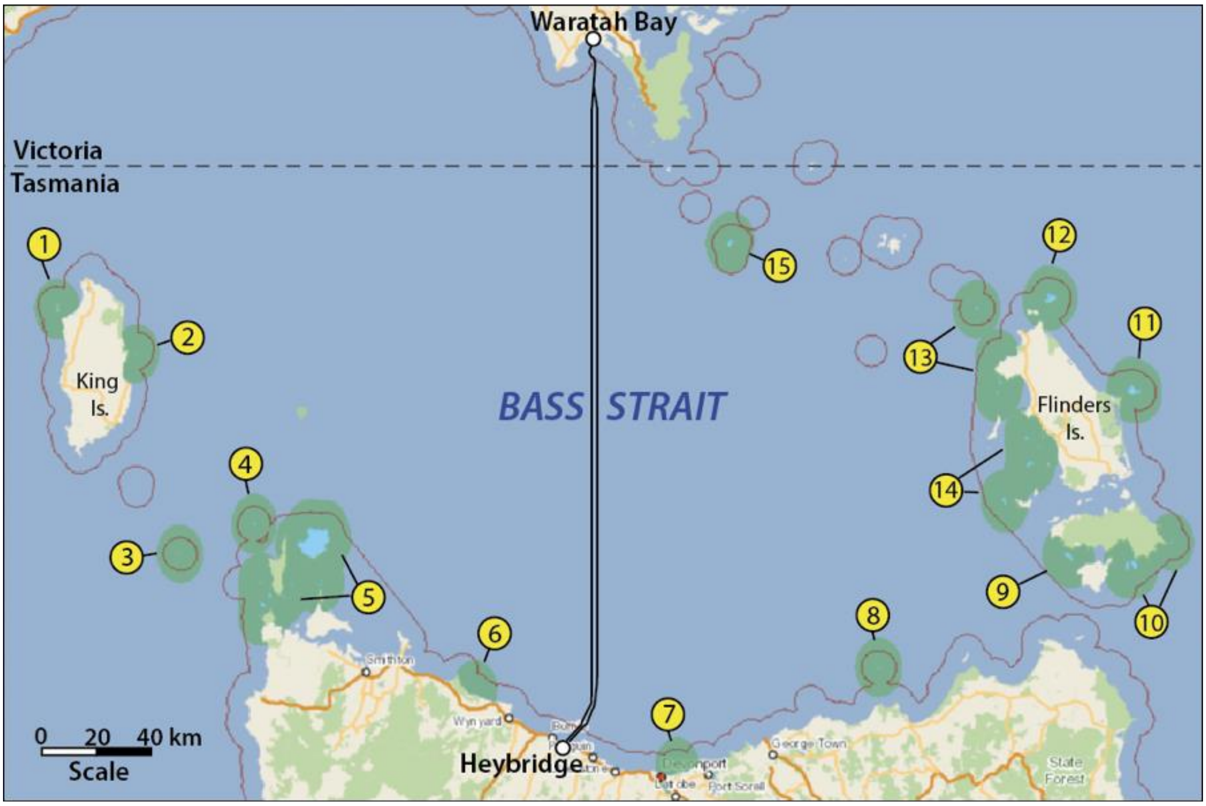
Along the central north coast of Tasmania, minor Little Penguin breeding and nesting sites are located at Penguin Point beach near Penguin, Parsonage Point at Burnie, and Lillico Beach, which are respectively 12.1 km, 9.5 km and 26 km distance from the nearest proposed alignment of the project. Many of these minor breeding and nesting site locations have observation decks or viewing platforms for people to watch Little Penguins coming ashore in the evenings (mainly during the period early October to late March).

Tasmanian foraging BIAs

The National Conservation Values Atlas (DCCEEW, 2022a) lists 15 foraging BIAs for Little Penguins in Bass Strait waters under Tasmanian jurisdiction. Figure 6.52 shows the locations of the 15 foraging BIAs for illustrative and informational purposes.

Table 6-34 lists the Little Penguin foraging BIAs in Tasmanian waters of Bass Strait along with the distances of their 10-km buffer outer limits to the nearest proposed alignment of the project.

Based on Table 6-34, the closest foraging BIAs are Egg Island (28.2 km), Sisters Island (34.3 km), and the Curtis Group (40.2 km). All other foraging BIAS are located 84.5 – 185 km distance from the project. Overall, all Little Penguin foraging BIAs are considered as outside the project's area of direct influence.



Source: National Conservation Values Atlas (DCCEEW, 2022a). Black lines denote the project's proposed alignment.

Figure 6.52: Little Penguin foraging BIAs of Bass Strait (Tasmania)

Table 6-34: Little Penguin foraging BIAs and distances to the project

No.	Foraging BIA descriptor	Distance of BIA foraging buffer edge to the project (km)
1	Christmas Island (King Island)	185.0
2	Councillor Island (King Island)	157.5
3	Black Pyramid Rock	137.6
4	Albatross Island	112.4
5	Three Hummock and Hunter islands	84.5
6	Sisters Island	34.3
7	Wright and Egg Islands	28.2
8	Ninth Island	91.8
9	Southwest Cape Barren Island	158.7
10	Southeast Cape Barren Island	176.2
11	Babel Island	182.6
12	Eastern Tip of Flinders Island	152.4
13	Northwest edge of Flinders Island	127.4
14	Western Flinders Island	136.8
15	Curtis Group	40.2

Source: National Conservation Values Atlas (DCCEEW, 2022a). Foraging BIAs greater than 50 km distance from the nearest proposed alignment of the project are considered outside of the project's area of direct influence.

6.3.9.3 Important Bird Areas

Important Bird Areas (IBAs) are sites that are recognised as internationally important for bird conservation and known to support key bird species (Dutson et al., 2009). In general, IBAs are non-government and non-statutory and an IBA can be proposed if it meets at least one of three criteria. The three criteria are based on threshold numbers of globally threatened species, restricted-range species, or congregatory bird species.

6.3.9.3.1 Victorian IBAs

The main Victorian IBAs in proximity to the project's proposed alignment are the Corner Inlet Marine and Coastal Park (18.35 km^2) and the Gippsland Lakes (600.15 km^2), which are located 15 km and 130 km to the northeast of the interconnector, respectively.

Corner Inlet is particularly important for migratory and resident waterbirds, supporting significant numbers of several IUCN-trigger species (Roy, 2015), as well as providing saltmarsh habitat for the critically endangered, Orange-bellied Parrot (*Neophema chrysogaster*) (BirdLife International, 2022).

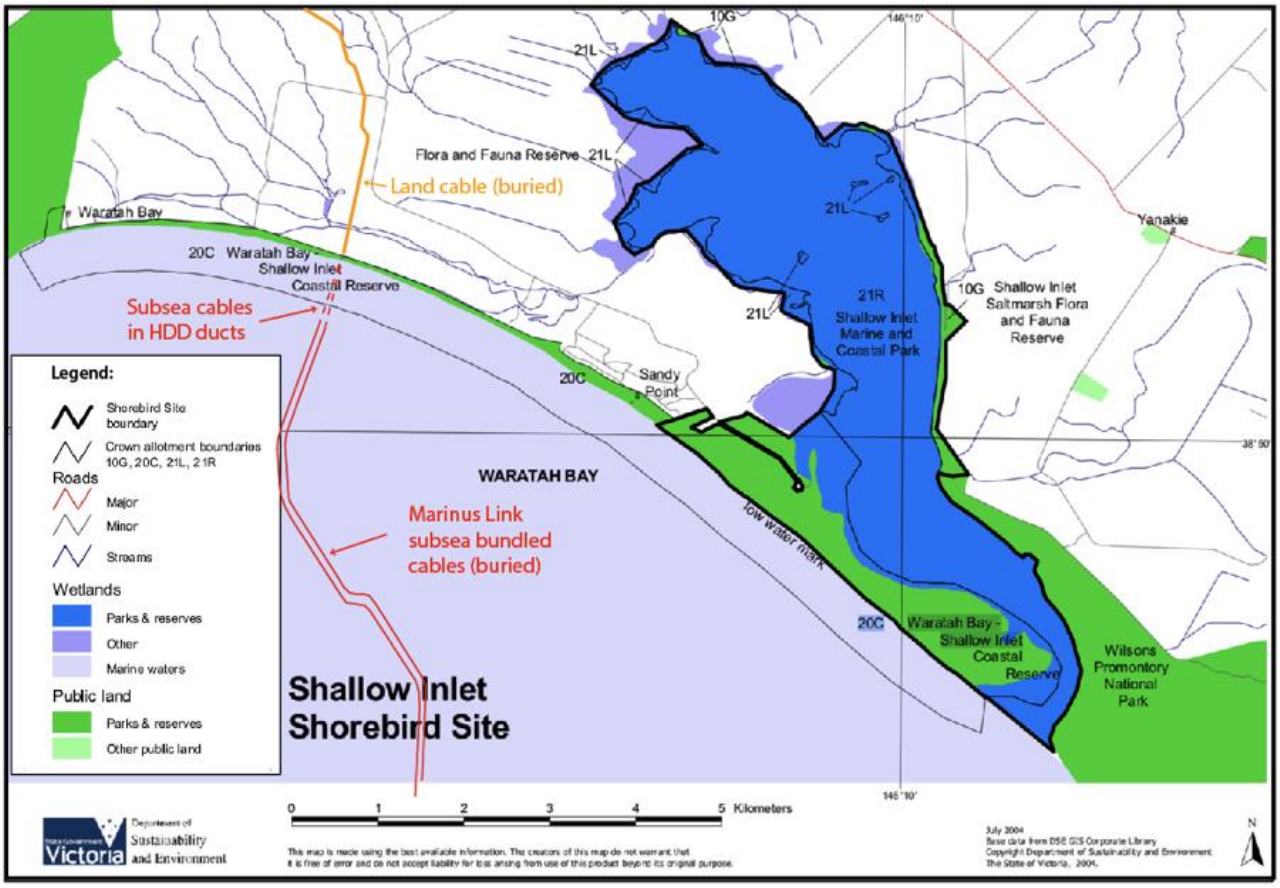
Corner Inlet Marine and Coastal Park IBA is separated from Waratah Bay and the adjacent offshore water by a strip of land (i.e., the Yanakie isthmus) and the nearest point of which is 11.5 km from the proposed landfall of the project in Waratah Bay. This IBA is outside the direct influence of the project's area; however, some species of migratory birds and shore birds from this IBA may forage along the foreshore of Waratah Bay, as well as some species of birds foraging over open waters of the bay and adjoining offshore waters to the west of Wilsons Promontory.

The nearest IBA to the project's proposed alignment is Shallow Inlet, which is connected to Waratah Bay and the nearshore project area by a tidal sea channel (BirdLife International, 2022). The Shallow Inlet IBA overlaps with Shallow Inlet Marine and Coastal Park. This is described below.

Shallow Inlet IBA

Figure 6.53 shows a map of Shallow Inlet Marine and Coastal Park in relation to the proposed alignments of the land and subsea cable of the project. The IBA includes all coastal habitats in the inlet, notably intertidal mud and saltmarsh, and the seaward side is enclosed by a sandy barrier complex of spits, bars and mobile dunes (BirdLife International, 2022). The extensive mudflats and sandy intertidal areas provide excellent habitat for shorebirds.

Shallow Inlet regularly supports more than one per cent of the flyway populations of five species of migratory shorebird, which is based survey data collected between 1981 and 1990 (Collins, 2004). The five species of migratory shorebird species are the Double-banded Plover (*Charadrius bicinctus*), Red-necked Stint (*Calidris ruficollis*), Sanderling (*Calidris alba*), Curlew Sandpiper (*Calidris ferruginea*) and Eastern Curlew (*Numenius madagascariensis*). The Shallow Inlet site also supports significant numbers of Pacific Golden Plover (*Pluvialis fulva*) and Hooded Plover (*Thinornis rubricollis*).



Source: DSE (2004).

Figure 6.53: Shallow Inlet Marine and Coastal Park

In 2004, about 180 species of birds have been recorded in Shallow Inlet (DSE, 2004) of which 19 bird species were listed under the Japan-Australia Migratory Birds Agreement (JAMBA) and 16 species were listed under the China-Australia Migratory Birds Agreement (CAMBA).

The extensive intertidal sand and mud flats of Shallow Inlet are important feeding areas for resident and migratory shorebirds.

6.3.9.3.2 Tasmanian IBAs

IBAs within 50 km of the project’s proposed alignment include the offshore Curtis Island IBA in northern Bass Strait and both the Egg Island IBA and Three Sisters IBA along the central north coast of Tasmania.

Curtis Island IBA

Curtis Island (1.50 km^2) is part of the Curtis Group that also includes Cone Islet, Sugarloaf Rock and the Devil’s Tower. The Curtis Island IBA supports more than one per cent of the global population of Short-tailed Shearwaters (*Ardenna tenuirostris*), which are protected within the Curtis Island Nature Reserve (Birdlife International, 2022). Other birds recorded include Little Penguins, Fairy Prions, Pacific Gulls and Sooty Oystercatchers.

Egg Island IBA

The Egg Island IBA overlaps the Wright and Egg Islands Conservation Area. Egg Island is part of Horseshoe Reef, about 800 m off the coast north of the Devonport Airport in north Tasmania. The reef also comprises Wright Island and numerous small, jagged rocks, totalling 100,000 m^2 at low water and less than 10,000 m^2 at high water (BirdLife International, 2022). Egg Island is located about 34 km from the nearest proposed alignment of the project.

The Egg Island IBA supports more than one per cent of the world population of Black-faced Cormorants (*Phalacrocorax fuscescens*). In addition, small numbers of Caspian Terns, Crested Terns (*Sterna bergii*), Pacific Gulls, Little Penguins and Sooty Oystercatchers have bred in the past and probably continue to do so (BirdLife International, 2022).

Three Sisters IBA

The Three Sisters Island (or Three Sisters Islands) are three small and rocky granite islands with a collective land area of 20,000 m^2 and are located about 500 m off the coast between the towns of Penguin and Ulverstone. This IBA is located 12.7 km from the nearest proposed alignment of the project.

The Three Sisters IBA overlaps the Three Sisters-Goat Island Nature Reserve and this IBA supports more than 1% of the world population of Black-faced Cormorants (*Phalacrocorax fuscescens*). In addition, Pacific gulls (*Larus pacificus*) and sooty oystercatchers (*Haematopus fuliginosus*) breed there every year in small numbers, Caspian terns (*Hydroprogne caspia*) have nested there, and White-bellied sea-eagles (*Haliaeetus leucogaster*) forage around the islands (BirdLife International, 2022).

6.3.9.3.3 Shorebirds and coastal species

This section provides baseline characterisation of shorebirds and waders that are likely to forage along the sandy beaches of Waratah Bay in the vicinity of the proposed Victorian landfall of the project's subsea cables. The EPBC Act Protected Matters Reports indicate that EPBC Act listed threatened, migratory marine birds or listed marine species may occur in the nearshore Victoria (PMST, 2023; Attachment B) and nearshore Tasmanian (PMST, 2023; Attachment C).

The nearshore coastal environment in Victoria within the project area includes a range of nationally and internationally significant shorebird habitats, particularly in the following areas:

- Sandy beaches of Waratah Bay and the west coast of Wilsons Promontory.
- Shallow Inlet intertidal sand and mud flats, and saltmarsh habitats.
- Rocky intertidal shores of the west coast of Waratah Bay and the west coast of Wilsons Promontory and its numerous offshore islands.
- In general shorebirds include plovers, terns, sandpipers, snipes, godwits, and knots.

Distribution in nearshore Victoria

Table 6-35 lists the shorebirds and coastal species that are known to, likely to, or may be expected to occur in nearshore Victoria (Waratah Bay). The list is long as part of the Shallow Inlet IBA (see Figure 6.53 above) includes the Shallow Inlet Coastal Reserve east of Sandy Point Township. An extension of the Shallow Inlet Coastal Reserve from Sandy Point township to Waratah township is known as the Waratah Bay Foreshore Reserve. It is this foreshore reserve and seaward intertidal beach within Waratah Bay that will be crossed by the proposed landfall of the project.

Four species of shorebirds or wetland birds in Table 6.35 are protected under the Threatened Species Action Plan 2015-16: 20 birds by 2020 (DoE, 2015c), including the Regent Honeyeater (*Anthochaera phrygia*), Eastern Hooded Plover (*Thinornis cucullatus cucullatus*), Swift Parrot (*Lathamus discolor*) and Orange-bellied Parrot (*Neophema chrysogaster*); However, the Eastern Hooded Plover is the most likely species of these four species that may occur along the foreshore and sandy intertidal beach of Waratah Bay near the project's landfall.

In general, many of the shorebirds and coastal species listed in Table 6.35 will largely be restricted to the wetlands of Shallow Inlet, whereas those shorebirds along the foreshore and intertidal beach of Waratah Bay will largely comprise those plovers, terns, sandpipers, snipes, godwits and knots, some of which are listed in Table 6.35. The likelihood of occurrence of some of the more common shorebird species near the Waratah Bay landfall of the project are also shown in the last column of Table 6-35.

Table 6-35: Shorebirds or migratory wetland birds in nearshore Victoria (Waratah Bay)

Scientific name	Common name	EPBC Act Status	Presence	Likelihood of occurrence
Shore and/or wetland birds listed as critically endangered under EPBC Act:				
Anthochaera phrygia	Regent Honeyeater	CR	SL	Rare
Calidris ferruginea	Curlew Sandpiper	CR	KO	Likely
Calidris tenuirostris	Great Knot	CR	KO(r)	Rare
Neophema chrysogaster	Orange-bellied Parrot	CR	SL(m)	Remote
Numenius madagascariensis	Eastern Curlew	CR	KO	Likely
Lathamus discolor	Swift Parrot	CR	KO	Likely
Shore and/or wetland birds listed as endangered under the EPBC Act:				
Botaurus poiciloptilus	Australasian Bittern	EN	SL	Likely
Charadrius mongolus	Mongolian Plover	EN	KO(r)	Likely
Calidris canutus	Red Knot	EN	KO	Likely
Falco hypoleucos	Grey Falcon	EN	MO	Possible
Shore and/or wetland birds listed as vulnerable under the EPBC Act:				
Limosa lapponica baueri	Nunivak Bar-tailed Godwit	VU	KO	Likely
Pachyptila turtur subantarctica	Fairy Prion	VU	KO	Possible
Rostratula australis	Australian Painted Snipe	VU	SL	Possible
Thinornis cucullatus cucullatus	Eastern Hooded Plover	VU	KO	Likely
Sternula nereis nereis	Australian Fairy Tern	VU	SL	Likely
Non-threatened migratory wetland species:				
Actitis hypoleucos	Common Sandpiper	–	MO	Very likely
Arenaria interpres	Ruddy Turnstone	–	KO(r)	Likely
Calidris alba	Sanderling	–	KO(r)	Very likely
Calidris melanotos	Pectoral Sandpiper	–	MO	Possible
Calidris ruficollis	Red-necked Stint	–	MO	Possible
Charadrius bicinctus	Double-banded Plover	–	KO(r)	Likely
Gallinago hardwickii	Latham's Snipe	–	KO	Likely
Gallinago megala	Swinhoe's Snipe	–	SL(r)	Possible
Gallinago stenura	Pin-tailed Snipe	–	KO(r)	Likely
Limosa lapponica	Bar-tailed Godwit	–	KO(r)	Likely
Numenius minutus	Little Curlew	–	SL(r)	Possible
Numenius phaeopus	Whimbrel	–	SL(r)	Possible

Scientific name	Common name	EPBC Act Status	Presence	Likelihood of occurrence
Pandion haliaetus	Osprey	–	MO	Possible
Pluvialis fulva	Pacific Golden Plover	–	KO(r)	Likely
Thalasseus bergii	Greater Crested Tern	–	KO(b)	Likely
Tringa brevipes	Grey-tailed Tattler	–	KO(r)	Likely
Tringa nebularia	Common Greenshank	–	KO	Likely
Tringa stagnatilis	Marsh Sandpiper	–	KO(r)	Likely

Source: EPBC Act Protected Matters Report – Waratah Bay PMST search area results (PMST, 2023; Attachment B). Presence codes: KO= Species or species habitat known to occur; SL = Species or species habitat is likely to occur; MO= Species or species habitat may occur; Presence code subscripts: r=roosting; b=breeding; m=migratory route.

More detailed baseline descriptions of shorebirds in Waratah Bay are not warranted here, since potential impacts of the project relate to terrestrial issues such as visual disturbance (project vehicles and personnel) and terrestrial air pollution (acoustic disturbance), which are not in the remit of the present marine ecology and resource use report. Notwithstanding, physical impacts of beach trenching on shorebird foraging habitat is addressed in Section 7 (Impact assessment).

Distribution in nearshore Tasmania

Table 6.36 lists shorebirds or migratory wetland birds that may occur within nearshore Tasmania at the proposed landfall of the project. Three species are listed as critically endangered under the EPBC Act may occur in the PMST search area (PMST, 2023; Attachment C) for nearshore Tasmania. However, two of the species (the Swift Parrot and Eastern Curlew) are listed as endangered under the TSP Act.

Table 6-36: Shorebirds or migratory wetland birds in nearshore Tasmania (Heybridge)

Scientific name	Common name	EPBC Act status	Presence	Likelihood of occurrence
Shore and/or wetland birds listed as critically endangered under EPBC Act:				
Calidris ferruginea	Curlew Sandpiper	CR	MO	Rare
Lathamus discolor	Swift Parrot	*CR	KO(b)	Likely
Numenius madagascariensis	Eastern Curlew	*CR	SL	Rare
Shore and/or wetland birds listed as endangered under the EPBC Act:				
Calidris canutus	Red knot	EN	SL	Rare
Shore and/or wetland birds listed as vulnerable under the EPBC Act:				
Sternula nereis nereis	Australian Fairy Tern	VU	SK	Remote
Hirundapus caudacutus	White-throated Needletail	VU	SK	Possible
Limosa lapponica baueri	Nunivak bar-tailed godwit	VU	SK	Remote
Pachyptila turtur subantarctica	Fairy Prion	VU	SK	Rare
Thinornis cucullatus cucullatus	Eastern Hooded Plover	VU	SK	Rare
Listed Migratory Species:				
Apus pacificus	Fork-tailed Swift	–	SL	Rare
Ardenna carneipes	Flesh-footed Shearwater	–	FO	Rare
Ardenna grisea	Sooty Shearwater	–	MO	Rare
Sternula albifrons	Little Tern	–	MO	Possible

Scientific name	Common name	EPBC Act status	Presence	Likelihood of occurrence
Migratory Wetland Species:				
Actitis hypoleucos	Common Sandpiper	–	SK	Very likely
Calidris acuminata	Sharp-tailed Sandpiper	–	MO	Rare
Gallinago hardwickii	Latham's Snipe	–	SK	Likely
Limosa lapponica	Bar-tailed Godwit	–	SK	Likely

Source: EPBC Act Protected Matters Report – Waratah Bay PMST search area results (PMST, 2023; Attachment B). Presence codes: SK= Species or species habitat known to occur; SL = Species or species habitat is likely to occur; MO= Species or species habitat may occur; FO=Foraging, feeding or related behaviour likely to occur. Dash (–) denotes not listed. *Swift parrot and Eastern Curlew are listed as endangered under the TSP Act. Presence code subscripts: r=roosting; b=breeding; m=migratory route.

As was the case for nearshore Victorian shorebirds, the most common birds at nearshore Tasmania (Heybridge) are likely to comprise plovers, terns, sandpipers, snipes, godwits, and knots, some of which are listed in Table 6.36.

6.3.10 Marine fishes

It is estimated that there are over 500 species of fish found in the waters of Bass Strait, including species of importance to commercial and recreational fisheries. This section summarises fish species of conservation significance and the more dominant and common species in bass Strait.

6.3.10.1 Listed Threatened and/or Migratory fishes

The EPBC Act Protected Matters Reports indicate that seven species of threatened and/or migratory fish species or their habitat are likely to or may occur within the PMST search areas (PMST, 2023; Attachment A: Offshore Bass Strait, Attachment B: Nearshore Victoria and Attachment C: Nearshore Tasmania). Table 6.37 lists the species of conservation significance.

Table 6-37: List of marine fishes of conservation significance in central Bass Strait

Species	Conservation status		Reported presence in the project areas		
	EPBC Act	Migratory	Victorian nearshore	Bass Strait	Tasmanian nearshore
White shark (*Carcharodon carcharias*)	VU	Yes	FK	FK	SK
School Shark (*Galeorhinus galeus*)	CD	No	SL	SL	SL
Porbeagle, Mackerel shark (*Lamna nasus*)	–	Yes	SL	SL	SL
Shortfin mako or mako shark (*Isurus oxyrinchus*)	–	Yes	–	SL	SL
Australian grayling (*Prototroctes maraena*)	VU	Yes	SM	–	SL
Southern Bluefin Tuna (*Thunnus maccoyii*)	CD	No	SL	SL	SL
Blue warehou (*Seriolella brama*)	CD	No	SK	SL	SL

Source: EPBC Act and the IUCN Red List of Threatened Species: VU – Vulnerable, CD – Conservation Dependent. Dash (–) denotes not listed or not reported.
EPBC Act PMST results for species occurrence in area: FK – Foraging, feeding or related behaviour known to occur; SK = Species or species habitat known to occur; SM = Species or species habitat may occur; SL = Species or species habitat likely to occur.

Summary descriptions of the fish species in Table 6.37 are presented below.

6.3.10.1.1 White Shark

The white shark (*Carcharodon carcharias*), also known as the great white shark, is listed as vulnerable and migratory under the EPBC Act and listed as vulnerable under the TSP Act. However, the white shark is listed as endangered under the FFG Act. This species is managed under the Recovery Plan for the white shark (DSEWPaC, 2013c). The EPBC Act Protected Matters Reports indicate that the white shark foraging habitat is likely to occur in the project's PMST search areas (PMST, 2023: Attachment A, Attachment B, Attachment C).

The white shark is a large apex predator that grows to at least 6 m and can weigh up to 3,000 kg (Last and Stevens, 2009). Adult white sharks eat a variety of prey, including fish, other sharks and rays, marine mammals, squid and crustaceans (DSEWPaC, 2013c), whereas juveniles feed on finfish, rays and other sharks but shift to include marine mammals in their diet when they reach approximately 3.4 m long (Estrada et al., 2006).

White sharks are widely distributed throughout temperate and subtropical regions (Bruce et al., 2006). They are typically found from close inshore habitats (e.g., rocky reefs and shallow coastal bays) to the outer continental shelf and slope areas (Bruce and Bradford, 2008).

The South-east Marine Region supports a white shark population that is thought to move seasonally along the southern and eastern Australian coasts, moving north along the east coast during autumn and winter, and returning to southern Australian waters by early summer (Bruce et al., 2006). In southeast Victoria, juveniles are known to aggregate seasonally in specific areas such as the Corner Inlet−Ninety Mile Beach coastal area between Wilson's Promontory and Lakes Entrance (Bruce and Bradford, 2008). Heupel et al. (2007) found a consistent occupancy over multiple years of juvenile white sharks in the Corner Inlet-Ninety Mile Beach region.

Distribution in Victoria

The Atlas of Living Australia (CSIRO, 2022) indicates that there are 13 records of white sharks along the entire Victorian coast with two major sighting clusters. One cluster of four sightings is located near Portland at Cape Bridgewater, which is the site of an Australian fur seal colony. The second cluster of sightings is within an open water area east of Wilson Promontory between Rabbit Island and the Seal Island group that includes Notch, Rag, and Cliffy islands. These small islands have Australian fur seal breeding and haul-out sites, which may indicate the cluster of white shark sightings.

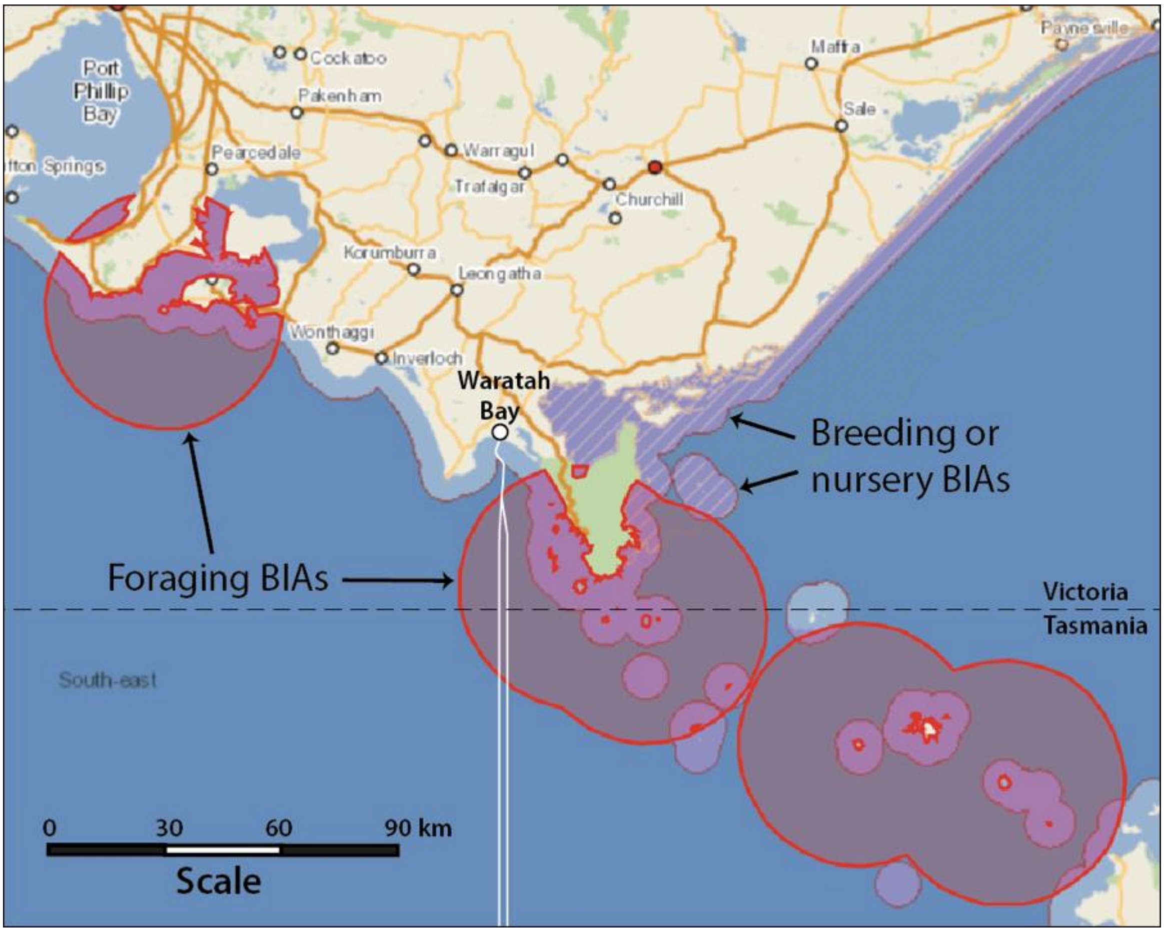
The presence of breeding areas, haul-outs, and foraging Australian fur seals near the project's proposed alignment (e.g., the islands along the west coast of Wilsons Promontory) indicates that great white sharks may be expected to frequent this coastline. For example, Kanowna Island is one of several breeding colonies of Australian fur seals where pups are born between November and December, and at this time white sharks are known to frequent waters adjacent to the pupping areas. Many of islands along the west coast of Wilsons Promontory also have breeding or nesting sites for Little Penguins, which forage in the adjacent waters and are also prey item of white sharks.

The likelihood of occurrence of white sharks in nearshore Victoria and the adjacent offshore water within the project area is assessed as ***Very likely***, with occurrences anticipated to be highest during November to December.

White Shark Biological Important Areas

Figure 6.54 shows the two distributional BIAs and two foraging BIAs for the white shark in Victorian waters. In Figure 6.54, Corner Inlet represents a major nursery environment and distributional BIA for juvenile white sharks, especially during the period from December to June (Holliday, 2003). This area extends from the shoreline out to the 50-m bathymetric contour (DCCEEW, 2022a).

The principal foraging BIA surrounding most of Wilson Promontory is the combined foraging BIA created by two 30-km radius buffer zones: one centred on Kanowna Island and the other centred on West Moncoeur Island. Only about half of this combined foraging BIA is located with Victorian waters of Bass Strait. The project's proposed alignment within Victorian waters intercepts approximately 29 km of the foraging BIA centred on Kanowna Island. It is expected that the abundance of Australian fur seals, long-nosed fur seals and Little Penguins located on Kanowna Island regularly use this foraging BIA and provide a varied source of prey items for foraging white sharks.



Source: National Conservation Values Atlas (DCCEEW, 2022a). The breeding or nursery BIAs are based on known distributions of white sharks. Dark blue shaded background in map is a white shark distribution BIA and light blue shading (e.g., in Waratah Bay) is a low-density white shark distribution IBA.

Figure 6.54: Victorian distributional and foraging BIAS in Bass Strait

The white shark 30-km diameter foraging BIA centred on Seal Rocks at Phillip Island is located 62 km from the nearest proposed alignment of the project and lies outside the project's direct influence.

Overall, the likelihood of occurrence of white sharks in the Victorian nearshore and adjacent offshore waters in proximity to the project's landfall in Waratah Bay is assessed as ***Very likely***, which is based on their distributional BIA and foraging BIA in this region west of Wilsons Promontory.

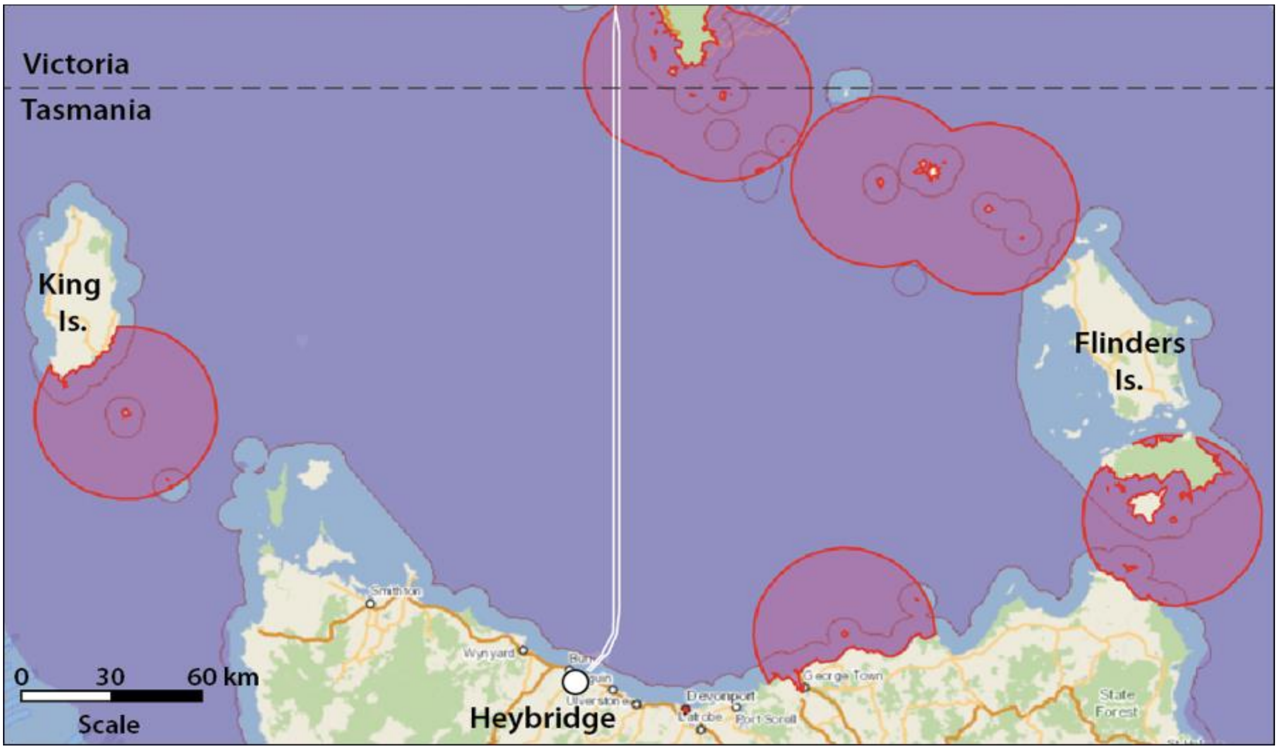
Distribution in Tasmania

The Tasmanian Natural Values Atlas (DNRE, 2022) indicates that there are 14 records of white shark sightings mostly in southeast Tasmania but only four records in Bass Strait. The nearest white shark sighting is just offshore of Doctors Rocks near Wynyard and is located 18 km west of the project's proposed alignment.

The likelihood of occurrence of white sharks in nearshore Tasmania at the proposed landfall of the project at Heybridge is assessed as ***Likely*** with occurrences anticipated between October and January when Australian fur seals breed on Bass Strait islands and forage along the central north coast of Tasmania.

Biologically Important Areas

Figure 6.55 shows the Bass Strait-wide distributional BIA and five foraging BIAs for white sharks in Bass Strait waters under Tasmanian jurisdiction.



Source: National Conservation Values Atlas (DCCEEW, 2022a). Medium blue shaded background in the map is a white shark distribution BIA and red shaded areas are foraging BIAs.

Figure 6.55: Tasmanian white shark distribution and foraging BIAs in Bass Strait

In Figure 6.55, the project's proposed alignment within Tasmanian waters of Bass Strait intercepts approximately 18 km of the foraging BIA centred on Kanowna Island. As noted above, the abundance of Australian fur seals, long-nosed fur seals and Little Penguins located on Kanowna Island regularly use this foraging BIA and provide a varied source of prey items for foraging white sharks. The next nearest foraging BIA is the 30-km buffer zone centred on Tenth Island, the western outer edge of which is located 45 km from the proposed nearshore alignment the project at Heybridge. Tenth Island is a major Australian fur seal breeding site (between October and January) and is also a haul-out site for long-nosed fur seals. The remaining foraging BIAs in Bass Strait are all greater than 50 km from the nearest proposed alignment of the project.

6.3.10.1.2 School shark

The school shark (*Galeorhinus galeus*) is distributed throughout temperate coastal waters of Australia between southern Queensland to across the entire southern coast of Australia and to southern Western Australia.

This species is listed as Conservation Dependent under the EPBC Act, the FFG Act and the TSP Act. According to the PMST search, this species is likely to occur in Tasmania and Victoria nearshore, as well as the offshore search area.

6.3.10.1.3 Porbeagle

The porbeagle or mackerel shark (*Lamna nasus*) is not listed as threatened under the EPBC Act but is listed as a migratory marine species. This species is also not listed as threatened on either the FFG Act or the TSP Act. The porbeagle is protected under the Convention on International Trade in endangered Species of Wild Fauna and Flora (CITES), which is also known as the Washington Convention.

The EPBC Act Protected Matters Reports indicate that the porbeagle or its habitat species or its habitat is likely to occur in all three of the project's PMST search areas (Appendices A, B, and C). The National Conservation Values Atlas (DCCEEW, 2022a) does not indicate the presence of any distributional BIAs or foraging BIAs for porbeagles in Australian waters.

The porbeagle is a wide-ranging shark inhabiting both temperate and subtropical of the North Atlantic and Southern Hemisphere. In Australia, porbeagle sharks occur from southern Queensland to south-west Australia, and is typically found in oceanic waters on the continental shelf, although it is occasionally found in coastal waters. The species undertakes extensive seasonal migrations (Last and Stevens, 2009) and are also known to conduct long-distance seasonal migrations. Pade et al. (2009) tracked both the horizontal and vertical movements of porbeagles with electronic tags and observed a general shifting between shallower and deeper waters.

Porbeagles are fast, active predators and feed mainly on bony fish and cephalopods within the entire water column, including the seabed (Last and Stevens, 2009). The presence of different prey types in porbeagle stomach contents (Stevens, 1973) may reflect the need for different search behaviour and/or habitat use by sharks in locations or at times when specific prey types are available. For example, Joyce et al. (2002) analysed porbeagle stomach contents from Canadian waters that indicated pelagic fish and cephalopods dominated diets in the boreal spring when sharks are further offshore on the continental shelf, whereas in the boreal autumn, the amount of demersal fish in diets increased with movements into shallower waters. A similar situation may exist in southeast Australian waters.

Distribution in Victoria

The Atlas of Living Australia (CSIRO, 2022) indicates that porbeagles are mostly found along the west and east Australia coasts, as well as the southeast and south coast of Tasmania. There are no sighting records for Bass Strait, with the nearest sighting (fishery discard) off Cape Howe near the Victoria-NSW border.

The likelihood of occurrence of porbeagles in Bass Strait in the vicinity of the nearshore Victorian project area is assessed as ***Remote***, given this species' preference of continental slope waters.

Distribution in Tasmania

The Tasmanian Natural Values Atlas (DNRE, 2022) revealed 11 sightings over the continental shelf of southeast and south Tasmania. The nearest sighting off the west coast of Tasmania is located about 230 km from the proposed project alignment.. Notwithstanding, porbeagles are known to make occasional forays to inshore waters (Joyce et al., 2002), which could include Bass Strait.

Overall, the likelihood of occurrence of porbeagles in Tasmanian nearshore waters at the proposed Heybridge landfall of the project and the adjacent offshore waters is assessed as ***Remote***, given their preference of open water habitat over the continental shelf of Tasmania.

6.3.10.1.4 Shortfin Mako

The shortfin mako (*Isurus oxyrinchus*) is listed as a migratory species under Part 13 of the EPBC Act on 29 January 2010, which was a historical legal requirement following the inclusion of this species in Appendix II of the Convention of Migratory Species (the 'Bonn Convention'), which is an international agreement to which Australia is a signatory). The National Conservation Values Atlas (DCCEEW, 2022a) does not show any BIA for the shortfin mako.

The shortfin mako is a large pelagic shark that has a relatively streamlined, slender body and a long-pointed snout, and primarily occurs in offshore and oceanic waters (DoE, 2014). The diet of the shortfin mako comprises mainly fish including other sharks and cephalopods such as squid (Last and Stevens, 2009). Adult mako sharks may feed on larger prey such as billfish and small cetaceans (White et al., 2006).

The shortfin mako reaches a maximum total length of 4.45 m (Weigmann, 2016) and is highly migratory and can travel large distances, migrating from Australian waters to areas well beyond the Australian Exclusive Economic Zone (Rogers et al., 2009). Rogers and Bailleul (2015) deployed satellite tags on eight shortfin makos (range 120 – 270 cm, total length) at locations off the Victorian coast at Portland (southwest Victoria), Phillip Island (central Bass Strait) and Lakes Entrance (Gippsland in eastern Bass Strait) between December 2012 and July 2013. This satellite tagging study found that shortfin makos tagged in western Victoria resided in Great Australian Bight and Bass Strait in summer, before migrating south to the lowest latitudes of 44 to 45°S near the Subtropical Front (STF) and then migrating north to the Coral Sea in the winter and spring.

Distribution in Victoria

The Atlas of Living Australia (CSIRO, 2022) indicates a total of 22 sighting records of the shortfin mako in Victorian waters with eight sightings in Bass Strait waters under Victorian jurisdiction. The actual distribution tends to follow straight lines in a grid pattern suggesting either sampling during research cruises or records of logged discards from fishing vessels.

There were no shortfin mako sightings in Waratah Bay or adjacent offshore waters to the west of Wilsons Promontory. However, one shortfin mako sighting was located to the southwest of Wilsons Promontory and about 10 km east of the nearest proposed alignment of the project.

Overall, the likelihood of occurrence of the shortfin mako in Victorian nearshore at Waratah Bay or adjacent offshore waters is assessed as ***Possible***, given that the tagging studies by Rogers and Bailleul, 2009) suggested that shortfin makos may migrate through Bass Strait during the summer before moving north to the Coral Sea during winter and spring.

Distribution in Tasmania

The Tasmanian Natural Values Atlas (DNRE, 2022) shows a total of 70 shortfin mako sightings in Tasmanian waters with 25 sightings in Bass Strait waters under Tasmanian jurisdiction. There is one shortfin offshore mako sighting between Burnie and Devonport, which is located north of Devonport and about 12 km of the nearest proposed alignment of the project. As was the case for Victorian waters of Bass Strait, the shortfin mako records follow straight lines in a grid pattern suggesting either sampling during research cruises or records of logged discards from fishing vessels.

Overall, the likelihood of occurrence of the shortfin mako in Tasmania nearshore at Heybridge or adjacent offshore waters is assessed as ***Rare***.

6.3.10.1.5 Australian Grayling

The Australian grayling (*Prototroctes maraena*) is listed as vulnerable and migratory under the EPBC Act. This species is listed as endangered under the FFG Act (i.e., the FFG Threatened List of October 2021) and is listed as vulnerable under the TSP Act.

Australian graylings are a diadromous species, migrating between rivers, estuaries, and coastal seas, so rely on free access to a range of freshwater, estuarine and marine habitats for their survival (Backhouse et al., 2008).

The species spends most of its life in freshwater and migrates downstream to the lower reaches of rivers to spawn in the autumn (Museums Victoria, 2017), though the timing of migration may vary depending on environmental variables such as water temperature (Blackhouse et al., 2008).

Larvae and juveniles inhabit estuaries and coastal seas, and there appears to be an obligatory marine stage (Crook et al., 2006), although their precise habitat requirements are not known. In the rivers, the larvae drift or are swept downstream during April to May each year, whereas upstream migration of juvenile grayling occurs about 6 months later, during October to December each year (Crook et al., 2006).

Distribution in Victoria

The Atlas of Living Australia (CSIRO, 2022) reveals only two sightings of Australian graylings within Fenwick Bight at the southern tip of Wilsons Promontory, which is located 24 km from the nearest proposed alignment of the project. No Australian grayling sightings were observed in Waratah Bay. Australian graylings are present in the catchment creeks of Corner Inlet and depend on the marine and estuarine waters of this inlet to complete their life cycle. However, a literature search did not reveal this species presence in Shallow Inlet or its catchment creeks.

The likelihood of occurrence of Australian graylings in the project area encompassing the Victorian nearshore waters of Waratah Bay and the adjacent offshore waters west of Wilsons Promontory is assessed as ***Rare*** and any occurrences will most likely be when the marine juvenile stages migrate back to the creeks between June and September.

Distribution in Tasmania

The Tasmanian Natural Values Atlas (DNRE, 2022) lists a total of 255 sighting records for Australian graylings in Tasmania with 18 sightings recorded between Burnie and Devonport. Along this central north coast reach most sightings are for the lower reaches of north-flowing rivers (e.g., Emu, Blythe and Don rivers, the River Leven and the River Forth). Australian graylings appear to be rarer in the coastal marine environment, as the estuaries of the north-flowing rivers allows completion of their life cycle without the need to seek nearshore marine waters.

Entura (2023) conducted a terrestrial ecology baseline and impact assessment for the Heybridge converter station site. That study reported that there is no suitable Australian grayling habitat at the converter station site and shore crossing.

The likelihood of occurrence of Australian grayling in the project area encompassing the Tasmanian nearshore waters at Heybridge and the adjacent offshore waters is assessed as ***Rare*** and any marine occurrences will most likely be when the marine juvenile stages migrate back to the creeks between June and September.

6.3.10.1.6 Southern bluefin tuna

The southern blue tuna (*Thunnus maccoyii*) is widely distributed in the southern oceans with a spawning ground in the Indian Ocean. In Australia, this species ranges from northern Western Australia, around the southern regions of Australia and up to northern New South Wales.

This species is listed as Conservation Dependent under the EPBC Act, the FFG Act, and the TSP Act. According to the PMST search, southern bluefin tuna is likely to occur in Tasmania and Victoria nearshore, as well as the offshore search area. Therefore, the likelihood of occurrence of southern blue tuna in nearshore Tasmania, nearshore Victoria, and offshore Bass Strait is assessed as ***Likely***.

6.3.10.1.7 Blue warehou

The blue warehou (*Seriolella brama*) is found off southern Australia and New Zealand, typically in waters between 5 to 400 m depth. In Australia there is an eastern stock and western stock of blue warehou. *The Blue Warehou Stock Rebuilding Strategy 2022* (AFMA, 2022c) is implemented to support the recovery of these stocks to above 20% of their unfished spawning biomass.

This species is listed as Conservation Dependent under the EPBC Act, the FFG Act and the TSP Act. According to the PMST searches, blue warehou is known to occur in Waratah Bay; therefore, its likelihood of occurrence in nearshore Victorian has been assessed as ***Very Likely***. The likelihood of occurrence of blue warehou in the Tasmania and offshore areas is assessed as ***Likely***.

6.3.10.2 Other protected of fish species

There are several other fish species besides the abovementioned threatened fish species that are afforded protection under Commonwealth, Victorian and Tasmanian legislation. These other protected fish species are summarised below.

6.3.10.2.1 Commonwealth protected fish species

Fish species in the family *Syngnathidae* (pipefishes, seadragons, and seahorses) are Listed Marine Species under the EPBC Act.

Table 6.38 presents a list of fish species in the family *Syngnathidae* that may occur in the project's PMST search areas. There are 26 *syngnathid* species or their habitats that may occur in offshore waters of Bass Strait (PMST, 2023; Attachment A).

Table 6-38: EPBC Act Listed Marine Species – *Syngnathidae*

Scientific name	Common name	IUCN	VIC N'shore	Offshore Bass Strait	TAS N'shore
Hippocampus abdominalis	Big-belly seahorse	LC	MO	MO	MO
Hippocampus breviceps	Short-head seahorse	LC	MO	MO	MO
Hippocampus minotaur	Bullneck seahorse	DD	MO	MO	MO
Heraldia nocturna	Upside-down pipefish	LC	MO	MO	MO
Histiogamphelus briggsii	Crested pipefish	LC	MO	MO	MO
Histiogamphelus cristatus	Rhino pipefish	LC	MO	MO	MO
Hypselognathus rostratus	Knife-snouted pipefish	LC	MO	MO	MO
Kaupus costatus	Deep-bodied pipefish	LC	MO	MO	MO
Kimblaeus bassensis	Bass Strait pipefish	LC	MO	MO	MO
Leptoichthys fistularius	Brushtail pipefish	LC	MO	–	–
Lissocampus caudalis	Smooth pipefish	LC	MO	MO	MO
Lissocampus runa	Javelin pipefish	LC	MO	MO	MO
Maroubra perserrata	Sawtooth pipefish	LC	MO	MO	MO
Mitotichthys semistriatus	Half-banded pipefish	LC	MO	MO	MO
Mitotichthys tuckeri	Tucker's pipefish	LC	MO	MO	MO
Mitotichthys mollisoni	Mollison's pipefish	LC	MO	–	–
Notiocampus ruber	Red pipefish	LC	MO	MO	MO
Pugnaso curtirostris	Pugnose pipefish	LC	MO	MO	MO
Stigmatopora argus	Spotted pipefish	LC	MO	MO	MO
Stigmatopora nigra	Wide-bodied pipefish	LC	MO	MO	MO
Stipecampus cristatus	Ringback pipefish	LC	MO	MO	MO
Urocampus carinirostris	Hairy pipefish	LC	MO	MO	MO
Vanacampus phillipi	Port Phillip pipefish	LC	MO	MO	MO
Vanacampus poecilolaemus	Long-nosed pipefish	LC	MO	MO	MO
Phycodurus eques	Leafy seadragon	LC	MO	MO	MO
Phyllopteryx taeniolatus	Common seadragon	LC	MO	MO	MO
Solegnathus robustus	Robust pipehorse	LC	MO	MO	MO
Solegnathus spinosissimus	Spiny pipehorse	DD	MO	MO	MO
		No. of species	**28**	**26**	**26**

Source: EPBC Act Protected Matters Reports for PMST search areas for offshore Bass Strait (PMST, 2023; Attachment A), nearshore Victoria at Waratah Bay (PMST, 2023; Attachment B), and nearshore Tasmania at Heybridge (PMST, 2023; Attachment C). Occurrence codes: MO=Species or its habitat may occur within area. Dash (–) denotes not listed.

Syngnathids mainly avoid predation by camouflage (e.g., mimicking seagrass or macroalgae) or by sheltering in caves or crevices, or by their hard bony rings, plates and spines. Their predator avoidance strategies have resulted in diverse body forms.

In general, knowledge of *syngnathids* across southern Australia including Bass Strait is limited due to the cryptic behaviour of many species, limited research, and few surveys. *Syngnathids* use a wide variety of habitats that range from seagrass and macroalgae, reefs and other hard bottom habitats.

Since most of the seafloor along the proposed offshore alignment of the project comprises medium- to fine-grained soft sediments (e.g., sands, sandy silt, silty sands, and silts and clays), this type of seabed substratum is not suitable habitat for most *syngnathid* species.

The likelihood of occurrence of *syngnathid* fishes in offshore central Bass Strait is assessed as ***Rare*** given the absence of suitable *syngnathid* habitat such as seagrasses, macroalgae, hard seabed.

6.3.10.2.2 Other Victorian protected fish species

The sandy seabed of Waratah Bay and the sparse areas of seagrass and general lack of hard seabed and associated macroalgal cover is not a favourable environment for many *syngnathids* fishes, many of which clasp onto macroalgae and rocky substrata.

6.3.10.2.3 Other Tasmanian protected fish species

Other threatened and non-threatened fish species in Tasmania are protected under the *Living Marine Resources Management Act 1995* (Tas) (LMRM Act) and/or the TSP Act include the following groups:

- Species of seahorse, pipefish, and seadragons of the family *syngnathidae*.
- Handfishes of the family *brachionichthyidae*.
- Blennies (*Forsterygion* spp.).
- Five species of sharks.

Protected *syngnathid* species

The EPBC Act Protected Matters report for nearshore Tasmania (PMST, 2023; Attachment C) and Table 6.38 above indicate that 26 species of *syngnathids* or their habitat may occur within the area.

Nine species are known to occur along the north coast of Tasmania (Aquenal, 2002), seven of which are pipefishes, one seadragon and one seahorse:

- Javelin pipefish (*Lissocampus runa*).
- Pug-nosed pipefish (*Syngnathus curtirostris*).
- Long-snouted pipefish (*Syngnathus poecilolaemus*).
- Port Phillip pipefish (*Syngnathus phillipi*).
- Spotted pipefish (*Stigmatopora argus*).
- Wide-bodied pipefish (*Stigmatopora nigra*).
- Half-banded pipefish (*Mitotichthys semistriatus*).
- Weedy sea dragon (*Phyllopteryx taeniolatus*).
- Short-headed seahorse (*Hippocampus breviceps*).

A common feature along the north coast of Tasmania is the presence of hard substrata (e.g., rock platforms, low- and high-profile rocky reefs, cobbles and stones, etc.) that are characterised by having high red, brown and green macroalgal cover and sponges, all of which provide suitable habitat for *syngnathids*.

The likelihood of occurrence of the nine *syngnathid* species listed above in nearshore Tasmania at the project's proposed landfall at Heybridge is assessed as ***Likely***, while the likelihood of occurrence of the remaining 17 *syngnathid* species in Table 6.38 for the Tasmanian nearshore is assessed as ***Rare***.

Protected handfishes

Five of the eight currently identified handfish species are endemic to Tasmania and Bass Strait (Last et al., 1983). The spotted, red, pink and Ziebell's handfishes are all classified as endangered under the TSP Act and as critically endangered under the IUCN Red List of Threatened Species.

There are four handfish species that all belong to the family *brachionichthyidae*, which are classified as endangered under the TSP Act and include:

- Spotted handfish (*Brachionichthys hirsutus*).
- Red handfish (*Thymichthys politus*).
- Pink handfish (*Brachiopsilus dianthus*).
- Ziebell's handfish (*Brachiopsilus ziebelli*).

Handfish are small, unusual, slow-moving fish that prefer to 'walk' on their pectoral and pelvic fins rather than swim. The pectoral or side fins are leg-like with their extremities resembling a human hand (hence their common name).

Spotted handfish

The Tasmanian Natural Values Atlas (DNRE, 2022) indicates a total of 525 records of the spotted handfish (*Brachionichthys hirsutus*) in Tasmania and this species is endemic to a small area of southeastern Tasmania, with no sighting records of this species in Bass Strait. The likelihood of occurrence of this species in nearshore Tasmania and adjacent offshore waters at the project's proposed landfall at Heybridge is assessed as ***Remote***.

Red handfish

The red handfish (*Thymichthys politus*) appears to be confined to a few restricted, shallow reef habitats in south-eastern Tasmania. However, the Tasmanian Natural Values Atlas (DNRE, 2022) indicates a total of six records for the red handfish with two records in Anderson Bay near Bridport on the north coast of Tasmania. Therefore, the likelihood of occurrence of this species in nearshore Tasmania at the project's proposed landfall at Heybridge is assessed as ***Rare***, given its known occurrence on the north coast of Tasmania.

Pink handfish

The pink handfish (*Brachiopsilus dianthus*) appears to be confined to the south and southeast coast of Tasmania based on the 24 sightings in the Tasmanian Natural Values Atlas (DNRE, 2022). The likelihood of occurrence of this species in nearshore Tasmania and adjacent offshore waters at the project's proposed landfall at Heybridge is assessed as ***Remote***.

Ziebell's handfish

Ziebell's handfish (*Brachiopsilus ziebelli)* appears to be confined to a few restricted, shallow reef habitats in southern and south-eastern Tasmania. The Tasmanian Natural Values Atlas (DNRE, 2022) indicates a total of 12 records for Ziebell's handfish with no records in Bass Strait. The likelihood of occurrence of this species in nearshore Tasmania and adjacent offshore waters at the project's proposed landfall at Heybridge is assessed as ***Remote***.

Protected blennies of the genus forsterygion

There are three blenny species in the genus *forsterygion* in Tasmania:

- Common threefin (*Forsterygion lapillum*).
- Tasmanian robust triplefin (*Forsterygion gymnotum*).
- Variable threefin (*Forsterygion varium*).

The common threefin (*F. lapillum*) is not listed in the Tasmanian Natural Values Atlas (DNRE, 2022) but does show sighting records of the other two species. A total of 41 Tasmanian robust triplefins (*F. gymnotum*) have been recorded in Tasmania with all sightings recorded in the southeast of the state with no records in Bass Strait.

The Tasmanian Natural Values Atlas (DNRE, 2022) indicates a total of 391 records of the variable threefin (*F. varium*) in Tasmania with two records in Bass Strait along the north coast of Tasmania. One sighting record is at Goat Island near Ulverstone, which is located 14 km from the nearest proposed alignment of the project. The other sighting record is located 155 km from the Link at Croppie Point in far northeast Tasmania.

The likelihood of occurrence of the common threefin and the Tasmanian robust triplefin in the nearshore Tasmania and adjacent offshore waters at the project's proposed landfall at Heybridge is assessed as ***Remote***. However, the likelihood of occurrence of the variable threefin (*F. varium*) at the same location is assessed as ***Rare*** given its occurrence within 14 km of the project's proposed alignment.

Protected sharks

The five species of sharks protected by the Tasmania LMRM Act are:

- White shark (*Carcharodon carcharias*).
- Basking shark (*Cetorhinus maximus*).
- Grey nurse shark (*Carcharias taurus*).
- Megamouth shark (*Megachasma pelagios*).
- Whale shark (*Rhincodon typus*).

Fisheries (General and Fees) Regulations 2006 under the LMRM Act prohibits the taking or possession of the above protected shark species.

Only the white shark (*Carcharodon carcharias*) is listed in the EPBC Act Protected Matters Reports and PMST search areas of offshore Bass Strait under Tasmanian jurisdiction (PMST, 2023; Attachment A) and nearshore Tasmania (PMST, 2023; Attachment C). The white shark is addressed in Section 6.3.10.1.1 and a description of this species and its occurrence in Bass Strait is not repeated here.

6.3.10.3 Common fish species

While the previous section has described threatened or listed marine species of fishes, the more common fish families are summarised below, since knowledge of their presence in Bass Strait is required for assessing impacts of the project on fishes in general.

6.3.10.3.1 Common fishes in Bass Strait

Table 6.39 presents the numerically dominant pelagic and demersal species in Bass Strait.

Table 6-39: Dominant fish species occurring in Bass Strait

Habitat	Major species	Distribution
Pelagic nearshore	Pilchards (*Sardinops neopilchardus*)	Embayments and coastal waters.
	Anchovies (*Engraulis australis*)	Embayments and coastal waters.
	Sandy sprat (*Hyperlophus vittatus*)	Embayments and coastal waters.
	Southern garfish (*Hyporhamphus melanochir*)	Embayments and coastal waters.
	Silver trevally (*Pseudocaranx dentex*)	Move into deeper water as adults.
	Blue warehou (*Seriolella brama*)	Depth 10 to 180 m; often over reefs.
	Australian salmon (*Arripis* spp.)	Embayments and coastal waters.
Demersal nearshore	Tiger flathead (*Platycephalus richardsoni*)	Coastal and central Bass Strait.
	Sand flathead (*Platycephalus bassensis*)	Coastal and central Bass Strait.
	School whiting (*Sillago bassensis*)	Shallow inshore waters.
	King George whiting (*Sillaginodes punctatus*)	Shallow inshore waters.
	Snapper (*Pagrus auratus*)	Coastal to continental shelf.
	Gummy shark (*Mustelus antarcticus*)	Coastal to continental shelf.
Demersal mid-shelf	School shark (*Galeorhinus galeus*)	Coastal to continental shelf.
	Saw shark (*Pristiphorus* spp.)	Coastal to continental shelf.
	Elephant shark (*Callorhynchus milii*)	Coastal to continental shelf.

Source: NSR (2001); BRS (1998)

6.3.10.3.2 Victorian common fishes

The Victorian nearshore soft sediment (sandy) seabed habitats support a variety of bottom living fish, such as flatfish and flounders (*Platycephalidae*), whereas at the reef habitats (where present) marine fish may be permanent residents ('reef-attached' species) or as transients moving seasonally along the reef system ('reef-associated' species). The most common reef fish are gummy shark, trevally, sand flathead, spiny gurnard, snapper, salmon and stingaree. Snapper and gummy shark are most sought after by commercial and recreational fishermen working from boats, and Australian salmon is fished from the shore. Snappers migrate southwestwards along the reef system from October to April, feeding on reef invertebrates, mainly bivalve molluscs and echinoderms.

A measure of common fishes can be augmented by using the dietary intakes of fishes by little penguins and Australian fur seals. For example, Table 6-20 (Section 6.3.7.1.1, Australian fur seal) presents the predominant fishes preyed on by Australian fur seals in Victorian waters, which are summarised below:

- Gurnards (*Triglidae*).
- Leatherjackets (*Monacanthidae*).
- Lionfishes and sculpins (*Scorpaenidae*).
- Ray-finned fish (*Carangidae*):
  - Jack mackerel (*Trachurus* spp.) and trevally (*Pseudocaranx* spp.).
- Gurnard perches (*Neosebastidae*).
- *Cyttidae:*
  - Silver dory (*Cyttus australis*).
- Stingrays (*Myliobatidae*).

- Flatheads (*Platycephalidae*).
- Codling (*Moridae*).
- *Emmelichthyidae:*
  - Redbait (*Emmelichthys nitidus*).
- *Ophidiidae*:
  - Pink ling (*Genypterus blacodes*).
- *Gempylidae:*
  - barracouta (*Thyrsites atun*).
- *Hemiramphidae*
  - garfish (*Hyporhamphus* spp.).

6.3.10.3.3 Tasmanian common fishes

In nearshore Tasmania, subtidal rocky platforms and reefs are likely to support a wide diversity of marine fish of a similar matrix as the Victorian nearshore reefs summarised above. Barrett and Edgar (2000) investigated reef fish communities at various sites on the Tasmanian north coast and Bass Strait islands and recorded a total of 69 species. Marine fish species found in northern Tasmania include reef fish that are permanent residents of coastal communities, migratory species that move between marine and freshwater in estuarine environments and offshore species that are transient visitors to inshore breeding and nursery habitats (Aquenal, 2002).

A list of the key pelagic and benthic or demersal fish families and example species that are likely to be encountered in nearshore Tasmania and offshore Bass Strait under Tasmanian jurisdiction is given below. The list is not exhaustive but serves to highlight the dominant fish families:

- *Engraulidae*: anchovies and sprats (e.g., Australian anchovy, *Engraulis australis*).
- *Clupeidae*: sardines and pilchards (e.g., Australian sardine, *Sardinops sagax*).
- *Carangidae*: trevallies and kingfish (e.g., yellowtail kingfish, *Seriola lalandi*).
- *Scombridae*: jack mackerel (e.g., *Trachurus* spp.) and tuna (e.g., southern bluefin tuna, *Thunnus maccoyii*).
- *Triakidae*: gummy sharks (*Mustelus antarcticus*) and school sharks (*Galeorhinus galeus*).
- *Lamnidae*: white shark (*Carcharodon carcharias*).
- *Alopiidae*: thresher shark (*Alopias vulpinus*).

Key benthic and demersal fish species include the following main family groups:

- *Platycephalidae*: flatheads e.g., southern sand flathead (*Platycephalus bassensis*).
- *Arripidae*: Australian salmon (e.g., *Arripis arripis* and/or *A. truttacea*).
- *Monacanthidae*: leatherjackets (e.g., Gunn's leatherjacket (*Eubalichthys gunnii*)).
- *Triglidae*: sea robins and gurnards (e.g., spiny gurnard (*Lepidotrigla papilio*)).
- *Neosebastidae*: gurnard perches (*Neosebastes* spp.).
- *Rajidae*: rays and skates (e.g., sparsely spotted stingaree (*Urolophus paucimaculatus*)).
- *Aracanidae*: cowfishes (e.g., Shaw's cowfish (*Aracana aurita*) and ornate cowfish (*A. ornata*)).
- *Odacidae*: weed whitings (e.g., slender weed whiting (*Siphonognathus attenuatus*)).

Given the proximity of the proposed landfall of the project in nearshore Tasmania to nearby estuaries and river mouths (e.g., the Blythe River), the principal migratory and/or diadromous fish species potentially affected by the project include anadromous species (e.g., short-headed lamprey (*Mordacia mordax*), pouched lamprey (*Geotria australis*) and Australian salmon (*Arripis trutta*)), and catadromous species (e.g., short-finned eel (*Anguilla australis*) and long-finned eel (*A. reinhardtii*)).

6.3.11 Marine invertebrates

The marine pelagic and benthic macroinvertebrates of Bass Strait have a high diversity, with several *polychaete* families, *pycnogonids*, *pericarid* crustaceans, *opisthobranch* molluscs, *bryozoans* and *brachiopods* being the most abundant groups. Crustaceans and *polychaete* worms dominate the infaunal communities of soft seabed sediments of central Bass Strait, many of which are unknown species (NSR, 2002).

6.3.11.1 Marine invertebrates of conservation significance

There is a number of threatened marine invertebrate species or families that are listed under the FFG Act and the TSP Act and which are summarised below.

6.3.11.1.1 Victorian waters

Table 6.40 lists threatened marine invertebrate species. The EPBC Act Protected Matters Reports for Waratah Bay (PMST, 2023; Attachment B) and adjacent offshore waters of Bass Strait (PMST, 2023; Attachment A) under Victorian jurisdiction do not list any of the threatened marine invertebrates shown in Table 6.40.

A search of the Atlas of Living Australia (CSIRO, 2022) for all the marine invertebrates listed in Table 6.40 revealed that many of the species are found sheltered embayments such as Port Philip Bay, Westernport Bay and Corner Inlet, with few records along the open coastline of southeast Victoria. The nearest threatened species is the brittle star (*Clarkcoma australis*) with two sighting records in Corner Inlet, with the closest record being 25 km from the proposed nearshore alignment of the project in Waratah Bay. Note that Corner Inlet is separated from Waratah Bay by the Yanakie isthmus and therefore lies outside the project's direct influence.

All the remaining sighting records of threatened marine invertebrate species were located at a range of between 30.5 and 107.6 km distance from the project's alignment in Bass Strait. Note that due to sensitivity concerns the sighting record coordinates of some species have been generalised to within a 10-km radius of its known location; for example, the ghost shrimp (*Pseudocalliax tooradin*) has a generalised 'record' location in Wonthaggi Town.

Table 6-40: List of threatened species of marine invertebrates in Victorian marine waters

Family	Scientific Name	Common Name	Status	Likelihood of occurrence
Cucumariidae	*Apsolidium falconerae*	Sea cucumber	CR	Rare
Cucumariidae	*Apsolidium densum*	Sea cucumber 5251	EN*	Rare
Cucumariidae	*Apsolidium handrecki*	Sea cucumber 5052	EN	Rare
Cucumariidae	*Pentocnus bursatus*	Sea cucumber	CR	Rare
Phyllophoridae	*Thyone nigra*	Sea cucumber	EN	Rare
Chiridotidae	*Rowedota shepherdi*	Sea cucumber	CR	Rare
Amphiuridae	*Amphiura trisacantha*	Brittle star	EN	Rare
Clarkcomidae	*Clarkcoma australis*	Brittle star	CR	Rare
Tubulariidae	*Ralpharia coccinea*	Stalked hydroid	CR*	Rare
Australomedusidae	*Australomedusa baylii*	Brackish jellyfish	EN	Rare
Discodorididae	*Platydoris galbana*	Sea slug	EN	Rare
Rhodopidae	*Rhodope rousei*	Marine *opisthobranch*	CR	Rare
Acanthochitonidae	*Bassethullia glypta*	Chiton 5254	CR	Rare
Eucalliacidae	*Pseudocalliax tooradin*	Ghost shrimp	EN*	Rare
Alpheidae	*Athanopsis australis*	Southern hooded shrimp	EN	Rare

Notes: Status denotes threat category under the FFG Act. Status codes: CR=Critically endangered; EN= Endangered. *Denotes a threat category that is at risk in Australia rather than Victoria.

The two brittle stars listed in Table 6.40 are not endemic to Victoria and have a very limited distribution typically within areas of seagrass. Both species present in the vicinity of Sand Island in the Nooramunga Marine and Coastal Park.

The only endemic species in Victoria listed in Table 6.40 is the sea cucumber labelled as 5251 (*Apsolidium densum*), with three records near Apollo Bay (southwest Victoria) and three records in Westernport Bay (two sightings at Mushroom Reef at West Head (near Flinders town) and one sighting at Point Leo (near Shoreham town). The nearest sighting at West Head is located 107.5 km from the project's proposed alignment. The morphology of this species suggests that it is likely to be restricted to the rocky shallow habitats up to 2 m depth (O'Hara and Barmby, 2000).

Overall, the likelihood of occurrence of all Victorian threatened marine invertebrate species is assessed as ***Rare***.

6.3.11.1.2 Tasmanian waters

The following threatened marine invertebrates are listed under the LMRM Act:

- Elephant snail (*Scutus antipodes*).
- Limpets belonging to the superfamilies *fissurellacea*, *patellacea* and *siphonariacea*.
- Gunns' screw shell (*Gazameda gunnii*).

Gunn's screw shell is also listed as vulnerable under the TSP Act.

The Tasmanian Natural Values Atlas (DNRE, 2022) was searched to ascertain the occurrences and distribution of the above marine invertebrate species or groups in nearshore Tasmania and adjacent offshore waters of Bass Strait under Tasmanian jurisdiction.

Elephant Snail

The elephant snail (*Scutus antipodes*) is a large species of marine gastropod mollusc in the family *fissurellidae* (superfamily *fissurellacea*). The Tasmanian Natural Values Atlas (DNRE, 2022) indicates a total of 261 records of the elephant snail in Tasmanian waters with most sightings along the east coast of Tasmania, and some clusters in Bass Strait at King and Flinders islands and along the north coast of Tasmania. The latter includes 10 sightings between Burnie and Devonport that straddles the project's proposed landfall at Heybridge, with one sighting at Titan Point that is only 650 m from the nearest proposed alignment of the project.

The likelihood of occurrence of the elephant snail in the nearshore Tasmanian waters at Heybridge is assessed as ***Possible***, given similar habitat at both locations (rocky platform and low-profile reefs covered in macroalgae).

Limpets in the superfamilies *fissurellacea*, *patellacea* and *siphonariacea*

It was difficult to ascertain the specific species of limpets that are protected under the LMRM Act. An inspection of the Tasmanian Natural Values Atlas (DNRE, 2022) indicated two limpet species in the family *fissurellidae* that may potentially occur in Bass Strait.

Scarred notched limpet

The Tasmanian Natural Values Atlas (DNRE, 2022) has a total 31 records of the scarred notched limpet (*Tugali cicatricosa*), which is mainly found at King and Flinders islands with eight records along the north coast of Tasmania. The nearest individual sighting is Emu Bay near Burnie, which located 5.5 km west of the project's proposed nearshore alignment at Heybridge.

The likelihood of occurrence of the scarred notch limpet in nearshore Tasmania in the vicinity of the proposed landfall of the Marnus Link at Heybridge is assessed as ***Possible***.

Pitted keyhole limpet

The Tasmanian Natural Values Atlas (DNRE, 2022) has a total 37 records of the pitted keyhole limpet (*Cosmetalepas concatenatus*) in Tasmanian waters with 16 sightings in Bass Strait. In Bass Strait, there sighting clusters around King and Flinders islands, as well as seven individual sightings along the north coast but only east of George Town. There are no sighting records for the central north coast and no sightings between Burnie and Devonport.

The likelihood of occurrence of the pitted keyhole limpet in nearshore Tasmania in the vicinity of the proposed landfall of the Marnus Link at Heybridge is assessed as ***Remote***.

Gunns' screw shell

The marine gastropod Gunns' screw shell (*Gazameda gunnii*) is also listed as vulnerable under the TSP Act. The Tasmanian Natural Values Atlas (DNRE, 2022) shows a total of 489 sighting records of Gunns Screw shell in Tasmanian waters including about 100 sightings in Bass Strait. There is a cluster of sightings either side of the Stanley Peninsula and another cluster along the coast between Port Sorrell and George Town. However, there are only four sightings between Burnie and Devonport, which is the stretch of coast that compasses the project's proposed landfall at Heybridge.

There is anecdotal evidence that the introduced New Zealand screw shell (*Maoricolpus roseus*) may be outcompeting Gunns' screw shell, since the latter has ostensibly disappeared from soft-sediment habitat in areas dominated by the invasive New Zealand screw shell, and now exhibits a reduced distribution at low densities (Bax et al, 2003, Gunasekera et al., 2005).

A search of the Tasmanian Natural Values Atlas (DNRE, 2022) revealed 538 records of the New Zealand screw shell in Tasmanian with most sighting along the east and southeast coast of Tasmanian, as well as along the central north coast. There were 12 New Zealand screw shell sightings between Burnie and Devonport, including one sighting at Heybridge close to the proposed landfall of the project.

Overall, the likelihood of occurrence of Gunns screw shells in nearshore Tasmania and adjacent offshore water at the proposed landfall of the project is assessed as ***Possible***.

6.3.11.2 Other non-threatened marine invertebrate fauna

Non-threatened marine invertebrate fauna occurring in both nearshore Victorian and Tasmanian waters, as well as offshore Bass Strait includes a wide variety of pelagic and benthic species, which are too numerous to summarise or discuss in detail. As there no site-specific, detailed investigations of marine invertebrates for Waratah Bay in Victoria or the Tasmanian nearshore at Heybridge in Tasmania, the following short summaries are based on seabed benthos surveys performed by others within comparable coastal zones.

6.3.11.2.1 Victorian nearshore

The marine invertebrate fauna of nearshore Victoria (Waratah Bay) comprises both pelagic and benthic species.

Common pelagic invertebrate fauna

Common pelagic invertebrate fauna include squid (e.g., Gould's squid, *Nototodarus gouldi*), jellyfishes (e.g., bluebottle jellyfish, *Physalia physalis*), nudibranchs (*Gastropoda*), salps, swimming crabs (e.g., blue swimmer crab, *Portunus armatus*).

Common benthic invertebrate fauna

Common benthic macroinvertebrates are dominated by *polychaete* worms, small crustaceans (e.g., amphipods and isopods), large decapod crustaceans (e.g., lobsters, hermit crabs and crabs), molluscs (e.g., gastropods, bivalves, and octopuses), and echinoderms (e.g., starfish, brittle stars, feather stars, sea cucumbers and sea urchins).

Sessile invertebrates likely to occur in Waratah Bay include *bryozoans*, sponges, hydroids, *anthozoans* (sea anemones, *gorgonians* and soft corals), and *ascidians* (mostly colonial but some solitary colonial sea-squirts). Many of these groups are attached to hard substrata (cobbles, gravels, shells rocky rubble) and predominantly filter feed. Given the predominance of sandy seabed within Waratah Bay the diversity of benthic macroinvertebrates will be lower than would be the case for seabed with hard substrata such as low- or high-profile coral reefs.

6.3.11.2.2 Tasmanian nearshore

As there is no site-specific information on marine invertebrates for nearshore Tasmania at Heybridge, the following description of common marine invertebrate species is based on a regional survey conducted by Aquenal (2005) at a Tasmanian north coast site off Five Mile Bluff (i.e., the site of a proposed marine outfall), which is located 64 km to the east of the nearest proposed alignment of the project in nearshore Tasmania. At Five Mile Bluff, the nearshore seabed was comprised of similar low- and high-profile reefs, with areas of cobbles and sandy seabed, and is therefore considered as a suitable representative surrogate to characterise the common marine invertebrate fauna of the nearshore Tasmania at Heybridge. Both the Tasmanian nearshore at Heybridge and the Five Mile Bluff site are within the same north coast Boags bioregion.

The predominant benthic macroinvertebrate fauna at Five Mile Bluff nearshore (Aquenal, 2005) were:

- *Porifera* – ball, plate, and finger sponges (31 species).
- *Bryozoa* – *bryozoans* (10 species).
- *Ascidiacea* – *ascidians* and *tunicates* or sea squirts (6 species).
- *Mollusca* - *gastropods* (4 species and bivalves (3 species).
- *Brachiopoda* – unidentified *brachiopod* (1 specie).
- *Cnidaria* – encrusting *gorgonian* (*Erythropodium hicksoni*) (1 species).

Based on the above list, the more common benthic macroinvertebrates at the nearshore Tasmanian site at Heybridge are anticipated to be dominated by sponges (Porifera) and *bryozoans* (Bryozoa), followed by gastropod and bivalve molluscs.

Some common species of commercial significance include the southern rock lobster (*Jasus edwardsii*), greenlip abalone (*Haliotis laevigata*) and the blacklip abalone (*Haliotis rubra*), which are discussed further within Section 6.4.2 (Commercial fisheries of Bass Strait), and Section 6.4.3 (Recreational fishing).Offshore Bass Strait.

6.3.11.2.3 Offshore Bass Strait

A detailed benthic sampling of benthic macroinvertebrates or sediment infauna of the 255-km long seabed of the proposed project alignment was not carried out nor necessary for the project, as they will be well represented in adjacent and lateral seabed areas of common water depth adjacent to the proposed route of the project. However, additional information on common benthic macroinvertebrates of the seabed is available from a video survey of the route that was carried out to characterise the seabed habitats. The following descriptions of the observed biological communities are based on the video survey carried out by CEE (2022) and provide additional information of the marine invertebrates of offshore Bass Strait. The observations are based on the following kilometre points (KPs) starting from the Victorian coast (Waratah Bay) to the Tasmanian nearshore at Heybridge:

- KP 8 (40 m depth) to KP 20 (70 m depth):
  - Flat seabed with fine sands with sparsely distributed erect colonies of eunicid worm tube stalks but disappear at KP 70. No sea pens were present and little surface bioturbation indicative of burrowing marine invertebrates.
- KP 40 to KP 70 (~75 m average depth):
  - Flat compacted sand seabed with patches of small opaque worm tube openings likely to represent the presence of *Eunicidae* or *Onuphidae polychaete* worms below the seabed surface. Unidentifiable low growth observed over the seabed probably represented early growth of encrusting or colonial invertebrates such as sponges, *bryozoans* and hydroids. The small, stalked hydroid *Lanceopora smeatoni* was present individually and in small patches. Small mounds representing actively burrowing biota were present but sparsely distributed.
- KP 100 to KP 140 (~80 m average depth):
  - The seabed along this section of the alignment was fine silt with mounds, dimples and open holes from biological activity below the seabed surface. Thin opaque worm tubes (possibly orbiniids) were abundant in some patches at KP 100. Epibiota in this segment were scarce. However, individual sponges or small patches of mixed invertebrates including sponges, *bryozoans*, *ascidians* and branching soft corals were scattered over the otherwise bare seabed surface.

- KP 180 (76 m depth) to KP 230 (68 m depth):
  - The seabed was comprised mainly of silt with abundant mounds of burrowing marine invertebrates. A slender branched octocoral (soft coral) was observed.
- KP 238 (60 m depth) to 240.5 (56 m depth):
  - Flat seabed with lower and more sparsely distributed mounds and burrow holes, with increasing amounts of mixed assemblages of sponges and *bryozoans* scattered over another wise bare seabed. Encrusted eunicid worm tubes were present.
- KP 246 (43 m depth) to KP 250 (33 m depth):

Seabed along this section showed the increasing influence of wave action. One individual seapen (*Sarcoptilus grandis*) was present but the seapen (*Pseudogorgia godeffroyi*) was not observed. The small, stalked *bryozoan* (*Lanceopora smeatoni*) was observed. Commercial scallops (*Pecten fumatus*) and doughboy scallops (*Chlamys asperrimus*) were present but sparsely distributed. Eleven arm seastars (*Coscinasterias muricata*) were observed feeding on the scallops.

6.3.12 Invasive marine species

Invasive Marine Species (IMS) in Commonwealth and State waters in southeast Australia are represented by a wide variety of taxonomic groups, including macroalgae, *bryozoans*, bivalve molluscs, sea squirts, tunicates, *polychaetes*, fishes and many more forms of marine life, especially sedentary or sessile invertebrates (Stephenson, 2021).

Sources of IMS information was researched to allow summary descriptions of the existing distributions of IMS in Bass Strait and their proximity to the nearest proposed alignment of the project. The presence or not of IMS is required for assessing potential risks introducing or translocating existing infestations likely to result from project activities (see Section 7.2.5, Impacts of introducing or translocating invasive marine species).

6.3.12.1 IMS data sources

Relevant documents were reviewed to provide information on the biology, ecology and the existing distribution of IMS either established or identify those IMS that may pose a risk of future introduction to Australia:

- Commonwealth and international databases:
  - The National Introduced Marine Pest Information System, NIMPIS (DAWE, 2021e).
  - Australian Priority Marine Pest List (ABARES, 2019).
  - IUCN Global Invasive Species Database, GISD (IUCN-ISSG, 2021).
- Victorian sources:
  - Marine pests in Victoria (Parks Victoria, 2021).
  - Priority marine pests (Agriculture Victoria, 2021).
- Tasmanian sources:
  - Marine pest Identification (DNRE, 2019).
  - An annotated checklist of Tasmanian marine molluscs (Grove, 2018).
  - Mediterranean blue mussel, *Mytilus galloprovincialis* (Pickett and David (2018).

6.3.12.2 Existing distribution of invasive marine species

Table 6.41 presents a list of IMS observed in Victoria and Tasmania. Most of the invasive species are found in ports (e.g., Port of Melbourne, Devonport and Launceston) and often restricted semi-enclosed embayments (e.g., Port Phillip and Westernport bays in Victoria) or estuaries (e.g., Tamar and Mersey estuaries). In Table 6-41, nine invasive marine species have been observed in Bass Strait coastal or offshore island waters.

Table 6-41: List of invasive marine species (IMS) in Victorian and Tasmanian waters

Taxon	Common name	Latin name	VIC	TAS	O/S
Invasive marine flora:					
Phaeophyta	*Undaria pinnatifida*	Wakame (kelp)	✓	✓	✓
Rhodophyta	*Grateloupia turuturu*	Devil's tongue weed	✓	✓	–
Chlorophyta	*Codium fragile subsp. fragile*	Deadman's fingers	✓	✓	–
Invasive marine fishes:					
Gobiiformes	*Tridentiger trigonocephalus*	Trident goby	✓	–	–
Gobiiformes	*Acanthogobius flavimanus*	Yellowfin goby	✓	–	–
Gobiiformes	*Acentrogobius pflaumi*	Streaked goby	✓	–	–
Invasive marine invertebrates:					
Mollusca	*Arcuatula senhousia*	Asian date mussel	✓	✓	–
Mollusca	*Magallana gigas*	Pacific oyster	✓	✓	✓
Mollusca	*Raeta pulchella*	Beautiful trough-shell	✓	–	–
Mollusca	*Varicorbula gibba*	European clam	✓	✓	✓
Mollusca	*Maoricolpus roseus*	New Zealand screw shell	✓	✓	–
Mollusca	*Theora lubrica*	East Asian bivalve	✓	✓	✓
Tunicata	*Styela clava*	Leathery sea squirt	✓	✓	–
Tunicata	*Ascidiella aspersa*	solitary *ascidian*	✓	✓	–
Tunicata	*Styela plicata*	Solitary *ascidian*	✓	–	–
Asteroidea	*Asterias amurensis*	Northern Pacific seastar	✓	✓	✓
Asteroidea	*Astrostole scabra*	rough sea star	✓	✓	✓
Decapoda	*Carcinus maenas*	European shore crab	✓	✓	✓
Decapoda	*Hemigrapsus sanguineus*	Asian shore crab	✓	–	–
Polychaeta	*Euchone limnicola*	Fan worm	✓	✓	✓
Polychaeta	*Sabella spallanzanii*	European fan worm	✓	✓	✓

Source: National Introduced Marine Pest Information System (DAWE, 2021e). Tick (✓) denotes an IMS is present; Dash (–) denotes IMS not present. *There are two subspecies of deadman's fingers including *Codium fragile fragile* and *Codium fragile tomentosoides*; however, the World Register of Marine Species (WORMS, 2021) notes that these are synonyms and that the accepted name is *Codium fragile fragile*. O/S denotes Offshore Bass Strait.

6.3.12.2.1 Distribution of IMS in Victorian waters

Table 6.42 lists those IMS in Victorian waters and gives their nearest location and distance to the nearest proposed alignment of the project. The likelihood of occurrence of IMS in Waratah Bay and the adjoining offshore water under Victorian jurisdiction are also presented in Table 6-42. The list is based on marine pests in Victoria published by Parks Victoria (2021).

Table 6-42: Proximity of invasive marine species (IMS) to the project in Victoria

Scientific name	Common name	Nearest location In Victoria	CPA (km)	Likelihood of occurrence
Invasive marine flora				
Undaria pinnatifida	Japanese kelp	Westernport Bay	80.5	Remote
Grateloupia turuturu	Devil's tongue weed	Williamstown	153	Remote
Codium fragile fragile	Deadman's fingers	Westernport Bay	82	Remote
Invasive marine fish:				
Tridentiger trigonocephalus	Trident goby	Port Phillip Bay	124	Remote
Acanthogobius flavimanus	Yellowfin goby	Tarwin River	30.3	Possible
Acentrogobius pflaumi	Streaked goby	Corio Bay, PPB	144	Remote
IMS – Marine invertebrates:				
Arcuatula senhousia	Asian date mussel	Shallow Inlet	5.5	Possible
Magallana gigas	Pacific oyster	Phillip Island	80	Rare
Raeta pulchella	Beautiful trough-shell	Corio Bay, PPB	166	Remote
Varicorbula gibba	European clam	Shallow Inlet	5.2	Possible
Maoricolpus roseus	NZ screw shell	Oberon Bay, WP	19.5	Rare
Theora lubrica	East Asian bivalve	Shallow Inlet	4.0	Possible
Styela clava	Leathery sea squirt	Port Phillip Bay	117	Remote
Ascidiella aspersa	Solitary *ascidian*	Golden Beach	130	Remote
Styela plicata	Solitary *ascidian*	Westernport Bay	91.5	Remote
Asterias amurensis	Northern Pacific seastar	Norman Bay	18.1	Possible
Astrostole scabra	Rough sea star	Wilsons Prom.	20.4	Possible
Carcinus maenas	European shore crab	Waratah Bay	5.5	Very likely
Hemigrapsus sanguineus	Asian shore crab	Port Phillip Bay	113	Remote
Euchone limnicola	Fan worm	Port Phillip Bay	115	Remote
Sabella spallanzanii	European fan worm	Flinders Pier	103	Remote

Source: National Introduced Marine Pest Information System (DAWE, 2021e). CPA denotes 'Closest Point of Approach' to nearest proposed alignment of the project. PPB is Port Phillip Bay; WP is Wilsons Promontory.

In terms of likelihood of occurrence in the project area, the principal IMS are the European shore crab (*Carcinus maenas*) that occurs in Waratah Bay already which is assessed as ***Very likely*** and both the European clam (*Varicorbula gibba*) and east Asian bivalve (*Theora lubrica*) that occur in Shallow Inlet and which are as assessed as ***Possible***.

6.3.12.2.2 Distribution of IMS in Tasmanian waters

Table 6-43 lists those IMS in Tasmanian waters of Bass Strait and gives their nearest location and distance to the nearest proposed alignment of the project. The likelihood of occurrence of IMS in nearshore Tasmania at Heybridge and the adjoining offshore water under Tasmanian jurisdiction are also presented in Table 6-43.

Table 6-43: Proximity of invasive marine species (IMS) to the project in Tasmania

Scientific name	Common name	Nearest location in Tasmania	CPA (km)	Likelihood of occurrence
Invasive marine flora				
Undaria pinnatifida	Japanese kelp	Table Cape	29	Possible
Grateloupia turuturu	Devil's tongue weed	George Town	63	Remote
Codium fragile fragile	Deadman's fingers	Hobart (BS=0)	>230	Remote
Invasive marine fish:				
Tridentiger trigonocephalus	Trident goby	Zero in Tasmania	0	Remote
Acanthogobius flavimanus	Yellowfin goby	Zero in Tasmania	0	Remote
Acentrogobius pflaumi	Streaked goby	Zero in Tasmania	0	Remote
IMS – Marine invertebrates:				
Arcuatula senhousia	Asian date mussel	Burnie	5.7	Possible
Magallana gigas	Pacific oyster	Burnie	5.7	Possible
Raeta pulchella	Beautiful trough-shell	Hobart (BS=0)	>230	Remote
Varicorbula gibba	European clam	Burnie	5.7	Possible
Maoricolpus roseus	NZ screw shell	Heybridge	0.3	Very likely
Theora lubrica	East Asian bivalve	Georgetown	63	Possible
Styela clava	Leathery sea squirt	Hobart (BS=0)	>230	Remote
Ascidiella aspersa	solitary *ascidian*	Devonport	30	Possible
Styela plicata	Solitary *ascidian*	Hobart (BS=0)	>230	Remote
Asterias amurensis	N. Pacific seastar	Georgetown	63	Possible
Astrostole scabra	Rough sea star	Penguin	7.2	Possible
Carcinus maenas	European shore crab	Burnie	5.7	Possible
Hemigrapsus sanguineus	Asian shore crab	Zero in Tasmania	0	Remote
Euchone limnicola	Fan worm	Burnie	5.7	Possible
Sabella spallanzanii	European fan worm	Devonport	30	Possible

Source: National Introduced Marine Pest Information System (DAWE, 2021e); Atlas of Living Australia (CSIRO, 2022); and Tasmanian Natural Values Atlas (DNRE, 2022). CPA denotes 'Closest Point of Approach' to nearest proposed alignment of the project. BS=0 denotes absence in Bass Strait.

The likelihood of occurrence of IMS in the Tasmanian nearshore at Heybridge and the adjoining offshore waters (include offshore islands in Bass Strait) under Tasmanian jurisdiction are those IMS known to occur at or near Heybridge. The principal invasive species is the New Zealand screw shell (*Maoricolpus roseus*) that occurs at the mouth of the Blythe River estuary and its likelihood of occurrence is assessed as ***Very likely***. There are four IMS that occur at Burnie (5.7 km from Heybridge) including the Asian date mussel (*Arcuatula senhousia*), Pacific oyster (*Magallana gigas*), European clam (*Varicorbula gibba*), European shore crab (*Carcinus maenas*) and a fan worm (*Euchone limnicola*) and one invasive rough sea star (*Astrostole scabra*) that occurs at Penguin (7.2 km from Heybridge), all of which have been assessed to have a likelihood of occurrence of ***Possible*** for the Heybridge nearshore.

As noted above for Victorian IMS distribution, Tasmanian IMS distribution is also mostly restricted and localised to Tasmania's ports (e.g., Burnie, Devonport and Georgetown, and especially Hobart) and the estuaries where these ports are located. The presence or not of IMS is required for assessing the potential risks of introducing or translocating IMS from existing infestations as a result the project activities (see Section 7, Impact assessment).

6.4 Existing marine resource use

This section describes existing marine resource uses and provides information about other maritime users of Bass Strait including navigation and commercial shipping traffic, commercial fisheries, and recreational boating, fishing, and other recreational activities within or in proximity to the project's proposed alignment across Bass Strait.

Existing marine resources uses covered in this section include:

- Navigation and shipping
- Commercial fisheries
- Recreational boating and fishing
- Offshore oil and gas industries

Conservation areas and the conservation of threatened or protected marine species are not treated as a marine resource use as it is described separately in Section 6.3 (Marine biological environment).

The abovementioned marine resource uses in relation to the project's proposed alignment across Bass Strait are described below.

6.4.1 Navigation and shipping traffic

Bass Strait contains major east-west shipping lanes with a high density of shipping. In addition, there are numerous cross-strait shipping routes used by commercial cargo ships and bulk carriers, as well as passenger ferries and commercial fishing vessels.

6.4.1.1 Navigation and shipping traffic data sources

The main data sources pertinent to navigation and shipping traffic are based on the following:

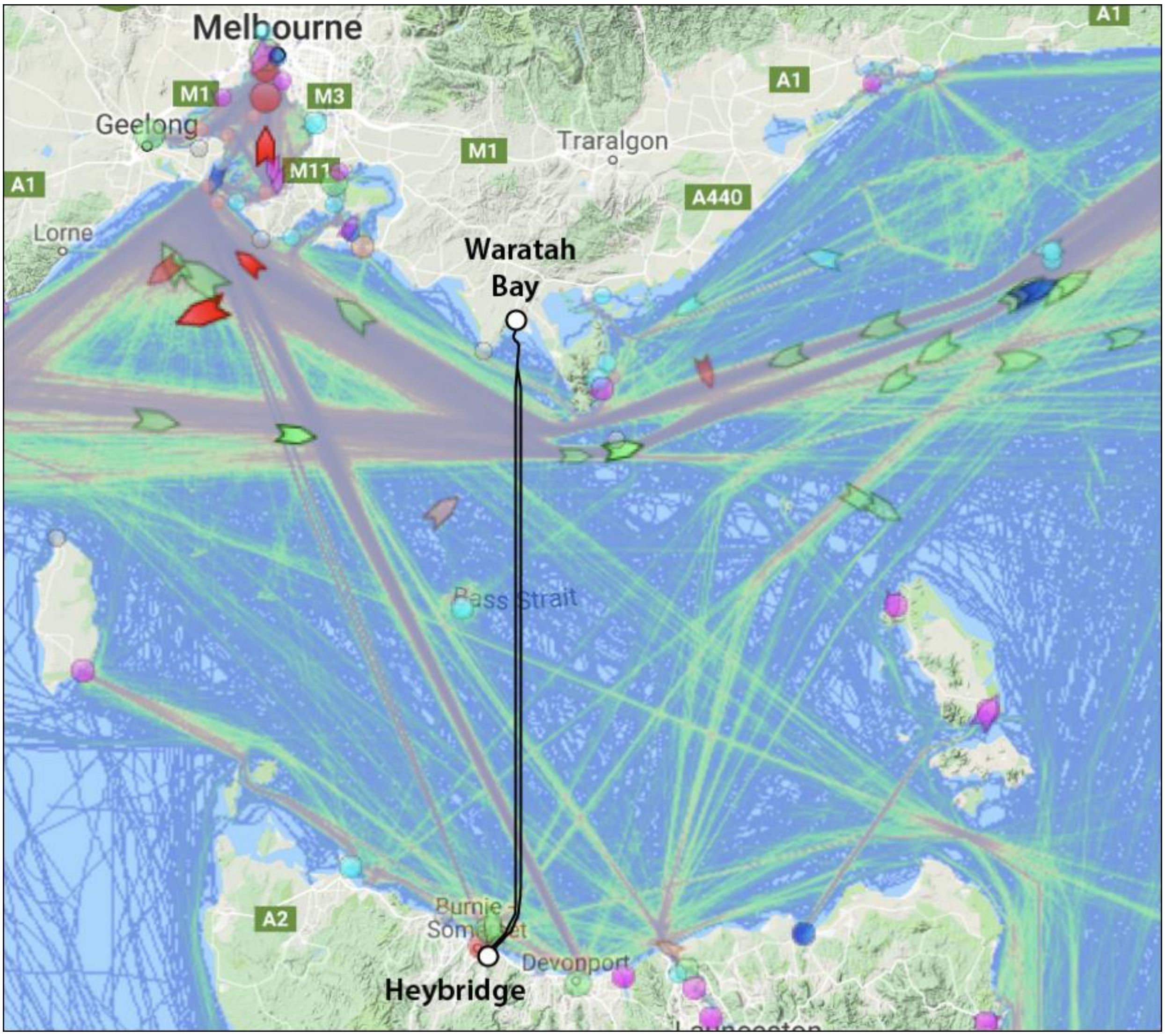
- Marine traffic density and routes (Fleetmon, 2019):
  - Vessel identification and tracking using the ship-based Automatic Identification System (AIS).
  - Shipping traffic density.
- Victorian and Tasmanian ferries:
  - Spirit of Tasmania I and II between the ports of Melbourne and Devonport.
- Australian Maritime Safety Authority (AMSA):
  - Main shipping lanes and two-way marine traffic system.
- Consultations with fishery representatives on fishing grounds and areas:
  - commercial fishing grounds.
  - boating and recreational fishing areas.

6.4.1.2 Shipping traffic density

AMSA undertakes vessel tracking and coastal traffic management measures using ship-based Automatic Identification Scheme (AIS) and Long-range Identification and Tracking (LRIT), which meets the requirements for safety and protection of the maritime environment.

Figure 6.56 shows a cumulative snapshot of plotted ships in Bass Strait taken on 25 March 2019, with an annual shipping traffic density ending on that date. An updated version of this snapshot is not presented as marine traffic density and port calls were significantly less during 2020–21, owing to a reduction in coastal and international marine traffic during the COVID-19 pandemic and a slow recovery in 2022.

In Figure 6.56, there is a traffic separation scheme south of Wilson Promontory that separates the eastbound and westbound shipping lanes and is intended to protect the offshore oil and gas installations and infrastructure shown in the far northeast of the figure. The project's proposed alignment passes through a 40-km wide section of the combined main shipping lane to the southwest of Wilson Promontory. The project will also intercept the busy shipping lane between Melbourne and Devonport, which carried commercial vessels (container ship sand bulk carriers) as well as the combined cargo and passenger ferries such as the MV *Spirit of Tasmania I* and MV *Spirit of Tasmania II*. Other minor shipping routes (shown as green in Figure 6.56) are also intercepted by the project. The interactions of the project with third party shipping and potential impacts are assessed in Section 7 (Impact assessment).



Source: Fleetmon (2019). Ship type icons: red = oil/chemical tanker; green = container or bulk cargo ship; light blue: offshore support vessel; orange = fishing vessel; purple = pleasure craft. Black lines denote the project's proposed alignment. The various ship types (coloured vessel icons) shown in this figure are incidental to the day that the marine traffic density snapshot was taken (i.e., 25 March 2019).

Figure 6.56: Annual cumulative marine traffic density in Bass Strait

6.4.1.3 Ports and harbours

The main ports in Victoria are the Port of Melbourne and Port of Geelong, which are all located within Port Phillip Bay. Numerous smaller ports and harbours are located along the southeast coast of Victoria including Port Franklin, Port Welshpool, Port Albert, and Lakes Entrance, with most being fishing ports.

The main ports along the north coast of Tasmania are Burnie, Devonport and Bell Bay (serves George Town and Launceston) and the smaller ports and harbours include Stanley and Port Latta (Savage River mine export facility).

Other smaller ports or harbours that are found on the larger Tasmanian islands of Bass Strait such as the Port of King Island and Lady Barron harbour undertake vessel tracking and coastal traffic management measures using ship-based Automatic Identification Scheme (AIS) and Long-range Identification and Tracking (LRIT), which meets the requirements for safety and protection of the maritime our on Flinders Island, and Cape Barren Island jetty and ferry terminal.

6.4.2 Commercial fisheries of Bass Strait

The South East Trawl Fishing Industry Association (SETFIA, 2022; Attachment F) undertook a study to identify the commercial fishing sectors present in the area of the project, commercial fishing sectors actually fishing there currently or within the last 10 years, the stakeholder organisations for these fisheries, and to provide general information about these fisheries. The scope also included noting any seasonal patterns to fishing as well as concerns or lessons from the similar Basslink HVDC interconnector project that has been in operation since 2005.

6.4.2.1 Commercial fisheries stakeholders

The fishing industry is a broad congregation, divided initially by state or Commonwealth management. Agreements between the Commonwealth and states for how this division occurs are unique, with some states such as NSW divided geographically (i.e., by a line or lines on the water), while other states such as Victoria use both a line on the water as well as allocation rights by species (or taxonomic group). This initial management division is then followed by management and rights issued by each fishery. This complication has seen the development of a network of representative peak bodies without formal structural linkages.

In southeast Australia, some fisheries may be represented by more than one peak body. Peak bodies can also be divided into those where stakeholders pay voluntary levies, choosing to join or not, and those that are funded through compulsory levies or funded by (state) Government. In a rough order of informal hierarchy, the seafood and fishing industries are divided into a hierarchy of four as represented by the following bullet points:

- Seafood Industry Australia (SIA) is the peak body representing seafood production in Australia. It covers a variety of issues including social licence and media, exporting, shared marine space policy and labelling on behalf of the wild catch and aquaculture industries. This body was initially Government funded but is now funded through voluntary levies.
- Commonwealth Fisheries Association (CFA) represents Commonwealth licensed fishing in Australia, working on uniquely Commonwealth issues such as management strategies, cost recovery and Commonwealth acts. The CFA is funded via voluntary levies.

Neither of these two associations are likely to become involved in regional issues such as the project unless they become of national significance, which is unlikely (SETFIA, 2022).

- State fisheries are represented by various state-funded bodies; the relevant association in Victoria being Seafood Industry Victoria (SIV) and the relevant associations in Tasmania are the Tasmanian Seafood Industry Council (TSIC) and potentially the Tasmanian Rock Lobster Fishermen's Association (TRLFA).
- A variety of fishery associations (some of which are significantly larger than the associations listed above) operate for Commonwealth and Tasmanian and Victorian fisheries.

6.4.2.2 Commercial fisheries of Bass Strait

SETFIA (2022; Attachment F) has defined an agreed project 'study area' in relation to those commercial fisheries that are currently active or have been active in the last 10 years in the general area of the project's alignment across central Bass Strait. The SETFIA-defined study area encompasses a marine 250-km long by 16-km wide corridor along the project's proposed alignment. In effect, those commercial fishery areas or fishing grounds that lie outside the 16-km wide buffer zone are considered to lie outside the project's area of direct influence.

Table 6.44 lists those commercial fisheries that have a presence in Bass Strait.

Table 6-44 List of managed fisheries within the 16-km wide fisheries study area

Commercial managed fisheries operating in Bass Strait		
Commonwealth	**Victorian**	**Tasmanian**
Commercial fisheries active in the project study area within the last 10 years):		
SESSF – Commonwealth Trawl sector	Abalone (Central Zone) Fishery	Abalone Fishery
SESSF – Shark Hook and Shark Gillnet sectors (SHSGS)	Ocean (General) Fishery	Rock Lobster Fishery
Southern Squid Jig Fishery	Rock Lobster (Eastern Zone) Fishery	Scalefish Fishery
Bass Strait Central Zone Scallop Fishery (BSCZSF)	Wrasse (Ocean) Fishery	
Commercial fisheries not active in the project study area within the last 10 years:		
Eastern Tuna & Billfish Fishery	Giant Crab Fishery	Giant Crab Fishery
Skipjack Tuna Fishery	Bait (General) Fishery	Commercial Dive Fishery
Southern Bluefin Tuna Fishery	Sea Urchin Fishery (Central Zone)	Mackerel Fishery
Small Pelagic Fishery	Purse Seine (Ocean) Fishery	Scallop Fishery
SESSF Scalefish Hook sector	Scallop (Ocean) Fishery	Seaweed Fishery
	Trawl (Inshore) Fishery	Shellfish Fishery
	Commercial permit	
	Octopus (Central Zone) Permit	

Source: SETFIA, 2022; Attachment F. SESSF = Southern and Eastern Scalefish and Shark Fishery.

There are 30 commercial fisheries that are permitted to work in Bass Strait (12 Commonwealth, nine Victorian, and nine Tasmanian), but there were only 11 fisheries with catch data indicating that they fished in the vicinity of the project within the last 10 years. Four of the 11 are Commonwealth managed, four are Victorian state managed, and three are Tasmanian state managed.

For the purposes of the present report, only those commercial fisheries actively fishing in the project's fisheries study area within the last 10 years are described below and for which residual impacts of the project have been assessed in Section 7 (Impact assessment). Those commercial fisheries in Table 6.44 that have not undertaken active fishing in the project's fisheries study area in the last 10 years are not considered further. However, details of those commercial fisheries operating outside the fisheries study area in Table 6.44 are addressed separately by SETFIA (2022; Attachment F).

Table 6.45 lists the types of fishing gear or fishing methods used by commercial fisheries in the study area along with target species. However, in the case of the school shark (*Galeorhinus galeus*), this species is not targeted owing to its critically endangered status (IUCN, 2022) but is caught incidentally with the gummy shark (*Mustelus antarcticus*), which is a targeted species.

Table 6-45: Fishing gears of commercial fisheries and target species within the study area

Commonwealth	Fishing technique	Target species
Commonwealth managed fisheries:		
SESSF Commonwealth Trawl sector (Operates year-round)	Otter-board trawls (mid-water or pelagic trawling)	Gummy shark, school shark, silver trevally, redfish, jackass morwong, blue grenadier, and tiger flathead
	Otter-board trawls (demersal or bottom-trawling)	Gummy shark, school shark, silver trevally, redfish, jackass morwong, and tiger flathead
	Danish seine	Tiger flathead Eastern school whiting
SESSF/ GHAT Shark Gillnet and Shark Hook sectors	Demersal gillnet, gillnets, fish traps and automatic longlines	Gummy shark and byproduct fishes such as school shark, elephantfish, and sawsharks
	Demersal longline, shark hook	Gummy shark as well as deepwater blue eye trevalla and pink ling
Southern Squid Jig Fishery	Squid jig	Gould's (arrow) squid
Bass Strait Central Zone Scallop Fishery*	Bottom-towed scallop dredge harvester Bass Strait continental shelf	Commercial scallop and to a lesser extent the doughboy scallop
Victorian managed fisheries:		
Abalone and Sea Urchin Fishery	Diving and restricted to rocky substrates of near shore areas	Greenlip abalone Blacklip abalone
Ocean General Fishery	Demersal longline; demersal gillnet; squid jig; minor line; and purse seine	Eastern Australian salmon, sardines, pilchards and bait fishes (various species)
Rock Lobster (Eastern Zone) Fishery	Baited lobster pots	Southern rock lobster wit bycatches of octopuses and leatherjackets
Wrasse (Ocean) Fishery	Demersal longline; minor line	Bluethroat wrasses with smaller catches of rosy, senator, southern Maori and spotted wrasses
Tasmanian-managed fisheries:		
Abalone Fishery	Diving	Black-lipped and green-lipped abalone
Rock Lobster Fishery	Rock lobster pots	Rock lobster
Scalefish Fishery	Various methods including pot; hook and line; gillnet; squid jig; beach seine; Danish seine; purse seine	Australia salmon, banded morwong, tiger flathead, eastern school whiting, bluethroat and purple wrasses, bastard and striped trumpeters, warehou, flounder, and silver trevally

Source: SETFIA (2022). The Commonwealth managed Shark Gillnet and Shark Hook Sector and Scalefish Hook Sector together comprise a subsector of the SESSF called the Gillnet, Hook and Trap Sector (GHAT).

Table 6.46 lists those Commonwealth, Victorian and Tasmanian fisheries that were identified by SETFIA, 2022) as operating in the 16-km wide fisheries study area, which straddles the project's proposed alignment. The percentage catch from the project's fisheries study area in Table 6.46 is calculated as the 10-year average annual catch in the study area (4th column in table) divided by the fishery catch in the most recent year (3rd column in the table).

Table 6-46: Fisheries identified as operating in the project's fisheries study area

Commonwealth, Victorian, and Tasmanian fisheries	Fishery TAC (t)	Fishery catch (most recent year) (t)	10-yr annual catch in study area (t)	Per cent of catch from study area (%)
Commonwealth-managed fisheries:				
Shark Gillnet and Shark Hook Sector (SGSHS)	2,516	2,268	15.2	0.70
Commonwealth Trawl Sector (CTS)	22,857	18,118	9.4	0.05
Southern Squid Jig Fishery (SSJF)	N/A	480	12.8	2.7
Bass Strait Central Zone Scallop Fishery (BSCZSF)	N/A	N/A	N/A	N/A
Victorian-managed fisheries:				
Abalone (Central Zone) Fishery	256	233.5	Conf.	Conf.
Ocean General Fishery	N/A	N/A	Conf.	Conf.
Rock Lobster (Eastern Zone) Fishery	40#	35	Conf.	Conf.
Victorian Wrasse (Ocean) Fishery	N/A	N/A	Conf.	Conf.
Tasmanian-managed fisheries:				
Abalone Fishery	1,019	1011	Conf.	Conf.
Rock Lobster Fishery	1,051	991	Conf.	Conf.
Scalefish Fishery	N/A	115	5.1	4.4
Totals	**27,739+**	**23,252+**	**43+**	**–**

Source: SETFIA, 2022; Attachment F. Fisheries study area defined as 16-km wide buffer zone straddling the project's proposed alignment (SETFIA, 2022). TAC = Total Allowable Catch. N/A = not available. Conf. denotes confidential information. #TAC given for 2019-20 fishing season.

6.4.2.3 Commonwealth managed commercial fisheries

Commonwealth managed commercial fisheries within the fisheries study area include:

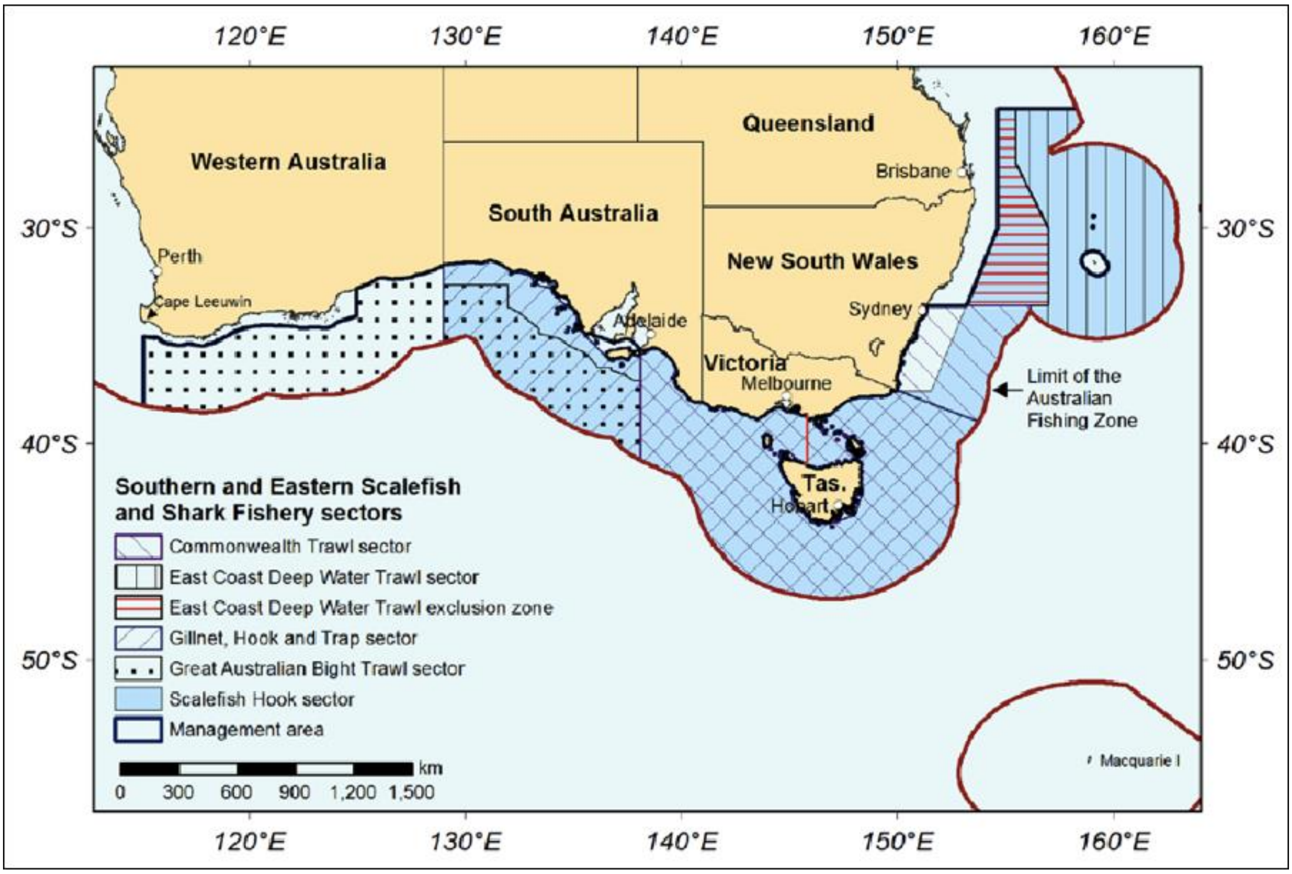
- Southern and Eastern Scalefish and Shark Fishery (SESSF):
  - SESSF Commonwealth trawl sector.
  - SESSF Shark Gillnet and Shark Hook sectors.
- Southern Jig Fishery.
- Bass Strait Central Zone Scallop Fishery.

The above Commonwealth managed fisheries are described below.

6.4.2.3.1 Southern and Eastern Scalefish and Shark Fishery

The Commonwealth Southern and Eastern Scalefish and Shark Fishery (SESSF) is a multisector fishery using a variety of fishing gears and targets a variety of bony and cartilaginous fish species and squid. The SESSF extends from state coastal waters (3 nautical mile (nm) limit) to the 200-nm limit of the Australian Fishing Zone (AFZ), which has the same outer limit as Australia's Exclusive Economic Zone (EEZ). The SESSF is managed by a combination of licensing, size limits and quotas.

Figure 6.57 shows the Commonwealth SESSF sectors.



Source: AFMA (2022a); Patterson et al. (2018). The project's proposed alignment is shown as a solid red line in central Bass Strait.

Figure 6.57: Southern and Eastern Scalefish and Shark Fishery (SESSF)

In Figure 6.57, the SESSF in Bass Strait includes three sectors: the Commonwealth Trawl Sector, the Gillnet, Hook and Trap Sector and the Scalefish Hook Sector, which are intersected by the project's proposed alignment.

SESSF Commonwealth Trawl Sector

The Commonwealth Trawl Sector (CTS) includes all waters inside the Australian Fishing Zone (AFZ) from Barrenjoey Point (north of Sydney, NSW) to Cape Jervis (SA) but excluding Australian Marine Parks and fishery closures. The CTS footprint is limited by several factors:

- The permitted fishing grounds allowed to be fished.
- Unfishable ground that is too rough and too risky to fish (known as natural refuges).
- Fish productivity – some areas are non-productive grounds deeper than 1,200 m are generally of low productivity for trawlers but do not apply to Bass Strait (maximum depth of 80 m).
- The fishing grounds' proximity to ports of domicile, markets and other services.
- Seasonal fishery closures.
- The presence of marine parks or reserves.
- Other closures such as petroleum safety zones and areas to be avoided (ATBA) such as the 5,650-km^2 ATBA off the coast Gippsland coast, which is defined in Schedule 2 of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* (Cwlth) (NOPSEMA, 2020).

The CTS comprises the following subsectors:

- Otter-board mid-water or pelagic trawling.
- Otter-board demersal or bottom-trawling.
- Danish seine.

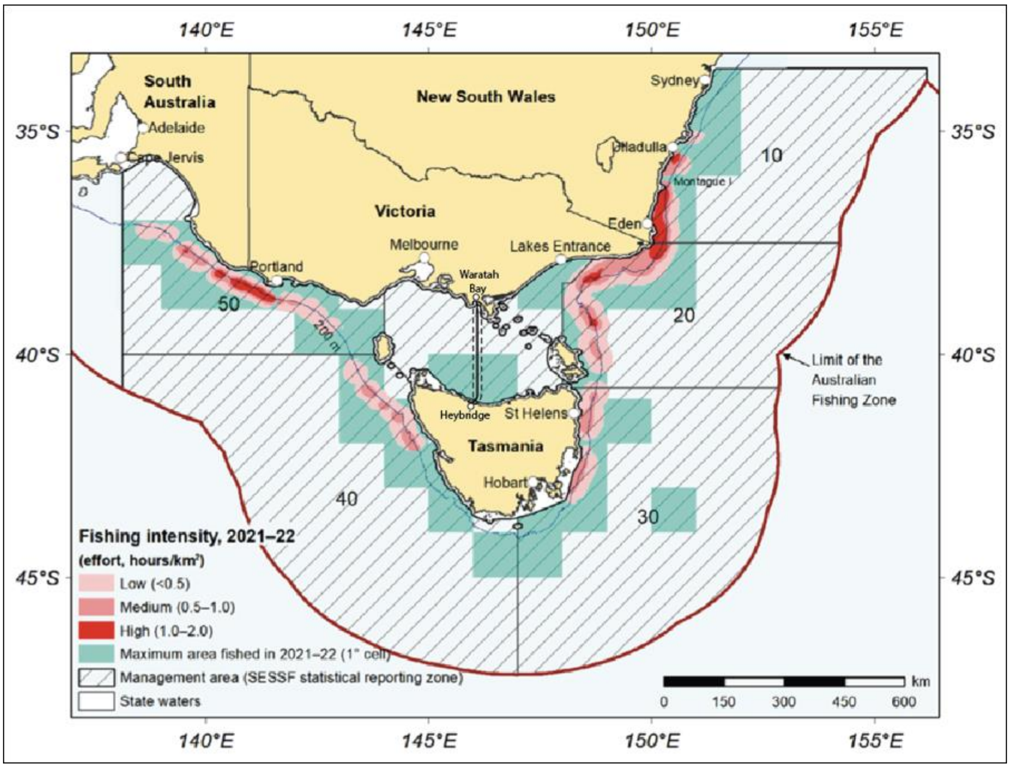
The above CTS subsectors are described below.

Otter-board Mid-water or Pelagic Trawling subsector

Otter-board mid-water or pelagic trawling used in the CTS currently targets the winter blue grenadier (*Macruronus novaezelandiae*), which is a deep-water fish caught mainly over continental shelf edge waters to the east and west of Bass Strait. The nearest fishing ground for blue grenadiers is located off east Gippsland coast and is 100 km from the nearest proposed alignment of the project. Mid-water trawling is unlikely to occur within the project study area as almost all trawling in the southeast Australia is demersal (bottom) trawling (SETFIA, 2022; Attachment F). For these reasons, mid-water trawl fisheries have not been considered further in this report.

Figure 6.58 shows the fishing intensity in 2021-22 for the Commonwealth Trawl Sector. In Figure 6.58, the proposed alignment of the project intercepts the maximum area fished in 2021-22 in Tasmanian waters of Bass Strait. However, the main mid-water or pelagic trawling areas and fishing effort were concentrated along deeper waters overlying the continental shelf break and slope at both the eastern and western ends of Bass Strait.

The likelihood of occurrence of mid-water or pelagic trawling within central Bass Strait and the project's fisheries study area is assessed to be ***Remote***.



Source: ABARES (2022). The back solid line in central Bass Strait is the project's proposed alignment, with black dashed lines denoting the project's 16-km wide fisheries study area that straddles the alignment.

Figure 6.58: Fishing intensity (2021-22) in the Commonwealth Trawl Sector

Otter-board Demersal Trawling subsector

Otterboard demersal trawl vessels are typically 18 to 28-m long and are powered by 250 to 700 horsepower (HP) diesel engines. Demersal trawling involves towing two otterboards (or boards) behind the fishing vessel using two long steel cables (or warps). Warps are set and hauled using hydraulic net drums on the deck of the vessel. At the other end, each warp is attached to one of the otterboards, which are large, rectangular steel boards that are attached at an angle designed to provide the outward force needed to spread (open) the mouth of the net. While being towed, otterboards on CTS trawlers can spread as wide as 100 to 120 m.

The otterboards connect to the net via sweeps and bridles, which act to herd the fish into the wings, then the mouth of the net and eventually to the cod-end. The trawl, the boards and the cable connecting the boards to the trawl (sweeps) all contact the bottom. The vertical opening of the mouth is maintained using floats on the headline. The lower edge of the net is weighted and uses bobbins or rollers to help the net move across the seabed and protect it from damage.

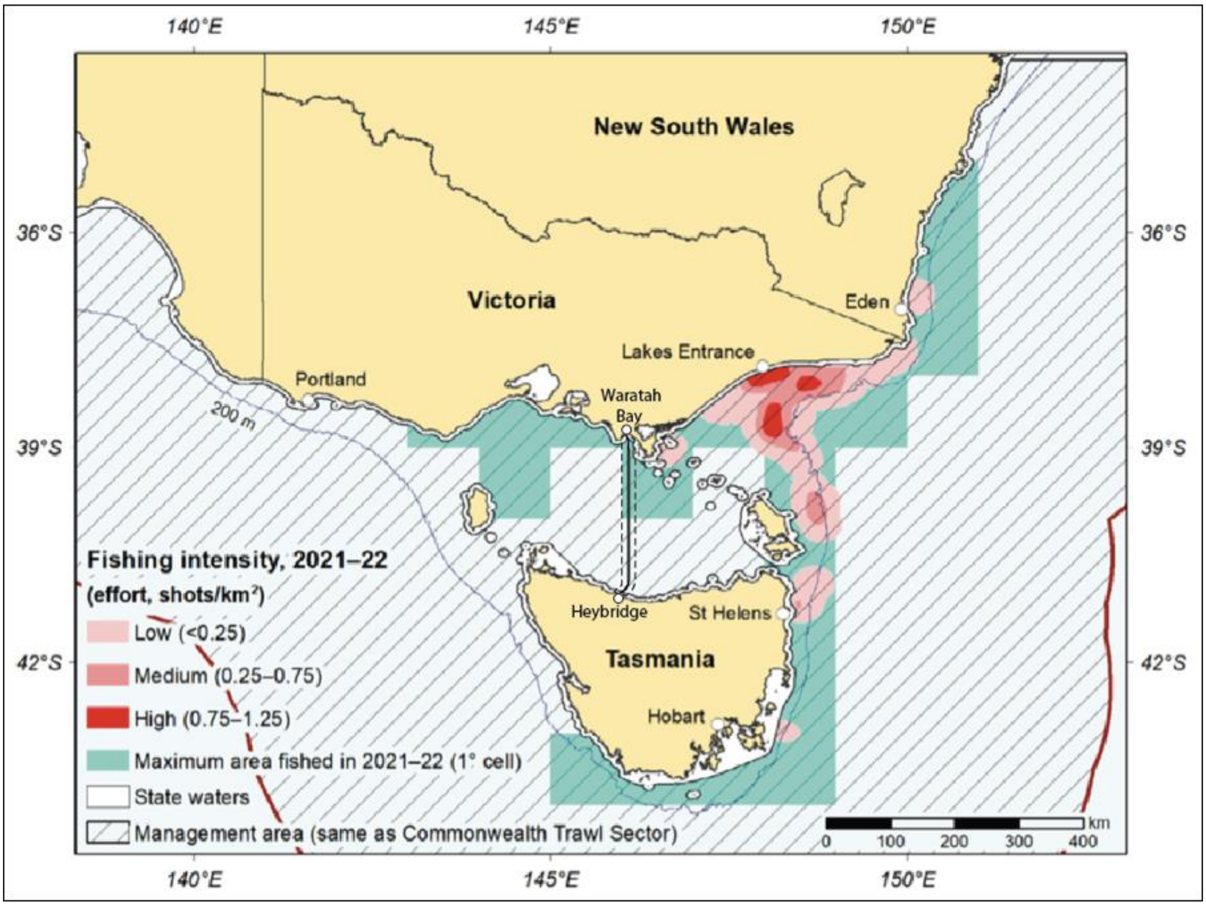
In Figure 6.58, the fishing intensity of the otter-board demersal fishery is shown mainly as green shading within Bass Strait, as the red shaded areas denote mid-water or pelagic trawl fishing, which is mainly carried over deeper waters as noted above.

Otter-board demersal (bottom) trawling currently targets blue grenadier (*Macruronus novaezelandiae*), mirror dory (*Zenopsis nebulosa*), pink ling (*Genypterus blacodes*) and many others in the area around the project study area. This fishery also catches Gould's squid (*Nototodarus gouldi*).

Overall, the likelihood of occurrence of bottom-trawling target fish species is assessed to be ***Very likely***.

Danish seining

The maximum area of Danish seining in Bass Strait for the 2021-22 fishing season includes the 16-km wide fisheries study area within Commonwealth waters (i.e., outside the 3-nm limits). Figure 6.59 shows the fishing intensity (2021-22) based on effort (shots/km^2) in Bass Strait, which include a low fishing intensity (0.25 shots/km^2) off the east coast of Wilsons Promontory. The main areas of high intensity (0.75 to 1.5 shots/km^2) are located off Lakes Entrance and along the outer shelf of eastern Bass Strait, both of which are located more than 220 km from the project study area. The project's proposed alignment intercepts previous Danish seining fishing areas to south of Waratah Bay and west of the Wilsons Promontory, which are shown as green shading in Figure 6.59.



Source: ABARES (2022). The back solid line in central Bass Strait is the project's proposed alignment, with black dashed lines denoting the project's 16-km wide fisheries study area that straddles the alignment.

Figure 6.59: Danish seine fishing intensity (2020-21 season) within Bass Strait

Danish seine fishing is mainly used to catch fish species found on sandy or muddy seafloor areas and the main species targeted using Danish seine gear are tiger flathead (*Platycephalus richardsoni*) and eastern school whiting (*Sillago flindersi*).

The likelihood of occurrence of Danish seining targeting tiger flathead and eastern school whiting within the 16-km wide fisheries study area is assessed as ***Very likely***.

SESSF Shark Gillnet and Shark Hook sector

The Shark Gillnet and Shark Hook Sector (SGSHS) within the SESSF includes waters of the Australian Fishing Zone between the New South Wales/Victorian border to the South Australian/West Australian border. The SGSHS includes two subsectors: the demersal gillnet fishery and demersal longline fishery.

The SGSHS uses gillnets and longlines set on the seafloor to target gummy shark (*Mustelus antarcticus*). School shark (*Galeorhinus galeus*), elephantfish (*Callorhinchus milii*) and sawsharks (*Pristiophorus cirratus* and *P. nudipinnis*) are by-products from the gummy shark fishery. After the nets or lines are set, the vessel often lies at anchor before starting the sequence of retrieval of the fishing gear. The whole of Bass Strait lies within the fishery management area of the SGSHS. The total catch limits of the SGSHS are controlled by quotas that are set using scientific stock assessments.

Demersal Gillnet Shark Fishery

The demersal gillnet fishery primarily uses the bottom-set gillnet, which is a passive fishing gear (i.e., they are not towed but the fish are caught in the filaments of the gillnet mesh) The bottom-set gillnets comprise a series of long panels of gillnet mesh anchored at each end and weighted along the bottom rope to keep the net on the sea floor. The gillnet is held upright in the water column by a series of floats.

Gillnets generally have the headline (top horizontal rope) set 2 m above the seafloor. The headline is typically a 16-mm diameter rope, which as previously stated, is floated vertically using small floats. The monofilament net is connected to a ground rope on the lower horizontal edge. The ground rope is usually a 14-mm weighted (lead core) rope with a breaking strain of 1.4 t. At either end of the gillnet, a 10-mm diameter down-line with a breaking strain of 1.1 t runs from floats that indicate the position of the net on the surface, to 2.0 m of chain attached to a 100 kg J-shaped anchor or lead weights.

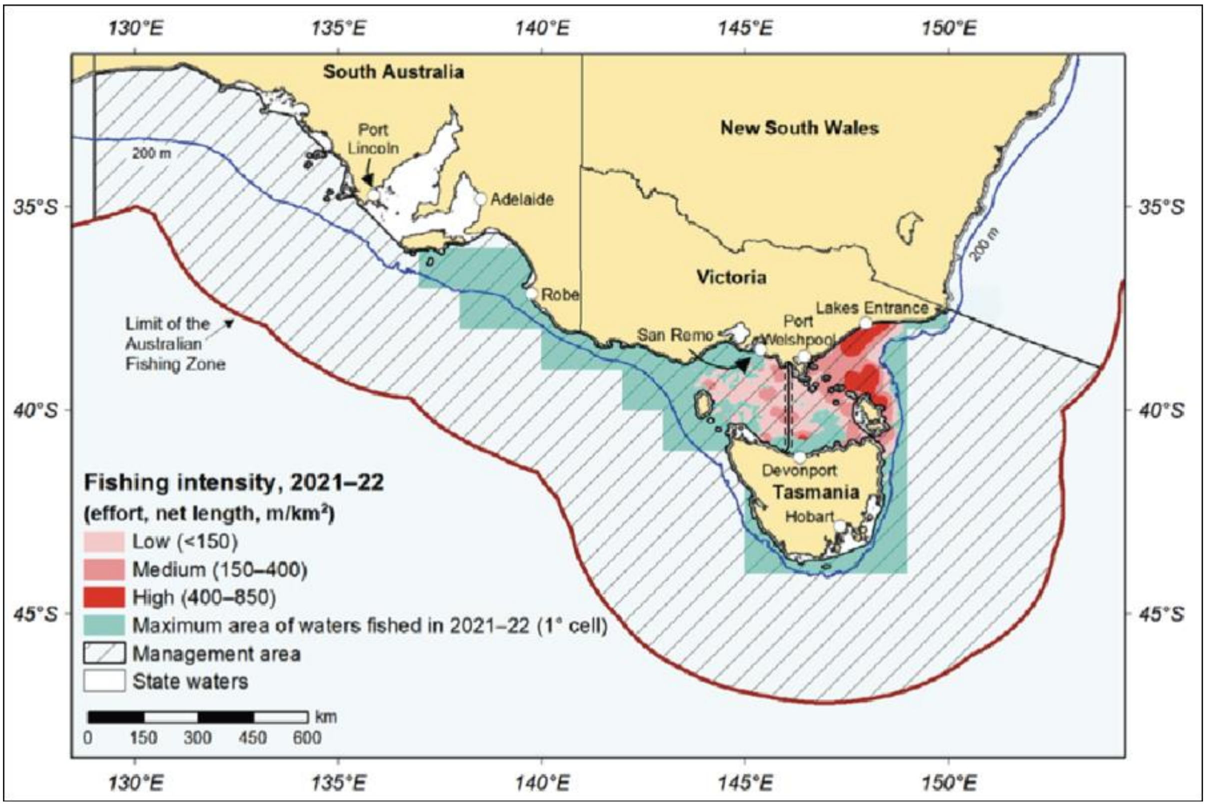
Figure 6.60 shows the fishing intensity of the SGSHS for the 2021-22 fishing season. The project's proposed alignment and its 16-km wide fisheries study area intercepts demersal gillnet fishing areas of both low fishing intensity (<150 m gillnet length/km^2) and medium fishing intensity (150–400 m gillnet length/km^2).

Overall, the likely occurrence of the demersal gillnet shark fishing and the target fish species within the project's proposed alignment and its 16-km wide fisheries study area is assessed to be ***Very likely***.

Demersal longline fishery

The demersal longline fishery has two subsectors: the gummy shark sector and the scale fish section.

All types of longlines consist of three components: a mainline, snoods (or branchlines) and hooks. Demersal (bottom) longlines are set horizontally along the sea floor and are held in place using anchors.



Source: ABARES (2022).

Figure 6.60: Shark gillnet sector fishing intensity

There are two main methods used in the longline fishery: bottom longline fishing and auto longline fishing. The primary difference between bottom longline fishing and auto longline fishing is that hooks are baited by hand rather than a machine.

When set, the longline can be many kilometres in length (typically 1.5–5 km) and may have several thousand hooks. Bottom longline gear consists of a rope mainline with baited hooks spaced every 2 to 5 m on monofilament or braided cord snoods (branchlines). The mainline is attached at both ends to downlines which have a large buoy on the surface for locating gear, and anchors at the bottom to hold the gear in place. Some vessels use radio beacons to be able to find gear in low visibility or if it drifts in heavy current. Each line is normally left to 'soak' for around 6 to 8 hours before being hauled. Hauling is done using hydraulic winches which are fixed to the deck of the boat. The gear can be hauled from either end by retrieving the downline.

Bottom longlines are used to target and catch shark species that live on or near the sea floor in shelf waters generally less than 100 m deep. Although some auto demersal longlines and bottom longlines are used to target deep-water species such as blue eye trevalla (*Hyperoglyphe antarctica*) and pink ling (*Genypterus blacodes*), these two species are unlikely to be present in sufficient numbers to be targeted in the shallow waters (maximum depth of 80 m) of central Bass Strait.

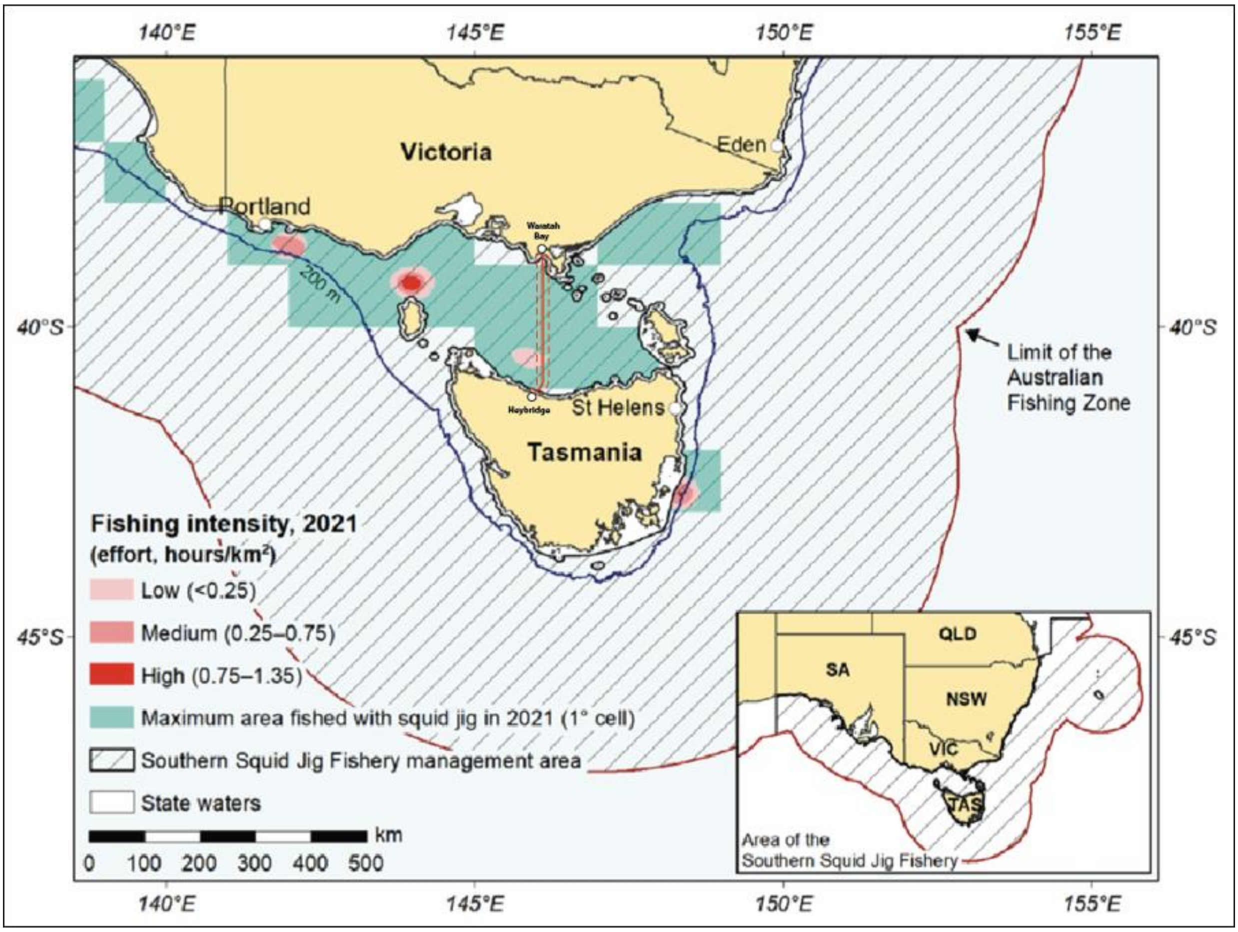
The likelihood of occurrence of demersal shark longline fishing and its targeted species within the project's proposed alignment and its 16-km wide fisheries study area is assessed as ***Very likely***.

6.4.2.3.2 Southern Squid Jig Fishery

The Southern Squid Jig Fishery (SSJF) is a low impact, single method (jigging), single species fishery that covers almost half of the Australian Fishing Zone. The target species is Gould's squid (*Nototodarus gouldi*), which is also known as arrow squid.

AFMA manages squid boats by limiting effort, restricting how many boats can fish in the fishery area and regulating what gear they can use. The gear allowance for 2018 was 550 standard squid jigging machines and it is presumed this will also be the gear allowance for the 2022-23 fishing season.

Figure 6.61 shows the relative fishing intensity in the 2021 fishing season for the Southern Squid Jig Fishery.



Source: ABARES (2022). The red solid line in central Bass Strait is the project's proposed alignment, with the dashed red line denoting the 16-km wide fisheries study area along the alignment.

Figure 6.61: Relative fishing intensity in 2021 for the Southern Squid Jig Fishery

In Figure 6.61, the project's proposed alignment intercepts a squid jigging area of low fishing intensity (effort of <0.25 hours/km^2) and passes through the maximum area of squid jig fishing in 2021.

The likelihood of occurrence of squid jig fishing in Commonwealth waters of Bass Strait and within the project's 16-km wide fisheries study area is assessed as ***Very likely***.

6.4.2.3.3 Bass Strait Central Zone Scallop Fishery

The Commonwealth Bass Strait Central Zone Scallop Fishery (BSCZSF) operates in central Bass Strait between the Victorian and Tasmanian scallop fisheries.

Commercial fishing for commercial scallops (*Pecten fumatus*) and doughboy scallops (*Mimachlamys asperrima*) to a lesser degree in Bass Strait is managed under three jurisdictions. Victoria and Tasmania manage zones out to 20 nm off their respective coastlines, and the Australian Fisheries Management Authority (AFMA) manages the Bass Strait Central Zone Scallop Fishery. The Commonwealth-managed BSCZSF area includes Commonwealth waters up to the 5-nm boundary of the Victorian nearshore and up to the 24-nm limit of Tasmanian contiguous zone. The fishery is currently managed through a range of input controls (seasonal and area closures) and output controls (total allowable catches), together with statutory fishing rights in the form of individual transferable quota.

The fishery is a single-species fishery targeting dense aggregations ('beds') of the commercial scallop (*Pecten fumatus*) using scallop dredges, although other scallop species may be caught as byproduct such as the doughboy scallop (*Chlamys asperrimus*) in much smaller numbers. The BSCZSF is not subject to overfishing and the biomass is not overfished.

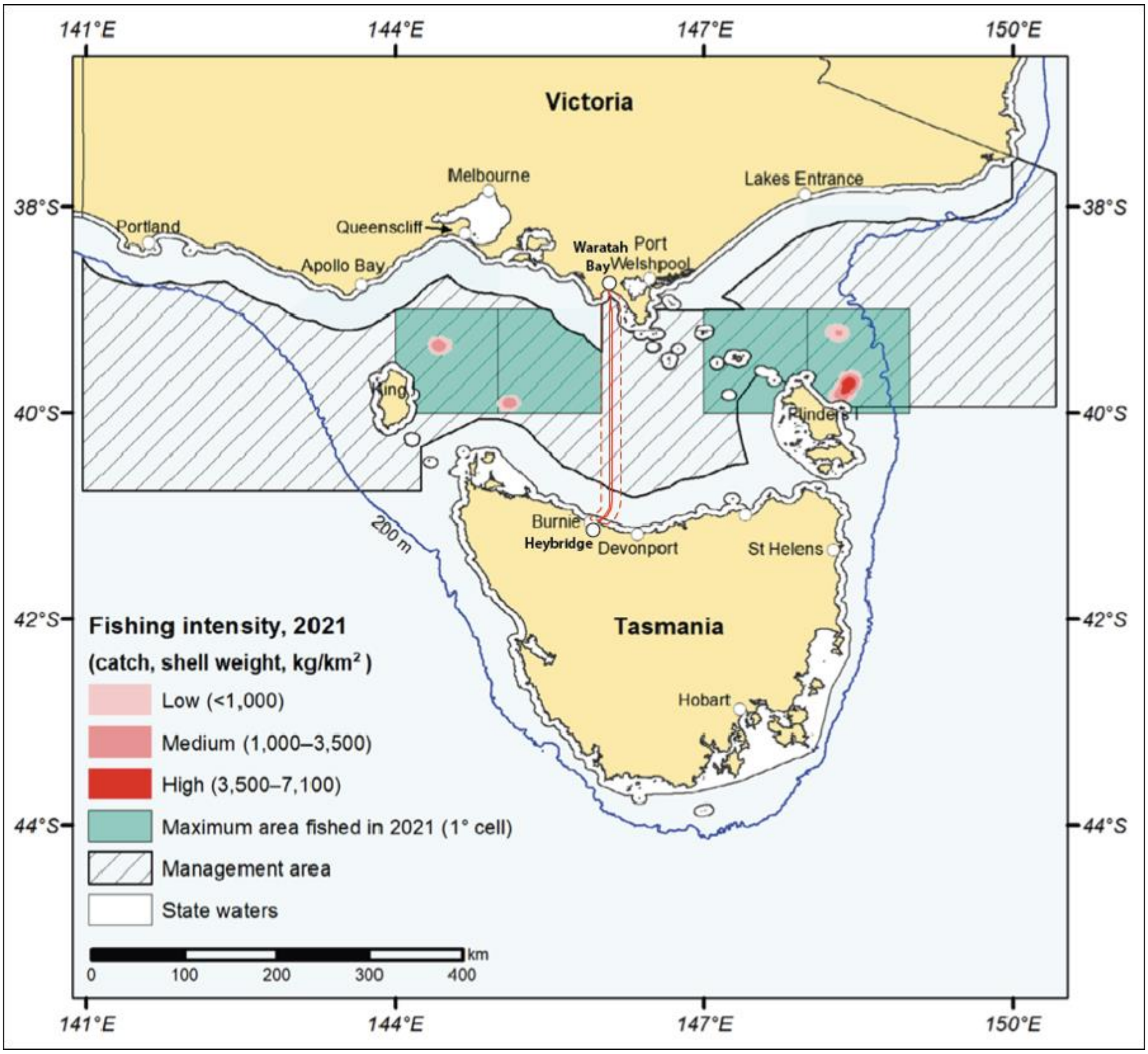
Scallops are harvested by collection in dredges (or 'harvesters') that are towed across the seabed. The harvesters are comprised of steel mesh cages, up to 4.4 m wide and 450 mm high, which are mounted on skids and weigh up to 500 kg. The mouth of the harvester is fitted with a tooth-bar, which has tines designed to penetrate up to 15 cm into the seabed, depending on coarseness and undulations of the seabed.

Scallops are characteristically highly variable in distribution and abundance from year to year, and newly recruited scallop beds may not always survive the two- to three-year growth period to meet commercial potential. The opening of scallop grounds to fishing is based on information from surveys of abundance, size and condition of scallop beds as agreed between industry representatives and scallop fishery managers. Typically, the fishery is closed over the summer months when condition and market values are poorest.

The number of active vessels has declined over the past three decades, from 103 during the period 1994–96 through 26 vessels when the fishery reopened in 2009 to 10 to 12 vessels in recent years (Bromhead et al., 2022).

Figure 6.62 shows the BSCZSF area and the maximum area fished during the 2021 fishing season (shown as green shaded areas). The relative fishing intensity of scallop dredging during the 2021 fishing season focussed on the scallop beds of western and eastern Bass Strait, with the highest fishing intensity (3,700–7,100 kg/km^2 shell weight) located to the east of Flinders Island. In central Bass Strait, none of the maximum area fished during the 2021 fishing season overlapped with the project's proposed alignment or its 16-km wide fisheries study area. However, the project lies within the BSCZSF area.

Historically, the majority of scallop fishing activity in the Victorian zone has occurred in the eastern waters of the state, with most vessels launching from the ports of Lakes Entrance and Welshpool.



Source: ABARES (2022).

Figure 6.62 Fishing intensity of the Bass Strait Central Zone Scallop Fishery, 2020

In the Central Zone and Tasmanian zone, the main areas of the fishery have been around the islands of eastern and western Bass Strait, with beds appearing sporadically along the north coast. The deeper parts of central Bass Strait have not been productive areas for scallops, but over the nearshore cable crossing areas, it is possible that beds could develop during the operating life of the project.

Going forward, the likelihood of occurrence of scallop dredging within the project's fisheries study area is assessed as ***Very likely***.

6.4.2.4 Victorian-managed commercial fisheries

Commercial fisheries in Bass Strait waters under Victorian jurisdiction are managed by the Victorian Fisheries Authority (VFA, 2022a).

Victorian-managed commercial fisheries that are likely to occur within the project's fisheries study area (SETFIA, 2022) include:

- Abalone (Central Zone) Fishery.
- Ocean (General) Fishery.
- Rock Lobster (Eastern Zone) Fishery.
- Wrasse (Ocean) Fishery.

Summary descriptions of the above fisheries are presented below.

6.4.2.4.1 Abalone (Central Zone) Fishery

The Victorian Abalone (Central Zone) Fishery is managed under a Victorian Wild Harvest Abalone Fishery Management Plan (DEDJTR, 2015). The Central Zone area includes that area of the Victorian coast between Lakes Entrance and the mouth of the Hopkins River. In proximity to the proposed landfall of the project within Waratah Bay and the adjoining offshore waters under Victorian jurisdiction, the southern limit of the Central Zone is the Victorian–Tasmanian maritime border (39° 12' S).

Abalone are caught along most of the Victorian coastline where suitable rocky habitat is available and the fishery primarily targets blacklip abalone (*Haliotis rubra*) and, to a lesser extent, the greenlip abalone (*Haliotis laevigata*). The maximum number of commercial abalone licences for the Central Zone is specified as 34 in the management plan (DEDJTR, 2015).

The most recent Total Allowable Commercial Catch (TACC) for the 2019-20 quota season for the Abalone (Central Zone) Fishery was 262.5 t black lip abalone and 3.4 t greenlip abalone. There was a decline in the fishery after 2002 due to the proclamation and subsequent establishment of marine parks and coastal reserves, which reduced the total fishery area.

The nearest abalone fishing grounds to the project are the rocky habitats of the coastal area between Cape Liptrap and Walkerville South in Waratah Bay. The closest abalone fishing area is at Bell Pont in Waratah Bay, which is 8 km distance from the project's proposed alignment and is also located within the 16-km wide fisheries study area (SETFIA, 2022).

The likelihood of occurrence of Victorian abalone fishing in the project's fisheries study area is ***Very likely***.

6.4.2.4.2 Ocean (General) Fishery

The Victorian Ocean (General) Fishery is based on a variety of fishing methods including, drop line, hand line, shark longline, snapper longline, and octopus trap or pot. The target species are the gummy shark (*Mustelus antarcticus*), school shark (*Galeorhinus galeus*), Australian salmon (*Arripis trutta*), pink snapper (*Pagrus auratus*) and small catches of flatheads (family *Platycephalidae*).

Other minor fisheries based on beach seines or purse seines are included in the Victorian Ocean (General) Fishery, which target shoaling fish species such as juvenile Eastern Australian salmon, and adult Australian sardines (*Sardinops sagax*), Australian pilchards (*Sardinops neopilchardus*), and bait fishes (various species).

Most of these targeted species will be found within the project's proposed alignment and its 16-km wide fisheries study area. SETFIA (2022) has assessed that this fishery overlaps the fisheries study area of the project (see Table 6.46 in Section 6.4.2.2, Commercial fisheries in Bass Strait).

The commercial catch of pink snapper in 2018/19 was 49 t with most of the landings coming from the Western Stock (Port Phillip Bay). A catch cap is in place on the commercial snapper harvest in Port Phillip Bay (88 t) and will be a hook-and-line only fishery from April 2022 (VFA, 2022a). In 2018, there was a record recruitment of Victoria's snapper stocks in Port Phillip Bay, which will lead to predications of strong catches in 3-4 years' time (VFA, 2018). However, in relation to the project, it is that part of the Ocean (General) Fishery based on the Eastern Stock of pink snapper that is most relevant and this stock has rarely exceeded 5 t per year, averaging around 3.5 t per year since 2009/10 (Cartwright et al., 2021).

Overall, the likelihood of occurrence of target species of the Ocean (General) Fishery in the project's 16-km wide fisheries study area within Victorian nearshore and offshore waters is assessed to be ***Very likely***, given the availability of suitable species habitats.

6.4.2.4.3 Rock Lobster (Eastern Zone) Fishery

The Victorian rock Lobster (Eastern Zone) Fishery stretches from the Victorian/NSW border in the east to Apollo Bay in southwest Victoria. The abundance of rock lobsters within the Eastern Zone increases in the direction from eastern to western Victoria. This fishery has a closed season between 1st June to 15th November inclusive for the purpose of protecting berried female lobsters, which cannot be taken or possessed, and a second closed season between 15th September and 15th November inclusive for the purposes of protecting male lobsters during their moulting phase. There is no rock lobster fishing allowed within Wilsons Promontory Marine National Park, the westernmost point of which is located 10 km from the nearest proposed alignment of the project.

In general, baited lobster pots are set each day and marked with buoy. This fishery targets the southern rock lobster (*Jasus edwardsii*) with occasional bycatches of hermit crabs (superfamily *Paguroidea*), various fish species that enter the lobster pots such as southern rock cods and red cods within the genera *Lotella* or *Pseudophycis*, and leatherjackets (family *Monacanthidae*), and octopuses (*Octopus* spp.).

Southern rock lobster catches are generally highest from August to January outside the closed seasons, with most catches derived from shallow nearshore waters (<100 m deep), which includes Bass Strait (maximum depth of 80 m). In the latest reported fishing season (2017-18), the TACC for the Eastern Zone was set at 59 t and the catch was 57.2 t for 25 vessels and 22 active rock lobster licences (VFA, 2022b).

The likelihood of occurrence southern rock lobster fishing in the project's 16-km wide fisheries study area is assessed as ***Very likely***, given that the rocky coastline between Cape Liptrap and Walkerville South in Waratah Bay is a known habitat for southern rock lobsters.

6.4.2.4.4 Wrasse (Ocean) Fishery

The Victorian Wrasse (Ocean) Fishery was established in the 1990s when a domestic market based on live trade to restaurants and seafood outlets was created.

The fishery extends along the entire length of the Victorian coastline and out to 20 nm offshore, except for marine parks or reserves. The fishery is divided into three commercial management areas: the West, Central and East zones. The Central Zone is relevant to the project as it includes Waratah Bay and Wilsons Promontory.

The commercial wrasse fishery is managed primarily by input (i.e., effort) controls such as gear restrictions, legal minimum size limits, and limited entry. Gear restrictions include six fishing lines at only one time, each line must not have more than three hooks, or more than one jig attached and longlines are not permitted. There are currently 22 Wrasse (Ocean) Fishery access licences issued under the Fisheries Act.

Most wrasse is harvested by hook and line although commercial rock lobster fishers who also hold a commercial wrasse licence can keep those fish that they catch in their rock lobster pots. Approximately nine per cent of the commercial wrasse harvest is taken in rock lobster pots.

The Wrasse (Ocean) Fishery targets the bluethroat wrasse (*Notolabrus tetricus*) and purple wrasse (*Notolabrus fucicola*), which comprise approximately 90 per cent of the commercial Victorian wrasse harvest. Minor caches include rosy wrasse (*Pseudolabrus psittaculus*), senator wrasse (*Pictilabrus laticlavius*), southern Maori wrasse (*Ophthalmolepis lineolatus*), spotted wrasse (*Notolabrus parilus)* with a small bycatch of various fathead species (family *Platycephalidae)*.

In the case of the bluethroat wrasses, are reef-associated fish and do not migrate extensively among the reef systems. This species is a hermaphroditic species in that the females at some point in their lives, transition to male to replace the dominant males removed from the reef. Reef-based groups are generally comprised of a larger male and a harem of smaller females.

In the 1990s, commercial wrasse annual catch rates increased to a peak of around 97 t in 1999. In 2020 the annual catch was around 23 t of which 20 t comprised bluethroat wrasse and the remaining 3 t consisted of saddled wrasse and unspecified wrasses.

The likelihood of occurrence of sufficient bluethroat and saddled wrasses within the sandy seabed environment of Waratah Bay and absence of rocky reefs is assessed as ***Likely*** given the presence of suitable reef habitat for wrasse along the coast from Cape Liptrap to Walkerville South in west Waratah Bay and the proximity to reef system to the west of Wilsons Promontory Marine Reserve (i.e., west of the Glennie Group, see Figure 6.14).

6.4.2.5 Tasmanian-managed commercial fisheries

Fishing Tasmania manages Tasmania's commercial fisheries under the LMRM Act and variations regulations for each commercial fishery.

6.4.2.5.1 Abalone Fishery

Fishing Tasmania manages the Abalone Fishery under the LMRM Act and the Fisheries (Abalone) Rules 2017.

The Tasmanian Abalone Fishery mainly targets blacklip abalone (*Haliotis rubra*) with greenlip abalone (*Haliotis laevigata*) typically accounting for around 5% of the total wild harvest. The blacklip abalone lives on intertidal rocky shores, and in coastal waters and oceans. This species is usually seen aggregating from the low-tide mark to depths of 25 m, and prefers to feed at night (Australian Museum, 2021). Greenlip abalone in Tasmania generally occur in more simple habitats, with low profile reef and seagrass, and are commonly found on the reef/sand edge in areas with high tidal flows (Mundy and McAllister, 2021).

Commercial abalone fishing in Tasmania waters began in the late 1950s with annual catches in the order of 2,000 t being landed by the mid-1960s. The total estimated landings for the 2021 Tasmanian Abalone Fishery were 749 t of blacklip abalone and 84 t of greenlip abalone, from a total allowable commercial catch (TACC) of 833 t. TACC and caps on regional catches are subject to an Abalone Harvest Strategy (DPIPWE, 2020) and to the outcomes of annual co-management meetings and settings developed through the Abalone Fishery Advisory Committee (AbFAC) process (Fishing Tasmania, 2022a).

The abalone fishing area relevant to the project is Bass Strait Block 46, which includes the nearshore area at Heybridge, which is the proposed landfall site of the project. The recommended Bass Strait Zone TACC for 2022 was reduced from 87.5 t to 80.5 t. Overall, the Bass Strait Zone is performing well (Mundy and McAllister, 2022).

The Tasmanian Natural Values Atlas (DNRE, 2022) show six records for black abalone along the coast between Burnie and Heybridge, with one sighting record at the proposed Tasmanian landfall site of the project at Heybridge. However, while there is only one record for gran abalone at Burnie with no sightings near Heybridge.

Overall, the likelihood of occurrence of commercial abalone fishing in nearshore Tasmania is assessed as ***Possible***, given the known presence of blacklip abalone in nearshore Heybridge. It is anticipated that commercial abalone divers will seek out more productive subtidal rocky reef areas for black abalone.

6.4.2.5.2 Rock Lobster Fishery

The Tasmanian Rock Lobster Fishery is managed under the LMRM Act and Fisheries (Lobster) Rules 2022. This fishery primarily targets the southern rock lobster (*Jasus edwardsii*), and small amounts of eastern rock lobster (*Jasus verreauxi*) (less than 1% of the fishery).

Commercial fishers use baited pots to harvest lobster all around Tasmania, including in waters surrounding major islands. Most of the commercial catch comes from the western half of the state, with fishers frequently facing rough weather and poor conditions to land their catch (Fishing Tasmania, 2022b).

The Tasmanian commercial rock lobster fishery is managed by quota management, supplemented by size limits, gear restrictions and seasonal closures. Each year, the rock lobster total allowable catch (TAC) is set for the next quota year which runs from 1 March to 28/29 February each year. A portion of the TAC is allocated to the commercial sector, known as the total allowable commercial catch (TACC). The TACC is split equally amongst the 10,507 quota units issued in the fishery. To determine the value of each quota unit, the yearly TACC is divided by 10,507. As the TACC changes, the values of the quota units are amended. The current season TACC for the commercial rock lobster fishery is 1050.7 t (100 kg/unit). In addition to the state-wide TACC, there are also competitive catch caps for the East Coast area (94 t) and Northeast area (100 t) of the fishery.

There are some waters where rock lobster fishing cannot take place at any time, including marine reserves (Commonwealth, Tasmanian, and Victorian), research areas and no potting areas. In Bass strait the nearest marine reserve is the Kent Group and the nearest no potting area is the Blow Hold on the east coast of King Island, which are 98 km and 162 km distance, respectively, from the nearest proposed alignment of the project.

The Tasmanian Natural Values Atlas (DNRE, 2022) shows only one record of the southern rock lobster between Burnie and Devonport, which was located off Penguin and 13.5 km from the nearest proposed alignment of the project. No records for the eastern rock lobster were observed in the atlas for Bass Strait.

Overall, the likelihood of occurrence of commercial lobster fishing within nearshore Tasmania at the proposed landfall of the project at Heybridge is assessed as ***Remote***.

6.4.2.5.3 Scalefish Fishery

The Tasmanian Scalefish Fishery is a multi-species and multi-gear fishery that is predominantly made up of small owner operated commercial businesses, as well as a large and diverse recreational fishery (see Section 6.4.3.2, Recreational fishing in nearshore Tasmania). The commercial scalefish fishery is managed under the provisions of the LMRM Act.

The Scalefish Fishery is diverse with many vessel types and sizes, and a plethora of different fishing gears are used such as gillnets, hook and line, longlines, spears, drop lines, squid jigs, automatic squid jig machines, fish traps, purse seine nets, beach seine nets, dipnets, octopus pots and Danish seine.

The principal commercially targeted scalefish species and invertebrates include:

- Marine scalefishes:
  - Australian salmon (*Arripis* spp.).
  - banded morwong (*Cheilodactylus spectabilis*).
  - tiger flathead (*Platycephalus richardsoni*).
  - eastern school whiting (*Sillago flindersi*).
  - southern garfish (*Hyporhamphus melanochir*).
  - bluethroat wrasse (*Notolabrus tetricus*).
  - purple wrasse (*Notolabrus fucicola*).
  - bastard trumpeter (*Latridopsis forsteri*).
  - blue warehou (*Seriolella brama*).
  - silver warehou (*Seriolella punctata*).
  - Bass Strait flounder (*Arnoglossus bassensis*).
  - silver trevally (*Pseudocaranx georgianus*).
  - striped trumpeter (*Latris lineata*).
- Marine invertebrates:
  - southern calamari (*Sepioteuthis australis*).
  - Gould's squid (*Nototodarus gouldi*).
  - pale octopus (*Octopus pallidus*),
  - gloomy octopus (*Octopus tetricus*).
  - Maori octopus (*Macroctopus maorum*).

Open and closed seasons for recreational and commercial fisheries including rock lobster (crayfish), squid, scallops, giant crab, garfish, striped trumpeter and banded morwong. Example closure periods include:

- Commercial squid and calamari spawning closures:
  - The 2022 North Coast (from Cape Grim in the far northwest to Cape Naturaliste in the far northeast of Tasmania) will be closed from 23 September to 31 October 2022 inclusive. Similar closure period timings will be applied going forward.

- Striped trumpeter:
  - Closed from 1 September to 31 October inclusive each year.
- Garfish:
  - Northern waters closed from 15 January to 14 February inclusive in 2023, 2024 and 2025.
- Banded morwong:
  - Closed from 1 March to 30 April inclusive each year.

Due to the wide variety of commercial fishing vessels, gear types and target scalefish and invertebrates targeted by the Tasmanian Scalefish Fishery and general absence of scalefish fisheries operating in nearshore Tasmania at the proposed landfall of the project, this fishery has not been discussed further. However, the nearshore at Heybridge is used by recreational fishers within the recreational scalefish fishery and is described below.

Overall, the likelihood of occurrence of scalefish fisheries operating in and/or targeting scalefish or invertebrate species in nearshore Tasmania at the proposed landfall of the project is assessed to be rare.

6.4.3 Recreational fishing

Recreational fishing is undertaken in Victorian and Tasmanian nearshore waters either from the land (e.g., beach fishing) or from small boats used for this purpose in nearshore waters. In addition, recreational game fishing is undertaken in offshore waters generally outside the 3-nm limits or further offshore.

6.4.3.1 Recreational fishing in nearshore Victoria

In Victoria a Recreational Fishing Licence (RFA) is required, which covers all forms of recreational fishing in all of Victoria's marine, estuarine and inland waters. Most nearshore recreational fishing is located to the east of Wilsons Promontory in Corner Inlet that has easy access via large population centres at Port Franklin and Port Welshpool. However, in Waratah Bay, there are very few large population centres along its coast except for small coastal communities (population) in the census divisions of Waratah Bay (56), Walkerville (89) and Sandy Point (270).

A literature review of recreational fishing in Waratah Bay and Shallow Inlet (Fishbrain, 2022a) revealed the dominant recreational fish species which, in descending order, are: Australian salmon, gummy shark, dusky flathead, Australasian snapper, King George whiting and sand flathead.

Table 6.47 provides a full list of fish and invertebrates species caught at different locations within Waratah Bay and Corner Inlet.

Table 6-47: Recreational fish and invertebrates caught in Waratah Bay and nearby

Scientific name	Common names	Waratah Bay		Shallow Inlet
		West coast	Central	
Bony fish (Osteichthyes):				
Arripis spp.	Australian salmon	✓	✓	✓
Chrysophrys auratus	Australasian snapper	✓	✓	✓
Sillaginodes punctata	King George whiting	✓	✓	✓
Platycephalus fuscus	Dusky flathead		✓	✓
Platycephalus bassensis	Sand flathead		✓	✓
Platycephalus caeruleopunctatus	Blue-spotted flathead		✓	✓
Sillago ciliata	Sand sillago			✓

Scientific name	Common names	Waratah Bay		Shallow Inlet
		West coast	Central	
Scomber australasicus	Blue mackerel	✓	✓	
Caranx papuensis	Brassy trevally		✓	✓
Pseudocaranx dentex	White trevally			✓
Carangoides gymnostethus	Bludger trevally			✓
Caranx hippos	Crevalle jack			✓
Sphyraena obtusata	Obtuse barracuda	✓		
Notolabrus tetricus	Blue-throated wrasse	✓		
Aldrichetta forsteri	Yellow-eye mullet		✓	
Mugil cephalus	Flathead grey mullet	✓		
Thyrsites atun	Snoek		✓	
Trachurus novaezelandiae	Yellowtail scad		✓	
Tetractenos glabe	Smooth toadfish			✓
Macquaria colonorum	Estuary perch			✓
Callorhinchus capensis	Cape elephantfish		✓	
Cartilaginous fish (Chondrichthyes):				
Mustelus antarcticus	Gummy shark		✓	✓
Trygonorrhina dumerilii	Southern fiddler ray	✓	✓	✓
Notorynchus cepedianus	Broadnose sevengill shark			✓
Sphyraena jello	Pickhandle barracuda		✓	✓
Marine invertebrates (Cephalopods):				
Sepioteuthis australis	Southern calamari	✓	✓	
	Total counts =	9	16	17

Source: Fishbrain (2022a). 'West coast' of Waratah Bay includes the coastline between Cape Liptrap and Walkerville North. 'Central' denotes offshore waters within Waratah Bay.

The total number of species caught by recreational fishers in Waratah Bay is 18 species of fish and one cephalopod (southern calamari). The additional species listed in Table 6.47 complements the list of common fish species found in Victorian nearshore water in Section 6.3.10.2.2 (Other Victorian protected fish species).

Overall, the likelihood of occurrence of recreational fishing in Waratah Bay is assessed as ***Very likely***. The interaction between the project and recreational fishers and the impacts of the project on recreational fishing and the fishers' target species are assessed in Section 7 (Impact assessment).

6.4.3.2 Recreational fishing in nearshore Tasmania

Information on potential recreational fishing along the north coast of Tasmania between Burnie and Penguin (which includes the proposed landfall of the project at Heybridge) was based on regional data for the 'North West Coast' region surveyed by Lyle et al. (2019) for the year 2017-2018. The survey area extends from Point Sorell (east of Devonport) along the northwest coast to Woolnorth Point (Cape Grim) and includes King Island and the Fleurieu Group (Three Hummock, Hunter, Walker and Robbins islands).

Annual recreational catch data for the North West Coast region survey area (Lyle et al., 2019) have been used to characterise the recreational fishery along the north coast of Tasmania with additional information from literature searches of sea angling clubs and associated social media for the Heybridge area and Blythe Estuary.

Recreational fish species and catch allowances (e.g., maximum sizes, bag limits and open and closed seasons, etc.) are described in detail in the current version of Tasmania's Recreational Sea Fishing Guide for 2022-23 (Fishing Tasmania, 2022c).

Table 6.48 lists the main groups or species of fish caught during the 2017-18 survey of northwest Tasmania (Lyle et al., 2019).

Table 6-48: Main recreational fish and catches in northwest Tasmania

Target groups or species	Surveyed group or species	2017-18 Catch (Nos.)
Flathead	Mainly southern sand flathead (*Platycephalus bassensis*) and tiger flathead (*Neoplatycephalus richardsoni*); southern, blue-spotted flathead (*Platycephalus speculator*)	116,124
Australian salmon	Eastern Australian salmon (*Arripis trutta*) and western Australian salmon (*Arripis truttaceus*)	19,490
Mullet	Yellow-eye mullet (*Aldrichetta forsteri*) and sea mullet (*Mugil cephalus*)	7,057
Flounder	Mainly greenback flounder (*Rhombosolea tapirina*), with smaller catches of long-snouted flounder (*Ammotretis rostratus*)	5,672
Gurnard	Common gurnard (*Neosebastes scorpaenoides*), red gurnard (*Cheildonichthys kumu*) and other *Triglidae* and *Scorpaenidae*	4,918
Whiting	School whiting (*Sillago flindersi*) and King George whiting (*Sillaginodes punctata*)	4,630
Pike	*Sphyraena* spp. and longfin pike (*Dinolestes lewini*)	4,564
Sharks and rays	School shark (*Galeorhinus galeus*), gummy shark (*Mustelus antarcticus*), draughtboard shark (*Cephaloscyllium laticeps*) and Whitley's skate (*Raja whitleyi*)	4,246
Cod	Red cod (*Pseudophycis bachus*), bearded rock cod (*Pseudophycis barbatus*) and southern rock cod (*Scorpaena papillosa*)	3,894
Wrasse	Mostly blue-throated wrasse (*Notolabrus tetricus*); followed by rosy wrasse (*Pseudolabrus rubicundus*), purple wrasse (*Notolabrus fucicola*), and other *labridae*	2,774
Scalefish (other)	Miscellaneous	2,010
Barracouta	*Thyrsites atun*	2,002
Silver trevally	*Pseudocaranx dentex*	1,841
Striped trumpeter	*Latris lineata*	<1,000
Bastard trumpeter	*Latridopsis forsteri*	<1,000
Black bream	*Acanthopagrus butcheri*	<1,000
Southern garfish	*Hyporhamphus melanochir*	<1,000
Jackass morwong	*Nemadactylus macropterus*	<1,000
Leatherjackets	Brown-striped leatherjacket (*Meuschenia australis*) and other *Monacanthidae*	<1,000

Source: Lyle et al. (2019).

In Table 6.48, flatheads (mainly southern sand flathead, *Platycephalus bassensis*) and Australian salmon (*Arripis* spp.) predominate in the annual recreational catch, followed by smaller catches of mullets, flounders, gurnards and whitings.

Many of the fish groups or species in Table 6.48 are associated with estuaries, reefs and shallow coastal areas (e.g., sand banks and seagrass beds). However, there is an overlap between the fish assemblages caught in the shallow coastal waters and those present in deeper offshore waters, since some fish species that occupy deeper waters of Bass Strait for most of the year may use inshore and nearshore habitats as nurseries.

A literature of review of actual recreational fish catches reported for Heybridge and nearby coastal bays was undertaken using fisher reports to Fishbrain (2022). Table 6.49 presents a list of fish and cephalopod species caught by, and reported by, recreational fishers on the north coast at Burnie and Emu Bay (Burnie), tioxide beach (Heybridge), and Claytons Bay (Ulverstone).

Table 6-49: Recreational fish and invertebrates caught at Heybridge and nearby

Scientific name	Common names	Emu Bay	Heybridge Beach	Claytons Bay
Bony fish (Osteichthyes):				
Arripis spp.	Australian salmon	✓	✓	✓
Chrysophrys auratus	Australasian snapper	✓		
Platycephalus fuscus	Dusky flathead	✓		
Platycephalus bassensis	Sand flathead	✓		
Platycephalus caeruleopunctatus	Blue-spotted flathead			✓
Pseudocaranx dentex	White trevally	✓		
Pseudophycis bachus	Red codling	✓		
Acanthopagrus butcheri	Southern black bream	✓		
Acanthopagrus australis	Surf bream	✓		
Notolabrus tetricus	Blue-throated wrasse	✓	✓	
Aldrichetta forsteri	Yellow-eye mullet	✓	✓	
Latropiscis purpurissatus	Sergeant baker			✓
Hemiramphus far	Black barred halfbeak		✓	
Cartilaginous fish (Chondrichthyes):				
Mustelus antarcticus	Gummy shark	✓		✓
Isurus oxyrinchus	Shortfin mako shark	✓		✓
Alopias vulpinus	Common thresher shark	✓	✓	
Notorynchus cepedianus	Broadnose sevengill shark		✓	
Marine invertebrates (Cephalopods):				
Sepioteuthis australis	Southern calamari	✓	✓	
Nototodarus gouldi	Arrow squid	✓		✓
Total counts =		15	7	6

Source: Fishbrain (2022).

Both the Emu and Claytons bays were included as the reported recreational catches at Heybridge beach were limited and very low in species diversity of the catches. It is anticipated that the results from the three recreational fishing sites in Table 6.49 are also representative of the broader recreational catch that may be expected at Heybridge beach and nearshore waters. In general, most recreational fishing at the Heybridge location of the proposed landfall of the project is based on shore-fishing that targets Australian salmon, flatheads, mullet, and various shark species.

The likelihood of occurrence of recreational fishing in nearshore Tasmania in the vicinity of the proposed landfall of the project is assessed as ***Very likely***. Potential interactions of the project with recreational fishing and potential impacts of the project on recreational fishing are assessed in Section 7 (Impact assessment).

6.4.3.3 Offshore recreational fishing

The offshore waters of Bass Strait (240-km wide with an average depth of 60 m) feature numerous islands, deep ocean drop-offs and a meeting point of currents created by the merging of the Pacific Ocean and Southern Ocean, which provide pelagic habitat for several game fishes, which are targeted by deep sea fishing and big game fishing charters. The principal game fishing and deep-water fishing charter operators have bases located in Victoria (e.g., Queenscliff and Sorrento) and Tasmania (e.g., Launceston, Port Sorrell and Wynyard).

In the offshore waters of Bass Strait, the larger recreational fishing boats are known to chase target game fish such as the shortfin mako shark and common thresher sharks. Other targeted species include barracudas, various shark species such as gummy, seven-gill and blue sharks (GameRec, 2019). Other potential but rarer game fish occurring in Bass Strait from time to time are the shortfin mako shark, broadbill swordfish, striped marlin, and various species of tuna.

Shortfin Mako shark

The shortfin mako shark (*Isurus oxyrinchus*) is a large pelagic shark that is a fast-swimming active predator and is capable of spectacular leaping and a favoured game fish (Last and Stevens, 2009). The Atlas of Living Australia (CSIRO, 2022) indicates that there are about 25 records of the shortfin mako in Bass Strait. The nearest record in Victoria is located offshore to the south of Venus Bay town and is located 35 km from the nearest alignment of the project. In Tasmania, the nearest record in Bass Strait of the shortfin mako shark is in offshore waters to the southwest of Wilsons Promontory, which is 5 km from the nearest proposed alignment of the Marnus Link and is also within the 16-km wide fisheries study area (SETFIA, 2022). In southern Bass Strait in proximity to Heybridge, the nearest record of the shortfin mako shark is offshore of Table Cape and is located 27 km west of the project.

The likelihood of occurrence of shortfin mako shark in the 16-km wide fisheries study area (SETFIA, 2022) straddling the project’s proposed alignment is assessed as ***Very likely***.

Broadbill swordfish

The broadbill swordfish (*Xiphias gladius*) is another top game fish that is found mainly in eastern Bass Strait and along the Tasmanian east coast. The broadbill swordfish is primarily a warm-water species that migrates toward temperate or cold waters for feeding in summer and returning to warm waters in autumn for spawning and overwintering. It is mostly found in deeper water, down to a maximum depth of 650 m, but will sometimes come inshore (McGrouther, 2019). The Atlas of Living Australia (CSIRO, 2022) indicates that the nearest record of a broadbill swordfish is located 220 km east of the nearest proposed alignment of the project. The likelihood of occurrence of this species in central Bass Strait and the project’s 16-km wide fisheries study area (SETFIA, 2022) is assessed as ***Remote***.

Striped marlin

The striped marlin (*Kajikia audax*) is an epipelagic and oceanic species, usually found close to shore only where deep drop-offs occur, and their abundance increases with distance from the continental shelf (Kailola et al., 1993). This species feeds on fish, crustaceans and squids. The southward extension of the East Australian Current also extends the southern distribution of warmer water large gamefish such as striped marlin. The Atlas of Living Australia (CSIRO, 220) shows the distribution of striped marlin along the east coast of Australia with the nearest observation being 85 km southeast of offshore of Mallacoota (Victoria), which is about 370 km east of the nearest proposed alignment of the project. The likelihood of occurrence of striped marlin in central Bass Strait is assessed as ***Remote***.

Tuna species

Game sports fishing for tuna is also practised in Bass Strait, mainly targeting subtropical species such as albacore, yellowfin tuna, and skipjack tuna, which appear with the southerly progression of the East Australia Current (DPIPWE, 2019). Temperate tuna species such as the southern bluefin tuna (*T. maccoyii*) occur in eastern Bass Strait, but this is outside the central zone of Bass Strait and the project's area of direct influence.

Albacore

The Atlas of Living Australia (CSIRO, 2022) indicates that five records of albacore (Thunnus alalunga) are found in Bass Strait. In general, the distribution records for this species are found mainly along the coast of NSW and Tasmania, including offshore waters overlying the eastern continental shelf edge of Bass Strait.

In Victoria, the nearest sighting in Victorian offshore waters of Bass Strait one record off Venus Bay town and is 35 km to the nearest proposed alignment of the project. In Tasmania, the nearest record is offshore of George Town and is located 53 km from the project. The likelihood of occurrence of albacore in central Bass Strait is assessed as ***Possible***.

Yellowfin tuna

The Atlas of Living Australia (CSIRO. 2022) only lists two records for yellowfin tuna (*Thunnus albacares)* in eastern Bass Strait only. The nearest record if offshore of Flinders Island and is located 142 km from the nearest proposed alignment of the project and this tuan species is considered to lie outside the project's area of direct influence. The likelihood of occurrence of yellowfin tuna in central Bass Strait is assessed as ***Remote***.

Skipjack tuna

The Atlas of Living Australia (CSIRO, 2002) list nine records of skipjack tuna in Victorian waters, mostly along the east coast from Wilsons Promontory to the NSW/Victorian border and includes four records in Bass Strait. The nearest record, offshore and east of Port Albert, is located 120 km from the nearest proposed alignment of the project. In Tasmania, there three sighting records in the offshore waters of Flinders Island. The nearest record south of Deal Island (Kent Group) is located 98 km to the east of the nearest proposed alignment of the project. The likelihood of occurrence of skipjack tuna within the 16-km wide fisheries study area (SETFIA) straddling the project's proposed alignment is assessed as possible.

Overall, the likelihood of occurrence of game fishing in the offshore waters of Bass Strait along the project's proposed alignment and within the 16-km wide fisheries study area (SETFIA, 2022) is assessed as ***Possible***, though given the very large expanse of offshore Bass Strait waters available to offshore game fishing, interaction with project may be expected to be very low. Potential impacts on offshore game fishing are assessed in Section 7 (Impact assessment).

6.4.4 Other recreational activities

Other recreational activities include:

- Recreational boating.
- Recreational beach and water activities.

6.4.4.1 Recreational boating

Recreational boating covers power boats, jet skis, yachts, kayaking, and sea-going canoes. Recreational boating in Waratah Bay and nearshore Tasmania at Heybridge are described below.

6.4.4.1.1 Recreational boating in Waratah Bay

In the Waratah Bay and region to the west of Wilson Promontory, boat access to the waters of the bay is facilitated by the presence of public boat ramps at the following locations:

- Shallow Inlet: Sandy Point beach for boat launching
- Walkerville North: public boat ramp
- Walkerville South: public boat ramp
- Waratah Bay village: Beach ramp

Recreational boating traffic includes boat transits from Waratah Bay settlements with boat ramps to the sheltered waters of Shallow Inlet Marine Park and Coastal Reserve. When sea states are conducive to recreational boating, transits to and along the west coast of Wilson Promontory are also undertaken for both pleasure and recreational fishing. Therefore, recreational boats involved in fishing may be spread around Waratah Bay especially in the summer months and in proximity to the project's proposed nearshore marine activities.

The likelihood of occurrence of recreational boats within the nearshore of Waratah Bay adjacent to the proposed landfall of the project is assessed as ***Very likely***, especially during the summer months when there is an influx of tourists in South Gippsland Shire. Potential interaction of recreational boating with the project and potential impacts of the project are addressed in Section 7 (Impact assessment).

6.4.4.1.2 Recreational boating along the Tasmanian north coast

The public in the coastal towns of the north coast of Tasmania have access to motor cruisers, yachts, and a variety of small watercrafts (e.g., kayaks and jet skis). Boat access to the waters of the northwest coast is facilitated by the presence of public and private boat ramps (MAST, 2020) in the following areas:

- Wynyard boat ramp.
- Burnie: Emu Bay boat ramp at breakwater; Burnie jetty boat ramp; Cradle Coast Outrigger Canoe Club
- Ulverstone: West Bank public boat ramp; East Bank public boat ramp; Leven Yacht Club
- Devonport: Horsehead Creek boat ramp; Victoria Parade boat ramp; Mersey Yacht Club.

Most recreational boating takes place within coastal waters, especially within sheltered waters such as the Blythe River and Blythe Estuary near the proposed landfall of the project. There is expected to be some alongshore small boat transits between coastal towns of Burnie, Heybridge, Ulverstone, Leith and Devonport; however, most recreational boats will remain close to the towns and adjacent nearshore waters. There is anticipated to be very low numbers of recreational boaters using the offshore waters adjacent to the proposed landfall of the project at Heybridge.

The likelihood of occurrence of recreational boating traffic in nearshore Tasmania in proximity to the proposed landfall of the project is assessed as ***Very likely***. Interaction between the project and recreational boating traffic and impacts are assessed in Section 7 (Impact assessment).

6.4.4.2 Other non-boating recreational activities

Other recreational activities include beach activities, swimming, snorkelling, scuba diving, sea kayaking, nature walks (e.g., native flora and fauna, and particularly birdwatching) and tourism.

6.4.4.2.1 Waratah Bay and environs

Other recreational activities, other than boating or fishing, occur within Waratah Bay and its environs and are described briefly below.

Beach activities

The Waratah Beach Surf Life Saving Club is located at Sandy Point village. The public using Waratah Bay Caravan Park at Waratah Bay village have access to the bay for beach activities, sunbathing, paddling, swimming and walking along the foreshore. The public using Camp Waratah Bay (Waratah Beach Camp, 2022) also have access to the beach. Other beach parking includes the beach parking area at the end of Gale Street (east of Waratah Bay village), and various beach parks and access in the vicinity of Sandy Point village (e.g., Ned's Lookout, Beach Parade track, Ned's Lookout, Waratah Beach Surf Life Saving club, and an access track from Manuka Street in the east of the village). The beach parking locations are mentioned as they are immediately adjacent to Waratah Bay beaches, where shore-based and marine recreational activities may take place and interact with the project's proposed shore-end and nearshore construction activities.

A key tourist attraction is the Waratah Beach Camp (WBC, 2022) which offers accommodation and provides over fifty on- and off-site activities for guests to choose from. Beach activities include swimming, snorkelling, beach games (e.g., beach volleyball and kite flying), surf school for learning to surf, night walks. The beach adjacent to the Waratah Beach Camp is located 1.7 km from the proposed landfall of the project in Waratah Bay.

Shallow Inlet Marine and Coastal Park

Shallow Inlet Marine and Coastal Park (23.77 km^2) protects a large tidal bay enclosed from the sea by a sand barrier, spits, bars and mobile dunes. It is popular for boating, fishing, and windsurfing. Shallow Inlet is also an Important Bird Area or IBA as described in Section 6.3.9.3, (Important Bird Areas).

Access to Shallow Inlet is by road (Sandy Point Road), which terminates in Shallow Bay, or by boat from the public ramps available within Waratah Bay (e.g., Walkerville North and South public boat ramps, and Waratah Bay village beach ramp).

Wilsons Promontory National Park

A major attraction for South Gippsland, Wilsons Promontory National Park (504.60 km^2) is at the southernmost tip of mainland Australia. This national park is popular for camping, short walks and overnight hiking and features granite mountains, sandy beaches and diverse plant communities including heathlands, woodlands and rainforests. This national park is accessible by road (Wilson Promontory Road) and by boats flaunched from Waratah Bay public and beach ramps.

Overall, the likelihood of occurrence of other reactional activities within Waratah Bay is assessed as ***Very likely***. Potential impacts of the project on these other activities within Waratah Bay are assessed in Section 7 (Impact assessment).

6.4.4.2.2 Nearshore Tasmania at Heybridge and environs

Swimming and surf fishing are mostly limited to beaches, especially tioxide beach adjacent to the project's landfall and Tasmanian converter station of the project. Nearshore shallow waters also include snorkelling or diving over rocky reefs for pleasure, spear fishing for reef fish, hand collecting or gleaning for marine invertebrates in the intertidal zone. The nearest rocky reefs are at Titan Point, which is located 700 m from the nearest proposed alignment of the project. This area has a car park and Titan Point has a range of recreational activities including walks, fishing over the rocky reefs, snorkelling, and intertidal gleaning for marine shellfishes.

At Blythe Heads and eastwards along the coast, there is limited off-street parking along Sice Ave, which also has several pedestrian access tracks for pedestrians to reach sandy beaches and rocky foreshores.

There is an access road from the Bass Highway to the beach opposite the former Tioxide Australia plant and proposed location of the project's Tasmanian converter station. This access track allows four-wheel drive vehicles to reach the beach for leisure, fishing and sport.

Overall, the likelihood of occurrence of other reactional activities at the Tasmanian nearshore at Heybridge is assessed as ***Very likely***. Potential impacts of the project on these other activities in nearshore Tasmania at Heybridge are assessed in Section 7 (Impact assessment).

6.4.5 Aboriginal cultural resources

Marine aspects of Aboriginal cultural resources are addressed separately in EIS/EES Technical appendix I: Underwater cultural heritage and archaeology and are not discussed further in the present report.

6.4.6 Maritime Archaeological Sites and Shipwrecks

Maritime archaeological sites and shipwrecks are addressed separately in EIS/EES Technical appendix I: Underwater cultural heritage and archaeology and are not discussed further in the present report.

7 Impact assessment

7.1 Introduction

This section assesses the impacts of the project during its construction (Section 7.2, Construction impacts), operations (Section 7.3, Operations impacts) and decommissioning (Section 7.4, Decommissioning impacts) on marine ecology and marine resource use. Within these three sections, impacts have been assessed under the impact source or pathway in preference to the location (i.e., nearshore Tasmania, offshore Bass Strait, and nearshore Victoria).

The assessment of residual impacts, after mitigation and management measures have been implemented, is based on the significance assessment method (see Section 5.3.2, Significance assessment method). However, in the case of underwater noise, the impacts have been assessed using a modified significance assessment method in which the 'sensitivity' of a receptor (e.g., a whale, fish, or a fur seal) is based on the receptor's sensitivity to underwater sound pressure, sound exposure level, or particle motion (see Section 7.2.3.3, Marine fauna hearing groups of interest). The impacts of invasive marine species have been assessed using the risk assessment method (see section 5.3.4, Risk assessment method).

7.2 Construction impacts

This section assesses the following construction related impacts on marine ecology and marine resource use:

- Shore crossing impacts (Section 7.2.1, Shore crossing impacts).
- Nearshore construction impacts (Section 7.2.2, Seabed disturbance impacts)
- Bass Strait offshore construction impacts (Section 7.2.3, Underwater noise impacts).

The sequence of marine construction activities for cable laying and installation will commence at landfall in Tasmania and progress across Bass Strait towards landfall in Victoria.

7.2.1 Shore crossing impacts

The shore crossings of the project's individual HVDC and optical fibre cables will be undertaken using horizontal directional drilling (HDD). A summary of the HDD method is presented below.

- Onshore drill pads:
    - establishing onshore HDD drill pads in both Tasmania and Victoria.
- Drill rigs:
    - depending on the length of the HDD this may be a track-mounted drill rig with or a drill rig without an attached drill string rack.
- Drilling (three step process):
    - a pilot hole will be drilled first.
    - the HDD pilot hole will then be reamed (hole opening) to provide a bore diameter that is 1.25 times larger than the cable diameters to be installed.
    - a high-density polyethylene (HDPE) duct (pipe) will then be pushed through or pulled through the reamed HDD bore for subsequent insertion of a subsea cable.

- Drilling fluid and circulation system:
    - the drilling fluid will be bentonite clay, a natural clay-based mineral that is non-toxic. Bentonite clay is mixed with water to create a slurry (95% water to 5% bentonite clay) in the drilling fluid mixing tank. The drilling fluid is then pumped down the drill string where it lubricates the drill head, assists in cuttings removal, and stabilises the HDD bore wall.
    - used drilling fluids are pumped from the annulus (i.e., the space between the drill string and the HDD bore wall) to a drilling fluids recycling unit for treatment and reuse.
    - waste drilling fluid will be pumped to road tanker for appropriate offsite treatment and disposal.

Prior to HDD exit hole breakthrough and within about 5 m of the remaining hole to be drilled, drilling fluid in the HDD borehole will be pumped out, as far as is possible, to remove all excess drilling fluid. However, residual drilling fluid that cannot be pumped out will remain in the HDD borehole and will escape to the external environment at the HDD exit holes during breakthrough.

Schematic diagrams of the HDDs are shown in Figure 4.2 and Figure 4.3 respectively for the Tasmanian and Victorian shore crossings (see Section 4.2.1, Pre-lay grapnel runs and route).

Section 6.2.5 (Coastal environment and coastal processes) described the existing coastal processes of the Tasmanian and Victorian shores in the vicinity of the project's proposed landfalls. The sand beaches at both landfalls were assessed to be stable over a 13-year period based on an examining the position of the shoreline from historical imagery using Google Earth™. The proposed long trajectory HDD is a trenchless technique does not disturb the backshore, foreshore, or intertidal zone of the beach, as the HDD borehole and ducts are deep underground. No impacts of long trajectory HDD are predicted for either of the Tasmanian or Victorian shore crossings and no impacts on coastal processes or the stability of the sand beaches and shorelines are anticipated.

The impacts of the HDD marine exit hole at the 10-m water depth mark are assessed in Section 7.2.2.1 (Nearshore construction seabed disturbance impacts).

7.2.2 Seabed disturbance impacts

Seabed disturbance impacts from project construction in nearshore and offshore Bass Strait are assessed below.

7.2.2.1 Nearshore construction seabed disturbance impacts

Section 5.1 (Study area) defines the nearshore zone as state waters within the three nautical mile (NM) limit. The nearshore zone has also been defined as that part of Bass Strait within 2.5 km from the coast or to the point at which the water depth is approximately 20 m. This definition of the nearshore environment is adopted in the literature by numerous coastal scientists and coastal engineers (e.g., 2.5 km distance (Chidgey et al., 2008) or 20 m water depth contour (CIRIA, 1996)).

For the purposes of this report, the subtidal nearshore zone in both Tasmania is defined as the zone from the low tide level to 2.5 km seaward where the water depth is 20 m. The subtidal nearshore zone in Victoria is defined as the zone from the low tide level to 4 km seaward where the water depth is 20 m. Therefore, the physical impacts of construction activities in the subtidal nearshore zone (where cable installation and burial will take place) can be described and assessed separately from those of intertidal zone or other areas within the broader definition of the nearshore zone as state waters within the 3-NM limits.

The project's proposed construction activities in nearshore Tasmania and nearshore Victoria include:

- Pre-lay grapnel runs for route clearance.
- HDD marine exit hole impacts to subtidal seabed.
- Cable lay impacts on seabed.
- Post lay cable installation and burial in soft seabed.
- Post lay cable installation on hard seabed.
- Post lay cable crossings of third-party seabed infrastructure.

In addition, the nearshore environments of Tasmania and Victoria may be affected by the following potential construction impact sources, which are assessed separately in the following sections:

- Section 7.2.3 (Underwater noise impacts)
- Section 7.2.4 (Artificial lighting impacts)
- Section 7.2.5 (Impacts of introducing or translocating invasive marine species)

7.2.2.1.1 Pre-lay grapnel runs

Pre lay grapnel runs (PLGR) will be carried out for route clearance. This will ensure that uncharted debris (e.g., chains, discarded fishing gear or nets) are removed and will not interfere with the project's cable laying operations, including the approaches to landfalls in Tasmania and Victoria. PLGRs between the cable ship and the long trajectory HDD marine exit hole (at 10 m water depth) need to be undertaken to ensure that the cable can be buried without obstruction between the beach trenches and the cable-lay ship. The PLGR method is described in Section 4.2.1 (Pre-lay grapnel runs and route).

PLGRs will be undertaken across Bass Strait commencing at the Tasmanian long trajectory HDD marine exit hole location (at 10 m water depth) to the Victorian long trajectory HDD marine exit hole location (at 10 m water depth). Approximately 98% of the PLGRs will be conducted along the seabed of offshore Bass Strait (see Section 7.2.2, Seabed disturbance impacts).

The PLGRs will be undertaken using an offshore supply vessel (OSV) under dynamic positioning (DP) mode to tow the grapnel along the seabed of the sections of the project alignment proposed for cable burial.

For the purposes of the present report, an assessment of the PLGRs on soft sediment seabed habitats and associated biological communities is not justified for the following reasons:

- Direct disturbance of the seabed along the track of a 5-cm wide towed grapnel within Tasmanian and Victorian nearshore waters is confined to a disturbance depth of 1.2 m and disturbance width of 0.5 m, which represents a very narrow strip of directly disturbed soft sediment seabed.
- The PLGRs will be followed soon after by a ROV seabed trencher that uses wet jetting to install and bury the project's subsea cables. Seabed trencher impacts to the seabed are wider than that of the PLGRs and have a total width of direct disturbance of 2.9 m (or approximately 3 m) compared to the towed grapnel seabed disturbance width of 0.5 m. The jet trencher's total seabed disturbance width is made up of a wet jetting direct disturbance width of 1.7 m and an additional 1.2 m of compaction of seabed sediments from the trencher's twin tracks.

A literature review revealed that PLGR impact assessments were commonly not undertaken due to their limited spatial and temporal extent. For example, the following projects with seabed infrastructure describe the PLGR method but their potential impacts were not assessed:

- Basslink Integrated Impact Assessment Statement (NSR, 2002).
- Swepol Link Interconnector. Marine biological assessment (Andrulewicz et al., 2003).
- Ichthys Gas Development Gas Development Project EIS (INPEX, 2008).
- Hawaiky Submarine Cable Environmental Assessment (GHD, 2016)
- NorthConnect UK Environmental Impact Assessment Report (NorthConnect, 2018).
- Ocean Wind 1 Offshore Wind Farm EIS (BOEM, 2022).

In those cases where the seabed impacts of PLGRs have been assessed, it is usually to assess impacts on a high- or medium-value benthic community. For example, in the case of the Nemo Link HVDC interconnector, PLGR impacts on high-value seabed habitats (herring spawning grounds in this case) were assessed as 'minor', even without the application of mitigation (PMSS, 2012).

For the above reasons, the seabed disturbance impacts of the PLGRs are not considered further. Greater emphasis has been placed on assessing the overriding seabed impacts of cable installation and burial by wet trenching (see Section 7.2.2.1.4, Physical impacts of cable installation and burial in soft sediment seabed).

7.2.2.1.2 Long trajectory HDD impacts on nearshore environment

The subtidal locations of the long trajectory HDD marine exit holes (at 10 m water depth) are within the nearshore zones of both Tasmania and Victoria. The potential impacts, mitigation measures and residual impacts of nearshore HDD exit hole breakthroughs are assessed below.

Potential Impacts

The potential impacts of HDD exit hole breakthroughs in soft sediment seabed include:

- Disturbance of seabed nearshore habitats.
- Changes to water quality:
    - unavoidable minor release of drilling fluids (water including bentonite clay) at HDD borehole breakthrough.
    - releases of HDD borehole solids (cuttings and coarse sediments).
- Disturbance of nearshore seabed benthic communities.

Environmental performance requirements

The proposed EPR for the HDD of the shore crossing is presented in Table 7-1.

Table 7-1 EPRs for HDD shore crossings

EPR ID	Environmental performance requirement	Project stage
MERU01	**Monitor HDD activities for the shore crossing to avoid or minimise impacts to the marine environment.** Prior to commencement of marine construction develop procedures for: • Monitoring HDD activities and drilling fluid pressures to minimise release of drilling fluid to the marine environment. • Extracting cuttings and drilling fluids from the HDD pilot boreholes for the shore crossing prior to breaking through to the sea floor. These procedures must be documented in a sub plan to the CEMP and implemented during construction.	**Construction**

Potential mitigation and management measures

It is recommended that the HDD contractor monitor and adjust drilling fluid pressures throughout the drilling process, which should avoid or minimize inadvertent releases of drilling fluid. During HDD boring, it is expected that drilling will be stopped typically about 5 m before reaching the proposed HDD pilot exit hole, which allows cuttings and drilling fluids to be pumped out of the HDD borehole. This will minimise the volume of residual HDD drilling fluids and cuttings at breakthrough to about 2.35 m^3 based on a pilot hole diameter of 0.3 m and the final 5 m of the pilot hole containing residual cuttings and drilling fluid.

Predicted residual impacts

The following sections assess the residual impacts of long trajectory HDD on nearshore marine ecology of Tasmania and Victoria.

Long trajectory HDD impacts on nearshore seabed habitats

Long trajectory HDD impacts on nearshore habitats in Tasmania

The HDD marine exit hole has a diameter of 300 mm, which will disturb an extremely small area (0.07 m^2) of subtidal seabed habitat. However, the area is estimated to be less than 3 m^2, if the short-term settling of the coarser fractions of cuttings and drilling fluid solids (bentonite clay) in the 2.35 m^3 are included at HDD pilot hole breakthrough. There is no accumulative impact of drilling solids or sand release, since the HDD pilot boreholes are drilled separately (i.e., 50 m apart) and sequentially (three for the first stage ML1 cables and then a further three marine exit holes for the second stage ML2 cables about two years' later).

The areal impact of HDD solids settlement on the seabed habitats of the sand-filled palaeochannels, surrounding each of the six marine exit holes (i.e., less than 3 m^2), is predicted to have a residual impact significance rating of ***Very low***. This is based on a palaeochannel sandy habitat sensitivity of *Low*, due to frequent natural sediment mobilisation within the palaeochannels, and a *Negligible* magnitude of impact, given the extremely small area of subtidal habitat impacted, the short-term nature of the impacts, and the inert nature of the residual drilling fluids and cuttings. Any HDD residual solids deposition is expected to be remobilised and distributed within the high-energy hydrodynamic environment of the palaeochannels, where they will admix with natural beach sediments.

Long trajectory HDD impacts on nearshore habitats in Victoria

In nearshore Victoria, the long trajectory HDD exit hole is also located at 10 m water depth in sandy seabed. At the HDD exit hole breakthrough, if the short-term settling of the coarser fractions of cuttings and drilling fluid solids (bentonite clay) are included on top of the exit hole diameter, the area will be typically less than 3 m^2 for an HDD pilot hole breakthrough release volume of about 2.35 m^3.

The areal impact of HDD solids settlement, at each of the six marine exit holes (i.e., less than 3 m^2), within the sandy seabed habitat of Waratah Bay, is predicted to have a residual impact significance rating of ***Very low***. This is based on a nearshore sandy seabed habitat sensitivity of *Low,* due to frequent natural sediment mobilisation of the seabed in nearshore Waratah Bay (as evidenced by sand ripples and the presence of coarse sands and cobble patches (Fugro 2020; CEE, 2022)), and a *Negligible* magnitude of impact*,* given the very small area of subtidal habitat impacted and the very short-term nature (once-off) of the impacts. Any HDD solids deposition is expected to be remobilised and distributed within the high-energy hydrodynamic environment of the shallow waters of Waratah Bay, where they will admix with natural beach sediments.

Long trajectory HDD impacts on nearshore water quality

Changes in water quality at HDD exit hole breakthrough will arise from the very-short term release of residual drilling fluids, which contain fine-grained (<0.63 µm particle size class) cuttings and bentonite clay. This will cause a localised increase in suspended sediment concentrations (SSC) and associated turbidity. The impacts of long trajectory HDD on Tasmanian and Victorian nearshore water quality are assessed below.

Long trajectory HDD impacts on water quality in nearshore Tasmania

The once-off and very short-term increase in SSC and associated turbidity at the HDD exit hole breakthrough, in the sand-filled palaeochannels, will disperse and dilute rapidly in the direction of tidal flows and prevailing longshore currents.

Predicted impacts on water quality are assessed as having a residual impact significance rating of ***Low***. This is based on a subtidal marine water quality sensitivity of *High*, given the good water quality for nearshore Tasmania (see Section 6.2.3.1) and a *Negligible* magnitude of impact given the small volume (less than 2.35 m^3) of residual drilling fluid released at breakthrough. A high level of confidence can be placed on this residual impact assessment, given the high dilution from the tidal flows and longshore currents, which reduce down-current SSC and associated turbidity to background levels within several kilometres as has been observed for turbidity plumes from dredging operations (Kim et al, 2018; PMSS, 2018).

Long trajectory HDD impacts on water quality in nearshore Victoria

The once-off and very short-term increase in SSC and associated turbidity at the HDD exit hole breakthrough (at the 10 m water depth), in the sandy seabed of Waratah Bay, will disperse and dilute rapidly in the direction of tidal flows and prevailing longshore currents.

Predicted impacts on water quality are assessed as having a residual impact significance rating of ***Low***. This is based on a subtidal marine water quality sensitivity of *High* given the good water quality in nearshore Victoria (see Section 6.2.3.3), and a *Negligible* magnitude of impact given the small volume (less than 2.35 m^3) of drill cuttings and residual drilling fluid released at breakthrough A high level of confidence can be placed on this residual impact assessment given the high dilution from the tidal flows and longshore currents, which reduce down-current SSC and associated turbidity to background levels within several kilometres as has been observed for turbidity plumes from dredging operations (Kim et al, 2018; PMSS, 2018).

Long trajectory HDD impacts on nearshore benthic communities

The abovementioned long trajectory HDD impacts on seabed habitats and marine water quality have potential consequential impacts on seabed flora and fauna. The impacts of long trajectory HDD on Tasmanian and Victorian nearshore benthic communities are assessed below.

Long trajectory HDD impacts on benthic communities in nearshore Tasmania

The areal extent of around 3 m^2 of disturbed seabed sediments, arising from deposition of drill cuttings at the long trajectory HDD marine exit points, represent a very small area of seabed in which macrobenthic fauna may be buried or partially smothered. In general, epibenthic macroinvertebrates were not visible during video surveys or drop camera, and given a lack of sediment infauna sampling, the infauna was inferred by CEE (2022). Those burrowing species such as *polychaete* worms and some molluscs may be expected to burrow out of drill cutting deposits. Notwithstanding, impacts resulting from the release of cuttings and drilling fluids will be restricted to the immediate vicinity of the HDD exit point and solids released into the water column will be rapidly dispersed, and any solids which are deposited on the seabed within the estimate area of less than 3 m^2 at each HDD pilot hole breakthrough will be removed quickly by natural scouring in the high-energy hydrodynamic environment within the palaeochannels.

The residual impacts of long trajectory HDD on the nearshore benthic communities of the sand-filled palaeochannels, in nearshore Tasmania, are assessed to have a residual impact significance rating of ***Very low.*** This is based on a sandy seabed benthic community sensitivity of *Very low,* due to its wide distribution of common species, and a *Negligible* magnitude of impact, given the very small area of seabed impacted by residual drilling solids and the absence of significant impacts on water quality. Population recovery of sandy seabed species is expected to be rapid, as these species have adapted to a high-energy hydrodynamic environment that is often exposed to large physical disturbances that result in sediment (sand) transport and increased turbidity, such as tides, wave action, and surf.

Long trajectory HDD impacts on seabed benthic communities in nearshore Victoria

The areal extent of around 3 m^2 of disturbed seabed sediments arising from deposition of drill cuttings at each of the six long trajectory HDD marine exit points represents a very small total area of seabed of 18 m^2 (i.e., 9 m^2 for ML1 and 9 m^2 for ML2 that will be installed two to three years later). The seabed and benthic communities around the HDD exit pilot hole (at 10 m water depth) were characterised as sandy seabed with seagrass, drift macroalgae, and inferred mixed infauna (CEE, 2023; EIS/EES Technical appendix G: Benthic ecology). The only threatened species present in Waratah Bay is the Tasman grass-wrack (*Heterozostera tasmanica*), which is an eelgrass that is listed as endangered under the FFG Act. This species is present in sparsely distributed patches of low to moderate densities between 10 m and 15 m water depth in Waratah Bay. This endangered seagrass may be present in the vicinity of each HDD exit hole and may be exposed to burial from deposited drill cuttings and residual drilling fluid solids (bentonite clay) at each HDD pilot hole breakthrough. However, since the HDD pilot hole breakthrough is located at the edge of 10 to 15 m water depth zone where sparse distributions of Tasman grass-wrack have been observed, the total predicted area of 18 m^2 of deposited drill cuttings represents a very small proportion (0.0002%) of the total area of 11 km^2 of Tasman grass-wrack habitat in this depth range (see Section 6.3.4.1). Permits for removal or disturbance of the Tasman grass-wrack will be obtained under the FFG Act where required.

The residual impacts of long trajectory HDD on the sandy seabed benthic flora and fauna, in nearshore Waratah Bay, are assessed to have a residual impact rating of ***Low***. This is based on a sandy seabed benthic community sensitivity of *High,* due to the likely presence of the endangered Tasman grass-wrack (*Heterozostera tasmanica),* and a *Negligible* magnitude of impact given the very small areal extent of nearshore seabed habitat loss or degradation by drill cutting deposition and absence of significant impacts to water quality due to the very short-term discharge of residual drilling fluid at HDD bore breakthrough.

Recovery of sandy seabed species is expected to be rapid as these species, including the endangered Tasman grass-wrack, have adapted to a high-energy hydrodynamic environment that is often exposed to large physical disturbances such as wave and tidal action, surf and resulting sediment (sand) transport and increased turbidity. Note that the endangered Tasman grass-wrack has been found to thrive in more open, coastal nearshore sediments (Sullivan, 2019), so may be expected to be more resilient to the temporary release of HDD residual cuttings and drilling fluids.

7.2.2.1.3 Cable lay impacts on nearshore seabed

The two HVDC cables and optical fibre cable will be pulled to shore from the cable lay ship maintaining station, using the dynamic positioning (DP) system at about the 15 m water depth, which allows a safety margin to accommodate the ship's draught (e.g., the CS *Giulio Verne* produces an 8.5-m draught when laden with cables).

During construction of the project, a fleet of small boats will manoeuvre the individual floated cables along the path of the western palaeochannel and the seaward extension of its sand gutter, using coordinates based on satellite navigation. The cable flotation devices will then be removed progressively, allowing the cables to sink into its final position. The cables will then be installed and buried by a jet trencher, resuspending sediment and allowing it to settle over the cable. This nearshore cable laying process will be repeated for the eastern palaeochannels and its sand gutter extension about 2 or 3 years later, during stage two of the project. A similar nearshore cable laying process will be carried out in Waratah Bay, Victoria.

Potential impacts

The principal potential impact of laying the cable on the seabed is the cables' direct contact with surficial sediments resulting in:

- temporary loss or disturbance of seabed habitat
- potential physical impacts on benthic communities and sediment infauna.

Potential impacts of cable laid on the seabed will be negligible, as once the cables are laid, a post lay installation and burial will be undertaken within a few days of the nearshore cable lay operation. Notwithstanding, potential impacts from cable laying, prior to post cable lay burial, are assessed below. During the short period that the cables are laid directly on the seabed, they are exposed to hook up or damage from vessels' anchors or from bottom trawled fishing gears (see Section 7.2.7.2, Impacts on commercial fisheries).

Environmental performance requirement

The proposed EPRs for location of subsea cables are presented in Table 7-2:

Table 7-2 EPR for location of subsea cables to minimise impacts on benthic habitats

EPR ID	Environmental performance requirement	Project stage
MERU02	**Placement of final subsea project alignment to avoid or minimise impacts on benthic habitats.** The subsea project alignment, should be located, to the extent reasonably practicable: • Within the sand-filled palaeochannels and gutters in nearshore Tasmania and within the sandy seabed of Waratah Bay, in nearshore Victoria. • Away from nearshore areas of higher biological productivity (e.g., low- and high-profile reefs). • To avoid obstacles such as rocks and relocated to areas of soft-sediment seabed. • The final subsea project alignment must be informed by geophysical surveys and geotechnical investigations, and seabed sampling	**Design / Construction**

Potential mitigation and management measures

Potential impacts on the seabed habitats from cable laying will be minimised or avoided by mitigation measures such as:

- Positioning the cables within the sand-filled palaeochannels and gutters in nearshore Tasmania and within the sandy seabed of Waratah Bay, in nearshore Victoria.
- Positioning the cables away from nearshore areas of biologically productive low- and high-profile reefs.

Predicted residual impacts

The predicted residual impacts of project's cables laid directly on the seabed area assessed separately below for nearshore Tasmania, at Heybridge, and for nearshore Victoria, Waratah Bay.

Impacts of cable laid directly on the seabed in nearshore Tasmania

Cable lay installation and burial impacts on benthic ecology (habitats and biological communities), including seabed disturbance and smothering, will be confined to the actual footprint of the individual cables that are in direct contact with the seabed. In the case of the individual HVDC cables (135 mm diameter) and assuming one-third of the cable's underside circumference penetrates surficial sediments in the palaeochannels, then an approximately 14-cm (0.14 m) circumference cross section of the underside of an HVDC cable will be in direct contact with the seabed at any one point.

The lengths of the cable alignments where subsea cable will be laid directly on the seabed commences at the HDD marine exit holes at 10 m water depth (KP 250.8 and KP 251.9) to the three nautical mile Tasmanian state limit (KP 248.5 and KP 249.0) and are 5,100 m and 5,300 m for the western monopole (ML1) and eastern monopole (ML2), respectively. The areas of bundled cable-impacted seabed for the 5,100-m-long nearshore palaeochannel (ML1) and the 5,300-m-long eastern nearshore palaeochannel (ML2) are approximately 1,425 m^2 and 1,485 m^2, respectively. These calculated areas are for the bundled cable resting on the seabed and with an assumed total width of 0.28 m (0.14 m plus 0.14 m for the two single HVDC cables within the bundled cable) in actual contact with the seabed. The bundled cable areas in contact with the seabed of the western and eastern palaeochannels represents less than 0.9% and 1.4% of the total estimated areas of undisturbed seabed within the western palaeochannel channel (153,000 m^2) and eastern palaeochannel (106,000 m^2), respectively. The seabed contact area of an individual 35-mm diameter optical fibre cable will be negligible and is not considered further.

Given the extremely low impact of project cables laid directly on the seabed of the Tasmanian nearshore and the very short window (a day or two) prior to post lay installation and burial, potential impacts on nearshore seabed habitats and associated benthic biological communities are not required to be assessed.

Impacts of cable laid directly on the seabed in nearshore Victoria

The physical impact area of a bundled cable laid on the Waratah Bay seabed is 2,070 m^2, based on the cable path length of 7,400 m between the HDD marine exit holes at a water depth of 10 m (KP 0.8) to the 3 NM Victorian state limit (KP 8.2) and a disturbance width of 0.28 m. For the western monopole (ML1) or the eastern monopole (ML2), the total direct seabed disturbance area is approximately 2,070 m^2 per monopole which represents an extremely small physical impact area (less than 0.003%) of the total area of unimpacted seabed (about 88 km^2) between the 10-m (HDD exit holes) and 27 m (3-NM Victorian state limit) water depths within the wider nearshore region. The seabed contact area of a typical 35-mm diameter optic fibre cable will be negligible and is not considered further.

Given the extremely low impact of project cables laid directly on the seabed of the Victorian nearshore and the very short duration (a day or two) prior to post lay installation and burial, potential impacts on nearshore seabed habitats and associated benthic biological communities are not assessed.

7.2.2.1.4 Physical impacts of cable installation and burial in soft sediment seabed

This section assesses the impacts of post lay cable installation and burial in areas of soft seabed, using a Helix T-1200 jet trencher (see Section 4.2.2.3, Offshore cable lay, installation and burial) or an equivalent cable installation and burial ROV may be used. The jet trencher will only be used as a post cable lay burying tool, and not used to open a pre-lay cable trench.

Potential impacts

The potential impacts of post lay cable installation and burial in soft sediment seabed include:

- Physical impacts on nearshore seabed habitats.
- Changes to nearshore water quality from increased suspended sediment concentrations and turbidity.
- Changes to nearshore sediment quality and release of sediment-associated contaminants to the overlying water column.
- Impacts on nearshore benthic flora and fauna.

Environmental performance requirement

The proposed EPRs for installation of subsea cables are presented in Table 7-3.

Table 7-3 EPR for installation of subsea cables to minimise seabed disturbance

EPR ID	Environmental performance requirement	Project stage
MERU03	**Undertake a pre-lay survey prior to subsea cable installation to minimise seabed disturbance.** Prior to commencement of subsea cable installation, undertake a pre-lay survey to inform the final subsea project alignment so that it is clear of obstacles to the extent reasonably practicable, including low-profile reefs.	**Construction**

Potential mitigation and management measures

A total of 98% of the subsea project alignment traverse soft sediment seabed. The soft sediment seabed facilitates post lay cable installation and burial using the self-propelled ROV jet trencher, in both nearshore Tasmania and nearshore Victoria.

Fugro (2020) conducted geophysical surveys, geotechnical investigations, and seabed sampling, which presented information and data to inform route design and provide confidence in the selected project alignment. The findings of these surveys allowed route refinements (e.g., re-routing around known obstacles such as rock outcrops).

Once the project alignment and burial technique have been selected there are limited measures that can be adopted to reduce seabed sediment disturbance. However, there is potential to use a different cable burial method in very shallow waters within the sand-filled palaeochannels and sand gutter extensions in nearshore Tasmanian waters. For example, cable burial could employ a shallow water eductor tool of the type used by The Diving Company (2022) for the Basslink project (Plate 7.1).

Source: Diving Company (2022).

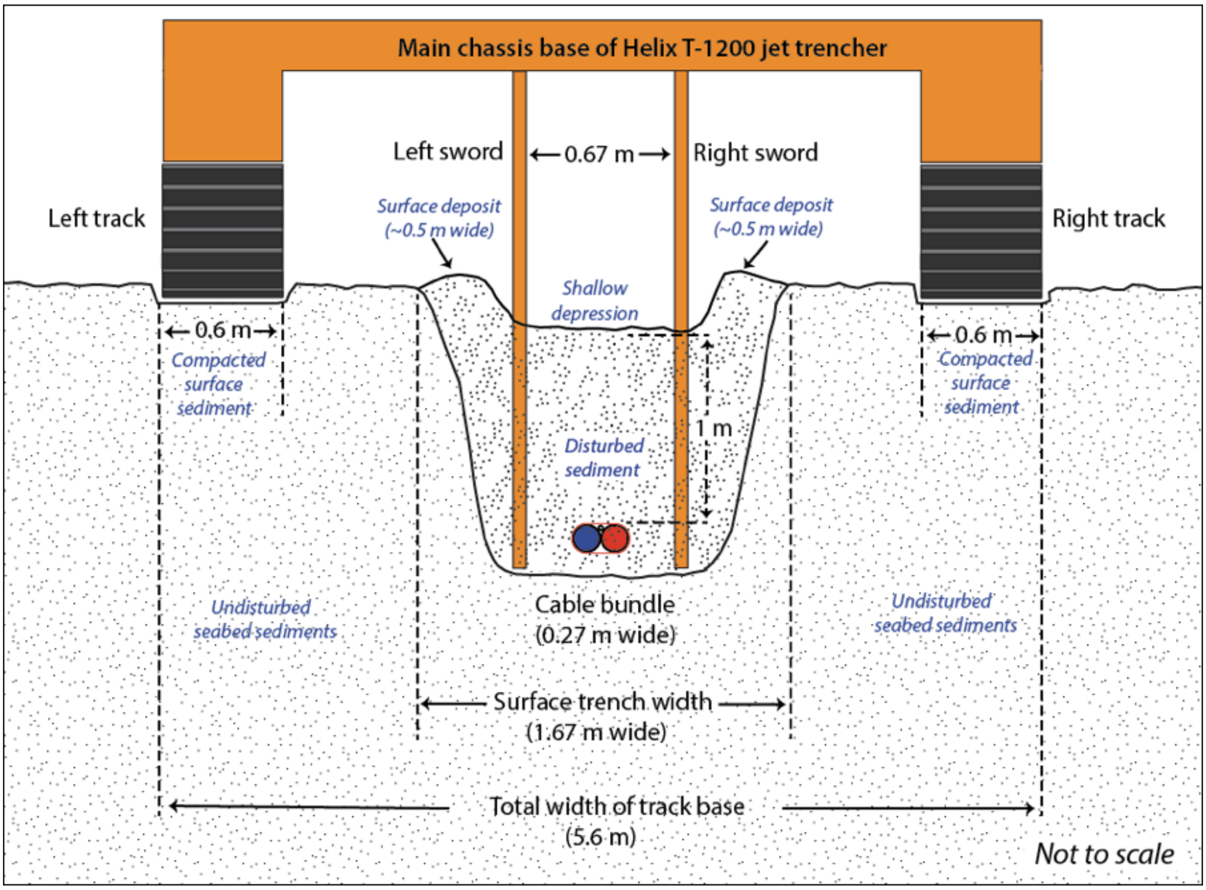
Plate 7.1: TD1 eductor tool for cable burial in shallow waters

Predicted residual impacts

This section assesses the residual impacts of cable burial using the Helix T-1200 (or similar) jet trencher as a cable installation and burial tool. Knowledge of the widths of physical seabed disturbance from the jet trencher's wet jetting operation and its caterpillar tracks are required for impact analysis. Figure 7.1 shows a schematic of the Helix T-1200 jet trencher with estimated physical impact width zones during cable installation and burial.

In Figure 7.1, the swords, fitted with water jet nozzles, fluidise the seabed sediments to the depth of sword penetration. In the case of using a Helix T-1200, the twin swords are lowered either side of the bundled cable with a buffer zone of around 20 cm, to reduce the likelihood of making direct contact with the bundled cable. The wet jetting and fluidisation operation allows the cable to sink under its own weight, such that the top of surface of the bundled cable will be located at a nominal depth of 1 m below the natural seabed surface.

The total width of soft seabed sediment disturbance from wet jetting is 1.67 m, which includes a total of 1 m width of lateral surface sediment deposits that form on either side (i.e., 0.5 m on each side) of the jet trencher as it progresses forwards. In addition to the jet trencher's cable installation and burial by wet jetting, the tracks of the ROV jet trencher, as it progresses forward, will cause direct disturbance of the seabed, most likely in the form of compaction. An individual track of the Helix T-1200 jet trencher is 0.6 m wide, or 1.2 m total width for the two tracks.



Source: EnviroGulf Consulting.

Figure 7.1: Schematic of Helix T-1200 jet trencher burying a bundled cable

The depth of track penetration will depend on the nature and compressibility of the seabed sediment. Penetration depths of between 5 and 10 cm have been assumed for soft sediment seabed. Note that the buoyancy of the jet trencher is monitored and can be adjusted for different seabed types, so that depth of track penetration may be controlled and limited. For the purposes of this report, the width of seabed disturbance from the wet jetting and cable burial operation has been assumed to be 1.67 m for the trenched area and a total 1.2 m for both caterpillar tracks (width of 0.6 m each), which gives a total disturbance width of 2.87 m.

The impacts of seabed cable installation and burial operations on seabed habitats, water and sediment quality, and benthic flora and fauna in nearshore Tasmania and nearshore Victoria are assessed below.

Physical impacts of cable installation and burial on nearshore soft seabed habitats

Cable installation and burial impacts on nearshore Tasmanian seabed habitats

Fugro (2020) used sub-bottom profiling (SBP) to characterise the depths of sediments and other substrata within the palaeochannels. The depths of sands in the palaeochannels ranged from 1 m to 7.5 m, which allows the target cable burial depth of 1 m. However, Fugro (2020) also noted that the depth of the palaeochannels can be less than 1 m in some localised cases (i.e., target burial depth of the cable cannot be achieved). This will possibly result in the cable being in contact with the underlying hard strata. The impacts of laying cable over hard seabed as well as across third-party seabed infrastructure is assessed separately in Section 7.2.2.1.6 (Cable installation on hard seabed and across third-party seabed infrastructure).

The lengths of the cable alignments between the onshore jointing pits (i.e., KP 255) to the three nautical mile limit for Tasmanian state waters is 6,500 m for the western monopole (ML1) and 6,800 m for the eastern monopole (ML2). The lengths of the cable alignments where subsea cable installation and burial will take place commences at the HDD marine exit holes at 10 m water depth to the three nautical mile Tasmanian state limit and are 5,100 m and 5,300 m for ML1 and ML2, respectively. Based on the seabed surface wet jetting width of 1.67 m, the total area of disturbed sediments by cable wet jetting is 8,520 m^2 for ML1 in the western palaeochannel, and 8,850 m^2 for ML2 in the eastern palaeochannel. Similarly, based on the two jet trencher tracks (each 0.6 m wide), the total compaction area is 6,120 m^2 for ML1 and 6,360 m^2 for ML2. Combining the wet-jetted trench seabed surface disturbance and the seabed impacted by compaction from both the jet trencher's tracks, the total areas of seabed disturbance in nearshore Tasmania are 14,640 m^2 for ML1 and 15,210 m^2 for ML2.

Overall, the above combined area of disturbance of seabed habitats in the broader western palaeochannel (average width of 30 m) represents about 9.5% of its total area of 153,000 m^2, whereas in the narrower eastern palaeochannel (average width of 20 m) the combined disturbance area represents 14.4% of its total seabed area of 106,000 m^2. These jet trencher-disturbed areas represent very small seabed habitat impact zones within the palaeochannels between the HDD marine exit holes at 10 m water depth and the 3 NM Tasmanian state limit.

While there may be mortalities of benthic macroinvertebrates within the compacted surficial sediments along the jet trencher's track lines, the shallow track depressions are anticipated to be refilled by naturally mobile or disturbed surface sediments within a few tidal cycles. These track infill sediments are expected to be repopulated by benthic sediments from undisturbed sandy areas of the palaeochannels, and the adjacent rock platforms and low-profile reefs that have patches of sand deposits with similar benthic communities.

The predicted impacts of nearshore cable installation and burial on the seabed habitats within the sand-filled palaeochannels in Tasmanian nearshore waters are assessed to have a residual impact significance rating of ***Very low***. This is based on a nearshore seabed habitat sensitivity of *Very low,* due to its frequent exposure to naturally mobile sediments, and an impact magnitude of *Negligible,* given the very small areas and short-term nature of disturbed seabed sediments. Any depressions along the cable burial paths are expected be filled quickly as the natural movements of the palaeochannel surface sediments restore the seabed to a natural pre-disturbance state.

Recovery of the seabed habitats of the sand-filled palaeochannels is expected to be rapid (say, a few months) given the high-energy hydrodynamic environment of the palaeochannels with scour redistributing the disturbed seabed sediments. CEE (2009) undertook marine biological monitoring of the Basslink cable buried in the nearshore sandy seabed at McGaurans Beach in Victoria seven months after cable installation and found that the cable trench had infilled with sand and that there was no indication of its presence.

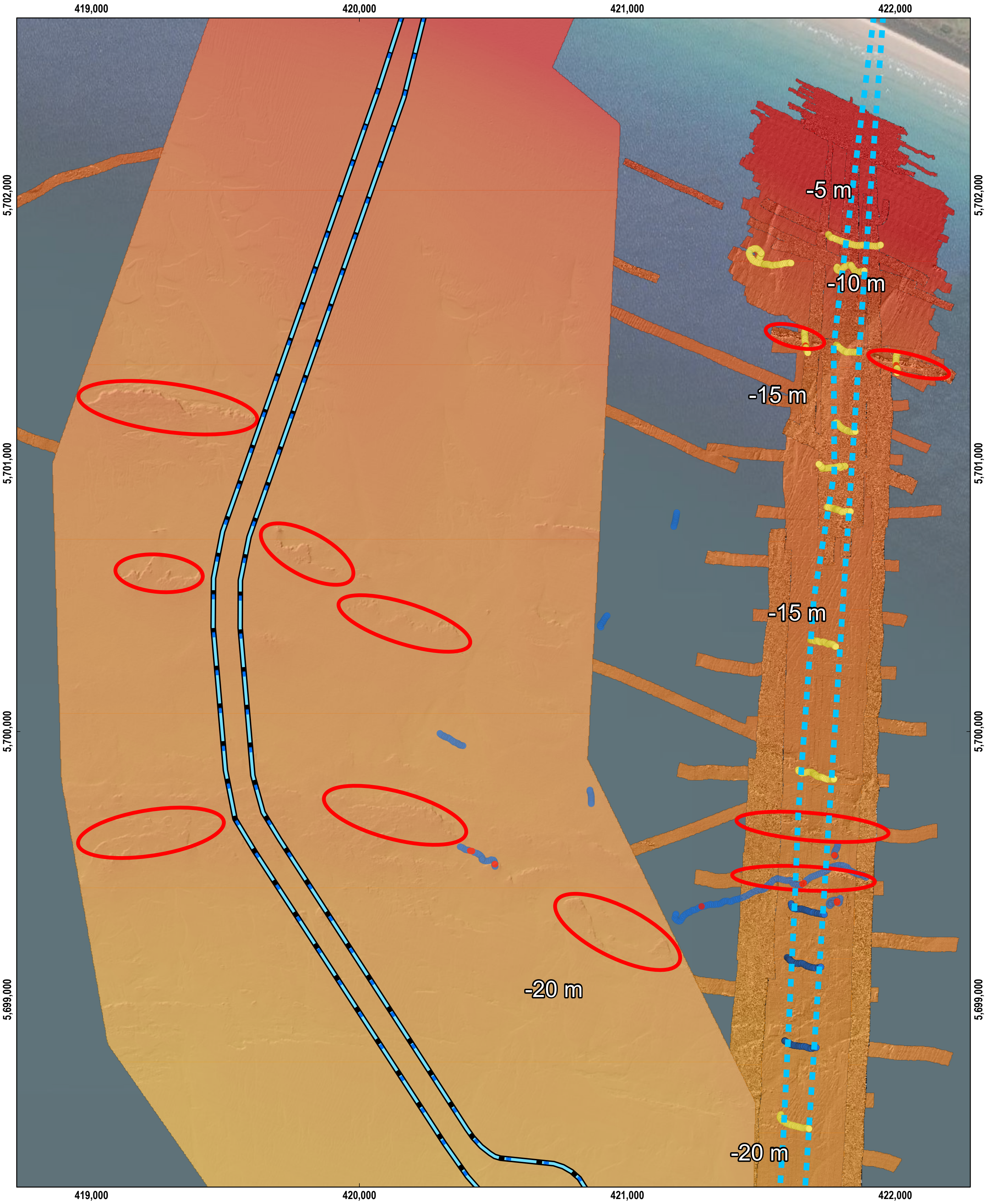
Cable installation and burial impacts on nearshore Victorian seabed habitats

A more recent geophysical survey of the new 2022 project alignment was carried out by XOCEAN (2023) and included interpretations of seabed types based on seabed sediment reflectivity and multibeam echosounder maps. These maps were compared to the seabed physical attributes and habitat types described for the old alignment (CEE 2023, EIS/EES Technical appendix G: Benthic ecology).

Comparison of the XOCEAN (2023) multibeam seabed bathymetry for the new 2022 project alignment with that of the old 2019 project alignment shows similar physical characteristics for both alignments. Figure 7.2 shows these bathymetric features for the old and current alignments. While both alignments traverse predominantly sandy seabed, the new 2022 alignment avoids patches of rock outcrops whereas the old alignment intercepts a number of rock outcrops. These outcrop features were described by CEE (2023) as low-relief rock and cobble reef with coarse unconsolidated seabed, and some patches of low-lying bedrock may also be present.

The benthic biological communities associated with the four seabed habitat zones of the old 2019 project alignment as described by CEE (2023) are expected to be present at the project's new 2022 alignment, given the similar depth zonation of marine biological communities and these two areas being within the same bioregion.

Figure 7.3 shows four zones of seabed habitats and associated biological characteristics within Waratah Bay in nearshore Victoria. The four seabed habitat zones are based on seabed habitat surveys of the 2019 project alignment carried out by CEE (2023, EIS/EES Technical appendix G: Benthic ecology).



LEGEND

Seabed characterisation

- Reef
- Cobble
- Sand

Proposed route

- HVDC subsea cable
- Previous subsea cable
- Rocky outcrop

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N

SCALE 1:20,000

PAGE SIZE: A4

PROJECTION: GDA2020 MGA Zone 55

SOURCE
Proposed routes from Tetra Tech Coffey.
Seabed characterisation from CEE (2021).
2023 bathymetry from XOcean.
2019/2020 bathymetry from Fugro.
Imagery from ESRI Online.

MARINUS LINK PTY LTD

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EIS/EES

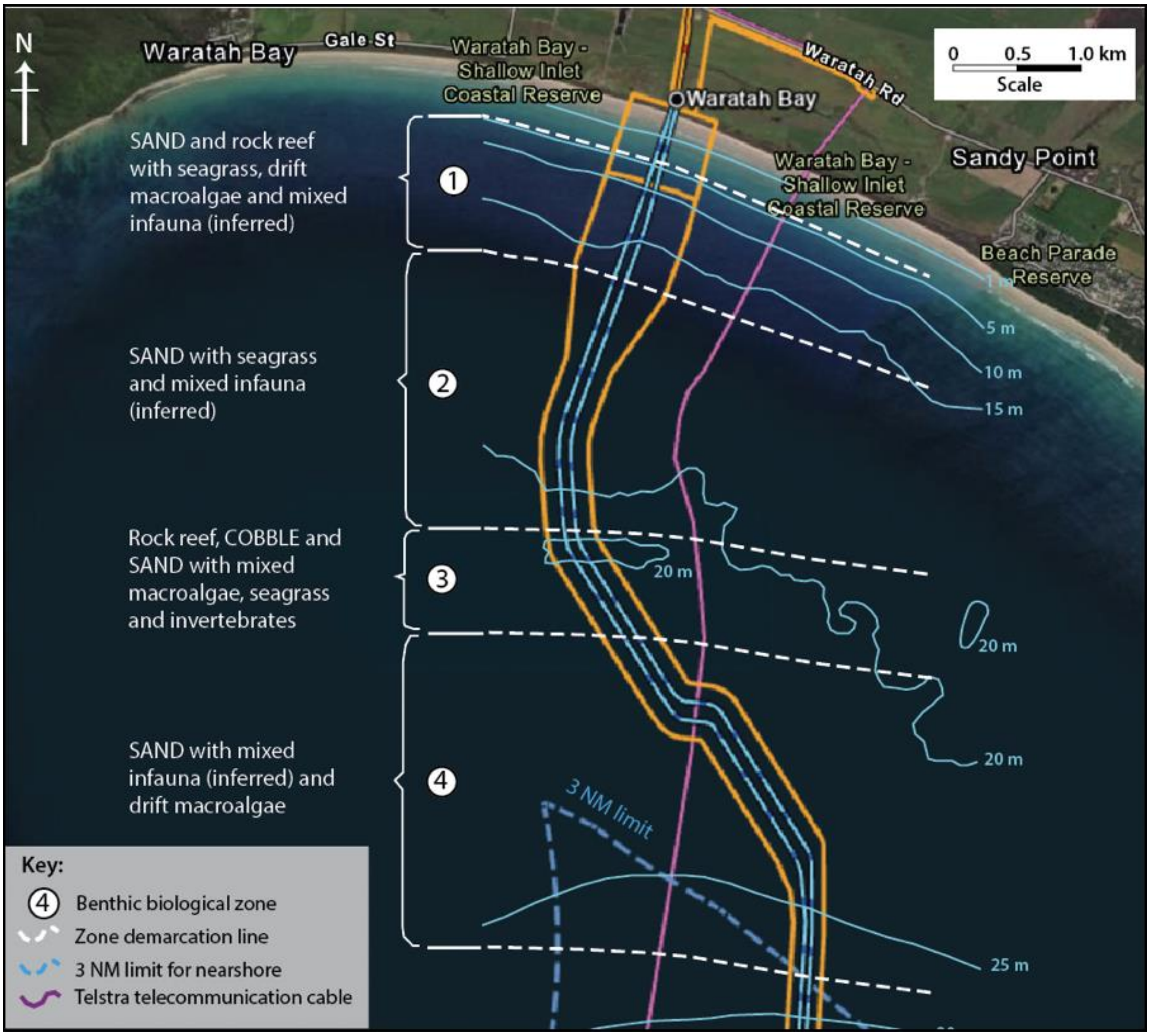
FIGURE 7.2

Seabed features at the new and former project alignments

TETRA TECH COFFEY

DATE: 19.12.23 PROJECT: 754-MELEN215878ML FILE: 215878ML_MERU_F007.2_GIS

SAVED BY: HELEN.JUNKOVICH 19.12.23 5:01 PM LAYOUT: 215878ML_MERU_F007.2_GIS_1



Source: GIS Webmap (Tetra Tech Coffey, 2022b). Red, orange, green and yellow dots represent main seabed habitat types and associated biological communities by CEE (2023; EIS/EES Technical appendix G: Benthic ecology).

Figure 7.3: Seabed habitat zones within Waratah Bay, nearshore Victoria

The cable installation and burial route lengths within each nearshore seabed habitat zone are given in Table 7-4. The lengths of the cable alignments between the onshore jointing pit (i.e., KP 0) to the 3 NM Victorian state limit (KP 8.2) is 8,200 m for both the western monopole (ML1) and the eastern monopole (ML2). However, the lengths of the cable alignments where cable installation and burial will take place for both ML1 and ML2 commence at the HDD marine exit holes at 10 m water depth (KP 0.8) to the 3-NM Victorian state limit is approximately 7,400 m. Table 7-4 presents the lengths of cable segments that will be buried within each of the seabed habitat zones that have been defined by CEE (2023, EIS/EES Technical appendix G: Benthic ecology) on the basis of seabed habitat types and their biological characteristics.

Table 7-4: Cable burial lengths in seabed habitat zones in nearshore Victoria (Waratah Bay)

Zone	KP	Cable burial length (m)	Seabed type	Main biological features
1	0.8 – 1.6	800	SAND with rock reef	Seagrass, drift macroalgae, and mixed infauna (inferred)
2	1.6 – 3.8	2,200	SAND	Seagrass and mixed infauna (inferred)
3	3.8 – 4.9	1,100	COBBLE and SAND with rock reef	Mixed macroalgae, seagrass, and mixed invertebrates
4	4.9 – 8.2	3,300	SAND	Mixed infauna (inferred) and drift macroalgae
Total		**7,400**	N/A	N/A

Source: Adapted from CEE (2023; EIS/EES Technical appendix G: Benthic ecology). Post lay cable burial lengths calculated by EnviroGulf. N/A not applicable. KP = Kilometre Point. .

Based on Table 7-4, the lengths of jet trencher-disturbed seabed habitat within nearshore Waratah Bay, for each of the ML1 and ML2 subsea bundled cables, are the same at around 7,400 m. Based on the surface trench width of 1.67 m, the areas of seabed sediments disturbed by cable wet jetting is 12,360 m^2 for each of the ML1 and ML2 bundled cables. Similarly, based on the two jet trencher's tracks (each 0.6 m wide), the potential seabed compaction area for each of the ML1 and ML2 cable routes traversed by the jet trencher is 8,880 m^2. The combined wet jetted trench surface disturbance area (12,360 m^2) and track compaction (8,880 m^2) gives a total seabed habitat disturbance area, for each of the ML1 and ML2 subsea cables, of 21,240 m^2 (about 2.1 ha). This represents an extremely small seabed habitat impact zone (0.02%) when compared to the very large area (about 88 km^2) of undisturbed nearshore seabed habitat of Waratah Bay between the 10 m isobath (i.e., HDD marine exit holes) and 27 m isobath (i.e., at the 3 NM limit) that extends laterally about 4 km to the west and 8 km to the east.

The predicted impacts of nearshore cable installation and burial on the seabed habitats within Waratah Bay are assessed to have a residual impact significance rating of ***Very low***. This is based on a nearshore sandy seabed habitat sensitivity of *Very low,* due to exposure to frequent natural sediment mobilisation and transport, and an impact magnitude of impact of *Negligible*, given the short-term impact of cable burial (about two days duration for wet jetting) and relatively very low areal extent of jet trencher-disturbed seabed habitats compared to the much larger area of undisturbed seabed habitats. Any depressions along the cable burial paths will be filled rapidly (within a few tidal cycles or days) as the natural movements of the seabed surface sediments restore the seabed to a natural pre-disturbance state in the shallow nearshore waters.

Cable burial sediment resuspension impacts on nearshore water quality

The principal water quality impacts relate to the wet jetting of soft-sediment seabed to allow cable installation and burial using the jet trencher as a burial tool. Impacts to water quality relate primarily to the development of wet-jetting turbidity plumes with increased suspended sediment concentrations (SSC), which will depend on the duration of wet jetting and the amount of very fine-grained sediments such as silts and clays (< 63 particle size fraction) that will be resuspended along the wet jetting track at point sources of active wet jetting. The speed of wet jetting progress that is typically between 500 to 1,000 m/h (OSPAR, 2012). However, Helix (2022) indicates that its Helix T-1200 jet trencher can undertake wet jetting through sands at a rate of 400 m/h and this progress rate has therefore been adopted in the present report.

As the jet trencher progresses along the seabed, water pumped via the water jet nozzles of the twin swords fluidises the sediments and the excess water rises and exits above the cable burial trench path. This excess water carries any disturbed fine-grained suspended sediment particles in the silt (4 to 63 µm particle diameter) and clay (2 to 4 µm particle diameter) size range into the overlying water column, causing short term increases in suspended sediment concentrations (SSC) and associated turbidity at the point of the active wet jetting operation. The wet jetting-generated turbidity plumes will travel in the direction of tidal and/or alongshore currents, with SSC reducing by settling of medium- to fine-grained sediment particles (deposition) with distance as well as by dilution as the plumes disperse down current. Background SSC (typically less than 2 mg/L) and turbidity (<5 NTU) are likely to be achieved within several kilometres down-current based conservatively on dredging sediment dispersal (Kim et al., 2018; PMSS, 2018).

A literature search on the impacts of cable burial by wet jetting on water quality indicated that this technique is 'environmentally friendly' as disturbances of the seabed sediments are kept at a minimum (EuropeCable, 2012). OSPAR (2012) considers that cable burial by wet jetting by means of sledge or ROV jet trencher involves the 'lowest environmental impacts' on water quality. Vise et al. (2008) notes that in those cases where cable burial is undertaken by wet jetting, if the jetting system only fluidises the seabed sediments to allow the cable to sink through it (as in the present project's case), the impact will be negligible, since there will be no significant sediment displacement. Notwithstanding, cable installation and burial in nearshore water quality are assessed below for nearshore Tasmania and nearshore Victoria.

Water quality impacts from cable burial sediment resuspension in nearshore Tasmania

Fugro (2020) observed that very fine-grained sediments, such as silts and clays (<0.63 µm particle size fraction), occurred in trace amounts and contributed less than 1% of the sampled size classes of sediments within the subtidal palaeochannels of nearshore Tasmania at Heybridge. This indicates that there is limited volume of very fine-grained sediment that can be mobilised during cable burial by wet jetting. At a jet trencher progression speed of 400 m/h (Helix, 2022), the durations of cable wet jetting operations for ML1 subsea cables (5,100 m long) and ML2 subsea cables (5,300 m long), in nearshore Tasmania, are 12.7 hours and 13.2 hours, respectively. These durations represent small periods within which nearshore water quality may be exposed to point source wet jetting-generated turbidity plumes as the jet trencher progresses along the project alignment.

The predicted impacts of sediment resuspension from nearshore cable installation and burial on marine water quality are assessed to have a residual impact significance rating of ***Low***. This is based on a nearshore water quality sensitivity of *High* given the good water quality in nearshore Tasmania (Section 6.2.3.1), and a magnitude of impact of *Negligible* given the relatively small quantities of resuspended fine-grained sediments (<63 µm particle size fraction) mobilised into the water column. The wet jetting generated turbidity plumes will disperse and dilute in the direction of prevailing tidal flows or longshore currents such that background SSC (<2 mg/L) and turbidity levels (<5 NTU) are likely to be achieved within a few kilometres down current, which is based conservatively on dredging turbidity plume modelling (Kim et al., 2018; PMSS, 2018).

The mouth of the Blythe River estuary is located 300 m from the nearest cable installation and burial location (i.e., the eastern monopole (ML2)), at which point the turbidity plumes will have already been diluted to low SSC concentrations prior to entering the estuary during flood tides only. Therefore, impacts on water quality of the Blythe River estuary could only arise during flood tides entering the estuary and carrying residual SSC from wet jetting, which will be further diluted and dispersed within the estuary resulting in lower SSC than in the nearshore waters. Given the high dilution rates as flood tidal water mixes with river water in the estuary, the predicted water quality impacts of turbidity and SSC on brackish water or freshwater flora and fauna, including the threatened ecological community of Temperate Coastal Saltmarsh located within this estuary, are assessed to have a residual impact significance rating of ***Low*** based on an estuarine water quality sensitivity of *High* given the good water quality in nearshore waters (Section 6.2.3.1) entering the estuary during flood tides, and a magnitude of impact of *Negligible* given the relatively small quantities of wet jetting resuspended fine-grained sediments (<63 µm particle size fraction) in the estuarine water column.

Water quality impacts from wet jetting disturbance of contaminated sediments in nearshore Tasmania are assessed separately below in Section 7.2.2.1.5.

Water quality impacts from cable burial sediment resuspension in nearshore Victoria

Fugro (2020) measured the particle size distribution of sediment samples from the sandy seabed of Waratah Bay (Zone 2 in Figure 7.2), along the path of the original 2019 project alignment. The sediment samples contained only 1% to 2% of silt and clay particles (<63 µm particle size fraction). It has been assumed that these percentage silt and clay values will also apply to the most recent 2022 project alignment, which is located within a similar depth range and at a maximum distance of 565 m to the west of the 2019 project alignment.

At the adopted jet trencher progression speed of 400 m/h (Helix, 2022), the duration of cable installation and wet jetting operations in nearshore Waratah Bay is 18.5 hours (or two days given that wet jetting will be carried out during daylight hours) for either the ML1 or ML2 subsea cables (both approximately 7,400 m long, see Table 7-4). This duration represents a very short period during which nearshore water quality may be exposed to point sources of wet jetting-generated turbidity plumes and SSC.

Given the small nearshore footprint of a cable installation (2.1 ha for either ML1 or ML2) and burial operation progressing at a rate of 400 m/h in sandy seabed and the limited quantities (1 to 2%) of fine-grained sediments (silts and clays) that may be mobilised into the water column, the predicted impacts of nearshore cable installation and burial on marine water quality are assessed to have a residual impact significance rating of ***Low***. This is based on a water quality sensitivity of *High*, given the long-term water quality data for nearshore Victoria (Section 6.2.3.3), and a *Negligible* magnitude of impact given the relatively small quantities of resuspended fine-drained sediments (<63 µm particle size fraction) mobilised into the water column. Any generated wet jetting turbidity plumes will disperse and become diluted in the direction of prevailing tidal flows or longshore currents such that background SSC (<2 mg/L) and turbidity levels (<5 NTU) are reached within several kilometres down current, which is based conservatively on dredging turbidity plume modelling (Kim et al., 2018; PMSS, 2018).

7.2.2.1.5 Cable installation and burial impacts on sediment quality and contaminant release

This section assesses the physico-chemical and ecotoxicological impacts of cable installation and burial disturbance of contaminated seabed sediments and the potential remobilisation of sediment particulate-bound and dissolved-phase contaminants such as metals and metalloids (hereafter referred to simply as 'metals').

In general, most seabed sediments along the project's proposed alignment are anticipated to be of good quality with concentrations of metals associated with uncontaminated seabeds and below sediment quality guidelines. Given this reasonable assumption, a program of sampling bed sediments across Bass Strait was considered unnecessary. A literature review did not reveal any industrial discharges or marine outfalls (current or historical) to Waratah Bay; therefore, seabed sampling to characterise background sediment quality of nearshore Victoria was not required. However, at the project's approach to landfall in nearshore Tasmania, historic discharges of treated wastewater from the former Tioxide Australia Plant (Heybridge) occurred via two offshore marine outfall pipelines (see Figure 6.8 for pipeline and marine outfall locations).

Based on the findings of Tetra Tech Coffey (2022; Attachment E), the area of observed seabed trace metal contamination is located primarily within the Tasmanian nearshore zone and possibly within adjacent offshore seabed beyond the 3 NM Tasmanian state limit. Therefore, for the purposes of assessment, impacts on seabed sediment quality by cable burial wet jetting in both the Tasmanian ML1 and ML2 nearshore palaeochannels, and their sand gutter extensions into the adjacent offshore seabed, have been included.

As outlined in section 7.2.2.1, impacts due to disturbance of acid sulfate soils are not predicted. Therefore, this section focusses on sediment quality contamination impacts due to disturbing sediment legacy metal contaminants of the Tioxide plant's historical waste discharges.

Potential impacts

The potential physico-chemical impacts by cable installation and burial on contaminated seabed sediments and sediment quality in general includes:

- Disturbance of surficial and deeper sediments with turbulent vertical mixing of sediment horizons (of varying particle sizes and trace metal content) with wet jetting.
- Release of sediment contaminants (particulate-associated and dissolved trace metals) to the overlying water column and down-current dispersal to the adjacent marine environment.
- Residual impacts of altered sediment and water quality to benthic biological communities.

Environmental performance requirements

The proposed EPR for cable installation and burial impacts on sediment quality and contaminant release is presented in Table 7-5:

Table 7-5: EPR for location of subsea cables

EPR ID	Environmental performance requirement	Project stage
MERU04	**Minimise impacts from disturbing contaminated sediments around the disused tioxide pipeline.** Prior to commencement of marine construction that could disturb contaminated sediments associated with the disused tioxide pipeline of the former tioxide factory at Heybridge, Tasmania, measures must be developed and documented in a sub-plan the CEMP to manage the release of contaminated sediments during construction activities (e.g., wet jetting operations) in the palaeochannels and gutters in the Tasmanian nearshore and offshore waters. These measures should also manage the release of surface sediment contaminants if the tioxide pipeline, currently exposed and resting on the seabed, is to be removed, cut or collapsed during construction.	**Construction**

Potential mitigation and management measures

Potential mitigation and management measures depend on the magnitude of potential impacts and the construction methods adopted by the contractor. For the purposes of assessing potential impacts on benthic biological communities, predicted residual impacts of changes in sediment quality and the potential release of sediment-associated and dissolved trace metals have been compared to the Australian and New Zealand marine sediment quality guidelines (ANZG, 2018b) and marine water quality guidelines (ANZG, 2018a), respectively. These guidelines act as references for characterising existing sediment metal concentrations and existing dissolved phase metal concentrations in receiving seawater, as well as for assessing levels, above or below, at which biological effects may occur.

The ANZG (2018b) sediment quality guidelines provide:

- Default guideline values (DGVs), which provide an indication of the concentrations below which there is a low risk of biological effects occurring.
- Upper guideline values (GV-high), which provide an indication of concentrations at which toxicity related effects would be expected.

At concentrations between the DGV and GV-high, toxicity related effects may occur, but further investigations would typically be recommended to investigate the risks of biological effects occurring. The ANZG (2018b) sediment quality guidelines are presented in Table 5-7 in Section 5.3.3.2.

Predicted residual impacts

Cable burial disturbances of contaminated seabed by wet jetting has the potential to release both particulate and dissolved phase metals, which have been assessed below for the nearshore Tasmanian sand-filled palaeochannels and their sand gutter extensions within the offshore seabed.

Cable burial impacts on total metal contaminant release in Tasmania

A sediment quality field investigation of the Tasmanian seabed near Heybridge was undertaken by Tetra Tech Coffey (2022; Attachment E). This provided consistent findings to previous investigations of marine sediment contamination near Heybridge (CSIRO, 1990) and that residual trace metal contamination was still present within the surficial and deeper sediments layers in the vicinity of the marine outfalls from the Tioxide Australia plant.

The sediment sampling site locations of Tetra Tech Coffey (2022) are shown in Figure 6.8 (see Section 6.2.4.2.1 (Existing sediment quality in nearshore Tasmania). Existing surficial trace metal concentrations in the less than 2,000-µm size fraction are given in Table 6.6, and existing trace metal concentrations at different depths are given in Table 6.7.

Particle size distribution followed a similar trend across most of the sediment sampling sites, with sediments being dominated by sand (0.05 to 2 mm) and gravel (>2 mm to <6 cm), and with trace silt (<2 µm) and clay (2 to 63 µm) content. Sediment metal concentrations were determined on the <2,000 µm size fraction of sediment samples to allow direct comparison with the ANZG (2018b) sediment quality guidelines, which are based specifically on this size fraction. The sediment survey indicated that trace metal contamination was still present 27 years after the marine discharges ceased in August 1996.

Based on existing sediment quality, only the two metals (nickel and chromium) and one metalloid (arsenic) were of potential ecotoxicological concern if disturbed and dispersed by the project's proposed wet jetting operations. In terms of seabed sediment, total chromium concentrations in only two sediment subsamples, out of the 28 subsamples analysed, were slightly above the DGV of 80 mg/kg for total chromium and neither exceeded the GV-high of 370 mg/kg. Therefore, total chromium concentrations of sediment have not been considered further. Potential sediment quality impacts relating to total arsenic and total nickel are assessed below.

Wet jetting remobilisation of total arsenic

In general, total arsenic concentrations in uncontaminated nearshore marine and estuarine sediments fall in the range from 5 to 15 mg/kg (Moore and Ramamoorthy, 1984), whereas the average concentration of total arsenic in deep-sea sediments is about 40 mg/kg (Bostrom and Valdes, 1969), which is twice the ANZG (2018b) total arsenic DGV of 20 mg/kg.

The sand-filled western palaeochannel has a high content of sands and gravels, which indicates a high porosity and permeability. For natural sands, depending on size, sorting, and packing, porosity may range 20-50% by volume, with a mean around 37% by volume for well sorted sands (McLachlan and Turner, 1994). In addition, well sorted coarse sands have the highest permeabilities and poorly sorted fine sands the lowest (McLachlan and Turner, 1994).

The depth profiles within the palaeochannels and their sand gutter extensions in the adjacent offshore seabed are expected to be fully aerobic to the deepest penetration of the jet swords of 1.2 m, which is based on the following observations from the scientific literature:

- Subtidal mobile sands are typically sufficiently oxygenated to several metres in coarse sand (Eagle, 1983).
- Sandy sediments are dynamic permeable environments and are characterised by advective porewater flow (Marchant et al., 2017).
- Water movement above the rippled sandy sediments forms pressure gradients pumping water rich in oxygen into the sediment (Huettel et al., 2003).

Given the presence of coarse sands (range 37 to 82%) and high gravel content (10 to 47%) of seabed sediments at sampling site SED-W4, in the western palaeochannel, the sediment depth profile of 1.2 m penetrated by the jet swords during cable burial is anticipated to be fully aerobic (i.e., in the presence of oxygen). The presence of an anaerobic (i.e., in the absence of oxygen) layer is expected to be greater than the 1.2 m penetration depth of the twin jet swords.

The inorganic forms of total arsenic in the sand-filled palaeochannels and their sand gutter extensions will be the less toxic arsenate (As V), which is the dominant form in aerobic seabed sediments and is associated primarily with iron oxyhydroxides. In anaerobic or reducing marine sediments, arsenate is reduced to the more toxic arsenite (As III) and is associated primarily with sulfide minerals (Neff, 1996; 2002). However, anerobic conditions are not expected to occur within the sandy sediments of the palaeochannels and their gutter extensions; hence arsenite (As III) is likely to be a minor form of the total arsenic in the sediments.

Predicted total arsenic impacts in the western palaeochannel

In the western palaeochannel, sediment sampling showed elevated concentrations of total arsenic at sites SED-W1 (ranging from 14 to 34 mg/kg), SED-W4 (ranging from 24 to 43 mg/kg) and SED-W5 (ranging from 17 to 21 mg/kg). At all three sites, the total arsenic concentrations exceeded the DGV of 20 mg/kg for total arsenic, which indicates that sediment infauna (if present) would be exposed to total arsenic concentrations that pose a risk of biological effects occurring. However, no western palaeochannel sediment samples exceeded the GV-high for total arsenic of 70 mg/kg, which provides an indication of total arsenic concentrations at which toxicity related effects would be expected (ANZG, 2018b). For the purposes of assessing the impacts of arsenic-contaminated sediment mobilised by wet jetting, sediment sampling site SED-W4 has been selected as a worst-case scenario for total arsenic contamination within the western palaeochannel and its sand gutter extension.

Table 7-6 shows the total arsenic concentrations with sediment depth and sediment particle size distribution within the three subsampled sediment horizons. Table 7-6 shows the Total arsenic concentrations and sediment grain size with depth at site SED-W4

Table 7-6: Total arsenic concentrations and sediment grain size with depth at site SED-W4

Subsample depth (m)	Total arsenic (mg/kg d.w.)	Percentage solids in each sediment fraction			
		Clays (<2 µm)	Silts (2–63 µm)	Sands (63 µm to 2 mm)	*Gravels (>2 mm
0.0–0.2	**43**	7	1	82	10
0.4–0.6	**25**	7	5	75	13
0.8–1.0	**24**	7	9	37	47

Source: Tetra Tech Coffey, 2022; Attachment E. * Gravels are included in the table for completeness but were excluded from total arsenic analysis as they exceed the <2,000 um size fraction used for comparison to the ANZG (2018b) sediment quality guidelines. Values in bold are above the DGV of 20 mg/kg for total arsenic.

Site SED-W4 is located 240 m to the northeast of the marine outfall of Tioxide Australia's longer seabed pipeline (see Figure 6.8), which may partially explain seabed sediments at this site having the highest total arsenic concentrations of all the western palaeochannel sediment sampling sites. At site SED-W4, the average total arsenic concentrations decreased with depth having a concentration of 43 mg/kg in the 0.0–0.2 m depth horizon, 25 mg/kg in the 0.4–0.6 m depth horizon and 24 mg/kg in the 0.8–1.0 m depth horizon. During wet jetting operations for cable burial, the fluidisation of the full depth of sediments penetrated by the twin jet swords will mix sediment particles from the different depth horizons, such that the average total arsenic concentration in the mixed sediments due to turbulence at the surface of the trench (due to the upward flow of pumped water) is calculated to be approximately 31 mg/kg. This average is based on proportioning the concentrations of total arsenic in the sediment horizons using an arbitrary core radius of 10 cm and using the volume of a cylinder ($\pi r^2 h$) for each sediment horizon.

At the natural bed, sediment surface of the wet jetting operation, both fine-grained sediments (silts and clays) and diluted sediment pore waters, will disperse and dilute in the direction of prevailing bottom currents. Fine sands and coarse silts containing particulate phase arsenic (31 mg/kg) will deposit on the adjacent down-current seabed and mix with natural seabed sediments that are lower in total arsenic concentrations. A minimum 0.65-fold dilution in the receiving natural seabed surface sediments is required to reduce the total arsenic concentration in mixed sediments to below the DGV of 20 mg/kg (ANZG, 2018b) with a low risk of biological effects occurring.

Overall, the predicted impacts of wet jetting operations and disturbance of total arsenic-contaminated seabed sediments in the western palaeochannel are predicted to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *Moderate,* due to the existing residual total arsenic contamination of the palaeochannel sediments, and a magnitude of impact of *Minor*, given that sediment disturbance is highly localised to the wet jetting disturbance area within the western palaeochannel, where displaced coarse-grained sediment particles rapidly settle out. In addition, the very low content of clays (7%) and silts (range 1–9%) at site SED-W4 and at other sediment sampling sites, indicates that total arsenic concentrations in fine-grained sediments, present in point source wet trenching turbidity plumes, will disperse and be diluted in the direction of prevailing currents, where they will mix with natural sediments upon deposition.

Predicted total arsenic impacts in the eastern palaeochannel

In the eastern palaeochannel, sediment sampling sites showed elevated concentrations of total arsenic at sites SED-E3 (range 19 to 29 mg/kg), SED-E4 (range 26 to 49 mg/kg) and SED-E5 (range 43 to 108 mg/kg). At all three sites, the total arsenic concentrations exceeded the DGV of 20 mg/kg for total arsenic, which indicates that sediment infauna (if present) would be exposed to total arsenic concentrations that pose a risk of biological effects occurring. Both the deeper sediment concentrations of 103 mg/kg and 108 mg/kg at site SED-E5 exceeded the GV-high of 70 mg/kg for total arsenic, which indicates that sediment infauna (if present) would be exposed to total arsenic concentrations at which toxicity related effects would be expected.

For the purposes of assessing the impacts of total arsenic-contaminated sediment, mobilised by wet jetting, sediment sampling site SED-E5 has been selected as a worst-case scenario for total arsenic contamination within the eastern palaeochannel and its sand gutter extension. Table 7-7 shows the total arsenic concentrations with sediment depth and sediment particle size distribution within the three subsampled sediment horizons for site SED-E5.

Site SED-E5 is located 1.6 km to the northeast of the marine outfall of Tioxide Australia's longer seabed pipeline (see Figure 6.8). At site SED-E5, the average total arsenic concentrations increased with sediment depth from 43 mg/kg (0.0–0.2 m depth horizon), through 103 mg/kg (0.4–0.6 m depth horizon), to 108 mg/kg (0.8–1.0 m depth horizon). During wet jetting operations for cable burial, sediment from different depth horizons (to the full depth penetrated by the twin jet swords) will mix. The average total arsenic concentration in the mixed sediments is calculated to be above approximately 85 mg/kg, due to turbulence within the wet-jetted trench and upward flow of pumped water escaping at the seabed-overlying water interface. This calculation is based on the same approach as used above for total arsenic in the western palaeochannel.

Table 7-7: Total arsenic concentrations and sediment grain size with depth at site SED-E5

Subsample depth (m)	Total arsenic (mg/kg d.w.)	Percentage solids in each sediment fraction			
		Clays (<2 µm)	Silts (2–63 µm)	Sands (63 µm to 2 mm)	*Gravels (>2 mm
0.0–0.2	**43**	3	8	46	43
0.4–0.6	103	7	10	42	41
0.8–1.0	108	8	12	24	56

Source: Tetra Tech Coffey, 2022; Attachment E. Values in bold represent exceedance of the DGV. Shaded cells represent exceedance of the GV-high. *Gravels are included in the table for completeness but were excluded from total arsenic analysis as they exceed the <2,000 um size fraction used for comparison to the ANZG (2018b) sediment quality guidelines.

A highly localised area of coarse sediment deposition with total arsenic concentrations above 85 mg/kg will contaminate the existing surface sediment in the vicinity of the wet jetting operations. This results in a small area of disturbed mixed coarse-grained sediment deposits with total arsenic concentrations exceeding the GV-high of 70 mg/kg for total arsenic above which toxicity related effects would be expected (ANZG, 2018b).

Fine sands and coarse silts containing an average total arsenic concentration of 85 mg/kg will deposit on the adjacent down-current seabed and mix with natural seabed sediments that are lower in total arsenic concentrations. However, total arsenic in silts and clays (<63 µm particle size fraction) will disperse and dilute in the direction of prevailing tidal flows or longshore currents and reduce to low levels, such that any deposited trench-sourced silts and clays containing total arsenic will admix with natural sediments. Tetra Tech Coffey (2022) (Attachment E: Tioxide sediment analysis report) measured a total arsenic concentration of 43 mg/kg in the <63 µm sediment size fraction (i.e., silts and clays) for the whole of the SED-E5 core depth (i.e., 0-1m). A minimum dilution of 2.1-fold in the receiving natural seabed surface sediments, will reduce the total arsenic concentrations in the settled silts and clays as they mix with natural surface sediments to levels below the ANZG DGV of 20 mg/kg where there is a low risk of biological effects occurring (ANZG, 2018b).

Overall, the predicted impacts of wet jetting operations and disturbance of seabed sediments in the eastern palaeochannel contaminated with arsenic are predicted to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *Moderate*, due to the existing residual arsenic contamination of the palaeochannel sediments, and a magnitude of impact of *Minor*, given the fact that sediment disturbance is highly localised to the wet jetting disturbance area within the eastern palaeochannel, where displaced coarse-grained sediment particles rapidly settle out. However, elevated total arsenic concentrations were reported at site SED-E5, that also observed a relatively higher content of combined clays and silts (up to 20%) in the sediment core. These fine-grained sediments present in wet trenching turbidity plumes will disperse over a greater distance and mix with natural surface sediments after settling. While a larger area of seabed may be impacted by the settling of wet jetting-disturbed fine-grained sediments with elevated total arsenic concentrations, subsequent mixing of seabed surface sediments in the high-energy hydrodynamic environment of the Tasmanian nearshore and adjacent offshore seabed is anticipated to readily reduce total arsenic concentrations in affected surficial sediments to levels below the total arsenic DGV of 20 mg/kg below which there is a low risk of biological effects occurring (ANZG, 2018b).

Wet jetting remobilisation of total nickel

Total nickel was the other primary metal contaminant associated with the Tioxide Plant's historic treated waste discharges to the Tasmanian nearshore environment off Heybridge. Wet-jetting remobilisation of total nickel has been assessed separately for the western palaeochannel (ML1) and the eastern palaeochannel ML2).

Predicted total nickel impacts in the western palaeochannel

Nine out of the 28 total sediment subsamples analysed had total nickel concentrations above the DGV of 21 mg/kg, including two subsamples that also exceeded the GV-high of 52 mg/kg (ANZG, 2018b). Only two out of the 28 total subsamples analysed showed total nickel concentrations above the GV-high guideline of 52 mg/kg including one from the western palaeochannel (SED-W5) reporting a concentration of 147 mg/kg in the 0.4–0.6-m depth horizon and one from the eastern palaeochannel (SED-E5) reporting a value of 109 mg/kg in the 0.8–1.0-m depth horizon. While these higher total nickel concentrations may be an anomalous, they are consistent in that they are associated with deeper sediment layers where the sediment sampling sites are close to the locations of the Tioxide Australia marine pipeline outfalls.

The sediment sampling site showing the highest nickel contamination was sediment sampling site SED-E5 in the eastern palaeochannel Figure 6.8, which has been used as a worst-case scenario. Table 7-8 shows the total nickel concentrations, sample depth, and sediment particle size distribution within the three subsampled sediment horizons for site SED-E5.

Table 7-8: Total nickel concentrations and sediment grain size with depth at site SED-E5

Subsample depth (m)	Total nickel (mg/kg d.w.)	Percentage solids in each sediment fraction			
		Clays (<2 µm)	Silts (2–63 µm)	Sands (63 µm to 2 mm)	*Gravels (>2 mm
0.0–0.2	**27**	3	8	46	43
0.4–0.6	**52**	7	10	42	41
0.8–1.0	109	8	12	24	56

Source: Tetra Tech Coffey, 2022; Attachment E. Values in bold represent exceedance of the DGV. Shaded cells denote exceedance of the GV-high. Gravels are included in the table for completeness but were excluded from total nickel analysis as they exceed the <2,000 um size fraction used for comparison to the ANZG (2018b) sediment quality guidelines.

Site SED-E5 is located 1.6 km to the northeast of the marine outfall of Tioxide Australia's longer seabed pipeline (see Figure 6.8). At site SED-E5, the average total nickel concentrations increased with sediment depth from 27 mg/kg (0.0–0.2 m depth horizon), 52 mg/kg (0.4–0.6 m depth horizon), and through to 109 mg/kg (0.8–1.0 m depth horizon). During wet jetting operations for cable burial, the fluidisation of the full depth of sediments penetrated by the twin jet swords will mix sediment particles from the different depth horizons, such that the average total arsenic concentration in the mixed sediments due to turbulence within the wet jetted trench and at the surface of the trench (due to the upward flow of wet jetting pumped water) is calculated to be approximately 63 mg/kg.

At the natural bed, sediment surface of the wet jetting operation, a highly localised area of coarse sediment deposition, with a calculated average total nickel concentration of 63 mg/kg, will contaminate the existing surface sediments in the vicinity. This results in a very small area of disturbed mixed coarse-grained sediment deposits with total nickel concentrations exceeding the GV-high of 52 mg/kg for total arsenic (ANZG, 2018b), which are at concentrations above which toxicity related effects would be expected.

Fine sands and coarse silts containing elevated particulate phase arsenic (63 mg/kg) will deposit on the adjacent down-current seabed and mix with natural seabed sediments that are low in total nickel concentrations. A minimum dilution of three-fold in the receiving natural seabed surface sediments, will reduce the total nickel concentration in mixed sediments to below the ANZG (2018b) DGV of 21 mg/kg, resulting in a low risk of biological effects occurring.

Overall, the predicted impacts of wet jetting operations and disturbance of seabed sediments in the eastern palaeochannel contaminated with nickel are predicted to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *Moderate,* due to the existing residual nickel contamination of the eastern palaeochannel sediments, and a magnitude of impact of *Minor*, given that sediment disturbance is highly localised to the site of wet jetting, where displaced coarse-grained sediment particles rapidly settle out. Contaminated fine-grained sediments (e.g., silts and clays) will be transported down current in any wet jetting turbidity plumes and settling at distance from the wet jetting path.

Cable burial impacts of dissolved metal contaminant release in Tasmania

During wet jetting operations for cable installation and burial in soft-sediment seabed within nearshore Tasmania, contaminated sediments in the vicinity of the two former Tioxide marine outfalls are likely to be disturbed and re-suspended. The primary sediment contaminants are arsenic and nickel (see Section 6.2.4.2.1). Remobilisation of these sediments will also mobilise sediment pore water with elevated concentrations of dissolved metals.

Sediment pore water contaminants were not analysed. However, since the sediments near the Tioxide marine pipeline outfalls are contaminated by arsenic and nickel, the dissolved phases of these contaminants in the pore waters are expected to be in equilibrium with the particulate (i.e., sediment-bound) phase, and therefore elevated with respect to concentrations in natural seawater.

Potential disturbance of contaminated seabed sediments in nearshore Tasmania has been conservatively assessed for the most contaminated sampling site of SED-E5 (see Section 6.2.4.2.1), where the concentrations of total arsenic and total nickel exceed the ANZG (2018b) GV-High values of 70 mg/kg and 52 mg/kg dry weight, respectively (see Table 6-7 and Figure 6.9).

At SED-E5, the average sediment sample particle size was 46% gravel (>2 mm), 37% sand (0.06–2 mm), 10% silt (2–60 μm) and 6% clay (<2 μm). This seabed type may be characterised as a "poorly graded gravel, sandy gravel, with little fines", which would typically have a void ratio range between a minimum of 0.26 to a maximum of 0.46 (Geotech Data, 2023). The void ratio is the volume of space (i.e., pore water) in a sediment (such as sand or gravel) that is not occupied by particles. Given that seabed sediments are likely to be tightly packed due to settling over time, an average void ratio of 0.3 has been assumed. Therefore in 1 m^3 (~1,000 L) of the prevailing sediment at SED-E5, the pore water volume (containing dissolved metal contaminants) would be approximately 300 L.

The proposed cable wet jetting burial method using a HELIX T-1200 trencher has a water pressure rating of 3 bar, which pumps 458 L/s into the sediment via its twin water-jet swords. Wet jetting to a burial depth of 1 m, an average width of 1 m and travelling for a horizontal distance of 1 m, gives a total wet jetted sediment volume of 1 m^3 (~1,000 L). Since the jet trencher moves at a speed of 400 m/h or 0.11 m/s, it will take the jet trencher about nine seconds to travel the 1-m horizontal distance. The wet jetting water volume over nine seconds will be 4,122 L (i.e., based on an assumed water jet pump rate of 458 L/s multiplied by 9 (duration of nine seconds)), which dilutes the pore water volume of 300 L by approximately 14-fold by the time the wet jet pumped water admixed with pore water leaves the 1-m long cable burial segment at the seabed surface.

The abovementioned initial 14-fold dilution of sediment pore water will disperse down current and become progressively more dilute with increasing distance as it further admixes with seawater. The literature was searched for examples of hydrodynamic modelling of disturbed seabed sediments. A study by Corell et al. (2023) investigated the fate of fine-grained seabed sediments resuspended from a trawling track in the Baltic Sea. Turbidity meters fitted to trawls showed an average turbidity of 500 FNU[8], which was converted by Corell et al. (2023) to a suspended sediment concentration (SSC) of about 1,000 mg/L using the approximation SSC = 2 x FTU. Bottom currents in the Baltic Sea study area are around 0.05 m/s (Bruun, 2020), which compares with the median bottom current velocity of 0.11 m/s (Fugro, 2020) for current flows within the 15 m water depth at the tioxide sediment sampling sites in nearshore Tasmania. The median bottom current in nearshore Tasmania is about two-fold higher than that of bottom currents in the Baltic Sea. In the Corell et al. (2023) study, down-current dilutions of the initial turbidity plume (SSC of 1,000 mg/L) were 25 mg/L at 500 m (i.e., 40-fold dilution), 15 mg/L at 750 m (i.e., 66-fold dilution), 10 mg/L at 1,000 m (i.e., 100-fold dilution), and 5 mg/L at 1,500 m distance (i.e., 200-fold dilution). There are differences in disturbed seabed particle size categories between the Baltic Sea study and the sediments at SED-E5, with the trawled sediment containing 46% fine silt/clay (<63 μm fraction) and SED-E5 containing an average

[8] FNU denotes a Formazin Nephelometric Unit that is equivalent to a Nephelometric Turbidity Unit (NTU) used in this report in that both measures scatter light at 90 degrees from the incident light beam, but the FNU is measured with an infrared light source whereas the NTU is measured with a white light source.

of 16% fine silt/clay (<63 μm fraction). Also, the median current velocity at the SED-E5 sampling site was twice that of the Baltic Sea study by Corell et al. (2023). Notwithstanding these differences in conditions, the Baltic Sea study provides an indication of typical dilutions in marine waters with distance down current.

Given the initial 14-fold dilution of sediment pore water at sampling site SED-E5 and, based on the Corell et al. (2023) study, a further dilution in the order of 100-fold at about 1 km down current gives a total dilution of 1,400:1 of sediment pore water within about 1 km.

The initial dilution of dissolved metals (arsenic and nickel) will occur as the pumped wet jetting seawater vertically admixes with the sediment pore waters and secondary dilution will occur as the turbidity plume containing dissolved metals is further diluted as it mixes with overlying bottom waters in nearshore Tasmania and disperses down current. The turbidity plumes are expected to initially be confined to bottom waters as the wet jetting water temperature will be about the same as that of the overlying bottom water and the sediment pore water. In general, vertical mixing in the receiving environment results from temperature differences. As currents typically induce turbulence, this encourages vertical mixing in the receiving marine environment giving rise to additional dilution of the turbidity plume as it mixes with seawater and reduces any residual dissolved metal concentrations.

Arsenic in sediment may occur in two oxidation states (As (III) and As (V). As (III) predominates in reduced marine environments (pH <6) and As (V) predominates in oxic marine environments (Sadiq, 1990). Therefore, As (V) species (arsenates) will be the most abundant form in the contaminated sediments and bottom waters in the vicinity of the tioxide pipeline in nearshore Tasmania. For example, arsenate species in coastal waters of South Australia constituted more than 97% of the total arsenic (Maher, 1985).

Fate of dissolved arsenic

During wet jetting, any mobilised anionic forms (negatively charged) of arsenic will be readily adsorbed onto the surface of hydrous iron oxides and form stable (least soluble) arsenate. This adsorption by hydrous iron oxides will further reduce the concentrations of dissolved arsenic species, which is in addition to the large dilutions arising from wet jetting pumped water and dilution in the receiving marine environment.

Fate of dissolved nickel

Dissolved nickel is present in seawater as a hydrated divalent Ni(II) cation (positively charged), which adsorbs strongly onto manganese oxides via structural incorporation and replacement of manganese (Peacock and Sherman, 2007). Nickel behaviour in pore waters is distinct from most other trace metals as it is largely unaffected by redox conditions (Jacobs and Emerson ,1982).

Predicted impact of remobilised dissolved metals

Overall, the predicted impact of remobilised dissolved metals during cable installation and burial by wet jetting has been assessed to have a significant impact rating of ***Low***. This is based on a water quality sensitivity of *High* given the good quality data in nearshore Tasmania (see Section 6.2.3.1), and a magnitude of impact of *Negligible* The negligible magnitude of impact is based on the very short duration of wet jetting at any one point along the wet jetting path and the brief and localised area where fauna will be exposed to elevated dissolved metal concentrations prior to admixing with seawater and becoming highly diluted. It is expected that due to the short term and transient disturbance of contaminated sediments, any brief exposure of elevated dissolved metal concentrations to marine fauna will not result in chronic toxicity or bioaccumulation.

Cable installation and burial impacts on benthic flora and fauna

Cable installation and burial impacts of wet jetting on seabed flora and fauna in nearshore Tasmania and Victoria are assessed below.

Cable installation and burial impacts on seabed flora and fauna in nearshore Tasmania

As described above for impacts on seabed habitats (Section 7.2.2.1.3, Cable lay impacts on nearshore seabed), the total areas of seabed disturbance from cable installation and burial are 14,640 m^2 for ML1 in the western palaeochannel, and 15,210 m^2 for ML2 in the eastern palaeochannel. The disturbance of seabed habitats in the western channel represents 9.5% of its total seabed area of 153,000 m^2, while disturbance of seabed habitats in the eastern palaeochannel represents 14.4% of its total seabed area of 106,000 m^2. These jet trencher-disturbed areas represent small seabed habitat impact zones within the palaeochannels.

The palaeochannels and their sand gutter extensions within the nearshore Tasmania at Heybridge are comprised mainly of relatively bare, mobile, medium to coarse sand and shell, with no surface-associated biological communities visible in either the 2019 or 2021 surveys (CEE, 2023; EIS/EES Technical appendix G: Benthic ecology). Notwithstanding, a low diversity and abundance of benthic fishes, macroinvertebrates and infauna are inferred to be present in the sand-filled palaeochannels. The jet trencher used for cable installation and burial impacts is expected to mainly displace benthic fish and the more mobile benthic fauna such as bottom-living fishes and crabs, as it moves along the paths of the two palaeochannel project alignment. Sessile macroinvertebrates or low mobility macroinvertebrates such as molluscs, sea cucumbers, starfishes and sea urchins may be buried during wet jetting or crushed by compactions under the jet trencher’s twin caterpillar leading to mortality.

Burrowing macroinvertebrates such as *polychaete* worms that are inferred to be present in the palaeochannels, will be displaced by the upward flow of pumped jet waters, also resulting in some mortalities due to the cutting action of the high-power water jets. Buried burrowing benthic macroinvertebrates have the capability to burrow out the wet-jetted trenches or any lateral surface sediment deposits created along the path of the wet-jetted trench, but this will depend on the depth of burial.

Observations from seabed habitat surveys following cable installation and burial by wet jetting in soft seabed sediments indicate that restoration is fastest where cables are buried in zones of high sediment supply and energetic waves and/or bottom currents (Kraus and Carter, 2018), such as the palaeochannels in nearshore Heybridge. Krause and Carter (2018) found that the physical recovery from cable burial varies with sediment supply, wave/current action, and mode of cable burial. The results from environmental monitoring of the impacts of cable burial in medium to coarse sand seabed in nearshore Victoria (near McGaurans beach) for the Basslink Project revealed that, after seven months, the post lay cable trench was visible in only three of the twelve transects as a shallow depression with accumulated drift material but there was no visible disturbance to the seabed in the other transects (Chidgey et al., 2006). A similar scenario is anticipated to occur for the cable buried in sandy seabed in nearshore Tasmania.

Based on the above observations and given the presence of coarse sands and cobble patches in the nearshore Tasmanian palaeochannels, the seabed habitats along the path of wet-jetted trench are anticipated to be restored to natural seabed surface within a few days or weeks. The diversity and population densities of palaeochannel benthic macroinvertebrates and sediment infauna in the disturbed wet jetted benthic habitats are expected to recover within six months to a year mainly through natural recruitment from unimpacted sediments within palaeochannels and in-migration from adjacent sandy areas, within low- and high-profile reefs, rubble or rock platforms that surround the palaeochannels.

Overall, the predicted impacts of wet jetting operations on both benthic macroinvertebrates and sediment infauna are assessed to have a residual impact significance rating of ***Very low***. This is based on a sandy seabed benthic community sensitivity of *Very low,* and a magnitude of impact of *Negligible,* given the small areas of impacted seabed benthic communities within larger areas of non-impacted seabed habitats and associated benthic communities of the palaeochannels. The prediction of residual impacts has high confidence given the small areas of jet-trenching disturbed habitat and inferred benthic macroinvertebrate and sediment infauna, which are widely represented in the nearshore environment and the Tasmanian north coast and Boags bioregion. No threatened species were identified in the Tasmanian nearshore underwater video surveys along the alignments.

Cable installation and burial impacts on seabed flora and fauna in nearshore Victoria

Figure 7.2 shows the four nearshore zones that will be crossed by the jet trencher during post lay burial of the ML1 and ML2 subsea bundled cables, both of which have an as-laid length of approximately 7,400 m. As noted above under impacts of cable installation and burial on nearshore Victorian seabed habitats, the combined total disturbance areas for the burial of the ML1 and ML2 bundled cables are each 21,240 m^2 (around 2.1 ha). This total combined wet jetting and caterpillar track disturbance area represents an extremely small seabed habitat impact zone of 0.02% when compared to the very large area (88 km^2) of similar undisturbed seabed habitat along the north coast of Waratah Bay that extends laterally to the west for about 4 km and to the east for about 8 km.

Within the Victorian nearshore, the 7,400-m long paths of the wet jetting operation will disturb mainly low biodiversity sandy seabed habitats with sparse seagrass, drift macroalgae, and mixed infauna (zones 2 and 4 in Table 7-4). Video surveys of the seabed habitats in nearshore Waratah Bay indicated that benthic macroinvertebrates were rarely visible and sediment infauna were inferred (CEE, 2023). However, cable installation and burial will also pass through a 1,100 m wide band of cobble and sand seabed (Zone 3 in Table 7-4) that runs parallel to the coastline, which has a greater biodiversity (CEE, 2023) and provides hard substrate for macroalgal attachment and habitat for seagrasses and mixed benthic macroinvertebrate assemblages.

The predicted impacts of post lay cable installation and burial in nearshore Waratah Bay on benthic fauna are assessed to have a residual impact significance rating of ***Very low***. This is based on a sandy seabed benthic community sensitivity of *Very low,* due to the high-hydrodynamic nearshore environment (e.g., natural sediment mobility and sand ripples), and a magnitude of impact of *Negligible,* given the very small areas of impacted benthic communities within larger but similar areas of non-impacted seabed habitats. The very low sensitivity of benthic flora and fauna arises from the fact that many species present within Waratah Bay are also widely distributed within the Central Victoria, Flinders, and Two Shelf marine bioregions. In addition, most benthic flora and fauna are well adapted to elevated suspended sediment concentrations, and periodic sand resuspension and redeposition.

The only threatened species present in Waratah Bay is the Tasman grass-wrack (*Heterozostera tasmanica*), which is an eelgrass, listed as *Endangered* under the FFG Act. This species is present in sparsely distributed patches of low to moderate densities, between 10 m and 15 m water depth, in Waratah Bay.

The HDD exit holes at 10 m depth will be located 50 m apart, giving a horizontal distance of 100 m and parallel to the shoreline for western monopole (ML1), which will be installed first. The second monopole (i.e., the eastern ML2 monopole) will be installed about 2 years later at a separate location. The transition zone where the bundled cable will split into its three individual component cables (i.e., two outer HVDC cables and one central fibre optic cable) to their respective HDD marine exit holes is approximately 100-m wide and with a 100 m seaward horizontal distance to a common point (i.e., end of the bundled cable), which gives a triangular area within which the individual cables will be buried. However, not all seabed in this triangular area will be disturbed, as the disturbance width for cables is assumed to be 2.87 m for each cable installed. This is based on the width of the wet jetted trench (1.67 m) combined with the width of the jet trencher's twin caterpillar tracks (1.2 m). Comparing this figure of 2.87 m with the area of the Tasman grass-wrack zone found between the 10 m and 15 m water depth zone (CEE, 2023), the total potential area of disturbed habitat within the bundled and individual cables' alignments can be calculated.

The Tasman grass-wrack habitat potentially disturbed by installing the bundled and individual cables within the 10 to 15 m water depth zone are calculated for the western monopole (ML1) as follows:

- Subtotal disturbed area (individual cables) is 929 m^2.
- Subtotal disturbed area (bundled cable) is 620 m^2.
- Total area disturbed (bundled + individual cables) is 1,549 m^2 (or 1,550 m^2).

The total area of potential Tasman grass-wrack habitat disturbed by seabed cable installations for both ML1 (1,550 m^2) and ML2 (1,550 m^2) is 3,100 m^2. Therefore, the total potential area of Tasman grass-wrack disturbed by cable installation and burial installation for ML1 and ML2 within the 10 to 15 m water depth represents 0.028% of the total area of 11 km^2 of Tasman grass-wrack habitat within Waratah Bay.

While some Tasman grass-wrack may perish (become buried in the wet jetted trench or compressed and damaged under the jet trencher's twin tracks), the passage of a jet trencher may also uproot Tasman grass-wrack plants directly in its path and displace them laterally in the direction of prevailing tidal flows or longshore currents, owing to the uprising of the pumped jet waters at the seabed-bottom water interface.

Indirect impacts of reduced water quality by jet-trenching include increases of SSCs and associated turbidity, which will only extend locally around the subsea project alignment, dispersing laterally in the direction of prevailing currents, and occurring for a short duration. Since the impacts of increased SSC to aquatic life are concentration-time dependent (Newcombe and MacDonald, 1991), they will not be exposed to sub-lethal levels due to down-current dilution and the short duration of jet trenching at any specific point or segment of the project alignment. The predicted indirect water quality impacts of post-lay cable installation and burial on Tasman grass-wrack are assessed to have a residual impact significance rating of ***Low***. This is based on a Tasman grass-wrack sensitivity of *High* being a listed endangered species under the FFG ACT(Vic) and a magnitude of impact of *Negligible* given the very small potential area of impact and the fact that nearshore benthic algae and seagrasses are frequently exposed to naturally elevated suspended sediment concentrations and turbidity within Waratah Bay. The associated turbidity plumes are also of short duration and unlikely to reduce the penetration of photosynthetically active light required by Tasman grass-wrack or benthic macroalgae in the medium to longer term.

7.2.2.1.6 Cable installation on hard seabed and across third-party seabed infrastructure

Fugro (2020) undertook a geophysical survey and a geotechnical investigation that identified several nearshore areas in Tasmania and Victoria, where the desired cable installation depth (i.e., nominal 1 m) may not be able to be met due to hard rock. In these locations, other alternative methods of cable trenching may be used such as a mechanical trenching tool. Typical hard substrate mechanical trenching tools include rock cutting machines that use rotating chainsaw wheels. These were used extensively on the Basslink project (CEE, 2009) to cross low-profile reef in nearshore Victoria as well as hard substrates encountered in the offshore Basslink cable route near the Hogan Group in central Bass Strait.

Almost the entire length of the project's proposed route crosses soft sediment seabed that is amenable to cable installation and burial by wet jetting. In the few isolated areas where the depth of soft sediments overlying hard substrata is less than the nominal depth of 1 m required for cable burial, the project's proposed method is to use either rock placement or concrete mattresses (or a combination of both), that provides sufficient depth over the cables to protect the cables from anchor hook-up or bottom trawling gear. Two locations of note are located within the western palaeochannel (KP 253) and the eastern palaeochannel (KP 254.5) in nearshore Tasmania, which are based on palaeochannel depth profiles at Heybridge interpreted from geophysical data in Figure 4.54 of Fugro (2020).

There are two locations where the project's subsea cables will need to unavoidably cross over third-party seabed infrastructure within the nearshore environment:

- Nearshore Tasmania:
    - Crossing of the two out-of-service Tioxide Australia marine outfall pipelines in the western palaeochannel by the project's ML1 subsea cables.
- Nearshore Victoria:
    - Crossing of the in-service Telstra Bass Strait 1 telecommunications cable by the project's ML1 subsea cables.
    - Crossing of the in-service Telstra Bass Strait 1 telecommunications cable by the project's ML2 subsea cables.

A third crossing of the Alcatel's Indigo Central telecommunications cable in offshore Bass Strait is assessed separately in Section 7.2.2.2.2 (Offshore cable lay crossings of third-party seabed infrastructure).

Potential impacts

The potential impacts of cable burial over hard substrate and at the crossings of third-party seabed infrastructure include.

- Changes to seabed habitats:
  - replacement of soft sediment seabed habitats (e.g., sands) by hard seabed habitats (e.g., targeted rock fill, rock mattresses, or a hybrid of the two methods of cable protection) and creating new hard seabed habitat.
- Changes to water quality due to targeted rock emplacement.
- Disturbance to existing soft sediment benthic communities.

Potential damage to third-party seabed infrastructure will be avoided by MLPL consulting and liaising with the owners of all identified subsea infrastructure and for which their exact locations and coordinates are known from seabed surveys carried out by Fugro (2020), which will be confirmed in the final pre-lay seabed survey.

Environmental performance requirements

The proposed EPRs for this section are outlined in:

- Section 7.2.2.1.5 (Cable installation and burial impacts on sediment quality and contaminant release).
- Section 7.2.2.2.2 (Offshore cable laying crossings of third-party infrastructure)

Potential mitigation and management measures

The International Cable Protection Committee (ICPC) publishes guidelines intended to assist the cable and pipeline industries to adopt a harmonised approach in relation to cable crossings (ICPC, 2023b). It is expected that MLPL and its contractors will abide by the guidelines wherever practicable.

The ICPC (2016) states that always present are the obligations to:

- avoid conduct that prejudices the repair of other cables or pipelines (article 112.2)
- indemnify damage to any first laid cable or pipeline that is crossed (“the first laid rule”) (article 115)
- indemnify mariners or vessel owners who, through no fault of their own foul a cable, but sacrifice their gear to avoid damage to the cable (article 114).

In terms of the ICPC (2016) information in relation to marine ecology, the ICPC term ‘marine protected area’ (MPA) includes proposals based on formal MPAs, Vulnerable Marine Ecosystems, and Particularly Sensitive Sea Areas. New MPAs may well be considered over existing cable routes. However, the ICPC cable community does not see this as a problem as submarine cables and MPAs are not mutually exclusive.

During the detailed geophysical surveys and geotechnical investigations with seabed sampling, Fugro (2020) identified sections of the project alignment where hard seabed was encountered. In some cases, the hard seabed was avoided by rerouting the project alignment. An example of this is the ML1 subsea cables in the western palaeochannel that divert around a rock outcrop that protrudes into the palaeochannel (see Figure 6.8 for the alignment).

In the case of crossing the out-of-service and disused Tioxide Australia marine outfall pipelines by the ML1 subsea cables, a minimum amount of targeted rock dumping or a single concrete mattress may be used.

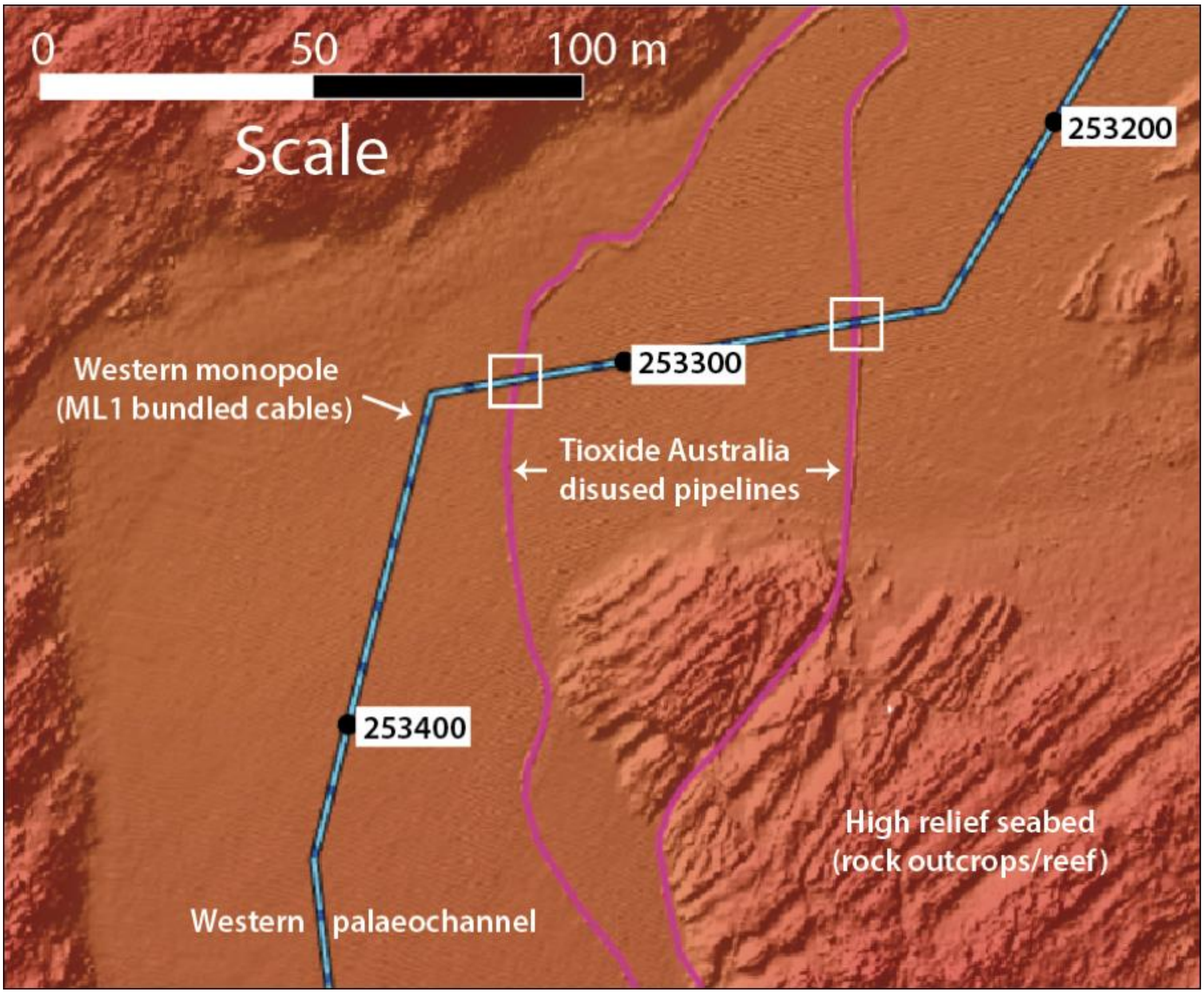
Predicted residual impacts

The following sections assess the residual impacts of cable installation and protection at crossings over existing seabed infrastructure on nearshore marine ecology.

Cable crossing impacts in nearshore Tasmania

Cable crossings impacts on seabed habitats of nearshore Tasmania

Figure 7.3 shows the locations where the project's ML1 subsea cables are required to cross over the Tioxide Australia's two marine outfall pipelines, assuming that they are not going to be cut and removed.



Source: EnviroGulf Consulting and Fugro (2020). Purple line denotes Tioxide Australia's disused marine outfall pipelines. Blue line denotes the ML1 bundled cable within the western palaeochannel. White boxes indicate the crossing locations but not the area of rock fill or concrete mattress cover.

Figure 7.4: ML1 subsea cables crossings of out-of-service pipelines in nearshore Tasmania

Figure 4.6 (see Section 4.2.2.3.3, Third party seabed infrastructure crossings) shows an example method of crossing a third-party seabed infrastructure. The sequence involves a pre-cable lay rock placement (i.e., bridge over the existing buried or partially buried pipelines). This is then followed by laying the bundled cable across this bridge, and then covering the as-laid bundled cable by either rock fill or rock mattresses (or a hybrid of the two cover methods) to the required minimum depth of 1 m to avoid anchor hook-ups.

Based on data from the NemoLink subsea interconnector (PMSS, 2017), which has a similar dimensioned cable bundle and configuration as the project's proposed cable bundle, a typical footprint over an in-service telecommunications cable is around 100-m long (rock fill or concrete mattress along the power subsea bundled cable) by approximately 30-m wide (bridging over a telecommunications cable), giving a total direct seabed disturbance area of 300 m^2. However, in the case of crossing over the Tioxide Australia's disused marine outfall pipelines, a much smaller footprint will be acceptable. For example, a 30-m long rock fill or concrete mattresses along the ML1 bundled cables by a 3-m bridging width, over the pipelines is a reasonable minimum footprint of 90 m^2. This footprint area of 90 m^2 has been adopted for the Tioxide Australia pipeline.

The total area of the ML1 pipeline crossings is 180 m^2, which is a very small area of sandy seabed that will be lost (0.01%) compared to the area of 153,000 m^2 of the sand-filled western palaeochannel.

The predicted impacts of loss of soft-bottom seabed habitats are assessed to have a residual impact significance rating of ***Very low***. This is based on a habitat sensitivity of *Very low,* due to the high-energy hydrodynamic environment and natural sediment mobilisation, and a *Negligible* impact magnitude, given the large areas of unimpacted seabed within the palaeochannel. The very small loss of soft seabed habitat (i.e., coarse sands and cobble patches) will be countered by the area of cable cover by rock fill and/or rock mattresses, which will represent a transition from soft-sediment seabed habitat to hard seabed habitat with higher structural diversity (e.g., greater porosity and void spaces as well as nooks and crannies within the rock mattress voids). The hard surfaces of rock fill or rock mattresses will also offer a new source of hard surface attachment sites suitable for colonisation and establishment of benthic encrusting algae and macroalgal holdfasts. Consequently, colonisation and establishment of benthic fish and macroinvertebrate communities of the new habitat is expected to occur over two or more years.

Cable crossing impacts on water quality in nearshore Tasmania

Potential impacts on water quality are significantly less than that caused by nearshore wet jetting operations for cable installation and burial in soft seabed. The main impacts are from the use of targeted rock fill, where abrasion between crushed rock chuted to a seabed crossing location generates very short-term turbidity plumes, which will disperse and dilute in the direction of prevailing currents, within the water column and near the seabed. The placement of rock mattresses at crossing locations does not generate turbidity plumes, as the rock mattresses are lowered into position using a crane or davit onboard a host construction vessel (e.g., an offshore supply vessel, OSV).

The predicted impacts of cable crossing construction are assessed to have a residual impact significance rating of ***Low***. This is based on a water quality sensitivity of *High* given the long-term water quality data for nearshore Tasmania (Section 6.2.3.1), and a magnitude of impact of *Negligible* given that the duration of rock fill placement will be typically less than a day and the dispersing turbidity plumes are expected to rapidly become diluted such that suspended solids concentrations (SSC) and associated turbidities are anticipated to reach background levels within a few kilometres downcurrent from the crossing construction activities based on dredging turbidity plume dispersal and dilution modelling (Kim et al., 2018; PMSS, 2017).

Cable crossing impacts on benthic flora and fauna in nearshore Tasmania

As noted above, the total area of the ML1 and ML2 crossings at the Tioxide Australia's disused marine outfall pipelines is 180 m^2, which is a very small area of sandy seabed that will be lost (0.01%) compared to the extensive area of 153,000 m^2 of the sand-filled western palaeochannel.

Seabed surveys by CEE (2022) did not detect the presence of benthic flora in the sand-filled palaeochannels in nearshore Tasmania at Heybridge. Therefore, the following cable crossing impact assessment relates to benthic fauna of sandy seabed habitats.

The loss of 0.01% of sandy seabed habitat also represents a direct loss of benthic macroinvertebrates and inferred infauna at the crossing locations, which will be buried under the cable pre-lay rock fill and/or rock mattresses. CEE (2023) indicated that, during both their 2019 and the 2021 video or towed camera surveys of the sand and gutter seabed habitats of the palaeochannels, benthic macroinvertebrates were not visible.

The predicted impacts of cable crossing construction on the sandy seabed fauna of the western palaeochannel are assessed to have a residual impact significance rating of ***Very low***. This is based on a benthic sandy seabed fauna sensitivity of *Low,* and a magnitude of impact of *Negligible* given the localised and short-term nature of the impact. Moreover, the replacement of soft seabed sediments by new hard substrata (i.e., rock fill or concrete mattresses) at the crossing locations will provide a more structurally diverse habitat, with microhabitats and niches for colonisation, establishment and growth of benthic flora and fauna.

Cable crossing impacts in nearshore Victoria

Cable crossing impacts on seabed habitats of nearshore Victoria

The seabed habitat zones within Waratah Bay in nearshore Victoria are shown in Figure 7.2 (in Section 7.2.2.1.4), which also shows the general area where the project's ML1 and ML2 subsea cables will cross Telstra's Bass Strait 1 telecommunications cable. Both the crossings are located within sandy seabed within Zone 4 of nearshore Waratah Bay (Figure 7.2), which lies outside and seaward of the Zone 3 cobble and sand seabed habitat that has higher structural diversity and biodiversity.

MLPL will consult Telstra to mutually agree on the project's proposed method of crossing its telecommunication cable in nearshore Victoria. In the absence of detailed information on the likely size of the area required to bridge the telecommunications cable, the area of directly impacted seabed habitats at either the ML1 or ML2 bundled cable crossings has been assumed to be 300 m^2, which is based on experience at the NemoLink project, as noted above. Since the project's second stage ML2 subsea cable will be installed in nearshore Waratah Bay, (i.e., about two to three years after the ML1 installation), the following impact assessment relates to the project's first ML1 cable bundle crossing installation on nearshore seabed habitats.

The predicted impacts of the proposed ML1 cable bundle crossing of Telstra's Bass Strait 1 cable in Waratah Bay are assessed to have a residual impact significance rating of ***Very low***. This is based on a sandy seabed habitat sensitivity of *Very low,* and a magnitude of *Negligible,* given the small proportion of benthic habitat impacted. In addition, the change from a sandy bed habitat at the crossings to one of hard seabed (i.e., rock fill and/or concrete mattresses) may be perceived as a beneficial impact, in that hard seabed habitat is structurally more diverse and supports a wider variety of benthic flora and fauna (see below for impacts on biological communities).

Cable crossing impacts on water quality in nearshore Victoria

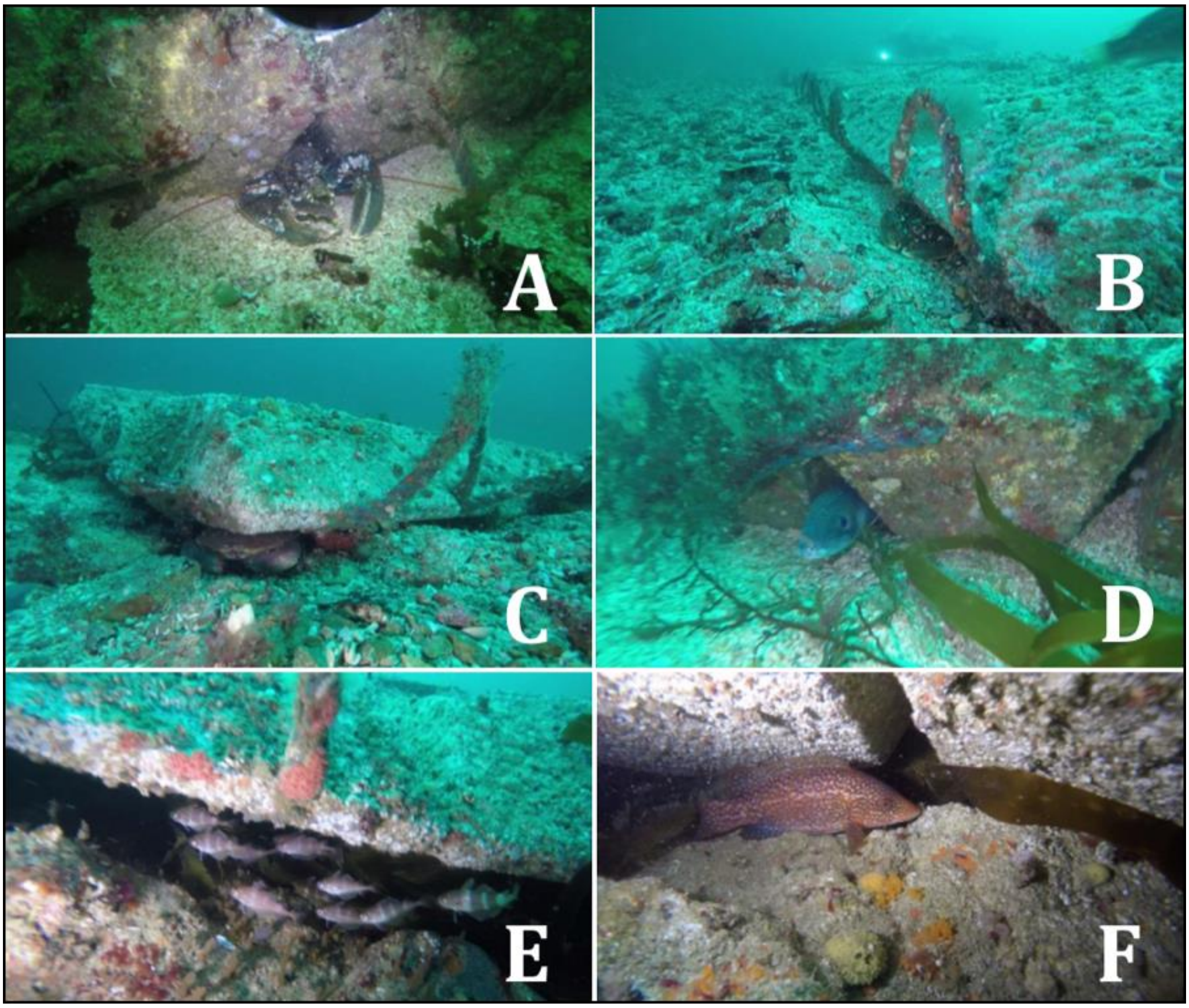
The predicted impacts of cable crossing construction at the sites of the Telstra Bass Strait 1 telecommunications cable are assessed to have a residual impact significance rating of ***Low***. This is based on a water quality sensitivity rating of *High*, given the long-term water quality data for nearshore Victoria (Section 6.2.3.3), and a magnitude of impact of *Negligible* given the duration of rock fill placement will be typically less than a day and the dispersing turbidity plumes are expected to rapidly disperse and dilute in the direction of tidal flows and/or longshore currents with SSCs and associated turbidities reaching background levels within a few kilometres downcurrent from the crossing construction activities based on dredging turbidity plume dispersal and dilution modelling (Kim et al., 2018; PMSS, 2017).

Cable crossing impacts on benthic flora and fauna in nearshore Victoria

The general area of the project's ML1 and ML2 crossings of the Telstra Bass Strait 1 telecommunications cable in nearshore Waratah Bay is within an area of sandy seabed, within Zone 4 (see Figure 7.2). In the absence of information on the areal extent of cable crossing works pending MLPL consultations with Telstra on an agreed crossing method and its likely dimensions, the present report has adopted a crossing area of targeted rock fill and/or rock mattresses of 300 m^2. This potential seabed impact area is based on experience gained at the Nemo Link subsea interconnector (PMSS, 2017) between the UK and Belgium when crossing in-service buried telecommunication cables. The bundled twin HVDC and single optical fibre cable of the Nemo Link project is of similar design and dimensions as the bundled cable proposed for the current project.

The predicted impacts of the areas of crossing construction (i.e., 300 m^2) on sandy habitat flora and fauna are assessed to have a residual impact significance rating of ***Very low***. This is based on seabed habitat flora and fauna having a sensitivity of *Low,* due to common widespread species and a magnitude of impact of *Negligible,* given the small area of impacted soft-bottom seabed habitat. The Tasman grass-wrack (*Heterozostera tasmanica*), classified as *Endangered* under the FFG Act, was observed by CEE (2022) to be present in patches of low to moderate abundance on sandy seabed within the depth range from 10 m to 15 m (KP 1.0 to KP 4.4) but was also present as sparse patches and individuals up to 34 m water depth. The locations of the ML1 and ML2 cable crossings are in deeper water between KP 5.5 and KP 5.7; therefore, potential impacts to this threatened seagrass species are anticipated not to be significant and no offsets are proposed. No offsets are required for any other environmental aspects in the marine environment.

The replacement of sandy seabed habitat by the hard seabed habitats of targeted rock fill and/or rock mattresses is expected to produce a 'reef effect', owing to the establishment of new seabed habitat of a high structural diversity and biodiversity compared to that of the surrounding sandy seabed. For example, Plate 7.2 shows post cable lay with burial protection using rock mattresses to cover and protect the export cable from the Paimpol-Bréhat pilot tidal turbine park shore in Brittany, France (Dufournaud, 2018). The photographs in Plate 7.2 show a high level of colonisation and establishment of hard seabed (i.e., rock mattress in this case) benthic communities after about four years' (i.e., initial placement in August 2013 to June 2017).



Source: Dufournaud (2018). The European benthic fauna is shown sheltering within or using voids as niches within the rock mattress located in nearshore Brittany (France): A and B - European lobster (*Homarus gammarus*); C - Edible crab (*Cancer pagurus*); D - Conger eel (*Conger conger*); E – a shoal of pout (*Trisopterus luscus*); and F - Ballan wrasse (*Labrus bergylta*).

Plate 7.2: Example of benthic communities colonising rock mattress at a cable crossing

The project's cable crossings of the Telstra telecommunications cable may include targeted rock and/or rock mattresses and a similar colonisation and establishment of hard seabed benthic communities is expected to occur compared to the less biodiverse benthic communities of the adjacent sandy seabed habitats.

There is a potential for colonisation of the cable crossings' rock fill and/or concrete mattresses by invasive marine species and this is addressed in Section 7.2.5 (Impacts of introducing or translocating invasive marine species).Offshore construction seabed disturbance impacts

The project's principal offshore construction activities having direct seabed disturbance impacts include:

- Pre lay rockfill and/or concrete mattresses at third-party crossings.
- Post lay cable installation and burial in soft sediment seabed.
- Post lay cable stabilisation on hard seabed and third-party seabed infrastructure protected by with rockfill and/or concrete mattresses.

The following offshore construction activity impact sources are not assessed:

- Pre lay grapnel runs (PLGRs):
  - Justification for exclusion is the very small spatial PLGR seabed impact zone (0.5 m width) and reasons given in Section 7.2.2.1.1 (Pre-lay grapnel runs).
- Cable lay on the seabed.
  - Justification for exclusion is the extremely small seabed impact zone (less than 0.27 m width of two HVDC cables side by side) as noted in Section 7.2.2.1.3 (Cable lay impacts on nearshore seabed).

7.2.2.1.7 Post cable lay installation and burial impacts on offshore soft sediment seabed

This section assesses the physical disturbance of the offshore seabed from cable installation and burial, and consequential impacts on seabed habitats, bottom water quality, and seabed benthic biological communities.

The project's offshore alignment of the ML1 or ML2 bundled cables is approximately 248 km long between the Tasmanian and Victorian nearshore seaward limits of the 20 m isobath, which represents about 97% of the total length of the project's Bass Strait crossing.

Offshore seabed sediment grain size varies in relation to current velocity, with fine materials (silt and clay) in the central basin of Bass Strait and coarser sands around the coastal margins, where wave and current action is stronger (AMOG, 2000; Li et al., 2011a, b and c). The percentages of seabed sands and muds (silts and clays) across central Bass Strait are shown in Figure 6.5 and Figure 6.7, respectively, in Section 6.2.4.1 (Particle size distribution).

Potential impacts

The potential impacts of post lay cable installation and burial in the soft sediment seabed of offshore Bass Strait include:

- Physical impacts on offshore seabed habitats.
- Changes to offshore bottom water quality.
  - increased suspended sediment concentrations and turbidity.
- Impacts on offshore benthic biological communities.

Environmental performance requirements

The proposed EPRs for this section are outlined in section 7.2.2.1.3 (Cable lay impacts on nearshore seabed).

Potential mitigation and management measures

Fugro (2020) conducted various detailed geophysical surveys and geotechnical investigations and seabed sampling, which provided information and data to provide confidence in the selected project alignment across offshore Bass Strait. The findings of these surveys allowed route refinements to be made to avoid obstacles to cable laying such as rock outcrops and restrict environmental impacts to soft sediment habitats. It is expected that contractors will undertake geophysical surveys for any locations of the alignment not surveyed to refine the alignment to avoid seabed features.

Once the project alignment, and cable installation and burial method have been selected there are limited measures that can be adopted to reduce offshore seabed sediment disturbance.

Predicted residual impacts

This section assesses the residual impacts of cable burial using the Helix T-1200 (or similar) jet trencher on offshore soft sediment seabed habitats, bottom water quality, and benthic biological communities.

Cable installation and burial impacts on offshore soft sediment seabed habitats

The cable installation and burial route lengths within each offshore seabed habitat zone are given in Table 7-9. Offshore waters and seabed habitats are defined in this report as including Commonwealth Marine waters between the Tasmanian and Victorian 3-NM state limits.

Table 7-9: Offshore seabed zones and dominant physical characteristics

Seabed zone	Water depth (m)	Kilometre Point	Segment length (km)	Dominant seabed type
Offshore Zone 1	25 to 65	KP 5.5 to KP 15	8.5	SAND
Offshore Zone 2	65 to 79	KP 15 to KP 88	73.0	Silty SAND
Offshore Transition	79 to 80	KP 88 to KP 125	37.0	Sandy SILT
Offshore Zone 3	80 to 62	KP 125 to KP 237	112.0	SILT/CLAY
Offshore Zone 4	62 to 10	KP 237 to KP 249.5	12.5	SAND/Rock
Total length of project alignment in offshore seabed			**243.0**	–

Source: Adapted from Fugro (2020). Dash (–) denotes not applicable. Capitalised emphasis for a seabed sediment type is based on Fugro (2022). The offshore marine environment commences at KP 5.5 and ends at KP 249.5, which denote the Victorian and Tasmanian 3-NM state limits.

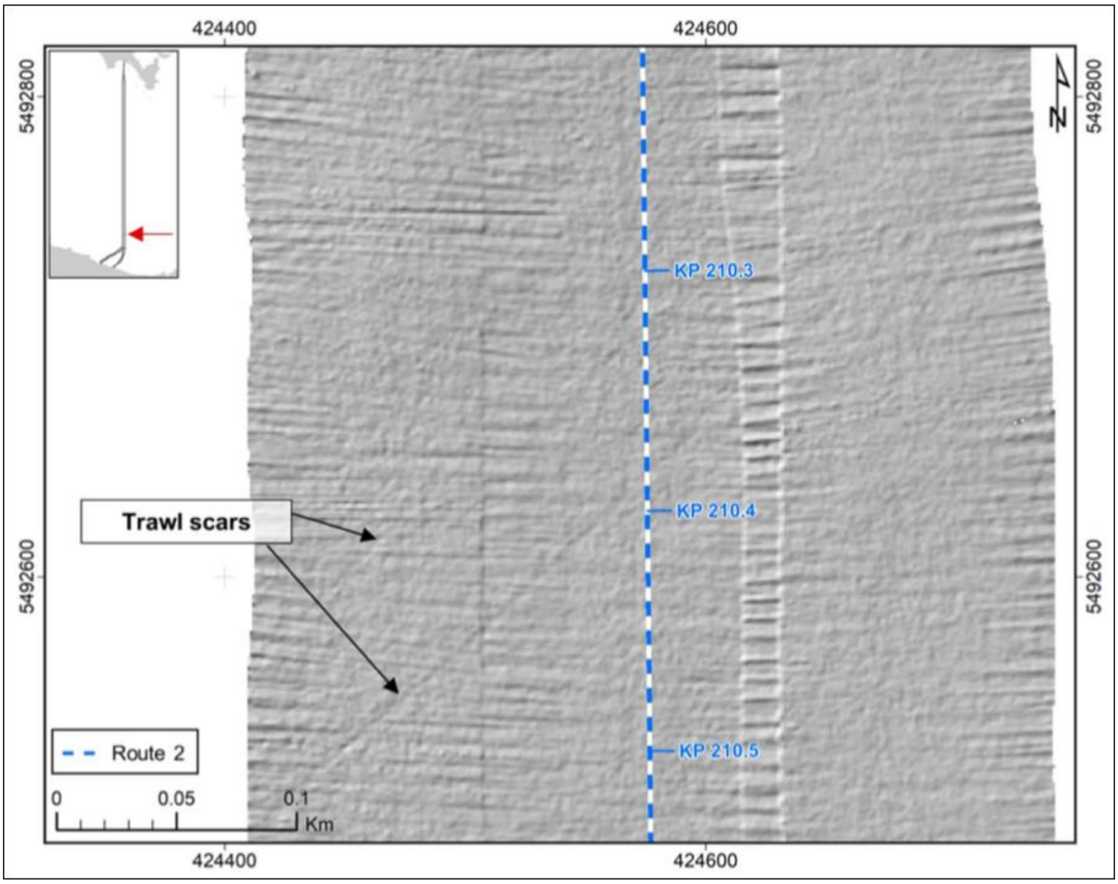
Based on a wet trench surface width of 1.67 m and the jet trencher's twin caterpillar tracks width of 1.2 m, the combined seabed disturbance width of cable installation and burial is 2.87 m. The total areas of offshore seabed habitat disturbed by wet trenching are 24,395 m^2 (Zone 1), 209,510 m^2 (Zone 2), 106,190 m^2 (Transition zone), 321,440 m^2 (Zone 3) and 35,875 m^2 (Zone 4). The overall total seabed disturbance area from bundled cable installation and burial along the 243-km-long offshore bundled project alignment is 697,410 m^2 or approximately 0.7 km^2, which represents a very small area within a very large expanse of adjacent undisturbed seabed habitat. For example, assuming a 1-km-wide buffer straddling 243-km-long bundled project alignment, the total area of wet jetting directly disturbed seabed habitat (0.7 km^2) is around 0.3% of the buffer zone (243 km^2).

The predicted impacts of wet jetting on the seabed habitats of offshore Bass Strait are assessed to have a residual impact significance rating of ***Very low*** based on a soft seabed habitat sensitivity of *Low* due to its common and widespread occurrence and a magnitude of impact of *Negligible*, given the very small areas of impacted seabed habitats. Recovery of offshore seabed habitats from wet jetting is anticipated to vary from a few months to a year in the case of the soft sediment seabeds of offshore Zone 3 (SILT/CLAY), between six months and a year in Zone 2 and the offshore transition zone, and less than six months within the sandy seabed of offshore Zones 1 and 4 that are adjacent to the nearshore zones of Victoria and Tasmanian, respectively. The derivation of these duration estimates for seabed recovery are based on observations at other projects, which are highlighted below.

For cable installation and burial in the sandy seabeds of both offshore Zone 1 and offshore Zone 4 (which are adjacent to the Victorian and Tasmanian nearshore zones), recovery of the seabed habitats is expected to take less than six months. This is confirmed by investigations of other subsea HVDC cable projects, which report a similar recovery timeframe. In the case of the Basslink Project Chidgey et al. (2006) undertook a video transect surveys one year after the Basslink bundled cable was installed and buried in offshore sandy seabed in Victorian waters and compared it with control transects outside the alignment and concluded that there was no remaining detectable residual effect of the cable installation on the sandy habitat structure along the project alignment.

Sherwood et al. (2016) presented results of offshore underwater video surveys of the Basslink cable seven months after burial at a remote site 25 km offshore of Tasmania and observed that the project alignment was identifiable as a shallow depression containing drift biota and adjacent low mounds of sediment to a distance approximately 1.5 m either side of the trench. This site is equivalent to the project's offshore Zone 4. In another investigation, Andrulewicz et al. (2003) investigated the ecological effects of laying the SwePol HVDC cable between Sweden and Poland and observed that, where it had been buried in offshore sandy sediments, there was no surface trace of the SwePol cable one year after its emplacement.

In the deeper Bass Strait zones such as offshore Zone 3 (SILTS/CLAYS), recovery of the seabed along the project alignment is expected to take longer (from six months to a year or so), owing to the low bottom-water velocities, lower sediment transport, and lower vertical sediment accumulation (gross sedimentation) rates. This is evident from the visible scarring of the offshore deeper seabed by scallop dredging or bottom trawling gear. For example, Figure 7.4 shows hill-shaded bathymetric data (Fugro, 2020) to highlight trawls scars on the seabed of the proposed ML2 alignment between KP 210.3 and KP 210.4, which is located about 45 km north of the ML2 landfall at Heybridge. It is expected that these trawls scars represent both recent trawling activities as well as trawling activities over several years. Bradshaw et al. (2021) state that trawl scars in cohesive sediment below the wave base and in areas of low sedimentation rates may be preserved for several years. In the case of the wet jetting, it is anticipated that the shallow depression formed along the wet jetting path will become filled with drift algae, debris, and benthic macroinvertebrates, leading to localised increases in biological diversity and productivity as has been shown by CEE (2009) for the Basslink wet jetting depressions.



Source: Fugro (2020).

Figure 7.5: Persistence of trawl scars on offshore seabed 45 km north of Heybridge

Overall, based on the above literature review and case study examples, any residual visible signs of wet jetting such as slight depressions in the natural surface of the seabed are expected to be less significant compared to seabed scars left by trawling gear.

Cable installation and burial impacts on offshore bottom water quality

In the absence of background measurements of bottom water quality in offshore Bass Strait background near surface water quality data presented in Table 6.3 (see Section 6.2.3.2, Offshore Bass Strait) has been used as a proxy for SSC concentrations and turbidity.

Based on Table 7-9, the seabed segments that are most susceptible to cable installation and burial impacts are offshore Zone 2 (silty/SAND) and offshore Zone 3 (SILT/CLAY). For the purposes of the seabed disturbance impact assessment, the 112-km-long offshore Zone 3 (SILT/CLAY) has been selected as a worst-case scenario, owing to the high content (range 81.7% to 87.2 %) of silts and clays (<63 µm particle size fraction) based on sediment sample analyses (Fugro, 2020).

Based on the seabed surface wet jetting trench width of 1.67 m and the 112-km-long seabed segment of offshore Zone 3, the total area of soft sediment seabed habitats disturbed by wet jetting is 187,000 m^2 or 0.18 km^2. Wet jetting will disturb seabed sediments down a depth of 1.2 m (i.e., the length of the wet jetting swords) and turbulent upward flow from the wet jetting pumped waters will carry silts and clays into the bottom waters overlying the wet jet trench path. The resuspended silt and clay seized particles will be mixed with overlying seawater increasing bottom-water SSC and associated turbidity. The wet jetting-generated turbidity plume will then disperse and dilute in the direction of prevailing bottom currents.

Fugro (2020) investigated bottom water currents between 67 and 71 m depth in offshore Bass Strait and measured a median (50-percentile) speed of 0.12 m/s and a 90-percentile speed of 0.22 m/s.

Therefore, at median bottom current speed of 0.12 m/s, the residual turbidity plume will take about six hours to reach a 1-km distance from a particular point of wet jetting. SSC and turbidity levels within the dispersing and diluting turbidity plumes are expected to reach background levels of SSC (<2 mg/l) and turbidity (<5 NTU) within several kilometres, which is based on modelling and observations of dredging turbidity plumes (Kim et a; 2021; PMSS, 2017). Note that the speed of the wet jetting operation is around 400 m/h in the silt clay seabed of offshore Zone 3, therefore, the down-current areas of the turbidity plumes do not accumulate as the jet trencher progresses along the bundled project alignment.

The predicted impacts on bottom water quality arising from wet jetting operations within the silt and clay seabed of offshore Zone 3 is assessed as have a residual impact significance rating of ***Low*** based on a bottom water quality sensitivity of *High*, given the long-term surface water quality data for offshore Bass Strait (Section 6.2.3.2) and assuming a well-mixed water column, and a magnitude of impact of *Negligible*, given the small areas and volumes of bottom water directly impacted by wet jetting turbidity plumes. Recovery in bottom water quality is expected to be rapid as silt-sized particles (4–63 µm diameter) settle out and as clay-sized particles (2–4 µm diameter) ultimately deposit on the seabed at longer distances from the wet jetting operation.

Offshore Zones 1, 2, Transition, and 4 are anticipated to be less susceptible to impacts to water quality from cable installation and burial, due to their lower content of silts and clays. The predicted impacts on bottom water quality from wet jetting operations in the sandier seabeds of offshore Zones 1, 2, Transition, and 4 are also all assessed as having a residual impact significance rating of ***Low*** based on a bottom water quality sensitivity of *High*, given the long-term surface water quality data for offshore Bass Strait (Section 6.2.3.2) and assuming a well-mixed water column, and a magnitude of impact of *Negligible* given the small areas and volumes of bottom water directly impacted by wet jetting turbidity plumes.

Cable installation and burial impacts on offshore soft sediment benthic communities

The seabed habitat and benthic communities of offshore Bass Strait along the project alignment are summarised in Section 6.3.4.2 (Offshore seabed habitats and benthic communities of Bass Strait). More detailed descriptions are provided by CEE (2023; EIS/EES Technical appendix G: Benthic ecology) and Fugro (2022).

The benthic communities along the project's alignments within the predominantly sandy seabed of offshore Zones 1, 2, transition, and 4 are assessed to have a low sensitivity physical disturbance from cable installation and burial. However, specific areas of the seabed within offshore Zone 3 (SILT/SAND) are assessed to have relatively higher seabed benthic community habitat sensitivities due to the alignment unavoidably having to pass through the known habitat of mesophotic 'sponge bed' communities (Butler et al., 2002).

Predicted wet jetting impacts on offshore Zones 1, 2, Transition, and 4

The benthic communities of the sand-dominated seabed of offshore Zones 1, 2, Transition, and 4 are briefly summarised below:

- Offshore Zone 1 benthic community characteristics:
    - The benthic communities along the seabed of offshore Zone 1 (KP 5.5 to KP 15 and water depth 25–65 m) comprised mixed macroalgae, sparse epibenthic macroinvertebrates, burrowing *polychaete* worms, inferred sediment infauna, and unidentifiable low growth over the seabed probably represented early growth of encrusting or colonial invertebrates such as sponges, *bryozoans*, and hydroids (CEE, 2023; EIS/EES Technical appendix G: Benthic ecology).

- Offshore Zone 2 benthic community characteristics:
  - The benthic communities along the seabed of Zone 2 (KP 15 to KP 88 and water depth 65–79 m) were scarce, with individual sponges or small patches of mixed invertebrates including sponges, *bryozoans*, *ascidians*, and branching soft corals scattered over the otherwise bare seabed surface.
- Offshore Transition zone benthic community characteristics:
  - The benthic communities along the seabed of offshore Transition zone (KP 88 to KP 125 and water depth 70–80 m) were scarce with individual sponges or small patches of mixed invertebrates including sponges, *bryozoans*, *ascidians* and branching soft corals scattered over the otherwise bare seabed surface. The presence of mounds, dimples and open holes were attributed to biological activity below the seabed surface.
- Offshore Zone 4 benthic community characteristics:
  - The benthic communities along the seabed of offshore Zone 4 (KP 237 to KP 249.5 and water depth 62–10 m) were sparse and included stalked *bryozoans*, doughboy, and commercial scallops, and eleven arm seastars that fed on the scallops. In addition, green macroalgae (e.g., *Caulerpa*) were present in low abundance. Between KP 238.0 (60 m water depth) to KP 240.5 (55 m water depth) video survey photographs showed increasing amounts of mixed sponge/*bryozoan* assemblages scattered over an otherwise bare seabed (CEE, 2023) however, this depth range (60–55 m) lies outside the 65 to 75 m depth zone where sponge beds are typically found (Butler et al., 2002).

Overall, the predicted impacts of wet jetting operations on both benthic macroinvertebrates and sediment infauna in the predominantly sandy seabed offshore Zones 1, 2, Transition, and 4 are assessed to have a residual impact significance rating of ***Very low.*** This is based on a sandy seabed benthic community sensitivity of ***Low*** due to common and widespread communities and a magnitude of impact of *Negligible* given the very small areas of impacted seabed benthic communities within larger offshore areas of non-impacted seabed habitats and associated benthic communities. However, in the case of offshore Zone 3 seabed benthic communities, the residual impact assessment takes account of moderately sensitive mesophotic ‘sponge-coral’ communities that are anticipated to occur between the 65 and 75 m water depths and is assessed below.

Predicted wet jetting impacts in offshore Zone 3

The benthic communities of the seabed within offshore Zone 3 (KP 125 to KP237, water depth 80–62 m) include abundant mounds of burrowing infauna, but benthic macroinvertebrates were sparse and included encrusted worm tubes, slender branched soft corals, and occasional commercial and doughboy scallops. In addition, the seabed includes areas of mesophotic sponge-coral community of southern Bass Strait in the depth range 65 to 75 m (Butler et al., 2002).

The predicted impacts of wet jetting operations on both benthic macroinvertebrates and sediment infauna in the silt-clay seabed of offshore Zone 3 are assessed to have a residual impact significance rating of ***Low*** based on a seabed benthic community sensitivity of *Moderate* due to the presence of the valued sponge bed community and a magnitude of impact of *Negligible* given the very small areas of impacted seabed benthic communities within larger areas of non-impacted seabed habitats and associated benthic communities of the offshore seabed.

The above predicted residual impacts on the offshore seabed of the project’s alignments are in accordance with the findings of the Basslink Project, where the abundance of benthic communities along the Basslink cable alignment transect were found not to be different from control transects (Chidgey et al., 2006).

In addition, the Bass Strait Environmental Review Committee (BSERC) concluded in 2008 (after three years of monitoring) that the ecological impacts associated with cable installation were minimal and that further environmental monitoring was not required. The Commonwealth Government DAFF, 2009) agreed and dissolved the BSERC on 23 January 2009 and, consequently, the environmental monitoring program was discontinued.

7.2.2.1.8 Offshore cable lay crossings of third-party seabed infrastructure

The only third-party seabed infrastructure is the Alcatel Submarine Networks (ASN) Indigo Central telecommunications cable, which requires to be crossed at KP 59.18 for the western ML1 and KP 59.13 for the eastern ML2 bundled cables. Therefore, the Alcatel cable crossing is within seabed Zone 1 in Table 7-9 above.

Alcatel Submarine Networks' Central Indigo cable is located at the following coordinates:

- Western Link (ML1) crossing at -39.339° S and 146.084° E.
- Eastern Link (ML2) crossing at -39.339° S and 146.107° E.

Potential Impacts

The potential impacts of cable burial over hard substrate and at the crossings of third-party seabed infrastructure include.

- Changes to seabed habitats:
  - replacement of soft seabed habitats (e.g., sands) by hard seabed habitats (e.g., targeted rock fill, rock mattresses, or a hybrid of the two methods of cable protection from anchor hook-up) and creating new hard seabed habitat.
- Changes to water quality due to targeted rock emplacement.
- Disturbance to existing soft sediment benthic communities.

Environmental performance requirements

The proposed EPRs for the Offshore cable lay crossing of third-party seabed infrastructure are presented in Table 7-10:

Table 7-10 EPRs for cable crossings of existing third-party subsea infrastructure

EPR ID	Environmental performance requirement	Project stage
MERU05	**Develop and implement a cable crossing management plan.** Prior to commencement of marine construction, develop a cable crossing management plan with measures to avoid impacts on existing third-party subsea cables during construction. The cable crossing management plan must: • Be developed through consultation with the owner of the Bass Strait 1 cable crossed by the project. • Be developed through consultation with the owner of the Indigo Central cable crossed by the project. • Describe the approach and key requirements for safe cable crossing. • Includes an engineering solution for the crossing with relevant infrastructure owners. • Includes requirements for informing the Australian Maritime Safety Authority (AMSA) of the location, timing and duration of cable crossing works.	Construction

EPR ID	Environmental performance requirement	Project stage
	• Be informed by guidelines published by the International Cable Protection Committee to assist the cable industry to adopt a harmonised approach in relation to crossings (ICPC, 2023b). • Document the crossing point locations for the subsea cables, and the distances that the jet trencher will stop before crossing existing third-party subsea cable. • Outline the notification protocols for informing Bass Strait 1 and Indigo Central cable owners of the final design and construction approach. The plan must be implemented during construction.	
MERU06	**Develop and implement a marine communication plan.** Prior to commencement of marine construction, develop and implement a marine communication plan that includes: • Identification of relevant stakeholders. • Protocol for notifying the AMSA of the proposed locations, timing and duration of proposed marine construction activities. • The approach for compliance with AMSA Marine Orders Part 30 (Prevention of Collisions), AMSA Marine Orders Part 59 (Offshore Support Vessel Operations) and the convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs). • Protocol for informing the Australian Hydrographic Office of the locations, dates, times and duration of proposed marine construction activities. • A plan to engage with commercial and recreational fisheries on the project activities, schedule, locations and durations. • The approach for using guard vessels to enforce the temporary exclusion zone during cable laying across Bass Strait and at the shore crossings. • The approach for informing recreational users of marine activities, in accordance with the Community and Stakeholder Engagement Plan (EPR S03). This plan must be implemented during construction.	Construction / Operation

Potential mitigation and management measures

The Cable Crossing Management Plan should be developed through consultation with Telstra and Alcatel to develop a safe crossing method and an acceptable engineering solution. MLPL will inform Telstra and Alcatel of the crossing point locations for ML1 and ML2 subsea bundled cables. In addition, Telstra and Alcatel will be informed of the proposed distances from the crossing at which both PLGRs and cable installation and burial by the jet trencher will stop before the crossing and recommence at the other side of the crossing.

The ICPC publishes guidelines intended to assist the cable and pipeline industries to adopt a harmonised approach in relation to crossings (ICPC, 2023a). MLPL will abide by the guidelines wherever practicable. The guidelines are outlined in Section 7.2.2.1.6 (Cable installation on hard seabed and across third-party seabed infrastructure).

Predicted residual impacts

The following sections assess the residual impacts of cable installation and protection at crossings over existing seabed infrastructure on offshore marine ecology.

Offshore cable crossing impacts on seabed habitats and benthic communities

The Alcatel telecommunications cable crossing is located at an average depth of 59 m, which is within the sandy seabed habitat of offshore Zone 2 (KP 15 to KP 88) in Table 7-9

The predicted impacts of the loss of sandy seabed habitats are assessed to have a residual impact significance rating of ***Very low***. This is based on a sandy seabed habitat sensitivity of *Low* due the common and wide distribution of the seabed habitat type and a magnitude of impact of *Negligible* given the very extensive area of similar unimpacted sandy seabed within the palaeochannel. The very small loss of sandy seabed habitat will be countered by a similar area of rock fill and/or rock mattresses, which will represent a transition from soft-sediment seabed habitat to hard seabed habitat with higher structural diversity (e.g., greater porosity and void spaces as well as nooks and crannies within the rock mattress voids).

While the benthic communities the pre crossing sandy seabed will be lost and cannot recover, the replacement rock fill or rock mattresses offers a new source of hard seabed, which presents surface attachment sites suitable for colonisation and establishment of benthic encrusting algae and macroalgal holdfasts (see below). Consequently, colonisation and establishment of hard seabed benthic fish and macroinvertebrate communities of the new habitat is expected to occur over two or more years.

Overall, the predicted residual impacts of the crossing of Alcatel's subsea telecommunications crossing on the existing sandy seabed benthic communities has been assessed as having a residual impact significance rating of ***Very low***. This is based on an existing benthic community sensitivity of *Low* due to its common and widespread distribution and magnitude of impact *Negligible* given the very small area of impacts (300 m^2) within a very large expanse of unimpacted similar sandy seabed habitat. Compared to the previous sandy seabed benthic communities, the replacement hard seabed habitat may provide a localised new hard seabed habitat of higher structural diversity with a consequential increase in abundance and biodiversity at the same location.

Offshore cable crossing impacts on water quality

The pre-lay cable crossing method at the Alcatel telecommunications cable crossing will involve rock placement to cover and protect the existing Alcatel cable. In addition, protection of the cable may adopt rock fill placement followed by rock mattress protection. In general, crushed loose rock used in rock emplacement will have already been washed at the source (e.g., quarry or storage area). However, during targeted rock placement rock at the crossing, the loose rock will pass through the water column may generate low-level turbidity plumes due to abrasion and any sediment residual fines that may be present. Further suspended sediment plumes may occur at the point of contact of the loose rock with the sandy seabed. The lowering of rock mattresses to the seabed is not expected to generate any turbidity plumes of significance.

The predicted residual impacts on marine water quality at the crossing of the Alcatel telecommunications cable are assessed to have a residual impact significance rating of ***Low***. This is based on a water quality sensitivity of *High*, given the long-term surface water quality data for offshore Bass Strait (Section 6.2.3.2) and assuming a well-mixed water column, and a magnitude of impact of *Negligible* given the short-term increased suspended sediment loadings and associated turbidity. Water quality recovery will be rapid (in the order of up to an hour) once active rock emplacement is completed. Any residual turbidity plumes will disperse and dilute in the direction of surface, mid-water, and bottom currents, reaching background values of SSC (<2 mg/L) and turbidity (<5 NTU) within estimated distances usually no more than a few kilometres, which is based on modelling and observations of dredging impacts on water quality from sediment turbidity plumes dispersing and diluting in the direction of near-surface, midwater, and bottom water currents (Kim et al., 2021; PMSS, 2017).

7.2.3 Underwater noise impacts

This section assesses the impacts of project-generated underwater noise on selected noise sensitive marine fauna. The primary underwater noise sources are generated during construction. However, for the purposes of this report, operational noise and decommissioning noise sources are also mentioned.

7.2.3.1 Background information

Background information and data relevant to the underwater noise impact assessment are summarised in the following subsections.

7.2.3.1.1 Project area for underwater noise impact assessment

In terms of the present underwater noise impact assessment, the project area includes the local environment along the north-south alignment of the proposed interconnector across Bass Strait, as well as a buffer zone of up to 20 km (i.e., 10 km either side of the alignments) within which low-frequency underwater noise may be expected to propagate. The 10-km buffer zone straddling the project's alignment is based on the loudest noise source (i.e., the cable lay ship source level of 185 dB re 1 μPa at 1 m), which attenuates to the lower range acoustic behavioural threshold of 130 dB re 1 μPa rms for eliciting subtle behavioural effects in low-frequency hearing cetaceans at about 4.6 km east or west of the project's alignment. In addition, at about 10 km distance from the project alignment, the underwater noise generated by the cable lay ship at this distance merges with the existing background general shipping noise level within Bass Strait.

7.2.3.1.2 Underwater sound terminology and metrics and noise prediction methods

Prior to assessing under water noise impacts to marine fauna, a variety of underwater sound metrics exist for the physical description of underwater sounds and sound terminology and measurement units are summarised below.

The basic measurement unit is the decibel (dB). Sounds travelling in water are measured using a logarithmic decibel (dB) scale, thus a 10 dB increase represents a ten-fold increase in power, a 20 dB increase represents a 100-fold increase, and a 30 dB would be a 1,000-fold increase. Decibel measurements are expressed as a ratio between measured and reference pressure values.

In this report, all underwater sound pressure levels (SPL) are reported in units of dB re 1 μPa. The source sound pressure level is referenced back to a representative distance of 1 m from an assumed point source and expressed in units of dB re 1 μPa at 1 m. This source SPL referenced to 1 m allows calculations of sound levels in the far-field. In most cases, the 1 m distance is a theoretical reference point that can rarely be measured in practice. For example, a super tanker may be hundreds of metres in length and therefore forms a very large, distributed source and, as a result, the actual sound pressure levels in the near-field zone (i.e., close to the ship) will be lower than predicted.

In some cases, the measured underwater noise source level is based on measurements taken at greater distances (e.g., tens of metres) and back calculated to the 1-m reference point. Where multiple measurements have been made, the measurement generally the closest to the source has been quoted as this is likely to have fewer errors associated with sound propagation (Wyatt, 2008).

Underwater sound metrics

There are many measurement units presented in the scientific literature (e.g., Ellison and Frankel, 2012; Ainslie and de Jong, 2016; Hawkins et al., 2015). Acoustic measurement units that are commonly used in the scientific literature to present measured, predicted or received sound levels include the following:

- Sound Pressure Level (SPL):
  - average noise level over the measurement period expressed in units of dB re 1 μPa. Continuous sources, such as vibratory piling (or vibropiling) and shipping, are commonly described in terms of SPL.
- Sound Exposure Level (SEL):
  - total noise energy over the measurement period expressed in units of dB re 1 $\mu Pa^2 \cdot s$. The SEL is commonly used for impulsive sources (e.g., seismic airguns, impact pile driving, explosions and geophysical surveys using echosounders) because it allows a comparison of the energy contained in impulsive signals of different duration and peak levels. For impulsive sources, such as impact piling and blasts, the measurement period is the time duration that contains 90% of the sound energy (Southall et al., 2007). SEL may also be measured over the duration of an impulse sound or cumulatively over 24 hours (NMFS, 2018).
- Mean squared pressure (root-mean-square; rms):
  - the mean squared pressure is the decibel value of the mean of the squared pressure over a defined period of a signal and is expressed in units of dB re 1 μPa_{msp}.
  - the SPL unit of dB re 1 μPa_{msp} is equivalent to dB re 1 μPa_{rms}, which is the SPL received by an underwater microphone or a marine animal.
- Zero-to-peak[9] sound pressure level:
  - maximum noise level recorded during the measurement period expressed in units of dB re 1 μPa_{pk}. The peak level is commonly used as a descriptor for impulsive noise sources.
- Peak-to-peak sound pressure level:
  - difference between the maximum and minimum noise level recorded during the measurement period, expressed in units of dB re 1 $\mu Pa_{pk\text{-}pk}$. The peak-to-peak level is used as a descriptor for impulsive noise sources.
- Spectral density level:
  - the convention for displaying frequency spectra is to reduce the bandwidth of the measurement (which may be across several Hertz) to 1 Hz, which gives units of dB re 1 $\mu Pa^2/Hz$ and represents the average sound pressure for each band of width 1 Hz. These are termed spectral level units and can be readily compared between sources as they offer a standardised frequency bandwidth for the measurement. Note that these units are sometimes expressed as dB re 1 μPa/√Hz).

All underwater sound pressure levels (SPLs) referenced in this report are expressed in terms of source SPL (dB re 1 μPa at 1 m) for non-impulsive noise source levels and dB re 1 μPa_{rms} for received non-impulsive levels (i.e., noise level experienced by a receptor such as a whale or what a hydrophone would receive).

All underwater sound exposure levels (SELs) are expressed in terms of source SEL (dB re 1 $\mu Pa^2 \cdot s$ at 1 m) and received cumulative SEL_{cum} (dB re 1 $\mu Pa^2 \cdot s$) for impulsive noise sources (if present). The cumulative SEL may be for 24 hours (SEL_{24hrs}) or cumulated over shorter time periods such as such as a one hour (SEL_{1hr}), which is relevant to assessing acoustic impacts of mobile sources of underwater noise, such as a vessel passing a particular location.

[9] Sometimes simply called ‘peak level’; however, this term is ambiguous as it can be interpreted either as 'peak (sound pressure level)' or ‘(peak sound pressure) level’ (TNO, 2011).

Sound propagation and transmission loss modelling

Two methods were used to calculate distances (metres) to nominal isopleths as well as isopleths representing acoustic threshold criteria for selected hearing groups of marine fauna:

- Geometric spreading loss equations.
- Computer modelling.

Geometric spreading laws

Where a noise source is detectable to marine fauna and has a sound pressure level that exceeds the behavioural disturbance criteria for selected species, a simple but conservative propagation loss model is typically used to estimate the range of potential behavioural disturbance from the noise source.

Propagation of root-mean-square (rms) sound pressure and range estimation is based on geometric spreading loss equations:

- **Spherical spreading loss equation** (20 $Log_{10}R$), where R is the radius in metres for use in the dep eater of Bass Strait. Spherical spreading results in a general 6 dB decrease in the intensity of noise per doubling of distance.
- **Practical spreading loss equation** (15 $Log_{10}R$), where R is radius in metres for use in shallow marine waters less than 50 m deep (e.g., the Tasmanian and Victorian nearshore zones). Practical spreading results in a general 4.5 dB decrease in the intensity of noise per doubling of distance.
- **Cylindrical spreading loss equation** (10 $Log_{10}R$), where R is radius in metres for use in very shallow marine waters less than 15 m deep (e.g., the Tasmanian and Victorian nearshore zones). Practical spreading results in a general 3 dB decrease in the intensity of noise per doubling of distance.

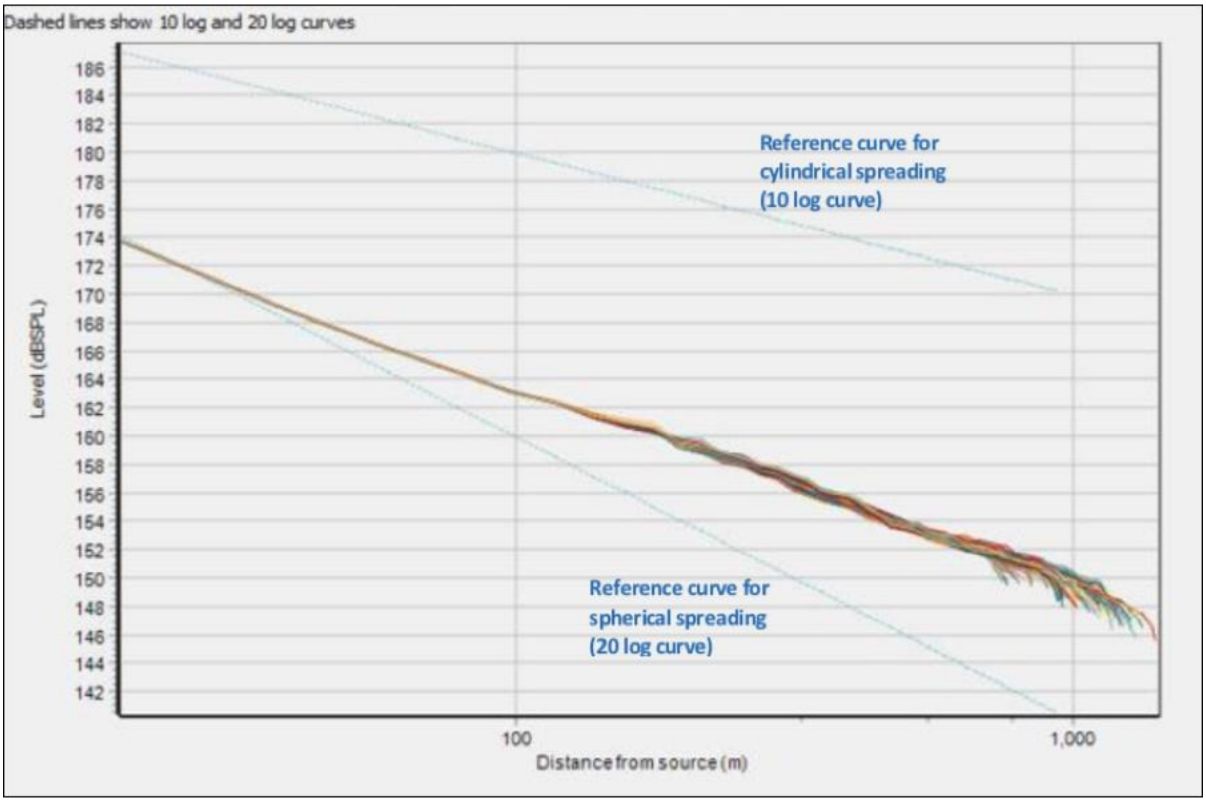
Note that the transition from 20 $log_{10}R$ to 15 $log_{10}R$ to 10 $log_{10}R$ is a continuous one, in that the surface of an expanding sound field (ray) does not instantly become a cylinder once the ray encounters a boundary.

In the case of Bass Strait with an average depth of 50 m, the practical spreading loss equation is most suitable for range estimation.

Numerical modelling

Based on 3D modelling inputs and using dBSea modelling software, Marshal Day Acoustics New Zealand (MDA, 2022) calculated propagation relationship curves shown in Figure 7.5. The curves depict the predicted reduction in noise levels with increasing distance from the noise source location. For this purpose, the reduction in noise level is the difference between the source noise level and the predicted noise level at the height within the water column where the predicted noise level is highest.

The trend of the predicted propagation curves is mathematically characterised by a 15.74 x log (distance) relationship. This result supports the use of a more general '15 x log' approach (i.e., the 15 Log 10 R practical spreading loss equation above) for high-level modelling of noise levels in the vicinity of the project for all noise sources associated with the project. Notwithstanding, detailed modelling using dBSea software was used to determine propagation loss of species-weighted cumulative sound exposure levels (SEL_{cum}) for either 24-hour or 1-hour duration.



Source: MDA (2022). The two blue dashed curves depict the reduction for spherical and cylindrical sound propagation.

Figure 7.6: Change in noise level with distance, dB SPL (logarithmic and 360 slices)

Numerical modelling of underwater noise propagation

MDA (2022) undertook numerical modelling of underwater noise propagation using dBSea software based on 3D modelling inputs. The modelling included a parabolic equation solver for below 2 kHz and a ray trace solver for above 2 kHz. A more detailed description of the underwater noise modelling inputs is given in Attachment D (EGC, 2023) of the present report.

7.2.3.1.3 Vibrations and particle motion

Some marine fauna species are capable of sensing both particle motion and sound pressure, other marine fauna are only capable of sensing vibrations and particle motion.

Sound pressure is the variation in hydrostatic pressure caused by the compression and rarefaction of particles as the sound wave propagates. Sound is propagated vibratory energy and put simply by Gans (1992), a sound wave propagates because particles next to a vibrating source are moved backwards and forwards in an oscillatory motion; these particles then move the particles next to them and so on, resulting in the propagation of vibratory energy. The particles of the medium do not travel with the propagating sound wave but transmit the oscillatory motion to their neighbours.

Vibrations and particle motion may be expressed in terms of the particle displacement (in metres), or its time derivatives such as particle velocity (metres per second, m/s) or particle acceleration (metres per second squared, m/s^2). Sound intensity is the product of the sound pressure and the particle velocity, for which the SI units are watts per metre squared, ($watts/m^2$) (Popper and Hawkins, 2019).

A literature review did not reveal any particle motion threshold criteria that could be used to assess impacts of vibrations or particle motion on marine organisms. While there are instruments available to measure particle motion in terms of either particle displacement, velocity or acceleration, there have been very few measurements made of the sensitivity of different marine fauna to particle motion.

There is an absence of peer-reviewed vibration and particle motion threshold criteria for those marine fauna that are sensitive to vibrations and particle motion (e.g., sharks, decapod crustaceans, cephalopods, and bivalve molluscs). For the purposes of this report, an impact assessment of vibrations and/or particle motion have not been undertaken. Notwithstanding, when a vibration source has been identified, the effects on potentially sensitive marine fauna have been assessed qualitatively.

7.2.3.1.4 Existing background noise

Prior to assessing the underwater noise impacts of the construction and operation of the project, a description of existing levels of background (or ambient) noise within Bass Strait and the Victorian and Tasmanian nearshore environments is required for comparison with potential project-generated underwater noise.

A review of the literature did not reveal any field measurements of underwater noise in Bass Strait or the nearshore zones. Therefore, an analysis of existing sources of natural and anthropogenic noise and their measurements was undertaken, including a review of similar coastal habitats elsewhere in Australia and overseas that could be used as comparative analogues (EGC, 2023; Attachment D). Based on the literature review and analysis in Attachment D, the following average ambient noise levels and ranges have been adopted for the purposes of the present report:

- Victorian nearshore location (Waratah Bay):
  - average of 105 dB re 1 µPa rms (range 90 to 145 dB re 1 µPa rms).
- Central Bass Strait location (mid-point):
  - average of 95 dB re 1 µPa rms (range 90 to 110 dB re 1 µPa rms).
- Tasmanian nearshore location off Heybridge:
  - average of 107 dB re 1 µPa rms (range 95 to 135 dB re 1 µPa rms).

Note that in both the Victorian and Tasmanian nearshore locations, the upper range of ambient background noise will tend to increase during the summer months when small watercraft density and frequency increases in coastal waters due to increased recreational boating and fishing.

7.2.3.2 Project underwater noise sources

Underwater noise impacts have been assessed for modelling locations in nearshore Tasmania, offshore Bass Strait (mid-point), and nearshore Victoria in Waratah Bay.

The main sources of project underwater noise are:

- Cable lay ship maintaining station under dynamic positioning and laying cable.
- Nearshore cable pulling and lay operations.
- Cable installation in soft seabed sediments using a jet trencher.
- Nearshore cable installation on hard seabed with targeted rock placement.

The assessment of underwater noise is based on description of underwater noise sources in Attachment D (EGC, 2023).

The following underwater noise source levels of project vessels or cable installation activities have been adopted in this report and are based on a review of similar marine interconnector projects and offshore wind farms as presented in Attachment D (EGC, 2023):

- Large cable lay ship (e.g., CS *Giulio Verne* as a surrogate):
  - Source level of 185 dB re 1 µPa_{rms} at 1 m.

- Cable installation and burial using a seabed jet trencher in burial mode (e.g., HELIX T-1200 jet trencher):
  - Source level of **150 dB re 1 μPa$_{rms}$ at 1 m** for the seabed trencher in burial mode.
  - Source level of **180 dB re 1 μPa$_{rms}$ at 1 m** for the jet trencher's host vessel at 0.5 knots.
- Nearshore floated cable pulling to shore using a spread of small boats:
  - Source level of **145 dB re 1 μPa$_{rms}$ at 1 m** for boats idling.
  - Source level of **165 dB re 1 μPa$_{rms}$ at 1 m** for boats manoeuvring floated cables.

7.2.3.3 Marine fauna hearing groups of interest

The marine fauna species or hearing groups of interest for assessing acoustic impacts of the project include:

- Low-frequency (LF) hearing cetaceans:
  - baleen whales (e.g., Humpback, southern right, blue whale, sei, fin whales, and minke whales).
- Mid-frequency (MF) hearing cetaceans:
  - dolphins (e.g., bottlenose dolphins, common dolphins)
  - whales (e.g., sperm, false killer, long finned pilot, killer whale, strap-toothed whales)
- High-frequency (HF) hearing cetaceans:
  - whales (e.g., pygmy sperm and pygmy right whales).
- Pinnipeds (seals and sea lions):
  - phocid pinnipeds (PW) – earless or true seals (e.g., leopard seals and crab-eater seals)
  - Otariid pinnipeds (OW) – eared seals (e.g., Australian fur and long-nosed fur seals).
- Sea turtles (e.g., loggerhead, green, olive ridley, leatherback turtles).
- Fishes:
  - *Osteichthyes* (bony fishes including those with or without swim bladders).
  - *Chondrichthyes* (cartilaginous fishes including sharks, rays, and skates).
- Macroinvertebrates:
  - pelagic macroinvertebrates (e.g., molluscs, including sea slugs and cephalopods (squid and calamari); and jellyfishes).
  - benthic macroinvertebrates (e.g., decapod crustaceans such as lobsters and crabs, molluscs such as scallops, abalone, and octopuses).

The last marine faunal group of macroinvertebrates mostly sense particle motion rather than sound pressure; however, some groups such as cephalopods respond to sound pressure.

7.2.3.4 Impact assessment approach

The impact assessment approach uses a modified significance assessment method and/or acoustic threshold criteria for injury to tissues or organs of marine fauna (including permanent or temporary hearing loss) and behavioural disturbance thresholds that have been published in the peer-reviewed scientific literature.

7.2.3.4.1 Underwater noise significance assessment method

The significance assessment method using the standard approach outlined in Section 5.3.2 (Significance assessment method) is not appropriate for assessing underwater noise impacts as the sensitivities need to relate specifically to underwater noise. For example, under the standard sensitivity criteria outlined in Table 5.2, the great white shark (*Carcharodon carcharias*), which is known to occur in the project area, has a sensitivity of *Moderate*, due to its classification of vulnerable under the EPBC Act. However, in the case of assessing underwater noise impacts to this species, its sensitivity is classified as *Very low* as sharks in general are not sensitive to underwater sound pressure and only respond to particle motion and vibrations (Myrberg, 2001). Accordingly, different sensitivity criteria and magnitude of impact criteria are used to assess the residual impact significance ratings of underwater noise to sound-sensitive marine fauna. Therefore, any listings of threatened species (e.g., critically endangered, endangered and vulnerable) have been removed from the table of sensitivity criteria when assessing underwater noise impacts.

Acoustic sensitivity criteria

Table 7-11 presents criteria for assessing the sensitivity of marine receptors (i.e., sound-sensitive marine fauna) to underwater sound pressure, which are met if one or more of the definitions apply.

Table 7-11: Criteria for assessing the sensitivity of a receptor to underwater noise

Sensitivity	Description
Very high	• The environmental receptor is intact and retains its intrinsic value. • It is unique to the environment in which it occurs. It is isolated to the affected area or system, and is poorly represented in the broader region, territory, country or globally. • It is fragile and predominantly unaffected by existing threatening processes. Small changes will lead to substantial changes to the prescribed value. • It is not widely distributed throughout the system/area and consequently will be difficult or impossible to replace.
High	• The environmental receptor is relatively intact and retains most of its intrinsic value. • It is locally unique to the environment or community in which it occurs, with few regionally available alternatives. • It is predominantly unaffected by existing threatening processes. Small changes may lead to changes to the environmental receptor. • It is not widely distributed throughout the project area or Bass Strait and consequently recovery potential may be limited.
	Group 4* fishes with a swim bladder connected to their ear or gas-containing spheres (*prootic bullae*) near their ear. All these fishes are members of the herring family and relatives (*Clupeiformes*) such as sardines, anchovies. Fishes within this group may be classified as having high sound pressure sensitivity.
Moderate	• The environmental receptor is in a moderate to good condition despite it being exposed to threatening processes. It retains many of its intrinsic characteristics and structural elements. • It is relatively well represented in the areas or systems in which it occurs, but its abundance and distribution are limited by threatening processes. • Threatening processes have reduced the environmental receptor's resilience to change. Consequently, changes resulting from project activities may lead to degradation of the environmental receptor. • Replacement of unavoidable losses is possible due to its abundance and distribution.
	Group 3* fishes with a swim bladder close to their ear and having some type of structure that is mechanically coupled to the inner ear. Examples include fishes within the superorder *Ostariophysi*, which are mainly freshwater species but include marine catfishes. This fish group may be classified as having a medium sensitivity to sound pressure.

Sensitivity	Description
Low	• The environmental receptor is in a poor to moderate condition resulting from existing threatening processes that have degraded its intrinsic value. • It is not unique or rare and numerous representative examples exist throughout the area or system. • The environmental receptor is widely distributed and abundant through the area or system. • There are slight detectable responses to change in the environmental receptor and recovery is rapid. • The abundance and wide distribution of the environmental receptor ensures replacement of unavoidable losses is assured.
	Group 2* fishes having a swim bladder distant from their ear but have no known structures in the auditory system that would enhance hearing of sound pressure. This fish group may be classified as having a low sensitivity to sound pressure.
	Other marine fauna that are weakly responsive to sound pressure or have low hearing sensitivity include pinnipeds, sea turtles and Little Penguins.
Very low	• The environmental receptor is in a poor condition due to existing threatening processes, which have degraded its intrinsic value. • It is not unique or rare and representative examples exist abundantly throughout the study area. • It is abundant and widely distributed throughout the project study area and wider Bass Strait and regional seas. • There are no detectable responses to change, or change does not result in further degradation of the environmental receptor. • Insensitivity to underwater noise at or just above ambient background noise levels; that is within natural variability of ambient underwater noise.
	Group 1* fishes that do not have a swim bladder or other gas-filled organ and do not sense sound pressure. This fish group is not sensitive to sound pressure but to vibrations and particle motion only.
	Other marine fauna that are not sensitive to sound pressure but to vibrations and particle motion only. Examples includes marine invertebrates including decapod crustaceans, cephalopods and other molluscs which Lovell et al., (2005), Hu et al. (2009); and Charifi et al. (2017) suggested they are comparable to those of fishes without a mechanically coupled swim or gas bladder to the inner ear, such as the Group 1 fishes above.

Notes: * denotes fish groups determined by Popper (2012).

The principal sound sensitive receptors include a range of pelagic marine fauna such as cetaceans (e.g., baleen and toothed whales), pinnipeds (e.g., seals and sea lions), sea turtles, and fishes, and benthic fishes and invertebrates. Note that additional emphasis on the sensitivity of fishes in Table 7-11 as they are the most abundant sound sensitive marine fauna likely to be exposed to project-generated underwater noise.

Criteria for magnitude of impact

A review of the scientific literature revealed that the impacts of underwater noise on marine species can be divided into three main categories: a) pathological, b) physiological and c) behavioural. In this section, the magnitude of impact has therefore been based on criteria that consider these categories.

Spatial and temporal aspects are considered after the sensitivity and magnitude criteria have been combined in the residual significance matrix. This arises because the areal extent (vertical or horizontal distance) or volumetric extent (volume of water) of underwater sound propagation is not known until sound propagation or transmission loss equations or modelling have been applied. The distances (e.g., radius) to acoustic threshold isopleths for a given sound sensitive receptor can then be calculated.

Table 7-12 presents criteria for assessing the magnitude of impact of underwater noise to marine fauna.

Table 7-12: Criteria for assessing the magnitude of impacts to marine fauna

Magnitude	Description
Very high	• An impact that is long lasting or severe in the very short term and leads to substantial and irreversible changes to the environmental receptor. • Mortality of marine fauna when exposed directly to high-energy, impulsive noise sources or extended exposure to low-energy non-impulsive continuous broadband noise. • Acoustic barotrauma results in rupture of swim bladder, or non-auditory bleeding, or substantial haemorrhaging of eyes and tissues (e.g., kidney or liver), which will lead to delayed mortality. • Acoustic criteria for permanent hearing loss (PTS threshold onset) are exceeded causing permanent hearing loss due to auditory cell death or nerve damage that is not reversible. • Sound-sensitive marine fauna permanently displaced vertically or horizontally from the sound field for duration of noise-generating activity. • Major shift in individual or group distribution (aggregation or separation). • Disruption of migration, breeding or feeding patterns. • High level of acoustic auditory masking of communications and/or the hearing of biologically relevant sounds.
High	• An impact that is short term and partially within the project's area of direct influence but extends beyond the area of acoustic disturbance to the surrounding area. • Acoustic criteria for permanent hearing loss (PTS threshold onset) are not exceeded. • Acoustic criteria for temporary hearing loss (TTS threshold onset) are exceeded but are reversible within weeks. • Acoustic threshold criteria for disruptive behavioural disturbance are exceeded. • Major changes in locomotion speed, direction or dive profile and major avoidance of sound sources and major shift in individual or group distribution (aggregation or separation). • Sound-sensitive marine fauna is temporarily displaced vertical or horizontally from the sound field for the duration of noise-generating activity. • Moderate level of auditory masking of biologically important sounds (e.g., vocalisation) and/or prolonged cessation or modification of vocal behaviour.
Moderate	• An impact that is short term and is contained and localised within the project's direct area of influence. • Acoustic criteria for permanent hearing loss (PTS threshold onset) are not exceeded. • Acoustic criteria for temporary hearing loss (TTS threshold onset) are exceeded but are reversible within a few days. • Moderate changes in locomotion speed, direction or dive profile and moderate avoidance of sound sources (temporary vertical and lateral displacement) and moderate shift within group distribution (aggregation or separation).

Magnitude	Description
	• Sound-sensitive marine fauna temporarily displaced vertically or horizontally from sound field but returns to previously occupied areas when the noise source ceases. • Low level of auditory masking of biologically important sounds (e.g., vocalisation) with minor cessation or modification of vocal behaviour.
Low	• An impact that is very short term and temporary and highly localised in extent. • Acoustic criteria for permanent hearing loss (PTS threshold onset) are not exceeded. • Acoustic criteria for temporary hearing loss (TTS threshold onset) are not exceeded. However, temporary hearing losses below the TTS threshold onset criteria are reversible within minutes to hours. • Disruptive behavioural disturbance criteria are not exceeded. • Minor changes in locomotion speed, direction, or dive profile but no avoidance of sound sources, and temporary orientation behaviour within sound fields during noise-generating activity. • Sound-sensitive mobile receptors not displaced vertically or horizontally from sound field during noise-generating activity through habituation. • Auditory masking of biologically relevant sounds is weak except when near to a noise source. • Brief or minor cessation of vocal behaviour in soniferous fauna during noise generating activities
Negligible	• An impact that is temporary and highly localised in extent within the project's immediate vicinity. • Acoustic criteria for permanent hearing loss (PTS threshold onset) are not exceeded. • Acoustic criteria for temporary hearing loss (PTS threshold onset) are not exceeded. However, temporary hearing losses below the TTS threshold onset criteria are reversible within a few minutes. • Acoustic disruptive disturbance criteria are not exceeded. • Subtle behavioural reactions may be present (e.g., startle responses) but behavioural avoidance and displacement are low or to very low. • Brief and temporary orientation response to sound field during project noise-generating activities. • Sound-sensitive mobile receptors remain within sound field during noise-generating activity through habituation and/or perceiving sound field as non-threatening. • Auditory masking of biologically relevant sounds is generally absent but may occur in very close proximity to noise source. • No significant cessation or modification of vocal behaviour in sound-producing fauna.

Residual impact significance rating

The residual impact significance rating for assessing underwater noise impacts to a receptor is determined by combining the sensitivity of the receptor (Table 7-11) and the magnitude of the impact (Table 7-12) on that receptor via the significance assessment matrix presented as Table 7-13.

Table 7-13: Residual impact significance ratings matrix

Magnitude of impact	Sensitivity of environmental value				
	Very high	**High**	**Moderate**	**Low**	**Very low**
Very high	Major	Major	Major	High	Moderate
High	Major	Major	High	Moderate	Low
Moderate	High	High	Moderate	Low	Low
Low	Moderate	Moderate	Low	Low	Very low
Negligible	Low	Low	Low	Very low	Very low

7.2.3.4.2 Assessment method using acoustic threshold criteria for marine fauna

A literature search was carried out to identify and collate Australian and international underwater non-impulsive and impulsive noise criteria for marine fauna, which may be applicable to the impact assessment of project-generated underwater noise. Where peer-reviewed acoustic threshold criteria are available, these have been used in the underwater noise impact assessment.

For this assessment, non-impulsive noise acoustic criteria are only used, as there are no significant impulsive noise sources (e.g., underwater blasting, seismic survey air guns, or impact pile driving) associated with the project. All project noise sources relating to project construction, operations and decommissioning generate continuous or intermittent non-impulsive noise broadband noise (e.g., vessels, rock placement, and cable installation and burial by use of a jet trencher used in burial mode).

Acoustic criteria for cetaceans

Non-impulsive noise threshold criteria are available for hearing damage in cetaceans and for behavioural disturbance of cetaceans.

Non-impulsive Sound Exposure Level (SEL) thresholds for cetaceans

Table 7-14 presents non-impulsive noise PTS and TTS onset acoustic threshold criteria for cetaceans based on the most recent criteria by NMFS (2018), which updates the technical guidance on acoustic thresholds for onset of permanent and temporary threshold shifts published by NOAA (2016) and Finneran (2016).

The non-impulsive noise threshold criteria for cetaceans in Table 7-14 have been adopted in the present report for subsequent assessments of project-generated non-impulsive underwater noise hearing impacts to cetaceans. However, the 24-hr SEL thresholds in Table 7-14 are based on the critical assumption that a cetacean remains stationary, or at a constant exposure range from a noise source, during an entire 24-hour period, which is an unlikely scenario (MDA, 2023; Attachment G).

Table 7-14: Non-impulsive Sound Exposure Level (SEL) thresholds for cetaceans

Cetacean functional hearing group	Hearing range	Non-impulsive Sound Exposure Level ($SEL_{24\text{-}h}$) (dB re 1 µPa^2·s)	
		PTS threshold	TTS threshold
Low frequency (LF) cetaceans	7 Hz to 35 kHz	199	179
Mid-frequency (MF) cetaceans	150 Hz to 160 kHz	198	178
High frequency (HF) cetaceans	227 Hz to 160 kHz	173	153

Source: NMFS (2018). SEL threshold criteria include a marine mammal auditory weighting (Finneran, 2016) and the recommended accumulation period is 24 hours (NMFS, 2018).

Non-impulsive Sound Pressure Levels (SPL) behavioural threshold criteria for cetaceans

A literature search revealed that many regulatory agencies and cetacean researchers identify a received sound pressure level of 120 dB re 1 μPa rms for non-impulsive continuous broadband noise as a minimum threshold level above which disturbance to whales may occur (Southall et al., 2007; 2019; NMFS, 2018; McCauley and Duncan, 2000).

McCauley and Duncan (2000) consider that the 120 dB re 1 μPa rms the level above which baleen whales will largely avoid an area due to continuous broadband underwater noise although some individuals may tolerate higher levels for short periods. However, the application of the 120 dB re 1 μPa rms threshold can be problematic because this threshold level can be either at or below the ambient noise level of certain locations (Pommerenck and Reyff, 2017; Blees et al., 2017). This is the case for the current project, since the existing background upper range values in the Tasmanian nearshore and Victorian nearshore are 135 and 145 dB re 1 μPa rms, respectively. Therefore, a conservative SPL of 130 dB re 1 μPa rms has been adopted as a threshold level for subtle behavioural responses in cetaceans. Notwithstanding, this report adopts the 120 dB re 1 μPa rms threshold for subtle behavioural responses for cetaceans in the offshore waters of Bass Strait where the background upper range value is estimated to be 120 dB re 1 μPa rms.

The following SPL threshold levels for behavioural disturbances are based on humpback whales (the most studied baleen whale) and have been adopted for all cetaceans in this report.

- Lower range acoustic behavioural threshold of **130 dB re 1 μPa rms** for nearshore waters:
  - Threshold level above which more subtle behavioural responses such as increased presence at the surface, less frequent diving, changes in breathing rate or swimming speed, and short-term avoidance which may be countered by habituation and desensitisation to continuous non-impulsive broadband noise.
- Lower range acoustic behavioural threshold of **120 dB re 1 μPa rms** for offshore waters:
  - Threshold level above which more subtle behavioural responses such as increased presence at the surface, less frequent diving, changes in breathing rate or swimming speed, and short-term avoidance which may be countered by habituation and desensitisation to continuous non-impulsive broadband noise.
- Upper range acoustic behavioural threshold of **160 dB re 1 μPa rms** for all waters:
  - Threshold above which disruptive behavioural responses may be expected such as sudden dives, abrupt movements, changes in swimming speeds, decreased foraging, and avoidance of the sound field by increasing distance from the sound source (either by moving away from the source or deviating around the noise field).

Acoustic criteria for pinnipeds

Non-impulsive noise threshold criteria are available for hearing damage in cetaceans and for behavioural disturbance of cetaceans.

Non-impulsive Sound Exposure Level (SEL) thresholds for pinnipeds

Table 7-15 summarises the pinniped group-weighted cumulative PTS and TTS onset threshold SELs for non-impulsive sounds.

Table 7-15: Non-impulsive noise PTS and TTS onset threshold criteria for pinnipeds

Pinniped hearing group	PTS cumulative	TTS cumulative
Phocidae (earless or true seals)	201 dB $SEL_{cum\ (pw)}$	181 dB $SEL_{cum\ (pw)}$
Otariidae (eared seals)	219 dB $SEL_{cum\ (ow)}$	199 dB $SEL_{cum\ (ow)}$

Source NMFA (2018). Cumulative SELs are weighted for phocid seals (pw) and *Otariid* seals (ow). PW = Phocid Weighted and OW = *Otariid* Weighted, which are pinniped group-weighting factors applied to the cumulative sound pressure level (SEL_{cum}).

Non-impulsive noise behavioural disturbance thresholds for pinnipeds

Based on NMFS (2018), the behavioural SPL threshold for both phocid and *Otariid* seals is 120 dB re 1 µPa rms. However, NMFS (2018) also state that the 120 dB re 1 µPa rms for non-impulsive continuous broadband noise may be adjusted if background ambient levels are above this level. For the purposes of the present report, the lower acoustic behavioural disturbance threshold criterion of **120 dB re 1 µPa rms** has been adopted for the offshore waters of central Bass Strait. However, a conservative higher acoustic behavioural disturbance threshold of **130 dB re 1 µPa rms** for non-impulsive continuous broadband noise has been adopted for nearshore Bass Strait waters, which takes account of the background ambient upper range values of 145 dB re 1 µPa rms and 135 dB re 1 µPa rms estimated for the Tasmanian and Victorian nearshores and allows upward adjustment of the NMFS (2018) threshold.

According to Southall et al. (2007) there is a general paucity of data relating to the effects of sound on pinnipeds. Most studies of sound effects on phocids have taken place in the northern hemisphere. Harris et al. (2001) in a study of underwater noise effects on northern hemisphere phocids using three species: ringed seals (*Pusa hispida*), bearded seals (*Erignathus barbatus*) and spotted seals (*Phoca largha*), found an onset of a significant behavioural responses at a received sound pressure level of between 160 to 170 dB re 1 µPa rms. However, larger numbers of animals showed no response at noise levels of up to 180 dB re 1 µPa rms. Based on this information, an SPL threshold of **160 dB re 1 µPa rms** has been adopted as an upper disruptive behaviour criterion for in-water phocids.

Acoustic criteria for sea turtles

Sea turtle hearing sensitivity is not well studied and there are no published noise level criteria for unconstrained, free-ranging sea turtles at sea. Avoidance reactions to seismic sources have been documented in caged turtles at levels between 166 and 179 dB re 1 µPa rms (McCauley et al., 2000; Moein-Bartol et al., 1995). The lower threshold level of 166 dB re 1 µPa rms is based on research by McCauley et al. (2000) who exposed caged turtles to the impulsive noise of a single airgun (Bolt 600B, 20 cubic inch chamber), increased swimming speed was noted above 166 dB re 1 µPa rms and more erratic behaviour above 175 dB re 1 µPa rms. This behavioural threshold is also recommended in Finneran (2017).

For the purposes of the present report, a conservative acoustic behavioural disturbance threshold of **175 dB re 1 µPa rms** has been adopted in this report as applicable to free-ranging sea turtles that may be exposed to non-impulsive, continuous broadband noise typical of the project's proposed marine construction activities and normal operations.

Popper et al. (2014) proposed that dual injury threshold levels of a cumulative SEL of 210 dB re 1 $\mu Pa^2 \cdot s$ (unweighted) and a peak SPL of 207 dB re 1 μPa_{pk} applicable to fish should apply to sea turtles. Table 7-16 presents the most recent updates to sea turtle behavioural and physiological threshold criteria for sea turtles (Hulton et al., 2020).

Table 7-16: Recent acoustic behavioural and physiological thresholds for sea turtles

Turtles species	Behavioural criterion	Physiological criteria for impulsive noise		
		PTS onset	TTS onset	GI Onset injury*
All	175 dB re 1 µPa$_{rms}$	204 dB re 1 µPa^2·s	189 dB re 1 µPa^2·s	243 dB re 1 µPa$_{pk}$
		232 dB re 1 µPa$_{rms}$	226 dB re 1 µPa$_{rms}$	

Source: Hulton et al. (2020). *GI onset injury denotes a gastrointestinal tract injury SPL of 50%.

The behavioural criterion of **175 dB re 1 µPa rms** in Table 7-16 has been adopted in this report. The gastrointestinal onset criterion is a non-standard acoustic threshold criterion and has therefore not been used. In addition, there are no PTS or TTS onset threshold criteria for non-impulsive broadband noise, so the impulsive noise threshold criteria for PTS and TTS onset in Table 7-16 are not relevant or used in this report, since impulsive noise sources are not present.

Acoustic criteria for Little Penguins

In general, there is very little known about the potential impacts of underwater noise to submerged Little Penguins. Little Penguins and other seabirds do not appear to have functional underwater hearing, and it is assumed therefore, that they are less sensitive to noise impacts than marine mammals (Mustoe, 2006). A literature review indicated that underwater hearing in penguins in general is poor. In the absence of published acoustic threshold criteria for underwater hearing in Little Penguins, the acoustic threshold criteria for Group 2 fish were adopted for Little Penguins as Group 2 fish are classified as having a low sensitivity to sound pressure (Popper, 2012). Therefore, Little Penguin sensitivity to underwater noise has been classified as *Low* (see Table 7-11 (Criteria for assessing the sensitivity of a receptor to underwater noise) in Section 7.2.3.4.1). For the purposes of the present report, the non-impulsive sound pressure level threshold of **150 dB re 1 µPa rms** has been adopted for behavioural responses in Little Penguins.

Acoustic criteria for fishes

Popper and Hawkins (2019) have published impulsive noise acoustic threshold criteria for three fish hearing groups for PTS threshold onset and TTS threshold onset. However, non-impulsive noise threshold criteria are not available for hearing damage in fishes.

Non-impulsive noise behavioural disturbance thresholds for fish

The US National Marine Fisheries Service (NMFS), and other agencies, currently use 150 dB re 1 µPa rms as the sound pressure level that may result in onset of behavioural effects (Caltrans, 2015). Other scientists also adopt the 150 dB re 1 µPa rms as a behavioural onset threshold for fish (Andersson et al. 2007, Wysocki et al. 2007, Mueller-Blenkle et al. 2010, Purser and Radford, 2011).

While there are problems with the 150 dB re 1 µPa rms criterion in that its origin and scientific basis is not known (Hastings, 2008), Popper and Hawkins (2019) consider that sound pressures above the 150 dB re 1 µPa rms are expected to cause temporary changes in behaviour such as startle responses, feeding disruption, area avoidance. Therefore, for the purposes of this report, the **150 dB re 1 µPa rms** has been adopted as an interim behavioural onset threshold for fish in the absence of any updated threshold criteria.

Acoustic criteria for marine invertebrates

A review of the scientific literature did not reveal any acoustic threshold criteria for various marine invertebrate groups. Based on a review of the hearing ranges and sensitivities of decapod crustaceans, cephalopods and molluscs, a common consensus was that these marine invertebrate groups lacked gas-filled chambers to sense sound pressure and their hearing capacities were comparable to fish without a mechanically coupled gas bladder to the inner ear (Lovell et al., 2005; Hu et al., 2009; Charifi et al., 2017). Therefore, acoustic threshold criteria for fish without a mechanically coupled gas bladder to the inner ear (Group 1 fish species – see Section 7.2.3.10.2 Hearing sensitivities of fishes) have been conservatively adopted for marine invertebrate groups of decapod crustaceans, cephalopods and molluscs.

7.2.3.5 Acoustic impacts to cetaceans

This section assesses underwater noise impacts to cetaceans arising from the cable lay ship during nearshore and offshore cable laying operations.

An underwater noise source level (SL) of **185 dB re 1 μPa$_{rms}$ at 1 m** has been adopted for the cable ship during cable lay operations as a worst-case scenario (EGC, 2023; Attachment D of this report). If residual impacts from this noise source to cetaceans are found not to be significant, then separate assessments of the project's quieter sound sources do not need to be assessed. Conversely, if significant impacts are predicted, then the other project noise sources will be assessed separately.

Cetacean species known to occur within the vicinity of the project's nearshore and offshore alignments and Bass Strait in general are described in Section 6.3.6 (Cetaceans).

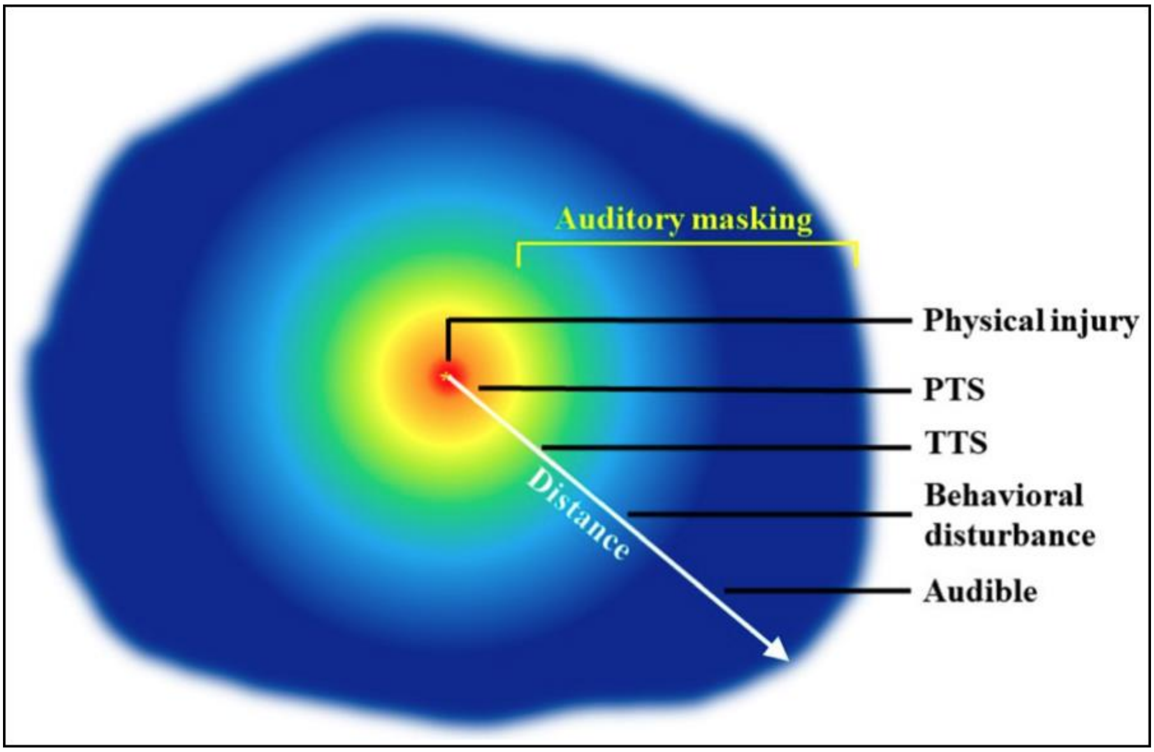
7.2.3.5.1 Potential impacts

Project-generated underwater noise significantly above existing background levels can have the following potential effects on cetaceans in descending order of severity:

- Mortality impacts at very high underwater noise levels or long exposures to intermediate noise levels.
- Physical injury and physiological impacts such as acoustic damage (tissue or gas-filled organs) and permanent hearing loss through loss of auditory cochlear hair cells (or permanently fatigued hair cell receptors). Hearing loss is measured by permanent threshold shift (PTS) onset for which cumulative SEL acoustic threshold criteria are available.
- Physiological effects such as temporary loss of hearing sensitivity, which is reversible.
- Behavioural impacts:
  - disruptive behavioural effects such as interferences in migration or other movements, displacement from foraging, breeding or resting habitats, swimming away from noise sources or bypassing (manoeuvring around) noise fields, shifts in individual or group distribution (aggregation or separation).
  - subtle behavioural effects such as minor changes in locomotion speed, direction, or dive profile but no avoidance of noise sources.
- Masking causing potential interference of biological relevant conspecific communications or mother-calf communications, the songs and/or mating calls of baleen whales (*Mysticeti*), and the calls and echolocation sounds of toothed whales (*Odontoceti*).

Acoustic Zones of Influence

One approach of attempting to assess the effects of underwater noise on cetaceans as well as other marine fauna (cetaceans, sea turtles and fishes) is the concept of acoustic zones of influence (Richardson et al., 1995). Table 7-11 shows a simple acoustic impact model based on the distance of the noise source from the receiver (receptor) such as a whale.



Source: Guan and Brookens (2021) based on the original concept by Richardson and Malme (1995). PTS is permanent threshold shift. TTS is temporary threshold shift.

Figure 7.7: Conceptual acoustic zones of influence

In Figure 7.7, the physical injury and permanent hearing loss (i.e., onset of permanent threshold shift or PTS) zones represent acoustic damage impacts to cetaceans whereas the zones of temporary hearing loss (i.e., onset of temporary threshold shift or TTS) and behavioural disturbance represent acoustic disturbance impacts. The zone of audibility is taken as the maximum potential radius of influence and is limited either by the hearing threshold of the cetacean under consideration or by the intensity of the sound related to ambient noise in that frequency range.

The zone of masking represents the range within the anthropogenic noise might obscure communication calls of marine mammals. For example, masking depends on the loudness of the call with the louder the call, the less likely it is to be masked, and two communicating whales close together will be less affected by masking noise than two animals further apart (Erbe, 2003).

Environmental performance requirements

The proposed EPRs for the acoustic impacts to cetaceans are presented in Table 7-17:

Table 7-17 EPRs for cetacean interaction management

EPR ID	Environmental performance requirement	Project stage
MERU07	**Develop and implement a marine fauna management plan.** Prior to commencement of marine construction, develop a marine fauna management plan to avoid or minimise impacts to marine fauna. The management plan should outline the approach to: • Managing interactions with marine fauna where there is not a specific species management plan required under EPR MERU08 and MERU09.	Construction / Operation

EPR ID	Environmental performance requirement	Project stage
	• Reporting and collation of information about siting of and interactions with marine fauna, including those covered by species specific management plans. • Protocols for incident management and reporting. • Protocols for managing injured seabird or coastal bird if discovered on a lit vessel. • Include species specific management plans as sub-plans. The measures in the plan must be consistent with the objectives of relevant EPBC Act recovery plans including • Recovery Plan for Marine Turtles in Australia (DoEE 2017a) • National Recovery Plan for threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC 2011) • Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC 2013c) • Sub-Antarctic Fur Seal and Southern Elephant Seal Recovery Plan (DEH 2004) • Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*)(DSEWPaC 2013b) The marine fauna management plan must be implemented during construction.	

MERU08	**Develop and implement a cetacean interaction management plan**
	Prior to commencement of marine construction, develop cetacean interaction management plan to avoid or minimise impacts to cetaceans during construction. The cetacean interaction management plan must:
	• Be developed in accordance with relevant guidelines including:
	  ○ EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales: Industry Guidelines (DEWHA 2008)
	  ○ Wildlife (Marine Mammals) Regulations 2019
	  ○ A guide to boating and swimming around whales, dolphins and seals (DELWP 2022)
	  ○ Wildlife Management. Whale and dolphin viewing guidelines (DNRE 2019b)
	• Define the area for visual monitoring for cetaceans that is appropriate for cable laying works.
	• Define precaution zones for maintaining a separation distance of cable laying works from cetacean and the distance at which works should be suspended when cetaceans approach.
	• Outline vessel-cetacean strike avoidance measures to minimise the potential for collision.
	• Include a procedure for marine mammal observations which may include the role of Marine Mammal Observers (MMOs) on construction vessels at or around active construction locations.
	The measures under the plan should be consistent with the goals of the EPBC Act Conservation Management Plan for the Blue Whale (DoE 2015f) and Conservation Management Plan for the Southern Right Whale (DSEWPaC 2012c).
	The cetacean interaction management plan should be a sub-plan to the marine fauna management plan (EPR MERU07) and be implemented during construction.
		Construction/ Operation

Potential mitigation and management measures

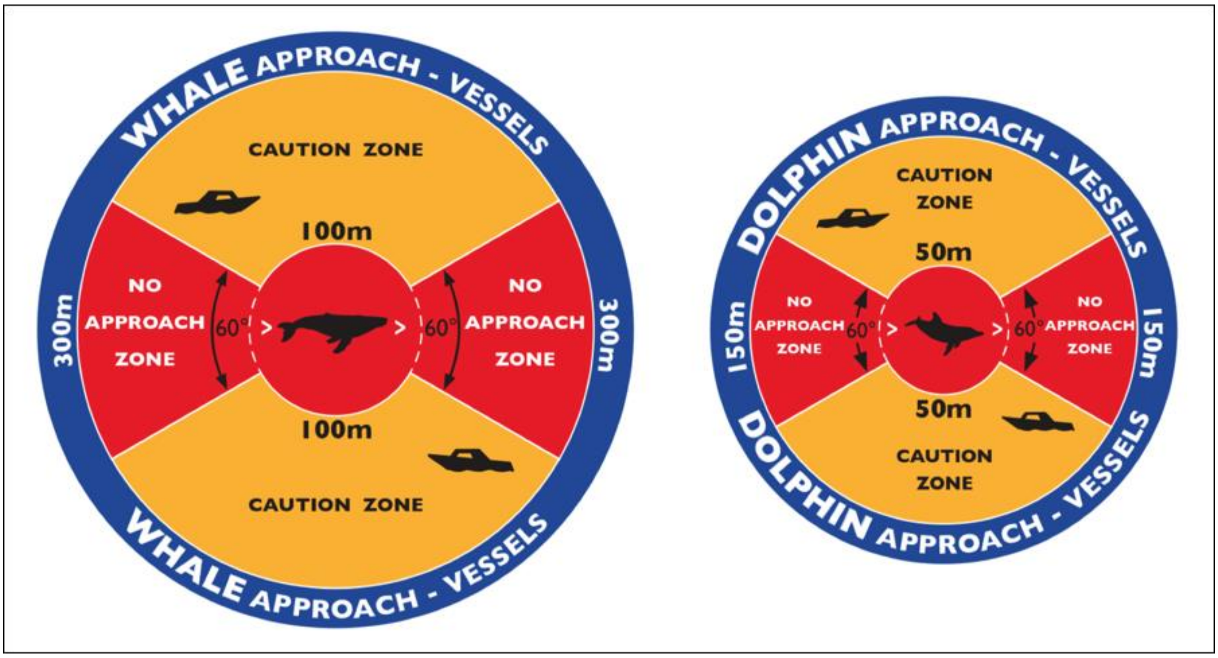
Account will be taken of some aspects of the EPBC Act Policy Statement 2.1 Interaction between Offshore Seismic Exploration and Whales: Industry Guidelines (DEHWA. 2008), which determines suitable whale exclusion zones with an unweighted Sound Exposure Level (SEL) threshold of 160 dB re 1 μPa^2·s. This threshold value may be used to determine whale exclusion zones where seismic surveys must lower their acoustic power output (or shut down completely) to prevent significant exposure to sound levels that could induce TTS. Note that Policy Statement 2.1 does not apply to smaller dolphins and porpoises, as DEWHA (2008) assessed these cetaceans have peak hearing sensitivities within higher frequency ranges than those that seismic arrays typically produce.

While the EPBC Act Policy Statement 2.1 is not directly relevant to the project's predominantly non-impulsive noise sources, a cetacean hearing grouping weighted SEL threshold of 160 dB re 1 μPa^2·s has been used conservatively in the present report (MDA, 2023; Attachment G) as a cumulative threshold (SEL_{cum24h} or SEL_{cum1h}) isopleth for onset of TTS.

Mitigation measures outlined in the different states regulations and guidelines include:

- Tasmanian whale and dolphin approach guidelines DNRE (2022) include measures such as:
  - vessels should approach no closer than 100 m to a whale or 50 m to a dolphin.
  - vessels underway should approach no closer than 300 m for whales or 150 m for dolphins and no more than three vessels within the caution zone (see Figure 7.7).
  - vessels should withdraw immediately at a slow and steady pace if the whales or dolphins show any kind of disturbance.
  - vessels should adopt a slow speed (no wake) while in a caution zone.
  - vessels should avoid approaching from the no-approach zones in front or behind the whale or dolphin (see Figure 7.7).
- During the arrival and departure of the cable ship to and from Tasmanian nearshore waters, the captain of the cable ship and the skippers of any other project vessels in attendance with the cable ship are required to follow the Tasmanian whale and dolphin approach guidelines (DNRE, 2022), which are shown in Figure 7.7 as a typical example of whale and dolphin approach guidelines.

Once the cable lay ship is in position and adjacent to the Tasmanian nearshore, mitigative measures such as reducing thruster power to reduce underwater noise if whales approach the ship is not an option, as the vessel must maintain its position for safety reasons. However, other guard vessels or boats associated with cable pull operations may slow down to a no-wake speed or idle if approached by whales.



Source: DNRE (2022).

Figure 7.8: Example of the Tasmanian whale and dolphin approach guidelines

Some dolphin species are inquisitive and may closely approach the cable ship or tender vessels and, in this case, normal construction activities may continue without the mitigation measures outlined in the Tasmanian dolphin approach guidelines, since the dolphins are free-ranging and have chosen to approach the tender vessels.

There are no Tasmanian guidelines for in-water interactions with other marine fauna such as pinnipeds, sea turtles, or Little Penguins. While there are disturbance guidelines for vessels and boats approaching seal and Little Penguin colonies either on the mainland or Bass Strait offshore islands, these guidelines do not apply to the project as no colonies will be disturbed.

Based on the cetacean watching and cetacean approach guidelines published for Tasmania (DNRE, 2019b), Victoria (DELWP, 2019) and Commonwealth Marine waters (DoEE. 2017b), the various precautionary or visual observation zones used in this report and their function are defined as:

- Caution zone:
  - vessels to slow down to less than 6 knots or operate at a no-wake speed within this zone.
  - vessels must not enter the caution zone when a cetacean calf is present.
  - vessels must not enter or remain in the caution zone of a whale if it shows signs of disturbance.
  - no more than three vessels are allowed within a caution zone.
- No approach zone:
  - vessels must not enter a no approach zone and must not wait in front of the direction of travel of an animal or pod of animals.
- Visual observation buffer zone:
  - a visual observation buffer zone, which extends beyond the caution zone, allows for sufficiently early detection of the presence of cetaceans that allows for planning of next actions to be taken by captains or skippers of vessels.

The dimensions of the various precautionary and/ no approach zones in Tasmanian, Commonwealth and Victorian waters are:

- Tasmanian whale and dolphin approach guidelines (DNRE, 2019a):
    - Caution zone for an adult whale is between 300 and 100 m.
    - No approach zone for an adult whale is 100 m.
    - Caution zone for an adult dolphin is between 150 m and 50 m.
    - No approach zone for an adult dolphin is 50 m.
- Commonwealth whale and dolphin approach guidelines DoEE (2017b) are the same as the Tasmanian guidelines for adult whales and dolphins, but include additional measures for whales and dolphins with calves:
    - Caution zone for whales with calves is 300 m.
    - Caution zone for dolphins with calves is 150 m.
- Victorian whale and dolphin approach guidelines (DELWP, 2019) include:
    - Caution zone for an adult whale is between 300 and 200 m.
    - No approach zone for an adult whale is 200 m.
    - Caution zone for an adult dolphin is between150 and 100 m.
    - No approach zone for an adult dolphin is 100 m.

In contrast to precautionary measures that may be undertaken when whales approach a marine seismic survey operation (i.e., a source of loud impulsive noise from airgun arrays), a cable lay ship actively laying a cable does not have the capacity to ramp down or shutdown operations if a whale enters a caution zone. In the case of a cable lay ship, the cessation of cable laying activity due to an approaching whale within a monitored caution zone ahead of the ship will not significantly alter the noise source, as the cable lay ship will still have to maintain position under DP control.

Since the cable-lay ship is moving very slowly (1.0 to 1.5 knots), the ship would be perceived by whales as essentially a stationary noise source. It is up to individual whales whether to approach the cable-lay ship or not, as the cable lay must still maintain its position using its thrusters in DP mode. However, the cable-lay ship can power down thrusters to the minimum required to maintain dynamic positioning (dependent on sea state and winds at the time, including any safety issues) to allow whales to pass and then power up the thrusters to continue cable-lay operation.

During construction (cable lay) activities, general whale watching guidelines will be followed and will include:

- A visual search for approaching large whales (e.g., humpback and southern right whales) ahead of the cable lay ship should be conducted prior to start-up of cable laying operations cable installation) and, if present, a short delay allows whales to migrate or move away from the cable ship's heading.
- Adoption of a 300-m-radius caution zone for large whales (DoEE, 2017b; DNRE, 2019a) and DELWP, 2019) ahead of the cable lay ship (viewing angle of 90° based on 45° either side of a centreline heading) and a visual monitoring buffer zone of 500-m radius ahead of the ship.
- Adoption of a 100-m radius no approach zone for a large whale in Tasmanian waters (DNRE, 2019a) and Commonwealth Marine waters (DoEE, 2017b) and a 200-m radius no approach zone for a large whale in Victorian waters (DELWP, 2019) ahead of the cable lay ship.
- Adoption of a 300-m radius no approach zone for a large whale mother and calf (DoEE, 2017b) ahead of the cable lay ship and a visual monitoring buffer zone of 500 m radius ahead of the ship. This Commonwealth no approach zone measure for a whale mother and calf has also been adopted for Victorian and Tasmanian waters in the absence of mother and calf no approach state guidelines.
- No action taken for large whales approaching the cable lay ship from the side or rear.

- The cable-lay ship may power down thrusters to the minimum required to maintain station under DP control to allow whales to pass and then power up the thrusters to continue cable-lay operation. An alternative is to deploy one of the guard vessels between the cable lay ship and whales observed to be approaching at 1 km distance or more (i.e., beyond the 0.5-km radius precautionary exclusion zone).
- Whale observation lookout points should be located at the highest elevation available on works vessels (e.g., cable-lay ship bridge port or starboard extensions for all round viewing) or service vessels (e.g., fly bridge if present).
- Whale observation effort should be maintained during construction activities.
- Responsible senior staff will maintain radio or mobile telephone contact with the skippers of other works and service vessels within or transiting to the cable-lay zone to report the presence of whales approaching, within or departing the cable-lay zone.
- Occurrence and behaviour of protected whale species will be documented in accordance with a whale interaction management plan.
- Whale sightings and coordinates will be provided to DEECA (Victoria) and DNRE (Tasmania).

7.2.3.5.2 Residual impacts to cetaceans

For the purposes of assessing acoustic impacts to cetaceans, the project's loudest sound source level of 185 dB re 1 µPa at 1 m for the cable lay ship during cable laying has been selected as a worst-case scenario (see Attachment D of this report). If impacts from this noise source to cetaceans are found not to be significant, then separate assessments of the project's quieter sound sources do not need to be assessed. Conversely, if significant impacts are predicted, then the other project noise sources will be assessed separately.

Acoustic impacts to low frequency (LF) hearing cetaceans

The potential for acoustic damage, disturbance, behavioural, and acoustic auditory masking impacts to LF cetaceans is assessed below.

Acoustic damage impacts to LF cetaceans and permanent hearing loss

The $SEL_{24\text{-h}}$ threshold of 199 dB re 1 µPa^2·s for onset PTS is not shown as it will be within one or two metres of the cable ship noise sources, where baleen whales are most unlikely to approach or be found at such close distances. Therefore, acoustic damage impacts to baleen whales are not predicted.

Acoustic disturbance impacts to LF cetaceans and temporary hearing loss

Table 7-18 presents the calculated horizontal distances to species weighted cumulative SEL isopleths of interest and acoustic threshold criteria for LF cetaceans. Note that the assumption of a LF cetacean remaining stationary for 24-hours (as required for application of the NMFS (2018) threshold) is not realistic; therefore, except for the NMFS (2018) TTS threshold value, all other isopleth $SEL_{cum(LF)}$values in Table 7-18 are predicted for LF cetaceans remaining stationary for one-hour.

Table 7-18: Calculated distances to $SEL_{cum(LF)}$ isopleths during cable laying (LF cetaceans)

Species-weighted source level: 210 $SEL_{cum(LF)}$ (dB re 1 µPa^2·s at 1 m)							
Parameter	**Isopleths $SEL_{cum(LF)}$ (dB re 1 µPa^2·s)**						
Isopleths	180	179	160	150	140	130	120
Distance to isopleth (m)	98	114	2,103	9,760	45,304	210,283	976,047
Threshold isopleth	–	**TTS**	–	–	–	–	–

Source: MDA, 2023; Attachment G. TTS = temporary threshold shift (NMFS, 2018).

In Table 7-18, the distance to the NMFS (2018) $SEL_{cum(LF)}$ threshold of 179 dB re 1 μPa^2·s for TTS onset is 114 m. This represents a small acoustic disturbance zone within which LF cetaceans may suffer from temporary hearing loss if they remain within the zone for a protracted period, which is an unlikely scenario. However, it is more than likely that an approaching LF cetacean will detect the underwater noise gradient at distance from the noise source of the cable ship and avoid (turn away) or pass around the sound field if migrating or moving along the coastline.

Predicted acoustic disturbance and temporary hearing loss impacts to LF cetaceans are assessed to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *Low* due to LF cetaceans being widely distributed and abundant in the project area and wider region and a magnitude of impact of *Moderate* due to the TTS onset threshold being exceeded but localised within the project's direct area of direct influence within a 114-m radius of the cable lay ship. However, an LF cetacean is unlikely to remain within the 114-m radius zone of influence where the TTS threshold is exceeded. In general, an LF cetacean is unlikely to closely approach the cable lay ship's location as it senses the sound field gradient and takes aversive action. Consequently, acoustic disturbance and temporary hearing loss are unlikely to eventuate.

Acoustic disturbance impacts on LF cetacean behaviour

Table 7-19 presents calculated distances to various nominal isopleths of interest, including the upper acoustic threshold criterion 160 dB re 1 μPa_{rms} above which disruptive behavioral responses and avoidance in LF cetaceans may occur and the lower acoustic threshold criterion of 130 dB re 1 μPa_{rms} for nearshore waters with higher ambient noise levels and above which more subtle behavioural responses may occur in low-frequency cetaceans (baleen whales).

Table 7-19: Calculated distance to selected SPL rms isopleths during cable lay operations

Noise Source Level	Isopleth (dB re 1 μPa_{rms})						
185 dB re 1 µPa at 1 m	180	170	160	150	140	130	120
Distance to isopleth (m)	2.2	10.0	46.4	215.4	1,000	4,641	21,544
Behavioural threshold	–	–	Upper	–	–	Lower	NMFS

Notes: Distances are calculated using the practical spreading loss equation ($15Log_{10}R$), where R is the range in metres. Upper = upper threshold for onset of disruptive behaviour; Lower = threshold for onset on subtle behavioural effects. Dash (–) denotes not a behavioural threshold isopleth. NMFS = NMFS (2018) behavioural threshold.

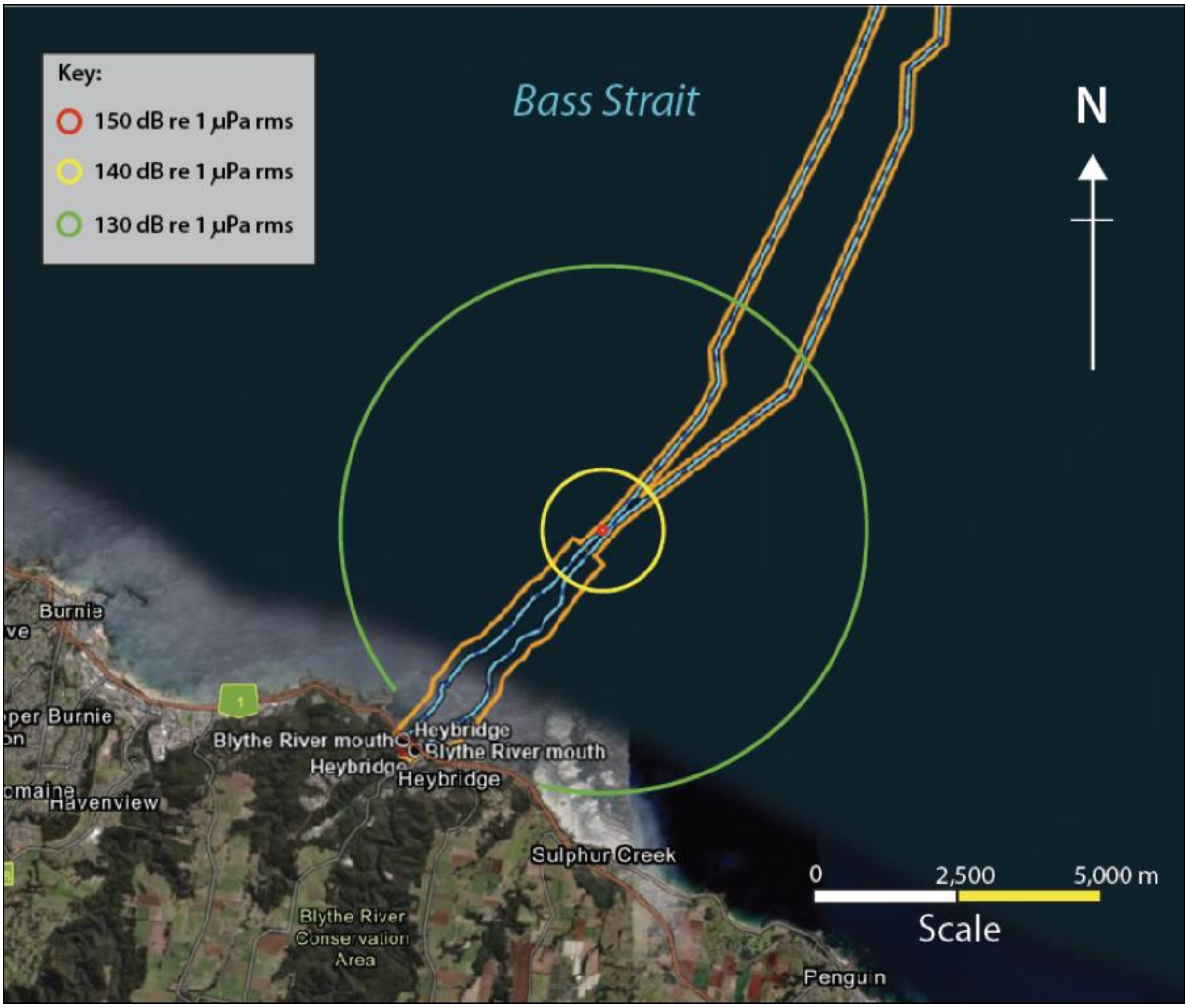
The distances to the isopleths in Table 7-19 are shown as a map in Figure 7.9 with the location (overlying 30 m water depth) of the cable ship laying cable shown.

Notes: Blue dashed lines are the ML1 and ML2 bundled cables. White dot = cable ship and underwater noise source level. Coloured rings represent selected isopleths that can be shown at the scale of the map.

Figure 7.9 Map showing distances to isopleths for cable ship laying cable In Waratah Bay

In Figure 7.9, the radial distances of the 180, 170 and 160 dB re 1 µPa$_{rms}$ isopleths could not be shown due to the large scale of the map. Similarly, the radial distance to the 120 dB re 1 µPa$_{rms}$ of 21.5 km lies outside the map area. Notwithstanding, the map visually illustrates the relative sizes of the acoustic zones of influence and the gradient of increasing underwater noise that an LF cetacean would need to cross to approach the cable lay ship. A similar map is presented in Figure 7.10 for nearshore Tasmania at Heybridge using the same data presented in Table 7.13 for a cable lay ship laying cable at a location with a similar water depth of 30 m.

In nearshore Tasmania at Heybridge, the 30-m isobath is located 4.3 km from the shore, whereas the same isobath in Waratah Bay is located about 5.9 km from shore. This difference accounts for the 130 dB re 1 µPa$_{rms}$ isopleth reaching the shoreline in Tasmania (see Figure 7.10).



Notes: Notes: Blue dashed lines are the ML1 and ML2 bundled cables. White dot = cable ship and underwater noise source level. Coloured rings represent selected isopleths that can be shown at the scale of the map.

Figure 7.10: Map showing distances to isopleths for cable ship laying cable near Heybridge

From analysis of the data, Table 7-19 indicates that the cable ship undertaking cable laying operations will ensonify an area of Bass Strait out to 21.5 km before reaching the background level of say 120 dB re 1 µPa $_{rms}$. The calculated distance of 21.5 km to the 120 dB re 1 µPa rms isopleth at which subtle behavioural effects on cetaceans in offshore Bass Strait may occur is an over simplification of using the practical spreading loss equation (i.e., 15 Log10R, where 'R' is the distance in metres). The equation is a simple formula that does not take account of noise source characteristics, noise frequency, bathymetry, water depth, bottom sediment composition and other factors that can cause sound transmission loss. For example, more detailed modelling results from DP thruster operation for the Deepwater Wind Project (NMFS, 2014) indicated that the average distance to the 120 dB re 1 µPa rms isopleth extends 4.75 km from the DP vessel source. Similarly, Xodus (2015) also modelled DP vessel thruster noise and considered that the true range of the cetacean behavioural disturbance zone would extend to 5 km, depending on environmental variables (e.g., background noise), uncertainty in the criteria and calculations and the noise source levels of the actual vessels used. In the case of the Marinus Link Project, the overly precautionary 120 dB re 1 µPa rms of subtle behavioural effects on cetaceans would also likely extend to around 4.5 to 5 km distance and not the 21.5 km estimated using the practical spreading loss equation.

At a specific point of cable laying in mid-Bass Strait and using an estimated 5-km maximum radius to the 120 dB re 1 µPa rms isopleth, this would encompass an area of 78.5 km^2, which represents about 3% of the total area of 2,500 km^2 (based on 250 km length of the bundled cable (one monopole) and a 5 km wide buffer zone either side of the alignment). In addition, as cable-laying activities are assumed to occur 24 hours per day, the cable lay ship would be continually moving along the cable route over a 24-hour period and the area within the 120 dB re 1 µPa rms isopleth would also be constantly moving over the same period. Hence, the estimated ensonified area (above 120 dB re 1 µPa rms isopleth) would not remain in the same location for more than a few hours.

Reactions to underwater noise are often subtle, and the long-term consequences of these responses are not readily apparent (Olesiuk et al., 2012). There are no peer-reviewed threshold criteria for assessing subtle or low-level behavioural effects in whales when exposed intermittently or continuously to low sound pressure levels within the range of ambient background levels.

Example response reactions may include:

- Some LF cetaceans may deviate in their passage or migratory route to maintain a buffer distance from project construction activities, such as migrating (or resting) humpback or southern right whales that are known to occur along the Victorian and Tasmanian nearshores and offshore Bass Strait. However, this may reduce as the whales acclimate or 'habituate' to the relatively constant source of low frequency, continuous broadband noise radiated from the generally fixed location of project construction activities including the cable ship, which moves at a cable laying speed of between 1.0 to 1.5 knots and would be perceived as a 'fixed location' by LF cetaceans.
- Subtle responses by cetaceans at distance from the cable ship and other marine construction activities are likely to vary depending on their gender, feeding status, or breeding condition (e.g., mother and calf), as well as previous exposure to anthropogenic noise (e.g., underwater noise from transiting coastal vessels in Bass Strait), which have similar continuous or transient broadband noise levels and frequencies).

Given decreasing noise with distance from the project's construction activities, LF cetaceans should be able to sense this gradient and may initiate a range of responses, such as moving towards or away from the activities, or not reacting at all (Richardson et al., 1995). Minor deviations of whales around project construction activities need not be regarded as deleterious to LF frequency cetaceans, since exposed or affected individuals (e.g., humpback or southern right whales) would most likely continue along their intended migration route or along coastal connecting habitat. Watkins (1986) emphasised that the most vigorous whale responses came from noise sources that changed suddenly, rapidly increased (such as an approaching ship) or were unexpected. Richardson et al. (1995) also noted that *'stationary industrial activities producing continuous noise result in less dramatic reactions by cetaceans than do moving sound sources, particularly ships'*.

As noted above, the very slow speeds (1.0 to 1.5 knots) involved in cable laying would be most likely perceived by LF cetaceans as essentially a 'stationary' noise source and perceive it as less threatening than a rapidly moving ship. This perception may be attributed to habituation that is the potential for a LF cetacean over time to become less sensitive to certain types of noise and disturbance to which they are repeatedly exposed and which they come to perceive as non-threatening.

Predicted impacts on LF cetacean behaviour are assessed to have a residual impact significance rating of ***Low***. This is based on a LF cetacean sensitivity of *Low* due to their wide distribution and abundance in the project area and wider region, and a magnitude of impact of *Low* in offshore waters given that the impact is very short term and temporary and localised in extent. Migrating whales are expected to detour around the cable lay ship when transiting Bass Strait. In nearshore waters, vessel noise will be short term at a given location (i.e., 10 days of construction in each nearshore area), resulting in an impact magnitude of *Moderate*. This, however, still results in a residual impact significance rating of ***Low***.

Overall, underwater noise generated by project marine construction activities are predicted to not have “a substantial adverse effect on a population of cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution of a LF cetaceans including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution’, which is based on the published significance impact criteria outlined in the Commonwealth’s Significant Impact Guidelines 1.1 (DoE, 2013).

Acoustic auditory masking impacts on LF cetaceans

Masking is the increase in the hearing threshold for one sound due to the presence of another sound (Erbe, 1997). For masking to occur, the underwater noise must be loud enough, have similar frequency content to the hearing sensitivity of a LF cetacean, and must happen concurrently with LF cetacean calls or songs (McPherson et al., 2019).

Underwater noise has the potential to interfere with or ‘mask’ vocal communication and natural sounds important to marine fauna for mate attraction, social cohesion, predator avoidance, prey detection, navigation, and other basic behaviours. Since different marine species have evolved unique vocal repertoires, they are differentially susceptible to the masking effects of underwater noise. In general, marine mammals are believed to be well-adapted to coping with a naturally noisy and variable ocean environment, and likely to have tolerance to some increase in masking relative to natural and human-made levels.

There are no threshold or acoustic criteria for assessing masking impacts on LF cetaceans; therefore, the following residual impact assessment is qualitative and based on the literature.

There are concerns about the overall rise of ambient noise and the potential masking of marine mammal communication by the world’s shipping and other underwater noise sources (e.g., seismic surveys, seabed mining, navy sonars, etc.). In Bass Strait, shipping using the main two-way shipping lanes to the southwest of Wilsons Promontory, cross-Strait ferry traffic, oil and gas industry vessel traffic, and other coastal shipping traffic all contribute to existing anthropogenic background sound of distant shipping. Underwater noise generated by the project’s proposed marine construction activities will add to the existing ambient noise in Bass Strait.

The cable lay ship, when operating in DP mode, will generate continuous non-impulsive underwater noise over a wide frequency bandwidth (20 Hz to 2 kHz), which presents a worst-case scenario for potential masking noise impacts, as there are limited opportunities to reduce noise source levels as maintaining station in DP mode is critical for safety and cable laying.

The underwater noise generated by the cable lay ship (20 Hz and 2 kHz) overlaps the hearing frequency range of 10 Hz to 24 kHz in humpback whales (Au et al., 2006) and with a peak hearing frequency range between 100 Hz and 3 kHz (Fournet et al., 2018). For southern right whales, the hearing range frequency is between 30 Hz and 2.2 kHz with maximum sensitivity around 50 to 500 Hz based on this species vocalisations (Erbe, 2002), which also overlaps the cable lay ship’s frequency range of 20 Hz to 2 kHz. Therefore, there is a potential for project-generated underwater noise to cause auditory masking of biologically relevant sounds to LF cetaceans.

In considering potential auditory masking effects to a LF cetacean, for the case of a baleen whale close to a project noise source, the noise level will be high, and the whale will be able to hear calls from only nearby whales, whereas a whale located further away from a project noise source where the noise level will be lower, the whale will be able to hear calls from more distant whales. Communications between baleen whale mother and calf pairs are least likely to be affected by acoustic auditory masking, given their natural protective proximity to each other.

Some LF cetaceans such as humpback whales and southern right whales have strategies that can counter auditory masking effects in areas of increased vessel noise by increasing the amplitude of their calls. One strategy to compensate for increased background noise involves increasing the source level or amplitude and/or frequencies of the acoustic signal found in some cetaceans. This phenomenon is known as the Lombard effect (Lombard, 1911) and most likely serves to maintain an appropriate and detectable signal-to-noise ratio for the receiver (e.g., a baleen whale). For example, humpback whales exposed to high noise exposures from tourism vessels in Glacier Bay National Park have been shown to increase the amplitude of their vocalisations by 0.8 dB for every 1.0 dB increase in ambient noise, while vocalising less frequently (Frankel and Gabriele, 2017; Fournet et al., 2018). Similarly, Parks et al. (2010) documented changes in calling behaviour of 14 tagged northern right whales (*Eubalaena glacialis*) under increasing background noise and found that the whales increased the amplitude of their calls from 125 to 150 dB re 1 µPa rms in response to a corresponding increase in background noise from 110 to 140 dB re 1 µPa rms in a direct relationship. It is assumed that southern right whales will show a similar response.

Overall, acoustic auditory masking due to cable lay ship-generated underwater noise is assessed to have a residual impact significance rating of ***Low***. This is based on a LF cetacean sensitivity of *Low* due to LF cetaceans being widely distributed and abundant in the project area and wider region, and a magnitude of impact of *Low* based on a low level of acoustic auditory masking of biologically relevant sounds with brief or minor cessation of vocal behaviour. Given that the cable ship noise field shown in Figure 7.9 is a snapshot in time, the position of the cable ship (travelling northwards and laying bundle cable at a speed of 1.5 knots) an hour earlier would have been 2.8 km to the south. Therefore, acoustic auditory masking of LF cetacean communication is transient within Waratah Bay or nearshore Tasmania.

Acoustic impacts to mid-frequency (MF) hearing cetaceans

Acoustic damage, disturbance, behavioural, and acoustic auditory masking impacts to MF cetaceans are assessed below.

Acoustic damage impacts to MF cetaceans and permanent hearing loss

The $SEL_{24\text{-}h}$ threshold of 198 dB re 1 µPa^2·s for onset PTS in MF cetaceans is not shown as it will be within one or two metres of the cable ship noise sources, where MF cetaceans are most unlikely to approach this zone of high underwater noise or be found at such close distances. Therefore, acoustic damage impacts to MF cetaceans are not predicted.

Acoustic disturbance impacts to MF cetaceans and temporary hearing loss

Table 7-20 presents the calculated horizontal distances to species weighted cumulative SEL isopleths of interest, and acoustic threshold criteria for MF cetaceans. Note that the assumption of a MF cetacean remaining stationary or at a constant distance from a moving ship for 24-hours (as used in the NMFS (2018) is an unrealistic scenario. Therefore, MDA (2023; Attachment G) calculated the $SEL_{cum(MF)}$values for MF cetaceans remaining stationary or at a constant distance for one-hour, which is still conservative.

In Table 7-20, the distance to the NMFS (2018) $SEL_{cum(LF)}$ threshold of 178 dB re 1 µPa^2·s for TTS onset is 43 m. This represents a very small acoustic disturbance zone within which MF cetaceans may suffer from temporary hearing loss if they remain within the zone for a protracted period, which is an unlikely scenario.

Table 7-20: Calculated distances to SEL_{cum} isopleths during cable laying (MF cetaceans)

Species-weighted source level: 202 $SEL_{cum(MF)}$ (dB re 1 µPa^2·s at 1 m)							
Parameter	**Isopleths ($SEL_{cum(LF)}$ (dB re 1 µPa^2·s)**						
Isopleths	180	178	160	150	140	130	120
Distance to isopleth (m)	32	43	680	3,157	14,653	68,012	315,685
Threshold isopleth	–	**TTS**	–	–	–	–	–

Source: MDA, 2023; Attachment G. TTS = temporary threshold shift (NMFS, 2018).

However, it is more than likely that an approaching MF cetacean will detect the underwater noise gradient at a distance from the noise source (the cable lay ship), which will trigger behavioural reactions such as avoidance (turning away or fleeing from the noise source) or passing around the sound field, if migrating or moving along the coastline. Some species of MF cetaceans are inquisitive and may be initially attracted to the cable ship's underwater noise source but are unlikely to remain within the 43-m radius zone of potential TTS onset. Such species, including bottlenose dolphins, are often attracted to vessels, especially when using high frequency geophysical instruments. However, their hearing ranges are typically much higher (150 Hz to 160 kHz) than those of the cable lay ship (20 Hz to 2 kHz), though there is some overlap at the lower frequencies.

Assuming that MF cetaceans will move away or 'flee' from the cable lay ship noise source, rather than remain stationary or at a constant distance from the cable lay ship, it is unlikely that they will receive a cumulative level of noise at which auditory injury (TTS onset) is expected to occur, and that that temporary auditory injury (TTS onset) is only likely to occur at ranges of less than one metre (Sweeney, 2018).

Overall, temporary hearing loss (TTS threshold onset) impacts to MF cetaceans are assessed to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *Low*, due to MF cetaceans being widely distributed and abundant in the project area and wider region, and a magnitude of impact of *Moderate* due to due to the TTS onset threshold being exceeded but localised within the project's direct area of direct influence within a 43-m radius of the cable lay ship. Since MF cetaceans include species such bottlenose dolphins and common dolphins, these inquisitive animals are known to closely approach ships and vessels.

Acoustic disturbance impacts on MF cetacean behaviour

Table 7-19 (presented earlier) gives calculated distances to various nominal isopleths of interest. This includes the upper acoustic threshold criterion (160 dB re 1 μPa$_{rms}$), above which disruptive behavioural responses and avoidance in MF cetaceans may occur, and the lower acoustic threshold criterion (130 dB re 1 μPa $_{rms}$) for nearshore waters with higher ambient noise levels and above which more subtle behavioural responses may occur in MF cetaceans. Figure 7.9 (presented earlier) shows a map of the isopleths around the cable ship location, which visually illustrates the relative acoustic zones of influence and the gradient of increasing underwater noise that a MF cetacean will need to cross to approach the cable ship.

Most MF cetacean species, such as dolphins, are agile, fast-moving, and have hearing frequencies in the range 500 Hz to 150 kHz. Some dolphin species, especially inshore species such as bottlenose dolphins (*Tursiops truncatus*), are inquisitive and are initially likely to be attracted to the cable lay ship during cable lay operations. Observations of bottlenose dolphins have indicated that it regularly appeared whenever vessels were using geophysical instruments such as depth sounders and side scan sonars (NSR, 2002).

Overall, MF cetacean disruptive behavioural impacts are assessed to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *Low,* due to MF cetaceans being widely distributed and abundant in the project area and wider region and a magnitude of impact of *Low*, given that the MF cetaceans will not be temporarily displaced vertically or horizontally from the project's 46.4-m radius sound field above 160 dB re 1 μPa rms for the duration of noise-generating activity due to habituation. MF cetacean hearing frequency range (150 Hz to 160 kHz) is mainly above the cable lay ship's underwater noise range (20 Hz and 2 kHz) and, therefore, is MF cetacean behaviour is unlikely to be disturbed by project's underwater noise field.

Acoustic auditory masking impacts on MF cetaceans

There are no threshold or acoustic criteria for assessing acoustic auditory masking impacts on free ranging MF cetaceans; therefore, the following residual impact assessment is qualitative and based on literature review.

The frequency range (20 Hz to 2 kHz) of underwater noise generated by the cable ship does not overlap the hearing frequencies of bottlenose dolphins (10 kHz to 120 kHz) or common dolphins (10 kHz and 150 kHz) (Richardson et al., 1995). However, the lower end of the hearing range of killer whales (500 Hz to 120 kHz) (Richardson et al., 1995) overlaps the cable ship's noise frequency range. The peak frequencies of the killer whale echolocation click ranges from about 40 kHz to 130 kHz (Au et al., 2000) and does not overlap the cable ship's noise frequency range.

While low frequency hearing has not been studied in many MF cetacean species, those species that have been tested (e.g., killer whale, false killer whale, and bottlenose dolphin) exhibit low audiometric and behavioral sensitivity to low frequency sound.

Masking in MF cetaceans can occur naturally from wind, precipitation, wave action, seismic activity, and other natural phenomena. For example, the ranges over which fish-eating killer whales use echolocation clicks to detect chinook salmon (*Oncorhynchus tshawytscha*) can be reduced by more than 50% in moderate rain (Au et al., 2004). As noted above for masking effects on LF cetaceans, odontocetes also have anti-masking strategies such as compensating for increased background noise by increasing the source level or amplitude and/or frequencies of their calls or other acoustic signals (i.e., the 'Lombard effect' (Lombard, 1911)), re-locating to quieter areas, or increasing the number of elements per call to improve detectability (Branstetter and Sills, 2022).

Overall, the potential for increased auditory masking of MF cetaceans resulting from the project's cable ship underwater noise transmissions is expected to be minimal, given their high frequency hearing range (150 Hz to 160 kHz) for communications and echolocation clicks. The residual impacts of acoustic auditory masking of MF cetaceans are assessed to have a residual impact significance rating of ***Low***. This is based on an MF cetacean sensitivity of *Low* due to MF cetaceans being widely distributed in Bass Strait and the wider region, and a magnitude of impact of *Low* given that auditory masking is weak except when very close to a noise source.

Acoustic impacts to High-frequency (HF) hearing cetaceans

Acoustic damage, disturbance, behavioural, and acoustic auditory masking impacts to HF cetaceans are assessed below.

Acoustic damage impacts to HF cetaceans and permanent hearing loss

Table 7-21 presents the calculated horizontal distances to species weighted cumulative SEL isopleths of interest and acoustic threshold criteria for HF cetaceans.

Table 7-21: Calculated distances to SEL_{cum} isopleths during cable laying (HF cetaceans)

Species-weighted source level: 200 $SEL_{cum(HF)}$ (dB re 1 μPa²·s at 1 m)							
Isopleths (dB re 1 μPa²·s)	180	173	160	153	140	130	120
Distance to isopleth (m)	23	67	489	1,433	10,541	48,928	227,105
Threshold isopleth	–	**PTS**	–	**TTS**	–	–	–

Source: MDA, 2023; Attachment G. PTS = permanent threshold shift (NMFS, 2018). TTS = temporary threshold shift (NMFS, 2018).

In Table 7-21, the distance to the NMFS (2018) $SEL_{cum(HF)}$ threshold of 173 dB re 1 μPa²·s for TTS onset is 67 m. This represents a very small acoustic disturbance zone within which HF cetaceans may incur auditory injury and suffer from permanent hearing loss, if they remain within the zone for an hour or more.

Overall, acoustic damage (i.e., permanent hearing loss) impacts to HF cetaceans are assessed to have a residual impact significance rating of ***Moderate***. This is based on a sensitivity of *Low* due to HF cetaceans being well represented with a wide distribution along Bass Strait continental shelf and offshore waters including transits through Bass Strait, and a magnitude of impact of *High* given that the cumulative 1-hour PTS onset threshold is exceeded but highly localised within the cable lay ship's 67-m radius area of direct influence. The PTS onset will only occur if the HF cetacean remains within the 67-m radius zone for an hour, which is an unlikely scenario given their ability to sense the cable lay ship's radiated underwater noise gradient and avoid the approaching the ship. Therefore, the residual impact significance rating is very conservative.

Assuming a HF cetacean is turning away ('fleeing') from the cable lay ship noise source at a rate of 1.5 m/s, which is considered to be a typical cruising speed for a marine mammal, it is unlikely that a HF cetacean will receive a level of noise at which auditory injury is expected to occur based on the 1-hour cumulative $SEL_{cum(HF)}$ criterion used by MDA (2022; Attachment G) for the cable lay ship noise source. In the case of a HF cetacean turning away or 'fleeing' from the cable lay ship noise source, rather than remaining stationary or at a constant distance from the cable lay ship, the PTS onset distance will be less than 1 metre (Nedwell et al., 2012; Sweeney, 2018; Subacoustech, 2021a,b), which will then have a residual impact significance rating of ***Low*** rather than ***Moderate***.

The only likely HF cetacean likely to occur in Bass Strait is the pygmy sperm whale (*Kogia breviceps*), which has a habitat preference of the continental shelf edge and deep slope, though they are known to pass through Bass Strait as occasional dead strandings of this species have been observed along the Victorian coastline including Waratah Bay and the west coast of Wilsons Promontory (Atlas of Living Australia, CISRO, 2022).

Acoustic disturbance impacts to HF cetaceans and temporary hearing loss

The principal HF cetacean that may occur in Bass Strait is the pygmy sperm whale (*Kogia breviceps*), which is assessed to have a likelihood of occurrence of ***Remote*** in Waratah Bay, where one sighting was previously recorded. This species is a solitary deep-diving species mainly found over the edge of the continental shelf feeding on prey (mainly cephalopods) of the continental slope. Notwithstanding, given its past strandings in Waratah Bay and west coast of Wilsons Promontory, this predominantly oceanic species may actively pass through Bass Strait.

In Table 7-21, the distance to the NMFS (2018) $SEL_{cum(LF)}$ threshold of 153 dB re 1 μPa^2·s for potential temporary hearing loss (i.e., TTS onset) is 1,433 m, which represents a small zone of influence surrounding the cable ship's noise source and within which HF cetaceans may incur temporary hearing loss, if they remain within the zone for an hour. It is expected that HF cetaceans will not remain within the TTS onset zone, as they detect the underwater noise gradient surrounding the specific project noise source and choose whether, or not, to continue to their approach or move away from the noise source. The latter response is expected given that is common with most cetaceans' reactions to vessels and other marine construction noise sources. In general, a review of the literature revealed that this species is known to avoid vessels (Wursig et al., 1998; al., NOAA Fisheries 2003; and McAlpine, 2018).

Overall, acoustic disturbance and temporary hearing loss (TTS onset) impacts to HF cetaceans are assessed to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *Low*, due to the wide distribution of HF cetaceans including the Bass Strait continental shelf, offshore including transits through Bass Strait, and a magnitude of impact of *Moderate* given that the TTS onset threshold is exceeded. Based on Table 7-21, temporary hearing loss (TTS onset) will only occur if the HF cetacean remained within the 1.4-km radius zone for an hour, which is unlikely given their sensing of the cable lay ship's radiated underwater noise gradient. Therefore, the residual impact significance rating is overly conservative. As noted above, the only likely HF cetacean likely to occur in Bass Strait is the pygmy sperm whale.

Acoustic disruptive behavioural impacts on HF cetaceans

Table 7-19 (presented earlier) gives calculated distances to various nominal isopleths of interest. This includes the upper acoustic threshold criterion (160 dB re 1 µPa rms), above which disruptive behavioural responses and avoidance in HF cetaceans may occur, and the lower acoustic threshold criterion (130 dB re 1 µPa rms) for nearshore waters with higher ambient noise levels and above which more subtle behavioural responses may occur in HF cetaceans. Figure 7.9 (presented earlier) shows a map of the isopleths around the cable ship location, which visually illustrates the relative acoustic behavioural zones of influence and the gradient of increasing underwater noise that a HF cetacean will need to cross to approach the cable ship.

Overall, HF cetacean disruptive behavioural impacts are assessed to have a residual impact significance rating of ***Very low***. This is based on a sensitivity of *Low* due to their wide distribution in within the Bass Strait continental shelf and offshore waters, as well as transiting through Bass Strait, and a magnitude of impact of *Low* given that the HF cetaceans are unlikely to approach the cable lay ship given their known avoidance of ship sand vessels (Wursig et al., 1998; al., NOAA Fisheries 2003; and McAlpine, 2018). Most HF cetacean species, such as pygmy sperm whales, are agile, fast-moving, and have hearing frequencies in the range 227 Hz to 160 kHz, which is mainly above but overlaps the lower range values of the cable lay ship's underwater noise frequency range (20 Hz and 2 kHz). Overall, HF cetacean behaviour is unlikely to be disturbed by the underwater noise field surrounding the cable lay ship. However, any deviations around the cable lay ship are anticipated to be minor as the HF cetaceans continue their migration path or other movements through Bass Strait.

Acoustic auditory masking impacts on HF cetaceans

Recordings of captive pygmy sperm whales indicated that their communication sounds have frequencies between 60 and 200 kHz, with peak frequencies around 120 to 130 kHz (Santoro et al., 1989; Carder et al., 1995). In addition, the results of an auditory brainstem response study indicated that pygmy sperm whales had their best underwater hearing range between 90 kHz and 150 kHz (Carder et al., 1995). Echolocation clicks range from 60 to 200 kHz, with a dominant frequency of 120–130 kHz. The pygmy sperm whale's hearing, echolocation, and communication sound frequency ranges do not overlap the frequency range of the underwater noise radiating from the cable ship during cable lay operations (20 Hz to 2 kHz).

Overall, the predicted impacts of acoustic auditory masking of HF cetaceans (including the pygmy sperm whale) communications or their sensing of biologically relevant sounds are assessed to have a residual impact significance rating of ***Low***. This is based on a HF cetacean sensitivity of *Low*, due to HF cetaceans being widely distributed within the Bass Strait continental shelf and offshore waters including transits through Bass Strait, and a magnitude of *Low* based on a low level of acoustic auditory masking of biologically relevant sounds with brief or minor cessation of vocal behaviour.

7.2.3.5.3 Compliance with Cetacean National Recovery Plans

There are several cetacean national recovery plans (NRPs) or conservation management plans (CMPs) for cetaceans and those relevant to the project area are addressed below in terms of project compliance with NRP or CMP requirements. An emphasis has been placed on those NRPs or CMPs for baleen whales given that their hearing range overlaps that of the project's non-impulsive, continuous or intermittent broadband noise.

Draft National Recovery Plan for the Southern Right Whale *(Eubalaena australis)*

A Draft National Recovery Plan for Southern Right Whales (SRW) was published by DCCEEW (2022e).

Under the southern right whale national recovery plan Action Area A5 (Assess and address impacts to Southern Right Whales from anthropogenic underwater noise), the following comments on project-related underwater noise impacts and mitigation are made:

- The project assessed underwater noise impacts of the cable lay ship (loudest noise source) on low-frequency hearing cetaceans ("LF cetaceans"), which includes SRWs as a baleen whale species.
- The project's proposed nearshore activities within and adjacent to SRW coastal connecting habitat BIAs demonstrated that SRWs are only likely to be temporarily disturbed by cable ship underwater noise while maintaining position using its thrusters under DP control or a period of around 10 days within each of the Victorian and Tasmanian nearshore environments.
- MDA (2023; Attachment G) calculated that the cumulative threshold of 179 dB $SEL_{cum(LF)}$ for a LF cetacean will be exceeded within 114 m of the cable lay ship. This is a very small zone of influence in which a SRW will have to remain within for an hour for temporary hearing loss (as measured by cumulative TTS onset) to occur. However, the prediction is for a fixed source (i.e., cable lay ship) and a fixed LF cetacean position, which assumes that no behavioural change in a LF cetacean will occur, which is an unlikely scenario.
- The quantitative modelling of project underwater noise impacts to LF cetaceans (which includes SRWs) assessed that permanent hearing loss (as measured by PTS onset) were absent and that temporary hearing loss (as measured by TTS onset) was not predicted. This is because LF cetaceans (including SRWs) will detect the noise gradient around the cable lay ship and either not approach the zone of influence within which TTS onset may occur or remain within the zone for an hour for TTS onset impacts to occur.
- The SRW 'migration and resting on migration' critical habitat for survival within nearshore Victoria is not critical core habitat (e.g., breeding BIA or high-density prey breeding habitat BIA), and that this coastal connecting habitat BIA for "migration and resting on migration" reflects SRW migratory movements along the coast with occasional resting for individual SRWs and/or occasional mother and calf pairs.
- SRW distributional records in the Atlas of Living Australia (CSIRO, 2022) indicate there have been six confirmed sightings in Waratah Bay between July to November over a period of more than about 20 years of records, which indicates that SRWs are an infrequent visitor to Waratah Bay.
- The project's commitment to developing and implementing a Marine Fauna Management Plan (EPR MERU07 in Section 7.6) and a Cetacean Interaction Management Plan (EPR MERU08 in Section 7.6), will satisfy the objectives of the national recovery plan requirement for mitigating underwater noise impacts to SRWs.

The interim recovery objectives listed under the Draft National Recovery Plan for the Southern Right Whale are:

- Current levels of Commonwealth and State legislative and management protection for Southern Right Whales are implemented, maintained, or improved so threats continue to be managed and reduced over the life of the plan.
- Anthropogenic threats are managed consistent with ecologically sustainable development principles and do not impede recovery of Southern Right Whales.
- The population demographics of the eastern and western Southern Right Whale populations are monitored using robust methodology to demonstrate that the abundance, areas of occupancy, and habitat use of Southern Right Whales is increasing.
- The population structure of Southern Right Whales in Australian waters is clearly characterised, including the level of interchange of individuals, to evaluate the degree to which the western and eastern populations are separate populations.
- Capability of Indigenous Australian, research, citizen science and general community groups is improved to assist in addressing recovery actions of Southern Right Whales in Australia.

The Draft National Recovery Plan for the Southern Right Whale lists the long-term recovery vision for the Southern Right Whale in Australia is for the population to increase in size to a level that the species is no longer listed as threatened under any of the EPBC Act listing criteria.

The project's very short-term generation of underwater noise of 10 days duration (nearshore Victoria and/or nearshore Tasmania) and very short-term transient duration in offshore waters are consistent with ecologically sustainable development principles and are assessed not to impede the long-term recovery of SRWs, which is main objective of the national recovery plan.

Visual monitoring for the presence of SRWs will be undertaken during marine construction activities and cable laying operations in accordance with the project's Cetacean Interaction Management Plan (EPR MERU08 in Section 7.6). SRW sightings will be reported to relevant regulatory authorities.

With the implementation of measures to comply with EPRs, and the considerations listed in this section, including the short-term transient duration of works in offshore waters, the residual impacts to southern right whale will not be inconsistent with the interim objectives and long-term recovery visions of the Draft National Recovery Plan for the Southern Right Whale.

Conservation Management Plan for the Blue Whale

A Conservation Management Plan for Blue Whale 2015–2025 was published by DoE (2015f). This Conservation Management Plan is a recovery plan under the EPBC Act and applies to the blue whale (*Balaenoptera musculus*) and its subspecies that are listed as endangered under the EPBC Act. The principal subspecies likely to present in Bass Strait is the pygmy blue whale (*Balaenoptera musculus brevicauda*) (see Section 6.3.6.2.5).

Under the blue whale conservation management plan Action Area A2 (Assessing and addressing anthropogenic noise) to pygmy blue whales (very high priority) and blue whales (high priority), the legal requirements (section A.2.3) require that "Anthropogenic noise in biologically important areas will be managed such that any blue whale continues to utilise the area without injury and is not displaced from a foraging area". The intent of this requirement is to ensure that any blue whale can continue to forage with a high degree of certainty in a foraging Area, and that any blue whale is not displaced from a foraging Area. In the case of the project, any minor deviations of blue whales or pygmy blue whales around project noise sources (e.g., cable lay ship or vessels involved in post-lay cable burying operations) will be of the same response of these whales to existing commercial vessels and other maritime traffic that these whales encounter in Bass Strait. Such minor deviations are not anticipated to 'displace' blue whales or pygmy blue whales from foraging areas, since the whole of Bass Strait is classified as a biologically important area (BIA) for blue whale foraging. Any minor deviations around project construction activities do not represent a loss of foraging area as the Conservation Management Plan for the Blue Whale (DoE, 2015f) does not detail any site-specific foraging areas within Bass Strait, only Bass Strait as a whole.

In instances where a threat of environmental harm exists and there is scientific uncertainty as to the outcome, a precautionary approach must be taken. Action A.2.3, applies in relation to BIAs. A whale could be displaced from a foraging area if impact mitigation is not implemented. This means that underwater anthropogenic noise should not:

- Stop or prevent any blue whale from foraging.
- Cause any blue whale to move on when foraging.
- Stop or prevent any blue whale from entering a foraging area.

Action A.2.3 of the blue whale CMP also states:

- It is considered that a whale is displaced from a foraging area if foraging behaviour is disrupted, regardless of whether the whale can continue to forage elsewhere within that foraging area.
- It is considered that a whale is displaced from a foraging area if foraging behaviour is disrupted, regardless of whether the whale can continue to forage elsewhere within that foraging area.
- For the purpose of interpreting and applying Action Area A.2 of the Blue Whale conservation management plan, injury is defined as both permanent and temporary hearing impairment (Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS, respectively) and any other form of physical harm arising from anthropogenic sources of underwater noise.

Based on underwater noise generated by the cable lay ship (i.e., loudest noise source), the following comments on underwater noise impacts and mitigation are noted with regards to adherence to the blue whale CMP requirements:

- The National Conservation Values Atlas (DCCEEW, 2022a) has a ‘foraging’ BIA for the blue whale that covers the whole of Bass Strait, and the conservation management plan (DoE, 2015c) has most of Bass Strait (except the western approach) as a ‘possible foraging area’ for the pygmy blue whale.
- The project assessed underwater noise impacts of the cable lay ship (loudest noise source) on low-frequency hearing cetaceans (“LF cetaceans”), which includes the blue whale and pygmy blue whale.
- The project's proposed nearshore and offshore marine construction activities are within the blue whale’s ‘known foraging area’ and pygmy blue whale’s ‘possible foraging area BIAs.
- Blue whales and subspecies are only likely to have the potential to be temporarily disturbed by cable ship underwater noise while the cable lay ship is maintaining position using its thrusters under DP control in nearshore waters (cable pulls to shore) and while actively laying bundled cables in Bass Strait offshore waters.
- MDA (2023; Attachment G) calculated that the cumulative threshold of 179 dB $SEL_{cum(LF)}$ for a LF cetacean will be exceeded within 114 m of the cable lay ship. This is a very small zone of influence in which a blue whale/pygmy blue will have to remain within for an hour for temporary hearing loss (as measured by cumulative TTS onset) to occur. However, the prediction is for a fixed source (i.e., cable lay ship) and a fixed (constant) LF cetacean position, which assumes that no behavioural change in a LF cetacean will occur, which is an unlikely scenario.
- The quantitative modelling of project underwater noise impacts to LF cetaceans (which includes SRWs) assessed that permanent hearing loss (as measured by PTS onset) were absent and that temporary hearing loss (as measured by TTS onset) was not predicted as LF cetaceans (including blue and pygmy blue whales) will detect the noise gradient around the cable lay ship and either not approach the zone of influence within which TTS onset may occur or remain within the zone for an hour for TTS onset impacts to occur.
- The distributional records of blue whales and pygmy blue whales in the Atlas of Living Australia (CSIRO, 2022) indicate there have been no confirmed sightings in central Bass Strait (including Waratah Bay and nearshore Tasmanian off Heybridge). Therefore, the likelihood of blue whales or pygmy blue whales foraging nearshore waters of Victoria and Tasmania interacting with the project is remote.
- During the initial arrival of the cable lay ship to Waratah Bay or nearshore Tasmanian off Heybridge, the ship will not enter nearshore areas if a blue whale or pygmy blue whale has been observed under the visual monitoring component of the project’s Cetacean Interaction Management Plan. Therefore, the presence of any foraging or resting whale will not be displaced. The cable lay ship will enter nearshore waters after the whales have vacated the area and moved on by their own free will.

- During the 10-day periods in either nearshore Victoria or nearshore Tasmania, when the cable ship maintains position using it thrusters under DP mode for 24 hours per day, it has been assessed that a blue/ or pygmy blue whale is most unlikely to approach the fixed location of the cable lay ship having detected the underwater noise gradient surrounding the cable lay ship. In the case that a blue whale or pygmy blue whale is sighted within the 1-km radius observation zone, a reduction in underwater noise level is not feasible as the cable lay ship must maintain position.

The Conservation Management Plan for the Blue Whale (DoE, 2015f) lists the following interim recovery objectives:

- The conservation status of blue whale populations is assessed using efficient and robust methodology.
- The spatial and temporal distribution, identification of biologically important areas, and population structure of blue whales in Australian waters is described.
- Current levels of legal and management protection for blue whales are maintained or improved and an appropriate adaptive management regime is in place.
- Anthropogenic threats are demonstrably minimised.

The long-term recovery objective included in The Conservation Management Plan for the Blue Whale (DoE, 2015f) are for the blue whale is to minimise the anthropogenic threats, with the aim of improving the conservation status of the blue whale so that they can be removed from the EPBC Act threatened species list.

Based on the above considerations, the temporary and short term nature of impact, and implementation of the mitigation measures outlined in the Cetacean Interaction Management Plan (EPR MERU08, Section 7.6), residual impacts to the blue whale/pygmy blue whale will not be inconsistent with the objectives of the blue whale conservation management plan.

7.2.3.6 Acoustic impacts to pinnipeds

This section assesses underwater noise impacts to pinnipeds, including eared seals (*Otariidae*) and true or earless seals (*Phocidae*), from the cable laying operations. All pinnipeds in Australian waters are Listed Marine Species under the EPBC Act.

As was the case for cetacean impact assessment, an underwater noise source level (SL) of 185 dB re 1 μPa_{rms} at 1 m has been adopted for the cable ship during cable lay operations as a worst-case scenario.

Pinniped species known to occur within the vicinity of the project's nearshore and offshore alignments, and Bass Strait in general are described in Section 6.3.7 (Pinnipeds).

7.2.3.6.1 Potential impacts

Potential impacts of project-generated noise to pinnipeds are similar to those described for cetaceans in Section 7.2.3.5.1 (Potential impacts), as well as the conceptual acoustic zones of influence shown in Figure 7.6 and are not repeated here.

Environmental performance requirements

Pinniped interactions will be managed under the Marine Fauna Management Pan (MERU07) presented in section 7.2.3.5.1

Potential mitigation and management measures

No specific mitigation and management measures are proposed for pinnipeds that may transit through active construction areas. Free-ranging pinnipeds are fast swimming marine mammals that may enter the project's underwater noise fields at will. In general, it is only approaching large cetaceans that require monitoring or surveillance under the EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales: Industry Guidelines (DEHWA. 2008). Note that other marine mammals such as dolphins and pinnipeds are not included in this policy statement, which is only relevant to loud impulsive noise sources such as marine seismic survey air guns.

7.2.3.6.2 Residual impacts to pinnipeds

Acoustic damage, disturbance, behavioural, and acoustic auditory masking impacts to phocid and *Otariid* pinnipeds are assessed below.

Residual impacts to phocids

This section assesses residual impacts of underwater noise to phocid pinnipeds, which are represented in Bass Strait by the leopard seal (*Hydrurga leptonyx*) and the southern elephant seal (*Mirounga leonina*) (see Section 6.3.7.2, Earless seals (*Phocidae*).

Acoustic damage impacts to phocids and permanent hearing loss

The NMFS (2018) $SEL_{cum(PW)}$ threshold of 201 dB re 1 μPa^2·s for onset PTS is not shown as it will be within one or two metres of the cable ship noise sources, where phocids are most unlikely to approach or be so close. Therefore, acoustic damage impacts to phocids are not predicted.

Acoustic disturbance impacts to phocids and temporary hearing loss

Table 7-22 presents the calculated horizontal distances to species weighted cumulative SEL isopleths of interest and acoustic SEL threshold criteria for phocids. Note that the assumption of a phocid remaining stationary for 24-hours (as required for application of the NMFS (2018) threshold) is not realistic; therefore, except for the NMFS (2018) TTS threshold value, all other isopleth $SEL_{cum(PW)}$ values in Table 7-22 are predicted for phocids remaining stationary for one-hour, which are also conservative.

Table 7-22: Calculated distances to SEL_{cum} isopleths during cable laying – phocids

Species-weighted source level: 207 $SEL_{cum(PW)}$ (dB re 1 μPa^2·s at 1 m)							
Isopleths (dB re 1 μPa^2·s)	181	170	160	150	140	130	120
Distance to isopleth (m)	56	301	1,397	6,483	30,092	139,677	648,323
Threshold isopleth	**TTS**	–	–	–	–	–	–

Source: MDA, 2023; Attachment G. TTS = temporary threshold shift (NMFS, 2018).

In Table 7-22, the distance to the NMFS (2018) $SEL_{cum(PW)}$ threshold of 181 dB re 1 μPa^2·s for TTS onset is 56 m. This represents a very small acoustic disturbance zone within which phocids may suffer from temporary hearing loss if they remain within the zone for an hour or longer, which is an unlikely scenario for a foraging phocid. However, it is more than likely that an approaching or transiting phocid will detect the underwater noise gradient at distance from the noise source of the cable lay ship and avoid (turn away) or pass around the sound field, if moving along the coastline or foraging in the general area where the cable lay ship is located.

Overall, acoustic disturbance and temporary hearing loss impacts to phocids are assessed to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *Low* due to their wide distribution in Bass Strait and the wider region, and a magnitude of impact of *Moderate* based on the TTS onset threshold ($SEL_{cum(PW)}$ of 181 dB re 1 µPa^2·s) being exceeded within a 56-m radius zone of influence but reversible within a few days. Phocids are most unlikely to approach or remain within the 56-m radius zone of influence where the TTS onset threshold is exceeded for more than an hour.

Acoustic disturbance impacts on phocid behaviour

Table 7-19 (presented earlier) gives calculated distances to various nominal isopleths of interest for low frequency cetaceans and which has also been adopted for application to phocid pinnipeds. This radial distance to the upper acoustic threshold criterion (160 dB re 1 μPa_{rms}) is 60 m. This represents a very small impact zone within which disruptive behavioural responses and avoidance in phocids may occur.

Overall, the predicted impacts of underwater noise causing disruptive behavioural responses in phocids are assessed to have an impact significance rating of ***Very low***. This is based on a phocid sensitivity of *Low* due to widespread distribution in Bass Strait and the wider region, and a magnitude of impact of *Moderate,* given that phocids will be temporarily displaced vertically or horizontally from the project's sound field above 160 dB re 1 µPa rms for the duration of noise-generating activity but return to previously occupied areas when the noise source ceases or the cable lay ship moves on to a new location. Migrating phocids such fast swimming southern elephant seals (*Mirounga leonina*) are expected to detour around the cable lay ship when transiting Bass Strait.

Acoustic auditory masking impacts on phocids

The generalised underwater hearing range of phocids is between 50 Hz and 86 kHz (NMFS, 2018) and its lower range overlaps the frequency range (20 Hz to 2 kHz) of underwater noise generated by the cable lay ship. Phocids have consistently demonstrated an extended range of hearing compared to *otariids* (Kastelein et al., 2009; Reichmuth et al., 2013).

Phocid ears have larger and more dense middle ear ossicles, inflated auditory bullae and larger inner ear components (e.g., tympanic membrane, oval window and round windows), which makes them more adapted to underwater hearing (Reichmuth et al., 2013).

The southern elephant seal (*Mirounga leonina*) may occasionally transit through Bass Strait. There is an absence of information on hearing frequency data for this species. However, the hearing frequency range of the northern elephant seal (*Mirounga angustirostris*) of between 75 Hz and 50 kHz (Hemila et al., 2006) with a peak sensitivity range between 3.2 and 45 kHz and greatest sensitivity at 6.4 kHz (Kastak and Schusterman, 1999) has been used as a surrogate for the southern elephant seal. It is a reasonable assumption that the common ancestor of all elephant seals represents a functional hearing group with similar aerial and in-water hearing characteristics, as well as the fact that these two elephant seal species belong to the same genus, which indicates similar evolutionary biology, including underwater hearing abilities.

Leopard seals are highly vocal and are found occasionally in Bass Strait. Rogers (2014) investigated five different underwater call types of a single male leopard seal and found the calls had broadband source levels that ranged from 153 to 177 dB re 1 µPa at 1 m, and mean values per call type ranged from 159 to 179 dB re 1 µPa at 1 m. The frequency ranges varied depending on the underwater call types; for example, type 'L' low double trill calls (250–630 Hz), type 'O' single trill calls (200–250 Hz) and type 'D' low descending trill calls (200–1,250 Hz) had lower frequency ranges, while type 'M' medium trill calls (1.6–2.0 kHz) and type 'H' high double trill calls (2.5–4.0 kHz) had higher frequency ranges. Therefore, potential acoustic auditory masking of the abovementioned type 'L', 'O', 'D', and

'M' calls (total range between 200 Hz and 2 kHz) is likely given that these underwater calls wholly overlap the cable lay ship's frequency range of 20 Hz to 2 kHz. However, the leopard seal's type 'M' medium trill calls (range 1.6–2.0 kHz) and type 'H' high double trill calls (range 2.5–4.0 kHz) do not overlap the underwater noise frequency range of the cable lay ship and, are therefore unlikely to be masked.

Overall, the predicted acoustic auditory masking impacts on phocid seals are assessed to have a residual impact significance rating of ***Low***. This is based on phocid sensitivity of *Low* due to their widespread regional distribution, and a magnitude of impact of *Moderate* based on a low level of acoustic auditory masking of biologically relevant sounds with brief or minor cessation of vocal behaviour.

Residual Impacts to *otariids*

This section assesses residual impacts of project underwater noise to *otariid* pinnipeds, which are represented in Bass Strait by the Australian fur seal (*Arctocephalus pusillus doriferus*), long-nosed fur seal (*A. fosteri*), Antarctic fur seal (*A. tropicalis*) and the Australian sea lion (*Neophoca cinerea*) (see Section 6.3.7.1).

Acoustic damage impacts to otariids and permanent hearing loss

The $SEL_{24\text{-}h}$ threshold of 219 dB re 1 μPa^2·s for onset PTS in *otariids* is not exceeded within the sound field of the cable lay ship, while laying the bundled cable. Therefore, acoustic damage impacts to *otariids* are not predicted.

Acoustic disturbance and temporary loss of hearing impacts on otariids

Table 7-23 presents the calculated horizontal distances to species weighted cumulative SEL isopleths of interest and acoustic threshold criteria for otariids (NMFS, 2018).

Table 7-23: Distances to weighted SEL_{cum} isopleths during cable laying – Otariids

Species-weighted source level: 207 $SEL_{cum(OW)}$ (dB re 1 μPa^2·s at 1 m)							
Isopleths (dB re 1 μPa^2·s)	199	170	160	150	140	130	120
Distance to isopleth (m)	4	306	1,409	6,586	30,569	141,888	658,586
Threshold isopleth	**TTS**	–	–	–	–	–	–

Source: MDA, 2023; Attachment G. TTS = temporary threshold shift (NMFS, 2018).

In Table 7-23, the distance to the NMFS (2018) $SEL_{cum(OW)}$ threshold of 199 dB re 1 μPa^2·s for TTS onset is 4 m. This is an extremely small zone of influence that is most unlikely to be approached by an *otariid*. *Otariids* in Waratah Bay, nearshore Tasmania at Heybridge, and in the vicinity of the cable lay ship will also sense the ship's presence visually when they are at the sea surface, as well as acoustically when submerged.

Overall, acoustic disturbance and temporary hearing loss (TTS onset) impacts to *otariids* are assessed to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *Low* due to their wide distribution and abundance in Bass Strait and wider region, and a magnitude of impact of *Moderate,* given that the TTS onset cumulative threshold ($SEL_{cum(OW)}$ of 199 dB re 1 μPa^2·s) is exceeded but only within 4-m radius of the cable lay ship. Since *otariids* are most unlikely to approach or remain within the 4-m radius zone of influence (basically adjacent to one of the ship's thrusters), The impact significance rating is conservative.

Acoustic disturbance impacts on otariid behaviour

Table 7-19 (presented earlier) gives calculated distances to various nominal isopleths of interest. This includes the upper acoustic threshold criterion (160 dB re 1 µPa$_{rms}$), above which disruptive behavioural responses and avoidance by *otariids* may occur, and the lower acoustic threshold criterion (130 dB re 1 µPa$_{rms}$), for nearshore waters with higher ambient noise levels, and above which more subtle behavioural responses may occur in *otariids*. The NMFS (2018) acoustic threshold criterion of 120 dB re 1 µPa$_{rms}$ is not used as it has been amended to 130 dB re 1 µPa$_{rms}$ to take account of the upper range values of existing background noise in the Victorian and Tasmanian nearshore environments.

Figure 7.9 (Waratah Bay) and Figure 7.10 (Nearshore Tasmania off Heybridge) shows a map of the isopleths around the cable lay ship's location, which are based on the distances to selected SPL rms isopleths.

The upper acoustic threshold criterion of 160 dB re 1 µPa$_{rms}$ will be exceeded at about a horizontal radial distance of 46 m. The lower acoustic threshold of 130 dB re 1 µPa$_{rms}$ will extend to 4.6 km radius. Within this larger 4.6-km zone of influence, *otariids* are anticipated to show more subtle behaviours such as longer times spent at the sea surface, which will reduce through habituation.

Overall, acoustic disruptive impacts on *otariid* behaviour are assessed to have a residual impact significance rating of ***Low***. This is based on an *otariid* sensitivity of *Low* due to their wide distribution and abundance in Bass Strait and wider region, and a magnitude of impact of *Low* given that *otariids* will be temporarily displaced vertically or horizontally from the project's sound field above 160 dB re 1 µPa rms for the duration of noise-generating activity but return to previously occupied areas when the noise source ceases or the cable lay ship moves on to a new location.

Acoustic auditory masking impact to otariids

The generalised underwater hearing range of *otariids* is between 60 Hz and 39 kHz (NMFS, 2018) and the lower level of this range overlaps the cable lay ship's noise frequency range of 20 Hz to 2 kHz. *Otariids* appear to have poorer hearing than phocids below 1 kHz and have a similar but slightly poorer hearing between 1 kHz and their high frequency cut off at around 39 kHz (Richardson et al., 1995, Thompson et al., 1998). The high frequency cut off for *otariids* is between 10 to 15 kHz below that of phocids.

Fur seals and sea lions are known to bark underwater and make clicks with most energy below 4 kHz (Richardson et al., 1995). Asselin et al. (1993) examined the underwater calls of grey seals (*Halichoerus grypus*) and found that most calls consisted of guttural 'rups' and 'rupes' (100 Hz to 3 kHz), low-frequency growls (100 to 500 Hz), and low-frequency clicks (around 3 kHz). In the absence of information on the underwater hearing frequency ranges of Australian *otariids*, the hearing range of the northern fur seal (*Callorhinus ursinus*) of between 400 Hz and 40 kHz (Hemila et al., 2006) has been adopted as a generalised hearing range for the Australian fur seal, which has been selected as representative of Australian *otariids* and occurs widely in Bass Strait (see Section 6.3.7.1.1, Australian fur seal). The frequency range of the underwater calls or communications of some of the above *otariids* overlap the frequency range of (20 Hz to 2 kHz) of the project's underwater noise sources. Therefore, masking of underwater sounds and *otariid* communications may potentially occur.

Overall, the predicted masking impacts on *otariids* are assessed to have a residual impact significance of ***Low***. This is based on an *otariid* sensitivity of *Low* due to their wide distribution and abundance in the project area and wider region, and a magnitude of impact of *Low* based on weak masking of biologically relevant sounds (vocalisations if present), except when close to a project underwater noise source. Most of the *otariid* foraging areas are offshore where there is a very large expanse of undisturbed foraging habitat in the region, so potential masking of sounds and *otariid* vocalisations during diving for prey (e.g., Little Penguins, fish and cephalopods) will only be affected in proximity to the cable lay ship while laying bundled cables in the offshore zone. This is expected to be of short duration as the ship transits at a speed of 1.5 knots.

7.2.3.7 Acoustic impacts to sea turtles

This section assesses residual impacts of project-generated underwater noise to sea turtles that are known or likely to occur in Bass Strait. The cable lay ship underwater noise level of 185 dB re 1 µPa at 1 m has been used as a worst-case scenario.

Sea turtle species known to occur within the vicinity of the project's nearshore and offshore alignments and Bass Strait in general are described in Section 6.3.8 (Sea turtles).

There is limited information on underwater hearing in sea turtles. The anatomy of the sea turtle ear has been described by Wever (1978) and Lenhardt et al. (1985). The sea turtle ear has three principal divisions comprising the outer, middle, and inner ear; however, an external ear is entirely absent (Wever, 1978). The outer ear of sea turtles receives sound waves from the external medium (e.g., seawater or air) and sound is transmitted to well-developed sound-receptive and sound-conducting mechanisms of the middle ear, which includes an air-filled chamber known as the tympanic cavity (Viada et al., 2008).

Lenhardt et al. (1983) proposed that the sea turtle ear is adapted for hearing via bone conduction in water, but bone conduction is a poor receptor in air, suggesting that the whole body serves as a receptor while the turtle is underwater. Bone-conducted hearing (except for leatherback turtles) appears to be an effective reception mechanism for loggerhead and Kemp's ridley turtles, with both the skull and shell acting as receiving surfaces for water-borne sound at frequencies between 250 to 1000 Hz (Lenhardt et al., 1983; Moein et al., 1993, 1994). As high sound frequencies are attenuated by bone, the range of bone-conducted sounds detected by sea turtles are limited to only low frequencies (Tonndorf, 1972).

Table 7-24 summarises hearing sensitivities of different developmental stages of sea turtle species that are known to occur in Bass Strait. A literature review did not reveal any underwater hearing frequency ranges for juvenile, subadult, or adult hawksbill turtles (*Eretmochelys* imbricata). However, Monteiro et al. (2019) showed sound production by pre-hatch hawksbill turtles (i.e., within the beach nest), which confirms the findings of other researchers (e.g., McKenna et al. 2019) who suggest that acoustic communication among the embryos may be used to synchronise hatchling and nest emergence.

Table 7-24: Underwater hearing ranges of different sea turtle life stages

Species	Hearing range (Hz)	Most sensitive hearing range (Hz)	Reference
Green turtle (*Chelonia mydas*)	100 – 800 (sub-adult)	200 – 400 (sub-adult)	Bartol and Ketten (2006)
	50 – 1,600 (juvenile)	600 – 700 (juvenile)	Piniak et al (2016)
	1,478 – 1,734 ('HF croaks') (juvenile)	NR	Charrier et al. (2022)
	293 – 399 ('LF rumbles') (juvenile)	NR	Charrier et al. (2022)
	24 – 508	NR	Charrier et al. (2022)

Species	Hearing range (Hz)	Most sensitive hearing range (Hz)	Reference
	(*LF FM sound) (juvenile)		
	3,334 – 4,625 (HF squeaks) {juvenile}	NR	Charrier et al. (2022)
Loggerhead turtle (*Caretta caretta*)	25 – 1,000 (juvenile)	100 – 400 (juvenile)	Bartol et al. (1999), O'Hara and Wilcox (1990)
	50 – 1,000 (juvenile)	100 – 400 (juvenile)	Lavender et al. (2014)
	110 – 1,131 (adult)	200 – 400 (adult)	Martin et al. (2012)
*Kemp's ridley (*Lepidochelys kempii*)	100 – 500 (juvenile)	100 – 200 (juvenile)	Bartol and Ketten (2006)
Leatherback turtle (*Dermochelys coriacea*)	50 – 1,200 (hatchling)	100 – 400 (hatchling)	Cook and Forrest (2005); Piniak et al. (2012).

Note: LF = Low Frequency; HF = High frequency; MF = Frequency Modulated. *Kemp's ridley turtle is a North Atlantic species not found in Australia but has been included as a proxy for the olive ridley turtle (*Lepidochelys olivacea),* which is within the same genus and is known to occur irregularly in Bass Strait. NR = Not reported.

Based on Table 7-24, most of the sea turtle hearing frequency ranges overlap the underwater noise frequency range (20 Hz to 2 kHz) generated by the cable lay ship during cable lay operations. Therefore, project-generated underwater noise has the potential for masking environmental sounds and subadult/adult sea turtle communications (if present).

7.2.3.7.1 Potential Impacts to sea turtles

Potential impacts to sea turtles include:

- Mortality if exposed for prolonged periods to non-impulsive broadband noise cumulative sound exposure levels.
- Permanent hearing loss (irreversible) if exposed to loud underwater noise or exposed to lower noise levels for protected periods.
- Temporary hearing loss (reversible) if exposed moderate under water sound levels.
- Behavioural modification in presence of project-generated noise.
- Potential masking of underwater sounds that biologically relevant to sea turtles.

Environmental Performance Requirements

In Australia, vessel operators are not required to stay a specific distance away from sea turtles. While provisions for vessel-cetacean interactions are outlined in of the Environment Protection and Biodiversity Conservation Regulations 2000 (Part 8 Division 8.1 Interacting with cetaceans) and Commonwealth and/or state guidelines for viewing or interacting with cetaceans, there is no equivalent sea turtle approach, watching or interaction guidelines in legislation or regulations.

Based on a literature review of overseas vessel-sea turtle interactions with approach distances and observation buffer distances, a recurring theme is that vessels should not approach a sea turtle within 50 yards (NOAA Fisheries, 2022), which is 45.72 m or approximately 50 m. In Australia, offshore oil and gas developments state that "*project vessels will not approach closer than 50 m for a dolphin or turtle*" (e.g., Woodside, 2019, 2022). For the project, MLPL proposes to adopt a voluntary (i.e., non-statutory or regulatory) approach for managing vessel-sea turtle interactions and using the generally accepted vessel caution zone of 50 m for sea turtles.

The proposed EPR for the acoustic impacts to sea turtles is presented in Table 7-25:

Table 7-25 EPRs for managing interactions with sea turtles

EPR ID	Environmental performance requirement	Project stage
MERU09	**Develop and implement a plan for managing interactions with sea turtles** Prior to commencement of marine construction, develop a sea turtle interaction management plan for managing interactions with sea turtles to avoid or minimise impacts during construction. The plan must: • Define the area for visual monitoring. • Document the approach to vessel based visual monitoring with a minimum visual monitoring buffer zone of 200 m. • Define exclusion and buffer zones for maintaining a separation distance of vessels from sea turtles, including the requirement for transiting vessels to maintain a minimum separation distance of 50 m from sea turtles. • Outline vessel-sea turtle strike avoidance measures to minimise the potential for collision with sea turtles, including if sea turtles are sighted within the 50 m separation distance, vessels must reduce speed and shift the engine to neutral, not engaging the engines until sea turtles are clear of the area. • Consider all construction vessels including guard vessels, small boats manoeuvring floated cables, crew transit vessels and dive boats. A plan is not required for slow moving vessels laying cable, towing gear or subsea machines. The sea turtle interaction management plan should be a sub-plan to the marine fauna management plan (EPR MERU07) and be implemented during construction.	Construction / Operation / Decommissioning

Potential mitigation and management measures

Mitigation and management measures for project interaction with sea turtles include:

- Transiting vessel-based visual monitoring for sea turtle presence:
  - Visual monitoring requires the use of observers to scan the sea surface visually for the presence of sea turtles at the sea surface during daylight hours only. Specialist observers are not required as the monitoring can be conducted by vessels' skippers and deck crew and it is not necessary to know the species of sea turtle that may be approached.
  - Vessels must slow down to no-wake speed within the 150-m caution zone and wait until sea turtles are clear of the area before returning to normal operation.
  - No vessels will be allowed to enter the no approach zone of 50 m if a sea turtle is present.

The above mitigation measures do not apply to the project's larger and slower moving vessels such as the cable lay ship (1.5 knots) during cable lay operations or offshore support vessel (<1 knot) acting as a host vessel for the ROV jet trencher during cable installation and burial. Under these slow transit speeds, vessel-sea turtle collisions are unlikely to occur.

7.2.3.7.2 Acoustic damage impacts to sea turtles and permanent hearing loss

Popper et al. (2014) proposed that dual injury threshold levels of a cumulative SEL of 210 dB re 1 $\mu Pa^2 \cdot s$ (unweighted) and a peak SPL of 207 dB re 1 μPa_{pk} applicable to fish should apply to sea turtles. This remains the position in the updated report by Popper et al. (2019).

MDA (2023; Attachment G) uses mortality threshold data for sea turtles presented in Popper et al. (2019), which include an unweighted sound exposure level (SEL) of 210 dB re. 1 µPa^2·s SEL_{cum} or a peak sound pressure level (SPL) of 207 dB re. 1 μPa_{pk}. Whichever is the higher has been be conservatively applied in the impact assessment.

Table 7-26 presents the calculated horizontal distances to species weighted cumulative SEL isopleths of interest and acoustic threshold criteria for sea turtles.

Table 7-26: Calculated distances to SEL_{cum} isopleths during cable laying – sea turtles

Species-weighted source level: 210 $SEL_{cum(ST)}$ (dB re 1 µPa^2·s at 1 m)							
Isopleths (dB re 1 µPa^2·s)	210	200	190	186	180	170	160
Distance to isopleth (m)	1	5	21	98	453	2,103	9.760
Threshold isopleth	**Mort.**	–	–	–	–	–	–

Source: MDA, 2023; Attachment G. Mort. denotes mortality. There are no PTS or TTS thresholds available for sea turtles.

In Table 7-26, mortality of sea turtles will be confined to an extremely small zone within 1 m of the cable lay ship's source level, which is basically at the site of one of the thrusters of the cable lay ship. Given that a sea turtle is most unlikely to approach so closely to the thrusters (partly due to the water flow created by the thrusters), mortality of sea turtles is not predicted from the cable lay ship.

7.2.3.7.3 Acoustic disturbance impacts on sea turtle behavior

Table 7.20 presents calculated distances to various nominal isopleths of interest, including the acoustic threshold criterion 175 dB re 1 μPa_{rms} above which disruptive behavioral responses and avoidance in sea turtles may occur.

In Table 7-27, the calculated distance to behavioral threshold of 175 dB re 1 μPa_{rms} is 4.6 m, which represent an extremely small zone of influence for potential avoidance behavior or displacement.

Table 7-27: Calculated distance to selected SPL rms isopleths for sea turtles.

Noise Source Level	Isopleth (dB re 1 μPa_{rms})						
185 dB re 1 µPa at 1 m	180	175	170	160	150	140	130
Distance to isopleth (m)	2.2	4.6	10.0	46.4	215.4	1,000	4,641
Behavioural threshold	–	Upper level	–	–	Lower level	–	–

Notes: Distances are calculated using the practical spreading loss equation (15Log10R), where R is the range in metres. Behav. = threshold for onset of disruptive behaviour; Dash (–) denotes not a behavioural threshold isopleth. Upper level of 175 dB re 1µPa rms denotes disruptive behavioural response expected. Lower level of 150 dB re 1µPa rms denotes subtle behavioural response.

In Table 7-27, the distance to the disruptive behavioural threshold of 175 dB re 1 µPa rms is 4.6 m, which represents an extremely small zone of influence for potential avoidance behaviour. Similarly, the distance to the subtle behavioural threshold of 150 dB re 1 µPa rms is 215.4 m, which also represent as small zone surrounding the cable lay ship.

Overall, the predicted impacts on sea turtle disruptive behaviours (e.g., avoidance or aversion behaviour) are assessed to have a residual impact significance rating of ***Low***. This is based on a sea turtle sensitivity of *Low* due to their weak responsiveness to sound pressure, and a magnitude of *Low* given that the zone of disruptive behavioural effects (i.e., exceedance of 175 dB re 1 µPa rms) is only exceeded within 4.6-m radius of the cable lay ship (which is effectively at the site of one of the ship's thrusters) and sea turtles are most unlikely to approach the ship's thrusters. In the case of more subtle behavioural responses of sea turtles within the 215.4-m radius lower level zone, this also represents a low impact zone and has been assessed to have an impact significance rating of ***Very low*** based on a sensitivity of *Low* due to their weak responsiveness to sound pressure and a magnitude of impact of *Low* given the small 215.4-m zone within which subtle behavioural response are predicted.

7.2.3.7.4 Acoustic auditory masking of sea turtle hearing

Based on Table 7-24, most of the sea turtle hearing frequency ranges overlap the underwater noise frequency range (20 Hz to 2 kHz) generated by the cable lay ship during cable lay operations. Therefore, the potential for masking environmental sounds and subadult/adult sea turtle communications (if present) has been assessed below.

All sea turtle species investigated emit sounds as hatchlings (Ferrara et al., 2013, 2014) and McKenna et al. (2019) suggest that this is a universal trait of sea turtles. McKenna et al. (2019) investigating vocalisations in green, leatherback and olive ridley turtles did not find any significant differences in the types, frequency, or duration of vocalisations between incubation, hatching, and emerging from the nest. In general, vocalisation in sea turtle hatchlings and juvenile sea turtles is less relevant to assessing underwater noise effects on sea turtles occurring in Bass Strait, as the latter and southeast Australia in general represents the southern distribution limit of most species of turtle and most sighting records are for sub-adult or adult sea turtles.

Although Lenhardt et al. (1983) speculated that turtles may use acoustic cues for navigation during migrations, information on subadult and adult turtle communication is lacking. There is an almost complete lack of data on masking of biologically important signals in sea turtles by anthropogenic noise (Popper et al. 2014; Erbe et al., 2022).

Given the low numbers of sea turtles in Bass Strait and them typically being present as solitary individuals and passing migrating vagrants, there is a low likelihood of a sea turtle (e.g., the 'sender' of a signal) communicating with another sea turtle of the same species (e.g., the receptor or the 'receiver'). In the case of the most frequently recorded sea turtle (i.e., the leatherback turtle), sightings have been declining and between 2012 and 2017, there have only been seven records in Victorian waters (SWIFFT, 2023).

Overall, predicted acoustic auditory masking impacts on sea turtles are assessed to have a residual impact significance rating of ***Low***. This is based on sea turtle sensitivity of *Low* due to their weak responsiveness to sound pressure and their lack of communication underwater, and a magnitude of impact of *Low* given that auditory masking of biologically relevant sounds is generally weak except when in proximity to a noise source. Any acoustic auditory effects will be short-lived and persist only for the duration of the marine construction activity being carried out or for the time that a sea turtles continue their foraging movements while passing through Bass Strait.

7.2.3.7.5 Compliance with the objectives of Sea Turtle National Recovery Plan

The Recovery Plan for Marine Turtles in Australia, 2017-2027 (DoEE, 2017a) was examined to determine threatening processes to sea turtles in southeast Australian temperate waters including Bass Strait. DoEE (2017a) assessed the risks of threatening processes to sea turtle stocks mainly within the warmer waters of WA, NT, QLD and the Great Barrier Reef. There are no BIAs for nesting or internesting in the temperate waters of Bass Strait, which represents the southern distribution limit of adult and subadult sea turtle species in Australian waters. The main threatening processes to sea turtles include, but are not limited to, marine debris, fisheries bycatch, vessels, underwater noise and light pollution, of which underwater noise and light pollution are most relevant to the project. Light pollution is assessed separately in Section 7.2.4.5.2.

In the current list of marine species for which BIAs have been identified as regionally significant in the National Conservation Values Atlas (DCCEEW, 2022a), no sea turtle BIAs are located within southeast Australia. The three main species occurring in Bass Strait are the leatherback, loggerhead and green turtles in descending order of occurrence, with most species being present as foraging on migration adults and subadults. In terms of project compliance with the national recovery plan's interim objectives of demonstrably minimising anthropogenic threats to sea turtles, the underwater noise mitigation measures listed under the project's EPRs for managing interactions with sea turtles (Table 7-25) is in concordance.

7.2.3.8 Acoustic impacts to marine birds

This section assesses residual impacts of project underwater noise to those marine birds that forage or dive below the sea surface for prey items and potentially may be exposed to underwater acoustic impacts. The cable lay ship underwater noise level of 185 dB re 1 µP at 1 m has been used as a worst-case scenario.

Pelagic seabird species and Little Penguins known to occur within the vicinity of the project's nearshore and offshore alignments and Bass Strait in general are described in Section 6.3.9 (Marine birds). Bass Strait is a key region for seabirds with Little Penguins (*Eudyptula minor*), short-tailed shearwaters (*Ardenna tenuirostris*), fairy prions (*Pachyptila turtur*) and common diving-petrels (*Pelecanoides urinatrix*) being particularly abundant in the region (Fromant et al., 2020). Little penguins consumed mainly fish whereas the three *procellariforms* primarily consumed coastal krill (*Nyctiphanes australis*) (Fromant et al., 2020).

It is the diving depths and duration of underwater foraging that are of interest when assessing underwater noise impacts of the project. Underwater foraging or diving pelagic seabirds include albatrosses, petrels, storm-petrels, shearwaters, and Australasian gannets. Table 7-28 gives examples of the mean and maximum diving depths of petrels and shearwaters, which are based on studies from New Zealand (Taylor, 2008). In Table 7-28, the common-diving petrel has a mean diving/foraging depth of 10.0 m (range 6.9 to 22.2 m), which is greater than the 2 to 4-m diving depth range reported in Australia (Dunphy et al., 2015; Fromant et al., 2020) for the same species. However, the difference in foraging depths may be due to the depth at which their prey items were located.

Table 7-28: Summary statistics of the maximum dive depths of petrels and shearwaters

Species		No.	Mean	S.D.	Range
Grey-faced Petrel	*Pterodroma macroptera gouldi*	53	4.7	4.7	0.7–23.6
Black-winged Petrel	*Pterodroma nigripennis*	4	1.6	0.3	1.3–1.9
Sooty Shearwater	*Puffinus griseus*	16	42.7	23.7	1.2–92.9
Flesh-footed Shearwater	*Puffinus carneipes*	23	13.6	7.9	0.8–28.7
Common-diving Petrel	*Pelecanoides urinatrix*	6	10.9	6.1	6.9–22.2

Source: Taylor (2008). Note most of the petrels in the table are New Zealand species; however, the Common-diving Petrel and two shearwater species are present in Bass Strait.

The diving depths and/or foraging durations for albatrosses and petrels in southeast Australian waters include:

- Shy Albatrosses (*Thalassarche cauta*) diving activity occurs mostly during daylight (from 7 am to 10 pm), with the deepest dives (up to 7 m) occurring from 10 am to noon (Hedd et al., 1997).
- Grey Headed Albatrosses (*Thalassarche chrysostoma*) dive to at least 6 m and remain swimming below the surface for up to 11 seconds in search of prey (Prince et al. 1994)
- Southern Giant Petrel (*Macronectes giganteus*) take prey at sea by surface seizing, surface filtering, surface diving, and surface plunging, with dive depths between 1 and 2 m (Harper, 1987).
- Northern Giant Petrel (*Macronectes halli*) take prey at sea by surface seizing, surface filtering, surface diving, and surface plunging (to about 2 m) (Harper, 1987)
- Black-browed Albatross (*Thalassarche melanophris*) take most prey by surface-seizing and surface-plunging with diving depths up to 2.5 m, but they are also capable of remaining submerged for almost 20 seconds in pursuit of prey (Harper 1987).

Based on the above literature review, the diving depths of the albatrosses are all less than 7 m and albatrosses will not be exposed to underwater noise in the immediate vicinity of the cable lay ship given that its thrusters are located at about 7 m depth with most underwater noise initially oriented downwards. It is considered very unlikely that albatrosses will dive and forage in the direct vicinity of the cable lay ship given that their prey (pelagic fishes) will also be displaced by the ship's underwater noise. Therefore, underwater noise impacts on albatrosses are not considered further.

In a worst-case scenario, the deeper diving depths of the Sooty Shearwater indicate that this species could be exposed to underwater noise from the cable lay ship if diving for prey in proximity to the ship. While Taylor (2008) stated that Sooty Shearwaters had a mean diving depth of 42.7 m, the mean diving duration was not reported. However, in a similar study, Shaffer et al. (2009) observed that 90% of sooty shearwater dives were less than 30 m with estimated duration of 100 seconds (1.6 minutes). Therefore, the mean dive duration for a mean diving depth of 42.7 m reported by Taylor (2008) will be around 142 seconds (or 2.4 minutes). In the unlikely case that a Sooty Shearwater dives and forages in the immediate vicinity of the cable lay ship, exposure to underwater noise received levels in range 150 to 185 dB re 1 μPa rms below the 7-m depth of ship's thrusters down to 42. m depth will be less than 122 seconds (about 2 minutes). This represents a very short exposure to underwater noise such that no impacts from underwater noise are predicted. For these reasons pelagic seabirds have been excluded from further assessment in relation to underwater noise and are not discussed further.

The remainder of this section assesses the potential impacts of underwater noise on Little Penguins, which spend longer periods underwater while foraging for prey resulting in potential longer exposures to underwater noise.

7.2.3.9 Acoustic impacts to Little Penguins

A literature search revealed little information on the hearing of penguins (in general) in air or underwater, and little or no information on Little Penguin hearing ranges or sensitivity. There is little information on the auditory systems and communication of different penguin species. However, McCauley (1994) notes that the hearing range of most birds lies between 100 Hz and 8 kHz.

On land, Little Penguins communicate via calls (vocalisations) that allow adult pairs to recognise each other and their chick. The in-air hearing abilities of penguins have been examined and reviewed by Jouventin (1982). For example, in-air and/or auditory frequency ranges include:

- the Emperor Penguin (*Aptenodytes forsteri*) has an in-air frequency range of 500 Hz to 6 kHz and an auditory range of 30 Hz to 12.5 kHz (Jouventin, 1982).
- the Blackfooted Penguin (*Spheniscus demersus*) has an in-air hearing range of 100 Hz to 15 kHz with a peak between 600 Hz to 4 kHz based on analyses of cochlear potentials (Wever et al., 1969).

7.2.3.9.1 Potential impacts

Potential effects of underwater noise on Little Penguins includes:

- Acoustic damage impacts and physiological impacts (PTS onset) to Little Penguins if exposed to loud underwater noise sources.
- Acoustic disturbance impacts and physiological impacts (TTS onset) to Little Penguins exposed to underwater noise sources.
- Acoustic disturbance and behavioural impacts to Little Penguins.
- Indirect impacts on Little Penguins via underwater noise impacts on their preferred prey (e.g., sardines and anchovies).
- Acoustic masking of sounds and underwater communications.

Environmental performance requirements

EPRs for this section are outlined in section 7.2.3.5.1 (Acoustic impacts to cetaceans).

Potential mitigation and management measures

No mitigation measures or precautionary safety zones and buffers are proposed for Little Penguins, given that these wild, free-ranging, rapid swimming birds have high maneuverability and the opportunity to not enter or avoid project-generated sound fields. In addition, there are very large expanses of similar foraging habitat and prey available in the region.

Underwater acoustic threshold criteria

A literature search did not reveal any underwater acoustic threshold criteria for Little Penguins or other penguin species. However, in the absence of underwater threshold criteria, the generic underwater sound pressure level of 150 dB re 1 µPa rms (NMFS (2018) for fish with their swim bladder involved in hearing has also been adopted for the assessment of project underwater noise Little Penguins behaviour.

7.2.3.9.2 Predicted residual impacts

The following section assesses impacts of project underwater noise on Little Penguin behaviour.

Predicted impacts on Little Penguin behaviour

The literature was searched for examples of Little Penguin reactions and behaviour when exposed to other anthropogenic noise sources. One example includes the Little Penguin nesting colonies in Port Phillip Bay (Victoria) where shipping noise is above background levels.

Giling et al (2008) described the little penguin colony that uses the St Kilda Pier breakwater within Hobsons Bay, Melbourne. Little Penguins from this colony transit through Hobson Bay and Port Phillip Bay waters to forage for fish. Part of their transit (between 0.5 and 1.5 km) intercepts the frequent passing of small motorboats moving between the Yarra River mouth to St Kilda Yacht Club (and vice versa) and part of their transit (3 km from shore) intercepts the main shipping channel leading to and from Melbourne ports. During these transits, the Little Penguins are exposed to underwater noise from fast-moving pleasure boats (outboards, inboard diesels, and jet skis) that generate higher frequency noise (100 Hz to 5 kHz) from propellers and high-frequency cavitation noise, and to underwater noise from passing slow-moving large ships that generate a lower frequency range 20 Hz to 2 kHz. Despite these higher levels of boating and shipping underwater noise, the nesting colony at the St Kilda Pier breakwater has persisted, indicating that Little Penguins are tolerant of, or have acclimated to, existing anthropogenic noise above background levels in northern Port Phillip Bay.

Based on the adopted 150 dB re 1 μPa_{rms} acoustic threshold for behavioural impacts on Little Penguins, the distance to this behavioural threshold isopleth is calculated to be 215 m (see Table 7-19 in Section 7.2.3.5.2 Residual impacts to cetaceans), which represents a very small zone of potential impacts to Little Penguin behaviour. The 150 dB re 1 µPa rms threshold isopleth contours are just visible in Figure 7.9 and Figure 7.10 for the Victorian and Tasmanian nearshores, respectively.

Bethge et al. (2009) determined that the mean swimming speed of Little Penguins at sea is 1.8 m/s with a maximum of 3.3 m/s and that diving depths ranged from 2 to 27 m with a mean dive duration of 21 seconds. Based on this evidence, it is more than likely that Little Penguins' passage through the project's underwater noise field above 150 dB re 1 μPa_{rms} will be fleeting and disruptive behavioural avoidance impacts are unlikely.

Overall, the predicted impacts of project underwater noise on Little Penguin behaviour have been assessed to have an impact significance rating of ***Low***. This is based on Little Penguin sensitivity of *Low* due to their wide distribution and abundance in Bass Strait and wider region, and a magnitude of impact of *Minor* given the fleeting passage through and very short-term exposure of foraging Little Penguins within the 215-m radius around the cable lay ship that exceeds the 150 dB re 1 μPa_{rms} acoustic threshold for behavioural impacts.

Acoustic masking of sounds and underwater communications

A literature review of underwater calls and communications of penguins revealed that some penguin species may vocalise underwater (Markov 1974, 1977).

Thiebault et al. (2019) provided the first observations of underwater penguin vocalisations while foraging at sea and recorded a total of 203 underwater vocalisations from three species of penguin: the King Penguin (*Aptenodytes patagonicus*), Gentoo Penguin (*Pygoscelis papua*) and the Macaroni Penguin (*Eudyptes chrysolophus*). Penguin underwater vocalisations were very short in duration (0.06 seconds on average), with a frequency of maximum amplitude averaging 998 Hz, 1,097 Hz and 680 Hz for King, Gentoo, and Macaroni penguins, respectively.

The in-water fundamental frequencies ranged from 139 to 1,529 Hz for Gentoo Penguins and from 309 to 85 Hz for King Penguins, and no vocalisation was observed to contain energy at frequencies higher than 7 kHz (Thiebault et al., 2019). All vocalisations were emitted during feeding dives and more than 50% of them were directly associated with hunting behaviour. This suggests that such underwater vocal behaviour may exist in all penguin species, including Little Penguins.

The above frequency ranges for penguin vocalisations (total range 139 to 1,529) as measured by Thiebault et al. (2019) if adopted as a proxy frequency range for Little Penguins (assuming they also vocalise underwater), then this fundamental frequency range overlaps the frequency range (20 Hz to 2 kHz) of the cable lay ship and other project vessels. Therefore, the masking of underwater sounds and Little Penguin vocalisations has the potential to occur.

Note that Thiebault et al. (2019) did not present any sound source levels of penguin underwater vocalisations. A literature review did not reveal any source levels of penguin underwater vocalisation calls for any species.

Overall, the predicted masking impacts on Little Penguins are assessed to have a residual impact significance of ***Low***. This is based on an assumed Little Penguin sensitivity of *Low* due to its wide distribution and abundance in Bass Strait and the wider region, and a magnitude of impact of *Low* based on weak masking of biologically relevant sounds (vocalisations if present) except when close to an underwater noise source. Most of the Little Penguin's foraging areas are offshore where there is a very large expanse of undisturbed foraging habitat in the region, so potential masking of sounds and Little Penguin vocalisations during diving for prey will only be affected in proximity to the cable lay ship while laying bundle cables in the offshore zone, which will be of short duration as the ship transits at a speed of 1.5 knots.

No indirect impacts on Little Penguin's offshore food resources (e.g., sardines and anchovies) are predicted given the absence of significant impacts on pelagic fishes assessed below in Section 7.2.3.10 (Acoustic impacts to fishes).

7.2.3.10 Acoustic impacts to fishes

This section assesses underwater noise impacts to fishes arising from the cable lay ship laying the bundled cable, for which an underwater noise source level (SL) of 185 dB re 1 μPa_{rms} at 1 m has been adopted as a worst-case scenario.

Fish species known to occur within the vicinity of the project's nearshore and offshore alignments and Bass Strait in general are described in Section 6.3.10 (Marine fishes).

7.2.3.10.1 Potential impacts to fishes

Project-generated underwater noise significantly above existing background levels can have the following potential effects on fishes in descending order of severity:

- Mortality impacts at very high underwater noise levels or long exposures to intermediate noise levels.
- Physical injury and physiological impacts such as acoustic damage (tissue or gas-filled organs) and permanent hearing loss through loss of auditory cochlear hair cells (or permanently fatigued hair cell receptors).
- Physiological effects such as temporary loss of hearing sensitivity, which is reversible.
- Behavioural impacts:
  - Disruptive behavioural effects such as displacement from the underwater noise field (e.g., swimming away from noise sources or bypassing (manoeuvring around) noise fields), displacement from foraging or breeding habitats, shifts in individual or group distribution (aggregation or separation).
  - Subtle behavioural effects such as minor changes in locomotion speed, direction or diving (swimming) depth profile but no avoidance of noise sources.
- Masking causing potential interference of communications between sound-producing (soniferous) fishes or disrupting the ability of fishes to perceive natural sounds.

Environmental performance requirements

EPRs for this section are outlined in section 7.2.3.5.1 (Acoustic impacts to cetaceans).

Potential mitigation and management measures

There are no proposed mitigation and management measures proposed for managing underwater noise impacts to fish.

7.2.3.10.2 Hearing sensitivities of fishes

Prior to assessing project-generated underwater noise impacts on fish, the hearings sensitivities of various fish groups need to be described to provide context.

The hearing abilities and sensitivities of fish vary depending on whether they are bony fishes or cartilaginous fishes which are described briefly below.

Bony fishes (Osteichthyes)

Hearing in bony fish (Osteichthyes) may be generally divided into two categories: a) hearing generalists and b) hearing specialists (Popper and Hastings, 2009). Generalists hear within a narrow bandwidth and are sensitive to particle motion; therefore, hearing generalists typically do not show a significant response to sound pressure levels.

In contrast, hearing specialists have well-developed sound pressure sensitivity and relatively low hearing thresholds. Their sensitivity is related in part to the fact that they have anatomical connections between their inner ear and swim or gas bladder structures. The swim bladder is a gas-filled sac located in the dorsal portion of certain species of fish, which is vulnerable to underwater acoustic pressure. It has flexible walls that contract or expand according to the ambient pressure.

According to Popper and Hastings (2009), hearing specialists include all the *Otophysi* (e.g., catfishes) and *Clupeiformes* (e.g., anchovies, herrings, and sardines), Perciformes (e.g., tuna, sciaenid drummers and croakers) and *Beryciformes* (e.g., roughies). *Otophysi* are characterized by possession of a complex Weberian apparatus (a swim bladder–internal ear connection with four movable bones).

Cartilaginous fishes (Chondrichthyes)

Cartilaginous fish (Chondrichthyes) such as sharks, skates, and rays, only possess inner ear labyrinths, which allow them to detect particle motion (Myrberg, 2001; Casper, 2006). The inner ear labyrinths are connected via an endolymphatic duct to an external pore on top of the head.

Cartilaginous fish have no accessory organs of hearing often found in bony fishes, such as a swim bladder (Amundsen and Landrø, 2011), or gas-filled spheres (*prootic bulla*) as in clupeid fish such as herring, anchovies, pilchards, and sprats. Since elasmobranchs do not have a swim bladder or any other air-filled cavity, they are incapable of detecting sound pressure and that particle motion is presumably the only sound stimulus that can be detected (Casper et al., 2012).

Fish hearing groups

Popper (2012) divided fishes into four groups based on hearing abilities:

- **Group 1 fish:** Fish that do not have a swim bladder:
    - Group 1 fish include species that are likely to use only particle motion for sound detection. The highest frequency of hearing is likely to be no greater than 400 Hz, with poor sensitivity compared to fish with a swim bladder. Fish within this group includes flatfish, some gobies, some species of tuna and all elasmobranchs (i.e., sharks, skates, and rays).
- **Group 2 fish:** Fish that detect sounds from below 50 Hz and up to perhaps 800-1,000 Hz (though several probably only detect sounds to 600-800 Hz).
    - Group 2 fish include species that have a swim bladder but no known structures in the auditory system that enhance hearing, and sensitivity (lowest sound detectable at any frequency) is therefore considered to be poor. Sounds will have to be more intense to be detected when compared to fishes in Group 3 (described below).
    - Group 2 fish species detect both particle motion and pressure, and the differences between species are related to how well the species can use the pressure signal. A wide range of species falls into this category, including tuna with swim bladders (e.g., yellowfin tuna).
- **Group 3 fish:** Fishes that have a structure that mechanically couples the inner ear to the swim bladder, thereby resulting in detection of a wider bandwidth of sounds and lower intensities than fish in other groups.
    - Group 3 fish species detect sounds to 3,000 Hz or more, and their hearing sensitivity, which is pressure driven, is better than in fishes of Groups 1 and 2. There are not many marine species known to fit within Group 3, but this group may include some species of *sciaenids* (drummers and croakers). It is also possible that some deep-sea species fall within this category, but that is only based on morphology of the auditory system. Other members of group 3 are all *Otophysi* fishes, though few of these species other than catfishes are found in marine waters.
- **Group 4 fish:** All of these fish are members of the herring family and relatives (*clupeiformes*).
    - Group 4 fish hear sounds below 1,000 Hz in a similar manner to fish in Group 1, but their hearing range extends up to at least 4,000 Hz (e.g., sardines), but some species (e.g., shads) can detect sounds up to 180 kHz (Mann et al., 2001).

The *clupeiform* fishes (herrings, shads, sardines, and anchovies) have a unique and complex linkage between gas-filled spheres (*prootic bulla*) in the head and one region of the ear, the utricle (all other species that have specialized connections have them with another ear region, the saccule) (O'Connell 1955; Popper and Platt 1979). Enger (1967) obtained a tentative audiogram for Atlantic herring (*Clupea harengus*) in a small tank indicating that the fish was sensitive to pure tones over the range 30 Hz to 1,000 Hz but falling off steeply above 2 kHz.

The four fish groups described above are included in sensitivity criteria of Table 7.6 (Criteria for assessing the sensitivity of a receptor to underwater noise), which is part of the Significance Assessment Method described earlier in this report (see Section 5.3.2, Significance assessment method).

7.2.3.10.3 Residual impacts to fishes

Acoustic damage, disturbance, behavioural, and acoustic auditory masking impacts to fishes are assessed below. The conceptual acoustic zones of influence shown in Figure 7.6 are relevant to fishes.

Acoustic damage impacts to fishes and permanent hearing loss

Table 7-29 presents the calculated horizontal distances to cumulative SEL isopleths of interest and interim unweighted acoustic threshold criteria for fishes (Popper et al., 2019).

Table 7-29: Calculated distances to SEL_{cum} isopleths during cable laying – fishes

Species-weighted source level: 221 SEL_{cum} (dB re 1 µPa^2·s at 1 m)							
Isopleths (dB re 1 µPa^2·s)	207	200	190	186	180	170	160
Distance to isopleth (m)	8	67	489	201	506	2,349	10,903
Threshold isopleth	Mort.	–	–	**TTS**	–	–	–

Source: MDA, 2023; Attachment G. Mort. denotes mortality. TTS = temporary threshold shift. TTS onset and mortality threshold criteria are based on Popper et al. (2019).

In Table 7-29, the distance to the Popper et al. (2019) unweighted SEL_{cum} of 207 dB re 1 µPa^2·s isopleth above which mortality of bony fishes with a swim bladder mechanically connected to the inner ears (Group 3 fishes, see above) is calculated to have a 8-m radius, which represents an extremely small zone of impact surrounding the cable lay ship during cable lay operations. Fish will have to remain within this zone for an hour to be exposed long enough for mortality to occur. However, it is highly unlikely that bony fish will remain within this 8-m radius zone as earlier behavioural responses (displacement) will have been initiated in response to the presence of the cable lay ship, whether maintaining its position in DP mode (i.e., a stationary noise source to which bony fish are expected to avoid) or as the cable lay ship transits at a low speed (1.5 knots) when laying cable (i.e., a mobile noise source to which bony fish will avoid). Therefore, mortalities of highly mobile Group 3 bony fishes and other bony fish groups with swim bladders are not predicted. A high level of confidence can be placed on this conclusion as the SEL_{cum} mortality threshold of 207 dB re 1 µPa^2·s of Popper et al. (2019) is based on impulsive noise associated with impact pile driving and is therefore over-conservative for bony fishes exposed to underwater non-impulsive broadband noise typical of the cable lay ship and other project vessels, as well as other marine construction activities (e.g., PLGRs and wet jetting for cable installation and burial).

In terms of cartilaginous fish that are only sensitive to particle motion but not to sound pressure levels, no mortalities or permanent hearing loss are predicted.

Acoustic disturbance and temporary hearing loss in fishes

In Table 7-29, the distance to the Popper et al. (2019) unweighted SEL_{cum} of 186 dB re 1 µPa^2·s isopleth for TTS onset is 201 m, which represents a small area within which bony fishes will have to remain for more than one hour to be exposed to temporary hearing loss. It is more than likely that bony fish will not remain within the TTS onset zone as they will have detected the underwater noise gradient at distance from the noise source of the cable lay ship and avoid (swim away) or pass around the sound field if moving along the coastline or foraging in the general area where the cable lay ship is located.

Overall, acoustic disturbance and temporary hearing loss impacts to bony are assessed to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *Low* due to bony fish being widely distributed and abundant in the project area, Bass Strait, and the wider region, and a magnitude of impact of *Moderate* given that the unweighted SEL_{cum} of 186 dB re 1 µPa^2·s isopleth for TTS onset is exceeded within a 201-m radius of the cable lay ship. As noted above, the unweighted SEL_{cum} of 186 dB re 1 µPa^2·s isopleth for TTS onset in fishes was based on impulsive noise sources associated with impact pile driving and this TTS onset threshold therefore over-protective for TTS onset in fishes exposed to the project's predominantly non-impulsive broadband noise sources during marine construction activities.

There are no TTS onset threshold criteria for cartilaginous fishes given that they primarily sense particle motion and vibrations but not sound pressure.

Acoustic impacts on fish behaviour

The generic acoustic threshold criterion for onset of behavioural impacts in fishes is 150 dB re 1 µPa rms (NMFS, 2018). In Table 7-19 (presented earlier in Section 7.2.3.5.2, Residual impacts to cetaceans), the distance to the 150 dB re 1 µPa rms threshold is approximately 215 m, which represents a small impact zone in which pelagic and benthic fishes may be disturbed. The 150 dB re 1 µPa rms acoustic behavioural threshold isopleths are just visible in Figure 7.9 (Victorian nearshore) and in Figure 7.10 (Tasmanian nearshore), which emphasises the very small ensonified zones that exceed the behavioural threshold isopleth.

Project-generated underwater noise SPLs above the behavioural threshold 150 dB re 1 µPa_{rms} are expected to cause localised and temporary behavioural changes such as startle or alarm responses, disruption of feeding, or avoidance of an area. Note that this threshold is for onset of potential behavioural effects, and not necessarily an 'adverse effect' threshold.

Behavioural impacts are different for pelagic and benthic or demersal fishes.

Acoustic impacts on pelagic fish behaviour

The acoustic threshold of 150 dB re 1 µPa_{rms} is based on noise-sensitive Group 3 fish with swim bladders involved in hearing; therefore, the following assessment of acoustic disturbance impacts on fish behaviour does not apply to the other less-sensitive fish hearing groups, which are not expected to show significant aversive behaviour due to the noise emissions.

The most likely responses in resident or passing Group 3 fishes within the 215-m radius zone above 150 dB re 1 µPa_{rms} are vertical displacement (near-surface fishes diving deeper) or horizontal displacement (fishes swimming away from the noise source). These behavioural responses are likely to reduce in time as fish habituate to the new noise source created by the cable lay ship when it is stationary in the nearshore zones (i.e., maintaining position in DP mode) or transiting and laying cable in the offshore Bass Strait (i.e., slow-moving (1.5 knots) and mobile). The localised and temporary displacement of fish pelagic or migrating fish in the vicinity of the cable lay ship is not likely to have any significant repercussions at a population level (McCauley, 1994).

Overall, the predicted residual impacts of underwater noise within the 215-m radius behavioural zone of influences are assessed to have a residual impact significance of ***Low*** based on Group 3 pelagic fish sensitivity of *Moderate* due to the presence of swim bladders involved in hearing, and a magnitude of impact of *Low* given minor changes in locomotion speed, direction or dive (swimming) depths and temporary vertical and horizontal lateral orientation behaviour during noise-generating activities within sound field of noise generating activities. The impact significance rating is conservative as the impact will be temporary with disturbed fishes returning to previously occupied areas once the cable lay ship moves on at a rate of 1.5 knots while cable laying.

Acoustic impacts on benthic fish behaviour

Many benthic fish species do not have a swim bladder, or their swim bladder is at a distance from or not connected to their auditory systems. Most of these fish species (e.g., bottom living sharks and rays, and flounders and other bottom-living bony fishes) primarily sense particle motion and have little or no sensitivity to sound pressure. In addition, in central Bass Strait the underwater noise reaching the seabed is diminished; for example, at the maximum depth of 80 m in central Bass Strait immediately below the cable lay ship (noise source level of 185 dB re 1 µPa at 1 m at thrusters located at 6 m below the surface), the noise level at the seabed is 147 dB re 1 μPa_{rms}, which is below the acoustic threshold criterion of 150 dB re 1 μPa_{rms} for behavioural onset effects in Group 3 fish. Therefore, acoustic behavioural disturbance of bottom-dwelling Group 3 fishes is not anticipated to occur.

Overall, the predicted residual impacts of underwater noise on deep water Group 3 benthic fishes of central Bass Strait are assessed to have a residual impact significance of ***Low*** based on a Fish Group 3 sensitivity of *Moderate* due to the presence of swim bladders involved in hearing, and a magnitude of impact of *Negligible* given that the underwater noise at the seabed is close to the behavioural threshold criterion of 150 dB re 1 µPa rms and may exceed it depending on sea surface conditions (e.g., higher winds or sea state will require more thruster power to keep the cable lay ship on track).

No impacts on Group 1 fishes (absence of swim bladder) such as sharks, soles, and flounder are predicted.

Acoustic auditory masking of natural sounds and fish communications

In general, sounds produced by soniferous (sound-producing) fishes for communication are generally associated with either reproductive activities (e.g., courtship or spawning) or stressful conditions (e.g., aggression or territorial defence).

Underwater sounds produced by soniferous fishes include fish choruses, and swim bladder sounds. Fish choruses have a frequency range of between 100 Hz to 5 kHz with a mean source level of 120 dB re 1 µPa at 1 m and a maximum of 160 dB re 1 µPa at 1 m (Mann, 2012). Swim bladder sounds are typically low frequency and range between 75 and 150 Hz (URI, 2015) and 4 to 60 Hz (Tsai, 2009); however, SPL source levels were not revealed.

Some bony fish (Osteichthyes) produce sounds by means such as striking bony structures against one another, or by muscle movement amplified by the gas-filled swim bladder (or air bladder) (NRC, 2003). Sciaenid fish (e.g., croakers and jewfish) also emit underwater noise by drumming their swim bladders with their sonic muscles and producing short pulses of between 45 and 60 Hz but generally less than 500 Hz (Tsai, 2009). Some marine catfish also emit low frequency sound <1,000 Hz (Tsai, 2009).

In general, the lower end of fish vocalisation or other sound frequencies overlap with the frequency ranges of the project's proposed marine construction activities (20 Hz to 2 kHz); therefore, there is a potential for masking of fish vocalisations and communication calls.

Given the slow rate of 1 knot for the cable lay ship during offshore cable laying operations, the noise field surrounding the ship will be temporary at any one point; therefore, potential masking impacts on pelagic and benthic fishes in offshore waters are anticipated to be ephemeral.

In the case of nearshore fishes in the vicinity of the cable lay ship as it maintains position in DP for up to a week while the cables are pulled to shore via the long trajectory HDD ducts, the noise field surrounding the cable lay ship will be continuous. Therefore, masking impacts on soniferous fishes and the masking of other sounds that fish may use to detect predators or for locating reefs, for example, are anticipated to be occur in the short term.

Overall, predicted impacts on auditory masking of nearshore fishes near the location of the cable lay ship are assessed to have an impact significance rating of ***Low***. This is based on fish sensitivity of *Low* due to their wide distribution in the project area, Bass Strait and wider region, and a magnitude of *Moderate* given the presence of soniferous fishes (communications) and fishes using sound to detect predators within the shallow nearshore waters.

No masking impacts are predicted for cartilaginous fishes such as sharks, rays, and skates, since the detect particle motion rather than sound pressure.

7.2.3.11 Acoustic impacts to marine invertebrates

This section assesses underwater noise impacts to pelagic and benthic marine invertebrates arising from the project's proposed marine construction activities. Marine invertebrate species known to occur within the vicinity of the project's nearshore and offshore alignments and Bass Strait in general are described in Section 6.3.11 (Marine invertebrates).

The cable lay ship's underwater noise source level (SL) of 185 dB re 1 μPa_{rms} at 1 m has not been adopted as a worst-case scenario to assess impacts on marine invertebrates for the following reasons:

- Marine macroinvertebrates lack sensory organs to perceive sound pressure, but many do have organs or tactile hairs that are sensitive to hydrostatic disturbances (McCauley, 1994).
- Marine invertebrates lack gas-filled chambers or organs (except cuttlefish and nautiluses) and are thus unable to detect sound pressure changes associated with sound waves (Carroll et al., 2017).
- There are few measurements or data on sound detection by marine macroinvertebrates and the data available indicate that only low frequency sounds are detected and relate mainly to the particle motion component of the sound field that is important (e.g., Mooney et al., 2010).
- Decapod crustaceans are sensitive to low-frequency particle motion as they lack gas-filled organs such as swim bladders or gas-filled chambers (Edmund et al., 2016)
- There are no particle motion threshold criteria available for assessing vibrations from seabed construction activities.
- In cephalopods that do not have any air bladders or other gas-filled chambers, except for cuttlefishes (*Sepia* spp.) and nautiluses (Nautilus spp.), there is no possibility for amplification of sound pressure waves.

Based on the above, impacts of project-generated sound pressure levels on marine invertebrates cannot be assessed. Notwithstanding, the seabed vibrations generated by wet jetting of soft-sediment seabed using a jet trenching machine (used in burial mode) to install and bury the subsea cables, is expected to temporarily disturb benthic macroinvertebrates. However, given the rate of travel of the jet trencher and wet jetting operation of 400 m/hour in sandy seabed, potential vibration impacts will be highly localised and of very short duration at any one point along the path of wet jetting operations.

Overall, no mortalities or sublethal physiological impacts on benthic marine invertebrates are predicted to arise from project-generated vibrations within the seabed. In terms of benthic marine invertebrate behavioural impacts, the more mobile benthic species (e.g., crabs, prawns, and rock lobsters) may be temporarily displaced by the approaching jet trencher while sessile benthic macroinvertebrates will not be displaced.

Given the importance of arrow squid (*Nototodarus gouldi*) to the Southern Squid Jig Fishery and southern calamari (*Sepioteuthis australis*) to other small fisheries in Bass Strait, the underwater 'hearing' systems of cephalopods were used as a means of assessing potential underwater sound impacts to arrow squid, as cephalopods in general detect low-frequency sounds, vibrations, and particle motion via their statocyst and mechanoreceptors (cilia) distributed over their bodies.

7.2.3.11.1 Potential impacts

Project-generated underwater noise significantly above existing background levels is unlikely to cause mortality or physiological tissue damage to cephalopods since the project's sound source levels are non-impulsive broadband noise. However, behavioural impacts may occur in cephalopods.

Potential behavioural impacts include:

- Disruptive behavioural effects such as displacement from the underwater noise field (e.g., swimming away from noise sources or bypassing noise fields).
- Subtle behavioural effects such as minor changes in locomotion speed, direction, or diving (swimming) depth profile but no avoidance of noise sources.

Environmental performance requirements

EPRs for this section are outlined in section 7.2.3.5.1 (Acoustic impacts to cetaceans).

Potential mitigation and management measures

There are no specific mitigation and management measures proposed for marine invertebrates, including cephalopods.

7.2.3.11.2 Residual impacts to cephalopods

Prior to assessing residual impacts of project-generated underwater noise on cephalopods, a cephalopod's 'hearing' system is briefly described below.

Cephalopod 'hearing' sensitivities

Cephalopods are sensitive to vibration stimuli and perceive these stimuli through the statocyst receptor and their lateral line systems (Budelmann et al., 1997; Budelmann and Bleckmann, 1988). The cephalopod statocyst and lateral line systems are sensory organs involved in orientation and balance, and the mechano-receptors (cilia) of the lateral lines allow cephalopods to detect particle motion and are used for locating prey or predators in low light conditions (Solé et al., 2018).

Like fishes, cephalopods have statocysts (otoliths) that in principle can be used to detect whole body motions such as those caused by the displacement component of a sound wave (Young 1989). Young (1960) pointed out that the statocyst might serve as a detector for vibrations, or sound, in a similar way as the vertebrate vestibular system. The cephalopod statocyst with its macula–statolith system shows many comparative features, which are similar to the fish inner ear with the macula–otolith complex.

Cephalopods are sensitive to the following frequency ranges:

- Bigfin reef squid (*Sepioteuthis lessoniana*) is a large muscular squid found in shallow waters up to 100 m depth in tropical waters and detect sounds ranging from 400 Hz to 1500 Hz (Hu et al. (2009).
- Common octopus (*Octopus vulgaris*) known to be present in Bass Strait detects sounds ranging from 400 Hz to 1000 Hz (Hu et al, 2009).
- Ocellated octopus (*Amphioctopus fangsiao*) detects sounds ranging from 50 to 200 Hz (Kaifu et al., 2007).
- Longfin inshore squid (*Loligo pealeii*) detects sounds ranging from 30 to 500 Hz Mooney et al., 2010).
- Longfin inshore squid (Loligo pealeii) detects sounds ranging from 80 to 1,000 Hz (Mooney et al., 2016)).
- Common cuttlefish (*Sepia officianalis*) detects sounds ranging from 85 to 1,000 Hz (Samson et al., 2014).

The above sound detection ranges all overlap with the project's marine construction generated noise range of 20 Hz to 2 kHz.

Adopted surrogate cephalopod behavioural threshold criteria

On a relative scale, the hearing ability of cephalopods is comparable to those of fishes without a mechanically coupled swim or air bladder to the inner ear (Lovell et al., 2005). In this report, these fishes are referred to as Group 1 fishes after Popper (2012) (see Section 7.2.3.10.2, Hearing sensitivities of fishes).

While there are no acoustic threshold criteria for Group 1 fishes (surrogate for cephalopods), the NMFS (2018) acoustic threshold of 150 dB re 1 µPa rms for onset of behavioural effects in fishes has been adopted. Note that the NMFS (2018) threshold criteria are based on Group 3 fishes, which have a swim bladder connected to the inner ear. Therefore, the adopted threshold criterion is overprotective when applied to Group 1 fishes (swim bladder absent) or Group 2 fishes (swim bladder located at distance from the inner ear). In this case the adopted NMFS (2018) threshold criterion is also overprotective for assessing cephalopod behavioural responses.

Based on Table 7-19 (presented earlier in Section 7.2.3.5.2, Residual impacts to cetaceans), the distance to the (NMFS (2018) 150 dB re 1 μPa_{rms}) threshold is approximately 215 m, which represents a small impact zone in which pelagic cephalopods may be disturbed. The 150 dB re 1 μPa_{rms} acoustic behavioural threshold isopleths are just visible in Figure 7.9 (Victorian nearshore) and in Figure 7.10 (Tasmanian nearshore), which emphasises the very small ensonified zones that exceed the behavioural threshold isopleth. Note that this threshold is for onset of potential behavioural effects, and it is not necessarily an 'adverse effect' threshold. The radial distance of 215 m to the 150 dB re 1 μPa_{rms} acoustic behavioural threshold will be much shorter if behavioural threshold criteria for Group 1 fishes without a swim bladder (under which cephalopods are included) were available.

Overall, the predicted residual impacts of underwater noise within the 215-m radius behavioural impact zone where the 150 dB re 1 μPa_{rms} acoustic behavioural threshold is exceeded are assessed to have a residual impact significance of ***Low***. This is based on Group 1 fishes that do not have a swim bladder and do not sense sound pressure, which is used as a surrogate for cephalopod sensitivity of *Very low* due to insensitivity to sound pressure. This impact significance rating is also based on a magnitude of impact of *Negligible* given that cephalopod behavioural displacement is temporary, and they are expected to return to previously occupied areas once the cable lay ship moves at a rate of 1.5 knots while cable laying.

No negative impacts are predicted on arrow squid or southern calamari, which are targeted by commercial fisheries and recreational fishers.

7.2.4 Artificial lighting impacts

This section assesses potential nighttime lighting impacts, mitigation, and management measures to reduce potential impacts, and assesses the residual impact significance ratings to birds and marine fauna that may be attracted to project artificial light sources.

7.2.4.1 Artificial light sources

The principal sources of artificial lighting are the lights used onboard the cable lay ship during cable lay operations and onboard other large project support vessels. Nighttime marine construction is anticipated as the cable lay ship will conduct cable laying operations across Bass Strait on 24-hour and seven days per week basis. Therefore, light spill from the cable lay ship operating during the night is expected to be present along the project alignment during the first stage of construction (ML1 monopole subsea bundled cable laying) and during the second stage of construction (ML2 monopole subsea cable laying).

Numerous smaller project support vessels (e.g., a dive boat and smaller boats) involved in manoeuvring floated cables to the HDD duct exit hole at 10 m water depth will only operate during daylight hours, owing to safety concerns for divers operating at nighttime. In addition, the cable lay ship will have two escort (guard) vessels that will be used to alert other maritime traffic that may be approaching the cable lay ship's temporary exclusion zone; however, at during nighttime cable laying these escort vessels will only display normal nighttime navigations lights. Therefore, these smaller escort vessels are not considered as a significance nighttime lighting source.

During nighttime cable laying operations across Bass Strait, the cable lay ship's aft deck and stern area requires to be sufficiently lit for safety reasons, so that deck crew and/or engineers can bundle the individual HVDC and optical fibre cables with ties while the bundled cables are directed over the stern chute. The cable lay ship will be the principal source of nighttime artificial lighting at sea. However, when the cable lay ship is maintaining its position using it thrusters under dynamic positioning (DP) control in nearshore waters (at around the 15 m water depth mark), nighttime artificial lighting of its aft deck and stern is not required as cable pulling to shore from the ship is a daytime activity only. Therefore, when maintaining position in nearshore waters of Victoria (Waratah Bay) and Tasmania (adjacent to Heybridge), the nighttime lighting on the cable ship will be derived from its navigational lights in conformance with COLREGS and AMSA regulations and deck lighting limited to the amount and intensity necessary to maintain deck crew safety.

7.2.4.2 Potential impacts

Potential impacts of nighttime artificial lighting from project vessels may affect terrestrial and marine birds and near surface marine fauna (e.g., sea turtles).

Potential lighting impacts on birds include:

- Attraction to illuminated sources such as the cable lay ship and other large project vessels outside daylight hours.
- Bird collisions with ship and vessel superstructures, resulting in injury of mortality.
- Light-induced disorientation with possible deviations in the flight paths of nocturnally migrating birds.
- Light entrapment by vessel illumination of nocturnally migrating birds and their reluctance to continue their migration.

- Resting (i.e., temporary harbourage), habitual roosting sites, and foraging sites for seabirds and/or temporary refuge for migrating land birds.
- Lighting may provide an enhanced capability for seabirds to forage at night.

Studies by Johnson et al. (2011) indicated that most interactions between birds and illuminated offshore vessels or platforms were at dawn and dusk, rather than during the middle of the night.

Potential lighting impacts and interactions with near-sea surface marine fauna include:

- Nighttime lighting at the sea surface and localised light glow can act as an attractant to light-sensitive marine fauna such as invertebrate zooplankton and micronekton.
- Fishes and *cephalopods* (especially squids that are caught using high intensity lamps to which they area attracted) may be directly attracted to the light glow surrounding the project vessels but may also be indirectly attracted to the vessels due the direct attraction of invertebrates (crustaceans) and smaller fish, which form a food source for predatory fishes and cephalopods.

7.2.4.3 Environmental performance requirements

The proposed EPR for the artificial lighting impacts is Table 7-30:

Table 7-30 EPR for minimising artificial lighting impacts to marine fauna and avifauna

EPR ID	Environmental performance requirement	Project stage

MERU10	**Develop and implement measures to minimise impacts on marine fauna and avifauna due to lighting**
	Prior to commencement of marine construction, develop measures to minimise impacts on marine fauna due to artificial lighting for construction and operation. The measures must consider the following:
	• Australia's National Light Pollution Guidelines for Wildlife (DoEE 2020), to manage the effect of artificial light on marine turtles, seabirds, and migratory shorebirds that are listed under the EPBC Act, species that are part of a listed ecological community, and species protected under state or territory legislation for which artificial light has been demonstrated to affect behaviour, survivorship, or reproduction.
	• Australian Standard AS/NZS 4282:2019 Control of the obtrusive effects of outdoor lighting and recognise the impact of artificial light on living organisms.
	• EPBC Act Policy Statement 3.21 - Industry Guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (DoEE 2017d).
	• The measures must:
	  o Minimise lighting where practicable and where safety is not compromised, minimise the number of lights, the intensity of lights, and the amount of time lights are turned on.
	  o Direct lighting to where it is needed and avoid general area floodlighting.
	  o Limit area and deck lighting to the amount and intensity necessary to maintain deck crew safety.
	  o Direct lighting inboard and downward (where possible) to reduce the potential for seabird attraction.
	  o Avoid direct lighting of the sea surface and minimise indirect lighting on the sea surface to the extent practicable.
	  o Include routine inspection of lighted areas of the cable lay vessel and other night-time operating vessels for birds that may have been attracted.
		Design / Construction / Operation / Decommissioning

EPR ID	Environmental performance requirement	Project stage
	The measures must be addressed in the marine fauna management plan (EPR MERU07) and be implemented during construction.	

Further EPRs for this section are outlined in section 7.2.3.5.1 (Acoustic impacts to cetaceans) and 7.2.3.6.1 (Acoustic impacts to pinnipeds).

7.2.4.4 Potential mitigation and management measures

Given the potential for project vessel nighttime lighting to attract listed and special status marine birds to the area. The following mitigation and management measures are proposed to reduce the effects of artificial lighting attraction and minimise potential impacts to marine and coastal birds:

- Minimise lighting whenever and wherever possible. This includes minimising the number of lights, the intensity of lights, and the amount of time lights are turned on.
- Direct lighting to where it is needed and avoid general area 'floodlighting'. Area and deck lighting should be limited to the amount and intensity necessary to maintain deck crew safety.
- Direct lighting inboard and downward (where possible) to reduce the potential for seabird attraction.
- Avoid direct lighting of the sea surface and minimise indirect lighting on the sea surface to the extent practicable.

Orr et al. (2013) reviewed mitigation measures to reduce offshore lighting impacts to birds and listed the following main principles:

- Fewer lights are preferable to more lights.
- Lower intensity lights are preferable to higher intensity lights.
- White lights are the least favourable choice for lighting structures.
- Strobing lights are preferable to steady lights.

Many of the studies of artificial lighting impacts on birds relates to more permanent and brightly lit structures such as the exploration rigs and production platforms of the offshore oil and gas industry. Therefore, not all the above mitigation and management measures need be considered or applied to the presence of ships and vessels undertaking pipe laying or cable laying operations, as they are mobile and temporary and not permanent like offshore structures.

7.2.4.4.1 Vessel navigation lights

Ship navigation lights are based on Convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs) of which the following rules apply to the project's cable lay ship and other large project vessels.

- Rule 20 states rules concerning lights apply from sunset to sunrise.
- Rule 21 gives definitions.
- Rule 22 covers visibility of lights - indicating that lights should be visible at minimum ranges (in nautical miles) determined according to the type of vessel.
- Rule 23 covers lights to be carried by power-driven vessels underway.
- Rule 27 covers light requirements for vessels not under command or restricted in their ability to manoeuvre.

Project vessel external navigational lighting is also managed in accordance with AMSA Marine Orders Part 30 (Prevention of Collisions) and AMSA Marine Orders Part 59 (Offshore Support Vessel Operations).

7.2.4.4.2 Light Pollution Guidelines

The National Light Pollution Guidelines for Wildlife provide information on the management of artificial light on marine turtles, seabirds, and migratory shorebirds (DoEE, 2020). The guidelines also provide technical information to guide the management of artificial light for the EPBC Act listed threatened and migratory species, species that are part of a listed ecological community, and species protected under state or territory legislation for which artificial light has been demonstrated to affect behaviour, survivorship, or reproduction.

Australian Standard AS/NZS 4282:2019

THE Australian Standard AS/NZS 4282:2019 relates to the control of the obtrusive effects of outdoor lighting and recognises the impact of artificial light on living organisms.

There are no regulations on types or levels of external works' lighting on the decks of ships or vessels with respect to avoiding potential impacts to EPBC Act threatened species or listed migratory species of birds or marine fauna. However, the abovementioned guidelines with respect to artificial light spillage may be followed if light-sensitive are present.

EPBC Act Policy Statement 3.21

EPBC Act Policy Statement 3.21 – Industry Guidelines for avoiding, assessing, and mitigating impacts on EPBC Act listed migratory shorebird species (DoEE, 2017d).

MLPL will abide by the abovementioned Light Pollution Guidelines and the Australian Standard to ensure all lighting objectives are adequately addressed, and to abide by the EPBC Act Policy Statement 3.21. Potential mitigation and management measures to meet these EPR objectives are described below.

7.2.4.5 Prediction of residual impacts

Residual impacts of artificial lighting on birds and near-sea surface marine fauna are assessed below.

7.2.4.5.1 Residual impacts of lighting to birds

Many nocturnal seabird species are highly attracted to nighttime artificial lighting on offshore vessels and structures. The principal light-sensitive bird species in the project area are seabirds, shorebirds and nocturnal migratory terrestrial birds.

Intense sources of artificial lighting on the sea surface have the potential to attract marine birds from a very large catchment area (Wiese et al., 2001). Poot et al. (2016) showed that bird responses to artificial light conditions are strongest on overcast nights when moon and starlight are unavailable as orientation cues.

Orr et al (2013) indicated that migrating birds can become disoriented when encountering an artificial light source at night, possibly due to disruption in their internal magnetic compass used for navigation. When birds are attracted to nighttime lighting, they may become 'trapped' when a light source enters their zone of influence at night. This phenomenon can cause birds to circle the light source for hours, increasing the risk of collision with the lighted structure, decreasing fat reserves, and potentially interrupting migration (Longcore and Rich, 2004; Montevecchi, 2006).

Overall, the results of the Poot et al. (2016) field study fitted the hypothesis based on laboratory work that white and red light interfere with the magnetic compass of migrating birds. This magnetic compass is especially important to birds during overcast nights, when celestial cues are not visible. The strongest bird responses are found in white light (long wavelength), which seems to interfere with visual orientation on celestial cues (Verheijen, 1958, Evans Ogden, 1996) and the artificial light becomes a strong false orientation cue and birds can get trapped by the beam (Verheijen 1958, 1985). Migratory birds reacted strongest to white and red light (both long wavelengths) and reacted little to green light (shorter wavelength), whereas blue light (short wavelength) did not have any observable effect on the birds' orientation.

The cable lay ship will be a nighttime light source during offshore cable lay operations from dusk to dawn and will be a mobile source of light spill. When the cable lay ship maintains its position in DP mode in nearshore Tasmania and Victoria for the purposes of cable pulls to the HDD marine exit hole ducts, the cable ship will be on station for about a week. However, since cable pull operations will be conducted in daylight hours only for high visibility and safety reasons (e.g., divers in the water), the cable lay ship's light spill during the hours of darkness (normal navigation and reduced deck lighting necessary to maintain deck crew safety) will be of similar magnitude as other large ships at anchor.

Residual impacts of project vessel nighttime lighting impacts on seabirds, shorebirds, and migratory terrestrial birds are assessed below.

Residual impacts on seabirds

Residual impacts on seabirds have been assessed for albatrosses and petrels, and Little Penguins.

Impacts on albatrosses

Threatened or listed marine birds with biological important areas (BIAs) within Bass Strait are listed in Table 6-26. In the project area, five species of albatross have foraging BIAs in Commonwealth marine waters (i.e., outside of state 3 NM limits). In addition, the foraging BIA of the EPBC Act listed endangered Shy Albatross (*Thalassarche cauta*) includes nearshore waters within the Victorian and Tasmanian 3 NM limits, and the offshore Commonwealth marine waters of Bass Strait. The nearest Shy Albatross breeding colony is Albatross Island, which is located 122 km west of the project's western monopole (ML1) alignment across Bass Strait.

Impacts on albatrosses from project nighttime lighting could arise indirectly as the localised light spill may act as an attractant to light-sensitive marine species (e.g., pelagic fish, squid, and zooplankton), which form key prey items of albatrosses. In turn, foraging albatrosses may home in on the illuminated prey by inducing attraction during their nocturnal foraging flights. Croxall and Prince (1994) noted that there have been direct observations of albatrosses eating squid in the vicinity of illuminated ships or active fishing vessels.

Phalan et al. (2007) noted that albatrosses forage most actively during daylight, even though many of their fish and squid prey approach the surface only at night. Albatrosses were more active on bright moonlit nights, they seem to have no fixed daily requirement for sleep, rest, preening or digestion time on the water, and they can navigate in darkness. They are probably less active at night because their ability to see and capture prey from the air is reduced and it is then more energy-efficient for them to rest or to catch prey using a 'sit-and-wait' foraging strategy (Phalan et al. 2007).

In terms of assessing the project nighttime light spill from cable lay ship actively laying cable across Bass Strait, the Shy Albatross was selected as being representative of other albatrosses in general.

Overall, predicted nighttime light spill impacts on the Shy Albatross are assessed to have a residual impact significance rating of ***Low***. This is based on sensitivity of *High* (i.e., being classified as an endangered species) and a magnitude of impact of *Negligible* given the mobile and short-term nature of light spill from the cable lay ship during cable laying operations at night. The foraging BIA of the Shy Albatross covers the whole of Bass Strait within which many other ships will be lit up at night, including light spill at the fixed locations of numerous offshore oil and gas exploration rigs and platforms. Project light spill impacts will be short term as the laying of a 125-km cable run is 1.8 days (~2 days) for the cable ship travelling at 1 knot (or ~3 days at a speed of 1.5 knots). In addition, many of the mitigation measures outlined above to avoid and/or reduce light spill impacts on albatrosses.

Impacts on petrels

The Southern Giant Petrel (*Macronectes giganteus*) and Gould's petrel (*Pterodroma leucoptera leucoptera*) are listed as endangered under the EPBC Act, of which the former of its habitat is likely to occur in the project area. Four other petrel species listed as vulnerable under the EPBC Act may also occur in the project area (see Table 6-25). However, the principal petrel species in the project area is the Common Diving Petrel (*Pelecanoides urinatrix*), which is abundant and has both foraging and breeding BIAs in Bass Strait. Therefore, this species has been selected as representative of petrels for assessing nighttime lighting impacts on petrels.

The Common Diving Petrel is not listed as threatened or migratory but is a listed marine species under the EPBC Act. However, this species is common within the project area with the nearest breeding colonies located on the Glennie Group (Great Glennie, Dannevig, Citadel and McHugh islands), the neatest of which (Great Glennie Island) is 9.9 km distance from the nearest project alignment (i.e., the eastern monopole, ML2). Figure 6.49 shows an example of the offshore foraging area of the Common Diving Petrel (Fromant et al., 2021).

Sources of light pollution that may affect petrel behaviour is commercial shipping and fishing activity in coastal areas, with the potential for directly illuminating colony sites (Fischer et al. 2021).

Potential project nighttime lighting impacts on the Common Dicing Petrel and other burrowing petrel species include changes in orientation behaviours such as light attraction to the cable lay ship during cable laying operations at night with the potential for collision events, and light spill affecting the petrels returning after foraging to their breeding colony burrows. In the case of the latter, the potential for temporary cable lay ship light spill impacts on Common Diving Petrels returning to their burrows on Great Glennie Island, for example, are not predicted given the nearest distance of 9.9 km from the passing cable lay ship. The other key breeding colony is Kanowna Island, which is located 17 km from the nearest project alignment.

In terms of the cable lay ship’s light spill during nighttime cable laying operations, while light attraction behaviour in the Common Diving Petrol may occur with the potential of collision events, the impact anticipated to be low since the cable lay ship will moving at between one and two knots (1.8 to 2.8 km/hour) such that lighting impacts to nocturnal flights and foraging forays of the Common Diving Petrel will be short term as the ship moves through a given foraging area southwest of the Glennie Group.

Overall, predicted nighttime light spill impacts on the Common Diving Petrel are assessed to have a residual impact significance rating of ***Very low***. This is based on sensitivity of *Low* (i.e., non-threatened and species) and a magnitude of impact of *Negligible* given the mobile and short-term nature of light spill from the cable lay ship during cable lay operations.

Compliance with National Recovery Plan requirements for Albatrosses and Petrels

The National Recovery Plan (DCCEEW, 2022g) identifies artificial lighting as a threat to albatrosses and petrels due to interactions with offshore installations and ships, which can lead to avoidance behaviours and collisions with vessel decks and superstructure potentially resulting in a bird being killed or injured. However, in terms of threats from interactions with offshore installations and ships (including lighting), the National Recovery Plan indicates that the number of affected albatrosses and petrel species, and prioritisation within Australia's jurisdiction, was zero.

In terms of environmental performance requirement (EPRs), the project has committed to developing and implementing measures to minimise impacts on marine fauna and avifauna due to lighting (see MERU10 in Section 7.6 for specific details). These light mitigation measures are designed to meet the project EPR objectives for reducing nighttime lighting impacts on albatrosses and petrels to an acceptable level.

Given the adherence to the National Light Pollution Guidelines for Wildlife (DoEE, 2020) to manage the effect of artificial lighting on seabirds and the various mitigation and management measures to reduce potential lighting impacts outlines in Section 7.2.4.4, the project is in agreement with Strategy 4 of the National Recovery Plan (DCCEEW, 2022g), which has the objective of improving the "*effectiveness of management measures that reduce marine based threats to albatrosses and petrels foraging in Australia's jurisdiction*".

Residual impacts on shorebirds

A larger number of shorebird species are found on the shoreline of Waratah Bay (Victoria) than tioxide Beach (Tasmania). The higher number of shorebirds in Waratah Bay near cable landfall relates to its closeness (5 km) to the Shallow Inlet important bird area (IBA), the presence of vegetated dunes, and the lack of foreshore development and nearby townships or villages. Whereas tioxide Beach near the Heybridge landfall, is close to roads and railway, and adjacent town of Heybridge. For the purposes of this report, nighttime lighting impacts on nocturnal shorebirds using the Waratah Bay shoreline have been assessed as the worst-case scenario. Table 6-35 lists information on shorebirds and waders that are likely to forage along the sandy beaches of Waratah Bay in the vicinity of the proposed Victorian landfall of the project’s subsea cables.

In terms of assessing lighting impacts on nocturnal shorebirds that utilise the foreshore of Waratah Bay near cable landfall, these shorebirds have been treated as a group rather than assessing the impacts on individual species, which assumes that most species are anticipated to respond nighttime light glow from the cable lay ship in a similar manner.

As noted earlier, the cable lay ship will maintain its position over the 15 m water depth mark for around 10 days for the purpose of nearshore operations (i.e., cable pay out for pulling to the marine exits holes of the HDD ducts during daylight hours only). At this location, the cable lay ship will be approximately 2.5 km from the shoreline and during the night, the cable lay ship will only be displaying its navigations lights and subdued deck lighting. Therefore, nighttime light glow is expected to be minimal.

Overall, predicted nighttime light spill impacts on the nocturnal shorebirds are assessed to have a residual impact significance rating of ***Low***. This is based on sensitivity of *High* (i.e., accounting for the presence of endangered shorebird species presence) and a magnitude of impact of *Negligible* given that the cable lay ship lighting will be restricted to navigation lights and subdued deck lighting necessary for crew safety.

Residual impacts on marine, shore, and migratory terrestrial birds

Exposure to artificial light at night has been shown to be a threat to nocturnally migrating birds Longcore and Rich, 2004).

Marquenie et al (2015) observed that large flocks of migratory birds occasionally accumulated around illuminated installations on the open sea at night. Potential impacts of trapping at offshore structures included delaying migration, exhaustion, and collisions with structures. The results of the study by Marquenie et al (2013) suggested that artificial lighting was responsible for the disorientation of migratory birds during periods of cloudy skies, and that the response was dose related, (i.e., more light had a stronger effect). Switching off the lights appeared unworkable due to the cost of redesigning the electrical scheme, the cost of installation and, moreover, the lights were essential for safety reasons. The installation low-red exterior lighting on the offshore platforms solved the problem, which reduced the distraction of migrating birds by up to 90%. Given the that nighttime navigational and deck lighting from ships (except cruise ships) is significantly less than offshore platforms, light spill impacts are not expected to cause nighttime attractions of migratory terrestrial birds.

Rebke et al (2019) reviewed the literature on light pollution and migratory birds, which revealed that often specific weather conditions (e.g., heavy clouds, fog, and drizzle) are responsible for concentrations around artificial lights. Since birds use the stars for orientation during migration, then overcast conditions may impair the orientation of nocturnal migrants and thus influence the attraction to light.

While there are no BIAs for migratory terrestrial birds in the project area, there are Important Bird Areas (IBAs) nearby. The nearest IBA for migratory terrestrial birds is Shallow Inlet, which is connected to Waratah Bay by a tidal sea channel (BirdLife International, 2022). It is not clear as to which migratory terrestrial birds specifically fly over the central Bass Strait and within the project area; therefore, lighting impacts have been based on treating migratory terrestrial birds overflying the project area as a group, with an average sensitivity of *High* based on the sensitivity criteria outlined in Table 5-2. and assume some endangered species may be present.

The principal potential impact of nighttime lighting to migratory terrestrial birds is during the night when the cable lay ship is actively laying cables in offshore waters, and aft deck and stern lighting is required for applying ties around the bundled cables, monitoring progress of cable payout, and sufficient lighting for crew safety requirements.

Overall, predicted nighttime light spill impacts on overflying migratory terrestrial birds are assessed to have a residual impact significance rating of ***Low***. This is based on sensitivity of *High* (i.e., potential presence of an endangered species) and a magnitude of impact of *Negligible* given the mobile and short-term nature of light spill from the cable lay ship during cable lay operations at night. As is common for many ships and offshore oil and gas platforms lit up at night, occasional groundings of overflying migratory birds may occur by individuals landing on deck infrastructure due to exhaustion or for temporary resting. However, such impacts are highly localised and are most unlikely to have repercussions at the population level. Two critically endangered shorebirds birds that may fly over the alignment are discussed in the section below.

Compliance with the National Recovery Plans for the Orange-bellied Parrot and Swift Parrot

The Orange-bellied Parrot (*Neophema chrysogaster*) and Swift Parrot (*Lathamus discolor*) do not forage over Bass Strait. However, both species may pass over the subsea cable alignment during migration between Victoria and Tasmania. Overall, the predicted light spill impacts, including the potential for collisions with project vessels, on migratory terrestrial birds are assessed to be ***Low*** due to the mobile and short-term nature of the cable lay operations at night, and no impacts to population level are predicted. Therefore, no conflict with the objectives of the National Recovery Plan for the Orange-bellied Parrot (DELWP, 2016) is expected. The objectives being:

- To achieve a stable or increasing population in the wild within five years.
- To increase the capacity of the captive population, both to support future releases of captive-bred birds to the wild and to provide a secure long term insurance population.
- To protect and enhance habitat to maintain, and support growth of the wild population.
- To ensure effective adaptive implementation of the plan.

Further, no conflict with the objectives of the National Recovery Plan for the Swift Parrot (Saunders and Tzaros, 2011) is expected. The overall objective is 'to prevent further population decline of the Swift Parrot and to achieve a demonstrable sustained improvement in the quality and quantity of Swift Parrot habitat to increase carrying capacity'. Implementing the following objectives will help achieve the overall objective:

- To identify and prioritise habitats and sites used by the species across its range, on all land tenures.
- To implement management strategies to protect and improve habitats and sites on all land tenures.
- To monitor and manage the incidence of collisions, competition and Beak and Feather Disease (BFD).
- To monitor population trends and distribution throughout the range.

Residual impacts on Little Penguins

Project nighttime lighting impacts on Little Penguins (*Eudyptula minor*) are not predicted for this marine bird due to its diurnal foraging habit and the fact that this species returns daily to its burrows and/or breeding colonies at dusk. Since the nearest breeding site of the Little Penguin is Great Glennie Island, which is located 9.9 km from the nearest project alignment (i.e., monopole ML2), potential light spill from the cable lay ship at dusk and cable laying in offshore waters adjacent to the Great Glennie Island breeding site is unlikely to deter Little Penguins returning to their burrows.

Overall, project artificial lighting from the offshore lit cable lay ship is not predicted to affect Little Penguins.

7.2.4.5.2 Residual impacts of lighting to near-surface marine fauna

Residual impacts of artificial nighttime lighting on marine mammals, sea turtles, and marine fishes and invertebrates are assessed below.

Lighting impacts on Marine mammals

Most of the literature that has considered the effects of artificial lighting on marine mammals in the low risk and low negative impact categories. Orr et al. (2013) concluded that direct effects of artificial lighting on marine mammal distribution, behaviour, or habitat use may be minimal or unknown.

Mattfield et al. (2005) undertook a comprehensive review of over ninety-nine studies of offshore nighttime light pollution, the results of which did not provide any evidence for light-based disturbances to marine mammals. Therefore, potential light spill impacts on marine mammals have been excluded and are not considered further.

Lighting impacts on Sea turtles

Most studies on sea turtles in relation to nighttime lighting on offshore platforms found that artificial lighting impacts to sea turtles were conducted at nesting sites, where artificial lighting effects were related hatchling orientation success during migration from nests to the open ocean. For example, Pendoley (2004) monitored the intensity and spectral signature of electric lights on Barrow Island in Australia. Their study indicated that the lights most disruptive to sea turtle hatchlings on Barrow Island are likely to be the bright white lights that emit low wavelength light, such as fluorescent, metal halide and mercury vapor.

In the case of the low distribution and density of sea turtles in Bass Strait and the project area, light spill or light glow impacts to these predominantly subadult and adult sea turtles are not predicted.

Therefore, potential project artificial lighting impacts on sea turtles passing through Bass Strait have been excluded and are not considered further.

Lighting impacts on marine fishes

There is a lack of available literature on the topic of artificial lighting impacts to marine fish. Responses in marine fishes to artificial nighttime lighting vary greatly between species and between age classes of fishes, and can impact upon foraging and schooling behaviour, spatial distribution, predation risk, migration, and reproduction (Nightingale et al., 2006).

Nocturnal species respond to extremely low illumination levels and light spill from the project's cable lay ship and other large vessels may be expected to increase the zone of increased depth of illumination. Elevated illumination can increase the predation risk on fishes at night. In general, greater increases in illumination may allow normally diurnal predators to continue to forage at night, perhaps even on normally diurnal prey species (Hobson 1965). Increased light also aids predatory fish or mammals (e.g., dolphins) attacking from below by allowing them to distinguish the dark silhouette of their prey against an illuminated background (Hobson 1966).

Indirect effects of nighttime lighting on fishes may arise due to the congregation of zooplankton, *micronekton*, and smaller fishes at the sites of in-water illumination. For example, Prinslow et al. (1980) observed that the spiny dogfish (*Squalus acanthias*), a Puget Sound sharks, appeared to be attracted to security lighting, probably because it illuminated aggregating prey fishes.

Overall, lighting impacts and increased light glow will be highly localised to the immediate vicinity of the cable lay ship and mainly at the stern, when the cable lay ship is undertaking cable lay operations. During cable lay operations, the cable lay ship will be lit during the nighttime as cable lay operations are undertaken on a continuous basis (i.e., 24-hours/7-days a week). Therefore, unlike fixed position (stationary) oil and gas exploration rigs or production platforms, the project's principal source of nighttime illumination will be mobile and potentially affecting offshore marine fishes.

When the cable lay ship maintains location in DP mode in either nearshore Tasmania or nearshore Victoria, nighttime lighting will be limited to navigation lights for a vessel with restricted manoeuvrability and in accordance with AMSA requirements (e.g., AMSA Marine Orders Part 30 and Part 59). Nearshore cable pull operations by small boat crews will be undertaken during daylight hours only for safety reasons and, as such, there will be no requirement for illumination the aft deck and stern of the cable lay ship. Hence, nighttime lighting impacts of the cable lay ship will be limited to offshore Bass Strait waters during the cable laying operations. The intensity of nighttime illumination of the cable lay ship will be comparable to the floodlighting of the aft decks of offshore supply vessels (OSVs), offshore support vessels (OSVs), and offshore anchor handling tug supply (AHTS) vessels used in the oil and gas industry in offshore Bass Strait to the northeast of Wilsons Promontory.

Overall, the predicted impacts of artificial nighttime lighting on marine fishes are assessed to have a residual impact significance rating of ***Low***. This is based on an assumed marine fish light sensitivity of *Moderate* due to nighttime attraction of a limited group of fishes and an impact magnitude of *Negligible* given the highly localised area and volume (depth) of in-water illumination and the mobile nature of the cable lay ship (1.5 knots).

Lighting impacts on marine invertebrates

Lighting impacts on marine invertebrates are assessed for those light-sensitive zooplankton that undertake diel vertical migrations and to cephalopods such as squid that are highly attracted to light spill from ships on the sea surface.

Squid

Artificial lights are commonly used by the fishing industry to attract and catch several squid species (Davies et al., 2014). Extensive use of this light-fishing method is made by the Commonwealth managed Southern Squid Jig Fishery (see Section 6.4.2.3.2, Southern Squid Jig Fishery), which operates in Bass Strait. It is surmised that the squid are opportunistic and associate bright light with increased food abundance prey items such as zooplankton, micronekton and small fishes that are also drawn to the artificial light, or simply because they display positive phototaxis (attraction to intense light).

Overall, the predicted impacts of project nighttime artificial light sources on squid species are assessed to have a residual impact significance of ***Low***. This is based on a sensitivity of *Very low* (widely distributed and common species and no species of squid are listed under the EPBC Act) and a magnitude of impact of *Minor* (highly localised and short-term lighting effect). The mobile nature of the cable lay ship prevents large aggregations of squid that could otherwise be preyed upon by large predators.

7.2.5 Risks of introducing or translocating invasive marine species

This section assesses the impacts of the project’s proposed marine activities resulting in either the introduction of new IMS or the translocation of existing IMS between ports and different areas of Bass Strait between Tasmania and Victoria.

At least 14 anthropogenic vectors are, or have been, responsible for spreading marine organisms beyond natural bio-geographic boundaries (Carlton 2001). The dominant vectors for the introduction of and translocation IMS and their subsequent spread vary over time and with geographical region. In Australia they are ballast water, hull fouling, and accidental releases associated with oyster mariculture (Thresher et al., 1999).

Section 6.3.12 (Invasive marine species) provides information on existing invasive marine species in Victorian and Tasmanian marine waters and offshore Bass Strait.

Table 6-41 lists 21 IMS that have been recorded in Bass Strait coastal and/or offshore islands, which are based on a search of the National Introduced Marine Pest Information System (DAWE, 2021e). The 21 IMS are presented by macroalgae (3 species), gobioid fishes (3 species), molluscs (6 species), sea squirts (3 species), starfishes (2 species), crabs (2 species) and fan worms (2 species). Overall, there are 21 IMS in Victorian waters, 15 species in Tasmanian waters and 9 species in Commonwealth waters of Bass Strait.

7.2.5.1 Potential impacts

Potential sources and impacts associated with the unplanned introduction of invasive marine species (IMS) include:

- Vessels to be used during project construction have the potential to carry IMS via their ballast waters and hulls, depending upon the origin of the vessels or previous ports.
- Discharges of ballast water that may contain the planktonic stages of organisms, free swimming juveniles or adults, fouling organisms attached to the vertical walls of the ballast compartments, and benthic organisms in deposits of sediments that accumulate at the bottom of ballast tanks (Carlton, 2001).

- Release of IMS attached to the exterior hulls and nooks and crannies (e.g., thruster tunnels, rudder specie and water intake port) of the cable lay ship or other project vessels when on location in Bass Strait.
- Construction vessels moving between southeastern Australian ports may translocate existing IMS, which are typically found at higher numbers of species and densities within ports and harbours.
- Targeted rock placement and/or the use of concrete mattresses to cover exposed or shallow buried cables (i.e., less than 1 m) provides hard substrate seabed that has the potential to be colonised by both native and introduced IMS (or spread of existing established IMS) that prefer hard substrate for attachment.
- If introduced IMS become established and disperse within new habitats in the project area, they have the potential to outcompete local species for space and resources, prey directly on local species, or introduce pathogens.
- IMS also have the potential to introduce pathogens that may infect native fauna.

7.2.5.2 Environmental Performance Requirements

The proposed EPR for introducing or translocating IMS is in Table 7-31:

Table 7-31 EPR for minimising the introduction and spread of invasive marine species

EPR ID	Environmental performance requirement	Project stage

MERU11	**Develop and implement a plan to avoid the introduction of invasive marine species**
	Prior to commencement of marine construction, develop a ballast water management plan and biofouling management requirements for each marine vessel to avoid the introduction of marine pests via ballast water and biofouling of the vessels hull and semi-enclosed spaces.
	Compliance with ballast water management requirements
	During construction and operation vessel owners must comply with the:
	• Australian Ballast Water Management Requirements (DAFF 2020)
	• Biosecurity Act 2015 (Cwlth)
	• International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM Convention 2004)
	• Australian Anti-fouling and in-water cleaning guidelines (DoA, DoE 2015)
	• Ballast Water Management Requirements (DAFF 2020)
	• Maritime and Aircraft Reporting System (MARS) and the Vessel Compliance Scheme (VCS):
	  ○ Prepare and submit a Pre-arrival Report (PAR) for answering the ballast water questionnaire from DAFF.
	  ○ Non-First Point of Entry (NFP) application v16.
	  ○ Ballast Water (BW) report v108.
	International marine traffic must have a ballast water management plan for water and sediments that includes:
	• A ballast water record book.
	• An International Ballast Water Management certificate where ships are 400 gross tonnes and above in accordance with the
		Construction / Operation

	BWM Convention and specifies which standard the ship is complying with, as well as the date of expiry of the Certificate. • Vessels with a ballast water management system must carry a type approval certificate specific to the type of ballast water management system installed • Complete and accurate record of all ballast water movements. • Detailed information regarding vessel maintenance history for treating biofouling. **Compliance with biofouling management requirements** During construction and operation vessel owners must comply with the: • Biosecurity Amendment (Biofouling Management) Regulations 2021 (Cwlth) that require operators of all vessels to provide information on biofouling management practices prior to arriving in Australia. • Australian Biofouling Management Requirements ('ABFMR') (DAWE 2022) via: o Biofouling Management Plan o Biofouling Record Book. • Alternatively, clean all biofouling within 30 days prior to arriving in Australia and submit a cleaning report to DAFF. • Australian National Antifouling and In-water Cleaning Guidelines (DoA, DoE 2015). The ballast water management plans and biofouling management requirements must be implemented during construction and operation.	

7.2.5.3 Potential mitigation and management measures

The following mitigation and management measures address the abovementioned EPR.

7.2.5.3.1 Ballast water management and mitigation

Compliance of project-contracted vessel owners with the Australian biofouling requirements is viewed and considered as a key mitigation and management measure to reduce the risk of the introduction and spread of IMS.

Ballast water will be managed in accordance with the Ballast Water Management Requirements (DAFF, 2020), which set out the obligations on vessel operators with regards to the management of ballast water and ballast tank sediment when operating within Australian territorial seas.

The Australian Ballast Water Management Requirements (DAFF, 2020) provides details of Australia's pre-arrival reporting requirements and guidance for operators of international vessels that are subject to biosecurity control while in Australian territorial seas.

Ships and vessels contracted for the project will also abide by the standards and requirements of the 2004 BWM Convention, which helps to prevent the spread of potentially harmful aquatic organisms and pathogens in ships' ballast water. An MLPL contracted marine construction vessel such as the cable lay ship is required to abide by the BWM Convention D-1 Standard but is not required to meet the BWM D-2 Standard because it is not a new ship.

Ships involved in international traffic are required to manage their ballast water and sediments to a certain standard, according to a ship-specific ballast water management plan. Ships are mandated to carry:

- A Ballast Water Management Plan (BWMP) is required and is specific to each ship, the BWMP includes a detailed description of the actions to be taken to implement the ballast water management requirements and supplemental ballast water management practices.
- A Ballast Water Record Book is required to record when ballast water is taken on board; circulated or treated for ballast water management purposes; and discharged into the sea. It should also record when ballast water is discharged to a reception facility and accidental or other exceptional discharges of ballast water.
- An International Ballast Water Management Certificate applies to ships of 400 gross tonnage and above and the certificate is issued by or on behalf of the administration (flag State) and certifies that the ship carries out ballast water management in accordance with the BWM Convention and specifies which standard the ship is complying with, as well as the date of expiry of the Certificate.
- Vessels with a Ballast Water Management System (BWMS) must carry a type approval certificate specific to the type of BWMC installed.
- All vessels must maintain a complete and accurate record of all ballast water movements.

Operators of all project-contracted vessels subject to biosecurity control must provide information relating to ballast and ballast sediment management through the mandatory pre-arrival report (PAR). This information is reported through the DAFF’s web portal for the Maritime and Aircraft Reporting System (MARS), which includes mandatory questions relating to ballast water management practices.

Operators of all project-contracted vessels subject to biosecurity control must provide information relating to biofouling management through the mandatory pre-arrival report (PAR). This information is reported through the DAFF's web portal for the Maritime and Aircraft Reporting System (MARS), which is operated by DAFF. Of relevance to the Marinus Link Project overseas arriving vessels subject to biosecurity controls, vessel owners will be required to download pre-arrival questionnaire and prepare a PAR and answer mandatory questions relating to ballast water management practices such as:

- Does the vessel have an approved Ballast Water Management Certificate on board?
- Does the vessel have an approved Ballast Water Management Plan on board?
- Does the vessel have either a ballast water record system or accurate ballast water records on board?
- Does the vessel intend to dispose ballast tank sediment in Australia?
- Is the vessel using an IMO Type Approved Ballast Water Management System to manage ballast water?
- Is the vessel claiming an Exception for this voyage?

Ships arriving in Australia from temperate water posts in the Northern Hemisphere (e.g., Europe and East Asia) have the highest potential to introduce IMS with the potential to establish populations in the temperate water ports of southern Australia. However, an additional IMS mitigation measure is for the cable lay ship to fully exchange ballast water as it crosses the equator. Therefore, potential IMS in the ballast water will be comprised of warm-water species that are less likely to survive in the colder temperate waters of Bass Strait.

7.2.5.3.2 Australian biofouling mitigation measures

Compliance of project-contracted vessel owners with the Australian biofouling requirements is viewed and considered as a key mitigation and management measure to reduce the risk of the introduction and spread of IMS. The Biosecurity Amendment (Biofouling Management) Regulations 2021 (Cwlth) requires operators of all vessels to provide information on biofouling management practices prior to arriving in Australia.

The Australian Biofouling Management Requirements (DAWE, 2022) set out vessel operator obligations for the management of biofouling when operating vessels under biosecurity control within Australian territorial seas to comply with the *Biosecurity Act 2015*.

Operators of all project-contracted vessels subject to biosecurity control must provide information relating to biofouling management through the mandatory pre-arrival report (PAR). This information is reported through the DAFF's web portal for the Maritime and Aircraft Reporting System (MARS), which includes mandatory questions relating to biofouling management practices such as:

- Does the vessel have an effective biofouling management plan?
- Has the vessel been cleaned of all biofouling within 30 days of arriving in Australia?
- Does the vessel have an alternative biofouling management method that has been pre-approved by the department?
- Do you intend to in-water (underwater) clean biofouling in Australia?

Vessel operators can demonstrate proactive management of biofouling by implementing one of the three accepted proactive biofouling management options (DAWE, 2022):

- Implementation of an effective biofouling management plan.
- Cleaned all biofouling within 30 days prior to arriving in Australian territory.
- Implementation of an alternative biofouling management method pre-approved by the department.

Documentary evidence must be available upon request by DAFF and the information will be used to target vessel interventions.

7.2.5.3.3 Australian National Antifouling and In-water Cleaning Guidelines

Australian national antifouling and in-water cleaning guidelines (DoA and DoE, 2015) apply to vessels that are permitted to undertake in-water hull cleaning.

- Removal of vessels from the water and cleaning on land (e.g., dry docking) is the preferred method of treating biofouling and should be used whenever possible.
- In-water cleaning of vessels, including immersible equipment, can reduce the likelihood of invasive marine species (IMS) introduction and spread. However, they can result in the release of IMS into the marine environment.
- Wherever possible, in-water cleaning activities should only occur using systems for which there is high-quality evidence, based on independent testing that they are capable of removing, capturing and containing biofouling, and contaminants.

Note that in-water cleaning is usually only recommended in exceptional circumstances. All requests to undertake in-water cleaning must be accompanied by the following:

- Detailed information regarding vessel history including:
  - recent IMS inspection or in-water cleaning documentation
  - dry dock reports
  - last ports of call information
  - information on anti-fouling coating condition
- Risk assessment of the vessel's biofouling management using the online Vessel-Check portal with the following required information:
  - biofouling management plan
  - biofouling record book
  - anti-fouling documentation

Provision of a desktop risk assessment by a qualified biofouling inspector may be acceptable. Notwithstanding, given the short duration of project construction vessels activities, it is unlikely that contracted ships will undertake in-water hull cleaning; therefore, potential IMS introductions from in-water hull cleaning are not considered further. However, the potential for IMS production from existing light biofouling on the hulls of project contracted ships and vessels is assessed.

7.2.5.3.4 Commonwealth and state legislation

Relevant legislation, regulations, and guidelines includes the following:

- *Biosecurity Act 2015* (Cwlth).
- Australian Ballast Water Management Requirements (DAFF, 2020).
- Australian Biofouling Management Requirements (DAWE, 2022).
- Biosecurity Amendment (Biofouling Management) Regulations 2021 (Cwlth)
- Australian National Antifouling and In-water Cleaning Guidelines (DoA and DoE, 2015)
- *Biosecurity Act 2019* (Tas).
- Biosecurity Regulations 2022 (Tas).
- Marine Pests in Victoria (Vic) (Agriculture Victoria, 2021).
- Victoria's Biosecurity Statement 2022 (Agriculture Victoria, 2022)

7.2.5.3.5 International standards for ballast water and biofouling

Ballast water management standards

The principal ballast water management standard is The International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM Convention). There are two ballast water management standards (D-1 and D-2) under the BMW Convention:

- **The D-1 standard:** This standard requires ships to exchange their ballast water in open seas, away from coastal areas. Ideally, this means at least 200 nm from land and in water at least 200 m deep. Under this ballast water exchange regime, fewer organisms are likely to survive and, consequently, ships will be less likely to introduce potentially harmful species when they release the ballast water.
- **The D-2 standard**: This standard specifies the maximum number of viable organisms allowed to be discharged, including specified indicator microbes harmful to human health.

From the date of entry into force of the BWM Convention (8 September 2017), all ships must conform to at least the D-1 standard; and all new ships, to the D-2 standard. Eventually, all ships will have to conform to the D-2 standard. For most ships, this involves installing special equipment to treat the ballast water.

Zooplankton and micronekton

As noted in Section 6.3.5.2 (Zooplankton), potential effects on zooplankton in the water column are not considered an issue of concern by regulatory authorities nor a specific requirement in the EIS scoping guidelines of the Commonwealth Government (DCCEEW, 2022b), Victorian State Government (DTP, 2023) or the Tasmanian State Government (EPA Tasmania, 2022a ; EPA Tasmania, 2022b). Therefore, for the purposes of the present report, impacts of zooplankton species are not assessed and are not of concern. However, light-sensitive zooplankton undertake daily (diel) vertical migrations and may be affected by nighttime artificial lighting, which is assessed below.

Diel vertical migration for zooplankton has shown to be able to be suppressed by all types of nighttime artificial lighting sources (Haarman, 2022) and is sufficient to alter the vertical distribution of zooplankton [Garratt et al., 2019). As the lit cable lay ship traverses Bass Strait at nighttime while laying bundled cables, the speed of the ship is around 1.5 knots and will have travelled 2.8 km in one hour. Therefore, potential impacts on diel vertical migration of invertebrates and invertebrate micronekton immediately below an astern of the cable lay ship will be short-term and transient.

Overall, the predicted impacts of project nighttime artificial light sources on vertical diel migration are assessed to have an impact significance of ***Low***. This is based on a sensitivity of *High* due to the presence of light-sensitive invertebrates that undertake diel vertical migrations and a magnitude of *Negligible* based on the short-term and transient passage of the cable lay ship while traversing Bass Strait.

Biofouling standards

Biofouling standards are set under the Australian Biofouling Management Requirements (DAWE, 2022), Biosecurity Amendment (Biofouling Management) Regulations 2021 (Cwlth), Maritime and Aircraft Reporting System (MARS) and the Vessel Compliance Scheme (VCS).

Anti-fouling of ships and other vessel are managed under the Australian national Antifouling and In-water Cleaning Guidelines (DoA and DoE, 2015). The Commonwealth and state governments are currently working on the development of requirements for managing biofouling.

7.2.5.4 Prediction of IMS impacts

The primary sources of introductions of IMS vary among species and depends on transport vectors. The main concerns relate to IMS in water and sediment discharges from vessels (e.g., ballast water and resuspended tank bottom sediments) and attached to vessel's hulls and other underwater compartments (e.g., propeller shafts, rudder cavities, thruster tunnels and anodes). The significance assessment method (see Section 5.3.2, Significance assessment method) is not suitable for assessing risks associated with IMS introductions or translocation. Therefore, the assessment of potential IMS impacts is based on the risk assessment method (see Section 5.3.4).

7.2.5.4.1 Residual impacts of ballast water discharges

In general, the discharge of ballast waters constitutes a significant entry route (vector) for IMS introductions to Australian temperate waters, particularly from ships coming from similar temperate water ports in the Northern Hemisphere and arriving in Bass Strait. However, given the abovementioned legislative requirements, guidelines, and standard control measures for managing vessel ballast water, the residual impact of IMS being introduced has been assessed to have a ***Low*** risk. This based on a likelihood of occurrence of *Possible* (i.e., while a pathway exists, and harm has occurred in similar environments and circumstances elsewhere and may occur over the duration of project life) and a consequence of *Minor* (i.e., given that IMS introduction could be effectively mitigated through standard management controls). The assessed ***Low*** risk of IMS introductions may be also considered in the light of the limited number of overseas ships (e.g., the cable lay ship) that will be involved in the project compared to the much larger numbers of maritime traffic from varied overseas ports to southeast Australian port including those in or near Bass Strait. In addition, adherence to the BWM Convention's requirement to exchange ballast water at least 200 NM from land and in water at least 200 m deep reduces the potential for IMS introductions when the ships arrive in the Commonwealth and state waters of Bass strait.

7.2.5.4.2 Residual impacts of IMS present in hull biofouling

Hull biofouling is likely to be a significant vector for translocation of introduced species to Bass Strait, although risks associated with hull biofouling and IMS are difficult to assess and quantify. There will only be a small number of project vessels when compared to the intense maritime traffic of merchant ships, fishing vessels, specialised vessels, recreation craft, fishing vessels, cruise ships and ferries that ply the waters of Bass Strait and visit ports where most biofouling organisms are found. Project vessels in local ports will generally have short stays, which reduces their exposure to port biofouling organisms including those IMS that prefer underwater habitats structures such as pier pilings and walls, which may be adjacent to ships' hulls.

Overall, given the abovementioned legislative requirements, guidelines, and standard control measures for managing vessel hull cleaning, IMS being introduced and becoming established (or an existing IMS being spread) and harming native marine fauna has been assessed to be a ***Very Low*** risk. This is based on a likelihood of occurrence of *Unlikely* (i.e., a pathway exists, and harm has occurred in similar environments and circumstances elsewhere but is unlikely to occur over the duration of the project life) and a consequence of *Negligible* (i.e., a localised effect that is temporary and does not extend beyond operational area).

7.2.5.4.3 Residual impacts of IMS colonisation of new habitat

Most of the project's subsea infrastructure (i.e., individual or bundled HVDC cables and optical fibre cables) are buried in soft-sediment seabed and do not present a source of hard substrate for colonisation by native benthic fauna or IMS that prefer for hard substrates (e.g., exotic molluscs). However, targeted rock placement and/or concrete mattresses will be used at the crossings of third-party subsea assets (e.g., pipelines or telecommunication cables) or at locations where the cables are insufficiently buried (i.e., less than 1 m burial depth). The presence of new habitat presented by rock placement and/or rock mattresses has the potential to be colonised by both native and existing IMS, which prefer hard substrates.

New hard seabed habitats in nearshore areas

Given the low presence and diversity of existing IMS in nearshore Victoria and Tasmania, most colonisers are anticipated to be native benthic fauna, which may be expected to outcompete potential introduced IMS. IMS such as the European shore crab with established nearshore populations may take advantage of project areas of newly formed hard substrate habitats. However, given the sparse distribution and very low densities of the European shore crab in nearshore Victoria (Waratah Bay) and its absence in nearshore Tasmania at Heybridge, the very small areas of rock placement and/or rock mattresses required by the project, it is assessed that there is a ***Low*** risk of IMS introduction and colonisation of newly formed hard substrates at project cable crossings of third-party subsea infrastructure. This is based on a likelihood of occurrence of *Possible* (i.e., while a pathway exists, and harm has occurred in similar environments and circumstances elsewhere and may occur over the duration of project life) and a consequence of *Minor* (i.e., given that IMS colonisation of new hard substrates could be effectively mitigated through standard IMS introduction management controls).

New hard seabed habitats in the offshore area

There are few records of IMS in the seabed of offshore central Bass Strait, though it is likely that European shore crabs may occasionally occur as they are continuing to spread naturally by their planktonic life stages to the nearshore seabed of the offshore islands of Bass Strait. For example, the Atlas of Living Australia (CSIRO, 2022) shows a sighting for this species on southern Flinders Island near the port of Lady Barron.

New hard seabed habitat will be created by the rock fill or rock mattresses that the project will place at the two crossings of Alcatel's Indigo Central telecommunications cable by the bundled cables of the ML1 and ML2 monopoles. These represent two small areas (about 300 m^2 each) in a vast expanse of surrounding sandy seabed.

Given the inferred very low presence of deepwater IMS in offshore Central Bass Strait, most colonisers of the hard substrate of the project's cable crossings in offshore Bass Strait are anticipated to be native benthic fauna, which may be expected to outcompete any potential IMS settling on the newly formed hard substrate habitat at the Alcatel cable crossing.

Overall, it is assessed that there is a ***Very low*** risk of IMS introduction and colonisation of newly formed hard substrates in offshore waters given the very small areas of rock placement and/or rock mattresses required by the project's bundled cable crossings of the Alcatel telecommunication cable. This is based on a likelihood of occurrence of *Unlikely* (i.e., a pathway exists, and harm has occurred in similar environments and circumstances elsewhere but is unlikely to occur over the duration of the project life) and a consequence of *Negligible* (i.e., given that IMS colonisation and spread to new hard surfaces in offshore waters could be effectively mitigated through standard IMS introduction management controls).

7.2.5.4.4 Residual impacts of translocation and spread of existing IMS infestations

The presence of the principal existing IMS in Tasmanian and Victorian nearshore waters has been assessed for potential translocation and spreading impacts.

Residual impacts of translocation of existing IMS in nearshore Victoria

IMS known to occur in Waratah Bay or along the coastal waters west of Wilson Promontory include:

- The European shore crab (*Carcinus maenas*) occurs in waters up to 60 m deep and has a habitat preference in bays, inlets, subtidal seagrass areas, and intertidal rocky platforms and reefs. Four confirmed sightings are recorded for Shallow Inlet, which is 5.6 km from the project alignment in Waratah Bay and also in Waratah Bay itself (Coleman and Sinclair, 1996). ABARES (2019) recognises this species as an established marine pest of national significance.
- The Northern Pacific seastar (*Asterias amurensis*) occurs at Norman Bay at Tidal River west coast of Wilsons Promontory, which is 18 km from the project alignment. ABARES (2019) recognises this species as an established marine pest of national significance.
- The New Zealand screw shell (*Maoricolpus roseus*) occurs Cotters Beach on the west coast of Wilson's Promontory based on the Atlas of Living Australia (CSIRO, 2023) which is located 13 km east of the project's nearest alignment (Parks Victoria, 2018).
- The Pacific Oyster (*Crassostrea gigas*) present at Tidal River on west coast of Wilsons Promontory, which is located 18 km from the project alignment.

Based on the above IMS distributions, the potential for translocation appears to be a higher risk only for the European shore crab and is assessed below. The presence of the Northern Pacific seastar, New Zealand screw shell, and the Pacific oyster lie outside the project's area of direct influence defined as greater than 10 km distance from the project alignment.

European shore crab

The European shore crab occurs in waters up to 60 m deep and prefers bays, inlets, subtidal seagrass areas, and intertidal rocky platforms and reefs. This crab is a benthic species so is unlikely to come in contact with the cable lay ship or other project vessels.

The impact of the European shore crab on native species in Australia is difficult to ascertain due to its long history as part of the intertidal and subtidal fauna, and lack of baseline studies in these habitats prior to its establishment (Aquenal, 2001). However, studies overseas have linked this IMS to dramatic declines in commercial shellfish and reductions in numbers of native invertebrates (Grosholz, 1997).

It is possible that this species spread naturally from ports in Victoria (Port Philip Bay and Westernport) via introductions by ships from Europe and has subsequently spread along the Victorian southeast coast by natural larval dispersal from established populations (Thresher et al., 2003).

Overall, the European shore crab is an established IMS in Victoria and this species may be considered as a continuing threat to native fauna with the potential for further rapid expansion of both its geographic range and population numbers. Given the sparse distribution and very low densities of the European shore crab in nearshore Victoria (Waratah Bay), the residual impacts of translocation of this IMS by the project's proposed marine construction activities in nearshore Victoria, this report has assessed that there is a ***Low*** risk of translocating and spreading the European shore crab, principally because the cable lay ship does not anchor and maintain station in DP mode and does not come into contact with is benthic invasive species. This is based on a likelihood of occurrence of *Possible* (i.e., while a pathway exists, and harm has occurred in similar environments and circumstances elsewhere and may occur over the duration of project life) and a consequence of *Minor* (i.e., given that shore crab translocation could be effectively mitigated through standard management controls).The spread of the European shore crab is anticipated to be mainly by natural larval propagation, which is independent of the project's fleet of construction vessels.

Residual impacts of translocation of existing IMS in nearshore Tasmania

IMS known to occur near the Tasmanian nearshore at Heybridge and the central north coast between Burnie and Penguin include:

- Asian date mussel (*Arcuatula senhousia*) is an invasive bivalve mollusc that occurs at Burnie Yacht Club, which is located 5.7 km from the nearest project alignment.
- New Zealand screw (*Maoricolpus roseus*) is an invasive gastropod mollusc that occurs mostly along the east and southeast coast of Tasmania. There is one record at Blythe Heads, which is 0.28 km from the project alignment.
- European shore crab (*Carcinus maenas*) occurs along the central north coast with three records between Burnie and Devonport but there have been no sightings near the project's proposed cable landfall at Heybridge.

Based on the above IMS, the potential for translocation appears to be a higher risk for both the Asian date mussel and the New Zealand screw shell, which are assessed below. There are no records for the European shore crab at or near Heybridge; therefore, it has been excluded from further consideration.

Asian date mussel

Asian date mussel (*Arcuatula senhousia*) is considered a pest in other parts of Australia because of its capacity to dominate seabed communities and potentially exclude similar native bivalve mollusc species. For example, in the Port of Geelong, this species occurs in virtually every available habitat, and comparisons between surveys indicate that its population size is increasing (Currie et al. 1998). This IMS is a fouling species that adapts to a range of habitats and is commonly found on sheltered intertidal flats with silt and clay (mud) substrates, although it also occurs in subtidal areas to a depth of 20 m (Slack-Smith and Brearly, 1987). This species has a high reproductive capacity which, combined with a gregarious habit, can lead to extremely dense aggregations. It this ability to form dense populations that threatens native bivalve species and their populations (Willan, 1987).

The Asian date mussel is widely distributed in the Port of Launceston, and has been recorded in the harbour entrance, Bell Bay and Long Reach (Aquenal, 2001). It is not known if project vessels will be using the Port of Launceston as the Port of Burnie is closer (5.7 km) to the project alignment near Heybridge. Notwithstanding, the Asian date mussel is a benthic species and unlikely to come into direct contact with ship or vessel hulls.

Overall, given the sparse distribution and inferred very low densities of the Asian date mussels along the central north coast with the nearest records at Burnie Yacht Club (5.7 km west of Heybridge) the nearest in nearshore Tasmanian (Heybridge) and considering the abovementioned guidelines for hull cleaning, this report has assessed that there is a ***Very low*** risk of translocating and spreading the Asian date mussel. This is based on a likelihood of occurrence of *Unlikely* (i.e., a pathway exists, and harm has occurred in similar environments and circumstances elsewhere but is unlikely to occur over the duration of the project life) and a consequence of *Negligible* (i.e., given that the spread of Asian date mussel could be effectively mitigated through standard management controls).

The spread of this species is anticipated to be mainly by natural larval propagation and its continued presence in a region or area is dependent on the production of a large larval pool (Creese et al., 1997). This spreading by natural reproduction is independent of the project's construction vessels. Creese et al. (1997) also suggest that any adverse environmental effects caused by Asian date mussels are likely to be local and short-lived.

New Zealand screw shell

The native range of the New Zealand screw shell is limited to New Zealand, while its known introduced range in Australia includes South Australia, Victoria, Tasmania, New South Wales and southern parts of Queensland (Aquenal, 2001). This IMS occurs within a wide range of seabed types including soft sediment (sandy-mud) substrates, pebbles and shell gravel, sandy and sandy-mud substrates, as well as in areas of mixed rocks/boulders and soft sediments. The highest abundances are found in areas of coarse and relatively stable soft-sediment seabeds (Allmon et al., 1994). The depth range of the New Zeeland screw shell in Australian waters extends from intertidal areas to depths of at least 50 m, and as such, may be expected to occur in the Commonwealth waters of Bass Strait beyond the state 3-nm state limits.

A major threat of the New Zealand screw shell is its potential for outcompeting the native Gunns screw shell (*Gazameda gunnii*), which is classified as vulnerable under the TSP Act. Gunns screw shell is known to have ostensibly disappeared from soft-sediment habitat in areas dominated by the invasive New Zealand screw shell, and now exhibits a reduced distribution at low densities (Bax et al, 2003, Gunasekera et al., 2005). However, there are very few records of Gunns screw shells in the Tasmanian nearshore, with only four sightings between Burnie and Devonport, which is a 40-km stretch of coastline that includes the project's landfall at Heybridge.

Overall, given the sparse distribution and inferred very low densities of the New Zealand screw shell along the central north coast and nearshore Tasmanian (Heybridge) and considering the abovementioned guidelines for ballast water management and cleaning, this report has assessed that there is a ***Low*** risk of the project's marine construction activities translocating and spreading the New Zealand screw shell. This is based on a likelihood of occurrence of *Unlikely* (i.e., a pathway exists, and harm has occurred in similar environments and circumstances elsewhere but is unlikely to occur over the duration of the project life) and a consequence of *Moderate* (i.e., given that the spread of the New Zealand screw shell could compete with the native Gunns screw shell).

7.2.6 Risks of construction vessel-marine megafauna collision impacts

Collisions between vessels and marine megafauna are a risk where high volumes of vessel traffic overlap high-use resting, breeding and feeding areas. Vessel collision risks can be a threat to slow-moving marine megafauna including threatened species of large cetaceans and sea turtles listed under the EPBC Act, FFG Act and TSP Act.

The most well documented vessel-marine megafauna collisions are with slow-moving large whales and sea turtles (Pirotta et al. 2019; Schoeman et al., 2020) and, as such, are the main focus of this report. Other fast-moving and highly manoeuvrable marine fauna such as seals, sea lions, little penguins, smaller cetacean species (e.g., dolphins) and large pelagic marine invertebrates such as squid are less vulnerable to vessel strikes. In addition, most pelagic fishes are fast-moving and can readily avoid transiting vessels; however, slow-moving fish species are vulnerable to vessel strikes. Slow-moving fish species such as basking sharks (*Cetorhinus maximus*) and whale sharks (*Rhincodon typus*) found just below the sea surface are vulnerable to vessel strikes. For example, basking sharks have typical swimming speeds of about 2 knots or 3.7 km/hr while feeding on plankton mostly near the sea surface (Sims, 2000). However, the distributions of both basking sharks (CSIRO, 2008a) and whale sharks do not include Bass Strait (CSIRO, 2008b) and these species have not been considered further.

For the purposes of this report, a vessel-marine megafauna collision is defined as a forceful impact between any part of a vessel, most commonly the bow or propeller, and a live large cetacean or sea turtle, resulting in death, major injuries, or physical trauma.

The risks of project construction vessel collisions with large cetaceans and sea turtles have been assessed, given that there are many more vessels engaged during the construction phase than the operations phase. Therefore, the risks of construction vessel collisions with large cetaceans and sea turtles are assessed below.

7.2.6.1 Risks of project vessel collision with large cetaceans

7.2.6.1.1 Potential risks of construction vessel-large cetacean collision impacts

The severity of injuries to whales typically depends on the size and speed of a vessel, with the probability of death or serious injury increasing as vessel speed increases (Laist et al., 2001). The most lethal and severe injuries are caused by vessels 80 m or longer (Laist et al. 2001). According to one study, the probability of serious injury or death increases from 45% to 75% as vessel speed increased from 10 to 14 knots (Pace and Silber, 2005).

Potential vessel collision risks to large cetaceans include:

- Fatal collisions where a cetacean is killed directly or succumbs to its injuries (delayed mortality).
- Non-fatal collisions where a cetacean is struck but recovers from its injuries.

Collision risks are higher in areas such as nearshore BIAs for foraging, resting habitats, coastal connecting corridors (e.g., for southern right whales), and offshore migratory whale corridors in Bass Strait.

The risk of a vessel and large whale collision is highest in places of extensive overlap between migrating whales and vessel densities such as seaways and shipping channels. Evidence suggests that not all whales killed by vessel strikes are detected, particularly in offshore waters, and especially for less buoyant species such as blue, humpback, and fin whales (Rockwood et al., 2017).

7.2.6.1.2 Mitigation measures to reduce the risk of vessel-large cetacean collisions

Relevant mitigation measures to avoid project vessel collisions with large cetaceans are outlined in the following EPRs:

- MERU07 – Develop and implement a Marine Fauna Management Plan (Section 7.6).
- MERU08 – Develop and implement a Cetacean Interaction Management Plan (Section 7.6).

Key mitigation measures to meet the objectives of the abovementioned EPRs include:

- Following minimum approach distances and best practices as outlined in Commonwealth, Tasmanian and Victorian whale watching and approach guidelines such as the:
  - Australian National Guidelines for Whale and Dolphin Watching (DoEE, 2017b) for offshore Bass Strait (i.e., Commonwealth waters).
  - Tasmanian whale and dolphin viewing guidelines (DNRE, 2019b) (i.e., nearshore Tasmanian waters).
  - Victorian guide to boating and swimming around whales, dolphins, and seals (DELWP, 2019).
- Monitoring for the presence of large cetaceans ahead of transiting vessels:
  - Caution zone of 300 m when vessels slow down or change the direction of transit.
  - Minimum observation zone of 500 m.
- Reporting of vessel-large cetacean collisions (AMSA, 2023) via:
  - Commonwealth waters – Whale Hotline
  - Tasmanian nearshore waters – Whale Hotline
  - Victorian nearshore waters – Whale and Dolphin Emergency Hotline.

The above mitigation measures including interactions of construction vessels and large cetaceans are consistent with the intent of the Conservation Management Plan for the Blue Whale (DoE, 2015f) and the Draft National Recovery Plan for the Southern right whale (DCCEW, 2022d).

Overall, reducing the spatial overlap of both high numbers of whales and high numbers of vessels globally remains the best means of reducing vessel strikes. However, cable lay and specialised construction vessels cannot be scheduled around fauna movements (e.g., migrations that may occur for several months of the year across a range of species) as construction of the subsea cables will occur when cable-laying vessels are available. These vessels are specialised and there are limited numbers available globally, so construction timing is subject to vessel availability. When cable laying commences, it is a continuous operation until cable-laying is complete. To a lesser extent vessel strikes are reduced by vessel speed reductions (Cates et al., 2017).

7.2.6.1.3 Residual risks of construction vessel-large cetacean collisions

The assessment of project construction vessel-whale collisions is based on the risk assessment matrix given in Table 5-10. The risk assessment is based on:

- The number and types of construction vessels, including their proposed locations in nearshore Tasmanian and Victoria, and offshore Bass Strait as described in Section 4 (Project description).
- Identification of slow-moving large cetaceans vulnerable to vessel collisions, including their:
  - existing distributions of baleen whales as described in Section 6.3.6.2 and toothed whales as described in Section 6.3.6.3
  - likelihood of occurrence within or proximity to the project area as described throughout Section 6.3.6.
- Identification of seasonal high-use areas where large whales aggregate or are known to return in numbers on a regular basis, including:
  - known BIAs including those for the pygmy blue whale (i.e., a known foraging BIA covering the whole of Bass Strait) and the southern right whale (i.e., a migration BIA between approx. April-October) covering Commonwealth waters of Bass Strait, and a reproduction BIA (approx. May-September) covering the Victorian and Tasmanian state waters.
  - nearshore areas used by resting mothers with calves.
  - coastal connecting corridor habitats, and migratory whale routes that may be intercepted by the project alignments.
- A literature review of vessel-whale collision databases in Australia[10] and overseas.
- For the purposes of this risk assessment, vessels undertaking marine construction activities for about ten days duration in either nearshore Tasmania and nearshore Victoria have been excluded from further consideration, as these vessels will be either stationary (e.g., cable lay ship holding position) or very slow moving (e.g., small boats manoeuvring floated cables) and, as such, do not pose a collision risk to whales. Therefore, the vessel-large cetacean collision risk assessment has been undertaken for the following offshore scenarios:
  - Scenario A -– Slow-moving cable lay, installation and burial vessels:
  - Cable lay ship during cable lay operations.
  - Offshore support vessel (OSV) and tethered subsea ROV trencher during cable installation and burial operations.
  - Scenario B – Fast-moving construction vessels transiting between port and construction site.

Observed incidences of vessel-large cetacean collisions

A literature review was conducted to assess existing levels of vessel-marine megafauna collisions in Australia and overseas, as well as identifying the most vulnerable species and at-risk areas. The literature review identified international mitigation measures that have been put in place to avoid or reduce the likelihood of vessel-large cetacean collisions.

Many studies have confirmed an increased risk of a strike being fatal with increased speed, supporting the use of speed restrictions to reduce risk. Examples of successes in reducing vessel-whale interactions include the enactment of mandatory 10-knot speed restrictions in seasonal northern right whale management areas along the Atlantic coast of the United States, where no

[10] The Australian National Ship Strike Database managed by the Australian Marine Mammal Centre is currently not operational, so this database could not be accessed to extract vessel strike data.

Northern Atlantic right whale (*Eubalaena glacialis*) deaths due to vessel collisions have been reported either in, or within 45 nautical miles, of these areas (IWC, 2022). Another example is the Ports of Auckland that introduced a voluntary protocol on ship strikes in 2013, where ships greater than 70 m in length were encouraged to travel at 10 knots in the Hauraki Gulf. Since, 2013, only one known whale fatality was recorded, which was a Bryde's whale (*Balaenoptera brydei*).

Detailed information of vessel strikes to large cetaceans is based on the more comprehensive North American ship strike databases. For example, Table 7-32 shows North American confirmed ship strikes involving large baleen whales, which indicates that the northwestern Atlantic humpback whale (*Megaptera novaeangliae*) and Northern Atlantic right whales (*Eubalaena glacialis*) are the most susceptible species to ship strikes with mean strike rates of 5.2 strikes per year and 2.0 strikes per year, respectively.

Table 7-32: North American confirmed vessel strikes involving large baleen whales (2016-2019)

Baleen whale	2015	2016	2017	2028	2019	Annual mean
Humpback Whale (*Megaptera novaeangliae*)	4	5	8	7	5	5.8
Northern Right whale (*Eubalaena glacialis*)	0	1	5	0	4	2.0
Fin Whale (*Balaenoptera physalus*)	0	0	1	1	0	0.4
Minke Whale (*Balaenoptera acutorostrata*)	1	0	2	1	0	0.6
Sei Whale (*Balaenoptera borealis*)	0	1	0	0	0	0.5

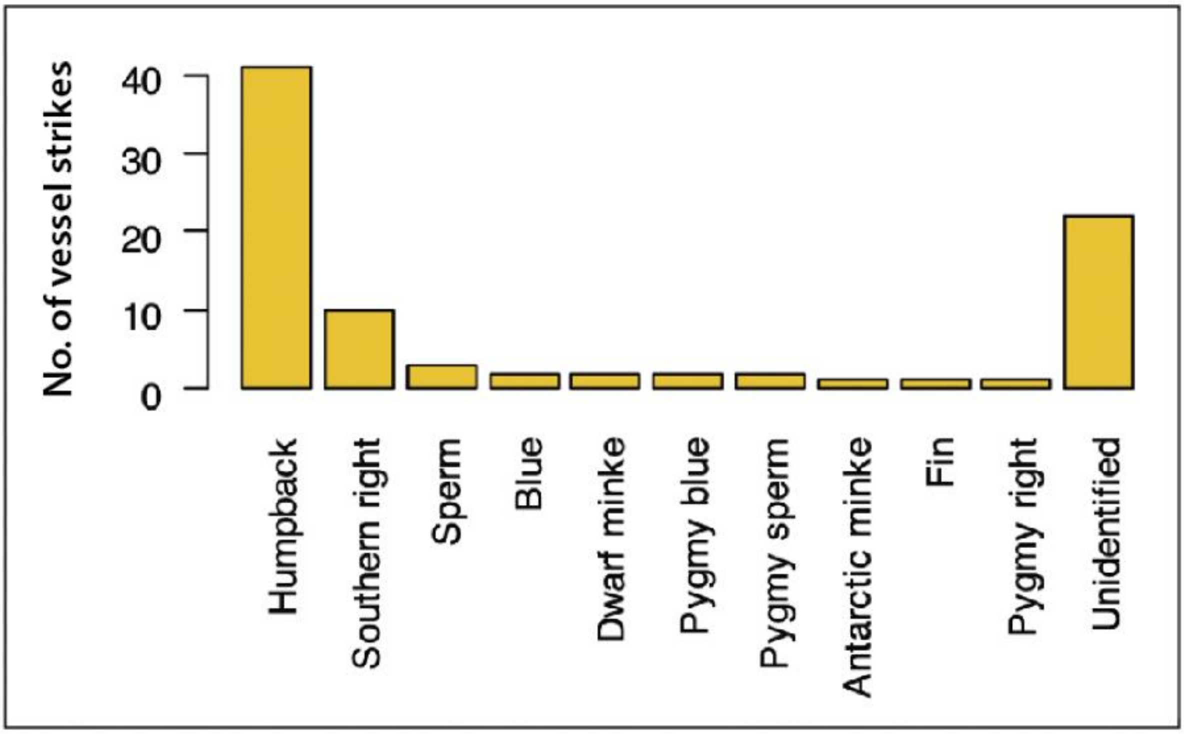
Source: Hayes et al. (2022). Based on whale subpopulations in North America including the western North Atlantic, Gulf of Maine, and the Canadian east coast and Nova Scotia

Vessel strike data for Australian waters are lacking compared to North American vessel strike databases. While most of the attention has been given to vessel-large cetacean collision records in the Northern Hemisphere, equivalent data have been compiled in Australia only since 1997 (Van Waerebeek et al., 2007). More recently, Peel et al. (2016) summarised ship strike records for large cetaceans between 1997 and 2015. Figure 7.11 shows the total number of vessel-large cetacean collisions reported over this 18-year period of records.

In Figure 7.11, the two main large cetacean species vulnerable to vessel strikes are the humpback whale and the southern right whale (*Eubalaena australis*) with 41 and 10 strike records, respectively over the period 1997 to 2015. This equates to approximate annual mean ship strikes of 2.3 strikes per year and 0.56 strikes per year for humpback whales and southern right whales, respectively. The mean annual ship strike rates in Australia are lower than the mean annual ship strike rates for their equivalent north American counterparts (i.e., the northwest Atlantic humpback whale and the northern right whale), which is probably a reflection of the higher densities of both maritime traffic and large cetaceans along the northwestern Atlantic coast of the northeast USA and eastern Canada.

The map of Australian ship-cetacean collisions (i.e., Figure 11 in Peel et al., 2016) shows the distribution of reported vessel strike collisions and strandings where the cause of death was attributed to vessel strike during the period 1986 to 2015. In this map, there were only three locations within the project's baseline study area and adjoining central Bass Strait waters. Two vessel strikes were recorded seaward of The Heads of Port Phillip Bay, with one vessel strike recorded in southern Bass Strait located about 50 km northwest of Devonport. These Bass Strait records represent three ship strikes over a 28-year period (1986-2015), with an averaged ship strike rate of 0.11 strikes per year.

Considering humpback whales as the most vulnerable large cetacean to vessel strikes, the very low incidence of ship strikes in Bass Strait may be attributable to Bass Strait being a minor migratory pathway for migrating humpback whales (i.e., the E1 subpopulation). Most individuals of this subpopulation pass by the east coast of Tasmania during their northern and southern migrations, which compares to minor migration route along the west coast of Tasmania then across Bass Strait to follow the Australian mainland east coast.



Source: Peel et al. (2016).

Figure 7.11: Australian recorded vessel-whale collisions over the period 1997 to 2015

In Australian marine waters, the risk of vessel strikes is greater along the seasonal migration route along the east coast of Australia from Cape Howe (Victorian/New South Wales border) to the breeding area in Queensland for the Australian E1 subpopulation of humpback whales. Similarly, the risk of vessel strikes to southern right whales is greater along nearshore coastal areas such as the BIA connecting corridors and resting areas.

Predicted risks of project construction vessel-large cetacean collisions

Vessel-large cetacean collision risks have been assessed for the project's slow-moving and fast-moving vessels during the construction phase.

Scenario A: Slow-moving vessel-large cetacean collision risk

Under Scenario A, the low speeds of the cable lay during cable laying operations is about 1.0 to 1.5 knots (1.8 to 2.75 km/h), while that of the offshore support vessel and tethered ROV trenching machine is between 0.22 and 0.4 knots (0.4 and 0.8 km/h). Both these speeds are unlikely to cause mortalities or serious injuries to large cetaceans.

Overall, operation of either the cable lay ship or the OSV with a tethered ROV burial machine are assessed to have an overall vessel strike risk rating of ***Very low***. This is based on a likelihood of occurrence of ***Rare*** given the very low vessel speeds and the impact is not anticipated to occur over the duration of the project's marine construction activities, and a consequence of *Negligible* (i.e., a localised effect that is temporary and does not extend beyond operational areas and could be effectively mitigated through standard mitigation and management controls (see Section 7.2.6.1.2)).

Whale behavioural avoidance of the underwater noise gradient radiated around the slow-moving cable lay ship and OSV further reduce the likelihood of vessel strikes. The presence of bridge crew watching for sea surface obstacles (including cetaceans) and the presence of onboard marine mammal observers or crew assigned as marine mammal lookouts also reduces the risks of vessel-large cetacean collisions.

Scenario B: Fast-moving vessel-large cetacean collision risk

During the construction of one of the monopoles (e.g., ML1 or ML2), there will be two campaigns to lay the bundled cables across Bass Strait, which is based on laying two approx. 125-km long segments. Cable laying for the two 125-km segments is separated in time, owing to the requirement for the cable lay ship to return to its overseas port to reload its cable carrousels. Therefore, the numbers of project vessel transits required during the construction phase have been based on marine construction activities involving the instalment and burial of the first 125-km long cable segment commencing at Heybridge in Tasmania. The types of vessels that will transit from ports to sites (and vice versa) include:

- Offshore support vessel (OSV) used for pre lay grapnel runs (PLGR).
- Post PLGR seabed survey vessel mapping seabed along the project alignment.
- OSV to lower concrete mattresses at the Tioxide pipeline crossings.
- Small boat fleet to manoeuvre floated cables to HDD ducts.
- Dive boat for divers to insert cables into HDD duct exit holes (10 m depth)
- Cable lay ship assisted by two guard vessels.
- OSV and ROV wet-trenching machine for cable installation and burial.
- Post cable installation seabed survey.

Based on EIS/EES Volume 1, Chapter 6 – Project description and a marine traffic assessment (Marine Traffic Assessment, Stantec 2023) carried out for the project, Table 7-33 presents a summary of the vessels required in the construction of the first 125-km long segment of one of the project's monopoles.

Table 7-33: Summary of vessel transits for the construction of one 175-km long cable segment

Vessel type	Transit speed* (knots)	No. of vessels	Inbound	Outbound	Total
OSV for pre lay grapnel run (PLGR)	12 –14	1	1	1	2
Post PLGR survey vessel	12 – 14	1	1	1	2
OSV to lay concrete mattresses#	10 – 12	1	1	1	2
Cable lay vessel	8 – 10	1	1	1	1
OSV and ROV burial machine	12 – 14	1	1	1	2
Guard vessels	12 – 16	2	2	2	4
Dive boat	13 – 15	1	10	10	20
Small boats for cable pulling	14 – 18	5	50	50	100
				Total	135

Source: (Maritime Traffic Assessment; Stantec, 2023). * Transit speeds are typical cruising ranges. # The crossings are at the disused Tioxide marine outfall pipelines, and it is assumed the OSV can complete the crossings during one trip to site.

Within one day and at any one point along the offshore bundled cable being laid or installed and buried, there will typically be between one to three vessels present, which represents between 2% and 6% of the daily transits of other maritime traffic crossing the project's north-south alignment in Bass Strait, which is estimated at about 50 vessels per day (Marine Traffic Assessment, Stantec 2023).

Overall, operation of either the cable lay ship or the OSV with a tethered ROV burial machine are assessed to have an overall vessel strike risk rating of ***Low***. This is based on a likelihood of occurrence of *Unlikely* given collision impacts have been known to occur in Bass Strait but are not expected to occur over the short duration of project construction activities such as 10 days in nearshore waters (cable pulling operations) and 20 days (for the first 175-km long cable lay). This is also due to the existing low density of background shipping in the project area (50 vessels passing per day), and a consequence of *Minor* (i.e., a localised effect that is short term and could be effectively mitigated through standard mitigation and management controls (see Section 7.2.6.1.2)).

7.2.6.2 Risks of vessel-sea turtle collision impacts

The transit of any project vessels in Bass Strait nearshore or offshore waters inhabited by EPBC Act listed threatened and migratory sea turtle species carries the risk of a vessel strike. Based on the EPBC Act PMST reports (Attachments A, B and C), the principal species in descending order of abundance based on sighting records are the leatherback turtle (*Dermochelys coriacea*), loggerhead turtle (*Caretta caretta*), and green turtle (*Chelonia mydas*), which are known to have foraging, feeding or related behaviour in Bass Strait (see Section 6.3.8). The EPBC Act PMST reports do not include the olive ridley turtle (*Lepidochelys olivacea*) or Hawksbill turtle (*Eretmochelys imbricata*) in the project's nearshore or offshore areas.

There are no critical habitats listed under the EPBC Act or BIAs for sea turtles in Bass Strait. Sea turtles passing through the Bass Strait are mainly vagrant adults and sub-adults, which are at the southern limit of their global roaming and foraging range. Notwithstanding, sea turtles may rest and forage while passing through Bass Strait with herbivorous green turtles feeding on seagrass and macroalgae in shallow-water nearshore areas, omnivorous loggerhead turtles feeding on benthic algae, sponges and invertebrates, and leatherback turtles feeding opportunistically on jellyfish and *ascidians*.

7.2.6.2.1 Potential risks to sea turtles

Vessel strikes are a potential significant threat to sea turtles since sea turtles use shallow coastal waters frequented by existing high-density vessel traffic and are often unable to avoid vessels travelling at high speeds.

Potential vessel collision risks to sea turtles include:

- Mortality where a sea turtle is killed directly or succumbs to serious injuries (delayed mortality), especially when sea turtles are at the sea surface while basking or coming up for air.
- Vessel strikes resulting in potential mortality include:
  - head trauma from impact.
  - cracking or crushing of carapace.
  - loss of one or more limbs.

- Vessel strikes resulting from potential propeller injuries to sea turtles include:
  - abrasions (surface damage to the skin or carapace not involving deeper tissues).
  - lacerations (more severe damage to soft tissues involving underlying muscle and connective tissue).
  - fractures (e.g., broken bones) and severed limbs.
  - increased risk of debilitation and/or exposure to diseases from wounds.

The likelihood or probability of a vessel strike on sea turtles depends on the number, size, and speed of transiting project construction vessels, as well as the distribution, abundance, and the behaviour of the three main sea turtle species known or expected to occur in Bass Strait.

7.2.6.2.2 Mitigation measures to reduce risk vessel-sea turtle collisions

Relevant mitigation measures to avoid or reduce the risk of project construction vessel collisions with sea turtles passing through the project area and within Bass Strait are outlined in the following EPRs:

- MERU07 – Develop and implement a marine fauna management plan (Section 7.6).
- MERU09 – Develop and implement a sea turtle interaction management plan (Section 7.6).

Key mitigation measures to meet the objectives of the abovementioned EPRs include, but are not limited to:

- Visual monitoring for the presence of sea turtles ahead of transiting vessels:
  - Caution zone of 50 m when vessels slow down or change direction of transit.
  - Minimum observation zone of 200 m.
- Maintaining a minimum separation distance of 50 m from sea turtles and, should a sea turtle occur within this caution zone, slowing down to idling or to less than five knots and/or producing no wake.
- Slow-moving construction vessels in transit (e.g., cable lay ship actively laying cable or the OSV and tethered installation and burial ROV) are exempt from maintaining a minimum separation distance of 50 m from sea turtles, given their low operating speeds (all below <1.5 knots) and very low likelihood of injuring sea turtles.

The above mitigation measures including interactions of construction vessels and sea turtles are consistent with the intent of the Recovery Plan for Marine Turtles in Australia (DoEE, 2017a). In addition, the Commonwealth government is developing a National Strategy for Mitigating Vessel Strike of Marine Megafauna to provide guidance on reducing the risk of vessel collisions and the impacts they may have on marine fauna (DoEE, 2017), which will include a section on sea turtles.

Cable construction cannot be scheduled around fauna movements (i.e., migration) as construction of the subsea cables will occur when cable-laying vessels are available. These vessels are specialised and there are limited numbers available globally, so construction timing is subject to vessel availability. When cable laying commences it's a continuous operation until cable-laying is complete.

7.2.6.2.3 Residual risks of construction vessel-sea turtle collisions

Vessels undertaking marine construction activities for about ten days duration each in nearshore Tasmania and nearshore Victoria have been excluded from further consideration, as these vessels will be either be stationary (e.g., the cable lay ship holding station by dynamic positioning) or very slow moving (e.g., small boat fleet pulling and manoeuvring floated cables to their respective HDD duct marine exit holes) and, as such, do not pose a collision risk to sea turtles.

The risk assessment is based on the following scenarios:

- Scenario A -– Slow-moving project construction vessels:
  - Cable lay ship during cable lay operations.
  - Offshore support vessel and tethered subsea ROV trencher during cable installation and burial operations.
- Scenario B – Fast-moving construction vessels transiting between port and construction site.

Project construction vessel-sea turtles collision risks have been assessed below for the abovementioned two scenarios.

Observed incidences of vessel-sea turtle collisions

A review of the literature did not reveal any statistics on vessel strikes to sea turtles in Bass Strait. However, Shimada et al. (2017) studied boat strikes to green and loggerhead turtles in Moreton Bay, Queensland, and found that by introducing go-slow zones within the bay reduced boat-sea turtle collisions within areas of seagrass in shallow waters less than 5 m deep.

In a separate study, Greenland et al. (2004) investigated confirmed cases of sea turtle mortality due to boat strikes in Queensland waters. The data are presented in Table 7-34 are for six species of sea turtles.

Table 7-34: Confirmed mortality of sea turtles to boat strikes in Queensland waters 1998-2002

Latin name	Common name	1988	1999	2000	2001	2002	Mean
Caretta caretta	Loggerhead turtle	14	8	10	8	5	9.0
Chelonia mydas	Green turtle	0	69	57	66	55	49.4
Eretmochelys imbricata	Hawksbill turtle	0	0	3	1	1	1.0
Natator depressus	Flatback turtle	0	0	0	0	0	0.0
Lepidochelys olivacea	Olive ridley turtle	0	3	3	0	0	1.2
Dermochelys coriacea	Leatherback turtle	0	0	0	0	0	0.0

Based on Table 7-34, boat strikes to sea turtles were highest for the green turtle (49.4 strikes per year) followed by loggerhead turtles (9.0 strikes per year). The absence of leatherback turtle strikes is likely due to its preference for open water and pelagic habitat, with few incursions into Queensland's semi-enclosed waters such as Moreton Bay, Hervey Bay, and Cooktown Bay.

The mean rates of boat strikes (range 1.2 to 49.4 strikes per year) in Table 7-34 for Queensland waters is expected to be much higher than would be the case for vessel-sea turtle collisions in Bass Strait, where the population densities of migrating sea turtles are very low, sea turtle BIAs are absent, and there is a lower prevalence of a high-value foraging habitats (e.g., seagrass beds). Overall, vessel-sea turtles strike rates are anticipated to be much lower within the study area. The low numbers of project construction vessels (one to three offshore vessels in any one day such as the cable lay ship plus two guard vessels during cable laying) will not add significantly to the existing maritime traffic rate of 50 vessels/day in Bass Strait (Marine traffic assessment, Stantec 2023).

Hazel et al. (2007) has shown that green sea turtles (*Chelonia mydas*) have been shown to be much more likely to avoid slow-moving boats (4 km/h) than fast-moving boats (1 km/h). The speeds of the cable lay ship between 1 and 1.5 knots (or 1.8 km/h and 2.7 km/h) and the offshore support vessel and tethered ROV (about 1 knot or 1.8 km/h) will readily be avoided by sea turtles at or near the sea surface.

Predicted risks of project construction vessel-sea turtle collisions

Vessel-sea turtle collision risks have been assessed for the project's slow-moving and fast-moving vessels during the construction phase.

Scenario A: Slow-moving vessel-sea turtle collision risks

Under Scenario A, the low speeds of the cable lay during cable laying operations is about 1.0 to 1.5 knots (1.8 to 2.75 km/h) while that of the offshore support vessel and tethered ROV trenching machine is between 0.22 and 0.45 knots (0.4 and 0.8 km/h). Both these construction phase vessels travel below 2 knots, which is a speed of travel level at which vessel strikes are unlikely to cause mortalities or serious injuries to sea turtles.

Overall, operation of either the cable lay ship or the OSV with a tethered ROV burial machine are assessed to have an overall vessel strike risk rating of ***Very low***. This is based on a likelihood of occurrence of *Rare* given the very low vessel speeds and the impact is not anticipated to occur over the duration of the project's marine construction activities, and a consequence of *Negligible*, i.e., a localised effect that is temporary and does not extend beyond operational areas and could be effectively mitigated through standard mitigation and management controls (see Section 7.2.6.2.2).

Sea turtle behavioural avoidance of the underwater noise gradient radiated around the slow-moving cable lay ship or OSV involved in cable installation and burial further reduce the likelihood of vessel strikes. The presence of bridge crew watching for sea surface obstacles (including sea turtles) and the presence of onboard marine fauna observers or crew assigned as marine fauna lookouts will reduce the risks of vessel-large sea-turtle collisions.

Scenario B: Fast-moving vessel-sea turtle collision risks

Table 7-33 shows the project's fast-moving vessels that will transit from home ports to a marine construction area (and vice versa) of the first 175-km long cable segment commencing at Heybridge in Tasmania.

Overall, fast-moving project vessels in transit are assessed to have an overall vessel-sea turtle collision risk rating of ***Low***. This is based on a likelihood of occurrence of *Unlikely* given collision impacts have been known to occur in Bass Strait and higher vessel speeds are known to increase the risk of sea turtle strikes (Shimada et al., 2017) but are not expected to occur over the short duration of project construction activities associated with the first 175-km long segment (e.g., about 20 days for cable laying). This is also based on a consequence of *Minor* (i.e., a localised effect that is short term and could be effectively mitigated through standard mitigation and management controls (see Section 7.2.6.2.2)).

7.2.7 Construction impacts on marine resource use

This section assesses the potential impacts of project construction activities on marine resource use, identifies mitigation and management measures to reduce potential impacts, and then assess the residual impacts after implementation of mitigation and management measures.

The principal marine resources use aspects that that are assessed include:

- Navigation and maritime traffic.
- Commercial fisheries.
- Recreational fishing.
- Recreational boating and water sports.
- Other marine resource usage

7.2.7.1 Impacts on navigation and maritime traffic

This section assesses the impacts of the project's proposed marine construction activities on navigation and general maritime traffic. Figure 6.56 in Section 6.4.1.2 (Shipping traffic density) shows the major shipping lanes and relative density of shipping in Bass Strait. The date selected (25 March 2019) was purposely chosen as it preceded the reduction in shipping traffic due to the COVID-19 pandemic when shipping numbers and traffic were unusually inflated.

The cable lay ship has restricted manoeuvrability during cable laying, and it will display day signals and lights for a 'hampered' vessel in accordance with AMSA requirements. During bundle cable installation, the subsea HVDC cable may not reach the seabed at deep-water locations until the cable lay ship is several nautical miles away.

Section 6.4.2, *Commercial fisheries of Bass Strait* describes the commercial fisheries of Bass Strait and in particular those fisheries that are located within a 16-km-wide buffer zone straddling the project alignment across Bass Strait (SETFIA, 2022; Attachment F).

7.2.7.1.1 Potential impacts

Potential impacts of the project's proposed marine construction activities on navigation and maritime traffic includes disruption to other marine users/vessels due to temporary exclusion zones on maritime traffic movements.

There are no ports within Waratah Bay in nearshore Victoria, so there are few large vessels entering or leaving Waratah Bay. In nearshore Tasmania, the main ports are the Port of Burnie, which is located 5.7 km from the alignment and Devonport that is located 30 km from the nearest alignment. Container ships and ferries (e.g., *Spirit of Tasmania I* and *Spirit of Tasmania II*) regularly transit between Devonport and Melbourne and/or Geelong ports. These transit routes intercept the project's offshore alignment at about 34 km north of Heybridge.

Potential impacts on navigation in terms of magnetic compass deviation are addressed separately in Section 7.3.1 (Magnetic field impacts), as this potential impact only occurs when the HVDC cables are energised (i.e., transmitting DC power during the project's operation).

7.2.7.1.2 Environmental Performance Requirements

EPRs for this section are outlined in section 7.2.3.5.1 (Acoustic impacts to cetaceans).

7.2.7.1.3 Potential mitigation and management measures

Mitigation and management measures to reduce impacts on navigation and maritime traffic are foremost based on AMSA's issuance of 'Notices to Mariners', which detail the locations, timing and durations of proposed marine activities to other maritime users. However, two guard vessels will accompany the cable lay ship as it lays the bundled cables across Bass Strait. These vessels act as lookouts and can travel towards other ships that may be approaching the cable lay ship within too close a distance.

7.2.7.1.4 Predicted impacts

Predicted residual impacts of the project's marine construction activities on commercial fisheries are assessed below for:

- Impacts of temporary exclusion zones on maritime shipping.

Impacts of temporary exclusions zones

The presence of the offshore 1.5 km by 1 km moving exclusion zone around the cable lay ship, including a buffer zone to include cable suspended from the stern of the cable lay ship, has the potential to affect shipping traffic during cable-laying operations.

There are few restrictions to shipping movements within the open water of offshore Bass Strait, except for the two-way Traffic Separation Scheme that operates to the south of Wilsons Promontory. During the cable lay ship's traverse across Bass Strait, passing ships will detour around the cable lay ship. Such small deviations from their planned routes are likely to be of minor nuisance value to navigation officers rather than a negative (potentially adverse) impact.

Overall, predicted impacts on navigation and maritime traffic are assessed to have an impact significance rating of ***Very low***. This is based on a shipping traffic sensitivity of *Low* due to ships adhering to AMSA requirements to avoid collisions and regularly undertaking navigation course changes and a magnitude of impact of *Minor* given minor navigation deviations.

7.2.7.2 Impacts on commercial fisheries

This section assesses the impacts of the project's proposed marine construction activities on commercial fisheries. Section 6.4.2 (Commercial fisheries of Bass Strait) describes the commercial fisheries of Bass Strait and in particular those fisheries that are located within a 16-km-wide buffer zone straddling the project alignments across Bass Strait.

7.2.7.2.1 Potential impacts

The following potential impacts on commercial fisheries include:

- Interference with access to commercial fishing grounds by the proposed temporary exclusion zones around the cable lay ship and shore-end construction activities.
- Interference with access to commercial fishing grounds by a temporary anchoring and fishing exclusion zone over the bundled cables while they are initially laid but not yet installed and buried in the soft-sediment seabed.
- Direct impacts on commercial fishery resources (e.g., fish stocks, squid, rock lobster abalone etc.) and resource habitats (e.g., pelagic fishery habitats and demersal fishery habitats)
- Indirect impacts on food sources of commercial fishery resources (e.g., direct impacts on water column macroinvertebrate food resource to fishery targeted pelagic fishes and impacts on benthic macroinvertebrate food resources to fishery targeted benthic and demersal fishes).

7.2.7.2.2 Environmental performance requirements

The proposed EPR for the impacts on commercial fisheries is Table 7-35.

Table 7-35 EPRs for engaging with commercial and recreational fisheries

EPR ID	Environmental performance requirement	Project stage
MERU06	**Develop and implement a marine communication plan.** Prior to commencement of marine construction, develop and implement a marine communication plan that includes: • Identification of relevant stakeholders. • Protocol for notifying the AMSA of the proposed locations, timing and duration of proposed marine construction activities. • The approach for compliance with AMSA Marine Orders Part 30 (Prevention of Collisions), AMSA Marine Orders Part 59 (Offshore Support Vessel Operations) and the convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs). • Protocol for informing the Australian Hydrographic Office of the locations, dates, times and duration of proposed marine construction activities. • A plan to engage with commercial and recreational fisheries on the project activities, schedule, locations and durations. • The approach for using guard vessels to enforce the temporary exclusion zone during cable laying across Bass Strait and at the shore crossings. • The approach for informing recreational users of marine activities, in accordance with the Community and Stakeholder Engagement Plan (EPR S03). This plan must be implemented during construction.	Construction / operation

7.2.7.2.3 Potential mitigation and management measures

MLPL will consult with representatives of the various commercial fishery associations in Victoria and Tasmania to alert them of the project's planned schedule of marine construction activities including their proposed locations, dates, times and expected duration.

The cable lay ship has restricted maneuverability during cable laying, and it will display day signals and lights for a 'hampered' vessel in accordance with AMSA requirements. During bundle cable installation, the subsea HVDC cable may not reach the seabed at deep-water locations until the cable lay ship is several nautical miles away. Commercial fishing vessels are required to keep at least 1 nautical mile away from the cable ship displaying these signals, and fishing vessels should not operate gear within 1.5 km astern of the cable lay ship during cable-laying operation. MLPL will provide fishing vessel owners/skippers with updated information on the location and progress of cable-laying operations as well as cable installation and burial operations, which ensures avoidance is maintained. This will be achieved through the abovementioned MLPL's liaison with commercial fishery or fishing representative bodies.

7.2.7.2.4 Predicted residual impacts

Predicted residual impacts of the project's marine construction activities on commercial fisheries are assess below for:

- Impacts of temporary exclusion zones on commercial fisheries.
- Impacts on commercial fishery areas (habitats) and resources.
- Indirect impacts on food sources of targeted fishery resources.

Impacts of temporary exclusion zones

The cable ship will have an offshore 1-km by 1.5-km moving exclusion zone around the ship including a buffer zone around the cable suspended behind the ship. Two guard vessels will accompany the cable lay ship during cable lay operations, which can be used to either communicate with the skippers of approaching commercial fishing vessels to keep clear of cable laying operations or, in the absence of direct communications, the guard vessels travel towards the approaching fishing vessel and alert them to the presence of the cable lay ship and its approximate 1-km-long trailing cable suspended from the rear of the cable ship.

During cable lay operations, commercial fishing vessels are required to abide by the conditions set by the temporary exclusion zone and not to operate fishing gear astern of the cable lay ship. Approximately 98% of the project's alignment across Bass Strait comprises of soft-seabed sediments comprised of mainly of sands, silty sands, and silts and clays. The main commercial fisheries along this zone include scallop dredging and demersal hook and line and bottom-set longlining targeting gummy sharks and other demersal fish species. Given the great size of these Bass Strait fishing grounds, fishing in alternative areas will be necessary while cable-laying operations are in progress.

Overall, the predicted impacts of temporary exclusion zones on commercial fishing vessel movements are assessed to have a residual impact significance rating of ***Very Low***. This is based on a sensitivity of *Low* due to the capability of commercial fishing vessels to easily manoeuvre around the temporary exclusion zones and to fish alternative fishery areas and a magnitude of impact of *Negligible* given the very small area of the moving exclusion zone around the cable ship and the large expanse of Bass Strait waters unaffected by the temporary exclusion zone.

Impacts on commercial fishery areas (habitats) and resources

The following assessment of residual impacts on commercial fishery resources (i.e., targeted fish and invertebrates) has been based on a generic approach, given that residual impacts on fishes and macroinvertebrates in general have already been assessed. It is not appropriate to assess the very large list of commercial fishery targeted species on an individual basis, since there is an absence of significant construction impacts on fishes and invertebrates in general, which precludes the necessity for a detailed assessment on individual catch species.

Impact on fishes (Section 7.2.3.10.3, Residual impacts to fishes) and their seabed habitats (Section 7.2.2.1.4, Physical impacts of cable installation and burial in soft sediment seabed) and Section 7.2.2.2.1 (Post cable lay installation and burial impacts on offshore soft sediment seabed), (Post cable lay installation and burial impacts on offshore soft sediment seabed) were assessed to have residual impact significance ratings ranging from ***Low*** to ***Very low***, which indicates that residual impacts on the fishes and their habitats targeted by commercial fisheries will also fall within this range.

Overall, the predicted impacts on fish species targeted by commercial fishers are assessed to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *High* due to high value attached to fish stocks by the commercial fishing industry and an impact magnitude of *Negligible* given the absence of any significant direct impacts on fishes (including fishes targeted by commercial fishers) assessed in earlier sections of this report and the large expanses of similar unaffected fish habitats and fishing grounds available in Bass Strait.

Indirect impacts on food sources of targeted commercial fish resources

Impacts on fishes (Section 7.2.3.11, Acoustic impacts to fishes) and their water column or seabed habitats (Section 7.2.2.1.4, Physical impacts of cable installation and burial in soft sediment seabed) and Section 7.2.2.2.1 (Post cable lay installation and burial impacts on offshore soft sediment seabed), (Post cable lay installation and burial impacts on offshore soft sediment seabed) were assessed to have residual impact significance ratings ranging from ***Low*** to ***Very low***. This indicates that residual impacts on the invertebrate food resources (and their habitats) available to fishes targeted by commercial fisheries will also fall within this range.

Overall, the predicted indirect impacts on the invertebrate food resources of targeted fish species are assessed to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *High* due to high value attached to fish stocks by the commercial fishing industry and an impact magnitude of *Negligible* given the absence of any significant indirect impacts on fish food resources and the large expanses of similar unaffected invertebrate fish food resources available to fishes targeted by commercial fisheries in Bass Strait.

7.2.7.3 Impacts on recreational fishing and boating

This section assesses the impacts of the project's proposed marine construction activities of commercial fisheries. Section 6.4.3 (Recreational fishing) describes recreational fishing in nearshore Tasmania at Heybridge and nearshore Victoria in Waratah Bay. Offshore sports fishing also occurs in Bass Strait targeting tuna and other fighting fish species.

7.2.7.3.1 Potential impacts

Potential impacts on recreational fishing include:

- Interference with access to nearshore subtidal recreational fishing areas by the proposed temporary exclusion zones around the cable lay ship when maintaining station in DP mode just offshore and overlying 15 m water depth, as well as shore-end construction activities (cable pulls from the cable lay ship to the nearshore HDD marine exit holes at 10 m water depth).
- Interference with the navigation of recreational boats and the boats of recreational fishers transiting to and from Waratah Bay boat ramps to preferred fishing spots of Cape Liptrap, Shallow Inlet, and Wilsons Promontory, owing to the physical presence of the cable lay ship maintaining position in DP mode within the nearshore environment and the floating of cables to the subtidal HDD marine exit hole at 10 m depth.
- Direct impacts on nearshore fish and macroinvertebrate species targeted by recreational fishers in nearshore Tasmania at Heybridge and nearshore Victoria.

For the purposes of this impact assessment, offshore recreational sports fishing vessels targeting tuna, swordfish , yellowtail kingfish and other pelagic fish species such as mako, thresher, gummy, seven gill and blue sharks are not considered further, given their rare occurrence in nearshore Bass Strait compared to nearshore recreational fishing from the shoreline or small boats, and the fact offshore sports fishing vessels can readily shift to other fishing areas away from the project's cable lay ship undertaking cable lay operations.

7.2.7.3.2 Environmental Performance Requirements

EPRs for this section are outlined in section 7.2.6.2 (Impacts on commercial fisheries).

7.2.7.3.3 Mitigation and management measures

MLPL will contact the Victorian Recreational Fishing Peak Body informing them of the locations, dates, times and duration of the project's proposed nearshore marine construction activities in Waratah Bay. Similarly, for nearshore Tasmania at Heybridge, MLPL will contact representative bodies such as Tasmanian Game Fishing Association, Sport Fishing Club of Tasmania as well as TARFish, which is the independent peak body representing the interests of recreational marine fishers in Tasmania.

There are no specific mitigation and management measures applicable to recreational fishers beyond informing local people of the project's planned scope of works (locations, dates, times and duration) for nearshore construction activities.

7.2.7.3.4 Predicted residual impacts

Predicted residual impacts of the project's marine construction activities on recreational fishing and boating are assess below for:

- Impacts of temporary exclusion zones on shoreline and nearshore recreational fishing.
- Impacts of temporary exclusion zones on navigation and transits of recreational boats and boats used for recreational fishing.
- Impacts of marine construction on fish targeted by recreational fishers.

Impacts of temporary exclusion zones on shoreline and nearshore recreational fishing

Since the project's shore crossings at landfall will be undertaken using long trajectory HDD, no impacts on the beaches or shoreline are envisaged, and no temporary exclusions zones are required. Give the absence of any temporary beach exclusion zones in either Waratah Bay in Victoria or tioxide beach in Tasmania, shore-based recreational fishers will have full access to the beaches. Therefore, no impacts on recreational beach and shoreline fishing are envisaged.

During nearshore cable pull operations, a fleet of small boats will manoeuvre the floated cables towards the HDD marine exit hole at 10 m water depth. A dive boat will be on hand for divers to attach the cable ends to a winch line located the HDD exit hole duct and then insert the cable into the HDD exit hole duct, which will be pulled through the HDD duct to the backshore jointing pits. These nearshore activities require emplacement of a 1-km long by 1-km wide temporary exclusion zone in nearshore Tasmania at Heybridge and a 3.2-km long by 1-km wide temporary exclusion zone in nearshore Waratah Bay, within which recreational fishing from boats will not be allowed.

Overall, the predicted impacts of the nearshore temporary exclusion zones on nearshore recreational boat fishing are assessed to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *Moderate* due to a medium value of recreational fishers attached to nearshore fishing by boat and an impact magnitude of *Negligible* given the availability of adjacent nearshore fishing areas outside the temporary exclusion zones. Recreational fishers that fish nearshore waters by boat will have access to alternative nearshore areas during the short period of nearshore marine construction activities.

Impacts of temporary exclusion zones on boat navigation and transits

The transits of recreational fishing boats along nearshore waters and parallel to the shoreline in both Waratah Bay in Victoria and tioxide beach in Tasmania will be affected by the temporary exclusion zones between the 10 m depth zone and the cable lay ship maintaining position in DP mode at about 15 m water depths. In nearshore Waratah Bay, this will require a seaward transit of 2.3 km to pass around the cable lay ship. However, depending on the state of the tide, transits may be available closer to shore (i.e., shoreward of the 10 m isobath where cables will be inserted into the subtidal HDD marine exit hole ducts) if water depths allow safe transits. Similarly, recreational fishing boats will require a seaward transit of 1 km to pass around the cable lay ship maintaining station in DP mode at about the 15 m water depth.

Overall, the predicted impacts of the nearshore temporary exclusion zones on the transits nearshore recreational fishing boats are assessed to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *Moderate* due to the nuisance of longer transits around the temporary exclusion zones and an impact magnitude of *Low* given that recreational fishing boat transits, albeit longer, can still be undertaken.

Impacts of nearshore construction on fish targeted by recreational fishers

Recreational fishing is undertaken in Victorian and Tasmanian nearshore waters either from the shoreline (e.g., beach and surf fishing) or from small boats used for this purpose in nearshore waters.

Table 6.47 in Section 6.4.3.1 (Recreational fishing in nearshore Victoria) lists the predominant fishes caught by recreational fishers in nearshore central Waratah Bay. Most of the fishes targeted by recreational fishers are associated with sandy seabed and the overlying water column. Similarly, Table 6.49 in Section 6.4.3.2 (Recreational fishing in nearshore Tasmania) lists the predominant fishes caught by recreational fishers at tioxide beach at Heybridge. Many of these fishes are associated with the sandy beach surf zone with some species associated with areas of low- and high-profile rocky reef that lies close to the shore.

Previous sections have assessed the residual impacts of nearshore marine construction activities (e.g., cable installation and burial) on seabed habitats (which includes fish habitats), and underwater noise impacts from nearshore marine construction. Section 7.2.2.1 (Nearshore construction seabed disturbance impacts) and Section 7.2.3.10 (Acoustic impacts to fishes) both assessed residual impact significance ratings of ***Low*** for seabed habitats and acoustic noise impacts to fishes. Therefore, similar residual impact significance ratings anticipated for nearshore construction impacts on fish habitats and fishes targeted by recreational fishers in both Victoria and Tasmania.

Overall, the predicted impacts on nearshore fish species targeted by recreational fishers is assessed to have a residual impact significance rating of ***Low*** based on a sensitivity of *High* due to high value attached to shoreline and nearshore fishes by recreational fishers and an impact magnitude of *Negligible* given the absence of any significant impacts on fish habitats and fishes assessed in earlier sections of this report and the presence of adjacent nearshore areas with similar unaffected fish habitats and fishes available to recreational fishers in Waratah Bay in Victoria and tioxide beach at Heybridge.

7.2.7.4 Impacts on other marine resources or uses

This section considers impacts on other marine resources or marine resource usage such as:

- Marine-based tourism and recreation.
- Marine aspects of Aboriginal cultural heritage.
- Maritime cultural history and shipwrecks.

7.2.7.4.1 Marine-based tourism and recreation

Marine-based tourism and recreation in both nearshore and offshore Bass Strait are primarily associated with recreational fishing and recreational boating for which residual impact assessments are presented above in Section 7.2.6.3 (Impacts on recreational fishing and boating) and are therefore not repeated here. In conclusion, residual impacts on these two activities were assessed to have residual impact significance ratings ranging from ***Low*** to ***Very low***.

Beach recreational activities are not predicted to be affected as the beaches are not required to be closed at the project's landfalls in Waratah Bay or nearshore Tasmania at Heybridge, since the cable shore crossings will be undertaken using long trajectory HDD boreholes with cable ducts.

Other recreational activities include scuba diving, surfing, sea kayaking and wind surfing. Potential impacts on these recreational activities will only occur if they require longshore access, in which case the temporary exclusion zones required during the pull of floated cables from the cable lay ship located offshore at around 15 m water depth will prevent longshore movements of swimmers, surfers and kayaks.

An impact assessment has not been carried out for the other recreational activities as the effects of the temporary exclusion zones are more of a short-term nuisance to the public and without a significant impact. The public will be alerted in advance to the proposed dates, times and duration of the project cable pull operations.

7.2.7.4.2 Defence and military marine resource use

Potential impacts on military and defence marine resource uses are outside the scope of the present report.

7.2.7.4.3 Marine aspects of Aboriginal cultural heritage

Aboriginal cultural heritage is assessed separately in EIS/EES Technical appendix I: Underwater cultural heritage and archaeology and is therefore not addressed here.

7.2.7.4.4 Marine archaeology and shipwrecks

Project impacts on marine archaeology and shipwreck is assessed separately in EIS/EES Technical appendix I: Underwater cultural heritage and archaeology and is therefore not addressed in the section.

7.2.8 Summary of construction impacts

Table 7-36 presents a summary of the residual impact significance ratings along with their sensitivity and magnitude of impact ratings.

Table 7-36 Summary of construction impacts on marine ecology and resource use

Impact or risk assessment descriptor	Sensitivity of value / Likelihood	Magnitude of impact / Consequence	Residual impact / risk significance
HDD marine exit hole breakthrough impacts:			
Nearshore seabed habitats (Tas)	Low	Negligible	Very low
Nearshore seabed habitats (Vic)	Low	Negligible	Very low
Nearshore water quality (Tas)	High	Negligible	Low
Nearshore water quality (Vic)	High	Negligible	Low

Impact or risk assessment descriptor	Sensitivity of value / Likelihood	Magnitude of impact / Consequence	Residual impact / risk significance
Nearshore benthic communities (Tas)	Very low	Negligible	Very low
Nearshore benthic communities (Vic)	High	Negligible	Low
Cable installation and burial impacts:			
Nearshore seabed habitats (Tas)	Very low	Negligible	Very low
Nearshore seabed habitats (Vic)	Very low	Negligible	Very low
Nearshore water quality (Tas)	High	Negligible	Low
Nearshore water quality (Vic)	High	Negligible	Low
Wet jetting remobilisation of dissolved metals (Tas)	High	Negligible	Low
Nearshore sediment quality and arsenic (Tas)	Moderate	Minor	Low
Nearshore sediment quality and nickel (Tas)	Moderate	Minor	Low
Nearshore benthic communities (Tas)	Very low	Negligible	Very low
Nearshore benthic invertebrates and fishes (Vic)	Very low	Negligible	Very low
Nearshore endangered Tasman grass-wrack (Vic)	High	Negligible	Low
Impacts of cable installation on hard seabed and third-party crossings:			
Soft-sediment seabed habitat degradation (Tas)	Very low	Negligible	Very low
Soft-sediment seabed habitat degradation (Vic)	Very low	Negligible	Very low
Third-party crossing water quality impacts (Tas)	High	Negligible	Low
Third-party crossing water quality impacts (Vic)	High	Negligible	Low
Third-party crossing benthic communities (Tas)	Low	Negligible	Very low
Third-party crossing benthic communities (Vic)	Low	Negligible	Very low
Offshore construction disturbance of seabed impacts:			
Offshore seabed habitat impacts	Low	Negligible	Very low
Offshore bottom water quality impacts	High	Negligible	Low
Offshore seabed fauna and infauna	Low	Negligible	Very Low
Offshore seabed benthic with sponge corals patches	Moderate	Negligible	Low
Offshore cable installation on hard seabed and/or third-party crossings:			
Soft-sediment seabed habitat degradation	Low	Negligible	Very low
Third-party crossing water quality impacts	High	Negligible	Low
Soft-sediment seabed benthic fauna	Low	Negligible	Very low
****Underwater noise impacts to marine fauna:***			
LF cetacean disturbance and TTS onset impacts	Low	Moderate	Low
LF cetacean behavioural disturbance impacts	Low	Low to Moderate	Low
LF cetacean communication masking impacts	Low	Low	Low
MF cetacean disturbance and TTS onset impacts	Low	Moderate	Low
MF cetacean behavioural disturbance impacts	Low	Low	Low
MF cetacean communication masking impacts	Low	Low	Low
HF cetacean disturbance and PTS onset impacts	Low	High	Moderate
HF cetacean disturbance and TTS onset impacts	Low	Moderate	Low
HF cetacean behavioural disturbance impacts	Low	Low	Low
HF cetacean communication masking impacts	Low	Low	Low
Phocid disturbance and TTS onset impacts	Low	Moderate	Low
Phocid behavioural disturbance impacts	Low	Moderate	Low
Auditory masking impacts to phocids	Low	Low	Low
Otariid acoustic disturbance and TTS onset impacts	Low	Moderate	Low

Impact or risk assessment descriptor	Sensitivity of value / Likelihood	Magnitude of impact / Consequence	Residual impact / risk significance
Otariid acoustic behavioural impacts	Low	Low	Low
Otariid acoustic masking impacts	Low	Low	Low
Sea turtle acoustic behaviour impacts	Low	Low	Low
Sea turtle acoustic auditory masking impacts	Low	Low	Low
Little penguins acoustic behaviour impacts	Low	Low	Low
Little penguins acoustic masking impacts	Low	Low	Low
Fish acoustic disturbance and TTS onset impacts	Low	Moderate	Low
Group 3 pelagic fish behaviour impacts	Moderate	Low	Low
Group 3 benthic fish behaviour impacts	Moderate	Negligible	Low
Nearshore fish acoustic auditory masking impacts	Low	Moderate	Low
Cephalopods acoustic behaviour impacts	Very low	Negligible	Very low
Nighttime artificial lighting impacts to fauna:			
Nighttime light-sensitive albatrosses	High	Negligible	Low
Nighttime light-sensitive petrels	Low	Negligible	Very low
Nighttime light-sensitive shorebirds	High	Negligible	Low
Nighttime light-sensitive marine birds	High	Negligible	Low
Near-surface pelagic fish behaviour	Moderate	Negligible	Low
Near-surface zooplankton and micronekton migration	High	Negligible	Low
Risks of introducing or spreading Invasive Marine Species (IMS):			
IMS in ballast water discharges	Unlikely	Negligible	Very Low
IMS colonisation of project nearshore hard seabed	Possible	Minor	Low
IMS colonisation of project offshore hard seabed	Unlikely	Negligible	Very Low
Asian date mussel spread in nearshore Tasmania	Unlikely	Negligible	Very Low
NZ screw shell spread in nearshore Tasmania	Unlikely	Moderate	Low
European shore crab spread in nearshore Victoria	Possible	Minor	Low
Risks of project vessel strikes to megafauna:			
Cable lay ship or OSV strike risks to large cetaceans	Rare	Negligible	Very low
Fast-moving vessel strike risks to large cetaceans	Unlikely	Minor	Low
Cable lay ship or OSV strike risks to sea turtles	Rare	Negligible	Very low
Fast-moving transit vessel strike risks to sea turtles	Unlikely	Minor	Low
Construction impacts on marine resource uses:			
Navigation and marine traffic exclusion zone impacts	Low	Negligible	Very low
Temporary exclusion zones and fisheries impacts	Low	Negligible	Very low
Commercial fishery resource direct impacts	High	Negligible	Low
Commercial fisher fish diet indirect impacts	High	Negligible	Low
Recreational fishing temporary exclusion zones	Moderate	Negligible	Low
Recreational fishing boat transit impacts	Moderate	Negligible	Low
Nearshore recreational fishing targeted fish (Tas)	High	Negligible	Low
Nearshore recreational fishing targeted fish (Vic)	High	Negligible	Low

Notes: LF cetacean = Low-frequency hearing cetacean; MF cetacean = Mid-frequency hearing cetacean; HF cetacean = High-frequency hearing cetacean. * Note that the underwater noise impact assessment uses a different Significance Assessment Method (see Section 7.2.3.4.1, Significance assessment method). Cells containing risk criteria for likelihood and consequence have a light blue shade to differentiate them from impact assessment criteria for sensitivity and magnitude.

7.3 Operational impacts

This section assesses the impacts of the project operation. The main impact sources relate to the energised HVDC cables (i.e., when transmitting power), which generate:

- Magnetic fields.
- Induced electric fields.
- Thermal fields.

The prediction of marine biological effects of the abovementioned impact sources are based on a knowledge of:

- Natural background static (DC) total magnetic field of the Earth (i.e., the geomagnetic field).
- Natural background static (DC) and time-varying (AC) electric fields in Bass Strait and produced naturally by marine organisms.
- Predicted HVDC cable-generated magnetic fields.
- Predicted induced electric fields generated by seawater (ionic) flow through the geomagnetic field and the HVDC cables' magnetic field.
- Bottom-water seabed interface temperature ranges.
- Magnetosensitive marine species present in Bass Strait.
- Electrosensitive marine species present in Bass Strait.
- Marine species susceptible to thermal heat generation.

Jacobs (2023; EIS/EES Technical appendix A) undertook desktop assessments of the electric and magnetic fields (EMF) and electromagnetic interference (EMI) associated with operation of the HVDC link. The key components of the HVDC link are the 750 MW, ±320 kV subsea e circuits, a 220 kV converter station at Heybridge (Tasmania) and a 500 kV converter station at either Driffield or Hazelwood (Victoria). This report assesses the impacts of magnetic fields, induced electric fields, and thermals field on marine fauna.

Other operations impacts associated with underwater noise generated by project vessels such as periodic cable inspection surveys and for remedial works are considered minor in comparison to the large number of ships and vessels that operate in Bass Strait. The acoustic impacts of project vessels during construction are assessed in Section 7.2.3 (Underwater noise impacts) and are considered the primary vessel noise impact sources. Noise from the few vessels deployed during project operations are therefore not assessed.

7.3.1 Magnetic field impacts

This section assesses the potential impacts of HVDC cable-generated magnetic fields, identified mitigation and management measures, and assesses residual impacts on marine ecology and marine resource use after mitigation and management measures have been implemented.

7.3.1.1 Background information

7.3.1.1.1 Measurement units

The magnitude of the magnetic field is usually expressed as magnetic flux density (hereafter referred to as the magnetic field) in units of gauss (G) or tesla (T). Magnetic fields are normally quantified in terms of the magnetic flux density, magnetic induction, or magnetic field strength.

Given the lower anticipated levels of magnetic fields addressed in the present report, the following units and subunits are also referenced:

- Tesla (T): The international (SI) unit of measurement 1 Tesla = 1,000,000 µT.
- Millitesla (mT): typical values used in experiments with marine fauna exposed to artificial magnetic fields.
- Microtesla (µT): Earth's magnetic field in Bass Strait (e.g., range of 60.3 to 61.2 µT).
- Nanotesla (nT): relating to the thresholds of highly magnetosensitive marine fauna.

The magnetic field units are interconvertible; for example, 1 Tesla = 1,000,000 µT or 1 Weber/m^2 and 1 µT = 1,000 nT = 10 mG = 0.01 Oe = 0.798 A/m. In the USA, magnetic fields are commonly expressed in units of gauss, whereas Australia and the rest of the world use the Tesla as the base unit.

7.3.1.1.2 The Earth's natural magnetic field (geomagnetic field)

Measurement of the background magnetic field allows the impact from the project's energised HVDC cables to be placed in the context of natural magnetic fields.

The Earth's natural magnetic field (or geomagnetic field) is a combination of several magnetic fields generated by various sources, which are superimposed and interact with each other. There are three major sources of the geomagnetic: the main (or core) field that is generated internally by electrical currents in the liquid outer core, the crustal (or lithospheric) field that results from magnetised materials in the outer layer of the Earth, and the external fields produced by currents in the ionosphere and the magnetosphere.

More than 90% of the Earth's total magnetic field measured is generated internally as the main field. The remaining 10% of the main field arises from the differential flow of ions and electrons inside the planet's magnetosphere and in the ionosphere. These external currents vary on a much shorter time scale than the internal main field, which varies slowly in time and is relatively stable.

The geomagnetic field does not vary greatly in the short term but does vary from century to century by about six percent (Gill et al., 2014). The sea or ocean itself is non-magnetic so has no effect on the prevailing geomagnetic field; however, as sea or ocean currents move through the Earth's static DC magnetic field, induced DC electric fields are generated.

Components of the geomagnetic field

The Earth's main magnetic field (or geomagnetic field) is a vector quantity that can be considered to have three components: a) an inclination, b) a declination, and c) an intensity (or magnitude or strength).

The inclination component represents magnetic field lines that emerge from the planet forming an angle to the Earth's surface with latitude. For example, this vector points vertically towards the sky at the south pole (−90°), runs parallel to the surface at the magnetic equator (0°), and enters the Earth at 64° 19' in Paris (Nordmann et al., 2017). In contrast, the declination refers to the angle of magnetic field lines with respect to true geographic north, which reflects the direction of a compass needle point.

The intensity of the Earth's magnetic field represents the density of magnetic field lines, which is measured in Tesla and ranges from 25,000 to 65,000 nT. In addition, magnetic field intensity is influenced by the distribution of ferromagnetic materials in the Earth's crust, and therefore can be shown as a topographic map of magnetic intensities.

Since the magnetic fields are vectors, they can be summed. For example, two vectors pointing in the same direction can be summed whilst two vectors pointing in opposite direction can be subtracted from each other.

Figure 7.12 shows the components of Earth's magnetic field in the Southern Hemisphere.

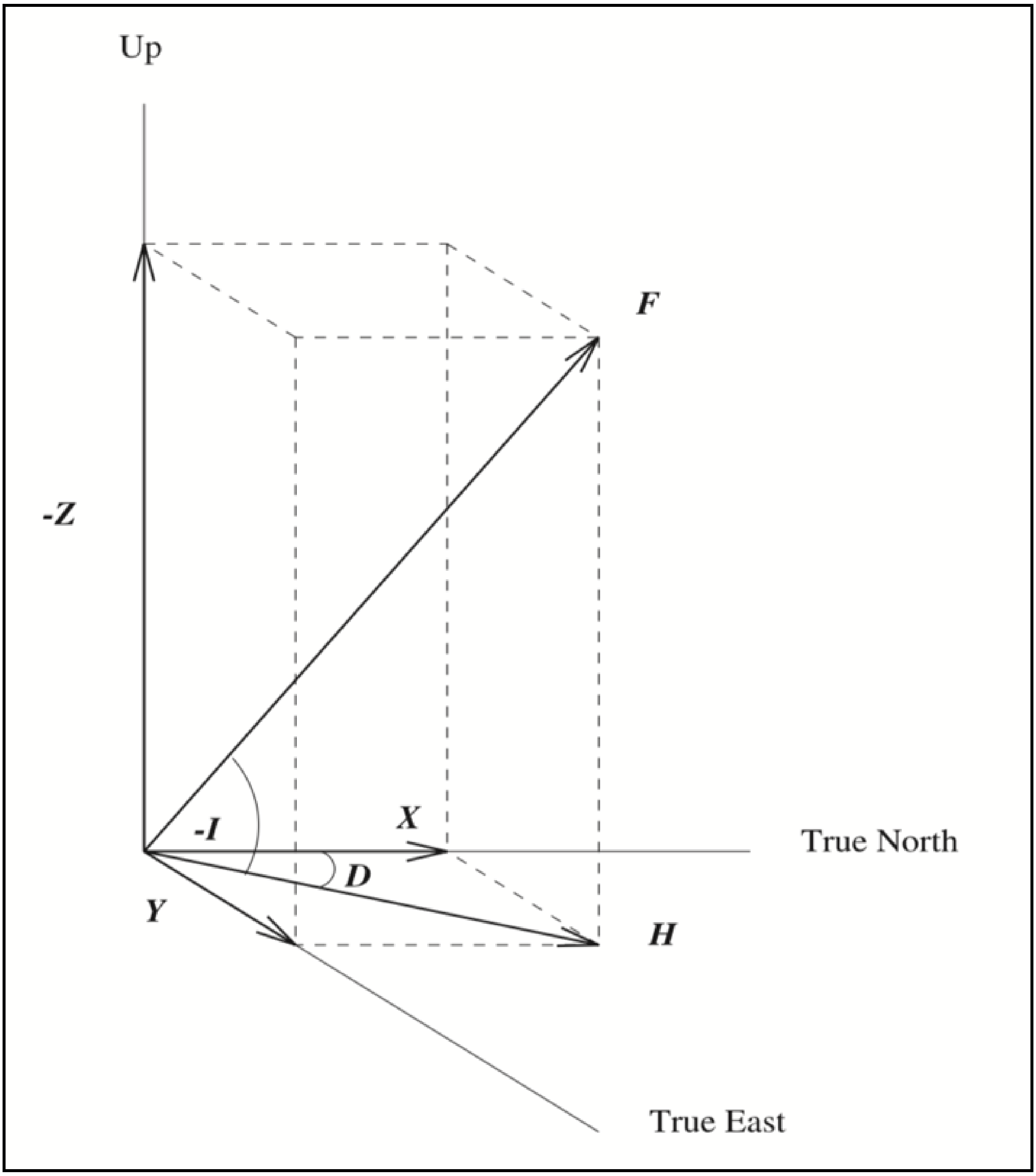
Ionospheric magnetic fields

The second largest magnetic source in the environment is generated by solar wind, which is a stream of energetic particles ejected by the sun. The flux of the particles hits the upper atmosphere and creates ions, which form electric currents in the ionosphere that give rise to magnetic field fluctuations at the Earth's land or sea surface, where the magnetic field has a strength of between 1 and 10 nT on a solar quiet day. However, after a solar eruption, the solar wind is stronger and can give rise to magnetic storms where the magnetic fields at the Earth's surface can be several hundred nanoteslas, which is around two orders of magnitude less than the geomagnetic field (Gill et al., 2014).

Bass Strait magnetic anomalies

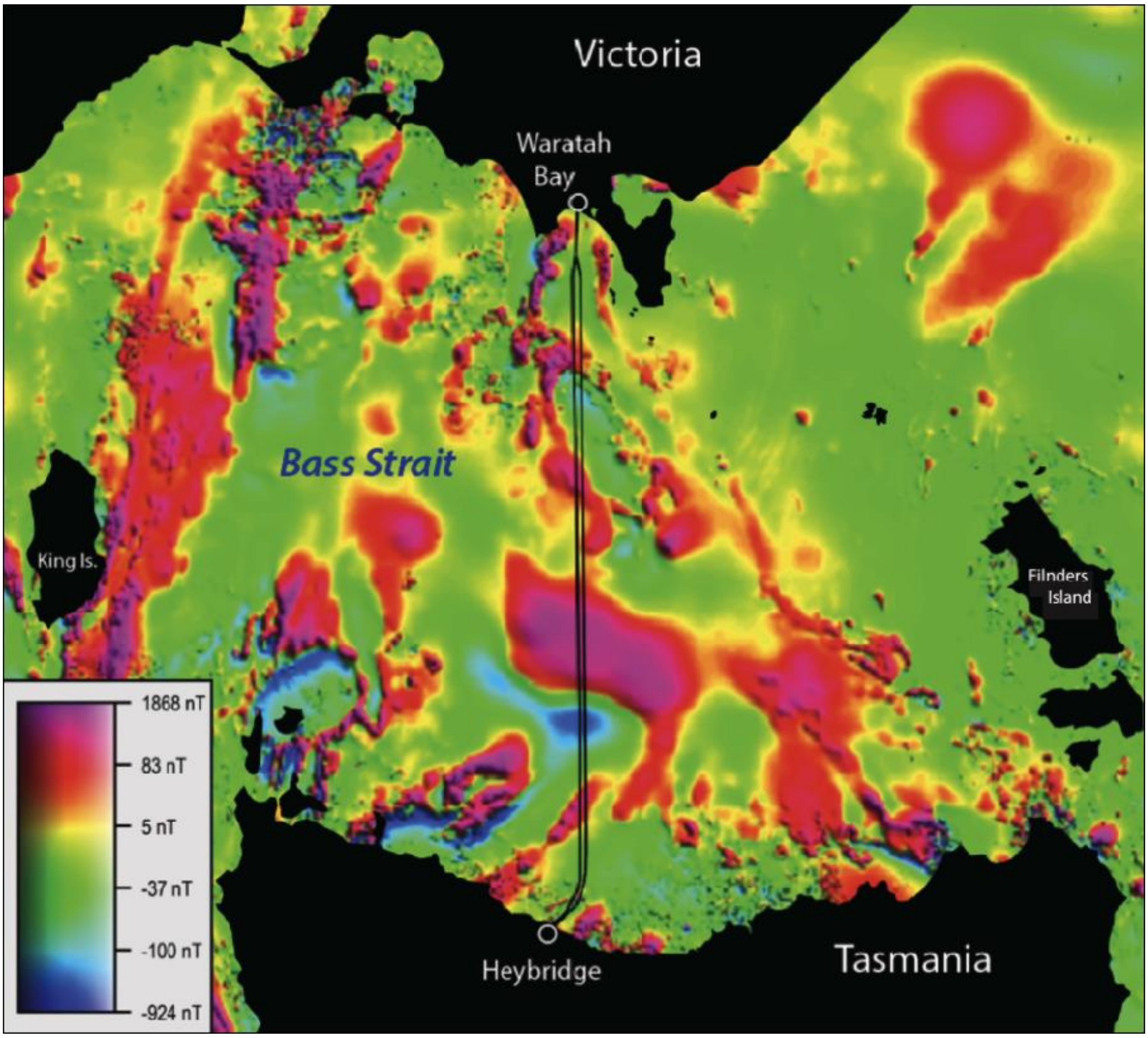
Figure 7.13 shows a magnetic anomaly map of Bass Strait, which shows large scale magnetic anomalies produced by deep (10 km and deeper) geological features (Morse et al., 2009). In general, magnetic anomalies are defined as the vector or scalar difference between the measured magnetic field and an estimate of the main field and are commonly assumed to reflect the magnetic properties of rocks lying in the Earth's crust (Thébault, 2014).

In general, magnetic anomalies are caused by differences in the magnetisation of the rocks in the Earth's crust. In particular, the iron-rich, volcanic rocks that makes up the seabed within Bass Strait, contain significant concentrations of magnetite that results in higher field levels near the seabed (Jacobs, 2023; EIS/EES Technical appendix A).



Source: Hitchman et al (2000). Components are the total field (F), horizontal component (H), vertical component (Z), north component (X), east component (Y), declination(D), and inclination (I). The orientation of the vertical component, which results in both Z and I having negative values, describes the magnetic field direction in the Southern Hemisphere.

Figure 7.12: Components of the Earth's magnetic field in the Southern Hemisphere



Source: Jacobs (2023) and Nakamura and Milligan (2015).

Figure 7.13: Magnetic anomaly map of Bass Strait

Jacobs (2023; EIS/EES Technical appendix A) concluded that the steady-state geomagnetic field along the subsea project alignment is approximately 60 +1.8/-0.9 μT (or 60,000 +1,800/-900 nT).

Local geomagnetic field in Bass Strait

Table 7-37 shows variation of the total geomagnetic field and its components across Bass Strait at three locations along the centre line of the proposed project alignment from Heybridge to Waratah Bay.

Table 7-37: Geomagnetic field component along the proposed project in Bass Strait

Component	Tasmanian Landfall	Mid-Bass Strait	Victorian landfall
Total field	61,334.83 nT	60,825.58 nT	60,281.09 nT
Horizontal component	19,685.11 nT	20,428.78 nT	21,203.14 nT
North component	19,139.42 nT	19,897.79 nT	20,694.39 nT
East component	4,602.87 nT	4,624.37 nT	4,616.83 nT
Vertical component	-58,090.09 nT	-57,292.62 nT	-56,429.05 nT
Declination	13.52°	13.08°	12.58°
Inclination	-71.28°	-70.38°	-69.41°

Source: International Geomagnetic Reference Field (NOAA, 2023).

In Table 7-37, the geomagnetic field within Bass Strait varies from 61,334.83 nT at the Tasmanian landfall near Heybridge to 60,281.09 nT at the Victorian landfall in Waratah Bay, which is a difference of 1,053.74 nT and represents an average change of 4.2 nT/km from south to north over the project's proposed 255-km long interconnector alignment across Bass Strait.

The natural geomagnetic field varies slowly in time and can be described by mathematical models such as the International Geomagnetic Reference Field (IGRF) and World Magnetic Model (WMM). The natural geomagnetic field changes and has historically experienced several pole reversals. In recent years, the total field is changing at a rate of zero to 120 nT/year depending on geographic location (British Geological Survey, 2018). However, in relation to magnetosensitive marine fauna, the geomagnetic remains relatively constant over ecological time (Albert et al., 2020).

7.3.1.2 Project-generated magnetic fields

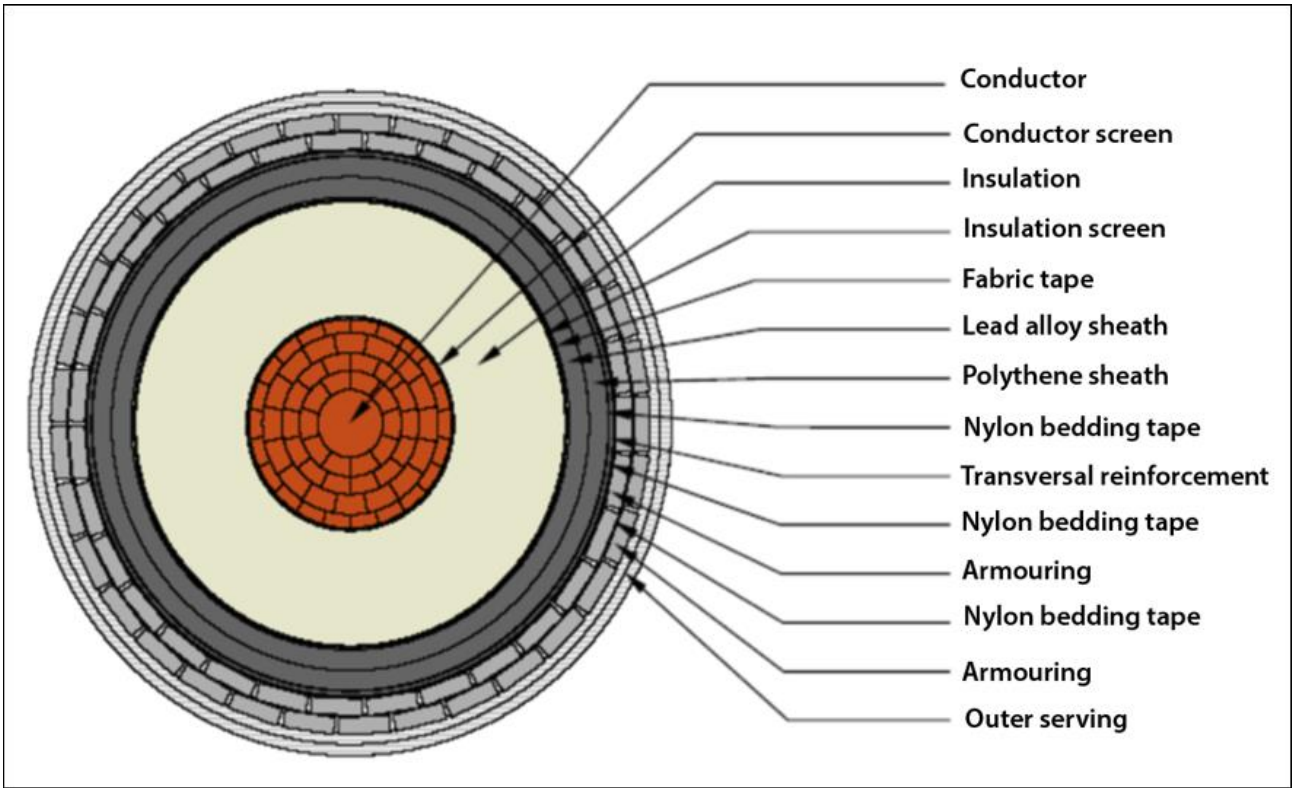
Magnetic fields are primarily generated during the operations phase when the project's proposed HVDC cables are energised (i.e., during power transmission). Very weak magnetic fields are also present when the HVDC cables are not energised, owing to the geomagnetic field interacting with the copper conductors and steel armouring in the HVDC cables. These very weak magnetic fields may be present during project construction and decommissioning after the HVDC cables are initially laid and prior to removal, respectively. Only project operation is considered in this report, as larger magnetic fields are generated during power transmission.

At this juncture, the final technical detail and specification of the extruded XLPE HVDC cables have not been finalised. Therefore, Jacobs (2023; EIS/EES Technical appendix A) made the following assumptions:

- HVDC cable modelled parameters:
  - The proposed Marinus HVDC link is proposed to operate as a symmetrical monopole arrangement with each circuit capable of transferring 750 MW across Bass Strait. The general arrangement is illustrated in Figure 1.1 (Section 1.2, Project overview).
  - The nominal voltage is presently proposed to be ±320 kV with a continuous rated current of 1,250 A.
  - A cross section of the type of typical subsea extruded XLPE HVDC cable in symmetrical monopoles is shown in Figure 7.14.
  - Each circuit will comprise a positive (sending), negative (return) and an optical fibre cable, which will be bundled for the main Bass Strait crossing but be separate in nearshore waters where the cables will be laid or buried separately in advance of the landfall (shore crossing).
  - It is assumed that the cable sheaths will be bonded to earth at both the Heybridge and Driffield converter stations.
- The geometry of the bundled cables geometry across Bass Strait is yet to be confirmed but will either be a horizontal flat or vertical stacked geometry. Figure 4.4 in Section 4.2.2.3 (Offshore cable lay, installation and burial) shows the horizontal flat version which, when turned through 90° represents the vertical stacked geometry.
- During cable lay operations twisting of the bundled cable may occur, which would cause variations in the localised magnetic field along the bundled cables.

The HVDC subsea cables have been modelled as 1,000 MW-rated ABB submarine cables, comprising a 2,500 mm^2 stranded copper core with an extruded lead alloy metallic sheath, and an overall nominal diameter of 135 mm.

Figure 7.14 shows a cross section of the type of subsea extruded XLPE HVDC cable that is typically used in symmetrical monopole configurations.



Source: Europecable (2012).

Figure 7.14: Cross section of typical extruded XLPE HVDC cable

The project will have a parallel symmetric monopole configuration, with each monopole comprising a bundled pair of 750 MW HVDC cables and an optic fibre cable. The first monopole is proposed to be installed in 2024 and the second monopole is proposed to be installed four years' later in 2028, if the project is approved and proceeds. For about 95% of the subsea alignment of the project, the two monopoles will be approximately 2-km apart; therefore, there will be no combination or interaction of their separate magnetic fields during operations.

Jacobs (2022; Attachment H and 2023; EIS Appendix A) undertook EMF modelling for both bundled HVDC cables (Section 7.3.1.2.1) and individually buried HVDC cables (Section 7.3.1.2.2). The individually buried HVDC cables occur within an approximate 100 m by 100 m transition zone where the cables separate from the bundled cable configuration to enter their respective HDD marine exit ducts, and thence underground to the land-based sea cable-land cable jointing pit.

7.3.1.2.1 EMF modelling scenarios for bundled cables

Jacobs (2022; Attachment H) used the following modelling locations and scenarios.

Modelling locations

The modelling locations are shown in and are briefly described below:

- **Modelling Location 1**: Nearshore Victoria (30 m water depth):
  - Total magnetic intensity for the buried HVDC cable bundle in nearshore Victoria is within Waratah Bay with the coordinates 146.091° E and -38.941° S, which has an approximate water depth of 30 m and a background geomagnetic field strength of 60.35 µT (Jacobs, 2022; Attachment H).

- **Modelling Location 2**: Offshore central Bass Strait (70 m water depth):
  - Total magnetic field predictions for the subsea HVDC cable bundle in central Bass Strait at a mid-point location with coordinates of 146.093° E and -39.946° S, which has an approximate water depth of 70 m and a background geomagnetic field strength of 60.87 µT (Jacobs, 2022; Attachment H).
- **Modelling Location 3**: Nearshore Tasmania (15 m water depth):
  - Total magnetic field predictions for the subsea HVDC cable bundle in nearshore Tasmania off Heybridge with coordinates of 145.9871° E and -41.062° S, which has an approximate water depth of 15 m and a background geomagnetic field strength of 61.39 µT (Jacobs, 2022; Attachment H).

Figure 7.15: Modelling locations for magnetic field calculations

Modelling scenarios

The calculations for modelling locations 1, 2, and 3 are presented as appendices within Jacobs (2022; Attachment H).

The calculations for modelling locations 1 (nearshore Victoria) and 3 (nearshore Tasmania) include:

- Four operating scenarios:
  - One circuit (ML1) in operation at half power (375 MW).
  - Both circuits in operation at half power (375 MW).
  - One circuit (ML1) in operation at full power (750 MW).
  - Both circuits in operation at full power (750 MW).
- For each operating scenario, three plots are produced:
  - Graphical representation of the calculated magnetic flux density at different heights above the sea floor for ML1.
  - Graphical representation of the calculated magnetic flux density at the sea floor for ML1 and ML2.
  - Tabular representation of the calculated magnetic flux density levels at different heights above the sea floor for ML1. The magnetic flux density levels are presented in a table at various horizonal and vertical distances from the cable.

The calculations for modelling location Point 2 (central Bass Strait) include:

- Two operating scenarios:
  - One circuit (ML1) in operation at full power (750 MW).
  - Both circuits in operation at full power (750 MW).

- For each operating scenario, three plots are produced:
  - Graphical representation of the calculated magnetic flux density levels at different heights above the sea floor for ML1
  - Graphical representation of the calculated magnetic flux density levels at the sea floor for ML1 and ML2
  - Tabular representation of the calculated magnetic flux density at different heights above the sea floor level for ML1. The magnetic flux density levels are presented in a table at various horizonal and vertical distances from the cable.

Adopted scenarios for magnetic field impact assessment

It is not considered necessary or required to assess the predicted magnetic fields for all the above scenarios under the two power transmission scenarios of full power (750 MW) or half-power transmission (375 MW). Therefore, only those calculations for full power transmission with both circuits (i.e., the western monopole (ML1) and eastern monopole (ML2)) in operation have been selected for impact assessments. Should the residual impacts be insignificant, then impact assessments for the half-power transmission (375 MW) or with one circuit in operation are not required.

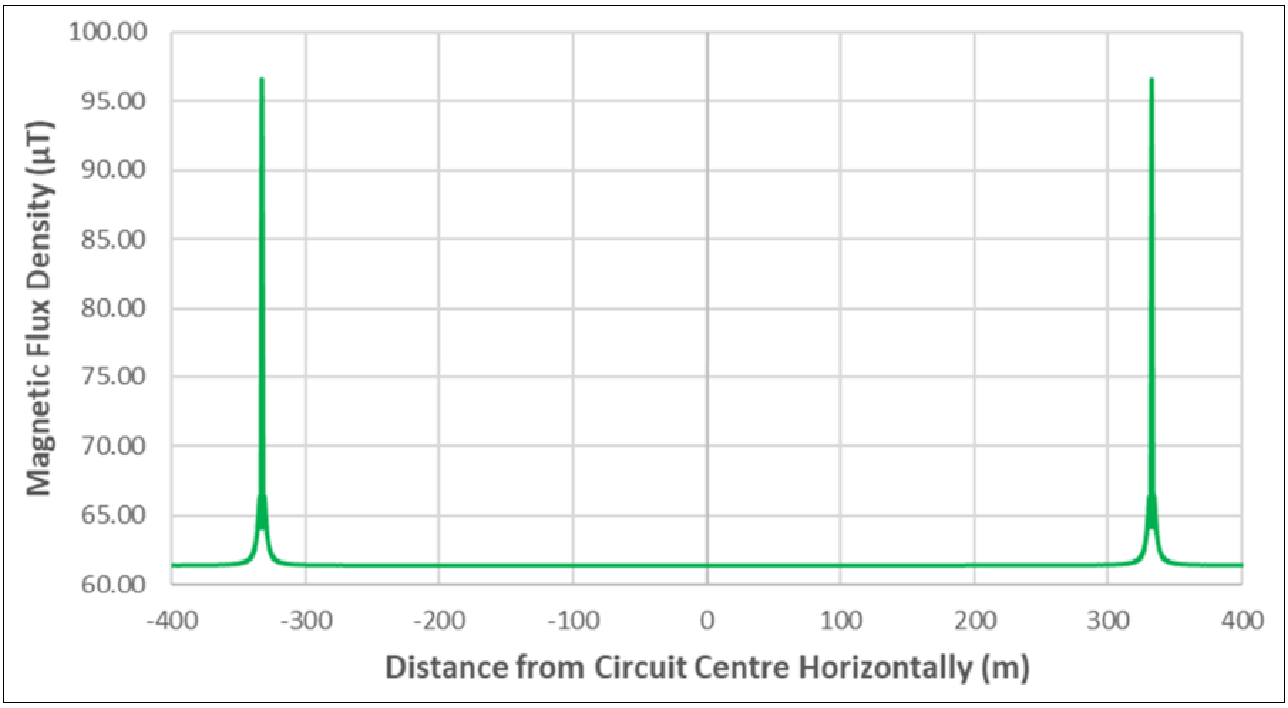
For the purposes of assessing the project's magnetic field impacts on marine fauna the following worst-case scenarios have been adopted:

- Modelling Location 1 (Nearshore Victoria):
  - Both circuits in operation at full power (750 MW).
- Modelling Location 2 (mid-point of Bass Strait):
  - Both circuits in operation at full power (750 MW).
- Modelling Location 3 (Nearshore Tasmania):
  - Both circuits in operation at full power (750 MW).

Note that in Jacobs, 2022 (Attachment H), the modelling locations start with nearshore Victoria (Modelling Location 1). This is the reverse order to the present report, which generally addresses nearshore Tasmania first (i.e., Modelling Location 3).

Total magnetic field predictions for nearshore Tasmania

Figure 7.16 shows the total flux densities for the two monopoles with each operating at full power (750 MW) in nearshore Tasmania (Modelling Location 3) and Table 7-38 gives the calculated combined cable and geomagnetic field strengths (i.e., the resultant magnetic field).



Source: Jacobs (2022, Attachment H).

Figure 7.16: Predicted resultant magnetic fields in nearshore Tasmania

In Figure 7.16, the distance between the two monopoles at Model Location 3 (nearshore Tasmania) is approximately 625 m apart. At this location, the resultant total magnetic density flux is 96.59 µT compared to the geomagnetic background value of 61.39 µT used by Jacobs (2023; EIS/EES Technical appendix A).

Table 7-38: Calculated resultant magnetic fields for nearshore Tasmania

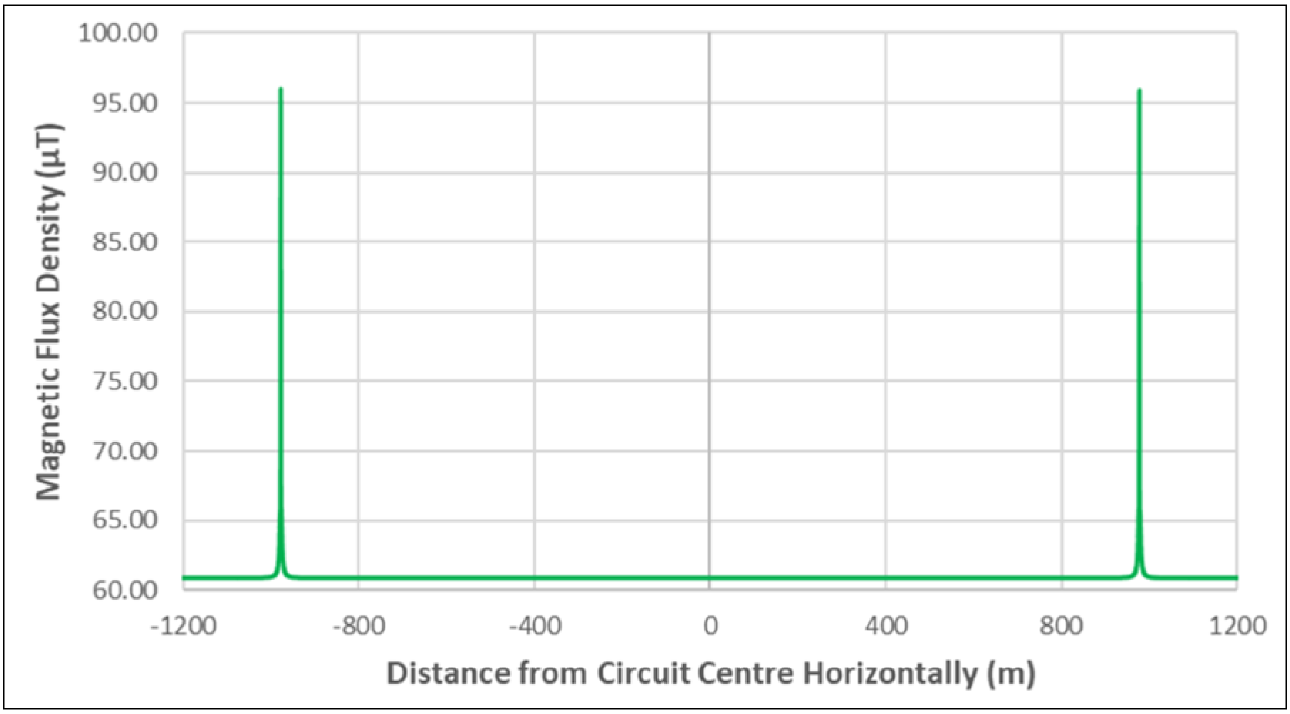
Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	61.39209	61.39473	61.40557	61.48520	61.77758	62.86292	96.59023	62.88771	61.77839	61.48818	61.40428	61.39253	61.39265
1	61.39222	61.39445	61.40727	61.49552	61.80185	62.37636	70.74902	62.42383	61.80213	61.49405	61.40589	61.39205	61.39269
2	61.39212	61.39452	61.40796	61.49476	61.74325	61.92556	65.63535	61.92294	61.74784	61.49526	61.40650	61.39209	61.39276
5	61.39205	61.39485	61.40862	61.47340	61.52569	61.53762	62.47328	61.54263	61.52493	61.47511	61.40768	61.39219	61.39277
10	61.39207	61.39503	61.40366	61.42882	61.41452	61.56985	61.71562	61.57072	61.41520	61.42846	61.40378	61.39221	61.39290
15	61.39203	61.39486	61.40141	61.40112	61.44416	61.50742	61.54465	61.50768	61.44446	61.40103	61.40101	61.39201	61.39291
20	61.39201	61.39460	61.39907	61.39447	61.43905	61.46724	61.48026	61.46733	61.43916	61.39457	61.39863	61.39178	61.39292
40	61.39190	61.39306	61.39117	61.40220	61.41049	61.41320	61.41418	61.41320	61.41062	61.40225	61.39070	61.39032	61.39296
60	61.39174	61.39177	61.39180	61.39836	61.40050	61.40108	61.40128	61.40107	61.40050	61.39840	61.39229	61.39089	61.39301
80	61.39153	61.39091	61.39260	61.39571	61.39642	61.39662	61.39667	61.39660	61.39642	61.39575	61.39308	61.39174	61.39306

Source: Jacobs (2022; Attachment H).

In Table 7-38, the maximum resultant total magnetic field at the seabed is 96.59 µT, which represents an incremental increase of 35.20 µT over the background geomagnetic field of 61.39 µT and reduces to an increment of 0.15 µT (150 nT) at the sea surface, which is 15 m above the seabed at Modelling Location 3. Total magnetic flux densities greater than 20 to 80 m in Table 7.25 can be ignored, since they exceed the water depth of 15 m.

Magnetic field predictions for offshore Bass Strait

Figure 7.17 shows the total magnetic flux densities for the two monopoles, each operating at full power (750 MW) and Table 7-39 gives the calculated combined cable and geomagnetic field strengths (i.e., the resultant magnetic field) for Location 2 in central Bass Strait.



Source: Jacobs (2022; Attachment H).

Figure 7.17 Predicted resultant magnetic fields for offshore Bass Strait

In Figure 7.17, the distance between the two monopoles at Modelling Location 2 (offshore Bass Strait at mid-point of the project alignment) is approximately 2 km apart. At this location, the highest total magnetic density flux at the seabed is 95.95 µT compared to the geomagnetic background value of 60.87 µT as used by Jacobs (2023; EIS/EES Technical appendix A).

Table 7-39: Calculated resultant magnetic fields for offshore Bass Strait

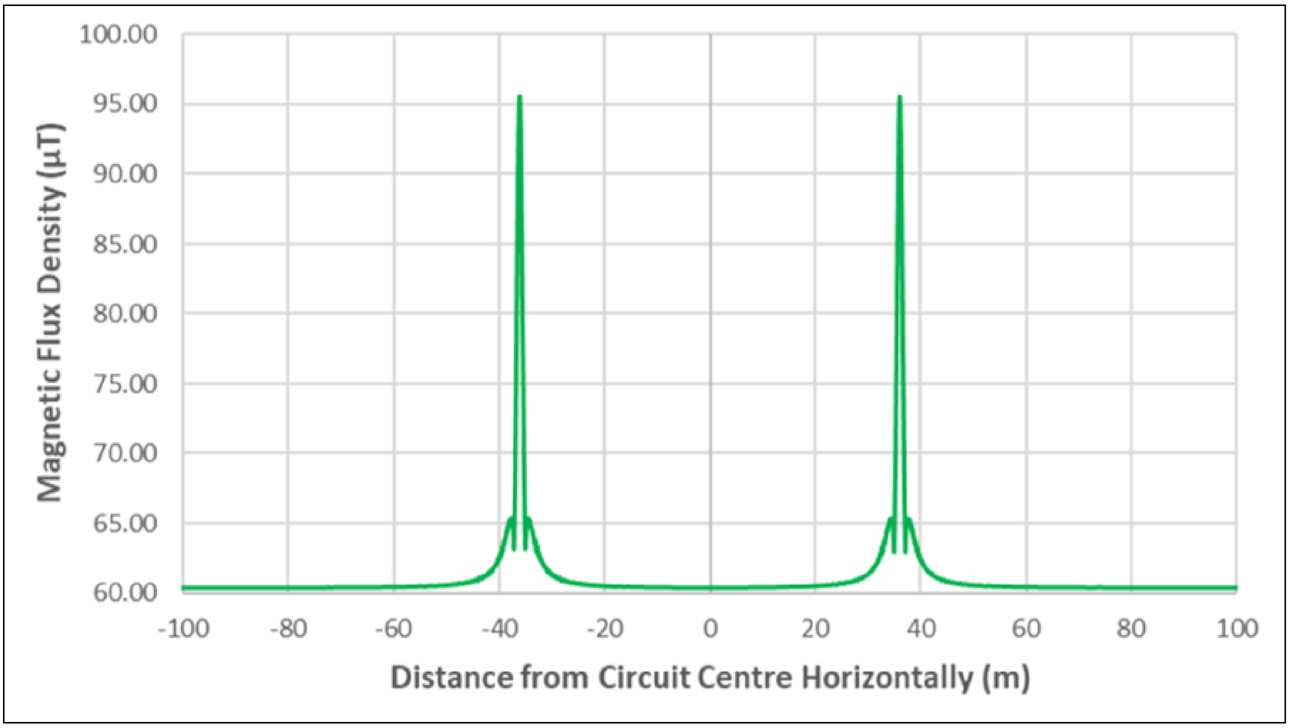
Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	60.87095	60.87373	60.88563	60.96189	61.27240	62.29185	95.94741	62.29691	61.25921	60.96311	60.88574	60.87397	60.87078
1	60.87094	60.87435	60.88876	60.97739	61.23039	61.78165	70.21759	61.78910	61.28614	60.97584	60.88866	60.87430	60.87104
2	60.87104	60.87421	60.88844	60.96447	61.12388	61.41767	65.11217	61.41342	61.15010	60.97118	60.88831	60.87430	60.87102
5	60.87118	60.87457	60.88429	60.93492	61.00822	60.99932	61.95246	61.00975	61.00649	60.93393	60.88464	60.87478	60.87123
10	60.87100	60.87344	60.88211	60.90794	60.88845	61.04594	61.19511	61.04809	60.89054	60.90851	60.88204	60.87343	60.87101
15	60.87097	60.87330	60.88067	60.88406	60.92096	60.98583	61.02408	60.98642	60.92226	60.88387	60.88056	60.87332	60.87092
20	60.87093	60.87320	60.87910	60.87169	60.91751	60.94617	60.95971	60.94645	60.91778	60.87192	60.87903	60.87313	60.87094
40	60.87087	60.87219	60.87206	60.88141	60.88978	60.89265	60.89367	60.89268	60.88983	60.88148	60.87200	60.87220	60.87091
60	60.87077	60.87125	60.87122	60.87765	60.87983	60.88045	60.88066	60.88046	60.87985	60.87763	60.87115	60.87124	60.87083
80	60.87062	60.87048	60.87209	60.87505	60.87576	60.87599	60.87605	60.87599	60.87578	60.87503	60.87202	60.87045	60.87068

Source: Jacobs (2022; Attachment H).

In Table 7-39, the maximum resultant total magnetic field intensity at the seabed is 95.95 µT, which represents an incremental increase of 35.08 µT over the background geomagnetic field of 60.87 µT and reduces to an increment of 0.01 µT (10 nT) at the sea surface, which is 70 m above the seabed at Modelling Location 2 in offshore central Bass Strait. Total magnetic field intensities for water depth of 80 m in Table 7-39) can be ignored since they exceed the water depth of 70 m at Modelling Location 2.

Total magnetic field predictions for nearshore Victoria

Figure 7.18 shows the total flux densities for the two monopoles, each operating at full power (750 MW) and Table 7-40 gives the calculated combined cable and geomagnetic field strength (i.e., the resultant magnetic field).



Source: Jacobs (2022; Attachment H).

Figure 7.18: Predicted resultant magnetic fields for nearshore Victoria

In Figure 7.18, the distance between the two monopoles at Modelling Location 1 (nearshore Victoria) is approximately 75 m apart. At this location, the highest total magnetic density flux is 95.58 µT at the seabed compared to the geomagnetic background value of 60.35 µT used by Jacobs (2023; EIS/EES Technical appendix A).

Table 7-40: Calculated resultant magnetic fields for nearshore Victoria

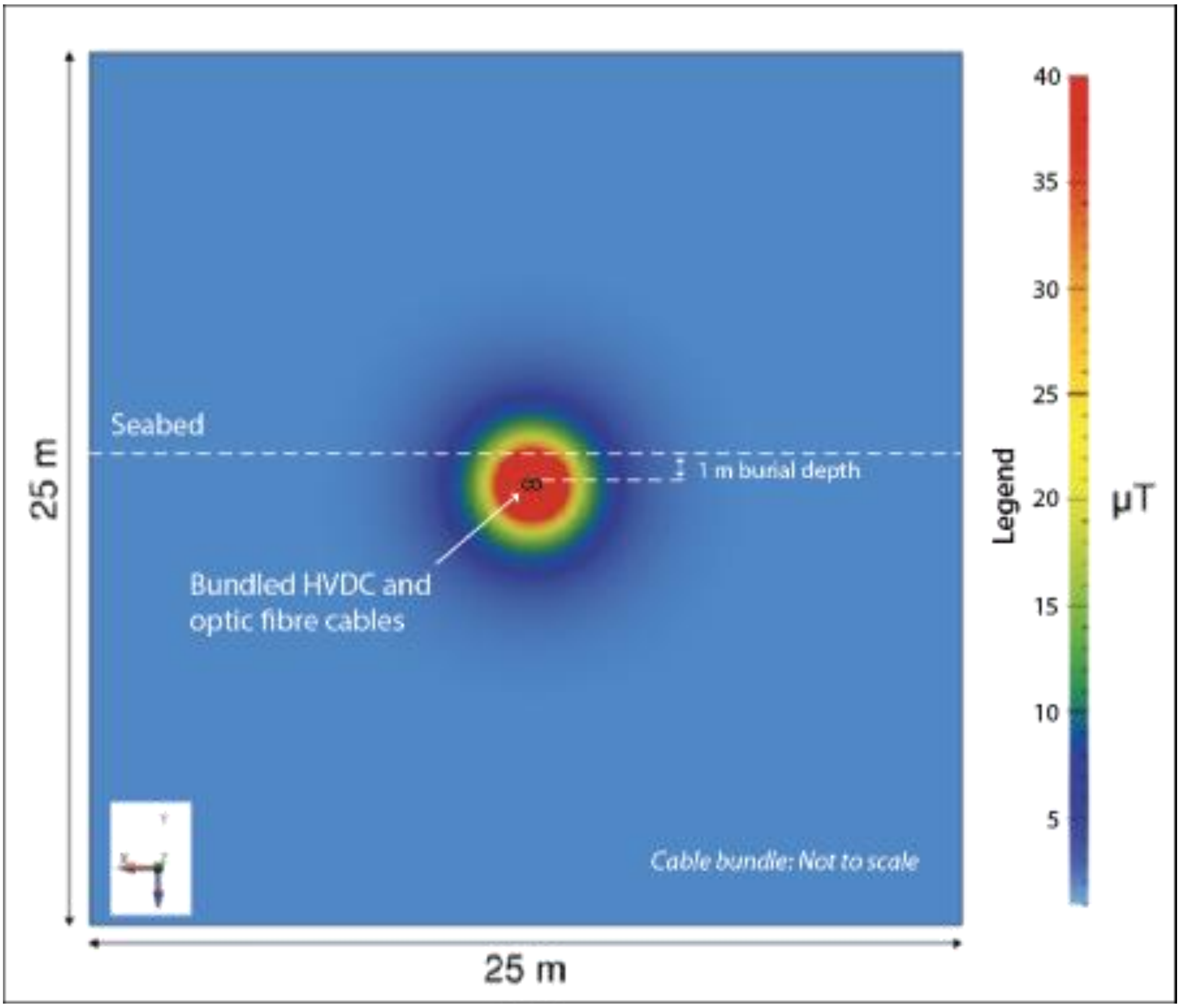
Height Above Seabed	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	60.35044	60.35249	60.36355	60.44028	60.73673	61.73892	95.58289	61.73722	60.72598	60.43010	60.41442	60.39908	60.35181
1	60.35039	60.35255	60.36514	60.44479	60.74509	61.26423	69.71876	61.25618	60.72889	60.44028	60.42093	60.39267	60.35125
2	60.35043	60.35285	60.36480	60.44156	60.64293	60.88152	64.60346	60.88674	60.62948	60.43574	60.42046	60.39311	60.35120
5	60.35046	60.35317	60.36188	60.41631	60.47881	60.49314	61.44081	60.49496	60.47370	60.40209	60.39415	60.39171	60.35126
10	60.35033	60.35236	60.36012	60.38459	60.37406	60.53498	60.68267	60.53520	60.37960	60.37569	60.37654	60.37886	60.35145
15	60.35033	60.35215	60.35863	60.35938	60.40551	60.47230	60.51142	60.47262	60.41005	60.35184	60.35531	60.36662	60.35138
20	60.35032	60.35203	60.35681	60.35633	60.40151	60.43167	60.44635	60.43223	60.40489	60.36169	60.35689	60.35594	60.35133
40	60.35029	60.35110	60.35002	60.36393	60.37254	60.37552	60.37645	60.37553	60.37243	60.36362	60.36229	60.35871	60.35104
60	60.35028	60.35032	60.35253	60.35897	60.36098	60.36139	60.36136	60.36086	60.35992	60.35659	60.35606	60.35713	60.35058
80	60.35017	60.35020	60.35282	60.35535	60.35582	60.35581	60.35563	60.35529	60.35468	60.35324	60.35281	60.35474	60.35009

Source: Jacobs (2022; Attachment H).

In Table 7-40, the maximum resultant total magnetic field intensity at the seabed is 95.58 µT, which represents an incremental increase of 35.23 µT over the background geomagnetic field of 60.35 µT, and reduces to an increment of 0.05 µT (50 nT) at the sea surface, which is 30 m above the seabed at Modelling Location 1 in nearshore Victoria. Total magnetic field intensities for water depths greater than 30 m water depth (i.e., 40 to 60 m) in Table 7-40 can be ignored, since they exceed the water depth of 30 m.

Calculated magnetic flux density around bundled HVDC cables

As an example of magnetic flux density surround the projects' ML1 and ML2 bundled HVDC cables, Figure 7.19 shows an example of the calculated magnetic flux density for the ML1 monopole operating at full power (750 MW) at Modelling Location 2 (mid-point in Bass Strait).



Source: Jacobs (2022; Attachment H).

Figure 7.19: Cross section of magnetic flux density around buried ML1 monopole at 750 MW

In Figure 7.19, the plot does not include the contribution of the background geomagnetic field, which is 60.87 µT at Modelling Location 2 in in central Bass Strait (Jacobs, 2022; Attachment H).

7.3.1.2.2 EMF modelling scenarios of separately buried individual HVDC cables

The bundled cables in both nearshore Victorian and Tasmania transition into separate individual cables as they feed into the subsea HDD duct exit holes. In both nearshore zones, this represents an approximate transition distance of 100 m and within which the cables will be separated by a maximum distance of 50 m. The magnetic fields generated by the separate individual HVDC cables will be higher than that of the bundled HVDC cables, since the magnetic fields of the bundled HVDC cables largely cancel each other due to the electric currents flowing in opposite directions within the bundled HVDC cables (i.e., the positive and negative circuits).

EMF modelling locations and scenarios

Jacobs (2022; Attachment H) undertook EMF modelling at the following locations:

- Nearshore Victoria (Waratah Bay):
  - Monopole (ML1) cable transition zone centered on 146.079° E and -38.875° S with an average water depth of 15 m and total geomagnetic field of 60.38 µT.
  - Monopole (ML2) cable transition zone centered on 146.060° E and -38.825° S with an average water depth of 15 m and total geomagnetic field of 60.35 µT.
- Nearshore Tasmania (adjacent to Heybridge):
  - Monopole (ML1) cable transition zone centered on 145.983° E and -41.067° S with an average water depth of 10 m and total geomagnetic field of 61.39 µT.
  - Monopole (ML2) cable transition zone centered on 145.991° E and -41.068° S with an average depth of 10 m and total geomagnetic field of 61.39 µT.

Geomagnetic field components for the above Bass Strait coordinates are presented in Table 7-37, which were based on NCEI (2023). However, the background total geomagnetic field values used by Jacobs (2023; EIS/EES Technical appendix A), which vary slightly, have been adopted in the following impact assessments of EMF on marine fauna as these values were used in EMF modelling and predicting the resultant total magnetic fields associated with project's subsea HVDC cables.

Adopted scenario for magnetic field impact assessment

For the purposes of this report, the predicted individual HVDC cable magnetic fields for Modelling Location 3 in nearshore Tasmania for the western monopole (ML1) have been selected for impact assessment. At this location, the background geomagnetic field intensity of 61.39 µT as used by Jacobs (2023; EIS/EES Technical appendix A).

Note that Jacobs (2023; EIS/EES Technical appendix A) calculated magnetic fields for a 1,000 MW cable, whereas the maximum HVDC cable power transmitted is proposed as 750 MW. Therefore, the predicted resultant total magnetic fields for an individual HVDC cable operating at 750 MW are conservative.

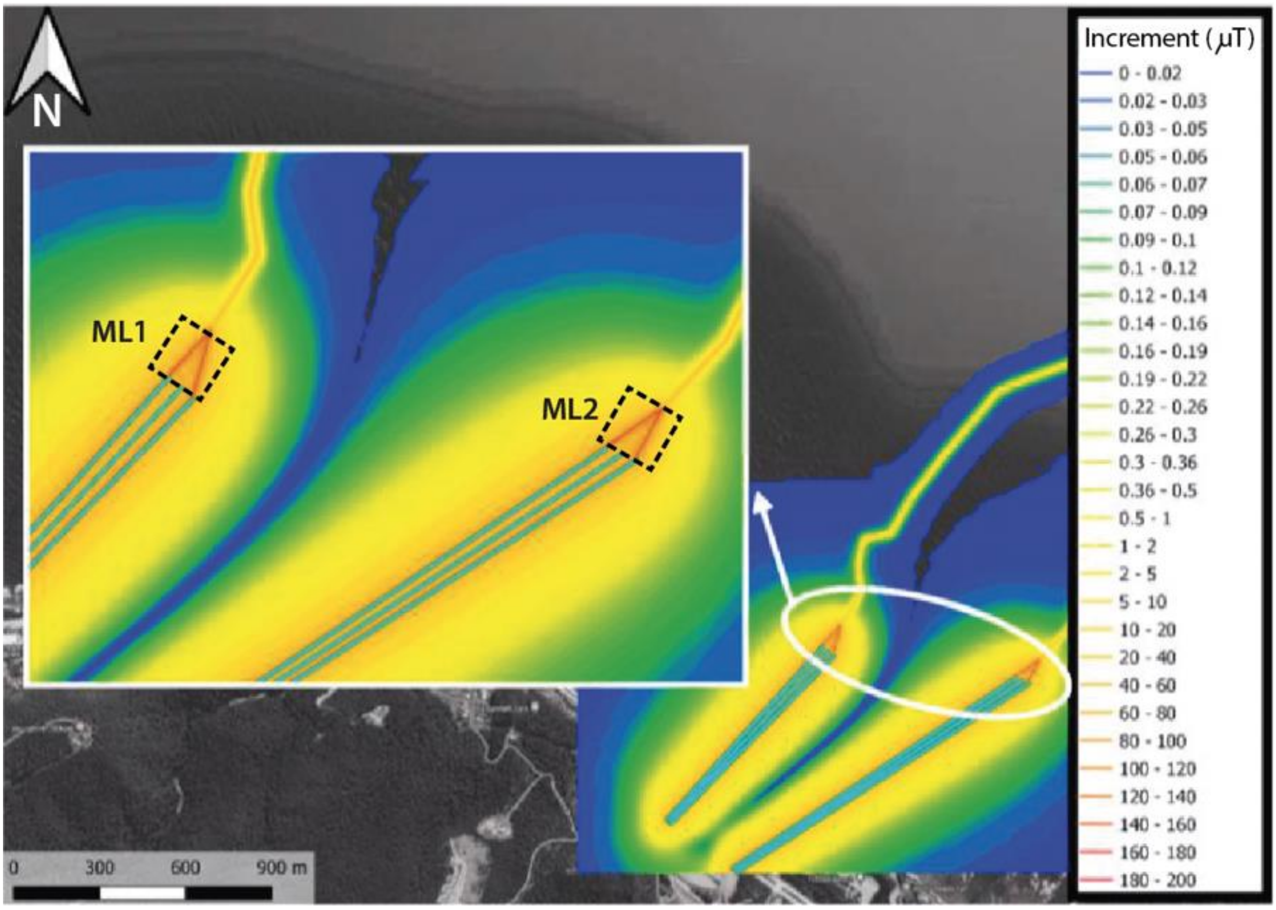
Individual HVDC cable magnetic field predictions for nearshore Tasmania

In contrast to the prediction of resultant magnetic fields (i.e., combined HVDC cable magnetic and geomagnetic fields) for the project's bundled HVDC cables (Section 7.3.1.2.1), Jacobs (2023; EIS/EES Technical appendix A) only predicted the magnetic fields of individual HVDC cables (i.e., unbundled) without consideration of the geomagnetic field. Notwithstanding, the predicted individual HVDC cable magnetic fields are summarised below.

In Figure 7.20, elevated HVDC cable magnetic flux densities are shown in the small 100 m by 100 m transition zones where the individual cables of the bundled cable separate out to enter their respective subsea HDD ducts for the shore crossing at Heybridge. There is no significant magnetic field associated with the optical fibre cable, which lies centrally between the two separately installed

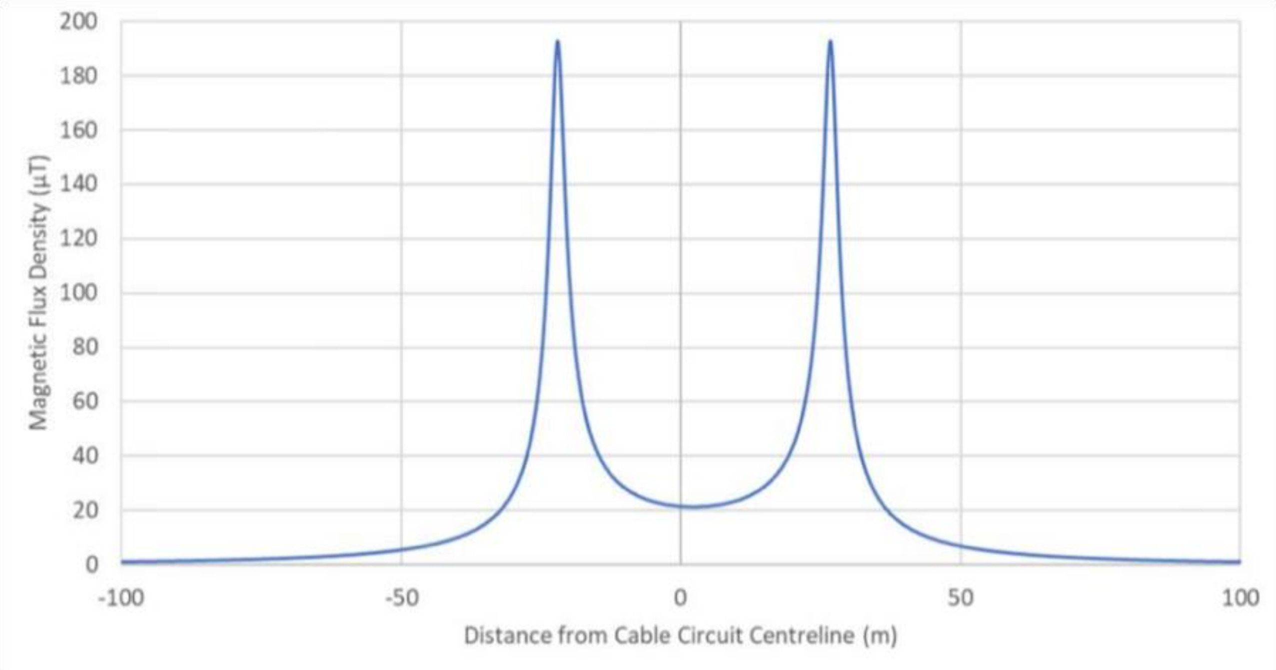
HVDC cables within the transition zones. The magnetic flux densities of the individual HVDC cables within the underground HDD ducts at the Tasmanian shore crossing show much lower magnetic flux densities at the intertidal seabed surface (shown as green in Figure 7.20) given that the HDD ducts are buried to much greater depths (up to 15 m) than the nominal 1 m depth at the transition zone and along the bundled cables heading offshore in Figure 7.20.

Figure 7.21 shows the magnetic field strengths of the individual HVDC cables within the transition zones, which reach a maximum of 193 µT at the seabed above each cable (shown in red in Figure 7.20) but reduce to around 5 µT within 50 m to the east and west of each HVDC cable (shown in yellow-orange transition in Figure 7.20). However, at the seabed where the magnetic field intensity is higher, the magnetic fields of the two HVDC cables (50 m apart) still interact and maintain an elevated magnetic field strength of around 20 µT (see the trough in Figure 7.21) rather than dropping to zero if the individual cables had been further apart (i.e., no individual HVDC cable magnetic field interaction).



Source: Jacobs (2023; EIS/EES Technical Appendix A). Dash-lined squares in the inset denote 100 m by 100 m transition zones.

Figure 7.20: Magnetic fields around individual HVDC cables buried in the transition zone



Source: Jacobs (2023; EIS/EES Technical Appendix A).

Figure 7.21: Magnetic flux density of individual HVDC cables in nearshore Tasmania

7.3.1.2.3 Potential Impacts

The potential impacts of the project's HVDC cable-generated magnetic fields include:

- Potential impacts on magnetosensitive marine fauna:
  - cetaceans that use the geomagnetic field for orientation during long open-ocean migrations.
  - sea turtles that use components of the geomagnetic field for orientation and positioning.
  - pinniped species such as elephant seals that undertake long migrations or long ocean transits.
  - species of bony fishes (Osteichthyes) such as eels that use the geomagnetic field during long migrations.
  - species of cartilaginous fishes (Chondrichthyes) such as elasmobranchs (sharks, skates and rays) that sense the geomagnetic field indirectly via their electrosensory systems as they move through the geomagnetic field.
  - marine invertebrates that sense the geomagnetic field.

While some migratory terrestrial and marine birds are known to use the geomagnetic field for positioning and goal direction, they are unlikely to use this magnetosense when under water (i.e., diving seabirds and Little Penguins). Since the magnetic fields generated by the project are at or near background levels at the sea surface, the above-water extension of the project's magnetic fields is also expected to be at or near background levels and, as such, no aerial magnetic field impacts of the project on overflying birds are anticipated. Therefore, magnetosensitive birds (including long distance, night-migratory terrestrial birds) flying over Bass Strait are not considered further.

- Potential impacts on marine resource use:
  - magnetic field interference (magnetic deviation) with ship and boat magnetic compasses.
  - magnetic field interference of movements of magnetosensitive species targeted by commercial fisheries (e.g., gummy and school sharks) across the HVDC cables and the project's generated magnetic fields acting as a potential barrier to their migrations (if present) or east-west movements and to address commercial fishers' concerns on this topic.

7.3.1.2.4 Environmental performance requirements

The proposed EPRs for magnetic field impacts are presented in Table 7-41:

Table 7-41 EPRs for minimising EMF and heat emissions on marine ecology and resource use

EPR ID	Environmental performance requirement	Project stage
MERU12	**Adopting a HVDC cable design that minimises the electromagnetic fields and heat emitted from the subsea and land cable** The cable and construction method must be designed to install and bury subsea cables in a manner that reduces the EMF emitted from the subsea cables at the seabed and overlying the water column. The cable design and installation must include: • Cable burial up to 1.5 metres. • Bundling the HVDC cables in each subsea circuit to cancel out or greatly reduce EMF. • Separating each subsea circuit to reduce interaction of electromagnetic fields.	Design / Construction
MERU13	**Notification of the final subsea project alignment** At the completion of marine construction, MLPL must inform the Australian Hydrographic Office and the Victorian Department of Energy, Environment and Climate Action of the locations and coordinates of the final subsea project alignment to enable the Australian Hydrographic Office to publish Notices to Mariners to inform maritime users of the presence of seabed power cables and mark them on navigation charts.	**Operation**

7.3.1.2.5 Potential mitigation and management measures

MLPL will inform the Australian Hydrographic Office of its proposed project alignment. The AHO will then publish Notices to Mariners to inform other maritime users of the presence of seabed power cables, which will be marked on navigation charts. The updated navigation charts (both paper and electronic versions) allow ships' navigators to be aware of the presence of seabed power cables and any restrictions with regards to anchoring as well as being made aware of potential interference of magnetic compasses if they are onboard passing ships and fishing vessels.

A literature review was undertaken for the present report to collate information and data on the magnetic fields of other subsea HVDC projects or operations with similar or different HVDC cable configurations, and to highlight best mitigation practice and management measures to reduce the magnitude and extent of magnetic fields from energised subsea HVDC cables.

The main mitigation measures that reduce magnetic fields in the water column included HVDC cable burial, which is primarily undertaken for cable protection (i.e., to avoid anchor and trawling gear hook ups). The other main mitigation measure is reducing the distance between installed HVDC cables such as the project's bundling of the HVDC cables, which results in a high degree magnetic field cancellation.

No additional mitigation measures are proposed in addition to EPR MERU12 because the magnetic field impacts can be managed via the design and configuration of the HVDC cables.

7.3.1.2.6 Predicted magnetic field impacts

This section assessed the residual impacts project-generated magnetic fields on various magnetosensitive fauna and interference of magnetic compasses.

Prior to assessing impacts on marine fauna and interference of magnetic compasses, a comparison has been made of the project's predicted project-generated total magnetic fields with those of similar HVDC interconnector projects or operating interconnectors with subsea cables. Table 7-42 presents a summary of similar subsea HVDC interconnector projects or operations and gives the resultant total magnetic field at a common distance of 10 m from the cable for comparison with the project's predicted resultant total magnetic fields. The last row of Table 7-42 presents an estimate of the resultant total magnetic field for a single HVDC cable buried to 1 m depth in the seabed within the transition zone between the end of the bundled cable section prior to its entry into the subsea duct exit hole in the Tasmanian nearshore. The estimate is based on the HVDC cable's predicted magnetic field of 11.4 µT at 10 m distance plus the addition of the background geomagnetic field of 61.39 µT, which gives an estimated resultant total magnetic field of 72.8 µT.

When comparing the resultant total magnetic fields of the various subsea HVDC cable systems, the proposed Marinus Link bundled cable has the lowest percentage increase over background geomagnetic field of 0.5% at 10 m distance, even though the power ratings for all other systems are less than the maximum 750 MW for the project's western monopole (ML1). As pointed out earlier, current flow is the primary driver that dictates the magnitude of a HVDC cable's magnetic field and the bundling of HVDC cables halves the total magnetic field due to the cancelling effect of currents in opposing directions in the bundled cables.

Table 7-42: Project comparison with total magnetic fields at 10 m distance at other HVDC cables

HVDC Link	Power (MW)	Voltage (kV)	Current (A)	GMF (µT)	Resultant TMF at 10m distance	Increment over GMF (µT)	Percent increase over GMF
Skagerrak	500	250	NR	50.0	63.0	13.0	26.0
SACOI Link single HVDC cable with sea electrodes	300	200	1,000	46.1	56.4	10.3	22.3
Basslink single HVDC cable with sea electrodes	600	400	1500	61.0	75.3	14.3	23.4
Basslink bundled HVDC cable and metallic return cable	600	400	750	61.0	61.4	0.4	0.6
Marinus Link bundled HVDC cables	750	320	625	60.9	61.2	0.3	0.5
Marinus Link single HVDC cable in transition zone	750	320	625	61.4	72.8	11.4	18.6

Source: NSR (2001; 2002). Jacobs (2022; Attachment H). GMF = Geomagnetic field. Resultant TMF = Resultant total magnetic field (i.e., cable magnetic field plus geomagnetic field). NR – Not reported by NSR (2002).

7.3.1.2.7 Magnetic field impacts on cetaceans

There may be some potential effects related to the proximity of a cetacean (e.g., bottom feeding dolphins) to subsea HVDC cables (Bilinksi, 2021). Certain cetacean species that undertake very long-distance migrations are recognised as being magnetosensitive and using the geomagnetic field for navigation. Examples include fin whales (*Balaenoptera physalus*) (Walker et al., 1992) and northern right whales (*Eubalaena glacialis*) (Kenney et al., 2020).

Sensitivity of cetaceans to magnetic fields

The geomagnetic field can serve as a global cue for long-distance cetacean migrations because it is ubiquitous over large spatial scales (around 1000 km) and fluctuates little over the lifetime of many marine species, including long-lived cetaceans. Some highly migratory cetaceans are hypothesised to use environmental cues such as the geomagnetic field to navigate across the oceans. However, testing the sensory and navigation abilities of free-ranging migratory cetaceans in the wild is challenging. However, there is anatomical evidence (Bauer et al., 1985) and behavioural evidence (Klinowska, 1986) that indicates that cetaceans may have a magnetic sense that is used for orientation during migration.

Kirschvink et al. (1986) noted that live stranding locations of whales were associated with magnetic field anomalies of less than 50 nT (or 0.05 µT), which implies that the whales can detect these very low levels of the magnetic field. May (2001) stated that that the sensitivity of cetaceans to the geomagnetic field is around 30 nT (or 0.03 µT).

Walker et al. (1992) suggested that fin whales (*Balaenoptera physalus*) possess a magnetic sense and that they use it to travel in areas of low geomagnetic field gradient and possibly low magnetic intensity during migration. However, the transduction mechanism for responses to magnetic fields has yet to be identified, an obvious candidate is particles of single-domain magnetite detected in the anterior *dura mater* of the humpback whale (*Megaptera novaeangliae*) (Fuller et al., 1985).

Observed effects of magnetic fields on cetaceans

Observed effects of magnetic fields on cetaceans include potential stranding effects and sub-sea HVDC cables potentially acting as a barrier to cetacean movements.

Cetacean strandings

In some areas, at least, studies have correlated cetacean stranding patterns with geomagnetic anomalies (Klinowska, 1985, 1990; Kirschvink et al., 1986; Ferrari, 2017), suggesting that cetaceans possess some type of magnetic sense.

Klinowska (1985) considers that some cetacean strandings are linked, not to absolute field strength, but rather small changes in the relative shape of the field's geomagnetic anomalies. This is reaffirmed by Kirschvink et al. (1986) who assessed that the cetacean magnetic orientation strategy relies on small local geomagnetic field variations. Such geomagnetic anomalies are caused by differences in the magnetisation of the rocks in the Earth's crust and iron-rich minerals in seafloor sediments. Local geomagnetic anomalies in Bass Strait are shown in Figure 7.11 above.

While actively migrating at sea, fin whales follow contours of low geomagnetic intensity and avoid steep gradients. Cetaceans usually avoid crossing 'hills' and swim parallel to linear contours during migration, keeping the higher field to one side and the lower field to the other (Klinowska, 1985). Kirschvink et al. (1986) considered that stranding locations of whales were associated with magnetic field anomalies of less than 50 nT.

The results of the above studies suggest that cetacean strandings have been associated with the cetaceans following magnetic minima or valleys of lower background geomagnetic fields that run perpendicular to the shoreline, where they then become stranded. This has implications for the disturbance of the local geomagnetic field due to operation of the project's subsea HVDC cables, which could be perceived by magnetosensitive cetaceans as a magnetic anomaly.

A recurring concern of commercial fishers, environmental NGOs, and the public with regards to the Basslink HVDC Cable Project in the early 2000s was the potential for the cable's magnetic field impacts on cetaceans to result in two possible outcomes:

- Cetaceans will detect the Basslink magnetic field and turn around.
- Cetaceans may follow Basslink magnetic field to shore where they may become stranded.

However, the Draft Integrated Impact Assessment (DIIAS) (NSR, 2001) and Final DIIAS (NSR, 2002), considered that a third outcome was the most reasonable case, based on overseas operational evidence, which is that cetaceans may sense the Basslink magnetic field, recognise that it is anomalous, ignore it, and continue their migration or seasonal movements.

In response, the Basslink Project proponent (Basslink Pty Ltd) engaged independent scientists to undertake desktop studies of cetacean live strandings at or in the vicinity of operating subsea HVDC cable landfalls. The commissioned studies were undertaken for the four HVDC subsea cable systems (sites of the Skagerrak, Kontiskan, Kontek, and Baltic Cable) in Denmark and one subsea HVDC cable system in New Zealand (site of the Inter-Island Link in Cook Strait with eight subsea HVDC cables). The key findings and conclusions of these studies were as follows:

- Denmark: Baltic Sea (Baltic Cable, Skagerrak, Kontiskan, Kontek and Baltic subsea HVDC cables) findings:
    - A total of about 20 species of cetaceans (one native and 19 exotic or 'non-restricted' species) are known to occur in the Baltic Sea (MacKenzie et al. 2002) and around the Danish coastline.
    - Warneke (2001a) concluded "Considering that none of the active strandings on Danish coasts occurred in close proximity to any HVDC cable, and only two events post-date the commissioning of the nearest cables (marked with an asterisk above), there is no evidence of a causal connection between these cables and active strandings of any of the exotic species."
- New Zealand: Cook Strait (Inter-Island Link) findings:
    - Warneke (2001b) concluded "On the basis of available data on strandings in Cook Strait, there is no evidence that migratory and/or seasonally common species of cetacean that visit or pass through the Strait have been detrimentally affected by HVDC cables operated there since 1964/1965."

In addition to the above findings of an absence of cetacean live strandings associated with operating Danish and New Zealand subsea HVDC cable systems, a literature review in the current study did not find any information of live cetaceans strandings at or in the vicinity of the Victorian and Tasmanian landfalls for the Basslink cable during the period of operations (i.e., from the start of operation in 2005 to 2023).

The above findings lend evidence to support that whatever correlations may or may not occur between live stranding and natural magnetic anomalies, cetaceans co-exist with (and are not impeded by) anthropogenic magnetic anomalies (e.g., subsea HVDC cables). Observations at operating subsea HVDC cable systems indicate that cetaceans continue to regularly move and/or migrate across these subsea power cables throughout the world. Therefore, no live strandings due to the magnetic fields generated by the project subsea HVDC cables are predicted during operations.

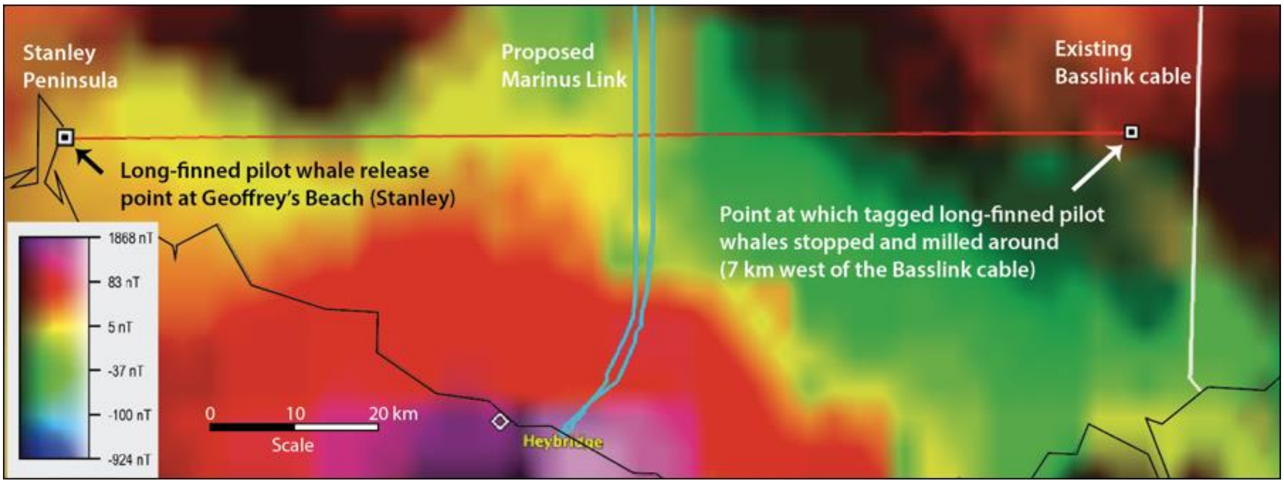
Barrier effects on cetacean migration of other movements

A field study of long-finned pilot whales by Gales et al. (2012) suggested that satellite tracking of these whales (during an easterly movement in Bass Strait) showed that they stopped and milled around the vicinity of the operating Basslink cable. This study is reviewed below since its findings may have implications for the proposed project.

Gales et al. (2012) is the only known scientific study that purports to show an inhibitive interaction of a cetacean with an operating subsea HVDC cable system. The study tracked the eastern movements of tagged long-finned pilot whales (*Globicephala melas*) in Bass Strait and stated that the whales "*stopped and milled around in the vicinity of the operating Basslink subsea HVDC cable*". However, a critical review of this study for the present report, assessed that this finding is not correct as the location where they stopped their easterly movement (135 km east of their release point at Godfrey's Beach at Stanley Peninsula) is 7 km short of the Basslink cable's location. Therefore, the tracked long-finned pilot whales could not have detected the Basslink cable magnetic field at 7 km distance because the resultant magnetic field (HVDC cable plus geomagnetic field) at the Basslink cable's location reaches the background geomagnetic field of 61.6 µT within 50 m horizontally to the west of the cable's location and within the entire water column.

Gales et al. (2012) stated that *"Clearly, the submarine cable did not represent a physical barrier because the tracked whales swam across it on at least 14 separate occasions during the study period, both singly and in a group, and often twice within 24 h. Apart from the initial encounter, there was little evidence of a change in horizontal movement."*

Therefore, the magnetic fields generated by the Basslink subsea HVDC cable were not a barrier to the movements of long-finned pilot whales, and the initial 'encounter' (stopping and milling) 7 km west of the cable's location may be coincidental such as stopping and milling to forage (presence of prey) and not related to the Basslink cable. The location where the tagged long-finned pilot whales stopped and milled around is also located in an area where the geomagnetic anomaly map shows a change geomagnetic background of around +80 nT, which is shown in Figure 7.22 below.



Source: Magnetic anomaly map (Jacobs, 2023; Nakamura and Milligan, 2015). Long-finned pilot whale data (Gales et al., 2012).

Figure 7.22: Gales et al. (2012) tagged long-finned pilot whales and magnetic anomaly map

Potential impacts of magnetic fields on cetaceans

The main concerns about potential impacts of artificial magnetic fields from energised subsea HVDC cables on cetaceans include:

- Interference with cetacean sensing of the geomagnetic field that is used for navigation.
- Disorientation when approaching and passing through an artificial magnetic field.
- Potential for artificial magnetic fields to be a causal factor in the live stranding of cetaceans.

Environmental performance requirements

EPRs for this section are outlined in section 7.3.1.3 (project-generated magnetic fields).

Mitigation and management measures

As noted above, there are no additional mitigation or management measures proposed to further reduce potential impacts of the project's HVDC cable-generated magnetic fields on cetaceans.

Predicted effects of magnetic fields on cetaceans

There are three considerations when assessing the impacts of the project's magnetic fields on cetaceans: a) interference with their magnetosensing of the geomagnetic field used for navigation, b) a potential causal factor in cetacean live strandings, and c) cumulative impacts of cetaceans crossing several HVDC cables in Bass Strait.

Impacts on cetaceans crossing of the project's magnetic field

A recuring theme amongst the public concerns about subsea HVDC interconnectors is that the generated magnetic fields, which will be higher than the background geomagnetic field, may create a barrier (a 'magnetic fence') to cetacean movements through Bass Strait.

The Basslink HVDC interconnector has been operating almost continuously since 2006 and humpback whales (*Megaptera novaeangliae*) regularly pass through or rest within Bass Strait during their seasonal migrations, to and from breeding grounds in tropical waters in eastern Australia, in autumn and spring. While most humpback whales of the Group E1 (eastern Australian coast) migrate along the east coast of Tasmania, a proportion migrate along the west coast of Tasmania and regularly transit across Bass Strait to follow the east coast of Australia northwards to their breeding grounds in nearshore waters off Mackay in Queensland (see Figure 6.18). The same humpback whales, including mothers and calves, are assumed to follow a similar course in reverse during their southern migration.

Humpback whales approaching the Basslink cable and the project's subsea HVDC cable will sense the gradient of cables' magnetic fields, which will be at a maximum when crossing the cables, and the diminishing magnetic gradient as the move away from the cable. Since humpback whales are surmised to sense geomagnetic high and low anomalies (i.e., ridges and valleys), they are likely to sense the cables' magnetic fields as another magnetic anomaly.

The continuing passage of the larger migratory whales over HVDC subsea cables around the world (e.g., the crossings of numerous Baltic Sea HVDC cables or the Sacoi HVDC cable in the Ligurian Sea whale sanctuary) indicates that the subsea HVDC cables do not interfere with whale migrations and that the cables' magnetic fields do not present a barrier to migration.

In the case of a surface or near-surface humpback whales crossing the subsea project alignment in Tasmania (15 m water depth), mid-Bass Strait (70 m water depth), and Victoria (30 m water depth), the predicted near-surface magnetic fields are 150 nT, 10 nT, and 50 nT, respectively, which represent very low increments to the geomagnetic field and are within the range of natural variability. Given the abovementioned the magnetic sensitivities for whales of between 30 nT (May, 2001) and 50 nT (Kirschvink et al., 1986), the predicted magnetic increments of 150 nT over background geomagnetic field in surface waters at the Tasmanian Modelling Location 3 off Heybridge (15 m water depth) and 50 nT in surface waters at Modelling Location 1 in Waratah Bay (30 m water depth) should readily be detected by humpback whales, whereas as the predicted near-surface magnetic field increment of 10 nT at Modelling Location 2 in mid-Bass Strait (70 m water depth) may not be detected.

In the case of humpback whales transiting Bass Strait from north to south will experience a gradual change of 1.04 μT (i.e., difference between the geomagnetic field of 60.35 μT in nearshore Victoria and 61.39 μT in nearshore Tasmania), which represents a gradual rate change of 0.0042 μT/km over the approximately 255 km long transit. However, in contrast, a humpback whale passing through the project's maximum HVDC magnetic field of 0.150 μT in nearshore Tasmania will experience an abrupt change from a geomagnetic background of 61.39 μT through the cable's magnetic field location of 61.54 μT that includes the 0.15 μT (150 nT) increment, and then passing again to the background geomagnetic field of 61.35 μT on the other side. Since humpback whale migration generally occurs in open waters, it is assessed that the effect of the project's abrupt and small magnetic field increases above the geomagnetic field on humpback whale navigation will be extremely localised and short lived, and therefore are not expected to lead to any significant deviation from a humpback whale's natural migration route or other movements. The energy spent during any minor deviations (if they were to occur) represents an extremely small addition to the overall energy budget of migrating humpback whales migrating between Antarctica and their breeding grounds in Queensland.

Overall, the predicted impacts of the project's energised subsea HVDC cables on migrating humpback whales, which have a known magnetic sense, are assessed to have a residual impact significance rating of ***Very low***. This is based on a sensitivity of *Low* due to their delisting from the EPBC Act list of threatened species and increasing population levels, and a magnitude of impact of *Negligible* given the predicted very low increase to the geomagnetic field. In the case of both Victoria and Tasmania, where the conservation status of humpback whale is still classified as endangered, the predicted impacts of the project's energised subsea HVDC cables on migrating humpback whales in nearshore Victoria and Tasmania are assessed to have residual impact significance ratings of ***Low***. This is based on a sensitivity of *High* due to their endangered listing and a magnitude of impact of *Negligible* given the predicted very low increments of the project's bundled cable magnetic fields over the geomagnetic fields in Victoria and Tasmania (refer Table 7-42 for increments at 10 m distance from the bundled cable).

Impacts of project magnetic fields and potential for cetacean live strandings

The principal potential impact of artificial magnetic fields (e.g., from subsea HVDC cables, or sea electrodes where used) on cetaceans is interference with their sensing of the geomagnetic field during long distance migrations or long-distance movements in non-migratory species. However, rather than the transitory effects as cetaceans pass through the project's generated magnetic field across Bass Strait, the main issue relates to potential live strandings along shorelines where geomagnetic minima are present. Therefore, potential impacts of the project's magnetic fields being a causal factor in cetacean strandings has been assessed below.

In addition, there is potential for a future cumulative impact of having three HVDC cable bundle crossings in Bass Strait (i.e., the existing Basslink subsea cable (a monopolar system) and the current project's western (ML1) and eastern (ML2) monopoles, across which cetaceans passing through Bass Strait will encounter. Therefore, live stranding records for similar multi-HVDC cable crossings are assessed below.

There is a general lack of evidence of between the locations of energised subsea HVDC cables and whale strandings. Examples include:

- Warneke (2001a) undertook a desktop study of the locations of live whales strandings in the Baltic Sea with reference to the locations of existing HVDC cables that linked Denmark to Norway and Sweden. Warneke (2001) extracted stranding data from Kinze (1995) and Kinze et al. (1998a, 1988b) for detailed analysis and assessed that none of the live strandings on the Danish coasts occurred at or near to the HVDC cable locations. Warneke (2001a) concluded that there was no evidence of a causal connection between the HVDC cables and live strandings.
- Warneke (2001b) extracted New Zealand cetacean stranding data from Gaskin (1968, 1972) and Brabyn (1991) and undertook a desktop study of the locations of live whales strandings in Cook Strait, between North and South islands, with reference to several subsea HVDC cables that cross the strait. Warneke (2001b) concluded that there was no evidence that migratory and/or seasonally common species of cetaceans that visited or passed through the Strait have been detrimentally affected by HVDC cables that had operated there since 1964/1965 and up to 2001.

The Basslink HVDC interconnector has been operating since 2006 without any publicised cetacean live stranding events that could be associated with the Basslink subsea HVDC cable's magnetic field. A short literature review was undertaken to ascertain if there has been any live strandings of cetaceans in the vicinity of the Basslink nearshore approaches to cable landfalls in Victoria (McGaurans Beach) or nearshore Tasmania (Four Mile Bluff). Key findings are summarised as follows.

Foord et al. (2020) noted that stranding data often reflected the known migration pathways of cetaceans. For example, humpback whales (*Megaptera novaeangliae*) are known to migrate through Victorian waters northward from April to August from their Antarctic feeding to tropical breeding grounds and travelling southward between October and December. Whilst a high number of sightings are recorded for the taxa on their northerly migration. the majority of strandings occurred in November, coinciding with the Group E1 (eastern Australian coast) subpopulation's southward migration. Reduced fitness due to nutritional stress could explain this pattern with previous work suggesting that both female and juvenile individuals are more likely to strand on the way from calving to feeding grounds (southward migration) as females have often depleted their energy stores. Between, 2016 and 2019, Victorian cetacean stranding records showed a total of 424 stranding events, the majority (411) were recorded as single strandings; seven mass cetaceans live strandings were recorded and six were mother and calf strandings (Foord et al. 2019).

The most commonly live-stranding cetaceans (no. of strandings in brackets) reported by Foord et al. (2020) were:

- Common dolphins (81).
- Undefined *Tursiops* sp. (77).
- Burrunan dolphins (55).
- Common bottlenose dolphins (13).
- Indo-Pacific bottlenose dolphins (1).
- Indo-Pacific bottle nose dolphins (1).
- Sperm whales (34).
- Long-finned pilot whales (12).
- Shortfin pilot whales (14).
- Pygmy sperm whales (24).
- Humpback whales (17).

Based on the stranding location maps provided by Foord et al. (2019) for the period 2016-2010, cetacean species stranding in Waratah Bay and the adjoining west coast of Wilsons Promontory included the following species (no. of standings in brackets): common dolphin (2), undefined *Tursiops* sp. (1), common bottlenose dolphins (2), sperm whales (2) and pygmy sperm whales (2). The were no humpback whale, long-finned pilot whale, or short-finned pilot whale stranding records for Waratah Bay or the west coast of Wilsons Promontory.

In terms of large whales such as humpback whales, most stranding records were for the far southeast coast of Victoria towards the NSW border. While there was one stranding near the Basslink landfall (details unknown if it was a live stranding or carcass that was found); however, this does not represent empirical evidence for a HVDC cable magnetic field-induced stranding as it was one stranding out of a total of 17 strandings and most of which were along far southeastern coast of Victoria and inshore of the oil and gas offshore area.

The project's proposed subsea project alignment is located at a minimum distance of 63 km from the Basslink cable. Therefore, magnetic fields generated by the project's HVDC cables are too distant to have any cumulative effect on the local marine environment of the Basslink HVDC cable. Similarly, the magnetic field generated by the Basslink HVDC cable will have negligible cumulative effects on the project cables (Jacobs, 2023; EIS/EES Technical Appendix A).

In the case of those magnetosensitive cetaceans sequentially crossing the Basslink and the project's HVDC cable locations from east to west, or vice versa, the impacts on their magnetosensory system will be transitory and last only for the short duration in which the cetaceans are within the cable's magnetic field impact zone, and with no lasting or remnant effects when they move out of the HVDC cables' impact zones.

In addition, to the existing Basslink HVDC cable's magnetic fields, nearshore and offshore waters in proximity to the project's proposed alignment are being considered as prospective areas suitable for offshore wind farms. Current proposals for offshore wind farms in Gippsland (DECA, 2023) include:

- Seadragon Offshore Wind Farm Project (Flotation Energy, 2023), which is 117 km northeast of the current project's alignment.
- Star of the South Offshore Wind Farm Project (SOTS, 2022), which is 60 m northeast of the project's alignment.

The proposed Great Southern Offshore Wind farm will be the closest to the project's western monopole (ML1), with an estimated nearest point of approach of 10 km. However, the wind farm's inter-array of seabed power cables between the monopiles will most likely have AC power transmission. This means that interaction of the project's DC magnetic fields with the wind farms AC magnetic fields is unlikely, given the distance between the two projects.

Overall, the predicted cumulative impacts of cetaceans passing over the Basslink and project's HVDC cables' magnetic fields are assessed to have an impact significance rating of ***Low***. This is based on a grouped cetacean sensitivity of *High* due to their mixed conservation listing statuses and presence of magnetosensory systems, and a magnitude of *Negligible* given the transitory exposures of cetaceans to both the project's cables' magnetic fields, which they will sequentially cross without any remnant residual impacts as they move away from the project alignment. In addition, the large distance between the operating Basslink cable and the project alignment negates any combined magnetic field interaction.

7.3.1.2.8 Magnetic field impacts sea turtles

Much of what is known about animal response to the geomagnetic field comes from studies of sea turtle migration, and especially loggerhead turtles (*Caretta caretta*). Based on field and laboratory studies, Putman et al., (2015) assessed the magnetic navigation of the oceanic life stages of loggerhead turtles. The conclusion of these studies was that the navigation behaviour of sea turtles was closely tied to the interactions between oceanic circulation and the dynamics in the geomagnetic field.

Sea turtle hatchlings are well known for their ability to head directly towards the sea. Breeding of loggerhead turtles (*Caretta caretta*) and leatherback turtles takes place at the sea surface or underwater. Their eggs are deposited in nests in the sand and, after egg incubation and emergence, the hatchlings head directly towards the sea or ocean. Although differences in light density seem to drive this behaviour, magnetic alignment appears to play a part. For instance, the natural directional preferences held by these hatchlings (which led them from beaches to the sea) are reverse upon experimental inversion of the magnetic poles (Merrill and Salmon, 2010).

Sensitivity of sea turtles to magnetic fields

A literature review did not reveal any threshold levels of geomagnetic sensitivity in sub-adult or adult sea turtles.

Artificial displacement experiments can be used to infer changes of the magnetic field that may result in a changed orientation of groups of animals. One study has shown loggerhead turtles displayed distinct average orientation from artificial displacements around 5,000 nT and 8° (Boles and Lohmann, 2003; Fuxjager et al., 2011). In experiments, short but strong (4-5 ms; 40 to 500 mT) magnetic pulses have incapacitated the ability of loggerhead turtles to orient after the magnetic field for a substantial period of time (Irwin and Lohmann, 2005).

Observed effects of magnetic fields on sea turtles

There are indications that the geomagnetic sense is critical for primary orientation to approach the general vicinity of a destination (e.g., nesting beaches, feeding grounds), but that fine-tuning is accomplished by using olfactory and visual cues (Tricas and Gill, 2011). Lohmann (1994) noted that sea turtles appear to rely on an inclination compass that does not distinguish the polarity of field lines (i.e., north versus south); instead, an inclination compass functionally defines ‘poleward’ as the direction along the Earth’s surface in which the angle formed between the total field vector and the gravity vector is smallest (Wiltschko and Wiltschko, 1972).

Fuxjager et al. (2011) observed disorientation of juvenile loggerhead turtles exposed under laboratory experimental conditions to magnetic fields in the range 44.0 to 51.1 µT. The results are consistent with the hypothesis that loggerhead turtles entering the sea for the first time possess a navigational system in which a series of regional magnetic fields sequentially trigger orientation responses that help steer turtles along the migratory route.

Predicted impacts

Most of studies and observed impacts of magnetic fields on sea turtles relate to hatchlings and juveniles. However, the results from such studies are less relevant to the mainly sub-adult and adult sea turtles that are known to pass through Bass Strait. Since sea turtles are known to use multiple cues (both geomagnetic and non-magnetic) for navigation and migration (Tricas et al., 2011), it is surmised that this will be the case for sea turtles passing through Bass Strait.

Those sea turtle species that migrate down the coast of Western Australia also follow the south-flowing Leeuwin Current, which meets the eastern-flowing South Australian Current and then Zeehan Current that flows eastwards to western Bass Strait, resulting in an eastward flow through the strait.

Tricas et al. (2011) considered that conclusions about the effects of magnetic fields from power cables were hypothetical as it was not known how sea turtles detect or process fluctuations in the geomagnetic field.

In the case of a surface or near-surface sea turtle crossing the subsea project alignment in Tasmania, mid-bass Strait and Victoria, the predicted near-surface magnetic fields are 153.1, 5.1, and 18.7 nT, respectively, which represent very low increments to the geomagnetic field. These low magnetic fields are not expected to interfere with sea turtles’ use of the geomagnetic field for navigation.

Overall, the predicted impacts of the project's subsea HVDC cables magnetic fields on magnetosensitive sea turtles during their passage through Bass Strait are assessed to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *High* due to their conservation status and presence of a magnetosensory system and a magnitude of *Negligible* given their common and widespread distribution and the fact that other non-magnetic sensory cues (e.g., olfactory, auditory and visual cues) may be used to assist during their passage through Bass Strait.

7.3.1.2.9 Magnetic field impacts on pinnipeds

A literature review indicated a paucity of information on the use of the geomagnetic field by pinnipeds and whether they have a magnetosensory system. However, there are indications that long-distance migratory elephant seals may be capable of sensing the geomagnetic field.

Sensitivity of pinnipeds to magnetic fields

Very little information on the sensitivity of pinnipeds to the geomagnetic field were available, except for a study by Robinson (2009), which is reviewed below.

Observed effects of magnetic fields on pinnipeds

Northern elephant seals are known to migrate across vast expanses of open ocean between breeding sites and foraging habitats (Mueller and Fagan, 2008). Northern elephant seals migrate twice per year between terrestrial colonies and productive feeding areas in the north Pacific transition zone and they return to land (colonies) twice per year with remarkable fidelity (Le Boeuf et al., 2000). They also surface regularly to breathe about every 20 minutes.

Robinson (2009) investigated the navigation performance of northern elephant seals (*Mirounga angustirostris)* and observed their homing behaviour during natural migrations and conducted experimental translocations that indicated an acute navigation ability and a positional sense. Northern elephant seals routinely complete continuous migratory movements of more than 1,000 km for periods exceeding two weeks and do so with less than a 6% mean offset from optimal migration 'great circle' paths. Robinson (2009) used high-resolution GPS tracking and demonstrated that some individual northern elephant seals were capable of far greater precision over similar spatio-temporal scales (less than 0.5% error), which strongly suggested the use of a positional sense. Robinson (2009) concluded that, while there was not any clear evidence for geomagnetic navigation in the northern elephant seal, his research suggested a weak association between direction of transit (azimuth) and geomagnetic intensity, and that the vertical component (Z-field) of the geomagnetic intensity explained most of the variation.

In Bass Strait, the equivalent to the northern elephant seal is the southern elephant seal (*Mirounga leonina*), which is found in very limited numbers over the continental shelf margins of South Australia, Victoria and New South Wales and Tasmania. Southern elephant seals appear on Tasmanian coasts only very occasionally with even rarer records of breeding (Van den Hoff, 2001). Off the coast of mainland Australia, several pups have been born and many animals recorded on Maatsuyker Island, which is located off the south-west coast of Tasmania (Shaughnessy, 1999). There are very few transit sightings within Bass Strait (DNRE, 2023b). Southern elephant seals migrate south to Antarctica to feed on squid and fish at the edge of the sea-ice (DAWE, 2021c).

DAWE (2021) also state that southern elephant seals can navigate very accurately to feed Antarctic waters. This accurate navigation ability is also confirmed by (Bradshaw et al., 2004) who found that long-term fidelity to Antarctic foraging may be assisted by simple navigational cues. For the purposes of the present report, it is assumed that the northern elephant seal and its weak magnetic sense (Robinson, 2009) can be used as a proxy for the southern elephant seal, given they are from the same genus and have similar evolutionary biology.

Southern elephant seals also known to cross vast expanses of open ocean between breeding sites and foraging habitats (DAWE, 2021c). The distances between sub-Antarctic islands (e.g., Macquarie Island, Campbell Island and Antipodes Island) and the Antarctic ice shelf is 1,500 km, and the expanse of open ocean between the sub-Antarctic islands (e.g., Macquarie Island) and the continental shelf of eastern Bass Strait is 1,750 km. Juvenile southern elephant seals that have transited from Macquarie Island have been recorded to haul out on coastal regions of Tasmania but their condition if often poor and some perish (van den Hoff, 2001).

Overall, based on the observed lack of clear evidence for geomagnetic navigation in elephant seals (Robinson, 2009), it is likely that southern elephant seals may also have a weak association between direction of transit (azimuth) and geomagnetic intensity, given their similar long-distances movements between the Southern Ocean and coastlines of southern Australia. Therefore, a weak magnetosense has been assumed for the purposes of the present report as likely to be present in southern elephant seals, though further research is needed to make firm conclusions about this phocid's use of geomagnetic cues.

Southern elephant seal movements within Bass Strait and along the southern coast of Australia are likely to use other available sensory modalities including extrinsic factors (e.g., physical landmarks, bathymetric features, currents and elevated coastal underwater noise sources) rather than intrinsic factors (navigation positional sense through sensing of geomagnetic or celestial cues) when present in or moving through the coastal waters of Australia.

Predicted magnetic field impacts on pinnipeds

The weak magnetic fields generated by the project's energised HVDC cables are not predicted to have any effects on eared seals (*Otariidae*), owing to their lack of a magnetosense. Therefore, residual impacts of magnetic fields on the fur seals and sea lions in Bass Strait are assessed as having an impact significance rating of ***Very low*** based on a sensitivity of *Very low* due to the absence of a magnetosensory system and a magnitude of impact of *Negligible* given that weak magnetic fields do not affect *otariids*.

In the case of true seals (*Phocidae*), the southern elephant seal has been assumed to have a weak magnetosense that could be used for navigation over vast expanses of the Southern Ocean. The predicted impacts on the southern elephant seal are assessed to have an impact significance rating of ***Low*** based on a *Moderate* sensitivity due to the likely presence of a magnetosensory system (based on northern elephant seals (Robinson, 2009)) and an impact magnitude of *Negligible* given that this magnetosense is expected to be of limited use in the shallow waters of Bass Strait as other cues (e.g., currents, physical landmarks, bathymetric features, or following the coastline) may assist navigation. Given the known swimming speeds of southern elephant seals of 79.4 km/day and a maximum of 115 km/day (Biuw et al., 2007), exposure to the project's magnetic fields will be very transitory.

7.3.1.2.10 Magnetic field impacts on bony fishes

Some species of bony fishes (Osteichthyes) that undertake long ocean migrations are magnetosensitive and are known to use the static (DC) geomagnetic field for functions such as orientation, homing and navigation. Examples include Atlantic salmon (*Salmo salar*) (Tanski et al. 1995), yellowfin tuna (*Thunnus albacore*) (Walker, 1984). Also included in the list of bony fishes, although not technically a teleost, is the fish group *Cephalaspidomorphi* that includes the sea lamprey (*Petromyzon marinus*) (Bodznick and Northcutt, 1981).

Studies of magnetoreception in bony fish have been conducted mainly with anadromous[11] fishes such as salmonids; for example, sockeye salmon (*Oncorhynchus nerka*) and Chinook salmon (*Oncorhynchus tschawytscha*), which have been demonstrated to have a compass sense. This was demonstrated in experiments in the 1980s by changing the axis of a magnetic field around a circular tank of young fish and to which they reoriented themselves in line with the changed field (Quin, 1980; Taylor, 1986). Other magnetosensitive bony fishes that are catadromous[12] include eels that undertake migrations from freshwater to tropical spawning zones.

Magnetic sensitivity of bony fishes

A few species of migratory bony fishes have been demonstrated to have a magnet map sense, including:

- European eels (*Anguilla anguilla*): Glass eels have been demonstrated to have a magnetic map, detecting <5% changes in magnetic intensity and inclination angle (Naisbett-Jones et al., 2017).
- Chinook salmon (*Oncorhynchus tshawytscha*): Juvenile chinook salmon demonstrated to have an innate magnetic map (Putman et al., 2014a; Burke et al., 2014; Naisbett-Jones et al., 2020).
- Steelhead trout (*Oncorhynchus mykiss*): Steelhead trout demonstrated to have an innate magnetic map (Putman et al., 2014b).
- Pink salmon (*Oncorhynchus gorbuscha*): Pink salmon demonstrated to have an innate magnetic map (Scanlon et al., 2020).
- Atlantic salmon (*Salmo salar*): Atlantic salmon demonstrated to have a magnetic compass (Minkoff et al., 2020).

The abovementioned list is entirely for northern hemisphere bony fishes, although Atlantic salmon (*Salmo salar*) are present around Tasmania but only as escapees from fish farms in the state, but they are not known to undertake any long-distance migrations. While there are no equivalent Australian bony fishes to salmonids in the southern hemisphere, Pacific eel species are present (e.g., the short-finned eel, *Anguilla australis*) in Bass Strait and local river systems, and which also undertake long-distance migrations (up to 2,000 km) to warm-water mating grounds near Vanuatu, Solomon Island, New Caledonia, and Fiji (Koster et al., 2021). Therefore, the magnetic sensing capabilities of the European eel (*Anguilla anguilla*) has been used as a proxy for assessing project magnetic field impacts on the shortfin eels that migrate from central Pacific spawning grounds to both Victorian and Tasmanian rivers on either side of Bass Strait.

Observed effects of magnetic fields on bony fishes

A review of the literature indicated that several bony fishes have a magnetosense including highly migratory species such as European eels (*Anguilla anguilla*), yellowfin tuna (*Thunnus albacares* (Walker, 1984)

Table 7-43 presents a summary of the effects of magnetic fields on bony fishes based on laboratory studies and experiments.

[11] Anadromous fishes spend most of their adult lives at sea but must return to freshwater to spawn.

[12] Catadromous fishes live most of their adult lives in freshwater but must return to saltwater to spawn.

Table 7-43: Field determined magnetic field impacts on bony fishes

Species	Magnetic field	HVDC Cable	Magnetic field effect	Reference
European eel (*Anguilla anguilla*)	5 µT (*60 m from cable)	Baltic Cable (HVDC)	Minor course deviation of eels when passing over cable during outmigration from Baltic Sea to North Sea. Water depth at the cable was 30 m.	Westerberg and Begout-Anras (2000)
European eel (*Anguilla anguilla*)	13.8–116.8 µT 24.6–42.8 µT	35 kV AC (exposed)	Out-migrating eels crossed location of subsea HVDC cable HVDC cable with slightly altered swimming behaviour and veering slightly off a straight path.	Westerberg and Lagenfelt (2008)
Chinook salmon (*Oncorhynchus tshawytscha*)	94–245 nT	Trans Bay Cable (HVDC)	Minor alterations to migratory routes and timing. The power cable was not a barrier to the seasonal chinook salmon outmigration. Distortion of the local geomagnetic field at metallic bridges was greater than the HVDC cable's distortion of the geomagnetic field.	Klimley et al. (2017)
Chinook salmon (*Oncorhynchus tshawytscha*)	543 nT at 5 m 185 nT at 10 m above cable	Trans Bay Cable (HVDC)	Cable energisation did not significantly impact the proportion of fish that successfully migrated through the bay or the probability of successful migration. However, higher proportions of fish crossed the cable location and fish were more likely to be detected south of their normal migration route.	Wyman et al. (2018)

Notes: *Westerberg and Begout-Anras (2000) quote a magnetic field of 5 µT at 60 m from the Baltic Cable an HVDC interconnector) but in the field experiments, where the eels crossed the cable, the water depth was 30 m deep (see explanatory text below).

In Table 7-43, Westerberg and Begout-Anras (2000) quote a magnetic field of 5 µT at 60 m from the a subsea HVDC cable (assumed to be the Baltic Cable between Sweden and Germany) Link) but in the field experiments the eels were released from cages to the east of the cable and when the eels crossed the cable, the water depth was only 30 m deep indicating that the eels passed through a much higher magnetic field above the cable. Westerberg et al. (2007) state that the Swepol Link emitted approximately 200 µT at the seabed 1 m above the HVDC cable and since both the Swepol and Baltic cables have similar ratings (e.g., both 600 MW, 450 kV DC and 1,300 A), it can be assumed that the Baltic Cable interconnector also has a magnetic field of 200 µT at 1 m at the seabed above the buried HVDC cable.

The assumed higher value of 200 µT at 1 m above the seabed for the Baltic Cable is about 5.7-fold and 11.8-fold greater than the approximate 17 µT and 35 µT at 1 m above the seabed, respectively, as predicted by Jacobs (2023; EIS/EES Technical appendix A) for the 375 MW and 750 MW transmission scenarios during project operations.

Predicted impacts of project -generated magnetic fields on bony fishes

The principal bony fishes potentially at risk from the magnetic fields produced by the project's subsea HVDC cables are the short-finned eel (*Anguilla australis*) and the long-finned eel (Anguilla reinhardtii), which are known to migrate through Bass Strait.

Based on the field experiments on European eels (*Anguilla anguilla*) of Westerberg and Begout-Anras (2000) for the Baltic Cable interconnector, the precited impacts of the current project-generated magnetic fields on migratory short-finned and long-finned eels may be summarised as:

- The magnetic fields of the project's energised HVDC cables are unlikely to present a barrier to the migration.
- Both short-finned and long-finned eels are expected to cross the project's HVDC cable' magnetic fields.
- Short-finned and long-finned eels passing over the cable near the surface at night-time hours will be the least affected by the project's magnetic field, as the predicted levels are at or near background levels.
- Short-finned and long-finned eels passing over the cable near the seabed during daylight hours will be exposed to higher magnetic fields between 17 and 35 µT above the geomagnetic field at the cable locations.

In consideration of the last point above, as the eels' approach the buried HVDC cable location they will sense the gradient of the magnetic field, which will increase steeply over the cable and then reduce as the eels' swim away from the cable locations. It is anticipated that short-finned and long-finned eels migrating in deeper waters during daylight hours will perceive the HVDC cable's magnetic field as an anomaly and continue their migration. All eels are expected to cross the cable locations when migrating from the offshore spawning grounds to the rivers as elvers and when leaving the rivers again as adults when migrating to the spawning grounds again.

Overall, the predicted impacts of the project's magnetic fields on short-finned and long-finned eel migrations are assessed to have a residual impact significance rating of ***Low*** based on a sensitivity of *Moderate* due to not being listed as an EPBC Act threatened species and the presence of their magnetosensory system and a magnitude of *Negligible* given that the project's HVDC cables' magnetic fields reduce to background geomagnetic field levels within about 10 m.

Typical swimming speeds of 30.8±7.3 km/day or 21.4±5.1 m/minute (Koster et al., 2021), which are also similar to the average swimming speeds of 46.3 cm/s (or 27.8 m/minute) noted by Westerberg and Begout-Anras (2000) for the European eels (*Anguilla anguilla*) passing over a HVDC cable in Sweden. Therefore, the daytime passage of short-finned eels through the HVDC cables' magnetic field extending 10 m either side of the cable location (or 20 m in total) until the background geomagnetic field is reached will be short and around 1 minute.

7.3.1.2.11 Magnetic field impacts on cartilaginous fishes

Early work on the effects of magnetic fields on fishes demonstrated that cartilaginous fishes could detect magnetic fields (Kalmijn, 1966) and this ability was later found to be widespread amongst electrosensitive cartilaginous fishes.

Magnetic sensitivity in cartilaginous fishes

In general, when a shark, ray, or skate swims towards or through a magnetic field, it experiences an induced electric field that stimulates its electrosensory system, which serves as an indirect mechanism used for detecting a magnetic field or magnetic stimulus (Newton and Kajiura, 2017).

Anderson et al. (2017) studied free-swimming cartilaginous fish to determine how they obtain positional and navigational information via geomagnetic fields. In behavioural conditioning experiments, they showed that magnetic field perception was not just associated with the electrosensory system, but they also appear to have a putative magnetoreceptor within their naso-olfactory apparatus. In terms of low magnetic field detection threshold values in sharks, rays or skates, Anderson et al (2017) reported that sandbar sharks (*Carcharhinus plumbeus*) can detect magnetic field intensities of 0.03 µT (30 nT).

Newton (2017) demonstrated the yellow stingray (*Urobatis jamaicensis*) uses geomagnetic polarity to solve spatial tasks and detect changes in geomagnetic strength and inclination angle. These two magnetic cues may be used for orientation and to derive a location.

Sensing the magnetic field via induction

Elasmobranch fishes can induce an electric field (range 5 to 50 µV/m) around their bodies as they swim through the static DC geomagnetic field, which may allow them to detect their magnetic compass headings. Elasmobranch do this through use of their highly specialised electrosensitive receptors (called ‘ampullae of Lorenzini), which are spread across their body surfaces and are capable of detecting very low levels of induced electric fields (e.g., 5 nV/cm Kalmijn, 1971, 1978). The detection of these weak electric fields induced around their bodies by swimming through the geomagnetic field is postulated to provide magnetic pointers to help them navigate through their local environment.

In general, natural geomagnetic field may provide three types of cues for navigation: horizontal directional component, vertical direction components, and total magnetic intensity, all of which vary across the Earth’s surface. In addition to these global geomagnetic components, there are also local geomagnetic anomalies (see Figure 7.11, geomagnetic anomaly map of Bass Strait), which are low-amplitude magnetic irregularities that vary between +1.8 µT and -0.9 µT over and below the background total geomagnetic field of 60 µT in Bass Strait (Jacobs 2023; EIS/EES Technical appendix A). These small distortions in the local geomagnetic field form a pattern of geomagnetic ‘ridges’, geomagnetic ‘valleys’, and geomagnetic contours, which may be tracked by cartilaginous fishes. In combination, all these magnetic components and variability could provide a cartilaginous fish with a low-resolution ‘magnetic’ map (Walker, 2001). However, in addition to geomagnetic cues, there are many other cues that may assist in cartilaginous fish orientation and navigation such as visual cues (e.g., sun and star compasses, sunset and sunset), olfactory cues, and auditory cues. The relative importance of these cues varies depending on the species cartilaginous fish and its age and previous experience.

Observed effects of magnetic fields on cartilaginous fishes

The geomagnetic field produces compass, map, and topographic information that can be used by magnetosensitive marine fauna to orient in a highly directional manner during migration (Klimley et al., 2021). A few species of elasmobranchs are hypothesised to display navigational behaviour by sensing the geomagnetic field including:

- Species using magnetic topotaxis[13] such as:

[13] Topotaxis is sensing and responding to the magnetic gradients associated with seabed topographic features (e.g., seamounts, ridges. and valleys).

- Scalloped hammerhead shark (*Sphyrna lewini*): trained to detect changes in the geomagnetic field and show to follow magnetic ridges in situ (Klimley, 1993; Meyer et al., 2005).
- Bonnethead shark (*Sphyrna tiburo*): the presence of a map-like sense and orienting to target locations using magnetic cues were demonstrated using a Y-maze (Keller et al., 2021).
- Yellowhead stingray (*Urobatis jamaicensis*): laboratory-based studies demonstrated the species can discriminate between components of the magnetic field and likely has a polarity-based compass (Newton and Kajiura, 2020a, b).

Scalloped Hammerhead Shark and Magnetic Navigation

Klimley (1993) observed large numbers of scalloped hammerhead sharks (*Sphyrna lewini*) converge by day and aggregate over a basaltic seamount in the northern Pacific Ocean. At night, the sharks swim long distances to their deep-water foraging grounds where they feed on squid, and by dawn the sharks return to the seamount. Klimley (1993) followed the sharks on their return journey while towing a magnetometer behind their research vessel and found that the sharks were following geomagnetic paths back to the seamount. The seamount was a positive magnetic anomaly (higher than the background geomagnetic field), and the sharks were assumed to be following the magnetic gradient to retrace their route.

Observed effects of magnetic fields at subsea HVDC interconnectors

Sundt et al. (1995) concluded that they could not find any significant effects of the Skagerrak HVDC link on marine biological resources, which included cartilaginous fishes such as pike dogfish (*Squalus acanthias*), blue skate (*Raja batis*), thorny skate (*Raja radiata*), and sailray (*Raja lineata*).

Predicted impacts of project magnetic fields on cartilaginous fishes

The generation of static DC magnetic fields by the project's HVDC cables is of the same magnitude as the background geomagnetic field. In direct proximity to the seabed overlying the buried HVDC bundled cables, the generated magnetic fields will be higher than background.

Weak electric fields will be induced by the movement of ions in seawater associated with the current and tidal flows through the static DC magnetic fields above the seabed overlying the project's subsea HVDC cables, which will be buried in the seabed to a nominal depth of 1 m. With distance above the seabed, the induced electric field will be lower owing to a concomitant reduction in the resultant total magnetic field (i.e., the combined HVDC cable magnetic field plus the background geometric field).

Based on the abovementioned observed effects of magnetic fields on cartilaginous fishes, the project-generated magnetic fields relate only to those electrosensitive shark, ray and skate species that can make use of electrosensory information about local electric fields induced around their bodies by swimming through the geomagnetic field and therefore in the higher resultant total magnetic field in the water column overlying the subsea cables. Benthic and demersal cartilaginous species such as gummy sharks and some species of skates and rays will be exposed to the higher magnetic total magnetic field, whilst those species living or swimming in near-surface waters of Bass Strait will be exposed to lower cable-modified total magnetic fields that are about the same as background geomagnetic field. For example, the project's magnetic field increment above background geometric fields is 15 and 35 µT above the background geomagnetic field total intensity for the energised HVDC cables operating at half-power (375 MW) and full power (750 MW), respectively.

Based on the findings of the above literature review, potential magnetic fields impacts are only likely on those sharks that undertake long-distance migrations or movements within southeast Australia. Within Bass Strait, this might include resident species such as the white shark (*Carcharodon carcharias*) and the school shark (*Galeorhinus galeus*). The school shark is highly migratory and pregnant females are known to occur in the Great Australian Bight during the early and middle stages of pregnancy, but later move to Bass Strait and waters off Tasmania to give birth. Also, non-pregnant adult and sub-adult females and, to a lesser extent, adult and sub-adult males, migrate between the Great Australia Bight and the waters of Bass Strait and Tasmania (Walker, 2001).

While both these species may detect the geomagnetic field using electroreception, the gradients of the total intensity, or field strength, they use are likely to be gradual (approximately 25 µT near the magnetic equator to 65 µT near the magnetic poles) across the oceans and given the relative stability of the geomagnetic field from year to year during the life cycle of these sharks. However, sharks swimming through the project's HVDC cable-generated magnetic fields are anticipated to be exposed to an abrupt change (short but steep gradient) due to the magnetic field being between 17 and 35 µT above the background geomagnetic field at the seabed and to background geomagnetic levels near the sea surface. This is anticipated to be detected as a singular anomaly and unlikely to affect their migration path or perceived as a barrier.

Those benthic and demersal sharks (e.g., gummy sharks (*Mustelus antarcticus*) that feed on the bottom), and many species of rays and skates, will be exposed to the highest project-generated magnetic fields at the seabed overlying the subsea bundled cables, typically between 17 µT (half-power transmission of 375 MW) and 35 µT (full-power transmission of 750 MW) higher than the existing average background geomagnetic field of 60.94 µT (range 30.35 to 61.59 µT) in Bass Strait.

Overall, the predicted impacts of the project's HVDC cable-generated magnetic fields are assessed to have an impact significance rating of ***Low*** based on elasmobranch fishes' sensitivity of *High* due to their conservation status and detection of low amplitude magnetic fields using their electroreceptor system as they swim through the magnetic fields and a magnitude of *Negligible* given their short duration transits through the sharp peaks of the HVDC cables' magnetic fields as shown in Figure 7.14 (nearshore Tasmania), Figure 7.17 (offshore Bass Strait, mid-point), and Figure 7.16 (nearshore Victoria), respectively. In the case of near-surface swimming sharks, the HVDC cable-generated magnetic fields are at similar levels as the background geomagnetic field; therefore, no magnetic field impacts to these pelagic sharks are predicted.

No significance impact ratings greater than ***Low*** are predicted for the project's magnetic field effects on the migration or long-distance movements of threatened sharks, rays or skates listed under the Commonwealth EPBC Act, the Tasmanian TSP Act or the Victorian FFG Act.

7.3.1.2.12 Magnetic field impacts on marine Invertebrates

A literature review indicated a paucity of information on the use of the geomagnetic field by marine invertebrates, except for long-distance migrations undertaken by spiny lobsters.

Sensitivity of marine invertebrates to magnetic fields

A literature review did not reveal any magnetosensory threshold for behavioural responses in marine invertebrates.

Observed effects of magnetic fields on marine invertebrates

Many reports that have assessed and shown magnetic field impacts on marine invertebrates have been based on laboratory studies that typically use magnetic field strengths (e.g., 2,800 µT) that are an order of magnitude higher than the magnetic field strengths of between 50 and 200 µT above the geomagnetic field when measured at the seabed typically at 1 m above buried operating subsea HVDC cables. In the case of the current project, calculated total magnetic field strengths at the seabed overlying the subsea bundled HVDC cables (buried to 1 m depth), range from an average of 17.58 µT under half-power transmission (375 MW) to an average of 35.16 µT for full power (750 MW) transmission above the background geomagnetic field (calculations based on Table 7-38, Table 7-39, and Table 7-40 above).

A literature review of the laboratory-based experimental effects of magnetic fields on marine invertebrates was undertaken and example results are given in Table 7-44.

Table 7-44: Laboratory determined effects on magnetic fields on marine invertebrates

Species	Magnetic Field (µT)	Effect	Reference
European lobster (*Homarus gammarus*) and edible crab (*Cancer pagurus*)	2,800	Larval deformities and reduction in growth of stage 1 lobster and zoea 1 crab larvae were recorded for exposure to magnetic field (MF) of 2,800 µT.	Collins (2020)
Edible crab (*Cancer pagurus*)	2,800 (up to 40,000)	Exposure to MF did not have any effect on the overall activity level in edible crabs. Some effects their ability to select a site to rest.	Scott et al. (2018)
European lobster (*Homarus gammarus*)	2,800 (up to 40,000)	Activity levels remained unchanged throughout exposure to EMF. Lobsters did not exhibit an attraction to MF based solely on experiment side selection (i.e., towards or away from the MF source). Exposure to the MF caused significant increases in D-Glucose concentrations over a 24 h period suggesting the onset of hyperglycaemia and subsequently confirming a state of increased physiological stress.	Scott et al. (2018)
European lobster (*Homarus gammarus*)	2,800	No significant effects on total number of hatched larvae per lobster. No effects on swimming speeds. Larval deformities were higher in MF-exposed larvae, but mortality rate was significantly lower than the control. Larval growth was affected (smaller total length).	Harsanyi et al. (2022)
Edible crab (*Cancer pagurus*)	2,800	No significant effects on total number of hatched larvae per crab. No effects on swimming speeds. No significant differences in larval mortalities or deformities. Larval growth was affected as MF-exposed larvae were significantly smaller.	Harsanyi et al. (2022)
North Sea prawn (*Crangon crangon*) *Isopods* (*Sadura entomon*) Round crab (*Rhithropanopeus harrisii*) and blue mussel (*Mytilus edulis*)	3,700	No effects on survival rates and no mortalities	Bochert and Zettler (2004)

Based on Table 7-44, most evidence of the effects of magnetic fields on marine invertebrates is based on experiments in which applied artificial magnetic fields are typically in the milliTesla (mT) range. The main reason for using such high magnetic fields appears to be that values in the range 2,700 to 2,800 mT are the predicted magnetic fields at the surface of operating HVDC cables. In contrast, a maximum total magnetic field strength of 116.8 µT at the seabed overlying buried HVDC cables has been measured during a limited number of field studies of energised subsea HVDC cables (Love et al., 2017). As noted above, the project's HVDC bundled cable magnetic fields are between 17 and 35 µT above the geomagnetic field at the seabed.

A literature review of field-exposed or experimental effects low magnetic fields on marine invertebrates was undertaken and example results are given in Table 7-45.

Table 7-45: Experimental effects of low magnetic fields to marine invertebrates

Species	Magnetic field (µT)	Source	Magnetic field effect	Reference
Brown crab (*Cancer pagurus*)	250, 500 and 1,000	Helmholtz coils DC and AC	Attraction observed; less travel times at 500 and 1,000 µT	Scott et al. (2021)
European lobster (*Homarus gammarus*)	220	Helmholtz coils DC and AC	No effect on exploratory and sheltering behaviour during exposure to DC or 50 Hz AC	Taormina et al. (2020)
American lobster (*Homarus americanus*)	65.3	DC	Subtle but significant change of its use of space during exposure but no barrier to movement (displacement)	Hutchison et al. (2018)
Dungeness crab (*Metacarcinus magister*) and red rock crab (*Cancer productus*)	46.2–80.0	35 kV AC (exposed)	No difference in crab distribution in the test boxes alongside the unenergised and energised cables.	Love et al. (2015)
Red rock crab (*Cancer productus*)	13.8–116.8 (Santa Barbera Channel)	35 kV AC (exposed)	Crabs crossed the exposed cable's magnetic fields. No evidence of adverse impacts on catchability of these commercially fished crabs.	Love et al. (2017)
Dungeness crab (*Metacarcinus magister*)	24.6–42.8 (San Juan Island)	69 kV AC (exposed)	Crabs crossed the exposed cable's magnetic fields. No evidence of adverse impacts on catchability of these commercially fished crabs.	Love et al. (2017)

Based on the results of the field experiments for assessing magnetic field effects on marine invertebrates in Table 7-45, the distribution of lobsters and crabs, exploratory and sheltering behaviour were not adversely impacted by the HVDC cable's significant changes, and all lobsters and crabs crossed the cable magnetic fields. However, subtle changes in the use of space near HVDC cables may be expected as shown by Hutchison et al. (2018) for American lobsters.

There are some lobster species that undertake long distance migrations, which are usually linked to specific periods of the life cycle such as pre-adult, moulting, and reproductive stages. Mass migrations are common in spiny lobsters of the family *palinuridae*.

The Caribbean spiny lobster (*Panulirus argus*) is a migratory crustacean indigenous to the Caribbean and the southeastern U.S.A. and has a remarkable homing ability. This species has been demonstrated to sense the geomagnetic field using magnetic map (Boles and Lohmann, 2003). During the northern summer, the spiny rock lobster hides in rock crevices and holes during daylight hours, but at night they emerge to forage over a very large area before returning in darkness to the same den or another one nearby (Herrnkind and McLean, 1971). This species is the only marine invertebrate presently known to fulfill the criteria of true navigation, which is defined as the ability to determine position relative to a goal in an unfamiliar area, without using cues associated with the destination or information obtained during the outward journey (Boles and Lohmann, 2003). In magnetic displacement experiments, spiny lobsters exposed to a magnetic field that exists north of the capture site-oriented southward, whereas those tested in a magnetic field replicating one that exists an equivalent distance to the south oriented northward (Boles and Lohmann, 2003).

The spiny ornate lobster (*Panulirus ornatus*) in Papua New Guinea also undertakes long-distance migrations from northern Torres Strait coral reefs to spawning grounds in the east of the Gulf of Papua near Yule Island, which is located 510 km to the east of the strait (Moore and MacFarlane, 1984). The spiny ornate lobster may also be assumed to have a magnetosense.

Predicted impacts of project-generated magnetic fields on marine invertebrates

Based on the above laboratory experiments of magnetic field effects on marine invertebrates, only migratory spiny lobsters are known to have a magnetosense. In Bass Strait, the southern rock lobster (*Jasus edwardsii*) inhabits hard substrata such as high-profile reefs and rocky outcrops that are absent along the proposed routes of the HVDC bundled cables, all of which traverse soft-sediment seabed from the sand-filled palaeochannels in nearshore Tasmania to the sandy seabed of Waratah Bay in nearshore Victoria.

In Australia, long distance mass migration by southern rock lobsters has not been shown. An initial tagging study in South Australia in the 1970s revealed that recaptured lobsters had moved relatively short distances (less than 5 km) and exhibited strong site fidelity (Lewis 1981). However, a small proportion of southern rock lobsters did exhibit longer distance directional migration (up to 28 km) from inshore to offshore sites near the Cape Jaffa in the southeast of the state. Similarly, a study of 39,000 tag recapture events in sites around Tasmania between 1973 and 2001 indicated that in most areas, more than 90% of animals moved less than 5 km (Gardner et al. 2003). Based on this information, it is unlikely that southern rock lobsters have developed a magnetosense, since there are other sensory cues for localised short distance movements between nearshore and offshore waters including olfactory and auditory cues, as well as electrosensory cues (see Section 7.3.2, Electric field impacts).

Overall, the predicted impacts of project-generated magnetic fields on decapod crustaceans are assessed to have an impact significance rating of ***Very low*** based on a marine invertebrate sensitivity of *Low* due a general absence of magnetoreception in Bass Strait decapod crustaceans and a magnitude of impact of *Negligible* given the absence of long-distance migratory lobsters or crabs.

At overseas HVDC monopolar interconnectors that return current through seawater between two electrodes (i.e., using land or sea electrodes for the return path), a wide diversity of marine benthic macroinvertebrate fauna occurs amongst sea electrodes (both anodes and cathodes), where high electric fields and magnetic may be present. For example, ELSAM (1986) took video tapes and photographs of macroinvertebrates, fish, and other organisms living on or within a test electrode site for the KontiSkan subsea HVDC link between Sweden and Denmark. Their work provided empirical evidence of the lack of effects of electric fields (14 V/m) and therefore associated magnetic fields (>6,000 µT) on marine invertebrates, including crabs, starfishes, and other benthic macroinvertebrates that lived amongst the electrode components.

Similarly, a wide diversity of benthic marine invertebrates has been observed on the surface of HVDC cables either exposed on the seabed (typically up to 2,800 µT) or on conduit pipes encasing HVDC cables (typically up to 1,500 µT depending on distance between the outer half-shell casing and the conductor). For example, CEE (2009) conducted successive surveys at two and four years after the

Basslink cable was commissioned and documented the colonisation of protective cable half-shell pipes with a diversity of marine algae and invertebrates. The species growing on the cable shell were typical of common species growing on nearby cobble and reef seabed.

Given the above empirical evidence of an absence of magnetic field impacts on a wide variety of benthic macroinvertebrates (excluding magnetosensitive migratory spiny lobsters), the predicted impacts of project-generated magnetic fields on all other marine benthic macroinvertebrates are assessed to have an impact significance rating of ***Very low*** base on a marine invertebrate sensitivity of *Very Low* due to the absence of magnetoreception in Bass Strait benthic macroinvertebrates and a magnitude of impacts of *Negligible* given the predicted low incremental magnetic fields of between 17 and 35 μT at the seabed above the project's buried and bundled HVDC cables operating at half-power (375 MW) and full power (750 MW), respectively, which are well below the much higher magnetic field levels outlined in the literature reviews above and which showed no adverse impacts.

7.3.1.3 Magnetic field impacts on marine resource use

The project's HVDC cable magnetic fields may cause interference with magnetic compasses on vessels. No magnetic field impacts are predicted on commercial fisheries or recreational fishing, as no significant impacts on fishes and marine invertebrates were predicted in previous sections. However, minor magnetic field interference of magnetic compasses may occur.

7.3.1.3.1 Interference with magnetic compasses

The static DC magnetic field generated by the project's HVDC cables during operation has the potential to interfere with shipboard magnetic compasses. Ships and boats not equipped with GPS or a non-magnetic compass (gyrocompass) may rely on magnetic compass readings for navigation, and localised disturbances in the geomagnetic field can disrupt the accuracy of the compass reading. Most larger and modern vessels use GPS and/or gyrocompasses that do not rely on detection of Earth's magnetic field. Notwithstanding, this assessment addresses the impact in the case a vessel with a magnetic compass that crosses the operating subsea cables.

The degree of interferences will depend on the amount of power being transmitted in either of the two proposed monopoles (e.g., 375 MW half-power or 750 MW full power) and the depth of water under the affected ships, hence ships in the middle of Bass Strait (80 m water depth) will be exposed to lower residual magnetic fields than ships or other vessels in shallow waters. In general, the deeper the water the lesser the compass deviation effect and conversely, the shallower the water the greater the compass deviation effect. The magnetic compass must be located very close (within 10 m) to the source of the disturbance to have any significant impact (Jacobs, 2023; EIS/EES Technical appendix A). In the case of larger ships, the magnetic compass is located on the bridge (where navigation instruments are installed), which is normally several or tens of metres above the sea surface.

Overall, the predicted impacts of magnetic field interference on magnetic compasses used by ships, fishery vessels and recreational boats are assessed to have an impact significance rating of ***Low***. This is based on a sensitivity of *Moderate*, due to the nuisance value of magnetic compass deviations to ship navigation officers and recreational boaters, and a magnitude of impact of *Low,* given that magnetic compass deviation will be fleeting when crossing the project's HVDC cable locations. In general, only small vessels (e.g., recreational boats) using a magnetic compass could be impacted during crossings in very shallow water, where the magnetic field influence is greatest. It is expected that any impact to the compass reading on these vessels near the shoreline will not impact navigation or safety as visual navigation will assist longshore transits. The magnetic fields generated by the project HVDC subsea cables will not impact GPS navigation, which is the primarily navigation tool in commercial ships and fishing vessels, and (to a lesser extent) in smaller boats.

7.3.1.4 Summary of project magnetic field impacts on marine fauna

Table 7-46 presents a summary of project magnetic field impacts on the marine fauna of Bass Strait.

Section 7.3.1.3 (project-generated magnetic fields) outlines the environmental performance requirements to manage these potential impacts on marine fauna.

Table 7-46: Summary of project magnetic field impacts on marine fauna

Scientific name	Common name/aspect	Sensitivity	Magnitude	Significance
IMPACTS ON MARINE FAUNA				
Magnetosensitive cetaceans:				
*Humpback whale	*Megaptera novaeangliae*	Low	Negligible	Very low
Sea turtles:				
Migratory sea turtles	As a group	High	Negligible	Low
Otariid (eared) seals:				
*Arctocephalus pusillus**	Australian fur seal	Very low	Negligible	Very Low
Arctocephalus forsteri	Long-nosed fur seal	Very low	Negligible	Very Low
Arctocephalus tropicalis	Sub-Antarctic fur seal	Very low	Negligible	Very Low
Neophoca cinerea	Australian sea lion	Very low	Negligible	Very Low
Phocid (earless) seals:				
Mirounga leonina	Southern elephant seal	Moderate	Negligible	Low
Hydrurga leptonyx	Leopard seal	Very low	Negligible	Very Low
Magnetosensitive bony fishes (Osteichthyes):				
Short-finned eel	*Anguilla australis*	Moderate	Negligible	Low
Long-finned eel	*Anguilla reinhardtii*	Moderate	Negligible	Low
Magnetosensitive cartilaginous fishes (Chondrichthyes –Elasmobranchii)				
#Elasmobranch fishes	As a group	Moderate	Negligible	Low
Marine invertebrates:				
Decapod crustaceans	As a group	Low	Negligible	Very low
All other marine invertebrates	As a group	Very low	Negligible	Very low
Impacts on marine resource use				
Magnetic compass deviation	–	Moderate	Negligible	Low

Notes: * Humpback whale is used as a surrogate for all whales. # Elasmobranchs sense the magnetic field indirectly via induction using their electrosensory system.

7.3.2 Electric field impacts

The metal armouring of the HVDC cables is grounded to earth to prevent any direct electric field being generated while the cables are in operation. However, seawater flowing through the HVDC cables' generated DC static magnetic field will induce a corresponding DC static electric field. The intensity of the induced electric field will depend on the intensity of the HVDC cables' external magnetic field, which itself is directly proportional to the current in the cables and inversely proportional to the radial distance. Therefore, the induced electric field will reduce with distance from the buried HVDC cables.

No strictly marine mammals (e.g., whales and pinnipeds) or marine birds (e.g., Little Penguins) are known to possess electrosensory systems. However, behavioural and anatomical evidence for electroreception in the common bottlenose dolphin (*Tursiops truncatus*) has been demonstrated by Hüttner et al. (2021; 2023). The PMST reports (Attachments A, B and C) indicate that this species, or its habitat, may occur in nearshore Tasmania, offshore Bass Strait and nearshore Victoria (see

Table 6-13 in Section 6.3.6.1). Therefore, project-related induced electric field impacts on bottlenose dolphins have been assessed.

The only terrestrial and freshwater semi-aquatic mammal with an electrosensory system is the platypus (*Ornithorhynchus anatinus*), which it uses to localise riverine benthic invertebrates (Pettigrew et al. 1999, Bullock et al. 1999). Platypuses in rivers are outside the influence of the project's marine induced electric fields and is therefore not considered further.

The principal electrosensitive marine fauna include cartilaginous fishes (*Chondrichthyes*) represented by *elasmobranchs* (e.g., sharks, skates, rays and chimaeras) and *Agnatha* such as the sea lamprey (*Petromyzon marina*), all of which are known to occur in Bass Strait.

7.3.2.1 Background information

Given the lower anticipated levels of natural and induced electric fields addressed in this report, the following units and subunits are referenced.

- Volt per metre (V/m): the international (SI) unit of measurement. A field strength of 1 V/m represents a potential difference of 1 V between points separated by 1 metre. Electric field strength is also referred to as electric field intensity. 1 V/m = 1,000,000 µV/m.
- Microvolt/m (µV/m): typical unit used for describing electric fields in the ocean or sea. 1 µV/m = 0.1 µV/cm.
- Microvolt/cm (µV/cm): typically used for characterising the electric field sensitivities of some marine organisms. 1 µV/cm = 1,000 nV/cm
- Nanovolt/cm: (nV/cm); typically used for marine organisms with a very high sensitivity to electric fields.

The above measurement units may be referred to in this report when describing natural electric fields and assessing electric field impacts on marine organisms.

7.3.2.1.1 Existing background natural electric fields

Knowledge of the existing natural electric fields (and variations in space) in Bass Strait is required for comparison with the induced electric fields generated by conductive seawater flowing through the vertical component of the project's HVDC cable magnetic fields.

Natural electric fields

Movements of conductive seawater through the geomagnetic field (by currents and tidal flows) induces electric fields typically between tens and hundreds of nV/cm (Nyqvist et al., 2020). Natural electric fields normally range 0.5-50 µV/m (5-500 nV/cm) in marine waters (Kalmijn, 1999; Randell, 1997; Nyqvist et al., 2020). In the Atlantic Ocean, the Gulf Stream and the North Sea, natural electric field strengths of 35 to 50 µV/m are reported by Buchanan et al. (2011).

In Bass Strait, the natural electric field ranges from around 0.5 µV/m (e.g., slack water between tides) to 184.3 µV/m. The maximum range value of 184.3 µV/m is based on the maximum tidal flow of 3.21 m/s in Banks Strait just to the south of Clarke Island in southeast Bass Strait (Rahimi et al., 2015). At this location (coordinates -40.56° S and 148.11° E), the vertical component of the geomagnetic field is -57.42 µT (NCEI, 2023), which gives a natural background induced electric field of 184.3 µV/m.

Magnetic disturbances can induce electric fields in the atmosphere and in the sea. Induced electric fields can be particularly high during storms and solar flares (Walker, 2001), reaching up to 10,000 nV/cm or 1,000 µV/m during magnetic storms (Kalmijn, 1999).

Electric fields induced by fauna swimming through the geomagnetic field

Weak electric fields can also be induced as marine animals move through the geomagnetic field. It is generally assumed that sharks swimming through the geomagnetic field, for example, can detect their induced electric fields and use it for navigation. Electrosensitive species that can detect their own induced electrical fields in this manner falls under two modes of usage:

- **Passive mode**: when the animal estimates its drift from the electrical fields produced by the interaction between tidal and wind-driven currents, and the vertical component of the geomagnetic field.
- **Active mode**: when the animal derives its magnetic compass heading from the induced electrical field it generates by its own interaction with the horizontal component of the geomagnetic field (Paulin, 1995; von der Emde, 1998).

For example, an animal swimming at a rate of 1 cm/s in an ambient magnetic field of 0.5 nT would induce an electric field strength of 5 nV/cm (Walker, 2001).

Bioelectric fields

All living organisms, including marine organisms, constantly generate electric fields during their life processes (Crampton, 2019). The weak bioelectrical currents are derived from muscle activity such as respiratory movements, cardiac contractions and locomotion, as well as the electrochemical difference between the organism's internal environment and the surrounding seawater (Gill et al. 2001).

Marine organisms themselves generate both AC and DC bioelectric fields. Characteristics of the biogenic bioelectric fields depend on the taxonomic group, position and activity of the organism, but typically range from 2 to 100 µV/cm (2,000 to 100,000 nV/cm) at a very close distance (Haine et al., 2001). For example, AC bioelectric fields are emitted due to heart activity and muscle contractions, while DC bioelectric fields occur due to biochemical processes in the body (Olsson et al, 2010). The muscular contraction of a fish may generate AC bioelectric fields of less than 10 and up to several hundred µV/cm at <10 Hz, although in an injured fish, the frequency may be up to 500 Hz (Bedore and Kajiura, 2013).

Weak bioelectric fields (like those discussed above) can be readily detected by most elasmobranchs, with their highly sensitive electrosensory systems.

Existing anthropogenic electric fields

Electric fields can be generated by ship movement (Rannou and Coulomb 2006; Nakamura et al., 2006). However, these fields are weak and not significant to the marine ecosystem.

Induced electric fields are generated in the vicinity of the existing Basslink subsea bundled HVDC cable and metallic return cable. Assuming a similar median and maximum seawater flows of 0.110 m/s and 0.646 m/s, respectively, the approximate induced electric fields 1 m above the seabed overlying the Basslink bundled HVDC and metallic return cable at Five Mile Bluff (41.016° S and 146.853° E) are 8.47 µV/m and 49.75 µV/m, which compares with the background levels of 6.38 µV/m and 37.45 µV/m for the same seawater flow rates at 1 m above the seabed for the same location. However, the nearest point of approach of the Basslink interconnector to the project's nearest alignment (i.e., the eastern ML2 monopole) is 64 km distance.

Direct electric fields are generated along oil and gas petroleum subsea pipelines that have anodic or cathodic protection systems. Cathodic electrochemical protection of an underground pipeline slows down the rate of corrosion of the metal piping by shifting the electrical protective potential at the pipe/soil boundary to a predetermined interval at which the oxidative processes in metal are reduced (Krizsky et al, 2021). The main oil and gas fields of northeastern Bass Strait are located 215 km from the project's nearest alignment (i.e., the eastern ML2 monopole).

7.3.2.1.2 Project-generated electric fields

Jacobs (2023; EIS/EES Technical appendix A) confirmed that there will be no direct electric currents outside of the HVDC cables as the cable's metallic armouring will be earthed. Since magnetic disturbances are known to induce electric fields in the sea (Nyqvist et al., 2020), the bottom currents and/or the tidal flows moving horizontally through the vertical component of the combined geomagnetic and the project's HVDC cables will induce a horizontal DC electric field in the vicinity of the cable.

Two scenarios were assessed for induced electric fields:

- Scenario 1: Bundled HVDC cables buried to 1 m depth
- Scenario 2: Unbundled individual HVDC cables buried to 1 m depth

Estimates of induced electric fields were derived by using the formula E (µV/m) = BVertical (µT) x V (m/s), where E is the induced electric field, BVertical is the vertical component of the geomagnetic field and V is the velocity of horizontal water movement (Sherwood et al., 2016). Table 7-47 shows the estimated induced electric fields generated by median and maximum seawater flows for EMF modelling locations in nearshore Tasmania, mid- Bass Strait and nearshore Victoria.

Table 7-47 Predicted induced electric fields at three modelling sites across Bass Strait

Modelling site	Location	Flow (m/s)	Estimated vertical component of magnetic field (µT)	Estimated Induced electric field (µV/m)
Induced electric fields at median flows:				
Victorian N/S (Modelling site 1)	Background	0.130	26.42	7.33
	At seabed (0 m)	0.130	89.45	11.62
	1 m above seabed	0.130	65.24	8.48
Mid-Bass Strait (Modelling site 2)	Background	0.112	57.79	6.42
	At seabed (0 m)	0.112	90.36	10.12
	1 m above seabed	0.112	66.13	7.40
Tasmanian N/S (Modelling site 3)	Background	0.110	58.09	6.39
	At seabed (0 m)	0.110	91.59	10.06
	1 m above seabed	0.110	66.86	7.35
Induced electric fields at maximum seawater flows:				
Victorian N/S (Modelling site 1)	Background	0.646	56.42	36.44
	At seabed (0 m)	0.646	89.45	57.78
	1 m above seabed	0.646	65.24	42.14
Mid-Bass Strait (Modelling site 2)	Background	0.639	57.79	36.61
	At seabed (0 m)	0.639	90.36	57.74
	1 m above seabed	0.639	66.13	42.26
Tasmania N/S (Modelling site 3)	Background	0.639	58.09	45.72
	At seabed (0 m)	0.639	91.59	72.00
	1 m above seabed	0.639	66.86	52.62

Source: Current flow data (Fugro, 2022). Magnetic field data based on Jacobs (2023) EIS/EES Technical appendix A. N/S =nearshore.

The highest seawater flow regimes occur within nearshore Tasmania (Modelling site 3) than at either nearshore Victoria (Modelling site 1) or mid-Bass Strait (Modelling site 2). Therefore, the calculated induced electric fields for nearshore Tasmania have been used as a worst-case scenario for impact assessment.

In Table 7-47 and under the median seawater flow of 0.110 m/s, the induced electric field at the seabed and 1 m above the seabed are predicted to be 10.06 and 7.36 µV/m, respectively, compared to the natural background electric field of 6.39 µV/m at the same seawater median flows and locations. Similarly, under the maximum seawater flow of 0.639 m/s in Table 7-47, the induced electric fields at the seabed and 1 m above the seabed are predicted to be 72.00 and 52.62 µV/m, respectively, compared to the natural background electric field of 45.72 µV/m at the same seawater maximum flow and locations. The predicted induced electric field of the project's buried bundle HVDC cables are of similar magnitude as the natural background electric field. The generally low induced electric fields at the seabed and 1 m above the seabed are a consequence of the bundling of the HVDC cables (i.e., magnetic fields are partially cancelled out due to the electric currents flowing in opposite directions within the two HVDC cables) and the burial of the bunded cables to a nominal 1 m depth in soft-sediment seabed.

In the vicinity of the buried bundled HVDC cables, natural background electric fields are reached within 10 m both horizontally and vertically from the bundled HVDC cable.

7.3.2.2 Potential Impacts

Potential impacts of induced electric fields to marine fauna include:

- Impacts to benthic and demersal electrosensitive fish species, such as elasmobranchs (sharks, skates and rays), including direct effects on elasmobranch electrosensory systems and feeding behaviour.
- Indirect impacts of the above on commercial fisheries targeting demersal sharks, such as gummy sharks.
- Interference on migration of electrosensitive elasmobranchs, such as ability to pass over the HVDC cable locations.
- Impacts to electrosensitive benthic macroinvertebrates.

7.3.2.3 Environmental performance requirements

As induced electric fields are a consequence of the magnetic fields surrounding the cables, mitigation measures to reduce the project's magnetic fields have already been proposed in Table 7-41. Therefore, no additional mitigation measures are proposed to reduce in-water electric fields induced by seawater flows through the cables' magnetic fields.

7.3.2.4 Predicted residual impacts

The following residual impacts to marine fauna are based solely on the induced electric fields that are generated by seawater flow through the HVDC cable-generated magnetic fields at the seabed and overlying bottom water.

7.3.2.4.1 Impacts on electrosensitive common bottlenose dolphins

Hüttner et al. (2023) observed that the minimum recorded behavioural electric field threshold for the common bottlenose dolphin is 240 µV/m. Based on Table 7-47 (predicted induced electric fields at three modelling sites across Bass Strait) and maximum bottom current flows (range 0.64 to 0.65 m/s), the induced electric fields at the seabed overlying the project's bundled cables for either the western monopole (ML1) or the eastern monopole (ML2) are predicted to be 57.8, 57.7 and 72.0 µV/m for nearshore Victoria, mid-Bass Strait, and nearshore Tasmania, respectively. All these predicted vales (57.7–72.0 µV/m) are well below the minimum electric field behavioural threshold of 240 µV/m for common bottlenose dolphin (Hüttner et al., 2023); therefore, this dolphin species is unlikely to sense the project-related induced electric fields and are not considered further.

7.3.2.4.2 Impacts on benthic electrosensitive fishes

The principal marine fauna with the capability for detecting electric fields are the cartilaginous fishes such as sharks, skates and rays (*Elasmobranchii*).

Sensitivity of elasmobranchs to electric fields

The elasmobranch electrosensory system comprises electroreceptors (hair cells) located at the end of vase-like structures called ampullae of Lorenzini, and a series of nuclei within the brain for processing the electrosensory information arriving from the afferent nerves that innervate the ampullae. Each ampullary receptor comprises a jelly-filled canal that leads from a pore open at the skin surface and exposed to external seawater to a round vesicle, at the base of which are located electrosensory hair cells.

The ampullary electroreceptors are insensitive to uniform or constant DC electric fields; that is, an external voltage step will evoke a transient response from a receptor at the step; but within a few seconds, the discharge rate of the primary afferent will return to the pre-step value, thus adapting completely (Neiman et al., 2000). However, the electroreceptors appear to be acutely sensitive to abrupt changes in voltage gradients, especially pulsating sources, such as the AC bioelectric fields emanating from elasmobranch prey species.

Elasmobranch ampullary electroreceptors have a very high sensitivity and can detect very weak electric fields that occur naturally in the marine environment. Estimates of the sensitivity of elasmobranch ampullary electroreceptors to electrical stimuli can be determined by both electrophysiological techniques (analysis of afferent nerve spike trains from individual receptors) and by behavioural response analysis.

Table 7-48 presents a summary of the measured sensitivities of elasmobranchs to electric fields, based on a literature search.

Table 7-48 Measured sensitivities of elasmobranchs to electric fields

Common name	Latin name	Sensitivity	Reference
Dusky smooth-hound	*Mustelus canis*	5 nV/cm	Kalmijn (1982)
Mangrove whipray	*Urogymnus granulatus*	4 nV/cm	Haines et al. (2001)
Blacktip reef shark	*Carcharhinus melanopterus*	4 nV/cm	Haines et al. (2001)
Dwarf sawfish	*Pristis clavata*	1 nV/cm	Kalmijn (1966)
Scalloped hammerhead	*Sphyrna lewini*	1 nV/cm	Kajiura & Holland (2002)

Based on Table 7-48, the natural background electric field and the project's induced electric fields at the seabed and immediate overlying bottom water (i.e., 1 m above the seabed), which are measured in microvolts per metre (note: 1 µV/m = 100 nV/cm) and greatly exceed the very low electrosensitivity values of all elasmobranchs.

Elasmobranchs use the electrosensory system for biologically important functions such as prey detection (Kalmijn, 1971), mate location (Tricas et al., 1995), and geomagnetic orientation (Kalmijn, 1971,1982). However, the electrosensory system of most elasmobranchs is predominantly used for predation and as a close-quarter sense to detect the biogenic DC and AC electric fields generated by their prey, especially those prey items that are buried or partially buried in soft seabed sediments (e.g., flatheads and flounders). Therefore, benthic elasmobranchs approaching the location of buried

HVDC cables will readily detect the induced electric field gradient, the magnitude of which will depend on seawater flow through the combined geomagnetic and cable magnetic field, as well as power transmission at the time.

Kajiura and Holland (2002) consider that a shark might well be able to detect an electric field but not exhibit an overt reaction until the electric field intensity exceeds a behavioural-response threshold, and that such thresholds are likely to be species-dependent. Therefore, the response of sharks to an electric field is not simply a reflex or fixed action response.

The reaction of an elasmobranch to an electric field only takes place when the electric field strength is within a biological reaction window (Kullnick, 1994). In near proximity to the buried HVDC cable's location, where the induced electric field voltage gradients are very steep, it is expected that some behavioural response in benthic elasmobranchs may occur. For example, a large benthic elasmobranch approaching the project's HVDC cable locations will span several equipotential lines and detect a potential difference between its head and its tail, using its widely distributed ampullary electroreceptors. Sharks approaching within about a few metres (say, 5 to 10 m) of the buried HVDC cable location may exhibit generic behavioural responses such as moving towards the source (attraction), turning away from the source (aversion) or an acceleration of swimming. However, subsequent approaches may result in responses that diminish with repetitive stimulation (i.e., habituation). Such diminishment with repetitive stimulation to an electric field suggests a learning process in the central nervous system, which has been observed by Wojtenek et al. (2001) in the freshwater paddlefish (*Polyodon spathula*) and Pals et al. (1982) have demonstrated very fast habituation of the lesser spotted dogfish (*Scyliorhinus canicula*) to electrical stimuli.

In addition to the abovementioned general behavioural responses, the wide distribution of shark ampullary electroreceptors, and their responsiveness to low-level bioelectrical signals (emitted by prey species) allows a shark, for example, to sense and capture prey species buried in soft-bottom sediments (Kalmijn, 1974). Therefore, it is anticipated that some benthic elasmobranchs may 'bite' at the soft sediment seabed (i.e., where most of the HVDC cables are buried) in anticipation that a prey item is hidden with the sandy seabed. This may result in repeat biting; however, the lack of a reward (i.e., prey item) will lead the affected elasmobranch to desist from further biting actions and recognise the induced electric field as an anomaly. While the induced electric field stimulates the elasmobranch's electrosensory system, this does not represent a negative impact as the elasmobranch will move on to other areas in search of prey.

A literature search was conducted to collate the results of field experiments with caged elasmobranchs at the sites of energised HVDC interconnectors. The following findings were noted:

- Whitehead (2001) undertook a field study of electric fields in marine waters in the immediate area of the Transpower HVDC cables and electrode system in Cook Strait, New Zealand.
  - The study included a control site (Sinclair Head), which was located 12 km away from the HVDC cables and electrode system. A secondary element of the field study was to document the existence of elasmobranchs (sharks, skates and rays) in the area of the operational HVDC cable system, since these electroreceptive species will be the most affected by the presence of artificial electrical fields.
  - During HVDC power transmission, the induced electric fields averaged 83.36 µV/m (range 73.37 to 97.53 µV/m) compared to a natural background electric field of 25.65 µV/m (range 17.99 to 37.01 µV/m). Note that these natural and induced electric fields are of similar magnitude as those of present project's natural background and predicted induced electric fields (see Table 7-47).

- Whitehead (2001) concluded that the presence of the Transpower cable system did not appear to affect the commercial shark fisheries or federally protected sharks' nurseries along the North and South Island. The results of this study suggest that the operational multi-cable system does not disturb the general ecology and behaviour of sharks and rays in the waters surrounding the system (Whitehead, 2001).

Overall, the predicted impacts of the project's induced electric fields on benthic elasmobranchs are assessed to have a residual impact significance rating of ***Very low***. This is based on a sensitivity of *Low* as there are no benthic elasmobranchs listed as threatened in the PMST search reports (PMST, 2023: Attachment A: Offshore Bass Strait, Attachment B: Nearshore Victoria and Attachment C: Nearshore Tasmania) and a magnitude of impact of *Negligible*, given that the induced electric fields are localised at the seabed (above background within 10 m horizontally and vertically) and of insufficient strength to cause displacement of benthic elasmobranchs from the general area of the energised HVDC cables.

In terms of assessing whether the induced electric fields overlying the project's buried HVDC cables pose a 'barrier effect' (i.e., a barrier to elasmobranch migration or other cross cable movements), a literature search was undertaken to determine levels at which elasmobranchs could be deterred or repulsed from an energised HVDC cable's location. The primary source of relevant information relates to the testing of DC electric deterrent devices to ward off sharks from attacking divers or surfboard riders.

To assess the possibility of the project's HVDC cable magnetic fields inducing electric fields (i.e., from horizontal seawater flows) that prevent elasmobranchs from passing over the cable's location, a literature review was undertaken to collate information on DC electric field levels that could repulse or prevent an elasmobranch's migration or movement across the project alignment.

Smith (1974, 1991) reported that sharks will not cross a voltage gradient greater than 5.5 V/m (i.e., 5,500,00 µV/m). However, Charter et al. (1996) stated in a patent that the effective voltage gradient for the most common use of the deterrent ranges from 1 to 10 V/m for sharks. In another experimental study, Marcotte and Lowe (2008) exposed scalloped hammerhead sharks (*Sphyrna lewini*) and leopard sharks (*Triakis semifasciata*) in tanks to pulsed DC electric fields over a 30-minute period. During the experiments, the sharks quickly turned and swam to an area of the tank where the voltage gradient was not as strong. Both hammerhead and leopard sharks displayed this behaviour, which was defined as the 'retreat' behaviour (i.e., effectively a repulse response). The results showed that scalloped hammerhead sharks were repulsed by DC electric field of between of 3.58 and 33.96 V/m, ranged between 3.46 and 36.65 V/m. Assuming the minimum repulsion DC electric field of 3.46 V/m for leopard sharks, this is about 18,000-fold higher than the highest project-related induced electric field of 193 µV/m at the transition zone where the HVDC cables separate out from the bundled cables to feed into their respective HDD ducts for the underground shore crossing in nearshore Tasmania.

Overall, the narrow strip of induced electric fields along the project's HVDC cables are not predicted to pose a barrier to elasmobranch migration or other movements, including benthic or demersal shark species targeted by commercial fishers in Bass Strait. This finding is confirmed by the Bass Strait Environmental Review Committee (BSERC) concluded in 2008 (after three years of monitoring) that the ecological impacts associated with the Basslink Project were minimal and that further environmental monitoring was not required. The Commonwealth Government (DAFF, 2009) agreed and dissolved the BSERC on 23 January 2009 and consequently the environmental monitoring program was discontinued (Sherwood et al., 2016).

7.3.3 Thermal field impacts

During power transmission in the project's HVDC Power cables, heat will generate inside the conductor and the insulation. Some power will be lost as heat by the Joule effect, leading to an increase in temperature at the cable surface and a subsequent warming of the immediate surrounding seawater (if exposed) or seabed sediments (if buried).

In the case of HVDC cables laid directly on the seabed (i.e., exposed and not buried), constant seawater flow around the cable will dissipate thermal energy and confine it to the cable surface (Worzyk, 2009). However, in the case of buried HVDC cables, thermal radiation can significantly warm the surrounding sediment in direct contact with the cable, even at several tens of centimetres away from it, and especially in the case of cohesive sediments (Emeana et al., 2016).

7.3.3.1 Calculated buried HVDC cable heat generation and dissipation

Jacobs (2023; EIS/EES Technical appendix A) undertook a cable heating assessment and calculated seabed sediment temperature rise contours for various project operating scenarios for the buried subsea HVDC cables in different areas along the proposed project alignment. Modelling was undertaken using CYMCAP software (Eaton, 2023). The CYMCAP modelling does not include the thermal mass of the water and the relatively strong ocean currents in the Bass Strait; however, these factors will attenuate the thermal contours and result in negligible heating of the seawater near the seabed (Jacobs, 2023; EIS/EES Technical appendix A).

Thermal resistivity of a material is a measure of how easily it conducts heat. The thermal resistivity of the seabed and ground in which the subsea and land HVDC cables are buried respectively, has a significant impact on the temperature of the cable and the surrounding soil.

The heating assessment was performed by Jacobs (2023; EIS/EES Technical appendix A) for three operating scenarios:

- The cables operating at a proposed steady-state current.
- The cables operating at a temperature of 70°C.
- The cables operating at a temperature of 90°C.

The operating scenarios where the cables are operating at 70°C and 90°C correspond to typical cable maximum operating temperatures. In general, the HVDC cable's conductor temperature can reach a maximum of 90°C and the sheath temperature a maximum of 70 C (Pophof and Deschwentner, 2013). The results of the Jacobs (2023; EIS/EES Technical appendix A) cable heating assessment are summarised in Table 7-49 for 0.1 m, 0.5 m and 1 m below the surface of the seabed.

Table 7-49: Project HVDC cable heating assessment results

Operating condition	Depth below seabed (m)	Increase in sediment temperature above ambient (18 °C)	Predicted total temperature in sediment
Steady state current	0.1	+0 °C	18°C
Conductor temperature of 70 °C	0.1	+0 °C	18°C
Conductor temperature of 90 °C	0.1	+0 °C	18°C
Steady state current	0.5	+2 °C	20°C
Conductor temperature of 70 °C	0.5	+9 °C	27°C
Conductor temperature of 90 °C	0.5	+12 °C	30°C

Steady state current	1.0	+ 7 °C	25°C
Conductor temperature of 70 °C	1.0	+22 °C	40°C
Conductor temperature of 90 °C	1.0	+30 °C	48°C

Source: Jacobs (2023; EIS/EES Technical appendix A).

Based on Table 7-49, it is evident that the temperature rise predicted at the seabed surface due to the subsea HVDC cables is indistinguishable from the ambient temperature. The model output demonstrates that sediment heating effects are extremely localised within 0.5 m above the HVDC bundled cables.

7.3.3.2 Potential Impacts

During operations, thermal fields will be produced by heating generated by power transmission in the HVDC cables. The potential effects of thermal fields include:

- Increased temperature effects on bottom water along subsea HVDC cables.
- Thermal effects on species composition, population density and productivity of benthic algae and seagrasses.
- Thermal effects on species composition, population density and productivity of benthic invertebrate fauna, epifauna and infauna.
- Indirect effects on fish by thermal-induced changes in the amount or type of benthic food (e.g., benthic flora and invertebrates) available to benthic and epibenthic fishes.

7.3.3.3 Environmental performance requirements

EPRs for this section are outlined in 7.3.1.2.3.

7.3.3.4 Potential mitigation and management measures

Mitigation measures by design have already been incorporated in the manufacture of the marine HVDC cable, ensuring that conductor surface temperatures are within the range of 70°C to 90°C, at the required power transmission (MW), as well as for cable stability and longevity.

In addition to protection against third-party hook ups (e.g., ships' anchors or bottom trawling gear), an advantage of the burial of HVDC cables to 1 m or deeper is that the heat generation from these same buried cables is also reduced at the seabed.

There are no proposed additional mitigation measures to reduce thermal fields caused by energised HVDC cables' heat generation.

7.3.3.5 Predicted residual impacts

Based on Table 7-49, it is evident from the values presented that the temperature rise at the seabed surface (i.e., upper 0.1 m), due to the project's subsea HVDC cable heat emissions, is indistinguishable from the ambient temperature and, therefore, will not have any negative impacts on benthic (e.g., sessile or seabed surface macroinvertebrates) or epibenthic fauna (e.g., benthic and demersal fishes). This conclusion is confirmed by Meiβner et al. (2006), who undertook a literature review on this topic and found that there was no evidence of significant influence on marine fauna due to water temperature rises caused by energised power cables.

Given that most sediment infauna (e.g., *polychaete* worms and molluscs) live within the more productive top 5 to 10 cm of seabed surficial sediments, the absence of increased sediment temperatures for the modelled 0.1 m depth below the surface in Table 7-49 indicates that sediment infauna within this upper zone is assessed to be not impacted by the HVDC cable's heat emissions.

The modelling calculations by Jacobs (2023; EIS/EES Technical appendix A) indicate that the predicted thermal fields dissipate rapidly and will therefore comply with the German EPR standard, which states that the temperature rise in the sediment at a depth of 30 cm below the seabed over an HVDC cable should not exceed 2 K. While many thermal fields have been calculated for buried HVDC cables, very few studies have measured actual temperatures in the sediments overlying buried HVDC cables to confirm modelling results. However, Meißner et al. (2007) measured sediment heating caused by cables in the Danish wind farm Nysted in the Baltic Sea and found that the maximum temperature increase compared to a reference point (without a cable) was approximately 25 cm away from the energised cable, at a seabed sediment depth of 0.5 m overlying the cable, the maximum temperature increase was 2.5 K and the temperature increase at the surface of the sediment was minimal. These results also confirm that thermal field model calculations were conservative and that the German standard’s requirements were met.

The HVDC bundled cable’s heat emissions are predicted to raise sediment and sediment pore water in very close proximity to the HVDC bundled cables by 22 °C and 30°C for the modelled conductor temperatures of 70°C and 90°C, respectively, and resulting in highly localised temperatures of 40°C and 48°C. Within this extremely small thermal impact zone, mortality of deep-sediment infauna such as nematode worms may be expected but which will be countered by increased metabolism, and productivity of deep-sediment infauna at the periphery of this thermal impact zone and where some deep-sediment fauna may flourish. In general, potential increases in deep-sediment infaunal growth and productivity is in accordance with the Van’t Hoff–Arrhenius relationship between temperature and metabolism; that is, a 10°C rise in temperature doubles the rate of metabolism (i.e., the ‘Q10 rule’) within the limits of ambient temperatures (Mundim et al., 2020). However, this potential stimulation of secondary productivity in deep-sediment infauna is extremely small and is not assessed or discussed further given the absence of information on the biology and ecology of deep-sediment infauna.

Overall, the predicted impacts of project thermal fields on seabed benthic and epibenthic fauna and infauna, of the top 10 cm of the sandy seabed are assessed to have a residual impact significance rating of ***Very low***. This is based on a benthic community sensitivity of *Low* due to low diversity and sparse distribution and a magnitude of impact of *Negligible* given that the benthic faunal communities are common and widespread within Bass Strait. These predicted impacts concur with the predictions of an absence of thermal effects of cable heat generation on benthic ecology for the Basslink Project (NSR, 2002).

7.3.4 Maintenance impacts

During operations, routine ROV surveys will be conducted to inspect the cables to ensure that the individual or bundled cables remain buried and have not become exposed. These surveys will check for exposed and damaged cable sections (e.g., such as an anchor hook-up) and for evidence of cable free spanning. Cable free spanning can arise from seabed scouring causing a localised lowering of the seabed level that exposes sections of the buried subsea power cables. In the unlikely event of a section of free spanning cable being found, it would typically be monitored to inform the most appropriate rectification response (e.g., rock fill for protection). Rock fill will require either a tug towing a rock hopper barge, or a dedicated rock installation vessel equipped with a flexible fall pipe that can be lowered into the water and place the rock.

In addition, the impacts of a major cable fault repair operation have been assessed, given that one or more cable faults have the potential to occur over the 40-year life of the project.

The subsea cable ROV inspections are scheduled for years two and four, and then every six years thereafter during operations. This results in eight ROV inspections across the project life.

The Marinus Link environment management system will also outline the process for monitoring compliance with project approvals and EPRs, and for continual improvement. The process for continual improvement will consider available information such as contractor reporting, auditing, monitoring results, incident management, complaints received and how they were resolved.

7.3.4.1 Routine inspection and maintenance impacts

During project operations, there will be routine subsea cable maintenance activities, which include:

- Periodic inspection of the subsea cables by remotely operated vehicles (ROVs).
- Servicing, testing and repair of the subsea cables, including scheduled minor outages.

The principal marine-based activities are the use of survey vessels required for periodic ROV inspections.

Potential impacts of routine maintenance during the operations phase to marine fauna include underwater noise generated by the ROV survey vessel and its propulsion and thruster system. The towed ROVs for video capture are essentially quiet, as there is no sound production associated with the ROVs.

7.3.4.1.1 Routine inspection and maintenance mitigation measures

All ROV vessels, vessels used for minor cable repairs, and smaller assist vessels used in routine maintenance will be required to follow the marine megafauna approach guidelines outlined in the environmental performance requirements in Section 7.6, including the Marine Fauna management plan (MERU07), Cetacean Interaction Management Plan (MERU08), and Sea Turtles Interaction Management Plan (MERU09).

Mitigation measures for minimising acoustic impacts of underwater noise from routine maintenance vessels are the same as those outlined in sections 7.2.3.5.1, 7.2.3.6.1 and 7.2.3.7.1.

7.3.4.1.2 Residual impacts of routine inspection and maintenance

Different vessel types are required for the routine ROV inspection surveys and for minor maintenance and repair works.

Routine ROV inspection survey impacts

The ROV inspection surveys will be undertaken by a multi-role offshore support vessel (OSV) such as the 33 m long RV *Silver Star* catamaran, which undertakes ROV operations out of its base port at Lakes Entrance. This vessel was also used by Fugro during the project's pre-construction marine engineering geophysical surveys (Fugro, 2020).

The underwater noise source level of an ROV survey vessel is around 175 dB re 1 µPa at 1 m at the expected survey transit speed of 4.5 knots (Attachment D: Underwater Noise Supplementary Information), which is based on average source levels measured for research vessels and fishing vessels (Veirs et al., 2016). This ROV survey vessel's noise source level is significantly less than that produced by the cable lay ship for which a conservative underwater noise source level of 185 dB re 1 µPa at 1 m (see Section 7.2.3.2). Given that the residual impacts of underwater noise from the cable lay ship on marine fauna were found to have significance impact ratings between ***Very low*** to ***Moderate*** (see Section 7.2.3), then the smaller ROV survey vessel with its lower underwater noise source level of 175 dB re 1 µPa at 1 m will have reduced significance impact rating levels for marine fauna compared to those assessed in Section 7.2.3 for the cable lay ship. As the surveys will occur over several days on eight occasions over 40 years, this represents an infrequent and short-term impact. It is expected that underwater noise generated by routine ROV inspections on marine fauna will have a significance impact rating range from ***Very low*** to ***Low***.

Routine ROV inspections will occur throughout project operation. The ROV survey speed will be approximately 4.5 knots, which is approximately one half to one quarter of the assessed speed range (8-18 knots) of construction vessels in section 7.2.6.1.3. This, combined with the reduced vessel movements, will reduce the impact of vessel-fauna collision during project operation, relative to project construction.

Minor maintenance and repairs impacts

During operations, minor repairs may be associated with sections of subsea cable becoming exposed (lowering of the seabed level) and resulting in unintended free spanning. The underwater noise source levels of two vessel options have been assessed: a) a tugboat towing a rock barge and b) a dedicated rock emplacement vessel.

In the case of a tugboat towing a rock barge and maintain station in DP mode, a typical noise source level is 170 dB re 1 μPa at 1 m (Veirs et al., 2016) and in the case of a dedicated rock emplacement vessel maintaining position in DP mode is 180 dB re 1 μPa at 1 m (Attachment D). Actual rock placement via the vessel's fall pipe does not contribute significantly to the underwater noise, which is dominated by the rock placement vessel as it maintains position using its thrusters in DP mode.

Given that the residual impacts of underwater noise from the cable lay ship with a noise source level of 185 dB re 1 μPa at 1 m were found to have significance impact ratings between ***Very low*** to ***Moderate*** (see Section 7.2.3), then the vessels for rock placement with its lower underwater noise source level of 180 dB re 1 μPa at 1 m will have lower residual impact significance ratings. Overall, it is expected that underwater noise generated by maintenance and minor repairs on marine fauna will also have significance impact ratings between ***Very low*** and ***Low*** with tendency towards the latter given that the source levels for rock emplacement vessel options are between 13 and 15 dB lower than the cable lay ship (185 dB re 1 μPa at 1 m).

7.3.4.2 Major cable fault repair impacts

In the event of a major fault within one of the buried subsea cables during project operation, the affected segment of cable will be required to be replaced with new cable. A typical timescale from finding a major cable fault, mobilising a repair team, making the repair, to re-energising the cable can vary from weeks to months (Leadvent Group, 2022).

A cable repair operation was completed about eight years ago for the Basslink interconnector, which failed on 20 December 2015 (Basslink, 2016a) and was reinstated after cable repairs on 5 June 2016 (Basslink, 2016b), which caused an outage of about five months.

Based on the experience gained during the Basslink cable repairs and the literature (e.g., Whiteford, 2021), the following sequential steps in a major cable repair operation for the project include:

- A cable repair specialist team will be set up.
- A ROV with fault detection instruments is used to find and pinpoint damaged cable.
- A cable repair ship with up to 2 to 3 km of new cable will be mobilised to site.
- As there is not enough slack to bring the cable up and cut a piece out, a second ROV equipped with cameras and robotic claws is deployed to cut the cable either side of the fault and the faulty cable segment raised to the surface for later recycling onshore.
- One end of the cable can then be hooked to a buoy and the other end brought onboard the cable repair ship.
- New cable will be spliced onto the existing cable end onboard the cable repair ship.

- A seabed geophysical survey will be undertaken to map the characteristics of the seabed where the new cable length (known as a 'bight'[14]) can be installed and buried.
- The section of new cable will be lowered back down to the seabed in an omega pattern to accommodate the extra length.
- An OSV with a tethered ROV trencher will then install and bury the new cable section.

7.3.4.2.1 Potential impacts of a major cable fault repair operation

Potential impacts during a major cable fault repair operation include:

- Underwater noise generated by the cable repair ship.
- Seabed disturbance arising from:
  - existing cable removal (de-burial) operation.
  - replacement cable installation and burial operations.
- Water quality impacts arising from:
  - increased in suspended sediment concentrations.
  - turbidity plumes.

7.3.4.2.2 Mitigation measures during a major cable fault repair operation

The mitigation measures applied during a major cable repair operation include those mitigation measures that were designed to meet the project's EPR objectives, particularly during the construction phase including:

- MERU02 – locate replacement cable to avoid and minimise impacts on benthic habitats.
- MERU06 – a marine communication plan.
- MERU07 – a marine fauna management plan.
- MERU08 – a cetacean interaction management plan.
- MERU09 – a sea turtle interaction management plan.
- MERU10 – a plan to minimise impacts on marine fauna and avifauna due to artificial lighting.
- MERU11 – a plan to avoid the introduction and minimise the spread of invasive marine species.
- MERU13 – informing the Australian Hydrographic Office and the Victorian Department of Energy, Environment and Climate Action of the final project alignment.

While location of a major cable fault and the extent of repairs cannot be known at this time, additional mitigations measures may be required to be developed nearer the time where the fault location is known. For example, if the faulty cable were to be located within shallow more biologically productive nearshore waters, a different set of additional mitigation measures may be required than for an offshore cable fault location.

[14] A bight is the loop of extra cable that is required to allow the jointing works to be conducted on the surface. It is anticipated that this will be approximately 240 m, or three times water depth.

7.3.4.2.3 Residual impacts from a major cable fault repair operation

Detailed impact assessment of a major cable fault repair operation has not been conducted, as the impacts assessed in sections 7.2.2, 7.2.3, 7.2.4, 7.2.5 and 7.2.6 are common to project construction and a cable repair operation. However, for cable repair, the impacts will be more localised and of longer duration than the impacts associated with the transient passage of the cable lay ship during cable installation and burial during the initial construction phase of the project..

Underwater noise impacts

Underwater noise impacts will arise to marine fauna will arise from:

- The cable repair ship maintaining position in DP mode.
- Removal (de-burial) of faulty cable segment.
- Installation and burial of the new cable (bight).

The residual impacts of these activities are assessed below.

Cable repair ship underwater noise impacts

The cable repair ship is only required to load between two and three kilometres of new HVDC cable and two kilometres of fibre optic cable and, as such, will be smaller than the cable lay ship (e.g., the CS *Giulio Verne* or equivalent). A typical small cable repair ship is the CS *Ile De Batz* (Attachment D: Underwater Noise Supplementary Information), which is a 140-m long DP2 vessel typically used for subsea cable recovery, repair, and installation, and has a measured underwater noise source of 180.3 dB re 1 µPa at 1 m (Green et al., 2018).

The cable repair ship used for Basslink was the CS *Ile de Re* (i.e., a sister cable repair ship to the CS *Ile de Batz*),which has an underwater noise source level of about 180 dB re 1 µPa at 1 m (Attachment D: Underwater Noise Supplementary Information), compared to 185 dB re 1 µPa at 1 m of the cable lay ship CS *Giulio Verne.* Therefore, the cable repair ship noise impacts are anticipated to be below those assessed for the cable lay ship in Section 7.2.3, which has a range of marine fauna significance impact ratings of between ***Very low*** and ***Low***. An exception is auditory damage hearing loss (PTS onset) in HF hearing cetaceans that were assessed to have a significance impact rating of ***Moderate***; however, this is overly conservative as the cumulative acoustic threshold criterion requires that a cetacean must maintain a constant distance from the sound source for 24 hours, which is a very unlikely scenario (see Section 7.2.3.5.2). Given that an HF hearing cetacean is expected to move away or 'flee' from the cable repair ship noise source, then distances to the PTS onset for permanent auditory damage will not be exceeded except with one or two metres of the noise source (i.e., directly adjacent to the thruster), which is a distance within which HF hearing cetaceans are unlikely to remain. Under this more likely scenario, the impact of underwater noise to HF cetaceans has been assessed to have a residual impact significance rating of ***Low*** based on a sensitivity of *Low* and a magnitude of impact of *Low*. Therefore, marine fauna residual impact significance ratings range has been assessed as ***Very low*** to ***Low***.

Residual acoustic impacts of faulty cable removal and new cable installation and burial

It is assumed that the existing subsea cable during operations will have been buried to a nominal 1 m depth and that the cable section with the major fault will need to be removed (de-burial). It is assumed that an OSV with a tethered ROV trencher will be required to wet jet along the cable to allow cable removal.

The underwater noise sound pressure source level for the ROV cable trencher in burial mode is 150 dB re 1 µPa at 1 m (Section 7.2.3.2) and is assumed to be the same in cable de-burial mode. However, during cable installation and burial operation, it is underwater noise of 175 dB re 1 µPa at 1 m (Section 7.2.3.2) for the OSV that dominates over the seabed cable installation and burial noise in shallow waters.

Therefore, the OSV is anticipated to have lower underwater noise impacts than were assessed for the cable lay ship in Section 7.2.3, which was assessed to significance impacts ratings of between ***Very low*** and ***Low***, excluding the overly conservative significance impact rating of ***Moderate*** for HF hearing cetaceans. Therefore, the residual underwater noise impacts of the OSV on marine fauna are expected to have a similar significance impact ratings range (i.e., ***Very low*** to ***Low***).

Water quality impacts

Water quality impacts can arise from faulty cable removal (de-burial) and the installation and burial of replacement cable. Both cable de-burial and new cable installation and burial operations are expected to be completed within a few hours given the short lengths of cable removed and replaced. Therefore, water quality impacts are predicted to be short-lived and concentrations of fine-grained suspended seabed sediment within the turbidity plumes generated by de-burial and installation/burial operations are expected to dilute rapidly and become dispersed in the direction of bottom currents.

Residual water quality impacts of faulty cable removal

The potential impacts of cutting and removing the section of faulty cable, which has been assumed to be a maximum of one kilometre including buffer sections either side of a fault location for safety (i.e., potential water ingress into remaining cable in situ) cable), is basically a reversal of cable installation and burial process. Residual impacts of cable installation and burial on water quality were assessed in Section 7.2.2, to have significance impacts ratings of ***Low*** and cable removal (de-burial) operations are anticipated to have similar significance impact ratings.

Residual water quality impacts of replacement cable installation and burial

The residual water quality impacts of the installation and burial of a new extended replacement section of cable (i.e., the bight) are the same as these described in Section 7.2.2, where the impact significance ratings were all assessed as ***Low***, given the small quantities of resuspended fine-grained seabed sediments and the rapid dilution and dispersion of turbidity plumes in the direction of bottom currents.

7.3.5 Summary of operational impacts

Table 7-50 presents a summary of the project's operational impacts.

Table 7-50: Summary of operational impacts on marine ecology

Impact assessment descriptor	Sensitivity of value or receptor	Magnitude of impact	Residual impact significance
Magnetic field impacts:			
Impacts on cetaceans	High	Negligible	Low
Impacts on sea turtles	High	Negligible	Low
Impacts on pinnipeds – eared seals	Very Low	Negligible	Very Low
Impacts on pinnipeds – true seals	Moderate	Negligible	Low
Impacts on bony fishes	Moderate	Negligible	Low
Impacts on cartilaginous fishes	High	Negligible	Low
Impacts on marine invertebrates	Low	Negligible	Very Low

Impact assessment descriptor	Sensitivity of value or receptor	Magnitude of impact	Residual impact significance
Impacts on marine resource use	Moderate	Low	Low
Electric field impacts:			
Impacts on benthic elasmobranchs	Low	Negligible	Very low
Thermal field impacts:			
Impacts on benthic and epi-benthic fauna	Low	Negligible	Very low
Maintenance impacts*			
Underwater noise impacts from ROV support vessels during routine maintenance and inspection	Low to Moderate	Negligible to Low	Very low to Low
Underwater noise impacts from OSV vessels during minor cable repairs	Low to Moderate	Negligible to Low	Very low to Low
Major cable fault repair – underwater noise and water quality impacts	Low to Moderate	Negligible to Low	Very low to Low

* Maintenance impact ratings are based on the ranges assessed for relevant construction impacts rather than repeated for each receptor.

7.4 Decommissioning impacts

7.4.1 Background

At the end of the operation life, the subsea HVDC and optic fibre cables may be left in situ or removed. Decommissioning will depend on the environmental laws of the three jurisdictions (Commonwealth, Tasmanian and Victorian legislation) that may apply in about 40 years after the project's initial operation. A draft Decommissioning Plan will be prepared about before the end of project life, which will take account of any legislative changes or updated industry codes or guidelines at that time.

In Victoria, DEECA have stated that the decommissioning plan needs to be consistent with the *Marine and Coastal Act 2018* and Marine and Coastal Policy 2020. If Victorian legislative changes or updated industry codes of best practice or guidelines are developed the decommissioning plan may be amended.

For the purposes of the report, the following scenarios are assessed:

- Scenario A: subsea cables are decommissioned and left in situ.
- Scenario B: subsea cables are decommissioned and removed.

The predicted impacts of the above scenarios are assessed in the following sections.

7.4.2 Potential impacts

This section assesses the project's key impacts from the decommissioning of the subsea cables (Scenarios A and B).

7.4.2.1 Potential impacts if cables are left in situ (Scenario A)

Leaving the cables in situ will result in avoidance of seabed disturbance, sedimentation, water turbidity and impacts on flora and fauna communities and their habitats. It will also mean avoidance of impacts at shore crossings and on intertidal zones since the cables in underground HDD ducts (including the ducts) will remain in situ and undisturbed.

The relatively benign chemical composition of the XLPE-extruded HVDC cables, poses a low likelihood of direct chemical contamination to marine or sediment quality in the decommissioning process. However, there is a potential for the release of metallic contaminants (e.g., copper conductor and cable metallic sheathing metals) in the very long term (decades, centuries, or millennia). This has been dismissed as an issue by Taormina et al., (2018) who state that heavy metals can potentially dissolve and spread into the sediment from damaged and abandoned cables, but the quantities released are considered insufficient to have significant impacts.

There is potential for buried project cables becoming exposed due to seabed scour, especially in the more hydrodynamic nearshore environments with the potential for hook-ups by vessel anchor and bottom-trawled fishing gears. However, this potential risk will have been evaluated over the 40 years of operations based on periodic surveys or inspections of the cables. While the risk is likely to be very low for the crossing of the main deepwater section of Bass Strait, the risk may be higher in the nearshore areas of higher hydrodynamic energy, particularly in association with major storm events that increase seabed sediment transport.

The absence of decommissioning vessels means that there will be no temporary exclusion zones to maritime traffic, including fishing vessels required for the cable removal option. In addition, there will no underwater noise given the absence of decommissioning vessels.

Hard substrata (e.g., rock fill or concrete mattresses) at third-party seabed infrastructure crossings (e.g., pipelines and telecommunication cables) will remain in situ and will continue to provide hard seabed habitat of high structural diversity for benthic fauna adapted to colonising and establishing populations on hard seabed as opposed to surrounding sandy seabed habitat.

7.4.2.2 Potential impacts if cables are removed (Scenario B)

Under Scenario B (cables removed), the following potential impacts are predicted:

- Physical disturbance to the seabed associated with the removal of cables; although the impacts will be significantly less than those caused by cable installation operations, owing to fewer and smaller ships and attendant vessels required for cable de-burial and retrieval operations.
- Impacts from cable de-burial and pulling the cables directly to the surface by a large vessel with sufficient bollard pull capacity, cutting the retrieved cables on deck, and storing the cut sections for subsequent transport to appropriate disposal or recycling at approved land-based facilities. This method is applicable to subsea cables buried to less than 1 m depth. The main potential physical impacts relate to minor seabed disturbance causing highly localised sedimentation and the generation of turbidity plumes, with consequential potential impacts on biological communities and their habitats.
- In case of deeper burial depth greater than 1 m, the use of ploughing, wet jetting, or a detrenching tool method may be required to release the cables from the seabed. In this case, the environmental impacts are a reverse of the residual impacts on seabed habitats and associated benthic biological communities assessed in previous sections of this report for cable installation and burial. The main potential physical impacts relate to more significant seabed disturbance causing localised sedimentation and the generation of turbidity plumes, with consequential potential impacts on biological communities and their habitats.
- Underwater noise will be generated by the vessels used to recover the buried cables and, if used, additional underwater noise will be generated by the ploughing or wet jetting operations at the seabed.
- Temporary exclusion zones will be required around the cable retrieval vessels with potential impacts on navigation and maritime traffic, including commercial fishery access to fishing grounds.

- Recovery of cables from the seabed will have a beneficial impact on the commercial fishing industry by eliminating a potential future snagging hazard for bottom trawling or other fishing gear should the cable left in situ become exposed for any reason.

As noted above, cable protection covers (e.g., concrete mattresses) at third-party seabed infrastructure crossings (e.g., pipelines and telecommunication cables) provides hard seabed habitat of high structural diversity for benthic fauna adapted to colonising and establishing populations on hard seabed as opposed to the surrounding sandy seabed habitat. The draft Decommissioning Plan developed towards the end of project life will likely contain a requirement to undertake a technical marine survey of the project alignment prior to decommissioning and cable removal operations. In addition, a marine biological survey may be undertaken to characterise the biodiversity of marine flora and fauna established at the concrete mattress sites. If listed threatened species are found to be present within the structure of the concrete mattresses, the regulatory authorities at that time may decide that the concrete mattresses and their associated benthic biological communities should not be disturbed. Therefore, under Scenario B (cables removed) there are two options that may be considered:

- Scenario B1 – cables fully removal:
  - cables fully removed including the removal of the concrete mattresses.
- Scenario B2 – cables partially removed:
  - partial cable removal but leaving the concrete mattresses in situ and undisturbed.

Under scenario B1 (cables fully removed), the impacts are the same as those described above under the main scenario B (cables removed) for removing the buried cables from the sandy seabed. However, the removal of the concrete mattresses (i.e., retrieved and brought onboard the offshore support vessel for subsequent onshore appropriate disposal) will result in the loss of sessile fauna while the more mobile fauns including fish will disperse in the water column. At this juncture, it is not feasible to characterise or predict the likely flora and fauna that may have colonised and/or established populations within the concrete mattresses or on their hard surfaces. This will be the subject of a marine biological survey towards the end of operation life.

Under scenario B2 (cables partially removed), the cables either side of the concrete mattresses will be cut and retrieved to the surface and placed on board the offshore support vessel, while the cables covered by the concrete mattresses will be left in situ without removing or disturbing biological communities of the concrete mattresses. The potential impacts of scenario B2 are the same as those general descriptions described under scenario B (cables removed) above since it involves removing the vast majority of the buried cables except at those few locations where rock mattresses have been retained in situ and undisturbed.

For the purposes of the present report, detailed impact assessments of the above scenarios and sub-options have not been undertaken; however, the principal impact pathways and generic high-level impacts have been characterised. Detailed impact assessments of the above scenarios and sub-options will be undertaken as part of the preparation and development of a draft Decommissioning Plan towards the end of operation life.

7.4.2.3 Environmental Performance Requirements

Decommissioning impacts in the marine environment will be managed through EPR EM06:

Develop and implement a marine decommissioning management plan

Prior to the commencement of decommissioning, prepare a marine decommissioning management plan with the objective of leaving a safe, stable and non-polluting environment, and minimising impacts during the removal of infrastructure.

The marine decommissioning management plan must:

- Identify marine infrastructure proposed to be removed or left in situ.
- Assess potential impacts of decommissioning activities for the removal or retention of infrastructure.
- Outline how activities associated with subsea cable decommissioning are to be carried out in accordance with the Offshore Electricity Infrastructure (OEI) Act licence.
- Describe measures to be implemented to avoid or reduce impacts from the removal of infrastructure (if required).
- Consider management measures adopted in construction and apply where similar impacts could occur.
- Comply with the requirements of relevant legislation and guidelines at the time.
- Apply the waste management hierarchy for removed materials.
- Be consistent with the Marinus Link Sustainability Framework.

The marine decommissioning management plan is to be developed in consultation with landholders, relevant stakeholders and regulator/s. The plan must meet the relevant requirements of legislation and guidelines at the time of decommissioning. The marine decommissioning management plan must be implemented during decommissioning.

7.4.2.4 Potential mitigation and management measures

The same mitigation and management measures proposed for cable installation and burial should apply to subsea cable removal (all or partial) and are therefore not repeated here.

7.4.3 Residual decommissioning impacts

Very few offshore wind energy projects or subsea HVDC or HVAC cable projects have been decommissioned to date, so environmental impacts and considerations are still not fully understood (Kreider et al., 2022).

A literature review was undertaken to gain an overview of considerations relating to subsea cable removal or abandonment in situ. The summary of the literature review is as follows:

- Clare (2022) considers that buried cable recovery activities have a minimal physical impact on the marine environment and that the main contributor is the grapnels used to cut and hold the cables being recovered, which is the same approach that is used in cable repair and is an environmentally benign activity.
- Krause and Carter (2018) consider that subsea cable de-burial using ploughs are preferable when possible as they can rebury the trench left behind cable when being pulled out and are less disturbing than et jetting and trenching methods. Therefore, seabed disturbance and consequential impacts on benthic habitats and biological communities from ploughing are smaller than other de-burial methods.
- Smith et al. (2015) considers that cable removal will mostly follow similar procedures to the installation.

In general, subsea cable de-burial will temporarily disturb the seabed along a very narrow path. However, scientific studies have shown that any disturbance to benthic ecosystems is minor and temporary with the seabed rapidly recovering to its natural state (Kogan et al., 2006; Sherwood et al., 2016; Krause and Carter, 2018).

Based on the literature review and the above examples, the main consensus appears to be that subsea cable de-burial and total or partial removal will have less of an environmental impact compared to the impacts of cable installation and burial impacts. Since the predicted impacts of cable installation and burial in previous sections of this report were assessed to have residual impact significance ratings of between ***Low*** and ***Very low***, the residual impacts of cable removal operations are also assessed to have residual impact significance rating within this range. Therefore, a detailed impact analysis of cable removal has not been repeated here. A detailed impact assessment will be undertaken for the project's Decommissioning Plan to be developed near the end of the project's operational life.

7.5 Cumulative impacts

The EIS guidelines and EES scoping requirements both include requirements for the assessment of cumulative impacts. Cumulative impacts result from incremental impacts caused by multiple projects occurring at similar times and within proximity to each other.

To identify possible projects that could result in cumulative impacts, the International Finance Corporation (IFC) guidelines on cumulative impacts have been adopted. The IFC guidelines (IFC, 2013) define cumulative impacts as those that 'result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/or reasonably anticipated future ones.'

The approach for identifying projects for assessment of cumulative impacts considers:

- Temporal boundary: the timing of the relative construction, operation, and decommissioning of other existing developments and/or approved developments that coincides (partially or entirely) with the project.
- Spatial boundary: the location, scale, and nature of the other approved or committed projects are expected to occur in the same area of influence as the project. The area of influence is defined at the spatial extent of the impacts a project is expected to have.

7.5.1 Proposed and reasonably foreseeable third-party projects

Proposed and reasonably foreseeable projects were identified based on their potential to credibly contribute to cumulative impacts within the marine environment due their temporal and spatial boundaries. Marine-based projects were identified based on publicly available information at the time of assessment.

The projects considered for cumulative impact assessment across Bass Strait are:

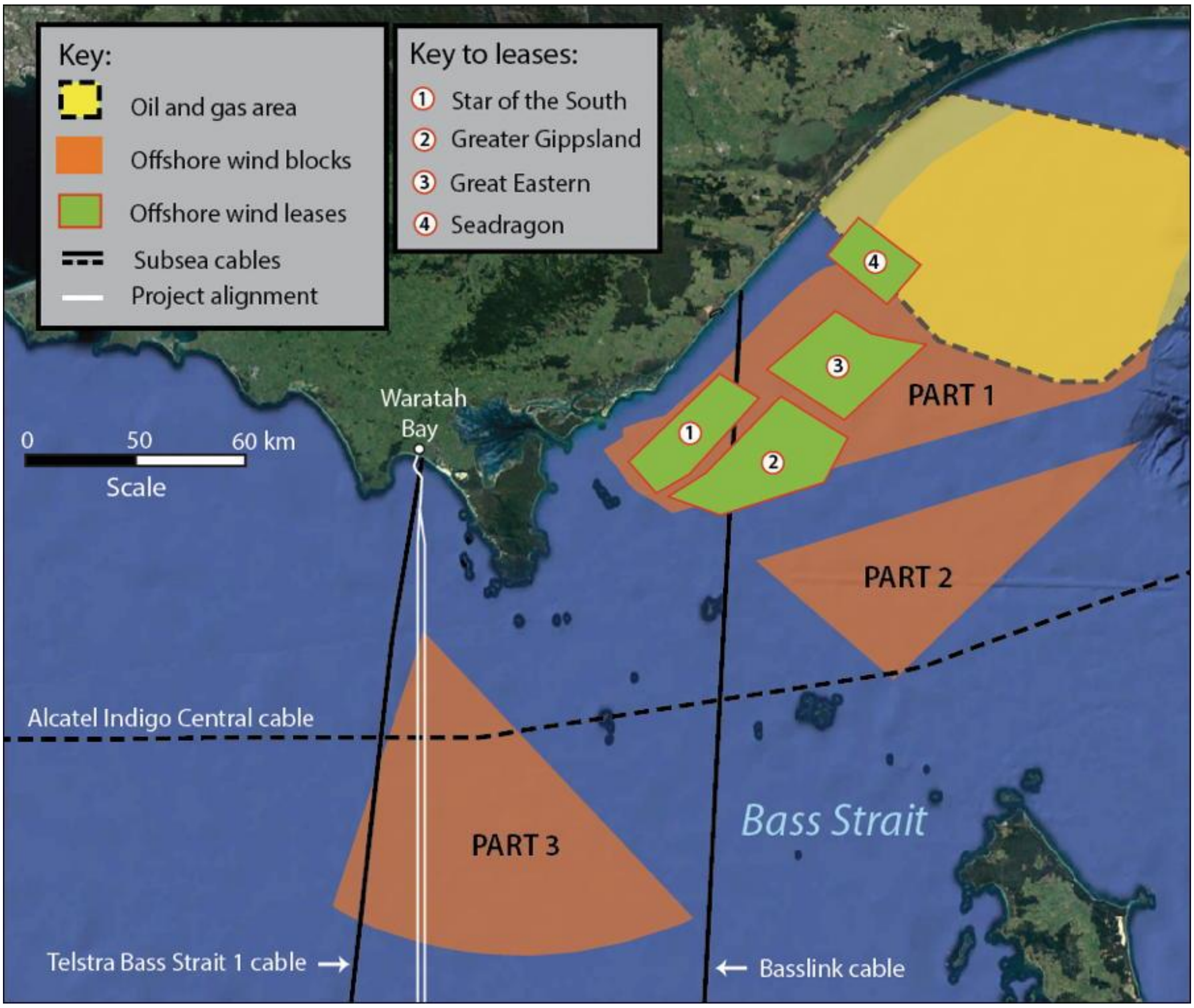
- Offshore Victorian wind development declared areas in Gippsland including:
  - Star of the South Offshore Wind Project (SOTS).
  - Great Eastern Offshore Wind (Corio Generation).
  - Greater Gippsland Offshore Wind Project (BlueFloat Energy)
  - Seadragon Project (Flotation Energy).
  - Yolla Infield Well Project

Table 7-51 presents a list of proposed and reasonably foreseeable offshore wind farm project lease areas within the declared blocks for offshore renewable area (DCCEEW, 2023c) and Figure 7.23 shows the locations of the declared blocks and lease areas to date (December 2023).

Table 7-51: Reasonably foreseeable marine-based projects near the project area

No.	Project	Proponent	Energy (MW)	Start of operation	CPA* distance (km)
Offshore wind energy projects:					
1	Star of the South	SOTS Pty Ltd	2,200	N/R	82
2	Great Eastern	Corio Generation	2,500	2030	78
3	Greater Gippsland	BlueFloat Energy	1,400	2030	130
4	Seadragon	Flotation Energy	1,500	N/R	160
Oil and gas projects:					
5	Yolla Infield Well Project	BassGas	N/A	N/R	25.5

Note: *CPA is closest point of approach to the project alignment. N/R = not reported; N/A= not applicable.



Source: Google Earth™, Tetra Tech Coffey Webmap, DCCEEW (2023c). Note map is for illustrative purposes. Widths of the telecommunication cables and HVDC cables are enlarged for visibility. Locations of offshore wind lease areas are approximate and have been based on interpolation of published small-scale maps.

Figure 7.23: Third-party subsea infrastructure and prospective offshore wind farm areas

The Declared Area (DCCEEW, 2023c) in Figure 7.23 comprises three offshore wind blocks:

- Part 1: Declared Area OEI-01-2022 Part 1 as specified in Schedule 1.
- Part 2: Declared Area OEI-01-2022 Part 2 as specified in Schedule 2.
- Part 3: Declared Area OEI-01-2022 Part 3 as specified in Schedule 3.

7.5.2 Cumulative impacts during construction

During project construction, cumulative impacts may occur in relation to general maritime traffic (i.e., continuation of existing background traffic) and future third-party offshore wind project vessel traffic crossing the project's alignment. The key potential cumulative impact relates to the cumulative impacts of underwater noise to marine fauna.

7.5.2.1 Cumulative impacts of underwater noise

Underwater noise generated by the project's construction vessels, general maritime traffic vessels (i.e., continuation of existing 'background' vessel traffic), and future offshore wind project vessel traffic have the potential to cause underwater noise cumulative impacts. Given the large separation distances of between 78 km (i.e., Great Eastern offshore wind project) and 160 km (Seadragon offshore wind project), from the project alignment, cumulative impacts are not predicted for PTS onset, TTS onset, or disruptive behavioural impacts to the marine fauna hearing groups assessed (see Section 7.2.3). This is due to the predicted short distances to the isopleths representing various acoustic threshold criteria (i.e., the maximum radius of 21.5 km for the behavioural threshold of 120 dB re 1 μPa rms (NMFS, 2018) relevant to LF hearing cetaceans (see Table 7-19). This distance of 21.5 km is much smaller than the 78 to 160 km between the project and the offshore wind projects. In addition, cumulative noise impacts of project construction and offshore wind project vessels transiting across the project's alignment are short term and expected to contribute to the local noise field but not significantly to the overall increase in regional background noise.

The general finding of short distances to acoustic threshold criteria for LF hearing cetaceans is also expected to be the case for the offshore wind projects' acoustic impact assessments. However, low frequency noise generated coincidentally by the project, offshore wind projects, and general maritime traffic can travel for very long distances (hundreds of kilometres), which adds to the overall background shipping noise of Bass Strait and has the potential to mask communication calls between LF hearing cetaceans.

Given the long distances travelled by low frequency underwater noise from shipping and the fact that some 18,644 vessels use Bass Strait per year (Marine Traffic Assessment, Stantec 2023), it is likely that background shipping noise is virtually constant in this region.

While there is no quantitative data available to assess how marine mammals and their sound perception is affected by multiple sources of underwater noise, the trend of increasing background noise in Bass Strait is expected to exacerbate the degree of masking by reducing the ability of distant LF hearing cetaceans to detect intraspecific communications (e.g., mating calls or songs) as well as other biologically relevant sounds (e.g., approaching predators).

The underwater noise impact of masking in LF hearing cetaceans (Section 7.2.3.5.2) indicated that acoustic auditory masking of due to cable lay ship-generated underwater noise was predicted to have a residual impact significance rating of ***Very low***. However, the cumulative impact of multiple sources from the project, offshore wind projects, and general maritime traffic increasing the overall background noise of Bass Straits is predicted to have a residual impact significance rating of ***Low***. This is based on a sensitivity of *Low* due to LF cetaceans being widely distributed and relatively abundant in Bass Strait and a magnitude of *Moderate* (due to the cumulative impact that extends beyond the operational areas of the project but is contained within the region, and the noise contribution from project construction being temporary). Despite this potential increase in underwater communication masking, there is growing evidence that in the presence of consistent noise, marine mammals can adapt their vocalisations (intensity/frequency) so that their calls are less likely to be masked (McGregor et al., 2013). For example, one strategy for some cetaceans is to compensate for increased background noise by increasing the source level or amplitude and/or frequencies of their calls, so that distant cetaceans of the same species can hear their calls and vice versa. This phenomenon is known as the Lombard effect (Lombard, 1911) and most likely serves to maintain an appropriate and detectable signal-to-noise ratio for the receiver (e.g., a baleen whale).

7.5.3 Cumulative impacts during operations

The numbers of project vessels deployed during the operations phase for ROV surveys, routine maintenance, and minor repairs are very low and cumulative interactions with other vessels associated with the reasonably foreseeable offshore wind project vessels, and general marine traffic does not warrant a cumulative impact assessment. However, at third-party cable crossings, the magnetic fields generated by the project's subsea HVDC cables during power transmission have the potential to interact with the magnetic fields generated around existing operating subsea telecommunication cables (i.e., Telstra's Basslink 1 cable and Alcatel's Indigo Central cable).

In general, short length optic fibre cables without repeaters have no associated magnetic field (GNL, 2011). However, long length optic fibre cables with repeaters (which require cable powering) generate weak magnetic fields between 30 to 38 µT at the cable surface (ROD, 2022), which are less than the background geomagnetic field (60.5 µT in Bass Strait). The maximum magnetic field intensity is at the exterior cable surface and decreases inversely with distance from the cable.

At the project cable crossings over third party subsea telecommunication cables, the HVDC cable magnetic fields will mask those of the underlying telecommunication cables, which will be separated from the project's HVDC cable by concrete mattresses by up to one metre. Therefore, it is expected that there will be little interaction between the cables' magnetic fields and no cumulative impacts are predicted on marine magnetosensitive fauna.

Other near-future projects include potential oil and gas projects and future offshore wind projects that are proposed within the DCCEEW (2023) declared area (e.g., Part 3 offshore wind block shown in Figure 7.23). The cumulative impacts of project operations and these third-party activities are discussed below.

7.5.3.1 Oil and gas projects

A possible near-future project is the BassGas Yolla Infield Well Project. Beach Energy (2022) is preparing an Environment Plan (EP) for the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA) to assess and accept before activities on the Yolla Infield Well Project can commence. As noted above, the existing BassGas Yolla production platform is located 64.5 km west of the current project's western monopole (ML1) and, assuming a prospective area around the platform of a 20-km radius, the BassGas Yolla Infield Well Project is still around 45 km west of the project's western monopole (ML1) alignment.

The current project, if approved, will likely be completed before the BassGas Yolla Infield Well Project commences, although no target dates have been given for completion of the Yolla Infield Well project (Beach Energy, 2022); therefore, cumulative impacts of increased marine construction traffic and underwater noise levels are unlikely to coincide. Also, given the distance of about 45 km between the Yolla Infield Well Project from the current project, cumulative impacts are not expected to occur.

Any future oil and gas project or developments within the east Gippsland oil and gas area shown in Figure 7.23 are too distant for cumulative environmental impacts with the current project, given the very large separation distance of about 170 km.

7.5.3.2 Future offshore wind energy projects

Offshore renewable energy companies considering the Part 3 offshore wind block are unknown at this juncture (December 2023). However, it is assumed that any future offshore wind leases are likely to be located within the larger eastern half of Part 3 offshore wind block (i.e., east of the current project alignment), which avoids any crossing of the project by directing export power cables to landfall in Waratah Bay and east of the current project's landfall zone. Any future offshore wind lease areas within the western half of Part 3 offshore wind block are also unlikely to cross the project alignment, since their export power cable(s) can run parallel to the project's alignment to landfall. However, any wind farm export cables will have to cross the Telstra Bass Strait 1 cable.

Notwithstanding, potential cumulative impacts have been assessed below with regards to underwater noise from vessels during project operation, and the construction and/or operation of offshore windfarms in the declared Part 3 offshore wind block.

7.5.3.2.1 Potential cumulative underwater noise impacts during project operation

Potential cumulative impacts between the project operations and third-party offshore wind energy projects (i.e., construction and operation) will be limited by both temporal and spatial separation:

- **Temporal separation:**
  - The project (if approved) will be operating before any future offshore wind farms are operational, which avoids potential construction cumulative impacts and interactions. This is based on any future project due to conduct feasibility studies in 2023 and 2024 and a typical duration of about ten years to progress from planning to operations.
  - During project operations, underwater noise from the construction of offshore wind farms within licensed leases within the declared area Part 3 offshore wind block may coincide with project vessels undertaking cable inspections, surveys or minor HVDC cable repairs.
- **Spatial separation:**
  - If any future offshore wind farm project crosses the project alignment within the declared area Part 3 offshore wind block, the developers will be required to maintain a buffer zone of 1-km either side of the current project's subsea HVDC cable alignments (see below for derivation).

The 1-km wide buffer zones either side of the existing subsea HVDC cables is based on the Star of the South project's license area, which has a 1-km width buffer either side of the existing Basslink HVDC bundled cable. In addition, the 1-km wide buffer zone either side of the project alignment is required for safety reasons in the case that a cable repair ship or other operational vessels lose dynamic positioning control or engine power; hence, giving the vessel sufficient time to drop anchor (Ryan Atkinson, Marinus Link Project Engineer, pers. comm.). A narrower buffer zone would give little time for re-establishing ship control and a distressed vessel may be moved by wind against the offshore wind farm infrastructure.

During operation, the project's energised subsea cables do not generate any underwater noise; therefore, cumulative noise interaction between project operation and offshore wind farm construction is not predicted. It is only during periodic inspections or surveys along the project alignment, when project vessel noise may interact with noise generated via wind farm construction activities. However, this would be a very short-term interaction that would be similar to the transit of any third-party vessel. Any coincidental overlapping noise would be very short term and very infrequent, and no cumulative underwater noise impacts are expected to have a residual impact significance rating of ***Very low***.

7.5.3.2.2 Potential cumulative electromagnetic field impacts during project operation

During project operation, the potential for the project cables' electromagnetic fields to combine with those of future offshore wind farm cables to cause cumulative impacts would only exist if the project's seabed cables are crossed by third-party offshore wind developers' cables. No electromagnetic field interactions between the project's HVDC cables and the inter-array field cables within the offshore wind farms are predicted, given that there will be a separation distance of at least 1 km between the current project and any future wind farm project. Therefore, no cumulative electromagnetic field impacts are predicted.

The export power cables from any future offshore wind projects operating either to the east or west of the project alignment within declared area Part 3 offshore wind block are not expected to cross the project alignment. For example, the export cable from a future offshore wind farm located in the western section of declared area Part 3 will likely have landfall west of the project's landfall near Cape Liptrap, while the export cable from a future offshore wind farm in the eastern section of declared area Part 3 is likely to have landfall to the east of the project's landfall in Waratah Bay.

Section 7.3.1 (Magnetic field impacts) of this report has demonstrated that the magnetic fields of the project's subsea HVDC cables are highly localised to the seabed and overlying water column out to about 20 m before reaching geomagnetic background levels. The predicted impacts of the project's magnetic field emissions on magnetosensitive marine fauna were assessed to have residual impact significance ratings of between ***Low*** and ***Very low***. In the case of the current project during operations, electromagnetic interactions between the electromagnetic fields of the project's subsea HVDC cables and the export cables of future offshore wind farms within declared area Part 3 and their landfalls are not predicted, owing to the minimum 1 km separation distance at which future offshore wind farms need to site their facilities from the project alignment.

Overall, no significant interaction between the projects' cable-generated magnetic fields (or any associated induced electric fields via seawater flows through the cables' magnetic fields) are predicted and cumulative impacts are not anticipated. In addition, the proponents of any future offshore wind farms in declared area Part 3 will be required by the Commonwealth and Victorian governments to assess and manage cumulative marine environmental impacts related to the project as part of their approvals process.

7.6 Summary of Environmental Performance Requirements

The EPRs are summarised in Table 7-52 and have been informed by the example potential mitigation measures discussed in the preceding impact assessment sections. These mitigation measures are discussed to provide an example of how the EPRs could be implemented. The EPRs have also been developed with consideration of industry standards and relevant legislation, guidelines, and policies.

Table 7-52: Summary of Environmental Performance Requirements

EPR ID	Environmental performance requirement	Project stage
MERU01	**Monitor HDD activities for the shore crossing to avoid or minimise impacts to the marine environment.** Prior to commencement of marine construction develop procedures for: • Monitoring HDD activities and drilling fluid pressures to minimise release of drilling fluid to the marine environment. • Extracting cuttings and drilling fluids from the HDD pilot boreholes for the shore crossing prior to breaking through to the sea floor. These procedures must be documented in a sub plan to the CEMP and implemented during construction.	Construction
MERU02	**Placement of final subsea project alignment to avoid or minimise impacts on benthic habitats.** The subsea project alignment, should be located, to the extent reasonably practicable: • Within the sand-filled paleochannels and gutters in nearshore Tasmania and within the sandy seabed of Waratah Bay, in nearshore Victoria. • Away from nearshore areas of higher biological productivity (e.g., low- and high-profile reefs). • To avoid obstacles such as rocks and relocated to areas of soft-sediment seabed. • The final subsea project alignment must be informed by geophysical surveys and geotechnical investigations, and seabed sampling	Design / Construction
MERU03	**Undertake a pre-lay survey prior to subsea cable installation to minimise seabed disturbance.** Prior to commencement of subsea cable installation, undertake a pre-lay survey to inform the final subsea project alignment so that it is clear of obstacles to the extent reasonably practicable, including low-profile reefs.	Construction
MERU04	**Minimise impacts from disturbing contaminated sediments around the disused tioxide pipeline.** Prior to commencement of marine construction that could disturb contaminated sediments associated with the disused tioxide pipeline of the former tioxide factory at Heybridge, Tasmania, measures must be developed and documented in a sub-plan the CEMP to manage the release of contaminated sediments during construction activities (e.g., wet jetting operations) in the paleochannels and gutters in the Tasmanian nearshore and offshore waters. These measures should also manage the release of surface sediment contaminants if the tioxide pipeline, currently exposed and resting on the seabed, is to be removed, cut or collapsed during construction.	Construction
MERU05	**Develop and implement a cable crossing management plan.** Prior to commencement of marine construction, develop a cable crossing management plan with measures to avoid impacts on existing third-party subsea cables during construction. The cable crossing management plan must: • Be developed through consultation with the owner of the Bass Strait 1 cable crossed by the project. • Be developed through consultation with the owner of the Indigo Central cable crossed by the project. • Describe the approach and key requirements for safe cable crossing. • Includes an engineering solution for the crossing with relevant infrastructure owners.	Construction

EPR ID	Environmental performance requirement	Project stage
	• Includes requirements for informing the Australian Maritime Safety Authority (AMSA) of the location, timing and duration of cable crossing works. • Be informed by guidelines published by the International Cable Protection Committee to assist the cable industry to adopt a harmonised approach in relation to crossings (ICPC 2023b). • Document the crossing point locations for the subsea cables, and the distances that the jet trencher will stop before crossing existing third-party subsea cable. • Outline the notification protocols for informing Bass Strait 1 and Indigo Central cable owners of the final design and construction approach. The plan must be implemented during construction.	
MERU06	**Develop and implement a marine communication plan.** Prior to commencement of marine construction, develop and implement a marine communication plan that includes: • Identification of relevant stakeholders. • Protocol for notifying the AMSA of the proposed locations, timing and duration of proposed marine construction activities. • The approach for compliance with AMSA Marine Orders Part 30 (Prevention of Collisions), AMSA Marine Orders Part 59 (Offshore Support Vessel Operations) and the convention on the International Regulations for Preventing Collisions at Sea, 1972 (COLREGs). • Protocol for informing the Australian Hydrographic Office of the locations, dates, times and duration of proposed marine construction activities. • A plan to engage with commercial and recreational fisheries on the project activities, schedule, locations and durations. • The approach for using guard vessels to enforce the temporary exclusion zone during cable laying across Bass Strait and at the shore crossings. • The approach for informing recreational users of marine activities, in accordance with the Community and Stakeholder Engagement Plan (EPR S03). This plan must be implemented during construction.	Construction / Operation
MERU07	**Develop and implement a marine fauna management plan.** Prior to commencement of marine construction, develop a marine fauna management plan to avoid or minimise impacts to marine fauna. The management plan should outline the approach to: • Managing interactions with marine fauna where there is not a specific species management plan required under EPR MERU08 and MERU09. • Reporting and collation of information about siting of and interactions with marine fauna, including those covered by species specific management plans. • Protocols for incident management and reporting. • Protocols for managing injured seabird or coastal bird if discovered on a lit vessel.	Construction / Operation

EPR ID	Environmental performance requirement	Project stage
	• Include species specific management plans as sub-plans. The measures in the plan must be consistent with the objectives of relevant EPBC Act recovery plans including: • Recovery Plan for Marine Turtles in Australia (DoEE 2017a) • National Recovery Plan for threatened Albatrosses and Giant Petrels 2011-2016 (DSEWPaC 2011) • Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC 2013c) • Sub-Antarctic Fur Seal and Southern Elephant Seal Recovery Plan (DEH 2004) • Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*) (DSEWPaC 2013b) The marine fauna management plan must be implemented during construction.	

MERU08	**Develop and implement a cetacean interaction management plan**
	Prior to commencement of marine construction, develop cetacean interaction management plan to avoid or minimise impacts to cetaceans during construction. The cetacean interaction management plan must:
	• Be developed in accordance with relevant guidelines including:
	  ○ EPBC Act Policy Statement 2.1 – Interaction between Offshore Seismic Exploration and Whales: Industry Guidelines (DEWHA 2008)
	  ○ Wildlife (Marine Mammals) Regulations 2019
	  ○ A guide to boating and swimming around whales, dolphins and seals (DELWP 2022)
	  ○ Wildlife Management. Whale and dolphin viewing guidelines (DNRE 2019b)
	• Define the area for visual monitoring for cetaceans that is appropriate for cable laying works.
	• Define precaution zones for maintaining a separation distance of cable laying works from cetacean and the distance at which works should be suspended when cetaceans approach.
	• Outline vessel-cetacean strike avoidance measures to minimise the potential for collision.
	• Include a procedure for marine mammal observations which may include the role of Marine Mammal Observers (MMOs) on construction vessels at or around active construction locations.
	The measures under the plan should be consistent with the goals of the EPBC Act Conservation Management Plan for the Blue Whale (DoE 2015f) and Conservation Management Plan for the Southern Right Whale (DSEWPaC 2012c).
	The cetacean interaction management plan should be a sub-plan to the marine fauna management plan (EPR MERU07) and be implemented during construction.
		Construction **/** Operation

MERU09	**Develop and implement a plan for managing interactions with sea turtles** Prior to commencement of marine construction, develop a sea turtle interaction management plan for managing interactions with sea turtles to avoid or minimise impacts during construction. The plan must: • Define the area for visual monitoring. • Document the approach to vessel based visual monitoring with a minimum visual monitoring buffer zone of 200 m.	Construction / Operation

EPR ID	Environmental performance requirement	Project stage
	• Define exclusion and buffer zones for maintaining a separation distance of vessels from sea turtles, including the requirement for transiting vessels to maintain a minimum separation distance of 50 m from sea turtles. • Outline vessel-sea turtle strike avoidance measures to minimise the potential for collision with sea turtles, including if sea turtles are sighted within the 50 m separation distance, vessels must reduce speed and shift the engine to neutral, not engaging the engines until sea turtles are clear of the area. • Consider all construction vessels including guard vessels, small boats manoeuvring floated cables, crew transit vessels and dive boats. A plan is not required for slow moving vessels laying cable, towing gear or subsea machines. The sea turtle interaction management plan should be a sub-plan to the marine fauna management plan (EPR MERU07) and be implemented during construction.	

MERU10	**Develop and implement measures to minimise impacts on marine fauna and avifauna due to lighting**
	Prior to commencement of marine construction, develop measures to minimise impacts on marine fauna due to artificial lighting for construction and operation. The measures must consider the following:
	• Australia's National Light Pollution Guidelines for Wildlife (DoEE 2020), to manage the effect of artificial light on marine turtles, seabirds, and migratory shorebirds that are listed under the EPBC Act, species that are part of a listed ecological community, and species protected under state or territory legislation for which artificial light has been demonstrated to affect behaviour, survivorship, or reproduction.
	• Australian Standard AS/NZS 4282:2019 Control of the obtrusive effects of outdoor lighting and recognise the impact of artificial light on living organisms.
	• EPBC Act Policy Statement 3.21 - Industry Guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (DoEE, 2017d).
	• The measures must:
	  o Minimise lighting where practicable and where safety is not compromised, minimise the number of lights, the intensity of lights, and the amount of time lights are turned on.
	  o Direct lighting to where it is needed and avoid general area floodlighting.
	  o Limit area and deck lighting to the amount and intensity necessary to maintain deck crew safety.
	  o Direct lighting inboard and downward (where possible) to reduce the potential for seabird attraction.
	  o Avoid direct lighting of the sea surface and minimise indirect lighting on the sea surface to the extent practicable.
	  o Include routine inspection of lighted areas of the cable lay vessel and other night-time operating vessels for birds that may have been attracted.
	The measures must be addressed in the marine fauna management plan (EPR MERU07) and be implemented during construction.
		Design / Construction / Operation

MERU11	**Develop and implement a plan to avoid the introduction of invasive marine species.** Prior to commencement of marine construction, develop a ballast water management plan and biofouling management requirements for each marine vessel to avoid the introduction of marine pests via ballast water and biofouling of the vessels hull and semi-enclosed spaces. ***Compliance with ballast water management requirements***	Construction / Operation

EPR ID	Environmental performance requirement	Project stage

	During construction and operation vessel owners must comply with the:
	• Australian Ballast Water Management Requirements (DAFF 2020).
	• Biosecurity Act 2015 (Cwlth).
	• International Convention for the Control and Management of Ships' Ballast Water and Sediments, 2004 (BWM Convention 2004).
	• Australian Anti-fouling and in-water cleaning guidelines (DoA, DoE 2015)
	• Ballast Water Management Requirements (DAFF 2020)
	• Maritime and Aircraft Reporting System (MARS) and the Vessel Compliance Scheme (VCS):
	  ○ Prepare and submit a Pre-arrival Report (PAR) for answering the ballast water questionnaire from DAFF.
	  ○ Non-First Point of Entry (NFP) application v16.
	  ○ Ballast Water (BW) report v108.
	International marine traffic must have a ballast water management plan for water and sediments that includes:
	• A ballast water record book.
	• An International Ballast Water Management certificate where ships are 400 gross tonnes and above in accordance with the BWM Convention and specifies which standard the ship is complying with, as well as the date of expiry of the Certificate.
	• Vessels with a ballast water management system must carry a type approval certificate specific to the type of ballast water management system installed.
	• Complete and accurate record of all ballast water movements.
	• Detailed information regarding vessel maintenance history for treating biofouling.
	
	Compliance with biofouling management requirements
	During construction and operation vessel owners must comply with the:
	• Biosecurity Amendment (Biofouling Management) Regulations 2021 (Cwlth) that require operators of all vessels to provide information on biofouling management practices prior to arriving in Australia.
	• Australian Biofouling Management Requirements ('ABFMR') (DAWE 2022) via:
	  ○ Biofouling Management Plan
	  ○ Biofouling Record Book.
	  ○ Alternatively, clean all biofouling within 30 days prior to arriving in Australia and submit a cleaning report to DAFF.
	• Australian National Antifouling and In-water Cleaning Guidelines (DoA, DoE 2015).
	The ballast water management plans and biofouling management requirements must be implemented during construction and operation.	

EPR ID	Environmental performance requirement	Project stage
MERU12	**Adopting a HVDC cable design that minimises the electromagnetic fields and heat emitted from the subsea and land cable** The cable and construction method must be designed to install and bury subsea cables in a manner that reduces the EMF emitted from the subsea cables at the seabed and overlying the water column. The cable design and installation must include: • Cable burial up to 1.5 metres. • Bundling the HVDC cables in each subsea circuit to cancel out or greatly reduce EMF. • Separating each subsea circuit to reduce interaction of electromagnetic fields.	Design / Construction
MERU13	**Notification of the final subsea project alignment** At the completion of marine construction, MLPL must inform the Australian Hydrographic Office and the Victorian Department of Energy, Environment and Climate Action of the locations and coordinates of the final subsea project alignment to enable the Australian Hydrographic Office to publish Notices to Mariners to inform maritime users of the presence of seabed power cables and mark them on navigation charts.	Operation

8 Conclusion

This report has examined aspects of the project that may result in impacts on the marine environment and on marine resource use. The assessment has addressed the issues outlined in the EIS and EES guidelines.

With adherence to environmental performance requirements and standards (where available) and implementation of the various mitigation measures set out in this report, the residual impacts are expected to be manageable.

The assessments undertaken in this report show that impacts of the project during, construction, operation and decommissioning are mainly restricted to within proximity of the project alignment and are manageable. Many potential impacts have been avoided or substantially reduced through early planning and design. For example, route selection along soft-sediment seabed for the installation and burial of the project's HVDC and optic fibre cables, resulted in avoidance of high marine biological diversity such as low- or high-profile reefs and other areas of hard substrata. In addition, the adoption of long trajectory horizontal directional drilling (HDD) for the shore crossings in Tasmania and Victoria avoided beach disturbance and potential impacts on intertidal flora and fauna.

8.1 Construction residual impacts

Construction residual impacts are predicted to arise from seabed disturbance, underwater noise and artificial light disturbance. Risks of introduction and spread of invasive marine species, and vessel collision with marine fauna were also assessed.

8.1.1 Seabed disturbance impacts

During construction of the project, this report has assessed that all seabed disturbance impacts to water and sediment quality, seabed habitats and associated benthic biological communities are short-term and recoverable, with the assessed residual impact significance ratings all being between ***Low*** and ***Very low***. These residual impact significance ratings for cable installation and burial are consistent with the findings of other HVDC interconnector projects such as the Basslink interconnector (CEE, 2009; Sherwood et al., 2016). Based on the results of a series of environmental monitoring campaigns, observations of impacts from Basslink showed no significant long-term impact on the seabed from the placement of subsea cables across Bass Strait and CEE (2009) and Sherwood et al. (2016) concluded that the ecological effects of the cable installation and burial on benthic communities have been transient and minor for soft sediments where the cable is buried.

8.1.2 Underwater noise impacts

Underwater noise sources of project construction are entirely non-impulsive continuous or intermittent noise, with no impulsive noise sources present. Underwater noise impacts were assessed for the project's loudest underwater noise source level estimated as 185 dB re 1 μPa at 1 m, which is for the cable lay ship maintaining position or actively laying cable using its thrusters under dynamic positioning control.

Underwater noise impacts to sound-sensitive marine fauna were assessed be mostly between ***Low*** and ***Very low***. However, a finding of a residual impact significance rating of ***Moderate*** was based on the potential for acoustic auditory damage (PTS onset) to high-frequency (HF) hearing cetaceans in the form of permanent hearing loss when using the NMFS (2018) cumulative sound exposure level (SEL_{cum}) threshold of 173 dB re 1 $\mu Pa^2 \cdot s$. NMFS (2018) recommends a maximum accumulation period of 24 hours for a stationary receptor (e.g., an HF cetacean in this case) that maintains a constant distance from a stationary noise source, which is a most unlikely scenario. NMFS (2018) acknowledges that there may be specific exposure situations where this accumulation period requires adjustment (e.g., if activity lasts less than 24 hours). This is the case for the present project in that the cable lay ship is a moving noise source, so a shorter cumulative period is more appropriate. MDA (2023; Attachment G) selected a shorter cumulation period of one hour to assess cumulative sound exposure level impacts on permanent hearing loss of HF cetaceans but which still resulted in a residual impact significance rating of ***Moderate***. This is a limitation of the above NMFS (2018) acoustic threshold criterion, which requires a receptor (such as an HF cetacean) to remain stationary or maintain a constant distance from the noise source, which is a most unlikely scenario.

In reality an HF cetacean approaching the cable lay ship will pass through and simultaneously detect the underwater noise gradient surrounding the cable lay ship before entering the predicted 67-m radius zone in which the NMFS (2018) cumulative sound exposure level (SEL_{cum}) threshold of 173 dB re 1 µPa^2 s will be exceeded. Under these conditions, an HF cetacean sensing the underwater noise gradient is unlikely to approach the ship and remain with the 67-m radius zone. In the case of a HF cetacean moving away or 'fleeing' from the cable lay ship noise source, rather than remaining stationary or at a constant distance from the cable lay ship, the PTS onset distance is less than 1 metre (Nedwell et al., 2012; Sweeney, 2018; Subacoustech, 2021a,b), which would then be assessed to have a residual impact significance rating of ***Low*** rather than ***Moderate***, and represent a more realistic scenario.

8.1.3 Artificial light disturbance

The cable lay vessel and the two guard vessels that will accompany cable lay operations will result in artificial light emissions during night-time works. Potential effects include injury or death to marine birds and invertebrates due to attraction to the light. Light emissions also have the potential to interrupt migration and roosting behaviour of marine birds. Artificial light impacts will be reduced by minimising lighting and light spill during construction.

Artificial light impacts were assessed as ***Low*** to ***Very Low*** due the localised, transient and short-term nature of light spill from the cable lay ship during cable laying operations at night.

8.1.4 Invasive marine species

There is a risk of introduction of invasive marine species (IMS) from vessel ballast water or hull fouling. Introduction of IMS has the potential to introduce pathogens that may infect native fauna and IMS can establish new habitats and outcompete local species. IMS risks will be managed by implementing a plan to avoid the introduction and minimise the spread of invasive marine species. This will include requirements for vessels to comply with a range of Australian and international ballast water, antifouling and biosecurity measures.

The risk of introduction of IMS due to vessel movements was assessed as *Low* given the range of well-established management measures to be implemented and the limited number of international ships (i.e., a cable laying vessel) that will be involved in the project in the context of a much larger number of international vessels using Bass Strait waters.

8.1.5 Vessel collision with marine fauna

Project vessel movements have the potential to collide with marine fauna causing injury or death, with the risk being highest during construction when more vessel movements will occur. Vessel collision can result in injury or death to slow-moving marine megafauna such as large cetaceans and sea turtles. Faster moving and agile fauna such as seals, sea lions, penguins, fish, squid and dolphins are less susceptible to collision strike as they can more readily evade approaching vessels.

The risk assessment focussed on risks to large cetaceans and sea turtles, given they are the most vulnerable to vessel collision.

Risks will be managed by implementation of marine fauna management plans (including cetacean interaction management plan and plan for managing interactions with sea turtles). These will include measures for monitoring the presence of cetaceans and sea turtles and implementation of precaution zones and no approach zones during vessel movements.

The risks of vessel-marine fauna collision ranged from very low to low, with the risk slightly higher in the case of faster moving construction vessels (typically between 12 to 18 knots). The risks are considered to be low with implementation of the precaution zones and in the context small number of project vessel movements in addition to existing maritime traffic, with which cetacean and turtle collisions are rare.

8.2 Operational residual impacts

During project operations, residual impacts have been assessed to have impact significance ratings of between ***Low*** and ***Very low***. The principal impact sources during operations relate to the energised subsea HVDC cables, which generate direct current static magnetic fields around the cables due to current flow, and thermal fields due to cable heating. Some magnetosensitive fauna will be able to sense the magnetic fields from the operating cables.

8.2.1 Magnetic field impacts

The key impact management approach is the adoption a modern HVDC cable design that minimises the electromagnetic fields and heat emitted from the subsea cable. The project design will include installation and burial of subsea cables in a manner that reduces the electromagnetic fields emitted from the subsea cables at the seabed and overlying the water column. Bundling of the HVDC cables in each subsea circuit will greatly cancel out and reduce electromagnetic fields.

The magnetic field generated by the energised bundled cable reduces to that of the background geomagnetic field at a distance of less than 20 m from the cable. Some magnetosensitive fauna will be able to sense the magnetic fields from the operating cables.

The residual impacts of the project’s magnetic fields on magnetosensitive fauna were assessed to have residual impact significance ratings between ***Low*** to ***Very low*** for cetaceans, sea turtles, pinnipeds, migratory eels, cartilaginous fishes (sharks, rays, and skates) and decapod crustaceans. No negative impacts are predicted for any threatened magnetosensitive marine fauna in the project area.

8.2.2 Induced electric field impacts

The metal armouring of the HVDC cables is grounded to earth to prevent any direct electric field being generated while the cables are in operation. However, seawater flowing through the HVDC cables’ generated DC static magnetic field will induce a corresponding DC static electric field. The induced electric field will reduce with distance from the buried HVDC cables.

The residual impacts of induced electric fields on electrosensitive cartilaginous fishes (sharks, rays and skates) were assessed to have residual impact significance rating of ***Low***. No negative impacts are predicted for any threatened electrosensitive marine species in the project area.

8.2.3 Thermal field impacts

During operations, thermal fields will be produced by heat generated by power transmission in the HVDC cables. Mitigation measures by design have already been incorporated in the HVDC cable, ensuring that conductor surface temperatures are within the range of 70°C to 90°C, at the required power transmission (MW).

The temperature rise at the seabed surface (i.e., upper 10 cm) due to the project's subsea HVDC cable heat emissions will be indistinguishable from the ambient seawater temperature and, therefore, will not have any negative impacts on benthic (e.g., sessile or seabed surface macroinvertebrates) or epibenthic fauna (e.g., benthic and demersal fishes). The predicted impacts of project thermal fields on seabed benthic and epibenthic fauna, and infauna within the top 10 cm of the sandy seabed, are all assessed to have a residual impact significance rating of ***Very low***.

8.3 Inspection and maintenance impacts

Routine subsea cable inspection and maintenance will occur during project operation. This will involve eight events over the 40-year operational life. Inspection and maintenance will involve the use of an ROV and offshore support vessel (OSV). As there will be less vessel movements during this time compared to construction, and the vessel will produce a lower sound level than that assessed for construction, the risks and impacts associated with marine fauna collision and underwater noise are predicted to be less than the range (very low to moderate), assessed for construction.

8.4 Decommissioning residual impacts

At the end of the operation life, the subsea HVDC and optic fibre cables may be left in situ or removed. Decommissioning will depend on the environmental laws of the three jurisdictions (Commonwealth, Tasmanian and Victorian legislation) that may apply in about 40 years after the project's initial operation. A draft Decommissioning Plan will be prepared about two or three years before the end of project life, which takes account of any legislative changes or updated industry codes or guidelines at that time.

Cable removal (de-burial) impacts will arise from pulling the cables directly to the sea surface by a large vessel with sufficient bollard pull capacity, cutting the retrieved cables on deck, and storing the cut sections for subsequent transport to appropriate disposal or recycling at approved land-based facilities. The process will basically be a reverse of the cable installation. However, the physical disturbance to the seabed associated with the removal of cables is significantly less than that caused by installation.

Overall, decommissioning impacts of cable removal have been assessed to have residual impact significance ratings of between ***Low*** and ***Very low*** due to reduced seabed disturbance from cable de-burial methods (e.g., absence of the need for wet jetting for shallow buried cables) and the smaller vessels used compared to the large cable lay ship that was required during project construction.

8.4.1 Residual impacts on marine resource use

Residual impacts on marine resource uses have been assessed to have impact significance ratings of between ***Low*** and ***Very low***. In terms of impacts navigation and marine traffic, temporary exclusions zones will be required around the cable lay vessel during cable lay operations and around the offshore support vessel during cable installation and burial operations. In general, ships' navigators and the skippers of smaller vessels will adjust their planned routes to deviate around the project's construction vessels that will have restricted movement. The location, timing and duration of the temporary exclusion zones will be presented as ‘Notices to Mariners’, which alerts other maritime users of the restricted manoeuvrability of project vessels undertaking marine construction or decommissioning activities. There will be no exclusion zones over the project’s subsea cables during operations as they will have been buried to a nominal depth of 1 m or more for protection against anchor and trawling gear hook-ups.

During power transmission, the project’s HVDC cable magnetic fields have the potential to cause interference with shipboard magnetic compasses. Ships and vessels not equipped with GPS may rely on magnetic compass readings for navigation and localised disturbances in the geomagnetic field can disrupt the accuracy of the compass reading. In general, the deeper the water the lesser the compass deviation effect and conversely, the shallower the water the greater the compass deviation effect. Therefore, transient magnetic compass deviations are only expected when a boat with a magnetic compass passes directly over the HVDC cables in nearshore shallow waters. It is expected that any impact to the compass reading on these vessels near the shoreline will not impact navigation or safety as visual navigation will assist longshore transits.

Commercial fishery resources (e.g., targeted fish, squid, abalone and shellfishes) are not predicted to be impacted, since the project’s impacts on marine fauna, which includes targeted fish and shellfish species, were assessed to have residual impact significance ratings of between ***Low*** and ***Very low***. As noted above, commercial fishers can forward plan to avoid the temporary exclusion zones around the cable lay ship during cable laying operations and/or the offshore supply vessel used in cable installation and burial.

The cumulative impact assessment has shown that the project’s interaction with third-party projects or developments are limited and that potential impacts are mitigated by temporal spatial separation. Reasonably foreseeable future projects include the recent push for offshore wind farm projects of which one area declared by the DCCEEW (2023) as suitable for offshore renewable energy overlaps the current project’s alignment to the southwest Wilsons Promontory. However, potential interactions of magnetic fields from a future wind farm’s subsea cable network and that produced by the current project will be sufficiently separated by a mandatory buffer zone around existing subsea HVDC cables. Therefore, no magnetic cumulative impacts are predicted based on preliminary information on the power and cable types likely to be used at a future offshore wind farm in the vicinity of the current project’s alignment (assuming the current project is approved and developed).

8.5 Uncertainties and information gaps

In terms of uncertainties and information gaps, there is lack of information on whether the project’s proposed parallel symmetric monopolar HVDC configuration with voltage source converter technology will generate residual AC magnetic fields in the subsea HVDC cables. It is known that the conversion process of HVAC power to HVDC power is not 100% efficient. This information gap relates to recent findings of AC magnetic fields in some overseas operating subsea HVDC interconnectors, where magnetometer surveys across HVDC cables have revealed the unexpected presence of low AC magnetic fields. For example, Hutchison et al., 2018) highlighted the presence of unexpected AC components in the magnetic field emissions for both the Cross Sound Cable and the Neptune Cable in the USA. In addition, the computer software programs used by Hutchison et al. (2018) for modelling and simulating DC magnetic fields in HVDC cables currently do not predict these AC fields. Notwithstanding, as with the DC static magnetic fields assessed in the present report, any weak AC magnetic fields are anticipated to be of similar in that they diminish rapidly with distance from the HVDC cables.

8.6 Marine ecology EPBC Act significant impact assessment

Critically endangered species in study area: Curlew sandpiper (*Calidris ferruginea*), Great Knot (*Calidris tenuirostris*), Eastern Curlew (*Numenius madagascariensis*), Swift parrot (*Lathamus discolor*), Orange-bellied Parrot (*Neophema chrysogaster*), Regent honeyeater (*Anthochaera Phrygia*), Sea cucumber (*Apsolidium falconerae*), Sea cucumber (Pentocnus bursatus), Sea cucumber (*Rowedota shepherdi*), Brittle star (*Clarkcoma australis*), Stalked hydroid (*Ralpharia coccinea*), Marine opisthobranch (*Rhodope rousei*), Chiton 5254 (*Bassethullia glypta*).

Endangered species in study area: Southern right whale (*Eubalaena australis*), Antarctic blue whale (*Balaenoptera musculus intermedia*), Pygmy blue whale (*Balaenoptera musculus brevicauda*), Sub-Antarctic seal (*Arctocephalus tropicalis*), Australian sea lion (*Neophoca cinerea*), Loggerhead turtle (*Caretta caretta*), Leatherback turtle (*Dermochelys coriacea*), Olive Ridley turtle (*Lepidochelys olivacea*), Northern royal albatross (*Diomedea sanfordi*), Southern Giant Petrel (*Macronectes giganteus*), Gould's Petrel (*Pterodroma leucoptera leucoptera*), Grey-headed albatross (*Thalassarche chrysostoma*), Shy albatross (*Thalassarche cauta*), Australasian Bittern (*Botaurus poiciloptilus*), Mongolian Plover (*Charadrius mongolus*), Red Knot (*Calidris canutus*), Grey Falcon (*Falco hypoleucos*), Sea cucumber 5251 (*Apsolidium densum*), Sea cucumber 5052 (*Apsolidium handrecki*), Sea cucumber (*Thyone nigra*), Brittle star (*Amphiura trisacantha*), Brackish jellyfish (*Australomedusa baylii*), Sea slug (*Platydoris galbana*), Ghost shrimp (*Pseudocalliax tooradin*), Southern hooded shrimp (*Athanopsis australis*).

Vulnerable species in the study area: Sei whale (*Balaenoptera borealis*), Fin whale (*Balaenoptera physalus*), Southern elephant seal (*Mirounga leonina*), Green turtle (*Chelonia mydas*), Hawksbill turtle (*Eretmochelys imbricata*), Antipodean albatross (*Diomedea antipodensis*), Gibson's albatross (*Diomedea antipodensis gibsoni*), Southern Royal Albatross (*Diomedea epomophora*), Wandering Albatross (*Diomedea exulans*), White-bellied Storm-petrel (*Fregetta grallaria grallaria*), Blue Petrel (*Halobaena caerulea*), Northern Giant Petrel (*Macronectes halli*), Sooty Albatross (*Phoebetria fusca*), Soft-plumaged Petrel (*Pterodroma mollis*), Buller's Albatross (*Thalassarche bulleri*), Northern Buller's Albatross (*Thalassarche bulleri platei*), Indian Yellow-nose Albatross (*Thalassarche carteri*), Campbell Albatross (*Thalassarche impavida*), Black-browed Albatross (*Thalassarche melanophris*), Salvin's Albatross (*Thalassarche salvini*), White-capped Albatross (*Thalassarche steadi*), Australian Fairy Tern (*Sternula nereis nereis*), Nunivak Bar-tailed Godwit (*Limosa lapponica baueri*), Fairy Prion (*Pachyptila turtur subantarctica*), Australian Painted Snipe (*Rostratula australis*), Eastern Hooded Plover (*Thinornis cucullatus cucullatus*), White-throated Needletail (*Hirundapus caudacutus*), White shark (*Carcharodon carcharias*), Australian grayling (*Prototroctes maraena*), Sperm whale (*Physeter macrocephalus*).

Migratory species in the study area: Humpback whale (*Megaptera novaeangliae*), Southern right whale (*Eubalaena australis*), Sei whale (*Balaenoptera borealis*), Antarctic blue whale (*Balaenoptera musculus intermedia*), Pygmy blue whale (*Balaenoptera musculus brevicauda*), Fin whale (*Balaenoptera physalus*), Pygmy right whale (*Caperea marginata*), Sperm whale (*Physeter macrocephalus*), Killer whale (*Orcinus orca*), Dusky dolphin (*Lagenorhynchus obscurus*), Indo-Pacific bottlenose dolphin (*Tursiops aduncus*), Antarctic minke whale (*Balaenoptera bonaerensis*), False killer whale (*Pseudorca crassidens*), Loggerhead turtle (*Caretta caretta*), Green turtle (*Chelonia mydas*), Leatherback turtle (*Dermochelys coriacea*), Olive ridley sea turtle (*Lepidochelys olivacea*), Hawksbill sea turtle (*Eretmochelys imbricata*), Antipodean Albatross (*Diomedea antipodensis*), Southern Royal Albatross (*Diomedea epomophora*), Wandering Albatross (*Diomedea exulans*), Northern Royal Albatross (*Diomedea sanfordi*), Southern Giant Petrel (*Macronectes* *giganteus*), Northern Giant Petrel (*Macronectes halli*), Sooty Albatross (*Phoebetria fusca*), Buller's Albatross (*Thalassarche bulleri*), Shy Albatross (*Thalassarche cauta*), Indian Yellow-nose Albatross (*Thalassarche carteri*), Grey-headed Albatross (*Thalassarche chrysostoma*), Campbell Albatross (Thalassarche impavida), Black-browed Albatross (*Thalassarche melanophris*), Salvin's Albatross (*Thalassarche salvini*), White-capped Albatross (*Thalassarche steadi*), Great Skua (*Stercorarius (Catharacta*) skua), Little Tern (western Pacific) (*Sternula albifrons sinensis*), Little Tern (*Sternula albifrons*), Crested Tern (*Thalasseus bergii*), Caspian Tern (*Hydroprogne caspia*), Sooty Tern (*Onychoprion fuscata*), White-bellied sea-eagle (*Haliaeetus leucogaster*), Flesh-footed Shearwater (*Ardenna carneipes*), Sooty Shearwater (*Ardenna griseus*), Short-tailed Shearwater (*Ardenna tenuirostris*), Fairy Prion (*Pachyptila turtur*), Southern Fairy Prion (*Pachyptila turtur subantarctica*), Common Sandpiper (*Actitis hypoleucos*), Ruddy Turnstone (*Arenaria interpres*), Sanderling (*Calidris alba*), Pectoral Sandpiper (*Calidris melanotos*), Red-necked Stint (*Calidris ruficollis*), Double-banded Plover (*Charadrius bicinctus*), Latham's Snipe (*Gallinago hardwickii*), Swinhoe's Snipe (*Gallinago megala*), Pin-tailed Snipe (Gallinago stenura), Bar-tailed Godwit (*Limosa lapponica*), Little Curlew (*Numenius minutus*), Whimbrel (*Numenius phaeopus*), Osprey (*Pandion haliaetus*), Pacific Golden Plover (*Pluvialis fulva*), Greater Crested Tern (*Thalasseus bergii*), Grey-tailed Tattler (*Tringa brevipes*), Common Greenshank (*Tringa nebularia*), Marsh Sandpiper (*Tringa stagnatilis*), Fork-tailed Swift (*Apus pacificus*), Flesh-footed Shearwater (*Ardenna carneipes*), Sooty Shearwater (*Ardenna grisea*), Little Tern (*Sternula albifrons*), Common Sandpiper (*Actitis hypoleucos*), Sharp-tailed Sandpiper (*Calidris acuminata*), Latham's Snipe (*Gallinago hardwickii*), Bar-tailed Godwit (*Limosa lapponica*), White shark (*Carcharodon carcharias*), Porbeagle, Mackerel shark (*Lamna nasus*), Shortfin mako or mako shark *(Isurus oxyrinchus*), Australian grayling (*Prototroctes maraena*).

Table 8-1 outlines each of the relevant criteria for significant impacts to MNES under the MNES Significant impact guidelines 1.1, along with a statement on whether the criteria for significant impact are met. Also included are brief supporting justifications and cross references to the relevant sections of the report where further detail is provided.

The following MNES are not included as they do not occur within the project's area of influence or are not relevant to this project:

- wetlands of international importance (see section 6.3.2)
- world heritage properties (see section 6.3.2)
- national heritage places (see section 6.3.2)
- Great Barrier Reef Marine Park (see section 6.3.2)
- nuclear actions
- protection of water resources from coal seam gas development and large coal mining development.

Table 8-1 Threatened species – critically endangered and endangered species

Criteria	Significant impact criteria met?	Justification
Threatened species – critically endangered and endangered species		
An action is likely to have a significant impact on a critically endangered or endangered species if there is a real chance or possibility that it will: • lead to a long-term decrease in the size of a population • reduce the area of occupancy of the species • fragment an existing population into two or more populations • adversely affect habitat critical to the survival of a species • disrupt the breeding cycle of a population • modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline • result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat • introduce disease that may cause the species to decline, or interfere with the recovery of the species.	No	• Based on the design of the project, the implementation of measures to comply with EPRs (including a fauna management plan with specific species sub plans) and the low severity and extent of residual impacts, all residual impacts and risks were assessed to be Low to Very Low (sections 7.2 and 7.3). The exception is underwater noise impact of moderate to high-frequency (HF) cetaceans (Section 7.2.3.5), which was based on a conservative assessment of cetacean remaining within 67 m of the noise sources for at least an hour. However, this is an unlikely scenario and the only HF cetacean species likely to be present in Bass Strait is the pygmy sperm whale, which is not listed under EPBC Act. • All seabed disturbance impacts to water and sediment quality, seabed habitats and associated benthic biological communities are short-term and recoverable (sections 7.2.1 and 7.2.2). • Direct disturbance of the seabed is limited to approximately 3 m wide across each cable alignment across Bass Strait and this disturbed seabed area is expected to fully recover as observed on other interconnector projects (Section 7.2.2). • Disturbance to the lower water column habitat during construction will be of low extent and be temporary, with benthic species returning to the area after construction (Section 7.2.2). • The operating cable will be buried under the seabed and electromagnetic field emissions during operation will be low and will not impede the movement of magnetosensitive fauna (Section 7.3.1). • No invasive species that are harmful to the viability of these species are expected to become established in Bass Strait as a result of the project (Section 7.2.5). The risk will be managed by project vessels (including domestic and international vessels) complying with a range of Australian and international ballast water, antifouling and biosecurity measures.

		• No loss of foraging, breeding, roosting, dispersal or biologically important areas will occur due to the relatively small and temporary impact area across Bass Strait and the implementation of a marine fauna management plan (sections 7.2.2, 7.2.3, 7.2.4 and 7.3). • There will be no loss of a proportion of a species population that could lead to a long term decline of the species (sections 7.2.2, 7.2.3, 7.2.4, 7.2.5). • There will be no permanent loss of occupancy area for any species, all of which have a much larger habitat area than the area of disturbance along the cable alignment(sections 7.2 and 7.3). Once construction is complete, there is no ongoing impediment to species movement or inhabitation. • Considering the very low to low residual impacts and the implementation of measures to comply with EPRs that are consistent with the objectives of relevant EBPC Act recovery plans, there is no predicted conflict with any species recovery in Bass Strait (sections 7.2.2, 7.2.3, 7.2.4 and 7.6).
Threatened species – vulnerable species		
An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will: • lead to a long-term decrease in the size of an important population of a species • reduce the area of occupancy of an important population • fragment an existing important population into two or more populations • adversely affect habitat critical to the survival of a species • disrupt the breeding cycle of an important population • modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline • result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat • introduce disease that may cause the species to decline, or interfere substantially with the recovery of the species.	No	As above

<table>
<tr><th colspan="3">Threatened species – critically endangered or endangered ecological communities</th></tr>
<tr><td>An action is likely to have a significant impact on a critically endangered or endangered ecological community if there is a real chance or possibility that it will:
• reduce the extent of an ecological community
• fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines
• adversely affect habitat critical to the survival of an ecological community
• modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community’s survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns
• cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora or fauna harvesting
• cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including, but not limited to:
  ○ assisting invasive species, that are harmful to the listed ecological community, to become established, or
  ○ causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community, or
• interfere with the recovery of an ecological community.</td><td>No</td><td>Giant Kelp Marine Forests of South East Australia ecological community is listed as endangered (Section 6.3.2.6). However, as there are no suitable habitats for the giant kelp occurs in the vicinity of the alignment no impacts to this threatened ecological community are predicted.</td></tr>
</table>

Listed migratory species		
An action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will: • substantially modify (including by fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species • result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species, or seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	No	• There will be no permanent loss of occupancy area for any species, all of which have a much larger habitat area than the alignment disturbance area (sections 7.2 and 7.3). Once construction is complete, there is no ongoing impediment to species movement or inhabitation. No fragmentation or substantial modification of migratory species habitat is predictedexpected. • No invasive species that are harmful to the viability of these species are expected to become established in Bass Strait as a result of the project (Section 7.2.5). Risk will be managed by project vessels (including domestic and international vessels) complying with a range of Australian and international ballast water, antifouling and biosecurity measures. • No loss of foraging, breeding, roosting, dispersal or biologically important areas will occur due to the relatively small and temporary impact area across Bass Strait and the implementation of a marine fauna management plan (sections 7.2.2, 7.2.3, 7.2.4 and 7.3). • There will be no loss of a proportion of a species population that could lead to a long term decline of the species (sections 7.2.2, 7.2.3, 7.2.4, 7.2.5).
Commonwealth marine environment		
An action is likely to have a significant impact on the environment in a Commonwealth marine area if there is a real chance or possibility that the action will: • result in a known or potential pest species becoming established in the Commonwealth marine area • modify, destroy, fragment, isolate or disturb an important or substantial area of habitat such that an adverse impact on marine ecosystem functioning or integrity in a Commonwealth marine area results • have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution	No	• No invasive species that are harmful to the viability of these species are expected to become established in Bass Strait as a result of the project (Section 7.2.5). Risk will be managed by project vessels (including domestic and international vessels) complying with a range of Australian and international ballast water, antifouling and biosecurity measures. • No fragmentation or substantial modification of marine habitat is expected. • No loss of foraging, breeding or biologically important areas will occur due to the relatively small and temporary impact area across Bass Strait and the implementation of a marine fauna management plan and cetacean interaction management sub-plan (sections 7.2.2, 7.2.3, 7.2.4 and 7.3).

• result in a substantial change in air quality or water quality (including temperature) which may adversely impact on biodiversity, ecological integrity; social amenity or human health • result in persistent organic chemicals, heavy metals, or other potentially harmful chemicals accumulating in the marine environment such that biodiversity, ecological integrity, social amenity or human health may be adversely affected, or • have a substantial adverse impact on heritage values of the Commonwealth marine area, including damage or destruction of an historic shipwreck		• There will be no loss of a proportion of a species population that could lead to a long term decline of the species (sections 7.2.2, 7.2.3, 7.2.4, 7.2.5). • No substantial contamination of land, air or water will occur (Section 7.2.2). • Shipwrecks are addressed in a separate assessment of underwater cultural heritage.

8.7 Concluding remarks

A high level of confidence can be placed on the findings of the present report based on experience gained at other HVDC interconnector projects and their operation, including:

- Basslink HVDC interconnector:
  - Sherwood et al. (2016) undertook a review of cable installation and operational effects of the Basslink interconnector and overseas interconnector studies and concluded that the marine biological effects of cable installation are transient and relatively minor where the cable is buried on soft sediment seabed.
  - The independent Bass Strait Environment Review Committee (BSERC), chaired by Professor John Sherwood of Deakin University, was established to oversee the monitoring of the environmental effects during the installation and operation of the Basslink operation and confirmed that the magnetic fields and induced electrical fields generated by the Basslink HVDC cable were within the range of predicted values and that the ecological impacts were minimal (DAFF, 2009).
- Swepol Link (Sweden to Poland interconnector):
  - Andrulewicz et al. (2003) conducted a monitoring study one year after cable installation, which showed that there were no visible changes on the surface of the seabed overlying the HVDC cable buried in soft sediment seabed and also confirmed that the measurements of the cable's magnetic fields were as predicted and concluded that the cable's magnetic field did not present an obstacle to migrating fishes.

The above impacts of the project on marine ecology and marine resource uses concur with the findings of the Bass Strait Environmental Review Committee (BSERC) that concluded in 2008 (after three years of monitoring) that the ecological impacts associated with the Basslink operation were minimal and that further environmental monitoring was not required. The Commonwealth Government DAFF, 2009) agreed and dissolved the BSERC on 23 January 2009 and consequently the environmental monitoring program was discontinued.

Overall, this report has assessed that project construction, operations and decommissioning impacts are not predicted to significantly impact upon on any threatened species of flora and fauna listed under the Commonwealth EPBC Act's threatened species, threatened ecological communities, listed migratory species and listed species, as well as the threatened species listed under both the Tasmanian TSP Act and Victorian FFG Act.

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9.2 Personal communications

Ryan Atkinson, Marinus Link ,Senior Electrical Engineer. Discussion re. 1-km buffer zone either side of the project alignment in relation to future third party offshore windfarm developments. Meeting at Sandy Point (Victoria) public information meeting held on 15 April 2023.

10 Glossary

Alignment: the route for the subsea Marinus Link interconnector across Bass Strait.

Ambient sound: The sound that is present in the marine environment due to wind, waves, surf, animal sounds and other anthropogenic noise sources not related to the project. Ambient sound is also background sound, and it has no single source or point.

Anadromous: applies to fishes that spend most of their adult lives at sea but must return to freshwater to spawn.

Attenuation: The weakening or reducing the amplitude of a sound caused by absorption in the water and sediment, spreading of the sound.

Auditory or hearing threshold: The hearing threshold represents the lowest signal level an animal can detect at a particular frequency, usually referred (and measured) as the threshold at which an animal will indicate detection 50% of the time.

Australian Fishing Zone (AFZ): waters adjacent to Australia and its external territories (excluding Torres Strait and the Antarctic Territories) that extend from defined baselines to 200 nautical miles seawards but not including coastal and excepted waters. Agreed boundaries apply where these zones intersect the 200 nautical-mile zones of other nations. Within the AFZ, Australia exercises jurisdiction over all fishing by Australian and foreign boats.

Background: The circumstance, situation, or level of a particular parameter prevailing at the time of assessment; natural or pre-existing level of a variable.

Bandwidth: The difference between upper and lower band edge frequencies.

Benthic zone: The ecological region at the lowest level of a body of water, including the sediment surface and some sub-surface layers.

Bioconcentration: accumulation of a substance in an organism by absorption from the environment irrespective of any intake with food. The concept is of particular importance for aquatic life with regards to the absorption of those fat- soluble substances that are only broken down slowly.

Biodiversity: the variety of all life forms; the different plants, animals and microorganisms, the genes they contain and the ecosystems they form.

Biomagnification: the accumulation of substances in a living organism via food intake. Simple organisms, such as algae, can absorb minute quantities of a substance that are transferred through the food chain to higher living species, such as fish or birds. Biomagnification along a food chain will result in the highest concentrations of a substance being found at the top of the food web.

Biophysical: a combination of physical features (such as climate, soils, geology and landforms) and biological features (such as flora and fauna).

Bipole or bipolar link: a link consisting of two cables with power normally flowing in both cables; the capacity of a bipole system is twice that of a monopole system with the same size cable.

***Bryozoans*:** phylum of small, usually fixed and colonial invertebrates, superficially resembling hydroid coelenterates but more complex. Typically forming sea-mats and corallines.

Bycatch: the incidental catch of non-target marine species that occurs while fishing for commercially harvested species.

Cable laying: the placing of a cable on the seabed from a specially designed and purpose-built cable-lay ship. The cable is paid out astern the cable ship from an onboard cable storage hold such as a carrousel or tank.

Cable: an insulated underground or subsea transmission or distribution line.

Catadromous: applies to fishes live most of their adult lives in freshwater but must return to saltwater to spawn.

Catenary: the curve assumed by a subsea cable of uniform weight that hangs freely from the cable-lay ship to the seabed.

Chondrichthyes: the class of cartilaginous fishes, such as sharks and rays. chondrichthyan.

Cnidarian: a member of the phylum Cnidaria, which includes jellyfish, anemones, and corals.

Community: the recognisable association of species of marine flora or fauna that regularly occur together in similar environments.

Conductivity (chemistry): the specific conductance of water or sediment pore water ability to conduct electricity and is a measure of the total amount of charged ions in the water.

Conductivity (thermal): a positive constant, K, that is a property of a substance and is used in the calculation of heat transfer rates for materials. It is the amount of heat that flows through a specified area and thickness of a material over a specified time period when there is a temperature difference of one degree between the surfaces of the material.

Conductor: any material that will carry the flow of electricity; in utilities, usually refers to the wires (overhead lines or underground cables) used to carry electricity.

Conduit: a tubular device used to encase and protect one or more electrical conductors (similar to ‘duct’ used in horizontal directional drilling (HDD).

Consequence: The outcome of an event (including one of more occurrences of the event or even consist of something not happening) affecting objectives. It can be certain or uncertain, have positive or negative effects on objectives, and be expressed qualitatively or quantitatively.

Coriolis Effect: Due to the Earth rotating on its axis, circulating air is deflected toward the left in the Southern Hemisphere.

Critical habitat: the whole or any part of the habitat that is essential to the survival of a threatened, vulnerable, or rare species of flora or fauna as determined by the Victorian DNRE under section 20 of the *Flora and Fauna Guarantee Act 1988* (Vic).

Cross-linked polyethylene (XLPE): a polymeric type of insulation with outstanding electrical, moisture and physical properties.

Current (electrical): the flow of electrical energy (electricity) in a conductor, measured in amperes.

Current (oceanography): the continuous, predictable, directional movement of seawater driven by gravity, wind (Coriolis Effect, see definition above), and water density.

Decibel (dB): Logarithmic unit used to express the ratio of two values of a physical quantity, often power or intensity. Used to described sound – the base 10 logarithmic function of the ratio of the pressure fluctuation to a reference pressure. The reference pressure for seawater is 1 µPa compared to 20 µPa for air. The reference level must be known to ensure proper interpretation of the dB value.

Decommissioning: the process of removing a facility from operation, including removal of subsea infrastructure.

Demersal fish: fish that live in the bottom of the water column at or near the seabed.

Demersal: living on or near the seabed.

Direct current (DC): an electric current in which the electrons flow relatively steadily in one direction in a circuit.

Diversity: The state of being diverse. A diversity index is a quantitative measure that reflects how many different types (e.g., species) there are in a dataset, and takes into account how evenly the individuals are distributed among those types. Biological diversity (biodiversity) is the variety of species (of plants, animals, etc.), their genes, and the ecosystems they comprise, in a particular habitat.

Duct: an underground pipe or conduit for carrying electrical cables, such as an HDD duct.

Dynamic Positioning (DP): A computer-controlled system to automatically maintain a vessel's position and heading by using its own propellers and thrusters, combined with a range of sensors. Examples of vessels that employ dynamic positioning include the project's cable lay ship and offshore supply and service vessels.

Echinoderm: member of the phylum of animals including sea-urchins, sea- cucumbers, starfish, brittle stars, and feather-stars.

Ecological community: an integrated assemblage of native species that inhabits a particular area in nature.

Ecosystem: a functional unit of energy transfer and nutrient cycling in a given place; it includes all the relationships within the biotic community and between the biotic components of the system.

Elasmobranchs: sharks, rays, skates, dogfishes, and other marine cartilaginous fish.

Electric field: a condition of space in the vicinity of an electric charge. Electric fields are related to the voltage in conductors, and electric field strength is measured in volts per metre (V/m).

Endemic species: a species whose natural distribution is restricted to a specific area.

Energised: state or condition of a conductor or power line that is carrying current.

Ensonified: Man-made underwater noise above background ambient levels as in an 'ensonified zone'.

Environmental value: A particular value or use of the environment, which is important for healthy ecosystems or for public benefit, safety or health and that requires protection from the effects of pollution.

Epifauna: bottom-living marine organisms that live on the surface of the seabed as opposed to within the seabed (see infauna).

Epipelagic: relating to or constituting the part of the oceanic zone into which enough light penetrates for photosynthesis (the 0-200 m depth zone).

Exclusion zone: a specially protected area within which there are severe restrictions on activities that can be carried out. The main purpose is to protect infrastructure, such as telecommunication and power cables, from potential damage, such as from anchors or demersal fishing gear. Exclusion zones will only be temporary as no permanent exclusion zones are necessary given that the Marinus Link bundled cables or individual cables will be buried to a nominal 1 m depth. The temporary exclusion zones will be implemented around construction vessels due to their restricted ability to manoeuvre and to keep third-part vessels (e.g., trawlers) away from cables submerged in the water column and astern of the cable-lay ship.

Optical fibre cable: light transmission through optical fibre bundled in a cable for communication, including voice, video, and data.

Frequency: Rate at which water particles move backwards and forwards measured in cycles per seconds or Hertz (Hz).

Gauss (G): the unit of measure of magnetic field intensity equal to 1 dyne per unit pole.

Geographic Information System (GIS): computer technology that can store, manipulate and display information in a spatial context.

Greenhouse effect: a popular term used to describe the heating effect due to the trapping of long-wavelength radiation by greenhouse gases produced from natural and human sources.

Greenhouse gases: those gases, such as water vapour, carbon dioxide, tropospheric ozone, methane, and low-level ozone, that are transparent to solar radiation but opaque to long- wavelength radiation and that contribute to the greenhouse effect.

Habitat: the place where an organism normally lives; habitats can be described by their flora and physical characteristics.

Hearing or auditory threshold: The hearing threshold represents the lowest signal level an animal can detect at a particular frequency, usually referred (and measured) as the threshold at which an animal will indicate detection 50% of the time.

Heat dissipation: the transfer of heat away from a heat source, such as a buried energised HVDC cable.

Hertz (Hz): a measure of the number of cycles of electrical energy per second; Australian domestic electricity supply has a standard frequency of 50 cycles per second, or 50 hertz.

Hertz: The unit for frequency where 1 Hz = 1 cycle per second. One Kilohertz (kHz) are 1,000 cycles per second.

High Voltage (HV): a voltage greater than 1,000 volts AC or greater than 1,500 volts DC.

Impulse or impulsive: Transient sound produced by a rapid release of energy, e.g., from a piling impact or explosive. Impulse sound has an extremely short duration (<1 second) and a high peak pressure with rapid rise time and rapid decay. Can be measured as zero-to-peak or peak-to-peak, the former is typically used in the study of underwater detonation of explosives and the latter for defining the source strength of seismic or impact piling sources.

Impulse sound: Transient sound produced by a rapid release of energy, e.g., from impact hammer piling or explosives. Impulse sound has extremely short duration and high peak sound pressure level.

Infauna: bottom-living marine organisms that live within the seabed as opposed to on the surface of the seabed (see epifauna).

Interconnector: a transmission or distribution line between regions in the National Electricity Market of Australia.

Isopleth: A line or curve of equal values; a line on a graph showing the occurrence or frequency of a phenomenon as a function of two variables.

Joule: a unit of measure of energy or work; the energy produced by a force of 1 newton operating through a distance of 1 metre; 1 joule per second equals 1 watt.

Kelvin: a unit of measure of thermodynamic temperature; as a unit of temperature interval, 1 kelvin is equivalent to 1 degree Celsius.

kilovolt (kV): one thousand volts.

kilowatt (kW): a standard unit of electrical power equal to 1,000 watts or to energy consumption at a rate of 1,000 joules per second.

Likelihood: Is the chance of something happening and can be measured objectively or subjectively, qualitatively, or quantitatively. It is used with the same broad interpretation as 'probability'.

Magnetic field: the force field around a permanent magnet or around an energised conductor. Magnetic fields are generated by the flow of current through a conductor: the stronger the current, the stronger the magnetic field. Magnetic field strength is either measured in milligauss (mG, one thousandth of a gauss (G)) or microtesla (μT, one millionth of a tesla (T)). One μT equals 10 mG.

Magnetic flux: the rate of flow of magnetic energy across or through a surface (real or imaginary).

Masking: Interference with the detection of one sound (the signal) by another sound (the masker). For example, masking of whale vocalisations may occur when the frequency of anthropogenic sound overlaps with the frequency of vocalisations at sufficient intensity to 'mask' the calls.

Megawatt (MW): a unit of measure of electric power plant generating capacity equal to one thousand kilowatts or 1 million watts.

micron: one millionth of a metre (micrometre).

microtesla (μT): one millionth of a tesla.

Milligauss: one thousandth of a gauss.

Milligram: one thousandth of a gram.

Mitigation: Action(s) taken to avoid or reduce the impact of an activity on the environment, socio- cultural and/or socioeconomic interests.

Monopole link: a link consisting of a single cable using the sea or earth for the return current; all power flow is interrupted during maintenance or repair of the cable or converter equipment.

Mysticete: Any whale of the suborder *Mysticeti* having plates of whalebone (baleen plates) instead of teeth. Mysticetes are filter-feeding whales, also referred to as baleen whales, such as blue, fin, gray and humpback whales.

Near, intermediate, and far field: Near field (or near and/or local scale) means the area from source up to 500 m, intermediate field means the area between 500 m and 5,000 m and far field means the area greater than 5,000 m from source. Note: definitions do not apply to underwater noise or acoustic modelling.

Nearshore: Within the study area, nearshore means within state wares (i.e., within the 3 nautical ,mile limits). The term nearshore is used loosely for near shore polygons within the EPBC Act Protected Matters Search Tool (PMST) search areas near the Victorian and Tasmanian coasts and straddle the 3 nautical mile limits (i.e., part nearshore and part offshore waters).

Nekton: Marine animals that swim and move independently of water currents.

Non-impulsive: Sounds that can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent, and typically do not have a high peak pressure with rapid rise time that impulsive sounds do.

Odontocete: Any toothed whale (i.e., cetacean without baleen plates) of the suborder *Odontoceti*, such as sperm whales, killer whales, beaked whales, dolphins, and porpoises.

Odontocetes: toothed cetacean, includes toothed whales, dolphins and porpoises.

Offshore: denotes Commonwealth waters outside the Victorian and Tasmanian state 3 nautical mile limits.

Peak level: peak level is the highest sound pressure level of an impulsive sound signal.

Peak level: The highest sound pressure level of an impulsive sound signal.

Peak-to-peak level: difference between the maximum and minimum noise level recorded during the measurement period, expressed in dB re 1 μPa. The peak-to-peak level is used as a descriptor for impulsive sound sources.

Pebble or cobble: natural stone fragments of any shape. Pebbles are 2 to 60 mm in size; cobbles are 60 to 200 mm in size.

Pelagic: Of or relating to living in open oceans or seas; living at or near the surface of the ocean, far from land, especially relating to fish.

Permanent threshold shift (PTS): The permanent reduction in hearing sensitivity caused by irreversible damage to the sensory hair cells of the ear.

Pinger: A device used underwater to produce pulses of sound, as for detecting an underwater object or a locator device.

Plankton: The mass of small and microscopic animal and plant organisms that float or drift in the sea or fresh water and are incapable of moving against water currents, especially at or near the surface; consisting chiefly of diatoms, protozoans, small crustaceans, and the eggs and larval stages of larger animals.

***Polychaete*:** member of *Polychaeta* and Order of Annelida (worms) including bristle worms, tube worms and fan worms.

Pulse: A transient sound having a finite duration.

***Rajidae*:** Cartilaginous fish belonging to the family *Rajidae* (skates).

Ramp rate: the rate of change of electricity output from a generating unit.

Received Level (RL): The sound pressure level (SPL) received by a species for a given frequency and source level. Given as root mean square (dB re 1 μPa_{rms}). RL may also be referred to as Radiated Noise Level (RNL) when describing sound emissions from ships and dredgers.

Recovery plan: a plan made for any species of flora or fauna that is under threat of extinction.

Reverberation: The reverberation field in the ocean is the product of acoustic scattering by the surface and bottom boundaries and by inhomogeneities within the ocean.

Risk: Is the effect of uncertainty on objectives. It is often expressed in terms of a combination of the consequences of an 'event' or 'events' and the associated likelihood of the consequences actually occurring.

Root mean square (rms): RMS of a time-varying quantity is obtained by squaring the amplitude at each instant, obtaining the average of the squared values over the interval of interest, and then taking the square root of this average. For a sine wave, if you multiply the RMS value by the square root of 2 (1.414), you get the peak value of the wave. The RMS value, also called the effective value of the sound pressure, is the best measure of ordinary continuous sound.

Sheath: the outer covering or jacket of a multi-conductor cable.

Shield: in cables, a metallic layer placed around a conductor or group of conductors to prevent electrostatic interference between the enclosed wires and external fields.

Short circuit: an electric current taking a shorter or different path than intended.

Sound Exposure Level (SEL): an acoustic metric that is most often used to compare the total energy in impulsive signals with different time durations, average pressure levels and temporal characteristics. Impulsive underwater noise sources for which the SEL noise descriptor is useful include piling, blasting and geophysical surveys.

Sound Pressure Level (SPL): Sound pressure level (SPL) is the sound pressure expressed in the decibel (dB) scale and with the standard reference pressures of 1 μPa for water. The pressure of sound for a given frequency.

Soundscape: the physical sound field at a particular time and place. The term does not consider the sound field as experienced or perceived by any marine organism living there.

Source Level (SL): A measure of the acoustic output of a source that is independent of the environment; may be related to sound energy or power output. Source level is sometimes stated as a spectral level as a function of frequency (e.g., in third-octave bands) or as a broadband level (summed over all the frequencies of radiation). Units are expressed in dB re 1 μPa at 1 m.

Spectrum: Distribution of sound energy versus frequency.

Spherical spreading: Received level diminishes by 6 dB per doubling of distance from the source.

Stressor: The physical, chemical or biological factors that can cause an adverse effect on ecosystem performance. Stressors may be natural or anthropogenic in origin.

Swim (or air) bladder: A gas-filled sac located in the dorsal portion of certain species of fish, which is vulnerable to underwater acoustic pressure. It has flexible walls that contract or expand according to the ambient pressure.

Taxon: a taxonomic group of any rank into which organisms are categorised. Plural is taxa.

Temporary threshold shift (TTS): Temporal and reversible elevation of the auditory threshold. TTS refers to a temporary increase in the threshold of hearing, i.e., the minimum intensity needed to hear a sound at a specific frequency, but which returns to its pre-exposure level over time. A temporary reduction in hearing sensitivity caused by exposure to sound. Exposure to high levels of sound over relatively short time periods can cause the same amount of TTS as exposure to lower levels of sound over longer time periods. The duration of TTS varies depending on the nature of the stimulus.

Tesla (T): the unit of measure for magnetic field strength (also called magnetic flux density).

Threatening process: any process that, in the absence of appropriate management, poses or has the potential to pose a threat to the natural survival of any species of native flora or fauna. Potentially threatening processes are listed under the Flora and Fauna Guarantee Act 1988 (Vic).

Tonne (t): a unit of measure of mass equal to 1,000 kilograms or 2,204.6 pounds.

Total allowable catch: the total amount of fish or shellfish species that can be taken from a fishery in a prescribed period.

Transmission (power): the process of sending or moving electricity from one point to another.

Transmission Loss (TL): Reduction of the sound pressure level with distance from the noise source, which occurs through geometric spreading, absorption and scattering of sound energy.

Trolling: a fishing method where lures or baits attached to lines are towed behind a slowly moving boat.

Volt (V): the unit of measure of electromotive force. It is equivalent to the force required to produce a current of 1 ampere through a resistance of 1 ohm.

Voltage: the amount of electromotive force, measured in volts, that exists between two points.

Watt: the rate of energy transfer equivalent to 1 ampere under an electrical pressure of 1 volt. One watt equals one joule per second.

Wavelength (sound): The length of the fundamental oscillation of the sound in the propagation medium.

Zero-to-peak pressure: The peak pressure measured from zero to peak amplitude.

Attachments

Attachment A: EPBC Act PMST Report for offshore Bass Strait, 2021

Attachment B: EPBC Act PMST Report for nearshore Victoria (Waratah Bay), 2021

Attachment C: EPBC Act PMST Report for nearshore Tasmania (Heybridge), 2021

Attachment D: Supplementary Information – Underwater noise impact assessment (EGC, 2023)

Attachment E: Tioxide sediment analysis report (Tetra Tech Coffey, 2022)

Attachment F: Commercial fisheries data (SETFIA, 2022)

Attachment G: Underwater noise modelling (MDA, 2023).

Attachment H: Technical Memorandum on additional EMF modelling (Jacobs, 2023)

ATTACHMENT A

Project Marinus

EPBC Act Protected Matters Search Tool (PMST) Report for offshore Bass Strait

Prepared by
Tetra Tech Coffey Pty Ltd

9 September 2021

Australian Government
Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

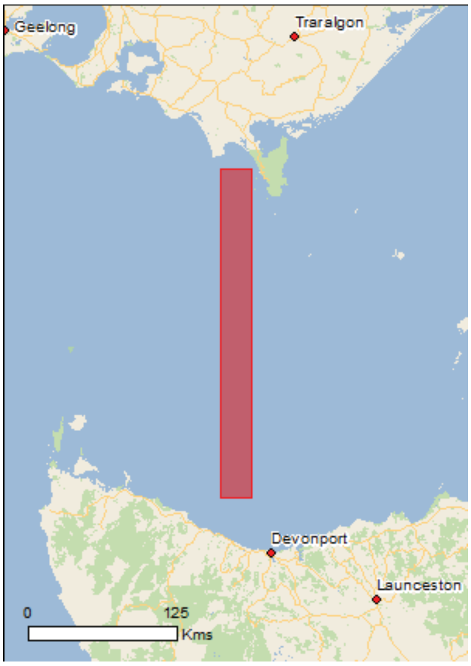
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

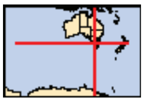
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 09/09/21 13:26:33

- Summary
- Details
  - Matters of NES
  - Other Matters Protected by the EPBC Act
  - Extra Information
- Caveat
- Acknowledgements



Coordinates
Buffer: 0.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	37
Listed Migratory Species:	38

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	66
Whales and Other Cetaceans:	15
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	None
Regional Forest Agreements:	None
Invasive Species:	None
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-east

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea antipodensis gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within

Name	Status	Type of Presence
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat may occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area

Name	Threatened	Type of Presence
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis rubricollis Hooded Plover (eastern) [66726]	Vulnerable*	Species or species habitat may occur within area
Fish		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus minotaur Bullneck Seahorse [66705]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys mollisoni Mollison's Pipefish [66260]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat known to occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-38.96751 145.969,-38.96751 146.20703,-40.859 146.20708,-40.859 145.969,-38.96751 145.969

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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ATTACHMENT B

Project Marinus

EPBC Act Protected Matters Search Tool (PMST)
Report for nearshore Victoria (Waratah Bay)

Prepared by
Tetra Tech Coffey Pty Ltd

9 September 2021

Australian Government
Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

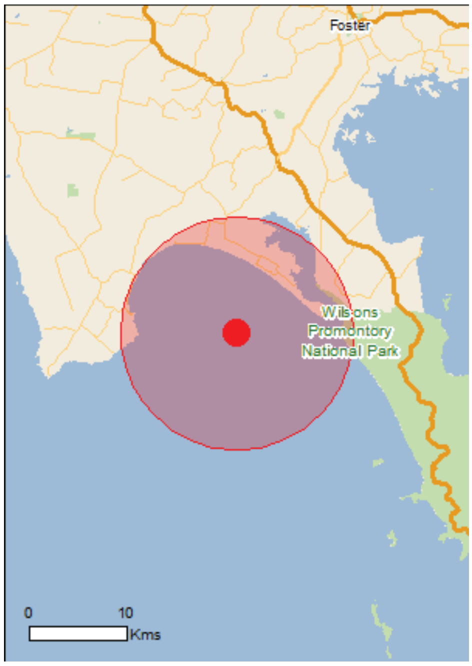
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 09/09/21 13:36:18

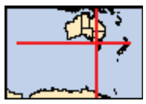
Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2015

Coordinates
Buffer: 12.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	3
Listed Threatened Species:	67
Listed Migratory Species:	60

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	98
Whales and Other Cetaceans:	13
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	2
Regional Forest Agreements:	1
Invasive Species:	37
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Corner inlet	Within 10km of Ramsar

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-east

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Giant Kelp Marine Forests of South East Australia	Endangered	Community may occur within area
Natural Damp Grassland of the Victorian Coastal Plains	Critically Endangered	Community may occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater [82338]	Critically Endangered	Species or species habitat likely to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur

Name	Status	Type of Presence
		within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea antipodensis gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat may occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area

Name	Status	Type of Presence
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis cucullatus cucullatus Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area
Fish		
Galaxiella pusilla Eastern Dwarf Galaxias, Dwarf Galaxias [56790]	Vulnerable	Species or species habitat likely to occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat likely to occur within area
Frogs		
Litoria raniformis Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat likely to occur within area
Mammals		
Antechinus minimus maritimus Swamp Antechinus (mainland) [83086]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or

Name	Status	Type of Presence
		related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat likely to occur within area
Mastacomys fuscus mordicus Broad-toothed Rat (mainland), Tooarrana [87617]	Vulnerable	Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat may occur within area
Potorous tridactylus tridactylus Long-nosed Potoroo (SE Mainland) [66645]	Vulnerable	Species or species habitat likely to occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat likely to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Foraging, feeding or related behaviour may occur within area
Plants		
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat may occur within area
Caladenia orientalis Eastern Spider Orchid [83410]	Endangered	Species or species habitat likely to occur within area
Caladenia tessellata Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat likely to occur within area
Dianella amoena Matted Flax-lily [64886]	Endangered	Species or species habitat may occur within area
Prasophyllum spicatum Dense Leek-orchid [55146]	Vulnerable	Species or species habitat likely to occur within area
Pterostylis chlorogramma Green-striped Greenhood [56510]	Vulnerable	Species or species habitat likely to occur within area
Pterostylis cucullata Leafy Greenhood [15459]	Vulnerable	Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Pterostylis tenuissima Swamp Greenhood, Dainty Swamp Orchid [13139]	Vulnerable	Species or species habitat may occur within area
Senecio psilocarpus Swamp Fireweed, Smooth-fruited Groundsel [64976]	Vulnerable	Species or species habitat may occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Listed Migratory Species

[Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area

Name	Threatened	Type of Presence
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur

Name	Threatened	Type of Presence
		within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Heteroscelus brevipes Grey-tailed Tattler [59311]		Roosting known to occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Species or species habitat known to occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area

Name	Threatened	Type of Presence
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Sterna albifrons Little Tern [813]		Species or species habitat may occur within area
Sterna bergii Crested Tern [816]		Breeding known to occur within area
Sterna caspia Caspian Tern [59467]		Breeding known to occur within area
Sterna fuscata Sooty Tern [794]		Breeding known to occur within area
Sterna nereis Fairy Tern [796]		Breeding known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Thinornis rubricollis rubricollis Hooded Plover (eastern) [66726]	Vulnerable*	Species or species habitat known to occur within area

Name	Threatened	Type of Presence
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Fish		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus minotaur Bullneck Seahorse [66705]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys mollisoni Mollison's Pipefish [66260]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known

Name	Threatened	Type of Presence
		to occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Cape Liptrap Coastal Park	VIC
Wilsons Promontory	VIC

Regional Forest Agreements	[Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
Gippsland RFA	Victoria

Invasive Species	[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Carduelis chloris European Greenfinch [404]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Turdus philomelos Song Thrush [597]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus scandens Asparagus Fern, Climbing Asparagus Fern [23255]		Species or species habitat likely to occur within area
Carrichtera annua Ward's Weed [9511]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species

Name	Status	Type of Presence
		habitat may occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Nassella neesiana Chilean Needle grass [67699]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Shallow Inlet Marine & Coastal Park	VIC

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-38.87539 146.09692

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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ATTACHMENT C

Project Marinus

EPBC Act Protected Matters Search Tool (PMST)
Report for nearshore Tasmania (Heybridge)

Prepared by
Tetra Tech Coffey Pty Ltd

8 September 2021

Australian Government

Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report

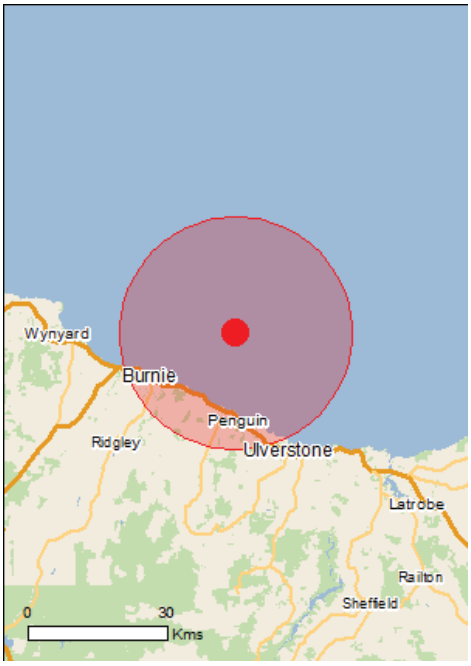
This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

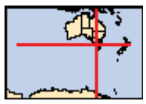
Report created: 08/09/21 13:41:21

- Summary
- Details
  - Matters of NES
  - Other Matters Protected by the EPBC Act
  - Extra Information
- Caveat
- Acknowledgements



Coordinates

Buffer: 25.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	58
Listed Migratory Species:	41

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	3
Commonwealth Heritage Places:	None
Listed Marine Species:	69
Whales and Other Cetaceans:	14
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	14
Regional Forest Agreements:	1
Invasive Species:	29
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside the Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area. Generally the Commonwealth Marine Area stretches from three nautical miles to two hundred nautical miles from the coast.

Name
EEZ and Territorial Sea

Marine Regions [Resource Information]

If you are planning to undertake action in an area in or close to the Commonwealth Marine Area, and a marine bioregional plan has been prepared for the Commonwealth Marine Area in that area, the marine bioregional plan may inform your decision as to whether to refer your proposed action under the EPBC Act.

Name
South-east

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Alpine Sphagnum Bogs and Associated Fens	Endangered	Community may occur within area
Giant Kelp Marine Forests of South East Australia	Endangered	Community may occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Tasmanian Forests and Woodlands dominated by black gum or Brookers gum (Eucalyptus ovata / E. brookeriana)	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Aquila audax fleayi		
Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian) [64435]	Endangered	Breeding likely to occur within area
Botaurus poiciloptilus		
Australasian Bittern [1001]	Endangered	Species or species habitat likely to occur within area
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Ceyx azureus diemenensis		
Tasmanian Azure Kingfisher [25977]	Endangered	Species or species habitat known to occur within area
Diomedea antipodensis		
Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or

Name	Status	Type of Presence
		related behaviour likely to occur within area
Diomedea antipodensis gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Breeding known to occur within area
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area

Name	Status	Type of Presence
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis cucullatus cucullatus Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area
Tyto novaehollandiae castanops (Tasmanian population) Masked Owl (Tasmanian) [67051]	Vulnerable	Species or species habitat known to occur within area
Crustaceans		
Astacopsis gouldi Giant Freshwater Crayfish, Tasmanian Giant Freshwater Lobster [64415]	Vulnerable	Species or species habitat known to occur within area
Engaeus granulatus Central North Burrowing Crayfish [78959]	Endangered	Species or species habitat may occur within area
Engaeus yabbimunna Burnie Burrowing Crayfish [66781]	Vulnerable	Species or species habitat known to occur within area
Fish		
Galaxiella pusilla Eastern Dwarf Galaxias, Dwarf Galaxias [56790]	Vulnerable	Species or species habitat may occur within area
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat known to occur within area
Mammals		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Dasyurus maculatus maculatus (Tasmanian population) Spotted-tail Quoll, Spot-tailed Quoll, Tiger Quoll	Vulnerable	Species or species

Name	Status	Type of Presence
(Tasmanian population) [75183]		habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Perameles gunnii gunnii Eastern Barred Bandicoot (Tasmania) [66651]	Vulnerable	Species or species habitat known to occur within area
Sarcophilus harrisii Tasmanian Devil [299]	Endangered	Species or species habitat likely to occur within area
Plants		
Barbarea australis Native Wintercress, Riverbed Wintercress [12540]	Endangered	Species or species habitat likely to occur within area
Caladenia caudata Tailed Spider-orchid [17067]	Vulnerable	Species or species habitat likely to occur within area
Hypolepis distans Scrambling Ground-fern [2148]	Endangered	Species or species habitat may occur within area
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat may occur within area
Leucochrysum albicans subsp. tricolor Hoary Sunray, Grassland Paper-daisy [89104]	Endangered	Species or species habitat may occur within area
Prasophyllum apoxychilum Tapered Leek-orchid [64947]	Endangered	Species or species habitat may occur within area
Pterostylis ziegeleri Grassland Greenhood, Cape Portland Greenhood [64971]	Vulnerable	Species or species habitat may occur within area
Senecio psilocarpus Swamp Fireweed, Smooth-fruited Groundsel [64976]	Vulnerable	Species or species habitat likely to occur within area
Thelymitra jonesii Sky-blue Sun-orchid [76352]	Endangered	Species or species habitat may occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Sharks		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species

[Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Name	Threatened	Type of Presence
Migratory Marine Species		
Balaena glacialis australis Southern Right Whale [75529]	Endangered*	Species or species habitat known to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Name
Commonwealth Land -
Defence - BURNIE TRAINING DEPOT
Defence - TS Leven

Listed Marine Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat likely to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Catharacta skua Great Skua [59472]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea gibsoni Gibson's Albatross [64466]	Vulnerable*	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Breeding known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Breeding known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [1043]		Foraging, feeding or related behaviour likely

Name	Threatened	Type of Presence
		to occur within area
Puffinus griseus Sooty Shearwater [1024]		Species or species habitat may occur within area
Sterna albifrons Little Tern [813]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche sp. nov. Pacific Albatross [66511]	Vulnerable*	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat known to occur within area
Thinornis rubricollis rubricollis Hooded Plover (eastern) [66726]	Vulnerable*	Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area
Fish		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus minotaur Bullneck Seahorse [66705]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammals		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Reptiles		
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area

Whales and other Cetaceans [Resource Information]

Name	Status	Type of Presence
Mammals		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]	Vulnerable	Species or species habitat known to occur

Name	Status	Type of Presence
		within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Blythe River	TAS
Chasm Creek	TAS
Dial Range	TAS
Emu River	TAS
Ferndene	TAS
Gwandalan	TAS
Heybridge	TAS
Mount Dial	TAS
Mount Montgomery	TAS
Mount Montgomery	TAS
North Motton	TAS
Sith Cala	TAS
Three Sisters-Goat Island	TAS
Unnamed (Fern Glade)	TAS

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
Tasmania RFA	Tasmania

Invasive Species [Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Alauda arvensis Skylark [656]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Carduelis chloris European Greenfinch [404]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Turdus merula Common Blackbird, Eurasian Blackbird [596]		Species or species habitat likely to occur within area
Mammals		
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Lepus capensis Brown Hare [127]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Anredera cordifolia Madeira Vine, Jalap, Lamb's-tail, Mignonette Vine, Anredera, Gulf Madeiravine, Heartleaf Madeiravine, Potato Vine [2643]		Species or species habitat likely to occur within area
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Asparagus scandens Asparagus Fern, Climbing Asparagus Fern [23255]		Species or species habitat likely to occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur

Name	Status	Type of Presence
		within area
Cytisus scoparius Broom, English Broom, Scotch Broom, Common Broom, Scottish Broom, Spanish Broom [5934]		Species or species habitat likely to occur within area
Genista linifolia Flax-leaved Broom, Mediterranean Broom, Flax Broom [2800]		Species or species habitat likely to occur within area
Genista monspessulana Montpellier Broom, Cape Broom, Canary Broom, Common Broom, French Broom, Soft Broom [20126]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Ulex europaeus Gorse, Furze [7693]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-40.98964 146.06536

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

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ATTACHMENT D

Project Marinus

SUPPLEMENTARY INFORMATION

Underwater Noise and Vibration Impact Assessment

Prepared by
EnviroGulf Consulting

16 February 2023

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1 Introduction

This addendum provides supplementary information for the Marine Ecology and Resource Use Impact Assessment. The following topics are covered:

- Derivation of ambient underwater noise.
- Offshore cable lay noise sources.
- Shore-end and nearshore cable burial noise sources.
- Other underwater noise sources:
    - Rock dumping.
    - Rock mattress installation
    - Geophysical instruments

2 Ambient background noise

At this juncture, no baseline measurements of ambient (background) underwater noise have been undertaken along the route of the proposed Marinus Link. Therefore, a literature review was undertaken to characterise measured ambient noise in Bass Strait and at other Australian or overseas sites, which can be used to estimate ambient noise in both the nearshore and offshore waters of Bass Strait within the project area.

Table 1 presents a summary of ambient sound levels measured at various local and overseas nearshore and offshore areas, ports, and harbours.

Table 1: Summary of ambient sound measurements in Australia and overseas

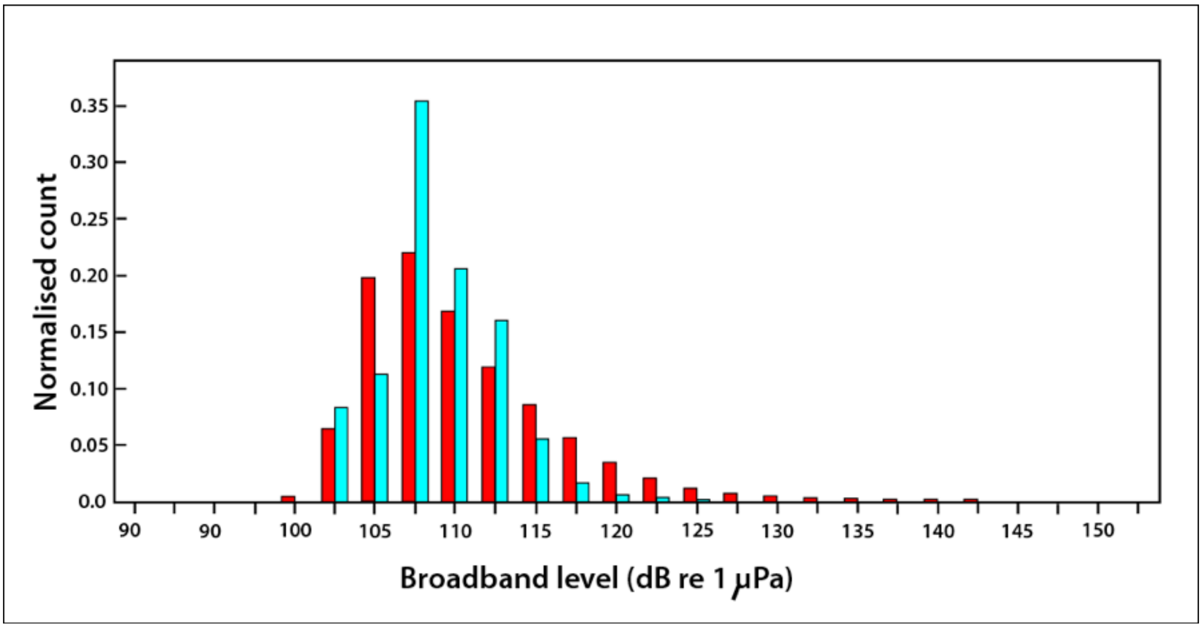
Location	Ambient sound (dB re 1 µPa rms)			Reference
	Mean	Min.	Max.	
Coastal and nearshore waters:				
Otway Basin (VIC)	95*	93	97	Enesar (2004)
Warrnambool (VIC)	100*	90	110	McCauley (2004)
Warrnambool (VIC)	110	–	161	Duncan et al. (2013)
Phillip Island (VIC)	117	58	144	Petersen (2008)
Port Hedland	92	90	110	Salgado Kent et al. (2009)
Gladstone 10-km outer harbour (QLD)	–	100	116	SLR (2019)
Crayfish Reserve, Taroona (TAS)	106	98	153	Day et al. (2016)
Shoemaker Point, South Coast (TAS)	107	100	150	Day et al. (2016)
Gulf of Exmouth (WA)	–	80	120	Li (2019)
Jervoise Bay, Cockburn Sound (WA)	115	113	136	McCauley et al (2000)
Offshore waters:				
Undisturbed ocean:	–	90	110	Entrix (2004)

Location	Ambient sound (dB re 1 µPa rms)			Reference
	Mean	Min.	Max.	
Open ocean	–	90	110	APPEA (2005)
Open sea	–	40	100	Heathershaw et al. (2001)
Timor Sea	93	80	110	McCauley (1998)
Gulf of Papua	–	90	110	Duncan and McCauley (2008)
Ports and harbours:				
Yarra River/Williamstown Chan.(VIC)	127*	122	133	Parnum et al. (2009) reported in SKM (2012)
Fremantle Inner Harbour (WA)	125*	110	140	Salgado Kent et al. (2012)
Aberdeen Harbour (UK)	130*	118	149	Hawkins (2005)
Southampton harbour (UK)	125	101	141	Nedwell et al. (2008)
Admiralty Inlet , Washington (USA)	117	94	144	Bassett et al. (2010)

Note: * Estimated mean values.

The literature review revealed ambient underwater noise measurements in Tasmanian coastal waters using sea loggers (Day et al., 2016).

Figure 1 shows normalised counts (histograms) of ambient background underwater noise levels (red bars) off Crayfish Point Reserve near Taroona in the Derwent Estuary and off Shoemaker Point (blue bars) off the south coast of Tasmanian.



Source: Day et al. (2016). Red vertical bars represent ambient noise recordings off Crayfish Point Reserve near Taroona (Derwent Estuary) and the blue vertical bars represent ambient noise recordings off Shoemaker Point at the southern tip of Tasmania.

Figure 1: Ambient noise measured at nearshore Tasmania (Crayfish and Shoemaker Points)

Differences in nearshore ambient noise levels (measured across 8 Hz to 3 kHz) and in consecutive 9.6-second periods over 12.6 days, revealed that both Crayfish Reserve Point and

Shoemaker Point had similar maximum broadband levels (153 and 150 dB re 1 μPa rms). However, the Crayfish Reserve Point had more frequent higher levels than Shoemaker Point on the south coast. The broadband distribution at Crayfish Reserve Point also was skewed more to the right, which reflected the higher frequency of passing vessels that add a background anthropogenic noise component to the ambient noise at this location on the Derwent Estuary.

Based on Table 1 and measured sea logger data by Day et al. (2016), the following ambient average noise levels and ranges have been adopted for the purposes of the present report:

- Victorian nearshore location in Waratah Bay:
    - average of **105 dB re 1 μPa rms** (range **90 to 145 dB re 1 μPa rms**).
- Central Bass Strait location:
    - average of **95 dB re 1 μPa rms** (range **90 to 110 dB re 1 μPa rms**).
- Tasmanian nearshore location off Heybridge:
    - average of **107 dB re 1 μPa rms** (range **95 to 135 dB re 1 μPa rms**).

Noe that in both the Victorian and Tasmanian nearshore locations, the upper range of ambient background noise will tend to increase during the summer months when small watercraft density and frequency increases in coastal waters due to increased leisure and recreational fishing uptake.

3 Project related underwater noise sources

Underwater noise and vibration will be generated within Bass Strait nearshore and offshore waters during the construction, operation, and decommissioning phases of the Marinus Link project. The following proposed activities represent the main sources of project underwater noise and vibration.

- Construction phase activities generating underwater noise:
    - nearshore horizontal directional drilling (HDD) with marine exit boreholes in 10 m water depth.
    - pre-lay grapnel runs (PLGRs) and vessels using to tow the grapnels.
    - works vessels and smaller vessels engaged in nearshore cable lay and/or floated cable pulling operations and cable protection measures (e.g., cast iron half-shells, rock mattresses or rock dumping).
    - offshore cable lay operations using a cable lay ship (e.g., C/S *Giulio Verne*) to lay the bundled cables on the sea floor and offshore support vessels (OSVs) assisting the cable lay ship (e.g., guard vessels to alert other maritime users).
    - post lay burial of the offshore bundled cables by a ROV trencher with umbilical to an OSV, and a spread of smaller vessels assisting post lay cable burial operations.

- pre lay geophysical surveys for micro-siting the cables within their proposed alignments to conform.
- post lay geophysical surveys (e.g., high frequency side scan sonars, multi-beam echosounders, positioning systems, etc.) along the cable alignments to confirm burial success.

- Operation phase activities generating underwater noise:
  - periodic geophysical surveys of the seabed along the alignment of the buried bundled cables to check for spanning or exposure of the cables, and vessels deployed for this activity
  - periodic environmental surveys of seabed ecology (habitats and seabed flora and fauna) and vessels deployed for this activity
  - periodic magnetometer surveys of the magnetic fields generated by the energised cable under different power (MW) transfers and to confirm EIS predictions of magnetic fields. While magnetometers do not generate underwater noise, the small towing vessels vessels deployed for these surveys are a source of broadband noise.
- Decommissioning phase activities:
  - decommissioning phase activities represent a reversal of the construction and cable installation phase activities, which assumes that the then out-of-service exposed non-bundled cables and the buried bundled cables will be removed at the end of project life (about 40 years).

It Is not possible to include all underwater noise sources of project activities as their respective noise signatures may be unknown and are likely to vary widely depending on their operational state. Moreover, it would be an onerous task to accurately predict the underwater noise fields of more than a few sources. Therefore, based on experience of other interconnector developments (e.g., Basslink), the louder sources of underwater noise generated during key construction and operational activities have been selected and conservatively estimated. The principal project-generated underwater noise sources and their estimated source levels are characterised in subsequent sections.

3.1 Construction phase noise sources

Not all construction activities required to be assessed for underwater noise. These include, but not limited, to the following:

Horizontal Directional Drilling (HDD) pilot borehole breakthrough to the subtidal marine environment at about 10 m water depth is a very short duration activity and is not considered further. The louder construction phase noise sources that require assessment are as follows:

- Offshore bundled cable laying and post lay installation and burial.
- Victorian shore-end cable laying and post lay installation and burial.

- Tasmanian shore-end cable laying and post lay installation and burial.
- Third-party crossings of existing subsea infrastructure and post lay burial or protection by half-shell protectors, rock matresses or loose rock fill.

Project noise sources associated with the above construction and cable burial and installation activities are summarised below along with estimated underwater noise source levels for acoustic analysis.

3.1.1 Offshore bundled cable lay noise sources

The offshore cable laying operation involves the use of large cable ship (e.g., *Giulio Verne*) maintaining position and forward movement using its dynamic positioning (DP) control of its variable pitched azimuthal and other thrusters. The cable ship will pay out the cables which will wrapped as a bundle. The actual laying of the bundled cable on the seabed is essentially a noiseless activity; therefore, the principle underwater noise source during the cable laying operations is the cable ship itself.

3.1.1.1 Cable lay ship underwater noise source level

A literature review did not find any measurements of large cable ships in the process of laying cables. However, underwater noise source levels were available for large vessels maintaining station using their thrusters under dynamic positioning (DP) control. Table 2 gives examples of noise sources levels.

Table 2: Example underwater noise source levels of dynamically positioned vessels

Vessel type	Activity	Source level dB e 1 μPa at 1 m	Reference
Cable ship CS *Ile de Batz (*140 m long)	DP: 2 x 4,000 kW fixed pitch propellers; 2 x 1,500 kW bow thrusters; 2 x 1,500 kW	180.3	Green et al. (2018)
Offshore support vessel in DP mode	Maintaining position in DP mode	182.0	McCauley (1998)
Offshore Support Vessel (67 m long)	DP mode with four main engines, two 600 HP thrusters and one 800 HP thruster	187.7	Austin et al. (2006)
Dive support vessel (107 m long by 35 m beam)	DP mode stationary using thrusters operating between 20% and 30% of maximum thrust (a typical level)	178	Seiche (2008)

Bald et al (2015) reported seven measurements of a power cable laying operation in Spain with an average source level (SL) level of 188.5 dB re 1 μPa at 1 m, though the authors described the cable ship noise as impulsive noise rather than non-impulsive noise. Green et al. (2018) measured a received sound level of 160 dB re 1 μPa rms at 25 m distance from a cable ship during cable laying, which can be back calculated to a SL of 188 dB re 1 μPa at 1 m using spherical spreading law (which is appropriate for such a short distance).

Based on underwater noise source levels for vessels in DP mode in Table 2, and the above two references for measured underwater noise source levels of two two cable ships undertaking cable laying operations, the present report has adopted a conservative underwater noise SL of **185 dB re 1 µPa at 1 m** for the Marinus Link cable ship and cable lay operation, which was derived in consultation with Marshall Day Acoustics (MDA) during a meeting on 3 November 2022.

3.1.2 Offshore bundled cable burial noise sources

MLPL propose a post-lay burial of the offshore bundled cables using a remotely operated vehicle (ROV) trencher with umbilical to an offshore supply vessel (OSV), and one or two smaller vessels assisting post-lay cable burial operations such as guard vessels to alert any approaching ships or other vessels.

3.1.2.1 Cable burial vessel underwater noise source level

Post lay burial of the bundled cables will be carried using a cable burial vessel and a robotic jet trenching machine.

Typical cable burial vessel may be a dedicated trenching support vessel or an OSV adapted to operate as a cable trenching support vessel. The MV *Fugro Saltire* is an example of a cable trenching support vessel and is 100 m long, 24 m beam and a draught of 7.5 m. This vessel is fitted with an A-frame equipped with cross beam winches and cursor, which forms the launch and recovery system (LARS) for deploying and recovering the jet trenching machine. A typical cable burial vessel transits to site at around 9 knots in good weather and sea conditions but, during trenching operations, the vessels operational speed is very low (0.2 knots) as the vessel maintains a position forward of the trenching machine that travels at speed of 400 m/hour when wet jetting in sand (see below).

A literature review did not reveal any noise source levels for cable burial vessels. However, Table 2 gives some examples of underwater noise source levels measures vessels using dynamic positioning (DP) systems. Given that the offshore support vessel used in cable burial operations will be smaller than the cable lay ship, an underwater noise source level of SL of **180 dB re 1 µPa at 1 m** has been adopted for acoustic analysis.

3.1.2.2 Jet trencher underwater noise source level

A robotic trenching machine such as a Helix T-1200 Trencher in burial rather than trenching mode may be used to install and bury individual or bundled cables in the soft-sediment seabed across Bass Strait. The trencher's specification sheet (Helix, 2022) states that the jet trencher can move at a constant speed of approximately 400 m/hr in sand.

An underwater noise source level for the Helix T-1200 trencher has been reported as 178 dB re 1 µPa at 1 m, which is based on Nedwell et al (2004). This source level reported by Nedwell et al. (2004) has been widely quoted by many more recent papers and appears to be in response to a lack of underwater noise measurements of actual jet trenching operations in the literature since 2004. The source level of 178 dB re 1 µPa at 1 m was based on an extrapolation from actual noise recordings of pile driving by Nedwell et al. (2003) and is based on a spreading loss of 22Log(R), where the R is the range in metres. The spreading coefficient (N) in this equation is 22, which is close to spherical spreading loss (i.e., 20Log(R)). This is unlikely to be the case, as the water depth of the study area was 7 to 11 m for the Astronomical Low Tide (AST), which represents very shallow water.

A more appropriate spreading loss model for shallow water is the practical spreading law model (sometimes called the 'intermediate spreading' law model) that uses 15Log(R) and is used frequently in the acoustic literature, particularly for estimating transmission loss in nearshore areas (Reine et al., 2012). The practical spreading law model was derived from a theoretical treatment of sound propagation in shallow water (Weston, 1971).

According to the original paper, Nedwell et al. (2003) actually measured underwater noise from the Helix T-1200 trencher at a distance of 160 m and reported an underwater noise received level of 123 dB re. 1 µPa rms. Using the above practical spreading loss of 15Log(R), the source level of the jet trencher is 156 dB re. 1 µPa at 1 m, and not the 178 dB re. 1 µPa at 1 m reported by Nedwell et al (2004) and based erroneously on a near spherical spreading model loss of 22Log(R), which is incorrect for such shallow water environment.

The seabed sediments of the jet trencher in Nedwell et al. (2004) were described as 'sand and gravels', which would be expected to generate higher underwater noise levels during jet trenching. Therefore, for the purposes of this report, a jet trencher underwater noise source level of **150 dB re. 1 µPa at 1 m** has been adopted, given the predominance of sands and muds across Bass Strait and specifically along the bundled cable sections that are to be buried.

3.1.3 Shore-end and nearshore noise sources

3.1.3.1 Victorian shore-end construction noise sources

The cable lay ship will maintain location using its various thrusters under DP control in nearshore waters while maintaining a hull clearance depth of 15 m. The individual HVDC power cables and the optic fibre cable will be pulled sequentially from the cable lay ship's stern to their respective HDD marine exit boreholes using a spread of small vessels. Considering manipulation of a single HVDC power cable, the cable will be paid out from a stern chute of the cable lay ship and the cable will then be fitted with flotation devices either onboard the cable lay ship or by operatives in the support vessels. The floated cable will be handled by operatives on about five support vessels to form a large loop in the shape of an omega (Greek symbol Ω). The end of the cables will be fitted by divers to a winch wire from a land-based winch via the HDD duct, so that they can be pulled to shore via their respective HDD marine exit boreholes.

The floated cable does not generate underwater noise itself. However, the spread of small vessels generates individual noise sources as well as cumulative underwater noise levels when in proximity to one another. Table 3 presents a summary of underwater noise source levels for a verity of different size workboats, tenders or small boats that may typically be employed to manoeuvre the individual floated cables that need to be pulled shoreward.

The loudest underwater noise from the support vessels is when they are manoeuvring the floated cables to feed them to the winch pull wire ends. Underwater noise source levels will be lowest when the support vessels are idling, as the skippers of the boats await instructions to begin cable manoeuvring and positioning.

Table 3: Example underwater noise source levels of small tenders and boats

Vessel type	Activity/frequency	Source level dB re 1 µPa at 1 m	Reference
Small work boat (Inboard twin 210 HP)	Stationary and idling 0.01 to 20 kHz	148	Galli et al. (2003)
Flat-bottom workboat (7 m long) 90 HP outboard	Stationary and idling 0.01–10 kHz	141	Galli et al. (2003)
Crew boat (8.5 m long); inboard diesels	Underway 13 kn 0.01 to 20 kHz	166	Zykov and Hannay (2006)
Cabin cruiser works boats; 6.7 to 19.7 m; 350 to 375 HP	Underway 10 kn 0.01 to 40 kHz	165	Kipple (2003)
Small work boat (Inboard twin 210 HP)	Full speed 0.01 to 20 kHz	162	Galli et al. (2003)
Small boat outboard engine	Full speed (20 kn) 1 to 5 kHz	160	Hildebrand (2009)
Flat-bottom workboat (7 m long) 90 HP outboard	Full speed 0.01– 10 kHz	163	Galli et al. (2003)
Flat-bottom workboat (7 m long) 90 HP outboard	Full speed 10 Hz–10 kHz	163	Galli et al. (2003)

Based on Table 3 the following underwater noise source levels for different support vessel activities have been adopted in this report:

- A SL of **145 dB re 1 µPa at 1 m** has been adopted for small boats idling.
- A SL of **165 dB re 1 µPa at 1 m** has been adopted for a spread of small boats manoeuvring a floated cable.

3.1.3.2 Tasmanian shore-end construction noise source

The Tasmanian nearshore construction noise sources are similar to the noise source levels for the Victorian shore-end construction activities. However, wet jetting and burial of the individual cables in the shallow nearshore sand-filled palaeochannels near Heybridge may also be carried out by a support vessel in DP mode while towing a TD 1 eductor burial tool to fluidise the sand for the cable to settle and become buried. This method was carried out for the Basslink project at its cable landfall in Tasmania in 2005 (The Diving Company, 2022).

Based on the 107-m-long dive support vessel in Table 2, which has an underwater noise source level of 178 dB re 1 µPa at 1 m, a small support vessel capable of operating in the shallow water of nearshore Tasmania is likely to have a lower noise level. For the purposes of this report, a conservative underwater noise SL of **170 dB re 1 µPa at 1 m** has been adopted for the support vessel involved in towing the T1 eductor.

The eductor burial tool is pulled along the seabed by the support vessel and the water is pumped to the eductor burial tool to fluidise the sand. For the purposes of this report, an underwater noise SL of **145 dB re 1 µPa at 1 m** has been adopted. This is less than the source level of 150 dB re 1 µPa at 1 m adopted for the Helix robotic jet trencher mentioned above, as there are no electric motors, water pumps or caterpillar tracks associated with a TD 1 eductor burial tool.

3.1.4 Other underwater noise sources

Other one-off underwater noise may be generated by rock dumping or rock mattress placement over third-party subsea infrastructure such as telecommunication cables (e.g., the Telstra Bass Strait 1 cable in nearshore Victoria, the Alcatel Indigo Central cable in central Bass Strait) and out-of-service pipelines in nearshore Tasmania (e.g., the two marine outfall pipelines of the former Tioxide Plant at Heybridge).

In general, the abovementioned noise sources are predominantly associated with vessel noise. For the purposes of this report, an underwater noise source level of **180 dB re. 1 µPa at 1 m** has been adopted for the surface vessel in DP mode.

3.1.4.1 Rock dumping underwater noise sources

Nedwell et al. (2012) stated that rocks falling through the guiding tube to the seabed generate only faint noise, although no source level measurements were given. However, the same authors stated that the underwater noise was dominated by the sound of the thrusters of the rock dumping construction support vessel in DP mode. When comparing normal operations (i.e., non-rock dumping) and during rock dumping activities, there was no noticeable rise in the level of underwater noise, and this indicated the sound levels were dominated by the underwater noise generated by the construction support vessel in DP mode and not the rock dumping activities (Nedwell and Edwards, 2004).

Rock dumping is anticipated to generate higher underwater noise levels than than installing concrete mattresses over third-party cables or pipelines. In the case where targeted rock dumping at cable crossings is proposed, the rock dumping vessel is assumed to have similar traits as the above cable burial vessel. Therefore, for the purpose of this report, an underwater noise source level of **180 dB re. 1 µPa at 1 m** has been adopted for the rock dumping vessel, which is representative of the actual rock dumping operation.

3.1.4.2 Rock mattress placement underwater noise sources

The laying of rock mattresses at the crossings of third-party seabed infrastructure is considered to generate little noise as the main source of underwater noise will be cable burial vessel operating in DP mode to maintain position. Therefore, for the purposes of this report, an underwater noise source level of **180 dB re. 1 µPa at 1 m** has been adopted for the proposed construction support vessel in DP mode. The lowering of the concrete mattress through the water column to the seabed is assessed to be a quiet operation.

3.1.4.3 Geophysical instrument noise sources

Since geophysical instruments will be used during project construction, operations and decommissioning, Table 4 presents a summary of typical source levels, pulse durations, frequency and rates and shows simultaneous measurements of Sound Pressure Level (SPL) and Sound Exposure Levels (SEL).

Underwater noise impacts assessments were not undertaken for geophysical instruments as these instruments are typically used by exploration marine geophysical surveys and geotechnical sampling, and both pre-lay seabed site investigations and post-lay inspections of the Project's proposed cable alignments, as well as by other maritime traffic plying Bass Strait. In general, impacts assessments of routinely used geophysical instruments are not part of the EIS process given their very narrow or relatively narrow vertical beams and the short duration exposure of marine fauna passing either actively or passively through the beams.

Table 4: Summary of adopted sound source levels of representative geophysical sensors

Geophysical source	Source Level			Pulse frequency (kHz)	Pulse duration (ms)	Pulses per second (pps)
	SPL Pk–Pk*	SPL RMS*	SEL#			
USBL acoustic navigation [a]	211	202	177	25	8	4
Sub-bottom profiler [b]	220	209	193	3.3	21.7	4
Multi-beam echosounder [b]	226	218	182	200	0.25	50
Single beam echosounder [b]	202	193	159	200	0.36	20
Side scan sonar [b]	232	220	179	200	0.084	N/R

Source: Source: [a] EGS (2017); [b] NMFS (2020). *Source level units are dB re 1 µPa at 1 m for peak-peak and RMS sound pressure levels. # Source level unit is dB re 1 µPa^2·s at 1 m for sound exposure levels (SEL).

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ATTACHMENT E

Project Marinus

Tioxide Sediment Analysis Report

Prepared by

Tetra Tech Coffey Pty Ltd

for

Marinus Link Pty Ltd

28 July 2022

Marinus Link

Tioxide sediment analysis report

Marinus Link Pty Ltd

Reference: 754-MELEN215878ML

28 July 2022

MARINUS LINK

Tioxide sediment analysis report

Report reference number: 754-MELEN215878ML_R13_Tioxide sediment analysis report_RevA
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ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
ANC	Acid neutralising capacity
ANZG	Australian and New Zealand Guideline
ASS	Acid sulfate soil
AASS	Actual acid sulfate soil
CRS	Chromium reducible sulfur
DGV	Default guideline values
HVDC	High voltage direct current
LOD	Limit of detection
MEGSI	Marine Engineering Geotechnical Site Investigation Services
PASS	Potential acid sulfate soil
PSD	Particle size distribution
QA	Quality assurance
QC	Quality control
w/w	Weight for weight

1. INTRODUCTION

1.1 BACKGROUND

Tasmanian Networks Pty Ltd (TasNetworks) is progressing the design and approvals phase of Marinus Link, the second high voltage direct current (HVDC) electricity interconnector between Tasmania and Victoria. Marinus Link will consist of land and subsea cables connecting converter stations in Gippsland, Victoria, and North West Tasmania, near Burnie.

The proposed converter stations site in Tasmania is located at Heybridge, at the site of the former Tioxide Australia plant, west of the Blythe River mouth. The plant produced titanium dioxide pigment between 1949 and 1996, primarily for use in paints and plastics. Throughout this period, an acid-iron liquor waste from the production process was discharged directly to Bass Strait via an outfall pipeline which extends approximately 2.8 km offshore from the plant. Anecdotal evidence suggests that at the time of operations, the discharged effluent caused red (iron oxide) staining of nearshore waters and the coastline. Other historic contamination sources, such as copper mining in the Blythe River catchment and submarine calcine dumping near Burnie, may have also contributed to marine sediment contamination.

The marine component of Marinus Link will involve laying and burial of the subsea cables on the seabed by water jetting, trenching or rock dumping, or a combination of these methods. These methods will disturb the seabed to varying degrees and may generate sediment plumes in the water column. Based on the proposed alignment of Marinus Link in Tasmanian nearshore waters, a key consideration for the project will be the possible disturbance and mobilisation of potentially contaminated sediments near the Tioxide waste outfall point, which may occur during construction (cable installation) and cable maintenance or repairs during operations. There is potential for contaminated sediments to be disturbed, suspended in the water column, dispersed and deposited on previously uncontaminated seabed habitats, reducing sediment quality and impacting on marine organisms.

The extent and significance of contaminated sediments and associated potential impacts on the marine environment is required to be assessed as part of the environmental impact assessment process to be undertaken for Marinus Link. A sediment sampling campaign was undertaken by a contractor as part of the Marinus Link Marine Engineering Geotechnical Site Investigation Services (MEGSI) with scope direction provided by Tetra Tech Coffey Pty Ltd.

1.2 OBJECTIVES

The objective of this scope is to characterise the sediment contaminant concentrations and potential occurrence of acid sulfate soils (ASS) along the proposed subsea cable route in nearshore Tasmania to determine whether disturbance during cable installation or maintenance will suspend and disperse sediments that may have adverse environmental effects.

2. METHODS

The following section provides a summary of sampling locations and methods.

2.1 SAMPLING AND ANALYSIS

Sampling was conducted by CoreMarine in accordance with a sampling plan prepared by Tetra Tech Coffey (Appendix A). Sampling was conducted in two separate sampling campaigns. The first being conducted between the 11th and 12th of February 2022, and the second on the 28th of February 2022, with all samples transported to ALS Environmental Melbourne and Brisbane laboratories for analysis. Appendix A provides further detail of the sampling method. Metals analysis of porewater could not be conducted as there was insufficient moisture in the sediments after sampling to allow analysis (as advised by the laboratory).

The sampling program largely complied with the sampling plan, with the exception of the sediment sampler used. The plan nominated a piston corer to be used for sediment collection, however this method proved unsuccessful due to the coarse sand of the seabed, and a vibra-corer was used for sediment sample collection. Both methods are considered suitable to recover undisturbed samples and the use of a vibra-corer does not adversely affect the program quality.

Sampling site locations and depths varied from those listed in the sampling plan due to hard rock refusal at numerous sites. Numerous cores were collected at most sites (distinguished by 'A' and 'B' suffixes in Table 2.1) as an attempt to sample deeper into the sediment profile. No samples were collected at SED-W2 and SED-W3 due to refusal at the surface. Sediment sampling sites and analyses performed are summarised in Table 2.1 and the sample site locations are displayed in Figure 2.1. Sampling locations were selected to follow the subsea cable alignments (i.e., where sediment disturbance will occur during subsea cable construction and/or maintenance) in areas where previous literature (CSIRO, 1990) has identified sediment contamination due to the Tioxide discharge.

Table 2.1 Sampling sites and analyses suites

Site ID	Easting[1]	Northing[1]	Subsampled depths	Chromium reducible sulfur suite	Particle size distribution	Metals analysis of sediment sieved to <2,000 µm	Metals analysis of sediment sieved to <63 µm
SED-W1	414878	5453819	10-25 cm 40-60 cm 65-72 cm	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	- - -
SED-W4	416208	5455127	0-20 cm 40-60 cm 80-100 cm	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	- - -
			0-100 cm	-	-	-	✓
SED-W5	417070	5456026	0-20 cm 40-60 cm	✓ ✓	✓ ✓	✓ ✓	- -
SED-E1	415363	5453285	0-10 cm	✓	✓	✓	-
SED-E1A	415366	5453289	0-10 cm	✓	✓	✓	-
SED-E2	415521	5453910	0-25 cm	✓	✓	✓	-
SED-E2A	415523	5453914	0-25 cm	✓	✓	✓	-
SED-E3	415948	5454311	0-20 cm	✓	✓	✓	-
SED-E3A	415959	5454304	0-20 cm 20-32 cm	✓ ✓	✓ ✓	✓ ✓	- -
SED-E3B	415961	5454307	0-20 cm 20-40 cm	✓ ✓	✓ ✓	✓ ✓	- -
SED-E4	416588	5454923	0-20 cm 40-60 cm 70-90 cm	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	- - -
SED-E4A	416581	5454920	0-100 cm	-	-	-	✓

Site ID	Easting[1]	Northing[1]	Subsampled depths	Chromium reducible sulfur suite	Particle size distribution	Metals analysis of sediment sieved to <2,000 µm	Metals analysis of sediment sieved to <63 µm
SED-E4B	416589	5454926.	0-20 cm (+Dup) 40-60 cm (+Dup) 80-100 cm (+Dup)	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	- - -
SED-E5	417224	5455964	0-20 cm 40-60 cm 80-100 cm	✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	- - -

1 Coordinates listed using MGA Z55 projection
+Dup – indicates duplicate samples were recovered for data quality control testing
Total metal suite includes: aluminium (Al), antimony (Sb), arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu) iron (Fe), mercury (Hg), lead (Pb), nickel (Ni), silver (Ag), vanadium (V), titanium (Ti) and zinc (Zn).

2.2 QUALITY ASSURANCE AND QUALITY CONTROL

This section outlines quality assurance (QA) protocols and quality control (QC) testing implemented by both the sampling team and ALS Environmental Brisbane and Melbourne. ALS Environmental is accredited by National Association of Testing Authorities (NATA) for the analyses undertaken.

2.2.1 Field

QA Procedures

Samples were collected using a vibracoring technique by staff experienced in the collection of off-shore marine sediments. The sampling unit was lined with a plastic liner for the collection of samples and a new liner was installed between each sample collected.

Each sample was brought to the surface and processed on a clean bench located on the vessel. Each liner was opened, and representative samples collected for appropriate depths for analysis. Samples were placed into laboratory supplied jars with Teflon lids (with the exception of sieving samples, which were sealed and transported whole to the laboratory for sieving). Samples were placed in eskies under ice bricks and stored in a fridge until they were transported to the laboratory for analysis. Acid sulfate soil samples were collected from the tubes and placed into zip sealed bags and the air squeezed out and placed under ice bricks, then stored in a freezer until they transported to the laboratory.

In order to reduce cross contamination during sample processing, new nitrile gloves were used during sampling and sample handling. All samples, excluding those stored in jars, were double bagged for storage to reduce the risk of leakage and cross-contamination during sample transit.

Between sampling locations, the vibracore equipment was washed in seawater to remove any attached solid materials and rinsed in fresh water prior to installing a new liner to reduce the potential for cross contamination.

QC Testing

Duplicate samples were collected from one location for quality control purposes. The duplicate samples (SED-E4B) were collected by second core taken within the vicinity of SED-E4. This was performed to check the representativeness and variability of samples collected.

At the start of each day, a rinsate sample was collected by pouring deionised water through the washed sampling equipment (and a new plastic liner used in the core sampler) and collected into laboratory provided containers for total metals analysis. The purpose of this is to assess the adequacy of the decontamination process used on sampling equipment. To indicate a low potential for cross-contamination, analyte concentrations in rinsate samples should be less than their respective limit of detection (LOD).

2.2.2 Laboratory

The following QC tests were conducted during the analysis of samples:

- Laboratory control spike (LCS) – the purpose of this QC parameter is to monitor method precision and accuracy. LCS results are described as a % recovered, with sediment matrix's acceptance limit requiring a 70%-130% recovery.
- Method blanks – the purpose of this parameter is to monitor potential laboratory contamination. Analyte concentration for method blanks should be less than their respective limit of detection (LOD).
- Matrix spike – the purpose of this parameter is to monitor potential matrix interferences that may hinder analyte recoveries. Matrix spike results are described as a % recovered, with sediment matrix's acceptance limit requiring a 70%-130% recovery.

- Duplicates – laboratory duplicates monitor method precision and sample heterogeneity.

3. RESULTS

3.1 PARTICLE SIZE DISTRIBUTION

Table 3.1 presents the sediment classifications based on particle size distribution (PSD) analysis. Appendix B includes the full PSD results.

Particle size distribution followed a similar trend across the majority of the sampling sites with sediments being dominated by sand and gravel with minor silt and clay content. Gravel content increased with sampling depth at SED-E3B, SED-E4B and SED-W4, whereas gravel/sand content was consistent across the sediment profile at SED-E4, SED-W5, SED-E3A and SED-E5 The subsample taken at the depth of 0.4-0.6 m at SED-W5 was characterised by higher clay and silt content compared to all other samples.

Table 3.1: Particle size distribution of sediment samples (% of solids in each fraction)

Sampling location	Subsample depth (m)	Clay (<2 µm)	Silt (2-60 µm)	Sand (0.06-2 mm)	Gravel (>2 mm)	Cobbles (>6 cm)
SED-W1	0.1-0.25	2	1	34	63	<1
	0.4-0.6	3	4	67	26	<1
	0.65-0.72	2	2	63	33	<1
SED-W4	0-0.2	7	1	82	10	<1
	0.4-0.6	7	5	75	13	<1
	0.8-1.0	7	9	37	47	<1
SED-W5	0.0-0.2	3	9	44	44	<1
	0.4-0.6	16	29	27	28	<1
SED-E1	0.0-0.1	<1	5	70	25	<1
SED-E1A	0.0-0.1	<1	2	85	13	<1
SED-E2	0.0-0.25	4	<1	43	53	<1
SED-E2A	0.0-0.25	1	2	22	75	<1
SED-E3	0.0-0.2	7	10	41	42	<1
SED-E3A	0.0-0.2	6	9	48	37	<1
	0.2-0.32	5	4	54	37	<1
SED-E3B	0.0-0.2	8	5	67	20	<1
	0.4-0.6	7	8	34	51	<1
SED-E4	0.0-0.2	7	3	83	7	<1
	0.4-0.6	8	4	83	5	<1
	0.7-0.9	7	1	86	6	<1
SED-E4B	0-0.2/D	9	8	83	<1	<1
	0.4-0.6/D	5	5	78	12	<1
	0.8-1.0/D	6	13	36	45	<1
SED-E5	0-0.2	3	8	46	43	<1
	0.4-0.6	7	10	42	41	<1
	0.8-1.0	8	12	24	56	<1

3.2 ACID SULFATE SOILS

The chromium reducible sulfur (CRS) suite is a standard method for determining existing acidity and potential acid production from the oxidation of iron sulfides. The Tasmanian Acid Sulfate Soil Management Guidelines (DPIPWE, 2009) contains an action criteria, that if exceeded, prompts the need for a management plan or development consent. Typically, marine sediments at the depths encountered in the project area are sufficiently deep and unlikely to be oxidised during below-water operations. However, in the event that disturbance results in sediment being brought to the surface or surface areas where they may oxidise, this study undertook an appraisal of the acid sulfate soils along the cable alignments.

The action criteria for 100-1,000 tonnes of disturbed sediment (sands to loamy sands) are listed below:

- Titratable actual acidity results greater than 0.03%S or 18 mole H+ / t, indicates the presence of actual acid sulfate soils (AASS).
- CRS results greater than 0.03%S or 18 mole H+ / t, indicates the presence of potential acid sulfate soils (PASS).
- Net acidity results greater than 0.03%S or 18 mole H+ / t, indicates that soil treatment may be required if disturbed. Net acidity is determined by:

  Net Acidity = Potential Acidity + Existing Acidity – Acid Neutralising capacity (ANC)

Table 3.2 presents chromium reducible sulfur suite results.

All samples reported pH ranging between 8.9 to 9.7 pH KCl units, indicating the sediments were non-acidic in their natural state. The titratable actual acidity was less than the laboratory limit of reporting (LOR) for all samples indicating the sediments were not actual acid sulfate soils. Following oxidation of the samples, the chromium reducible sulfur results for all samples exceeded the screening criteria of 0.03%S (w/w), which indicates that iron sulfides may be present in the samples. However, the acid-neutralising capacity (ANC) of the samples reported that the net acidity was less than the LOR for all samples, indicating that the sediments have a natural neutralising capacity that would be likely to overcome any acid generation if the sediments were oxidised. As a result, the sediments are not considered to warrant treatment or management if disturbed.

Table 3.2: Acid sulfate soil results

Sample Location	Subsample ID	pH KCl	Titratable Actual Acidity		Chromium Reducible Sulfur		Acid Neutralising Capacity			Net Acidity	
			(mole H+ /t)	(% pyrite S)	(% S)	(mole H+/t)	(%CaCO3)	(mole H+ /t)	(% pyrite S)	(% S)	(mole H+/t)
SED-E3B	0.0-0.2	9.5	<2	<0.02	0.144	90	36.1	7,210	11.6	<0.02	<10
	0.4-0.6	9.4	<2	<0.02	0.248	154	18.8	3,760	6.03	<0.02	<10
SED-E4	0.0-0.2	9.6	<2	<0.02	0.039	24	54.3	10,800	17.4	<0.02	<10
	0.4-0.6	9.5	<2	<0.02	0.067	42	70	14,000	22.4	<0.02	<10
	0.7-0.9	9.4	<2	<0.02	0.135	84	57.7	11,500	18.5	<0.02	<10
SED-E4B	0-0.2/D	9.1	<2	<0.02	0.452	282	63	12,600	20.2	<0.02	<10
	0.4-0.6/D	9.3	<2	<0.02	0.242	151	49.9	9,970	16	<0.02	<10
	0.8-1.0/D	9.1	<2	<0.02	0.316	197	30	5,990	9.61	<0.02	<10
SED-W4	0-0.2	9.5	<2	<0.02	0.233	146	64.6	12,900	20.7	<0.02	<10
	0.4-0.6	9.4	<2	<0.02	0.282	176	54.5	10,900	17.4	<0.02	<10
	0.8-1.0	9.5	<2	<0.02	0.296	185	18	3,600	5.77	<0.02	<10
SED-W5	0.0-0.2	9.6	<2	<0.02	0.066	41	15	2,990	4.79	<0.02	<10
	0.4-0.6	8.9	<2	<0.02	0.099	62	6.72	1,340	2.15	<0.02	<10
SED-W1	0.1-0.25	9.7	<2	<0.02	0.029	18	3.81	761	1.22	<0.02	<10
	0.4-0.6	9.5	<2	<0.02	0.035	22	29.3	5,860	9.4	<0.02	<10
	0.65-0.72	9.6	<2	<0.02	0.077	48	29.4	5,880	9.43	<0.02	<10
SED-E1	0.0-0.1	9.7	<2	<0.02	0.045	28	7.09	1,420	2.27	<0.02	<10
SED-E1A	0.0-0.1	9.7	<2	<0.02	0.036	23	8.1	1,620	2.59	<0.02	<10
SED-E2	0.0-0.25	9.7	<2	<0.02	0.047	29	8.27	1,650	2.65	<0.02	<10
SED-E2A	0.0-0.25	9.7	<2	<0.02	0.032	20	5.89	1,180	1.89	<0.02	<10
SED-E3	0.0-0.20	9.4	<2	<0.02	0.172	107	23.6	4,720	7.56	<0.02	<10

Sample Location	Subsample ID	pH KCl	Titratable Actual Acidity		Chromium Reducible Sulfur		Acid Neutralising Capacity			Net Acidity	
			(mole H+ /t)	(% pyrite S)	(% S)	(mole H+/t)	(%CaCO3)	(mole H+ /t)	(% pyrite S)	(% S)	(mole H+/t)
SED-E3A	0.0-0.20	9.6	<2	<0.02	0.048	30	32.8	6,550	10.5	<0.02	<10
	0.20-0.32	9.5	<2	<0.02	0.114	71	14.6	2,910	4.66	<0.02	<10
SED-E5	0-0.2	9.6	<2	<0.02	0.075	47	20.1	4,010	6.43	<0.02	<10
	0.4-0.6	9.5	<2	<0.02	0.085	53	12.2	2,430	3.89	<0.02	<10
	0.8-1	9.2	<2	<0.02	0.081	51	3.49	698	1.12	<0.02	<10

3.3 METALS

This section presents the metals analysis results. For simplicity, the metalloids arsenic and antimony are described as 'metals' in this report.

This section adopts the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZ, 2018) to act as a reference for characterising existing sediment metal concentrations. The sediment quality guidelines provide:

- Default guideline values (DGVs), which indicate the concentrations below which there is a low risk of biological effects occurring.
- Upper guideline values (GV-high), which provide an indication of concentrations at which toxicity related effects would be expected.

At concentrations between the DGV and GV-high, toxicity related effects may occur, but further investigations would typically be recommended to investigate the risks of biological effects occurring.

Table 3.3 presents total metal concentrations for each sampling site and associated DGV and GV-high values. In summary:

- Cadmium, mercury, copper, lead and zinc concentrations for every sample were less than their respective DGV at all sites and depths.
- Antimony concentrations for all samples where less than the laboratory limit of detection (LOD) (5 mg/kg); however, the LOD is above the DGV of 2 mg/kg.
- Silver concentrations for all samples, except SED-E5A (0.4-0.6), were less than the LOD (<2 mg/kg); however, the LOD is above the DGV of 1 mg/kg.
- Arsenic concentrations exceeded the DGV at most sampling depths across all sites, except for SED-E1, SED-E1A and SED-E3. Arsenic concentrations exceeded the GV-High at sampling depths 0.4-0.6 m and 0.6-0.8 m at SED-E5A.
- Chromium concentrations for every sample were less than the DGV, except at SED-W5 (0.4-0.6) and SED-E5A (0.8-1.0).
- Nickel concentrations at SED-E3B (0.4-0.6), SED-E4A (0.0-1.0), SED-E4B and SED-E5A (0.0-0.2) exceeded the DGV, and concentrations at SED-W5 (0.4-0.6) and SED-E5A (0.8-1.0) exceeded the GV-high.

Australian Institute of Metallurgy and Mining (2001) published estimated average abundance of selected minor elements in the earth's crust. Metals that do not have quality guidelines were also compared to average crustal abundance values from literature to further provide context on metals that could be considered 'elevated'. Vanadium and titanium concentrations for all samples were less than their respective average crustal abundance (135 and 5,700 mg/kg), except in SED-E5A (0.4-0.6 and 0.8-1.0) which had elevated concentrations of vanadium.

Prior to analysis, samples were either sieved to <2,000 μm or <63 μm (indicated in Table 3.3). Sieving to <2,000 μm allows comparison of a standardised particle size fraction to sediment quality guidelines. The sieving to <63 μm allows for characterisation of finer sediments that may be more readily suspended or ingested.

Table 3.3: Total metal concentrations (mg/kg, dry weight) and comparison to relevant DGVs and GV-high values

Sample ID	Sub-sample ID	Sieve (µm)	Hg	Al	Sb	As	Cd	Cr	Cu	Fe	Pb	Ni	Ag	V	Zn	Ti
ANZ 2018 DGV			0.15	N/A	2	20	1.5	80	65	N/A	50	21	1	N/A	200	N/A
ANZ 2018 GV-High			1.0	N/A	25	70	10	370	270	N/A	220	52	4	N/A	410	N/A
Average crustal abundance			0.08	N/A	0.2	1.8	0.2	100	55	N/A	12.5	75	0.07	135	165	5,700
SED-E1	0.0-0.1	<2,000	<0.1	1,130	<5	17	<1	9	<5	5,860	<5	3	<2	21	8	40
SED-E1A	0.0-0.1	<2,000	<0.1	900	<5	16	<1	8	<5	5,110	<5	3	<2	18	7	30
SED-E2	0.0-0.25	<2,000	<0.1	1,360	<5	**27**	<1	11	<5	11,200	<5	3	<2	31	10	70
SED-E2A	0.0-0.25	<2,000	<0.1	1,270	<5	**24**	<1	10	<5	10,600	<5	3	<2	29	9	70
SED-E3	0.0-0.20	<2,000	<0.1	4,030	<5	18	<1	35	8	8,850	<5	10	<2	38	14	350
SED-E3A	0.0-0.20	<2,000	<0.1	3,730	<5	**29**	<1	23	14	22,300	30	10	<2	46	30	220
	0.20-0.32	<2,000	<0.1	2,880	<5	19	<1	27	<5	11,000	<5	8	<2	32	10	220
SED-E3B	0.0-0.2	<2,000	<0.1	3,320	<5	**24**	<1	24	<5	14,700	5	10	<2	38	17	190
	0.4-0.6	<2,000	<0.1	8,540	<5	**22**	<1	58	39	23,400	<5	**21**	<2	65	23	300
SED-E4	0.0-0.2	<2,000	<0.1	1,770	<5	**49**	<1	19	<5	19,500	7	6	<2	63	24	180
	0.4-0.6	<2,000	<0.1	1,950	<5	**29**	<1	19	<5	14,000	<5	7	<2	44	13	170
	0.7-0.9	<2,000	<0.1	1,370	<5	19	<1	11	<5	10,700	<5	4	<2	28	8	100
SED-E4A	0-1.00	<63	<0.1	9,060	<5	**36**	<1	39	14	40,500	8	**40**	<2	70	65	450
SED-E4B	0-0.2/D	<2,000	<0.1	10,900	<5	**32**	<1	33	15	42,000	<5	**41**	<2	49	31	270
	0.4-0.6/D	<2,000	<0.1	6,960	<5	**34**	<1	26	12	31,100	<5	**31**	<2	47	23	230
	0.8-1.0/D	<2,000	<0.1	11,400	<5	**26**	<1	35	20	42,300	<5	**51**	<2	51	31	280
SED-W1	0.1-0.25	<2,000	<0.1	1,140	<5	**34**	<1	10	<5	16,100	8	3	<2	38	32	820
	0.4-0.6	<2,000	<0.1	1,400	<5	**24**	<1	10	<5	18,200	<5	3	<2	30	10	110
	0.65-0.72	<2,000	<0.1	1,100	<5	14	<1	9	<5	9,050	<5	2	<2	27	<5	60

Sample ID	Sub-sample ID	Sieve (µm)	**Hg**	Al	Sb	As	Cd	Cr	Cu	Fe	Pb	Ni	Ag	V	Zn	Ti
SED-W4	0-0.2	<2,000	<0.1	1,970	<5	**43**	<1	19	<5	20,100	<5	7	<2	64	16	210
	0.4-0.6	<2,000	<0.1	1,700	<5	**25**	<1	13	<5	11,700	<5	5	<2	36	6	130
	0.8-1.0	<2,000	<0.1	3,540	<5	**24**	<1	16	<5	14,300	<5	9	<2	29	9	220
SED-W5	0.0-0.2	<2,000	<0.1	4,100	<5	**21**	<1	25	<5	21,500	6	15	<2	43	23	290
	0.4-0.6	<2,000	<0.1	33,200	<5	17	<1	**124**	39	62,300	<5	**147**	<2	78	84	940
SED-E5	0-0.2	<2,000	<0.1	4,760	<5	**43**	<1	35	<5	23,500	<5	**27**	<2	68	21	320
	0.4-0.6	<2,000	<0.1	9,860	<5	**103**	1	63	8	45,500	<5	**52**	**2**	168	27	760
	0.8-1.0	<2,000	<0.1	14,700	<5	**108**	1	**95**	23	50,600	<5	**109**	<2	219	26	470
	0-100	<63	<0.1	5,750	<5	**39**	<1	30	7	22,100	<5	19	<3	46	22	300

N/A denotes no applicable ANZ 2018 value or crustal abundance concentration (Australian Institute of Metallurgy and Mining, 2001)
All concentrations are in mg/kg dry weight

3.4 QUALITY CONTROL

The following sections outline quality control results.

3.4.1 Field

The results of the field quality control regime are presented in Appendix B and summarised below:

- Both rinsate samples reported low but detectable levels of various metals, likely due to the presence of residual seawater remaining in the sampling equipment after the cleaning process. The detected metal concentrations in the rinsate samples are not expected to materially affect the results, given the analysis was of sediment containing metals at much higher concentrations.
- Field duplicate (SED-E4B subsamples) analysis reported 14 of the 42 metal results exceeded the RPD acceptance criteria when compared to SED-E4. RPDs were only considered where concentration was greater than 5 times the LOR. Acceptable RPDs for each LOR multiplier range are: 100 (5-10 x LOR); 50 (10-30 x LOR); 30 (> 30 x LOR). These discrepancies in metal concentrations are likely due to sediment profile heterogeneity as the duplicate was not sampled in the exact location as SED-E4.

3.4.2 Laboratory

The results of the laboratory quality control regime generally met target criteria and are summarised as follow:

- Laboratory control spike results showed no outliers, indicating good analytical accuracy.
- Laboratory method blank results showed no outliers with all results being below detection limit. This indicates low potential for laboratory contamination.
- Laboratory matrix spike results were mostly within laboratory limits. Of the 45 matrix spikes only two results were outside laboratory limits. Overall, these results indicate good analytical accuracy.
- Laboratory duplicate results showed two out of 171 duplicate analyses were outside the laboratory limits. This indicates good laboratory precision and repeatability.

4. DISCUSSION

4.1 ACID SULFATE SOIL

The results of the pH and acid sulfate soil testing indicates that the sediments are not currently acidic, which is as expected given they are submerged beneath several metres of seawater. The results of the testing also indicated that whilst there was an oxidation response to the test which could suggest the presence of potential acid sulfate soils, the neutralising capacity of the sediments was sufficiently high to neutralise all acid that may be generated with at least a 20 times factor of safety. If the sediments are brought to the surface, it is unlikely that acid generation would result in measurable acidic impacts to the environment.

Consequently, the results indicate that no specific management measures are required for the sediments in terms of acid sulfate soils present in the samples.

4.2 METALS

The results of the metals analysis showed that some samples contained concentrations of metals that exceeded the Default Guideline Values for sediment quality, but the majority did not exceed the upper guideline values at which point benthic toxicity effects are likely to be observed.

Concentrations of arsenic exceed the DGV at most locations, with a median value of 24.5 mg/kg and a 95% upper confidence limit of 39.7 mg/kg across the entire dataset. This indicates that the arsenic may be naturally elevated in sediments in the area. Elevated concentrations of arsenic above the upper-guideline (GV-high) value were detected at SED-E5 at depths of 0.4-0.6m and 0.8-1.0m with concentrations of 103 and 108 mg/kg, respectively. The arsenic at depth at this location may represent a potential risk to benthic species if disturbed in this area and may require additional investigation or management to confirm mobility, bioavailability and sensitivity of the surrounding environment.

Concentrations of chromium were also elevated at locations SED-E5 and SED-W5 above the DGV for sediments. However, as the concentrations were below the adopted upper-guideline values, it is considered that localised effects on benthic biota may potentially be observed, but more investigation would be needed to confirm the relevance. The elevated concentrations of chromium were observed at the 0.4-0.6m depth, with shallower samples reporting lower concentrations.

Concentrations of nickel were observed in some locations above the DGV sediment criteria, with two locations (SED-E5 and SED-W5) reporting concentrations above the upper-guideline values. Given the location of these samples coincides with the elevated arsenic and chromium concentrations, the sediments in this area may potentially result in observable toxic effects on benthic biota if disturbed and may require additional investigation or management.

In general, the shallow sediment samples reported lower concentrations of metals, which likely represents fresh sediments that have been deposited over the last 20 years. Patterns in metals concentrations with depth were generally not observed in the sampling locations closer to the shore (i.e., sites E1, E2, E3, and W1), with no clear pattern in metals concentration changes with depth. This may partially be attributable to the shallow rock depth at some of these locations meaning that an aged sediment profile was not present to be sampled.

At the furthest location from shore (the E5/W5 sampling points) a marked change in metals concentrations with depth was observed, with concentrations of most metals (aluminium, arsenic, chromium, iron, nickel, vanadium and titanium) all increasing in concentration with depth. A chart of the change in concentration at SED-E5 with depth is presented in Figure 4.1.

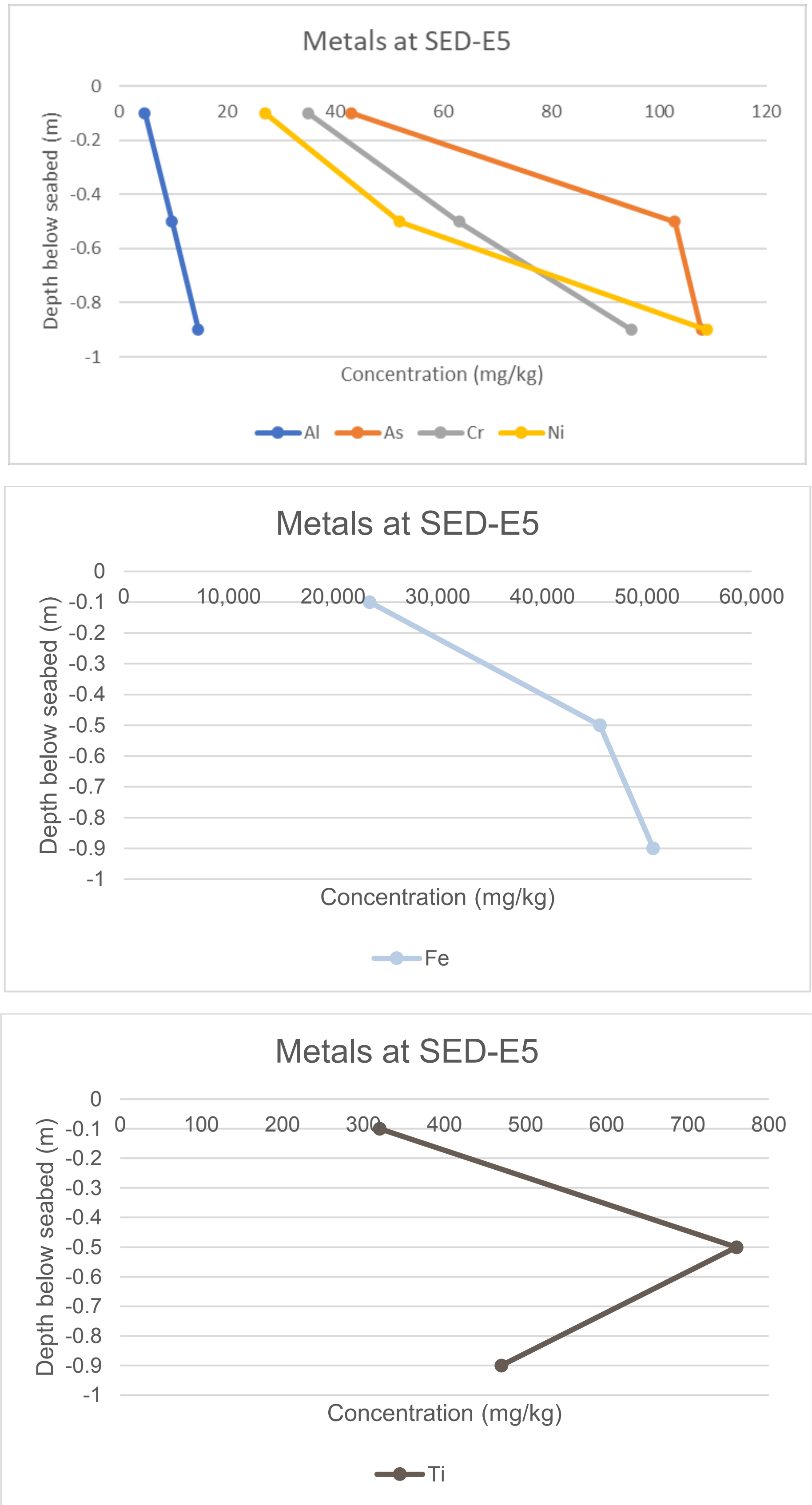

Figure 4.1: Metals concentrations with depth at SED-E5.

This location, based on the increased metals (in particular iron and titanium) may represent an area where former effluent from the processing of titanium oxides has increased metals concentrations, but has more recently been covered by sediments more representative of natural sediments from the area.

It would typically be expected that metals concentrations in the <63µm fraction would be higher than in the whole <2,000 µm due to the higher surface area for metal binding per unit weight. The appraisal of fine (<63 µm) versus coarse (<2,000 µm) sediment metals concentrations did not show significant differences between the fractions indicating no significant preference for metals adsorption to the sediments.

5. REFERENCES

CSIRO. 1990. Metal residues in sediments and macrobiota of Bass Strait near Burnie, Tasmania, in April 1989. Part I Synoptic Report. Prepared by C.J. Crossland and T.J. Ward of Commonwealth Scientific and Industrial Research Organisation Division of Fisheries, Hobart, Tasmania.

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The Australasian Institute of Mining and Metallurgy. 2001. Field Geologists' Manual. Fourth Edition. Monograph No.9.

APPENDIX A: SAMPLING PLAN

Marinus Link Project

Sediment sampling plan – Tioxide contaminant sediments

TasNetworks Pty Ltd

Reference: 754-MELEN215878

14 October 2021

MARINUS LINK PROJECT

Sediment sampling plan – tioxide contaminate sediments

Report reference number: 754-MELEN215878
14 October 2021

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1. INTRODUCTION

1.1 BACKGROUND

Tasmanian Networks Pty Ltd (TasNetworks) is progressing the design and approvals phase of Marinus Link, the second high voltage direct current (HVDC) electricity interconnector between Tasmania and Victoria. Marinus Link will consist of land and subsea cables connecting converter stations in Gippsland, Victoria, and North West Tasmania, near Burnie.

The proposed converter stations site in Tasmania is located at Heybridge, at the site of the former Tioxide Australia plant, west of the Blythe River mouth. The plant produced titanium dioxide pigment between 1949 and 1996, primarily for use in paints and plastics. Throughout this period, an acid-iron liquor waste from the production process was discharged directly to Bass Strait via an outfall pipeline which extends approximately 2.8 km offshore from the plant. Anecdotal evidence suggests that at the time of operations, the discharged effluent caused significant red staining of nearshore waters and the coastline. Other historic contamination sources such as copper mining in the Blythe River catchment and submarine calcine dumping near Burnie may have also contributed to marine sediment contamination.

The marine component of Marinus Link will involve laying and burial of the subsea cables on the seabed by water jetting, trenching or rock dumping or a combination of these methods. These methods will disturb the seabed to varying degrees and generate suspended sediment plumes in the water column. Based on the proposed alignment of Marinus Link in Tasmanian nearshore waters, a key consideration for the project will be the possible disturbance and mobilisation of potentially contaminated sediments near the tioxide waste outfall point, which may occur during construction (cable installation) and cable maintenance or repairs during operations. There is potential for contaminated sediments to be disturbed, suspended in the water column, dispersed and deposited on previously uncontaminated seabed habitats, reducing sediment quality and impacting on marine organisms.

The extent and significance of contaminated sediments and associated potential impacts on the marine environment is required to be assessed as part of the environmental impact assessment process to be undertaken for Marinus Link. Tetra Tech Coffey Pty Ltd (Coffey) recommends a sediment sampling and analysis program be undertaken in proximity to the outfall, with the findings to provide a key input to the marine ecology impact assessment component of the Environmental Impact Statement (EIS) for the project. The sediment sampling campaign will be undertaken by a contractor as part of the Marinus Link Marine Engineering Geotechnical Site Investigation Services (MEGSI) with scope direction provided by Coffey.

This document is a sediment sampling plan to be followed by the contractor during the MEGSI survey.

1.2 OBJECTIVES

The objective of this study is to characterise the sediment contaminant concentrations along the proposed subsea cable route in nearshore Tasmania to determine whether disturbance during cable installation and cable maintenance or repairs during operations will suspend and disperse sediments with elevated contaminant concentrations. A marine ecology impact assessment will be undertaken during the preparation of the EIS and will be based on the findings of this and other relevant studies.

The objective of this sediment sampling plan is to outline a clear set of steps for the MEGSI contractor to follow when sampling the sediments and packaging them for shipment to the laboratory. It provides directives on sampling sites, equipment, sample processing and handling, sample relinquishment to the laboratory and quality control measures.

2. METHODS

Sample collection and handling methods are consistent with procedures described in Australian/New Zealand Standards for water and sediment sampling (AS/NZS 5667.12:1999) and as per laboratory instructions.

2.1 SAMPLING SITES

Sediment sampling sites are summarised in Table 1-1 and displayed in Figure 1.1. Sampling locations have been selected to follow the subsea cable alignments (i.e., where sediment disturbance will occur during subsea cable construction) in areas where previous literature (CSIRO, 1990) has identified sediment contamination due to the tioxide discharge. Bathymetry was reviewed to place the sites where the seabed appears to be soft sediments (i.e., sandy sediments) to avoid hard rock and rubble.

Table 1-1 Sampling sites

Site ID	Latitude[1]	Longitude[1]	Approx. water depth (m)	Subsamples of core required (see Section 2.4)	Analyses required as per Table 1-2	Analyses required as per Table 1-3
SED-W1	-41.062438	145.986921	10	0-20 cm 40-60 cm 80-100 cm	✓ ✓ ✓	- - -
SED-W2	-41.058986	145.991532	15	0-20 cm 40-60 cm 80-100 cm	✓ ✓ ✓	- - -
SED-W3	-41.056109	145.996996	20	0-20 cm 40-60 cm 80-100 cm	✓ ✓ ✓	- - -
SED-W4	-41.050778	146.002933	25	0-20 cm 40-60 cm 80-100 cm	✓ ✓ ✓	- - -
				0-100 cm	-	✓
SED-W5	-41.042765	146.013318	35	0-20 cm 40-60 cm 80-100 cm	✓ ✓ ✓	- - -
SED-E1	-41.067248	145.992586	10	0-20 cm 40-60 cm 80-100 cm	✓ ✓ ✓	- - -
SED-E2	-41.061672	145.994605	15	0-20 cm 40-60 cm 80-100 cm	✓ ✓ ✓	- - -
SED-E3	-41.058127	145.999789	20	0-20 cm 40-60 cm 80-100 cm	✓ ✓ ✓	- - -
SED-E4	-41.052659	146.007394	25	0-20 cm 40-60 cm 80-100 cm	✓ ✓ ✓	- - -
				0-100 cm	-	✓

Site ID	Latitude[1]	Longitude[1]	Approx. water depth (m)	Subsamples of core required (see Section 2.4)	Analyses required as per Table 1-2	Analyses required as per Table 1-3
SED-E5	-41.043377	146.015082	35	0-20 cm 40-60 cm 80-100 cm	✓ ✓ ✓	- - -

1 Coordinates listed using WGS84 projection

2.2 EQUIPMENT

The following equipment is required to complete the sediment sampling:

- Piston corer and liner and associated deployment equipment
- Nitrile gloves
- Laboratory-supplied eskies (labelled with 'Keep Frozen' stickers) with freezer bricks (at least six freezer bricks per esky)
- Laboratory-supplied sample bags (for sediment samples) and bottles (for rinsate) with affixed labels
- Laboratory-supplied chain of custody documentation (hardcopies)
- Laboratory-supplied freight stickers (keep chilled, this way up, fragile, etc)
- Laboratory-supplied deionised water for rinsing equipment, for preparing rinsate samples
- Pens
- Permanent markers for labelling
- Packing tape for taping esky lids on
- Clean bench top for sample splitting
- Sponges, freshwater, deionised water and paper towel for cleaning sampling preparation area (e.g., scales and benchtop)
- Plastic wrap for sealing cores (in their liners) – if samples are processed on-shore
- Scales for weighing sample amounts

2.3 SAMPLING PROCEDURES

The piston corer should be operated as per standard procedure for the model to be used, collecting the uppermost 1 m of the sediment column. The core liner should be carefully retrieved containing the sediment sample so as to not disturb the sediment layers in the core. The sampling is to be conducted by personnel experienced in using this type of sampler.

In between sampling sites, the piston corer should be flushed out and cleaned with seawater. A new, contaminant-free liner should be used for each sediment sampling site.

The GPS coordinates and water depth of the actual sampling location should be recorded.

At all sites, the sediment core sample is to be split into subsamples from three depth profiles as outlined in Section 2.4. At sites SED-W4 and SED-E4 an additional sample of the entire 100 cm core (i.e., without any splitting) is to be collected. This is to allow sufficient sample of the fines fraction (particles <63 µm in size) to be obtained for analysis. These two sites were selected for assessment of metals in the fines fraction as they are in the general zone where previous studies (CSIRO, 1990) found the highest metals contamination of sediments. As the fines fraction in the sandy sediments is expected to be low (<10%, based on CSIRO, 1990) at all sites, the sampling will focus on only two sites to adequately characterise metals content of the fine sediments. This will enable the impact assessment to understand potential biological impact pathways associated with suspension and deposition of finer metal-bearing sediments. The remaining sites will focus solely on the total (<2,000 µm) fraction as this particle size fraction more accurately reflects the overall composition of the sandy sediments that will be disturbed and therefore metals concentrations in this fraction are of primary interest.

Figure 1.1
Sampling sites

Legend
- Sampling sites
- Landfall
- Proposed converter station

Proposed route
- HVDC subsea cable
- Former tioxide plant outfall pipeline

N

Scale: 1:25,000

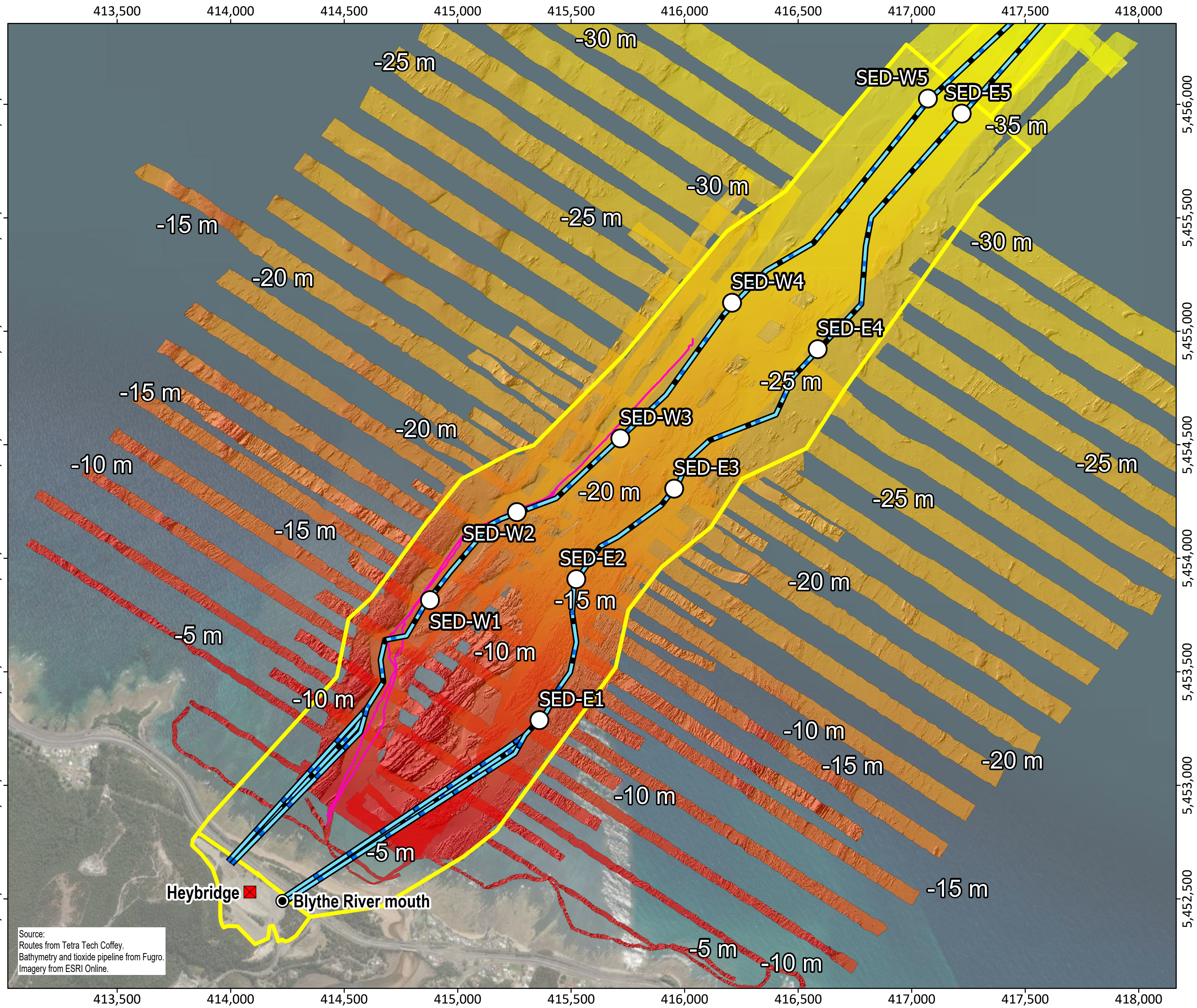
350 175 0 350 m

Coordinate System: GDA2020 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA2020

Date: 6/10/2021 10:20 AM
Prepared by: george.young

TETRA TECH COFFEY

PROJECT MARINUS



2.4 SAMPLE PROCESSING

If the core is to be processed on the vessel, the process below is to be followed. If the sample processing is to be conducted on-shore then once the piston corer is retrieved, the core (in its liner) is to be sealed from air using plastic wrap and stored in an esky with freezer bricks (or in a freezer) prior to transport to shore for processing as per the below process.

Sample processing is to be undertaken by personnel experienced in handling and splitting sediment cores.

Once the piston corer is retrieved, the sample core is to be removed from the plastic liner on a contaminant-free bench space, taking care not to disturb the sediment and mix the layers of sediment. The cores should be held vertically upright at all times until the split subsamples are obtained. Clean nitrile disposal gloves must be worn during all sample handling. For all sites, samples are to be split into subsamples of the following depth intervals:

- 0-20 cm
- 40-60 cm
- 80-100 cm

Each of the split subsamples are to be packed into the laboratory-supplied plastic ziplock bags for the suite of analyses outlined in Table 1-2. Care is needed to avoid loss (spillage) of water and fine sediments during tipping of subsamples into the bags.

Table 1-2 Minimum weight of sample needed for analysis (for each split subsample) – all sites

Analysis Parameters	Container type	Minimum weight	Label colour[2]
Porewater analysis of total and dissolved metals[1]	1 x 250 ml glass jar	100 g	Orange
Chromium reducible sulphur suite	1 x 200 ml plastic bag	70 g	Green
Particle size distribution	1 x 500 ml plastic bag	250 g	White
Sieving to <2,000 µm for metals[1] analysis	1 x 200 ml plastic bag	150 g	Green

1 - metals suite includes: arsenic, aluminium, antimony, cadmium, chromium, copper, mercury, nickel, silver, lead, zinc, iron, titanium, vanadium

2 – The label colours are as per ALS Laboratories standard labels at the time of writing. It is possible that label colours could change, so samplers should read the label to check what type of analysis the bag/bottle is used for.

At sites SED-W4 and SED-E4, an additional sample of the entire 100 cm core is to be placed in several laboratory-supplied plastic ziplock bags (use as many bags as required to obtain about 1.5 kg of sample) (Table 1-3).

Table 1-3 Minimum weight of sample needed for analysis at sites SED-W5 and SED-E5 only

Test Parameter			
Sieving to <63 µm for metals[1] analysis	1 x 200 ml plastic bag	Requires about 1.5 kg of total sample to produce 150 g (of fines)[2]	Green

1 - metals suite includes: arsenic, aluminium, antimony, cadmium, chromium, copper, mercury, nickel, silver, lead, zinc, iron, titanium, vanadium

2 - As the sandy sediments are expected to contain a small proportion (i.e., <10%) of silt/clay, a total sample of about 1.5 kg is to be collected so that about 150 g of fines are obtained.

Each subsample is to be doubled bagged (i.e., put inside a ziplock bag and sealed, which is then put inside another and sealed). Prior to sealing, the bags are to be gently squeezed to expel as much air as possible.

The sample bags are to be labelled as per the following convention:

- Sample ID: in the format of site number / depth interval (e.g., SED-W5/0-20 for site SED-W5 and depth interval 0 to 20 cm; SED-W6/40-60 for site SED-W6 and depth interval 40 to 60 cm)
- Date and time
- Sampler’s initials

2.5 STORAGE AND HANDLING

Once excess air is expelled from bags, the samples are to be tightly packed upright to avoid movement, and kept in a freezer or esky beneath ice bricks for transport to the analytical laboratory. A freezer is preferable as the samples for chromium reducible sulphur analysis need to be frozen as soon as possible after collection. The exception are the rinsate samples (see Section 2.8) which are to be kept chilled but not frozen.

The use of free-ice (i.e., crushed ice of ice cubes) is not recommended as melting ice can cause cross-contamination between samples. Eskies will be required when transferring the samples to the laboratory and when the receiving laboratory on-forwards them to its other laboratories.

It is prudent to tape the esky lids closed so they do not open or fall off during transit, which risks losing the samples. Place the laboratory-supplied stickers (keep chilled, this way up, fragile, etc) on the outside of each esky.

2.6 TRANSPORT TO LABORATORY AND DOCUMENTATION

Eskies containing the samples are to be collected by Tasfast Airfreight at the end of each day of sampling, along with completed chain of custody documentation. The samples will be preserved in a freezer/fridge at Tasfast Airfreight’s office before being shipped to ALS Environmental Melbourne and ALS Environmental Brisbane for analysis. Prior arrangements should be made with the Tasfast Airfreight regarding sample collection timing.

2.7 CHAIN OF CUSTODY DOCUMENTATION

A completed laboratory-supplied chain-of-custody (CoC) form is to be delivered along with each batch of samples delivered to TasFast Airfreight. A copy (e.g., photo or scan) of the CoC should also be made as a backup. A blank CoC form and an example of a completed form is included in Appendix A.

2.8 QUALITY CONTROL

2.8.1 Field Duplicates

Field duplicates provide information on the repeatability of the combined sampling and analysis process. A field duplicate sample is to be taken at one sampling site. This involves simply repeating the sampling procedures outlined in the above sections so that two samples are obtained from the same site in succession. The duplicate sample should be labelled using the following format: site number / depth interval / D (e.g., ‘SED-W1/0-20/D’ for duplicate sample collected at site SED-W1 and depth interval 0 to 20 cm). Duplicates of each depth interval at a site are to be collected and sent for the same suite of analyses.

2.8.2 Rinsate

Deionised water is to be poured through decontaminated (i.e., thoroughly flushed with clean freshwater and then flushed with deionised water) field sampling equipment (through the plastic liner used in the piston corer) to assess potential contamination from the equipment. As the deionised water passes through the liner the water (i.e., rinsate) is collected into laboratory-provided plastic sampling bottles. The labels of these bottles will state that the sample is for metals analysis. The deionised water will then be analysed for total metals (same suite of metals as outlined in Section 2.4). One sample of rinsate water is to be collected each day of sediment sampling. The rinsate samples are to be placed in cool storage (not a freezer).

The following sample ID is to be adopted for rinsate samples: RIN1, RIN2, etc.

2.8.3 Laboratory Quality Control

Sample analysis will be undertaken by the NATA accredited laboratory ALS Environmental in Melbourne and in Brisbane. An analytical laboratory quality assurance program will be implemented by both laboratories which includes method blanks, sample duplicates, laboratory control sample sand matrix spikes. Coffey will manage the laboratory analysis component.

3. CONTACT NUMBERS

The following personnel can be contacted should any queries arise during the sampling.

PROJECT PERSONNEL CONTACT DETAILS		Phone	Email
Study manager	Travis Wood	0438 096 241	Travis.Wood@tetratech.com
Courier	Tasfast Airfreight	1300 300 396	customerservice@tasfast.com.au
TasNetworks	TasNetworks	0419 949 408	Gordon.Clarke@tasnetworks.com.au

4. REFERENCES

CSIRO. 1990. Metal residues in sediments and macrobiota of Bass Strait near Burnie, Tasmania, in April 1989. Part I Synoptic Report. Prepared by C.J. Crossland and T.J.. Ward of Commonwealth Scientific and Industrial Research Organisation Division of Fisheries, Hobart, Tasmania.

APPENDIX A: CHAIN OF CUSTODY DOCUMENTATION

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

❑ADELAIDE 21 Burma Road Pooraka SA 5095
Ph: 08 8359 0890 E: adelaide@alsglobal.com

❑BRISBANE 32 Shand Street Stafford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com

❑GLADSTONE 46 Callemondah Drive Clinton QLD 4680
Ph: 07 7471 5600 E: gladstone@alsglobal.com

❑MACKAY 78 Harbour Road Mackay QLD 4740
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❑MELBOURNE 2-4 Westall Road Springvale VIC 3171
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❑NEWCASTLE 5/585 Maitland Rd Mayfield West NSW 2304
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❑PERTH 10 Hod Way Malaga WA 6090
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❑SYDNEY 277-289 Woodpark Road Smithfield NSW 2164
Ph: 02 8784 8555 E: samples.sydney@alsglobal.com

❑TOWNSVILLE 14-15 Desma Court Bohle QLD 4818
Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com

❑WOLLONGONG 99 Kenny Street Wollongong NSW 2500
Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: Tetra Tech Coffey	**TURNAROUND REQUIREMENTS :**	☐ Standard TAT **(List due date):**
OFFICE: Melbourne	(Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	☐ Non Standard or urgent TAT **(List due date):**
PROJECT: Marinus Link Project	**ALS QUOTE NO.:**	
ORDER NUMBER:		
PROJECT MANAGER: Travis Wood	**CONTACT PH:**	
SAMPLER:	**SAMPLER MOBILE:**	
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**	
Email Reports to: travis.wood@tetratech.com		
Email Invoice to: travis.wood@tetratech.com		

COC SEQUENCE NUMBER (Circle)							
COC:	**1**	**2**	**3**	**4**	**5**	**6**	**7**
OF:	**1**	**2**	**3**	**4**	**5**	**6**	**7**

FOR LABORATORY USE ONLY (Circle)			
Custody Seal Intact?	Yes	No	N/A
Free ice / frozen ice bricks present upon receipt?	Yes	No	N/A
Random Sample Temperature on Receipt:	˚C		
Other comment:			

RELINQUISHED BY:	**RECEIVED BY:**	**RELINQUISHED BY:**	**RECEIVED BY:**
DATE/TIME:	DATE/TIME:	DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	**SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)**			**CONTAINER INFORMATION**		**ANALYSIS REQUIRED including SUITES** (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								**Additional Information**
LAB ID	**SAMPLE ID**	**DATE / TIME**	**MATRIX**	**TYPE & PRESERVATIVE** *(refer to codes below)*	**TOTAL CONTAINERS**	**ASS (chromium suite)**	**PSD**	**Porewater analysis (metals)**	**Total metals (<2000 µm fraction)**	**Total metals (<63 µm fraction)**	**Weak acid metals (<2000 µm fraction) (1M HCL digest)**	**Weak acid metals (<63 µm fraction) (1M HCl digest)**		Metals analytes: As, Al, Sb, Cd, Cr, Cu, Hg, Ni, Ag, Pb, Zn, Fe, Ti, V
TOTAL														

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

CHAIN OF CUSTODY

ALS Environmental

ALS Laboratory: please tick →

❑BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com
❑ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com
❑GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com
❑MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com
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❑NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com
❑PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com
❑SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com
❑TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com
❑WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: Tetra Tech Coffey	TURNAROUND REQUIREMENTS :	☐ Standard TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: Melbourne	(Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact? Yes No N/A
PROJECT: Marinus Link Project	ALS QUOTE NO.: <<Tetra Tech Coffey will provide>>	COC SEQUENCE NUMBER (Circle)	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER: <<Tetra Tech Coffey will provide>>		COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: ˚C
PROJECT MANAGER: Travis Wood	CONTACT PH:	OF: 1 2 3 4 5 6 7	Other comment:

SAMPLER:	SAMPLER MOBILE:	RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):				
Email Reports to: travis.wood@tetratech.com		DATE/TIME:	DATE/TIME:	DATE/TIME:	DATE/TIME:
Email Invoice to: travis.wood@tetratech.com					

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		**ANALYSIS REQUIRED including SUITES** (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	Chromium reducible sulphur suite	Particle size distribution	Porewater analysis (metals)	Total and 1M HCl metals (<2000 µm fraction)	Total and 1M HCl metals (<63 µm fraction)	Total metals (water)			Metals analytes: As, Al, Sb, Cd, Cr, Cu, Hg, Ni, Ag, Pb, Zn, Fe, Ti, V
	e.g., SED-W4/0-20	15/11/2021 8:00	S	3 x Plastic bags; 1 x glass jar	4	✓	✓	✓	✓					Metals analytes: As, Al, Sb, Cd, Cr, Cu, Hg, Ni, Ag, Pb, Zn, Fe, Ti, V
	e.g., SED-W2/40-60	15/11/2021 8:15	S	3 x Plastic bags; 1 x glass jar	4	✓	✓	✓	✓					Metals analytes: As, Al, Sb, Cd, Cr, Cu, Hg, Ni, Ag, Pb, Zn, Fe, Ti, V
	e.g., SED-W2/80-100	15/11/2021 8:30	S	3 x Plastic bags; 1 x glass jar	4	✓	✓	✓	✓					Metals analytes: As, Al, Sb, Cd, Cr, Cu, Hg, Ni, Ag, Pb, Zn, Fe, Ti, V
	e.g., SED-W2/0-100	15/11/2021 14:30	S	1 x plastic bag	1					✓				Metals analytes: As, Al, Sb, Cd, Cr, Cu, Hg, Ni, Ag, Pb, Zn, Fe, Ti, V
	e.g., RIN1	15/11/2021 16:00	W	1 x Plastic bottle	1						✓			Metals analytes: As, Al, Sb, Cd, Cr, Cu, Hg, Ni, Ag, Pb, Zn, Fe, Ti, V
TOTAL														

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

APPENDIX B: LABORATORY CERTIFICATES

CERTIFICATE OF ANALYSIS

Work Order	: **EB2204434**	Page	: 1 of 19
Client	: **TETRA TECH COFFEY PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR TRAVIS WOOD	Contact	: Khaleda Ataei
Address	: 2-4 WESTALL ROAD SPRINGVALE VIC 3171	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 03 9290 7000	Telephone	: + 61 2 8784 8555
Project	: Marinus Link Project	Date Samples Received	: 17-Feb-2022 10:10
Order number	: ----	Date Analysis Commenced	: 25-Feb-2022
C-O-C number	: ----	Issue Date	: 11-Mar-2022 18:26
Sampler	: FF / JMWP		
Site	: ----		
Quote number	: BN/476/21		
No. of samples received	: 49		
No. of samples analysed	: 48		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Dave Gitsham	Metals Instrument Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA150H: Soil particle density results fell outside the scope of AS1289.3.6.3. Results should be scrutinised accordingly.
- ASS: EA033 (CRS Suite):Retained Acidity not required because pH KCl greater than or equal to 4.5
- EG005T (Total Metals by ICP-AES): SEDEW4 0.4-0.6 (EB2204434-036) shows poor duplicate results due to sample heterogeneity. This has been confirmed by visual inspection.
- EG005T (Total Metals by ICP-AES): SEDE3B 0.4-0.6 (EB2204434-027) shows poor matrix spike recovery due to sample heterogeneity. This has been confirmed by visual inspection.
- ASS: EA033 (CRS Suite): Laboratory determinations of ANC needs to be corroborated by effectiveness of the measured ANC in relation to incubation ANC. Unless corroborated, the results of ANC testing should be discounted when determining Net Acidity for comparison with action criteria, or for the determination of the acidity hazard and required liming amounts.
- ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SEDE3B 0.0-0.2	SEDE3B 0.4-0.6	SEDE4 0.0-0.2	SEDE4 0.4-0.6	SEDE4 0.7-0.9
			Sampling date / time	12-Feb-2022 00:30	12-Feb-2022 00:30	12-Feb-2022 02:00	12-Feb-2022 02:00	12-Feb-2022 02:00
Compound	CAS Number	LOR	Unit	EB2204434-001	EB2204434-002	EB2204434-003	EB2204434-004	EB2204434-005
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	9.5	9.4	9.6	9.5	9.4
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	0.144	0.248	0.039	0.067	0.135
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	90	154	24	42	84
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	36.1	18.8	54.3	70.0	57.7
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	7210	3760	10800	14000	11500
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	11.6	6.03	17.4	22.4	18.5
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.14	0.25	0.04	0.07	0.13
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	90	154	24	42	84
Liming Rate excluding ANC	----	1	kg CaCO3/t	7	12	2	3	6
EA150: Particle Sizing								
+75µm	----	1	%	86	84	90	88	90
+150µm	----	1	%	83	80	87	82	85
+300µm	----	1	%	73	76	73	68	69
+425µm	----	1	%	68	75	63	59	60
+600µm	----	1	%	63	72	47	46	46
+1180µm	----	1	%	45	63	9	8	9
+2.36mm	----	1	%	9	46	6	3	4
+4.75mm	----	1	%	1	37	4	1	2
+9.5mm	----	1	%	<1	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SEDE3B 0.0-0.2	SEDE3B 0.4-0.6	SEDE4 0.0-0.2	SEDE4 0.4-0.6	SEDE4 0.7-0.9
			Sampling date / time	12-Feb-2022 00:30	12-Feb-2022 00:30	12-Feb-2022 02:00	12-Feb-2022 02:00	12-Feb-2022 02:00
Compound	CAS Number	LOR	Unit	EB2204434-001	EB2204434-002	EB2204434-003	EB2204434-004	EB2204434-005
				Result	Result	Result	Result	Result
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	**8**	**7**	**7**	**8**	**7**
Silt (2-60 µm)	----	1	%	**5**	**8**	**3**	**4**	**1**
Sand (0.06-2.00 mm)	----	1	%	**67**	**34**	**83**	**83**	**86**
Gravel (>2mm)	----	1	%	**20**	**51**	**7**	**5**	**6**
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	**2.64**	**2.67**	**2.58**	**2.60**	**2.60**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SEDE4B 0-0.2/D	SEDE4B 0.4-0.6/D	SEDE4B 0.8-1.0/D	SEDEW4 0-0.2	SEDEW4 0.4-0.6
			Sampling date / time	12-Feb-2022 05:50	12-Feb-2022 05:50	12-Feb-2022 05:50	12-Feb-2022 06:30	12-Feb-2022 06:30
Compound	CAS Number	LOR	Unit	EB2204434-008	EB2204434-009	EB2204434-010	EB2204434-011	EB2204434-012
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	9.1	9.3	9.1	9.5	9.4
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	0.452	0.242	0.316	0.233	0.282
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	282	151	197	146	176
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	63.0	49.9	30.0	64.6	54.5
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	12600	9970	5990	12900	10900
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	20.2	16.0	9.61	20.7	17.4
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.45	0.24	0.32	0.23	0.28
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	282	151	197	146	176
Liming Rate excluding ANC	----	1	kg CaCO3/t	21	11	15	11	13
EA150: Particle Sizing								
+75µm	----	1	%	81	89	80	90	87
+150µm	----	1	%	59	87	76	88	84
+300µm	----	1	%	28	81	73	78	76
+425µm	----	1	%	17	75	70	70	70
+600µm	----	1	%	9	62	65	57	62
+1180µm	----	1	%	<1	19	50	22	29
+2.36mm	----	1	%	<1	9	42	5	6
+4.75mm	----	1	%	<1	4	26	1	<1
+9.5mm	----	1	%	<1	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: **SOIL**
(Matrix: **SOIL**)

			Sample ID	SEDE4B 0-0.2/D	SEDE4B 0.4-0.6/D	SEDE4B 0.8-1.0/D	SEDEW4 0-0.2	SEDEW4 0.4-0.6
			Sampling date / time	12-Feb-2022 05:50	12-Feb-2022 05:50	12-Feb-2022 05:50	12-Feb-2022 06:30	12-Feb-2022 06:30
Compound	CAS Number	LOR	Unit	EB2204434-008	EB2204434-009	EB2204434-010	EB2204434-011	EB2204434-012
				Result	Result	Result	Result	Result
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	9	5	6	7	7
Silt (2-60 µm)	----	1	%	8	5	13	1	5
Sand (0.06-2.00 mm)	----	1	%	83	78	36	82	75
Gravel (>2mm)	----	1	%	<1	12	45	10	13
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	2.67	2.69	2.69	2.56	2.61

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SEDW4 0.8-1.0	SEDE3B 0.0-0.2 <2mm sieve	SEDE3B 0.4-0.6 <2mm sieve	SEDE4 0.0-0.2 <2mm sieve	SEDE4 0.4-0.6 <2mm sieve
			Sampling date / time	12-Feb-2022 06:30	12-Feb-2022 00:30	12-Feb-2022 00:30	12-Feb-2022 02:00	12-Feb-2022 02:00
Compound	CAS Number	LOR	Unit	EB2204434-025	EB2204434-026	EB2204434-027	EB2204434-028	EB2204434-029
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	**9.5**	----	----	----	----
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	----	----	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	**0.296**	----	----	----	----
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	**185**	----	----	----	----
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	**18.0**	----	----	----	----
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	**3600**	----	----	----	----
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	**5.77**	----	----	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	**1.5**	----	----	----	----
Net Acidity (sulfur units)	----	0.02	% S	<0.02	----	----	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	<10	----	----	----	----
Liming Rate	----	1	kg CaCO3/t	<1	----	----	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	**0.30**	----	----	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	**185**	----	----	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	**14**	----	----	----	----
EA150: Particle Sizing								
+75µm	----	1	%	**83**	----	----	----	----
+150µm	----	1	%	**80**	----	----	----	----
+300µm	----	1	%	**77**	----	----	----	----
+425µm	----	1	%	**76**	----	----	----	----
+600µm	----	1	%	**74**	----	----	----	----
+1180µm	----	1	%	**61**	----	----	----	----
+2.36mm	----	1	%	**41**	----	----	----	----
+4.75mm	----	1	%	**14**	----	----	----	----
+9.5mm	----	1	%	<1	----	----	----	----
+19.0mm	----	1	%	<1	----	----	----	----
+37.5mm	----	1	%	<1	----	----	----	----
+75.0mm	----	1	%	<1	----	----	----	----

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	SEDW4 0.8-1.0	SEDE3B 0.0-0.2 <2mm sieve	SEDE3B 0.4-0.6 <2mm sieve	SEDE4 0.0-0.2 <2mm sieve	SEDE4 0.4-0.6 <2mm sieve
Sampling date / time				12-Feb-2022 06:30	12-Feb-2022 00:30	12-Feb-2022 00:30	12-Feb-2022 02:00	12-Feb-2022 02:00
				EB2204434-025	EB2204434-026	EB2204434-027	EB2204434-028	EB2204434-029
				Result	Result	Result	Result	Result
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	7	----	----	----	----
Silt (2-60 µm)	----	1	%	9	----	----	----	----
Sand (0.06-2.00 mm)	----	1	%	37	----	----	----	----
Gravel (>2mm)	----	1	%	47	----	----	----	----
Cobbles (>6cm)	----	1	%	<1	----	----	----	----
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	2.68	----	----	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	3320	8540	1770	1950
Antimony	7440-36-0	5	mg/kg	----	<5	<5	<5	<5
Arsenic	7440-38-2	5	mg/kg	----	24	22	49	29
Cadmium	7440-43-9	1	mg/kg	----	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	----	24	58	19	19
Copper	7440-50-8	5	mg/kg	----	<5	39	<5	<5
Iron	7439-89-6	50	mg/kg	----	14700	23400	19500	14000
Lead	7439-92-1	5	mg/kg	----	5	<5	7	<5
Nickel	7440-02-0	2	mg/kg	----	10	21	6	7
Silver	7440-22-4	2	mg/kg	----	<2	<2	<2	<2
Vanadium	7440-62-2	5	mg/kg	----	38	65	63	44
Zinc	7440-66-6	5	mg/kg	----	17	23	24	13
Titanium	7440-32-6	10	mg/kg	----	190	300	180	170
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	----	<0.1	<0.1	<0.1	<0.1
GEO26: Sieving								
-2000µm	----	0.01	%	----	79.8	32.8	88.2	94.7

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SEDE4 0.7-0.9 <2mm sieve	SEDE4A 0-1.00 <63µm sieve	SEDE4B 0-0.2/D <2mm sieve	SEDE4B 0.4-0.6/D <2mm sieve	SEDE4B 0.8-1.0/D <2mm sieve
			Sampling date / time	12-Feb-2022 02:00	12-Feb-2022 03:35	12-Feb-2022 05:50	12-Feb-2022 05:50	12-Feb-2022 05:50
Compound	CAS Number	LOR	Unit	EB2204434-030	EB2204434-031	EB2204434-032	EB2204434-033	EB2204434-034
				Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**1370**	**9060**	**10900**	**6960**	**11400**
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Arsenic	7440-38-2	5	mg/kg	**19**	**36**	**32**	**34**	**26**
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	**11**	**39**	**33**	**26**	**35**
Copper	7440-50-8	5	mg/kg	<5	**14**	**15**	**12**	**20**
Iron	7439-89-6	50	mg/kg	**10700**	**40500**	**42000**	**31100**	**42300**
Lead	7439-92-1	5	mg/kg	<5	**8**	<5	<5	<5
Nickel	7440-02-0	2	mg/kg	**4**	**40**	**41**	**31**	**51**
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	<2
Vanadium	7440-62-2	5	mg/kg	**28**	**70**	**49**	**47**	**51**
Zinc	7440-66-6	5	mg/kg	**8**	**65**	**31**	**23**	**31**
Titanium	7440-32-6	10	mg/kg	**100**	**450**	**270**	**230**	**280**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
GEO26: Sieving								
-2000µm	----	0.01	%	**82.4**	**----**	**97.7**	**88.4**	**49.4**
-63µm	----	0.01	%	**----**	**3.97**	**----**	**----**	**----**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SEDEW4 0-0.2 <2mm sieve	SEDEW4 0.4-0.6 <2mm sieve	SEDW4 0.8-1.0 <2mm sieve	SED_W5 0.0-0.2	SED_W5 0.4-0.6
			Sampling date / time	12-Feb-2022 06:30	12-Feb-2022 06:30	12-Feb-2022 06:30	12-Feb-2022 08:30	12-Feb-2022 08:30
Compound	CAS Number	LOR	Unit	EB2204434-035	EB2204434-036	EB2204434-037	EB2204434-038	EB2204434-039
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	----	----	----	9.6	8.9
Titratable Actual Acidity (23F)	----	2	mole H+ / t	----	----	----	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	----	----	----	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	----	----	----	0.066	0.099
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	----	----	----	41	62
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	----	----	----	15.0	6.72
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	----	----	----	2990	1340
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	----	----	----	4.79	2.15
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	----	----	----	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	----	----	----	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	----	----	----	<10	<10
Liming Rate	----	1	kg CaCO3/t	----	----	----	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	----	----	----	0.07	0.10
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	----	----	----	41	62
Liming Rate excluding ANC	----	1	kg CaCO3/t	----	----	----	3	5
EA150: Particle Sizing								
+75µm	----	1	%	----	----	----	87	54
+150µm	----	1	%	----	----	----	86	49
+300µm	----	1	%	----	----	----	85	47
+425µm	----	1	%	----	----	----	84	46
+600µm	----	1	%	----	----	----	81	44
+1180µm	----	1	%	----	----	----	64	38
+2.36mm	----	1	%	----	----	----	35	24
+4.75mm	----	1	%	----	----	----	10	13
+9.5mm	----	1	%	----	----	----	<1	<1
+19.0mm	----	1	%	----	----	----	<1	<1
+37.5mm	----	1	%	----	----	----	<1	<1
+75.0mm	----	1	%	----	----	----	<1	<1

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	SEDEW4 0-0.2 <2mm sieve	SEDEW4 0.4-0.6 <2mm sieve	SEDW4 0.8-1.0 <2mm sieve	SED_W5 0.0-0.2	SED_W5 0.4-0.6
Sampling date / time				12-Feb-2022 06:30	12-Feb-2022 06:30	12-Feb-2022 06:30	12-Feb-2022 08:30	12-Feb-2022 08:30
				EB2204434-035	EB2204434-036	EB2204434-037	EB2204434-038	EB2204434-039
				Result	Result	Result	Result	Result
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	----	----	----	3	16
Silt (2-60 µm)	----	1	%	----	----	----	9	29
Sand (0.06-2.00 mm)	----	1	%	----	----	----	44	27
Gravel (>2mm)	----	1	%	----	----	----	44	28
Cobbles (>6cm)	----	1	%	----	----	----	<1	<1
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	----	----	----	2.64	2.86
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	1970	1700	3540	----	----
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	----	----
Arsenic	7440-38-2	5	mg/kg	43	25	24	----	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	----	----
Chromium	7440-47-3	2	mg/kg	19	13	16	----	----
Copper	7440-50-8	5	mg/kg	<5	<5	<5	----	----
Iron	7439-89-6	50	mg/kg	20100	11700	14300	----	----
Lead	7439-92-1	5	mg/kg	<5	<5	<5	----	----
Nickel	7440-02-0	2	mg/kg	7	5	9	----	----
Silver	7440-22-4	2	mg/kg	<2	<2	<2	----	----
Vanadium	7440-62-2	5	mg/kg	64	36	29	----	----
Zinc	7440-66-6	5	mg/kg	16	6	9	----	----
Titanium	7440-32-6	10	mg/kg	210	130	220	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	----	----
GEO26: Sieving								
-2000µm	----	0.01	%	88.9	86.4	49.9	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SED_W1 0.1-0.25	SED_W1 0.4-0.6	SED_W1 0.65-0.72	SED_E1 0.0-0.1	SED_E1A 0.0-0.1
			Sampling date / time	12-Feb-2022 13:05	12-Feb-2022 13:05	12-Feb-2022 13:05	12-Feb-2022 19:21	12-Feb-2022 19:48
Compound	CAS Number	LOR	Unit	EB2204434-040	EB2204434-041	EB2204434-042	EB2204434-043	EB2204434-044
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	9.7	9.5	9.6	9.7	9.7
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	0.029	0.035	0.077	0.045	0.036
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	18	22	48	28	23
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	3.81	29.3	29.4	7.09	8.10
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	761	5860	5880	1420	1620
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	1.22	9.40	9.43	2.27	2.59
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.03	0.04	0.08	0.04	0.04
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	18	22	48	28	23
Liming Rate excluding ANC	----	1	kg CaCO3/t	1	2	4	2	2
EA150: Particle Sizing								
+75µm	----	1	%	97	92	95	95	98
+150µm	----	1	%	97	92	94	94	98
+300µm	----	1	%	96	89	91	93	96
+425µm	----	1	%	96	85	87	92	95
+600µm	----	1	%	95	77	77	91	94
+1180µm	----	1	%	89	39	40	40	26
+2.36mm	----	1	%	52	20	30	18	7
+4.75mm	----	1	%	26	7	26	11	5
+9.5mm	----	1	%	<1	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SED_W1 0.1-0.25	SED_W1 0.4-0.6	SED_W1 0.65-0.72	SED_E1 0.0-0.1	SED_E1A 0.0-0.1
			Sampling date / time	12-Feb-2022 13:05	12-Feb-2022 13:05	12-Feb-2022 13:05	12-Feb-2022 19:21	12-Feb-2022 19:48
Compound	CAS Number	LOR	Unit	EB2204434-040	EB2204434-041	EB2204434-042	EB2204434-043	EB2204434-044
				Result	Result	Result	Result	Result
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	2	3	2	<1	<1
Silt (2-60 µm)	----	1	%	1	4	2	5	2
Sand (0.06-2.00 mm)	----	1	%	34	67	63	70	85
Gravel (>2mm)	----	1	%	63	26	33	25	13
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	2.67	2.67	2.65	2.66	2.68

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)

Compound	CAS Number	LOR	Unit	SED_E2 0.0-0.25	SED_E2A 0.0-0.25	SED_E3 0.0-0.20	SED_E3A0.0-0.20	SED_E3A0.20-0.32
Sampling date / time				12-Feb-2022 20:37	12-Feb-2022 21:10	12-Feb-2022 22:18	12-Feb-2022 22:56	12-Feb-2022 22:56
				EB2204434-045	EB2204434-046	EB2204434-047	EB2204434-048	EB2204434-049
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	9.7	9.7	9.4	9.6	9.5
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	<2	<2
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	<0.02	<0.02
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	0.047	0.032	0.172	0.048	0.114
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	29	20	107	30	71
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	8.27	5.89	23.6	32.8	14.6
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	1650	1180	4720	6550	2910
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	2.65	1.89	7.56	10.5	4.66
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	1.5	1.5
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	<0.02	<0.02
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	<10	<10
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	<1	<1
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.05	0.03	0.17	0.05	0.11
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	29	20	107	30	71
Liming Rate excluding ANC	----	1	kg CaCO3/t	2	2	8	2	5
EA150: Particle Sizing								
+75µm	----	1	%	96	97	82	84	90
+150µm	----	1	%	96	96	78	80	88
+300µm	----	1	%	94	96	71	73	83
+425µm	----	1	%	90	95	68	70	79
+600µm	----	1	%	85	93	64	67	75
+1180µm	----	1	%	77	90	54	55	60
+2.36mm	----	1	%	43	68	37	30	28
+4.75mm	----	1	%	18	38	23	21	15
+9.5mm	----	1	%	<1	<1	<1	<1	<1
+19.0mm	----	1	%	<1	<1	<1	<1	<1
+37.5mm	----	1	%	<1	<1	<1	<1	<1
+75.0mm	----	1	%	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SED_E2 0.0-0.25	SED_E2A 0.0-0.25	SED_E3 0.0-0.20	SED_E3A0.0-0.20	SED_E3A0.20-0.32
			Sampling date / time	12-Feb-2022 20:37	12-Feb-2022 21:10	12-Feb-2022 22:18	12-Feb-2022 22:56	12-Feb-2022 22:56
Compound	CAS Number	LOR	Unit	EB2204434-045	EB2204434-046	EB2204434-047	EB2204434-048	EB2204434-049
				Result	Result	Result	Result	Result
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	4	1	7	6	5
Silt (2-60 µm)	----	1	%	<1	2	10	9	4
Sand (0.06-2.00 mm)	----	1	%	43	22	41	48	54
Gravel (>2mm)	----	1	%	53	75	42	37	37
Cobbles (>6cm)	----	1	%	<1	<1	<1	<1	<1
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	2.70	2.67	2.61	2.68	2.71

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	SED_W5 0.0-0.2 <2mm sieve	SED_W5 0.4-0.6 <2mm sieve	SED_W1 0.1-0.25 <2mm sieve	SED_W1 0.4-0.6 <2mm sieve	SED_W1 0.65-0.72 <2mm sieve
Sampling date / time				12-Feb-2022 08:30	12-Feb-2022 08:30	12-Feb-2022 13:05	12-Feb-2022 13:05	12-Feb-2022 13:05
				EB2204434-050	EB2204434-051	EB2204434-052	EB2204434-053	EB2204434-054
				Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	4100	33200	1140	1400	1100
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Arsenic	7440-38-2	5	mg/kg	21	17	34	24	14
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	25	124	10	10	9
Copper	7440-50-8	5	mg/kg	<5	39	<5	<5	<5
Iron	7439-89-6	50	mg/kg	21500	62300	16100	18200	9050
Lead	7439-92-1	5	mg/kg	6	<5	8	<5	<5
Nickel	7440-02-0	2	mg/kg	15	147	3	3	2
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	<2
Vanadium	7440-62-2	5	mg/kg	43	78	38	30	27
Zinc	7440-66-6	5	mg/kg	23	84	32	10	<5
Titanium	7440-32-6	10	mg/kg	290	940	820	110	60
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
GEO26: Sieving								
-2000µm	----	0.01	%	55.4	71.3	43.3	67.2	64.3

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SED_E1 0.0-0.1 <2mm sieve	SED_E1A 0.0-0.1 <2mm sieve	SED_E2 0.0-0.25 <2mm sieve	SED_E2A 0.0-0.25 <2mm sieve	SED_E3 0.0-0.20 <2mm sieve
			Sampling date / time	12-Feb-2022 19:21	12-Feb-2022 19:48	12-Feb-2022 20:37	12-Feb-2022 21:10	12-Feb-2022 22:18
Compound	CAS Number	LOR	Unit	EB2204434-055	EB2204434-056	EB2204434-057	EB2204434-058	EB2204434-059
				Result	Result	Result	Result	Result
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**1130**	**900**	**1360**	**1270**	**4030**
Antimony	7440-36-0	5	mg/kg	<5	<5	<5	<5	<5
Arsenic	7440-38-2	5	mg/kg	**17**	**16**	**27**	**24**	**18**
Cadmium	7440-43-9	1	mg/kg	<1	<1	<1	<1	<1
Chromium	7440-47-3	2	mg/kg	**9**	**8**	**11**	**10**	**35**
Copper	7440-50-8	5	mg/kg	<5	<5	<5	<5	**8**
Iron	7439-89-6	50	mg/kg	**5860**	**5110**	**11200**	**10600**	**8850**
Lead	7439-92-1	5	mg/kg	<5	<5	<5	<5	<5
Nickel	7440-02-0	2	mg/kg	**3**	**3**	**3**	**3**	**10**
Silver	7440-22-4	2	mg/kg	<2	<2	<2	<2	<2
Vanadium	7440-62-2	5	mg/kg	**21**	**18**	**31**	**29**	**38**
Zinc	7440-66-6	5	mg/kg	**8**	**7**	**10**	**9**	**14**
Titanium	7440-32-6	10	mg/kg	**40**	**30**	**70**	**70**	**350**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	<0.1	<0.1	<0.1
GEO26: Sieving								
-2000µm	----	0.01	%	**89.3**	**91.3**	**30.0**	**28.6**	**50.8**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SED_E3A0.0-0.20 <2mm sieve	SED_E3A0.20-0.32 <2mm sieve	----	----	----
			Sampling date / time	12-Feb-2022 22:56	12-Feb-2022 22:56	----	----	----
Compound	CAS Number	LOR	Unit	EB2204434-060	EB2204434-061	--------	--------	--------
				Result	Result	----	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**3730**	**2880**	----	----	----
Antimony	7440-36-0	5	mg/kg	<5	<5	----	----	----
Arsenic	7440-38-2	5	mg/kg	**29**	**19**	----	----	----
Cadmium	7440-43-9	1	mg/kg	<1	<1	----	----	----
Chromium	7440-47-3	2	mg/kg	**23**	**27**	----	----	----
Copper	7440-50-8	5	mg/kg	**14**	<5	----	----	----
Iron	7439-89-6	50	mg/kg	**22300**	**11000**	----	----	----
Lead	7439-92-1	5	mg/kg	**30**	<5	----	----	----
Nickel	7440-02-0	2	mg/kg	**10**	**8**	----	----	----
Silver	7440-22-4	2	mg/kg	<2	<2	----	----	----
Vanadium	7440-62-2	5	mg/kg	**46**	**32**	----	----	----
Zinc	7440-66-6	5	mg/kg	**30**	**10**	----	----	----
Titanium	7440-32-6	10	mg/kg	**220**	**220**	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	----	----	----
GEO26: Sieving								
-2000µm	----	0.01	%	**42.2**	**32.0**	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Sample ID	SEDW5 RIN	----	----	----	----
			Sampling date / time	12-Feb-2022 08:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB2204434-007	--------	--------	--------	--------
				Result	----	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.35**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	**0.014**	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.008**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	**0.003**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.033**	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----
Titanium	7440-32-6	0.01	mg/L	**0.02**	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.086**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.70**	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----

QUALITY CONTROL REPORT

Work Order	: **EB2204434**		
Client	: **TETRA TECH COFFEY PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR TRAVIS WOOD	Contact	: Khaleda Ataei
Address	: 2-4 WESTALL ROAD SPRINGVALE VIC 3171	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 03 9290 7000	Telephone	: + 61 2 8784 8555
Project	: Marinus Link Project	Date Samples Received	: 17-Feb-2022
Order number	: ----	Date Analysis Commenced	: 25-Feb-2022
C-O-C number	: ----	Issue Date	: 11-Mar-2022
Sampler	: FF / JMWP		
Site	: ----		
Quote number	: BN/476/21		
No. of samples received	: 49		
No. of samples analysed	: 48		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Dave Gitsham	Metals Instrument Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key :
- Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
- CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
- LOR = Limit of reporting
- RPD = Relative Percentage Difference
- # = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 4215559)									
EB2204434-026	SEDE3B 0.0-0.2 <2mm sieve	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Titanium	7440-32-6	10	mg/kg	190	180	0.0	0% - 50%
		EG005T: Chromium	7440-47-3	2	mg/kg	24	24	0.0	0% - 50%
		EG005T: Nickel	7440-02-0	2	mg/kg	10	11	0.0	No Limit
		EG005T: Silver	7440-22-4	2	mg/kg	<2	<2	0.0	No Limit
		EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	24	24	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	5	5	0.0	No Limit
		EG005T: Vanadium	7440-62-2	5	mg/kg	38	39	0.0	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	17	17	0.0	No Limit
		EG005T: Aluminium	7429-90-5	50	mg/kg	3320	3330	0.0	0% - 20%
		EG005T: Iron	7439-89-6	50	mg/kg	14700	14100	3.8	0% - 20%
EB2204434-036	SEDEW4 0.4-0.6 <2mm sieve	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Titanium	7440-32-6	10	mg/kg	130	180	33.2	0% - 50%
		EG005T: Chromium	7440-47-3	2	mg/kg	13	18	28.3	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	5	7	34.0	No Limit
		EG005T: Silver	7440-22-4	2	mg/kg	<2	<2	0.0	No Limit
		EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	25	32	26.1	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	<5	<5	0.0	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 4215559) - continued									
EB2204434-036	SEDEW4 0.4-0.6 <2mm sieve	EG005T: Vanadium	7440-62-2	5	mg/kg	36	45	22.6	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	6	9	29.0	No Limit
		EG005T: Aluminium	7429-90-5	50	mg/kg	1700	# 2380	33.5	0% - 20%
		EG005T: Iron	7439-89-6	50	mg/kg	11700	# 14700	23.1	0% - 20%
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 4215561)									
EB2204434-058	SED_E2A 0.0-0.25 <2mm sieve	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Titanium	7440-32-6	10	mg/kg	70	70	0.0	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	10	9	0.0	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	3	3	0.0	No Limit
		EG005T: Silver	7440-22-4	2	mg/kg	<2	<2	0.0	No Limit
		EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	24	24	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Vanadium	7440-62-2	5	mg/kg	29	29	0.0	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	9	10	0.0	No Limit
		EG005T: Aluminium	7429-90-5	50	mg/kg	1270	1240	2.3	0% - 20%
		EG005T: Iron	7439-89-6	50	mg/kg	10600	10600	0.2	0% - 20%
EB2206123-015	Anonymous	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Titanium	7440-32-6	10	mg/kg	110	110	0.0	0% - 50%
		EG005T: Chromium	7440-47-3	2	mg/kg	10	10	0.0	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	10	11	12.9	No Limit
		EG005T: Silver	7440-22-4	2	mg/kg	<2	<2	0.0	No Limit
		EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	6	5	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	26	25	0.0	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	11	11	0.0	No Limit
		EG005T: Vanadium	7440-62-2	5	mg/kg	24	24	4.5	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	94	100	6.3	0% - 20%
		EG005T: Aluminium	7429-90-5	50	mg/kg	3090	3200	3.5	0% - 20%
		EG005T: Iron	7439-89-6	50	mg/kg	19200	19700	2.4	0% - 20%
EA033-A: Actual Acidity (QC Lot: 4212420)									
EB2204434-001	SEDE3B 0.0-0.2	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	9.5	9.5	0.0	0% - 20%
EB2204434-025	SEDW4 0.8-1.0	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	9.5	9.5	0.0	0% - 20%

Sub-Matrix: **SOIL**

Laboratory Duplicate (DUP) Report

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EA033-A: Actual Acidity (QC Lot: 4212421)									
EB2204434-047	SED_E3 0.0-0.20	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	9.4	9.5	0.0	0% - 20%
EB2205452-008	Anonymous	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	6.9	6.8	0.0	0% - 20%
EA033-B: Potential Acidity (QC Lot: 4212420)									
EB2204434-001	SEDE3B 0.0-0.2	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.144	0.140	2.7	0% - 20%
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	90	87	2.7	No Limit
EB2204434-025	SEDW4 0.8-1.0	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.296	0.283	4.7	0% - 20%
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	185	176	4.7	0% - 50%
EA033-B: Potential Acidity (QC Lot: 4212421)									
EB2204434-047	SED_E3 0.0-0.20	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.172	0.168	2.5	0% - 20%
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	107	104	2.5	0% - 50%
EB2205452-008	Anonymous	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.034	0.020	52.9	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	21	12	52.9	No Limit
EA033-C: Acid Neutralising Capacity (QC Lot: 4212420)									
EB2204434-001	SEDE3B 0.0-0.2	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	36.1	36.2	0.1	0% - 20%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	11.6	11.6	0.1	0% - 20%
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	7210	7220	0.1	0% - 20%
EB2204434-025	SEDW4 0.8-1.0	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	18.0	17.9	0.7	0% - 20%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	5.77	5.73	0.7	0% - 20%
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	3600	3570	0.7	0% - 20%
EA033-C: Acid Neutralising Capacity (QC Lot: 4212421)									
EB2204434-047	SED_E3 0.0-0.20	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	23.6	23.2	1.9	0% - 20%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	7.56	7.42	1.9	0% - 20%
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	4720	4630	1.9	0% - 20%
EB2205452-008	Anonymous	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	0.34	0.37	7.3	0% - 20%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	0.11	0.12	0.0	0% - 50%

Sub-Matrix: **SOIL**

Laboratory Duplicate (DUP) Report

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EA033-C: Acid Neutralising Capacity (QC Lot: 4212421) - continued									
EB2205452-008	Anonymous	EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	68	74	7.3	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 4215558)									
EB2204434-026	SEDE3B 0.0-0.2 <2mm sieve	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EB2204434-036	SEDEW4 0.4-0.6 <2mm sieve	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 4215560)									
EB2204434-058	SED_E2A 0.0-0.25 <2mm sieve	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit
EB2206123-015	Anonymous	EG035T: Mercury	7439-97-6	0.1	mg/kg	0.2	0.1	0.0	No Limit

Sub-Matrix: **WATER**

Laboratory Duplicate (DUP) Report

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EG020T: Total Metals by ICP-MS (QC Lot: 4191672)									
EB2204434-007	SEDW5 RIN	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020B-T: Titanium	7440-32-6	0.01	mg/L	0.02	0.02	0.0	No Limit
EB2204503-009	Anonymous	EG020B-T: Silver	7440-22-4	0.001	mg/L	0.010	0.011	16.7	0% - 50%
		EG020B-T: Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 4191673)									
EB2204434-007	SEDW5 RIN	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.014	0.013	0.0	0% - 50%
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.008	0.005	50.0	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.003	0.006	48.5	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.086	0.079	8.9	0% - 50%
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.35	0.33	6.1	0% - 20%
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
EB2204503-009	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0705	0.0707	0.3	0% - 20%
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	0.034	0.035	3.0	0% - 20%
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.014	0.014	0.0	0% - 50%
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.224	0.223	0.0	0% - 20%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	7.35	7.31	0.6	0% - 20%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.061	0.060	1.7	0% - 20%
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	49.5	48.3	2.5	0% - 20%
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.05	0.05	0.0	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	0.78	0.76	2.3	0% - 50%

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 4191670)									
EB2204434-007	SEDW5 RIN	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit
EB2204503-006	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit

Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 4215559)								
EG005T: Aluminium	7429-90-5	50	mg/kg	<50	12940 mg/kg	104	70.0	130
EG005T: Antimony	7440-36-0	5	mg/kg	<5	----	----	----	----
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	83.4 mg/kg	112	84.0	123
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	----	----	----	----
EG005T: Chromium	7440-47-3	2	mg/kg	<2	14.1 mg/kg	115	83.0	125
EG005T: Copper	7440-50-8	5	mg/kg	<5	50 mg/kg	107	86.0	122
EG005T: Iron	7439-89-6	50	mg/kg	<50	29422 mg/kg	110	70.0	120
EG005T: Lead	7439-92-1	5	mg/kg	<5	55.4 mg/kg	89.2	84.0	119
EG005T: Nickel	7440-02-0	2	mg/kg	<2	11.8 mg/kg	110	81.5	118
EG005T: Silver	7440-22-4	2	mg/kg	<2	2.72 mg/kg	121	70.0	130
EG005T: Vanadium	7440-62-2	5	mg/kg	<5	39.7 mg/kg	119	88.0	127
EG005T: Zinc	7440-66-6	5	mg/kg	<5	148.7 mg/kg	103	80.0	120
EG005T: Titanium	7440-32-6	10	mg/kg	<10	447 mg/kg	124	70.0	130
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 4215561)								
EG005T: Aluminium	7429-90-5	50	mg/kg	<50	12940 mg/kg	99.2	70.0	130
EG005T: Antimony	7440-36-0	5	mg/kg	<5	----	----	----	----
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	83.4 mg/kg	111	84.0	123
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	----	----	----	----
EG005T: Chromium	7440-47-3	2	mg/kg	<2	14.1 mg/kg	110	83.0	125
EG005T: Copper	7440-50-8	5	mg/kg	<5	50 mg/kg	96.1	86.0	122
EG005T: Iron	7439-89-6	50	mg/kg	<50	29422 mg/kg	105	70.0	120
EG005T: Lead	7439-92-1	5	mg/kg	<5	55.4 mg/kg	84.9	84.0	119
EG005T: Nickel	7440-02-0	2	mg/kg	<2	11.8 mg/kg	106	81.5	118
EG005T: Silver	7440-22-4	2	mg/kg	<2	2.72 mg/kg	96.0	70.0	130
EG005T: Vanadium	7440-62-2	5	mg/kg	<5	39.7 mg/kg	112	88.0	127
EG005T: Zinc	7440-66-6	5	mg/kg	<5	148.7 mg/kg	99.9	80.0	120
EG005T: Titanium	7440-32-6	10	mg/kg	<10	447 mg/kg	118	70.0	130
EA033-A: Actual Acidity (QCLot: 4212420)								
EA033: pH KCl (23A)	----	----	pH Unit	----	4.4 pH Unit	99.2	91.0	107
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	19 mole H+ / t	76.8	70.0	124
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-A: Actual Acidity (QCLot: 4212421)								
EA033: pH KCl (23A)	----	----	pH Unit	----	4.4 pH Unit	101	91.0	107
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	19 mole H+ / t	82.6	70.0	124

Sub-Matrix: **SOIL**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Acceptable Limits (%) Low	Acceptable Limits (%) High
EA033-A: Actual Acidity (QCLot: 4212421) - continued								
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-B: Potential Acidity (QCLot: 4212420)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	0.246 % S	114	77.0	121
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-B: Potential Acidity (QCLot: 4212421)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	0.246 % S	115	77.0	121
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-C: Acid Neutralising Capacity (QCLot: 4212420)								
EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	<0.01	10 % CaCO3	100	91.0	112
EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	<0.01	----	----	----	----
EA033-C: Acid Neutralising Capacity (QCLot: 4212421)								
EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	<0.01	10 % CaCO3	106	91.0	112
EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	<0.01	----	----	----	----
EA152: Soil Particle Density (QCLot: 4185119)								
EA152: Soil Particle Density (Clay/Silt/Sand)	----	----	g/cm3	----	2.68 g/cm3	98.1	80.0	120
EA152: Soil Particle Density (QCLot: 4185121)								
EA152: Soil Particle Density (Clay/Silt/Sand)	----	----	g/cm3	----	2.68 g/cm3	99.2	80.0	120
EG035T: Total Recoverable Mercury by FIMS (QCLot: 4215558)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.087 mg/kg	113	70.0	125
EG035T: Total Recoverable Mercury by FIMS (QCLot: 4215560)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.087 mg/kg	125	70.0	125

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Acceptable Limits (%) Low	Acceptable Limits (%) High
EG020T: Total Metals by ICP-MS (QCLot: 4191672)								
EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	0.1 mg/L	92.5	84.0	117
EG020B-T: Titanium	7440-32-6	0.01	mg/L	<0.01	0.1 mg/L	105	88.0	112
EG020T: Total Metals by ICP-MS (QCLot: 4191673)								
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	106	80.0	114
EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	0.1 mg/L	110	87.0	115
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	107	88.0	112
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	104	88.0	111
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	105	89.0	115
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	108	88.0	116
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	104	89.0	112

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Acceptable Limits (%) Low	Acceptable Limits (%) High
EG020T: Total Metals by ICP-MS (QCLot: 4191673) - continued								
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	99.9	88.0	116
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	108	87.0	114
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	109	84.0	114
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	114	82.0	118
EG035T: Total Recoverable Mercury by FIMS (QCLot: 4191670)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	105	84.0	118

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Acceptable Limits (%) Low	Acceptable Limits (%) High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 4215559)							
EB2204434-027	SEDE3B 0.4-0.6 <2mm sieve	EG005T: Arsenic	7440-38-2	100 mg/kg	83.5	70.0	130
		EG005T: Cadmium	7440-43-9	25 mg/kg	77.2	70.0	130
		EG005T: Chromium	7440-47-3	100 mg/kg	70.9	70.0	130
		EG005T: Copper	7440-50-8	100 mg/kg	76.3	70.0	130
		EG005T: Lead	7439-92-1	100 mg/kg	# 66.8	70.0	130
		EG005T: Nickel	7440-02-0	100 mg/kg	74.0	70.0	130
		EG005T: Vanadium	7440-62-2	100 mg/kg	78.7	70.0	130
		EG005T: Zinc	7440-66-6	100 mg/kg	# 69.6	70.0	130
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 4215561)							
EB2204434-059	SED_E3 0.0-0.20 <2mm sieve	EG005T: Arsenic	7440-38-2	100 mg/kg	90.9	70.0	130
		EG005T: Cadmium	7440-43-9	25 mg/kg	85.4	70.0	130
		EG005T: Chromium	7440-47-3	100 mg/kg	87.6	70.0	130
		EG005T: Copper	7440-50-8	100 mg/kg	102	70.0	130
		EG005T: Lead	7439-92-1	100 mg/kg	73.5	70.0	130
		EG005T: Nickel	7440-02-0	100 mg/kg	84.0	70.0	130
		EG005T: Vanadium	7440-62-2	100 mg/kg	94.6	70.0	130
		EG005T: Zinc	7440-66-6	100 mg/kg	80.0	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 4215558)							
EB2204434-027	SEDE3B 0.4-0.6 <2mm sieve	EG035T: Mercury	7439-97-6	0.5 mg/kg	93.5	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 4215560)							
EB2204434-059	SED_E3 0.0-0.20 <2mm sieve	EG035T: Mercury	7439-97-6	0.5 mg/kg	99.9	70.0	130

Sub-Matrix: **WATER**

Matrix Spike (MS) Report

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Acceptable Limits (%) Low	High
EG020T: Total Metals by ICP-MS (QCLot: 4191673)							
EB2204485-001	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	106	70.0	130
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	102	70.0	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	95.6	70.0	130
		EG020A-T: Copper	7440-50-8	1 mg/L	104	70.0	130
		EG020A-T: Lead	7439-92-1	1 mg/L	97.4	70.0	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	101	70.0	130
		EG020A-T: Vanadium	7440-62-2	1 mg/L	97.4	70.0	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	111	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 4191670)							
EB2204485-001	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	101	70.0	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB2204434**	Page	: 1 of 9
Client	: **TETRA TECH COFFEY PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR TRAVIS WOOD	Telephone	: + 61 2 8784 8555
Project	: Marinus Link Project	Date Samples Received	: 17-Feb-2022
Site	: ----	Issue Date	: 11-Mar-2022
Sampler	: FF / JMWP	No. of samples received	: 49
Order number	: ----	No. of samples analysed	: 48

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Duplicate outliers exist - please see following pages for full details.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **SOIL**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Duplicate (DUP) RPDs							
EG005(ED093)T: Total Metals by ICP-AES	EB2204434--036	SEDEW4 0.4-0.6 <2mm sieve	**Aluminium**	7429-90-5	33.5 %	0% - 20%	**RPD exceeds LOR based limits**
EG005(ED093)T: Total Metals by ICP-AES	EB2204434--036	SEDEW4 0.4-0.6 <2mm sieve	**Iron**	7439-89-6	23.1 %	0% - 20%	**RPD exceeds LOR based limits**
Matrix Spike (MS) Recoveries							
EG005(ED093)T: Total Metals by ICP-AES	EB2204434--027	SEDE3B 0.4-0.6 <2mm sieve	**Lead**	7439-92-1	66.8 %	70.0-130%	**Recovery less than lower data quality objective**
EG005(ED093)T: Total Metals by ICP-AES	EB2204434--027	SEDE3B 0.4-0.6 <2mm sieve	**Zinc**	7440-66-6	69.6 %	70.0-130%	**Recovery less than lower data quality objective**

Outliers : Frequency of Quality Control Samples

Matrix: **SOIL**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
Soil Particle Density	0	23	0.00	10.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: ✘ = Holding time breach ; ✓ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-A: Actual Acidity							
Pulp Bag (EA033) SEDE3B 0.0-0.2, SEDE3B 0.4-0.6, SEDE4 0.0-0.2, SEDE4 0.4-0.6, SEDE4 0.7-0.9, SEDE4B 0-0.2/D, SEDE4B 0.4-0.6/D, SEDE4B 0.8-1.0/D, SEDEW4 0-0.2, SEDEW4 0.4-0.6, SEDW4 0.8-1.0, SED_W5 0.0-0.2, SED_W5 0.4-0.6, SED_W1 0.1-0.25, SED_W1 0.4-0.6, SED_W1 0.65-0.72, SED_E1 0.0-0.1, SED_E1A 0.0-0.1, SED_E2 0.0-0.25, SED_E2A 0.0-0.25, SED_E3 0.0-0.20, SED_E3A0.0-0.20, SED_E3A0.20-0.32	**12-Feb-2022**	**08-Mar-2022**	12-Feb-2023	✓	**08-Mar-2022**	06-Jun-2022	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EA033-B: Potential Acidity							
Pulp Bag (EA033) SEDE3B 0.0-0.2, SEDE3B 0.4-0.6, SEDE4 0.0-0.2, SEDE4 0.4-0.6, SEDE4 0.7-0.9, SEDE4B 0-0.2/D, SEDE4B 0.4-0.6/D, SEDE4B 0.8-1.0/D, SEDEW4 0-0.2, SEDEW4 0.4-0.6, SEDW4 0.8-1.0, SED_W5 0.0-0.2, SED_W5 0.4-0.6, SED_W1 0.1-0.25, SED_W1 0.4-0.6, SED_W1 0.65-0.72, SED_E1 0.0-0.1, SED_E1A 0.0-0.1, SED_E2 0.0-0.25, SED_E2A 0.0-0.25, SED_E3 0.0-0.20, SED_E3A0.0-0.20, SED_E3A0.20-0.32	**12-Feb-2022**	**08-Mar-2022**	12-Feb-2023	✓	**08-Mar-2022**	06-Jun-2022	✓
EA033-C: Acid Neutralising Capacity							
Pulp Bag (EA033) SEDE3B 0.0-0.2, SEDE3B 0.4-0.6, SEDE4 0.0-0.2, SEDE4 0.4-0.6, SEDE4 0.7-0.9, SEDE4B 0-0.2/D, SEDE4B 0.4-0.6/D, SEDE4B 0.8-1.0/D, SEDEW4 0-0.2, SEDEW4 0.4-0.6, SEDW4 0.8-1.0, SED_W5 0.0-0.2, SED_W5 0.4-0.6, SED_W1 0.1-0.25, SED_W1 0.4-0.6, SED_W1 0.65-0.72, SED_E1 0.0-0.1, SED_E1A 0.0-0.1, SED_E2 0.0-0.25, SED_E2A 0.0-0.25, SED_E3 0.0-0.20, SED_E3A0.0-0.20, SED_E3A0.20-0.32	**12-Feb-2022**	**08-Mar-2022**	12-Feb-2023	✓	**08-Mar-2022**	06-Jun-2022	✓
EA033-D: Retained Acidity							
Pulp Bag (EA033) SEDE3B 0.0-0.2, SEDE3B 0.4-0.6, SEDE4 0.0-0.2, SEDE4 0.4-0.6, SEDE4 0.7-0.9, SEDE4B 0-0.2/D, SEDE4B 0.4-0.6/D, SEDE4B 0.8-1.0/D, SEDEW4 0-0.2, SEDEW4 0.4-0.6, SEDW4 0.8-1.0, SED_W5 0.0-0.2, SED_W5 0.4-0.6, SED_W1 0.1-0.25, SED_W1 0.4-0.6, SED_W1 0.65-0.72, SED_E1 0.0-0.1, SED_E1A 0.0-0.1, SED_E2 0.0-0.25, SED_E2A 0.0-0.25, SED_E3 0.0-0.20, SED_E3A0.0-0.20, SED_E3A0.20-0.32	**12-Feb-2022**	**08-Mar-2022**	12-Feb-2023	✓	**08-Mar-2022**	06-Jun-2022	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA033-E: Acid Base Accounting								
Pulp Bag (EA033)								
SEDE3B 0.0-0.2,	SEDE3B 0.4-0.6,	**12-Feb-2022**	**08-Mar-2022**	12-Feb-2023	✓	**08-Mar-2022**	06-Jun-2022	✓
SEDE4 0.0-0.2,	SEDE4 0.4-0.6,							
SEDE4 0.7-0.9,	SEDE4B 0-0.2/D,							
SEDE4B 0.4-0.6/D,	SEDE4B 0.8-1.0/D,							
SEDEW4 0-0.2,	SEDEW4 0.4-0.6,							
SEDW4 0.8-1.0,	SED_W5 0.0-0.2,							
SED_W5 0.4-0.6,	SED_W1 0.1-0.25,							
SED_W1 0.4-0.6,	SED_W1 0.65-0.72,							
SED_E1 0.0-0.1,	SED_E1A 0.0-0.1,							
SED_E2 0.0-0.25,	SED_E2A 0.0-0.25,							
SED_E3 0.0-0.20,	SED_E3A0.0-0.20,							
SED_E3A0.20-0.32								
EA150: Particle Sizing								
Snap Lock Bag (EA150H)								
SEDE3B 0.0-0.2,	SEDE3B 0.4-0.6,	**12-Feb-2022**	**----**	----	----	**10-Mar-2022**	11-Aug-2022	✓
SEDE4 0.0-0.2,	SEDE4 0.4-0.6,							
SEDE4 0.7-0.9,	SEDE4B 0-0.2/D,							
SEDE4B 0.4-0.6/D,	SEDE4B 0.8-1.0/D,							
SEDEW4 0-0.2,	SEDEW4 0.4-0.6,							
SEDW4 0.8-1.0,	SED_W5 0.0-0.2,							
SED_W5 0.4-0.6,	SED_W1 0.1-0.25,							
SED_W1 0.4-0.6,	SED_W1 0.65-0.72,							
SED_E1 0.0-0.1,	SED_E1A 0.0-0.1,							
SED_E2 0.0-0.25,	SED_E2A 0.0-0.25,							
SED_E3 0.0-0.20,	SED_E3A0.0-0.20,							
SED_E3A0.20-0.32								
EA150: Soil Classification based on Particle Size								
Snap Lock Bag (EA150H)								
SEDE3B 0.0-0.2,	SEDE3B 0.4-0.6,	**12-Feb-2022**	**----**	----	----	**10-Mar-2022**	11-Aug-2022	✓
SEDE4 0.0-0.2,	SEDE4 0.4-0.6,							
SEDE4 0.7-0.9,	SEDE4B 0-0.2/D,							
SEDE4B 0.4-0.6/D,	SEDE4B 0.8-1.0/D,							
SEDEW4 0-0.2,	SEDEW4 0.4-0.6,							
SEDW4 0.8-1.0,	SED_W5 0.0-0.2,							
SED_W5 0.4-0.6,	SED_W1 0.1-0.25,							
SED_W1 0.4-0.6,	SED_W1 0.65-0.72,							
SED_E1 0.0-0.1,	SED_E1A 0.0-0.1,							
SED_E2 0.0-0.25,	SED_E2A 0.0-0.25,							
SED_E3 0.0-0.20,	SED_E3A0.0-0.20,							
SED_E3A0.20-0.32								

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA152: Soil Particle Density							
Snap Lock Bag (EA152) SEDE3B 0.0-0.2, SEDE3B 0.4-0.6, SEDE4 0.0-0.2, SEDE4 0.4-0.6, SEDE4 0.7-0.9, SEDE4B 0-0.2/D, SEDE4B 0.4-0.6/D, SEDE4B 0.8-1.0/D, SEDEW4 0-0.2, SEDEW4 0.4-0.6, SEDW4 0.8-1.0, SED_W5 0.0-0.2, SED_W5 0.4-0.6, SED_W1 0.1-0.25, SED_W1 0.4-0.6, SED_W1 0.65-0.72, SED_E1 0.0-0.1, SED_E1A 0.0-0.1, SED_E2 0.0-0.25, SED_E2A 0.0-0.25, SED_E3 0.0-0.20, SED_E3A0.0-0.20, SED_E3A0.20-0.32	**12-Feb-2022**	**----**	----	----	**10-Mar-2022**	11-Aug-2022	✓
EG005(ED093)T: Total Metals by ICP-AES							
Pulp Bag (-2000µm) (EG005T) SEDE3B 0.0-0.2 - <2mm sieve, SEDE3B 0.4-0.6 - <2mm sieve, SEDE4 0.0-0.2 - <2mm sieve, SEDE4 0.4-0.6 - <2mm sieve, SEDE4 0.7-0.9 - <2mm sieve, SEDE4B 0-0.2/D - <2mm sieve, SEDE4B 0.4-0.6/D - <2mm sieve, SEDE4B 0.8-1.0/D - <2mm sieve, SEDEW4 0-0.2 - <2mm sieve, SEDEW4 0.4-0.6 - <2mm sieve, SEDW4 0.8-1.0 - <2mm sieve, SED_W5 0.0-0.2 - <2mm sieve, SED_W5 0.4-0.6 - <2mm sieve, SED_W1 0.1-0.25 - <2mm sieve, SED_W1 0.4-0.6 - <2mm sieve, SED_W1 0.65-0.72 - <2mm sieve, SED_E1 0.0-0.1 - <2mm sieve, SED_E1A 0.0-0.1 - <2mm sieve, SED_E2 0.0-0.25 - <2mm sieve, SED_E2A 0.0-0.25 - <2mm sieve, SED_E3 0.0-0.20 - <2mm sieve, SED_E3A0.0-0.20 - <2mm sieve, SED_E3A0.20-0.32 - <2mm sieve	**07-Mar-2022**	**09-Mar-2022**	03-Sep-2022	✓	**09-Mar-2022**	03-Sep-2022	✓
Pulp Bag (-63µm) (EG005T) SEDE4A 0-1.00 - <63µm sieve	**07-Mar-2022**	**09-Mar-2022**	03-Sep-2022	✓	**09-Mar-2022**	03-Sep-2022	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation Date extracted	Due for extraction	Evaluation	Analysis Date analysed	Due for analysis	Evaluation
EG035T: Total Recoverable Mercury by FIMS							
Pulp Bag (-2000µm) (EG035T) SEDE3B 0.0-0.2 - <2mm sieve, SEDE3B 0.4-0.6 - <2mm sieve, SEDE4 0.0-0.2 - <2mm sieve, SEDE4 0.4-0.6 - <2mm sieve, SEDE4 0.7-0.9 - <2mm sieve, SEDE4B 0-0.2/D - <2mm sieve, SEDE4B 0.4-0.6/D - <2mm sieve, SEDE4B 0.8-1.0/D - <2mm sieve, SEDEW4 0-0.2 - <2mm sieve, SEDEW4 0.4-0.6 - <2mm sieve, SEDW4 0.8-1.0 - <2mm sieve, SED_W5 0.0-0.2 - <2mm sieve, SED_W5 0.4-0.6 - <2mm sieve, SED_W1 0.1-0.25 - <2mm sieve, SED_W1 0.4-0.6 - <2mm sieve, SED_W1 0.65-0.72 - <2mm sieve, SED_E1 0.0-0.1 - <2mm sieve, SED_E1A 0.0-0.1 - <2mm sieve, SED_E2 0.0-0.25 - <2mm sieve, SED_E2A 0.0-0.25 - <2mm sieve, SED_E3 0.0-0.20 - <2mm sieve, SED_E3A0.0-0.20 - <2mm sieve, SED_E3A0.20-0.32 - <2mm sieve	**07-Mar-2022**	**09-Mar-2022**	04-Apr-2022	✓	**10-Mar-2022**	04-Apr-2022	✓
Pulp Bag (-63µm) (EG035T) SEDE4A 0-1.00 - <63µm sieve	**07-Mar-2022**	**09-Mar-2022**	04-Apr-2022	✓	**10-Mar-2022**	04-Apr-2022	✓
GEO26: Sieving							
Snap Lock Bag (GEO26C) SEDE4A 0-1.00 - <63µm sieve	**12-Feb-2022**	**07-Mar-2022**	11-Aug-2022	✓	**----**	----	----
Soil Glass Jar - Unpreserved (GEO26) SEDE3B 0.0-0.2 - <2mm sieve, SEDE3B 0.4-0.6 - <2mm sieve, SEDE4 0.0-0.2 - <2mm sieve, SEDE4 0.4-0.6 - <2mm sieve, SEDE4 0.7-0.9 - <2mm sieve, SEDE4B 0-0.2/D - <2mm sieve, SEDE4B 0.4-0.6/D - <2mm sieve, SEDE4B 0.8-1.0/D - <2mm sieve, SEDEW4 0-0.2 - <2mm sieve, SEDEW4 0.4-0.6 - <2mm sieve, SEDW4 0.8-1.0 - <2mm sieve, SED_W5 0.0-0.2 - <2mm sieve, SED_W5 0.4-0.6 - <2mm sieve, SED_W1 0.1-0.25 - <2mm sieve, SED_W1 0.4-0.6 - <2mm sieve, SED_W1 0.65-0.72 - <2mm sieve, SED_E1 0.0-0.1 - <2mm sieve, SED_E1A 0.0-0.1 - <2mm sieve, SED_E2 0.0-0.25 - <2mm sieve, SED_E2A 0.0-0.25 - <2mm sieve, SED_E3 0.0-0.20 - <2mm sieve, SED_E3A0.0-0.20 - <2mm sieve, SED_E3A0.20-0.32 - <2mm sieve	**12-Feb-2022**	**07-Mar-2022**	11-Aug-2022	✓	**----**	----	----

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation Date extracted	Due for extraction	Evaluation	Analysis Date analysed	Due for analysis	Evaluation
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Natural (EG020B-T) SEDW5 RIN	**12-Feb-2022**	**25-Feb-2022**	11-Aug-2022	✓	**25-Feb-2022**	11-Aug-2022	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Natural (EG035T) SEDW5 RIN	**12-Feb-2022**	**----**	----	----	**25-Feb-2022**	12-Mar-2022	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type / *Analytical Methods*	*Method*	Count *QC*	Count *Regular*	Rate (%) **Actual**	Rate (%) **Expected**	*Evaluation*	*Quality Control Specification*
Laboratory Duplicates (DUP)							
Chromium Suite for Acid Sulphate Soils	EA033	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Soil Particle Density	EA152	0	23	**0.00**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	4	37	**10.81**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Chromium Suite for Acid Sulphate Soils	EA033	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Soil Particle Density	EA152	2	23	**8.70**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chromium Suite for Acid Sulphate Soils	EA033	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Total Mercury by FIMS	EG035T	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type / *Analytical Methods*	*Method*	Count *QC*	Count *Regular*	Rate (%) **Actual**	Rate (%) **Expected**	*Evaluation*	*Quality Control Specification*
Laboratory Duplicates (DUP)							
Total Mercury by FIMS	EG035T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Chromium Suite for Acid Sulphate Soils	EA033	SOIL	In house: Referenced to Ahern et al 2004. This method covers the determination of Chromium Reducible Sulfur (SCR); pHKCl; titratable actual acidity (TAA); acid neutralising capacity by back titration (ANC); and net acid soluble sulfur (SNAS) which incorporates peroxide sulfur. It applies to soils and sediments (including sands) derived from coastal regions. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Particle Size Analysis by Hydrometer	EA150H	SOIL	Particle Size Analysis by Hydrometer according to AS1289.3.6.3
Soil Particle Density	EA152	SOIL	Soil Particle Density by AS 1289.3.5.1: Methods of testing soils for engineering purposes - Soil classification tests - Determination of the soil particle density of a soil - Standard method
Total Metals by ICP-AES	EG005T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM Schedule B(3)
Total Mercury by FIMS	EG035T	SOIL	In house: Referenced to APHA 3112 Hg - B (Flow-injection (SnCl2) (Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM Schedule B(3)
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite B	EG020B-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM Schedule B(3).

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house

Preparation Methods	Method	Matrix	Method Descriptions
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	In house: Referenced to USEPA 200.2. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM Schedule B(3).
Sieving (fine to -2mm)	GEO26	SOIL	In house: The dried sample is sieved to 2mm and the fines are then analysed per the client's request.
Sieving (fine to -63µm)	GEO26C	SOIL	In house: The sample is sieved to -63µm and the fines are then analysed per the client's request.
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM Schedule B(3)

Batch as EB

ALS Environmental

CHAIN OF CUSTODY

ALS Laboratory: please tick →

ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com
BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com
GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com
MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com
MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com
MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com
NEWCASTLE 5/585 Maitland Rd Mayfield West NSW 2304 E: samples.newcastle@alsglobal.com
NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com
PERTH 10 Hod Way Malaga WA 6090 Ph. 08 9209 7655 E: samples.perth@alsglobal.com
S... / TOW... Ph: 07 ... / WOLL... Ph: 02 4...

Environmental Division Brisbane
Work Order Reference
EB2204434

Telephone: + 61-7-3243 7222

6F

CLIENT:	Tetra Tech Coffey
OFFICE:	[illegible]
PROJECT:	Marinus Link Project
ORDER NUMBER:	
PROJECT MANAGER:	Travis Wood
CONTACT PH:	
SAMPLER:	FF / JMWP
SAMPLER MOBILE:	0427569110
COC emailed to ALS?	(YES / NO)
EDD FORMAT (or default):	
Email Reports to:	travis.wood@tetratech.com
Email Invoice to:	travis.wood@tetratech.com

TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)
☑ Standard TAT (List due date):
☐ Non Standard or urgent TAT (List due date):

ALS QUOTE NO.: BN/476/21

COC SEQUENCE NUMBER (Circle)
COC: (1) 2 3 4 5 6 7
OF: 1 2 (3) 4 5 6 7

FOR LABORATORY USE: Custody Seal Intact? / Free ice / frozen ice bricks present upon receipt? / Random Sample Temperature / Other comment:

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
sean Varsteel	Josh Shiner	(ACW)	
DATE/TIME: 12/2/22 1030	DATE/TIME: 12/2/22 10:30	DATE/TIME: 16/2	DATE/TIME: 17/2/22 1010

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: Dropped off at Tasfast 12:30

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	ASS (chromium suite)	PSD	Porewater analysis (metals)	Total metals (<2000 µm fraction)	Total metals (<63 µm fraction)	Weak acid metals (<2000 µm fraction) (1M HCL digest)	Weak acid metals (<63 µm fraction) (1M HCl digest)	Total Metals (water)	Metals analytes: As, Al, Sb, Cd, Cr, Cu, Hg, Ni, Ag, Pb, Zn, Fe, Ti, V
1	SEDE3B 0.0-0.2	2022-02-12 00:30	S	3x Plastic bag 1x glass jar	4	✓	✓	✓	✓	26				
2	SEDE3B 0.4-0.6	2022-02-12 00:30	S	" " " "	4	✓	✓	✓	✓	27				
3	SEDE4 0-0.2	2022-2-12 02:00	S	" " " "	4	✓	✓	✓	✓	28				[redacted]
4	SEDE4 0.4-0.6	2022-2-12 02:00	S	" " " "	4	✓	✓	✓	✓	29				
5	SEDE4 0.7-0.9	2022-2-12 02:00	S	" " " "	4	✓	✓	✓	✓	30				
6.	SEDE4A 0-1.00	2022-2-12 03:35	S	1x plastic bag	1					✓	31			
7	SEDW5 RIN	2022-02-12 08:00	W	1x plastic bottle	1								✓	
8	SEDE4B 0-0.2/D	2022-2-12 05:50	S	3x plastic bag 1x glass jar	4	✓	✓	✓	✓	32				
9	SEDE4B 0.4-0.6/D	2022-2-12 05:50	S	" " " "	4	✓	✓	✓	✓	33				
10	SEDE4B 0.8-1.0/D	2022-2-12 05:50	S	" " " "	4	✓	✓	✓	✓	34				
11	SEDW4 0-0.2	2022-2-12 06:30	S	" " " "	4	✓	✓	✓	✓	35				
12	SED W4 0.4-0.6	2022-2-17 06:30	S	" " " "	4	✓	✓	✓	✓	36				
				TOTAL	42									

SCANNED

Received: 14/2, 11:52 Carrier: TasFast
C/note: C1009153001-007
Temp: 14-1 °C Seal: Y / N
Ice / Icebrick / NA
Tan

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

Batch as EB

ALS Environmental — CHAIN OF CUSTODY

ALS Laboratory: please tick →

- ☐ ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 08 8359 0890 E: adelaide@alsglobal.com
- ☐ BRISBANE 32 Shand Street Stafford QLD 4053 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com
- ☐ GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com
- ☐ MACKAY 78 Harbour Road Mackay QLD 4740 Ph: 07 4944 0177 E: mackay@alsglobal.com
- ☐ MELBOURNE 2-4 Westall Road Springvale VIC 3171 Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com
- ☐ MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com
- ☐ NEWCASTLE 5/585 Maitland Rd Mayfield West NSW 2304 Ph: 02 4014 2500 E: samples.newcastle@alsglobal.com
- ☐ NOWRA 4/13 Geary Place North Nowra NSW 2541 Ph: 024423 2063 E: nowra@alsglobal.com
- ☐ PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com
- ☐ SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 Ph: 02 8784 8555 E: samples.sydney@alsglobal.com
- ☐ TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com
- ☐ WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: Tetra Tech Coffey	TURNAROUND REQUIREMENTS: (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics) ☒ Standard TAT (List due date): ☐ Non Standard or urgent TAT (List due date):
OFFICE: Melbourne	
PROJECT: Marinus Link Project	ALS QUOTE NO.: BN/476/21
ORDER NUMBER:	COC SEQUENCE NUMBER (Circle) COC: 1 2 (3) 4 5 6 7 OF: 1 2 (3) 4 5 6 7
PROJECT MANAGER: Travis Wood	CONTACT PH:
SAMPLER: FF / JMWP	SAMPLER MOBILE: 0427569110
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):
Email Reports to: travis.wood@tetratech.com	
Email Invoice to: travis.wood@tetratech.com	

FOR LABORATORY USE ONLY (Circle)

Custody Seal Intact?	Yes	No	N/A
Free ice / frozen ice bricks present upon receipt?	Yes	No	N/A
Random Sample Temperature on Receipt:	°C		
Other comment:			

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Sean Vanstead	Jock Sherman	TW (ALS)	JB
DATE/TIME: 12/2/22 1030	DATE/TIME: 12/2/22 10:30	DATE/TIME: 16/2	DATE/TIME: 17/2/22 1010

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: dropped off @ Tasfast 12:30pm

ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price). Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).

ALS USE: LAB ID	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W): SAMPLE ID	DATE / TIME	MATRIX	CONTAINER INFORMATION: TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	ASS (chromium suite)	PSD	Porewater analysis (metals)	Total metals (<2000 µm fraction)	Total metals (<63 µm fraction)	Weak acid metals (<2000 µm fraction) (1M HCL digest)	Weak acid metals (<63 µm fraction) (1M HCl digest)		Additional Information
														Metals analytes: As, Al, Sb, Cd, Cr, Cu, Hg, Ni, Ag, Pb, Zn, Fe, Ti, V
25	SEDW4 0.8-1.0	2022-2-12 06:30	S	3x plastic bag 1x glass jar	4	✓	✓	✓	✓	37				
TOTAL					4									

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

Batch as EB

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ALS Environmental

ALS Laboratory: please tick →

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☐TOWNSVILLE 14-15 Desma Court Bohle QLD 4818 Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com
☐WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: Tetra Tech Coffey	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g., Ultra Trace Organics) ☑ Standard TAT (List due date): ☐ Non Standard or urgent TAT (List due date):
OFFICE: Melbourne	
PROJECT: Marinus Link Project	ALS QUOTE NO.: BN/476/21
ORDER NUMBER:	COC SEQUENCE NUMBER (Circle) COC: 1 (2) 3 4 5 6 7 OF: 1 2 (3) 4 5 6 7
PROJECT MANAGER: Travis Wood	CONTACT PH:
SAMPLER: FF / JMWP	SAMPLER MOBILE: 0427569110
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):
Email Reports to: travis.wood@tetratech.com	
Email Invoice to: travis.wood@tetratech.com	

FOR LABORATORY USE ONLY (Circle)
Custody Seal Intact? Yes No N/A
Free ice / frozen ice bricks present upon receipt? Yes No N/A
Random Sample Temperature on Receipt: °C
Other comment:

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
Sean Vorsteel	Jack Sharma	[illegible] (ACS)	[illegible]
DATE/TIME: 12/2/22 1030	DATE/TIME: 12/2/22 10:30	DATE/TIME: 16/2	DATE/TIME: 17/2/22 1010

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: dropped off at Testfast @ 12:30pm

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	ASS (chromium suite)	PSD	Porewater analysis (metals)	Total metals (<2000 µm fraction)	Total metals (<63 µm fraction)	Weak acid metals (<2000 µm fraction) (1M HCL digest)	Weak acid metals (<63 µm fraction) (1M HCl digest)		Metals analytes: As, Al, Sb, Cd, Cr, Cu, Hg, Ni, Ag, Pb, Zn, Fe, Ti, V
38	SED-WS 0.0-0.2	2022-02-11 08:30		3xP; 1x glass	4				50					
39	SED-WS 0.4-0.6	2022-02-11 08:30		– " –	4				51					
40	SED-W1 0.1-0.25	2022-02-11 13:05		– " –	4				52					
41	SED-W1 0.4-0.6	"		– " –	4				53					
42	SED-W1 0.65-0.72	"		– " –	4				54					
43	SED-E1 0.0-0.1	2022-02-11 19:21		– " –	4				55					
44	SED-E1A 0.0-0.1	2022-02-11 19:48		– " –	4				56					
45	SED-E2 0.0-0.25	2022 20:37		– " –	4				57					
46	SED-E2A 0.0-0.25	21:10		– " –	4				58					
47	SED-E3 0.0-0.20	22:18		– " –	4				59					
48	SED-E3A 0.0-0.20	22:56		– " –	4				60					
49	SED-E3A 0.20-0.32	22:56		– " –	4				61					
				TOTAL	48									

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

Certificate of Analysis

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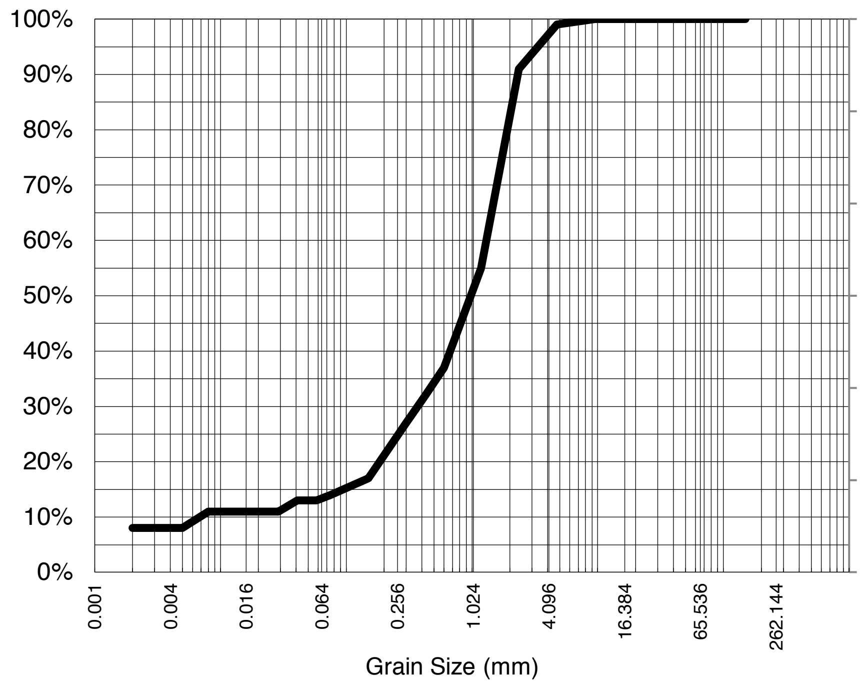
ALS Environmental

Brisbane QLD

CLIENT:	TRAVIS WOOD	**DATE REPORTED:**	11-Mar-2022
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-001 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SEDE3B 0.0-0.2

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	99%
2.36	91%
1.18	55%
0.600	37%
0.425	32%
0.300	27%
0.150	17%
0.075	14%
Particle Size (microns)	
58	13%
41	13%
29	11%
21	11%
15	11%
11	11%
8	11%
5	8%
2	8%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	1.019

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.64

NATA
WORLD RECOGNISED ACCREDITATION

Satish Trivedi
Soil Senior Chemist
Authorised Signatory

Certificate of Analysis

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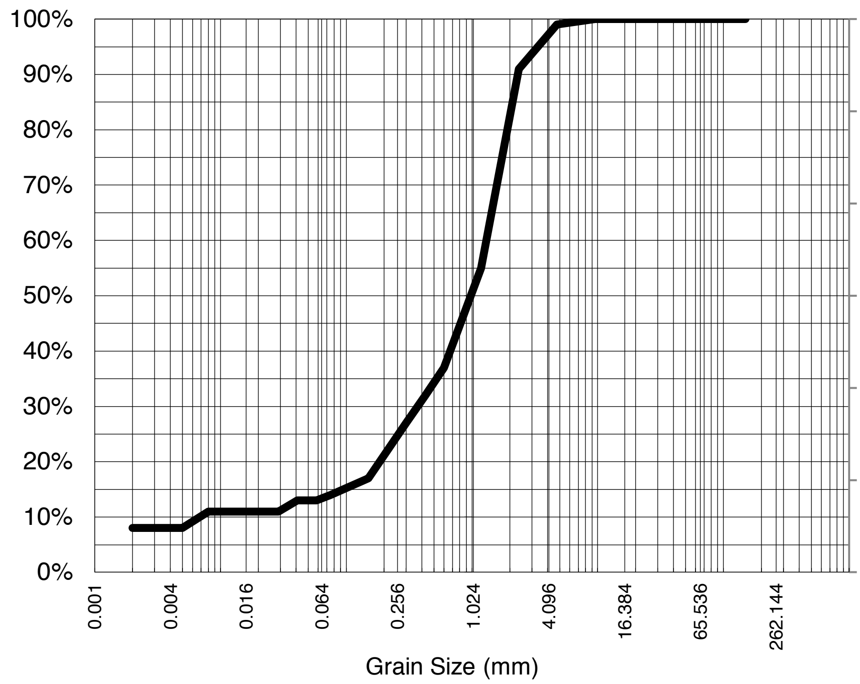
CLIENT:	TRAVIS WOOD	**DATE REPORTED:**	11-Mar-2022
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-001DUP / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SEDE3B 0.0-0.2

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	99%
2.36	91%
1.18	55%
0.600	37%
0.425	32%
0.300	27%
0.150	17%
0.075	14%
Particle Size (microns)	
58	13%
41	13%
29	11%
21	11%
15	11%
11	11%
8	11%
5	8%
2	8%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	1.019

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.64

NATA Accreditation: 825 Site: Brisbane
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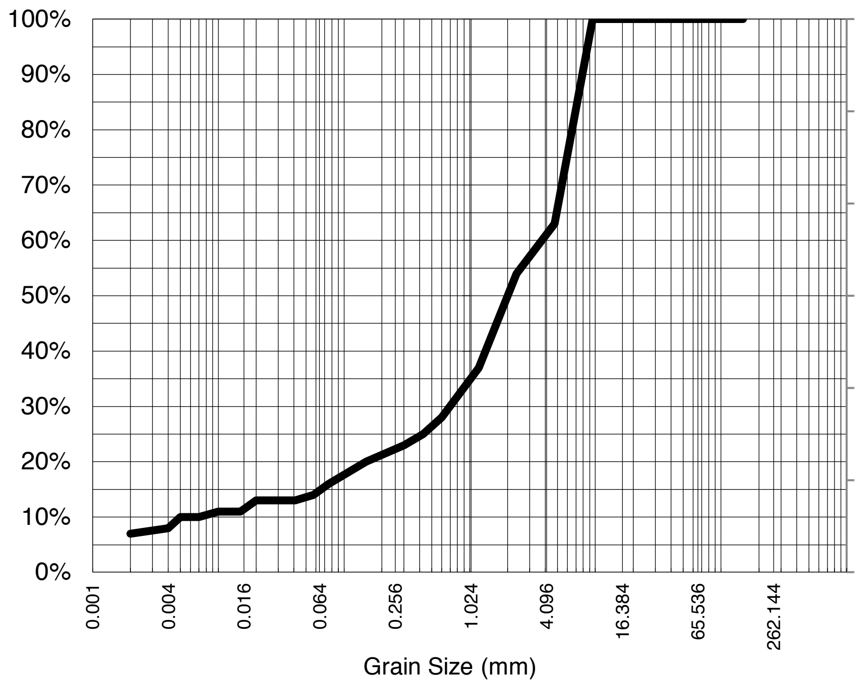
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-002 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SEDE3B 0.4-0.6

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	63%
2.36	54%
1.18	37%
0.600	28%
0.425	25%
0.300	23%
0.150	20%
0.075	16%
Particle Size (microns)	
57	14%
41	13%
29	13%
20	13%
15	11%
10	11%
7	10%
5	10%
2	7%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	2.082

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.67

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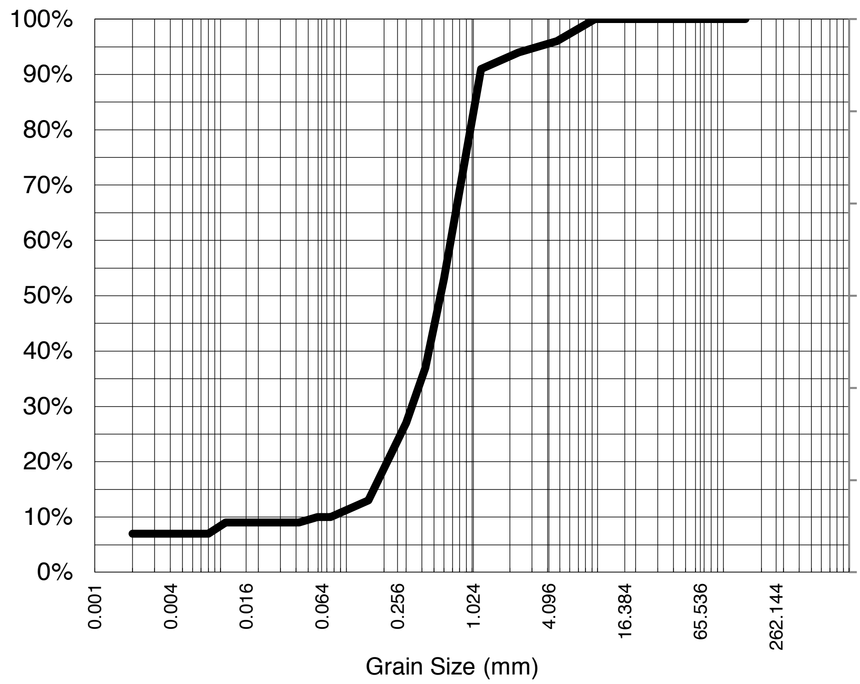
CLIENT:	TRAVIS WOOD	**DATE REPORTED:**	11-Mar-2022
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-003 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SEDE4 0.0-0.2

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	96%
2.36	94%
1.18	91%
0.600	53%
0.425	37%
0.300	27%
0.150	13%
0.075	10%
Particle Size (microns)	
59	10%
42	9%
30	9%
21	9%
15	9%
11	9%
8	7%
5	7%
2	7%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.567

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments: AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.58

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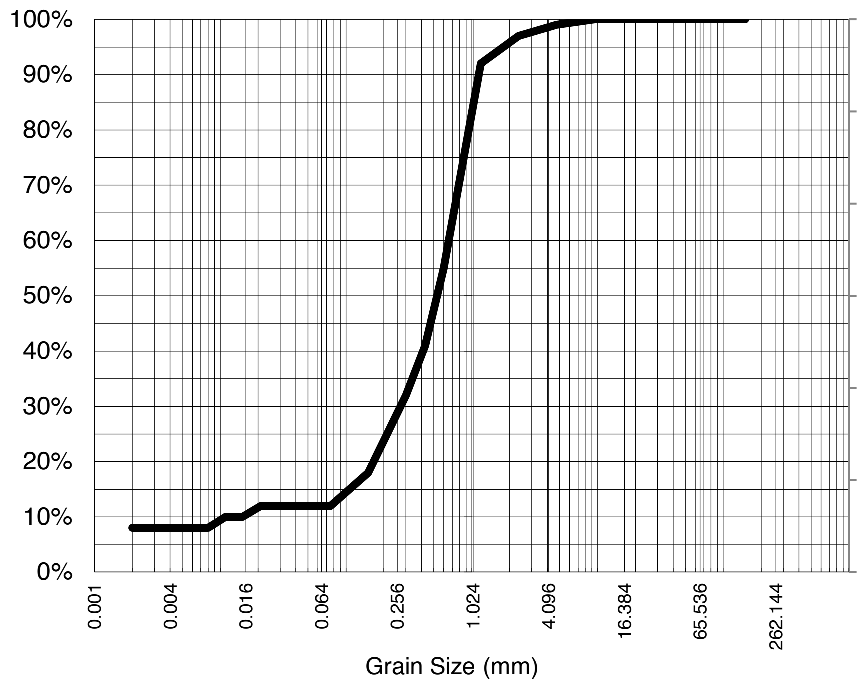
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-004 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SEDE4 0.4-0.6

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	99%
2.36	97%
1.18	92%
0.600	55%
0.425	41%
0.300	32%
0.150	18%
0.075	12%
Particle Size (microns)	
58	12%
41	12%
29	12%
21	12%
15	10%
11	10%
8	8%
5	8%
2	8%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.538

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.6

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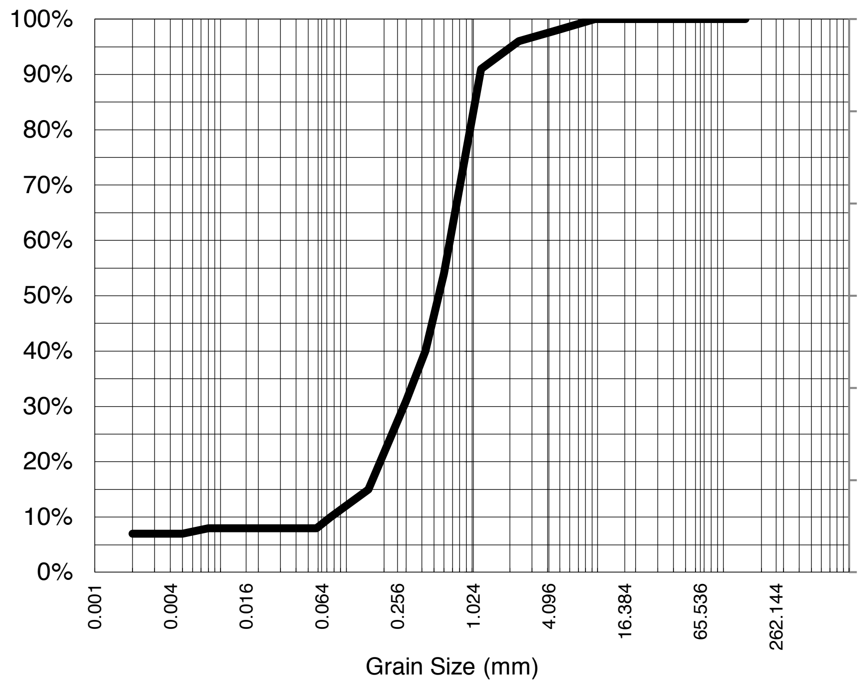
CLIENT:	TRAVIS WOOD	**DATE REPORTED:**	11-Mar-2022
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-005 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SEDE4 0.7-0.9

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	98%
2.36	96%
1.18	91%
0.600	54%
0.425	40%
0.300	31%
0.150	15%
0.075	10%
Particle Size (microns)	
58	8%
41	8%
29	8%
21	8%
15	8%
11	8%
8	8%
5	7%
2	7%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.550

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments: AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.6

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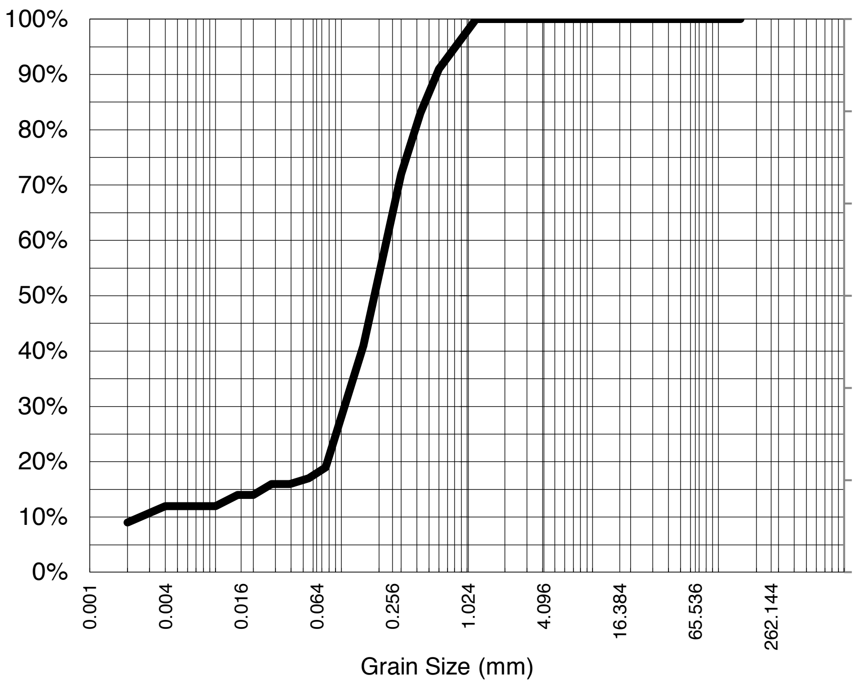
CLIENT:	TRAVIS WOOD	**DATE REPORTED:**	11-Mar-2022
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-008 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SEDE4B 0-0.2/D

Particle Size Distribution



Particle Size (mm)	% Passing
1.18	100%
0.600	91%
0.425	83%
0.300	72%
0.150	41%
0.075	19%
Particle Size (microns)	
55	17%
39	16%
28	16%
20	14%
15	14%
10	12%
7	12%
5	12%
2	9%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.194

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.67

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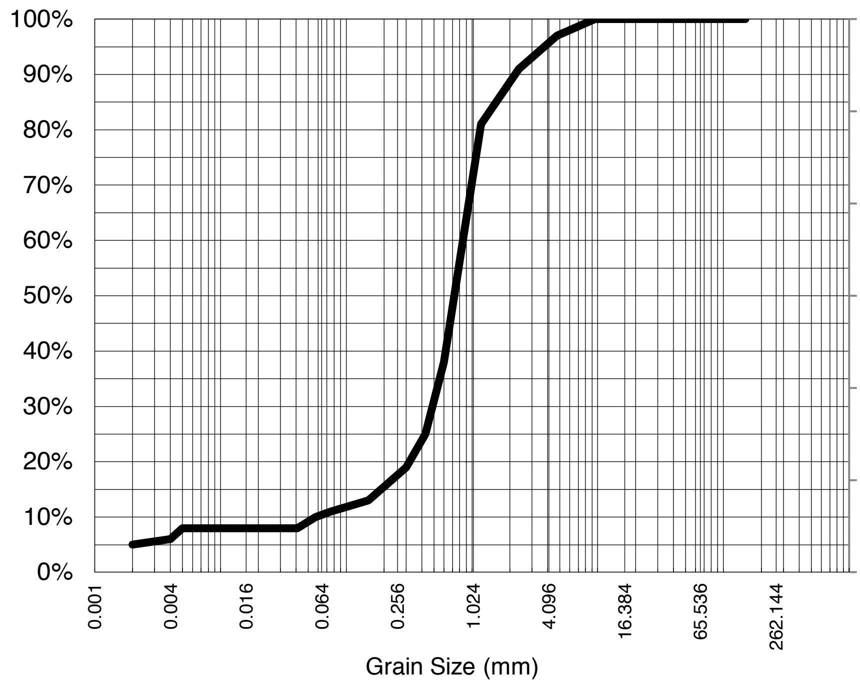
CLIENT:	TRAVIS WOOD	**DATE REPORTED:**	11-Mar-2022
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-009 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SEDE4B 0.4-0.6/D

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	97%
2.36	91%
1.18	81%
0.600	38%
0.425	25%
0.300	19%
0.150	13%
0.075	11%
Particle Size (microns)	
57	10%
41	8%
29	8%
20	8%
15	8%
10	8%
7	8%
5	8%
2	5%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.762

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.69

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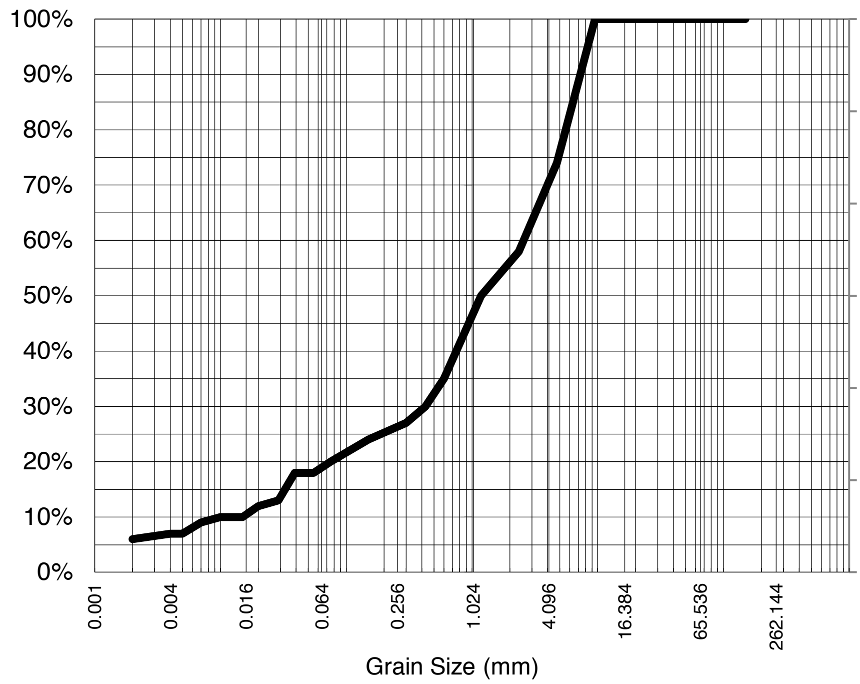
ALS Environmental

Brisbane QLD

CLIENT:	TRAVIS WOOD	**DATE REPORTED:**	11-Mar-2022
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-010 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SEDE4B 0.8-1.0/D

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	74%
2.36	58%
1.18	50%
0.600	35%
0.425	30%
0.300	27%
0.150	24%
0.075	20%
Particle Size (microns)	
55	18%
39	18%
29	13%
20	12%
15	10%
10	10%
7	9%
5	7%
2	6%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	1.180

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.69

WORLD RECOGNISED ACCREDITATION

Satish Trivedi
Soil Senior Chemist
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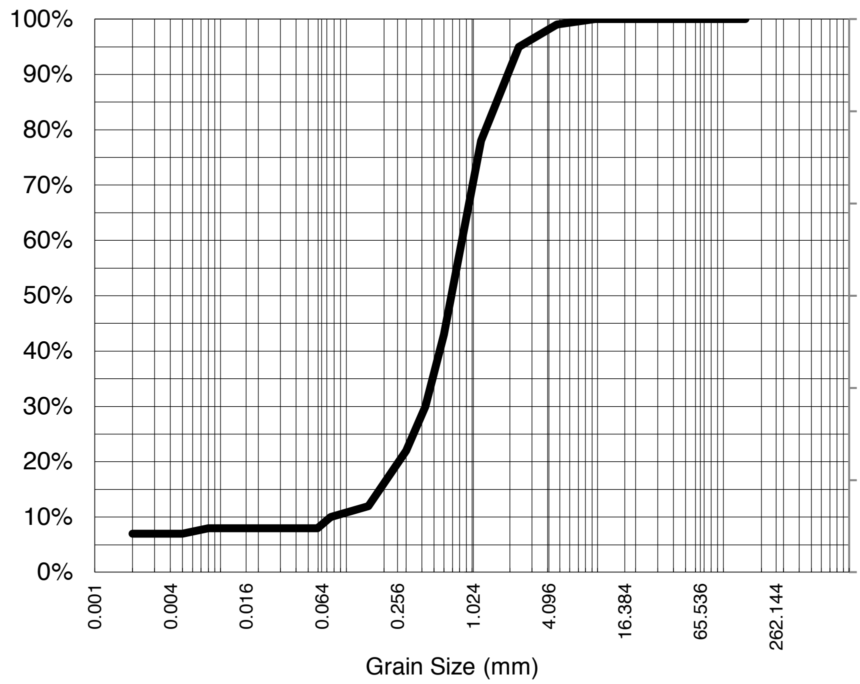
CLIENT:	TRAVIS WOOD	**DATE REPORTED:**	11-Mar-2022
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-011 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SEDEW4 0-0.2

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	99%
2.36	95%
1.18	78%
0.600	43%
0.425	30%
0.300	22%
0.150	12%
0.075	10%
Particle Size (microns)	
59	8%
42	8%
30	8%
21	8%
15	8%
11	8%
8	8%
5	7%
2	7%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.716

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.56

NATA WORLD RECOGNISED ACCREDITATION

Satish Trivedi
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Template Version PKV8.0 180919

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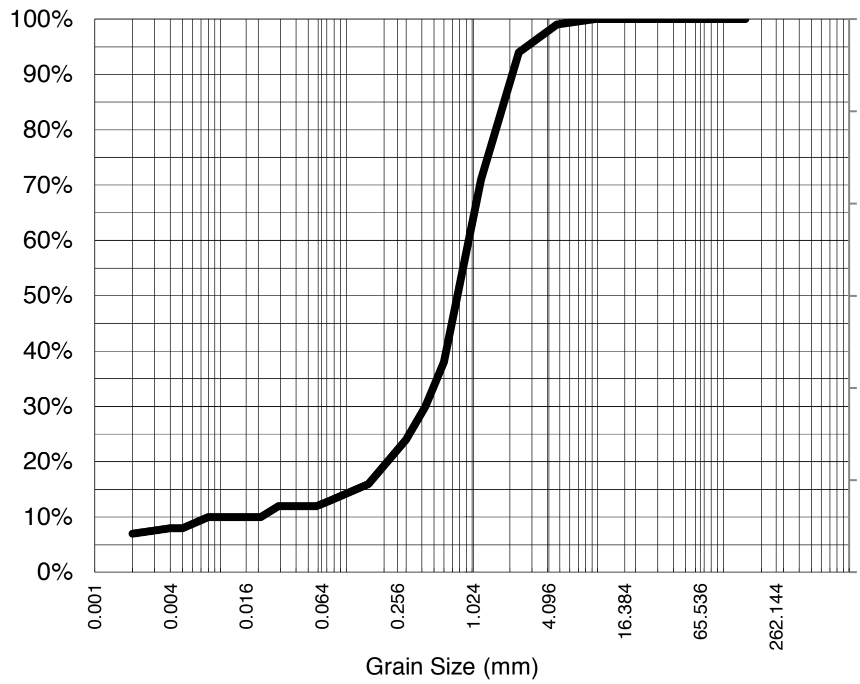
CLIENT:	TRAVIS WOOD	**DATE REPORTED:**	11-Mar-2022
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-012 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SEDEW4 0.4-0.6

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	99%
2.36	94%
1.18	71%
0.600	38%
0.425	30%
0.300	24%
0.150	16%
0.075	13%
Particle Size (microns)	
58	12%
41	12%
29	12%
21	10%
15	10%
11	10%
8	10%
5	8%
2	7%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.811

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.61

NATA Accreditation: 825 Site: Brisbane
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Satish Trivedi
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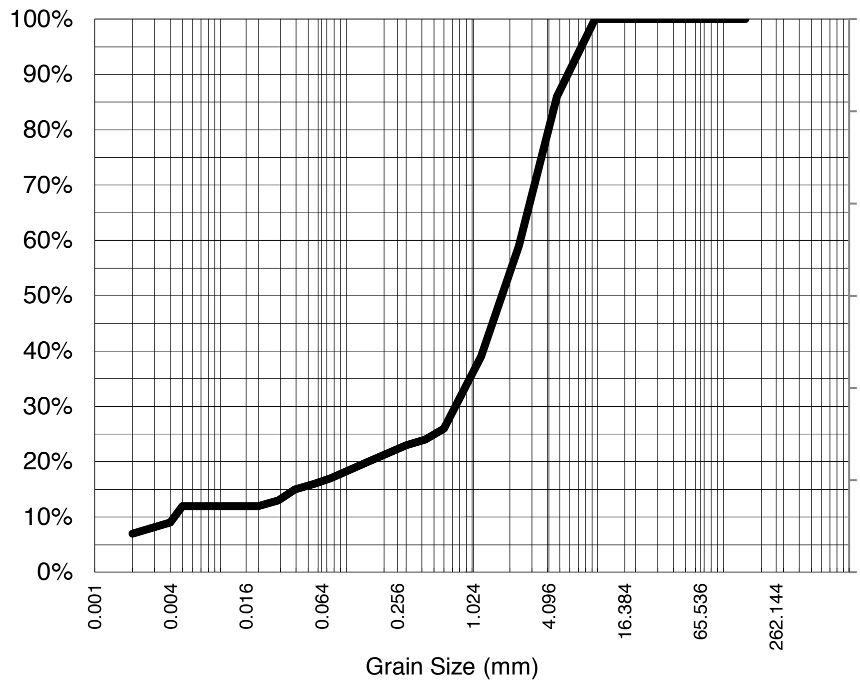
Brisbane QLD

CLIENT:	TRAVIS WOOD	**DATE REPORTED:**	11-Mar-2022
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-025 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SEDW4 0.8-1.0

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	86%
2.36	59%
1.18	39%
0.600	26%
0.425	24%
0.300	23%
0.150	20%
0.075	17%
Particle Size (microns)	
55	16%
39	15%
29	13%
20	12%
15	12%
10	12%
7	12%
5	12%
2	7%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	1.829

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.68

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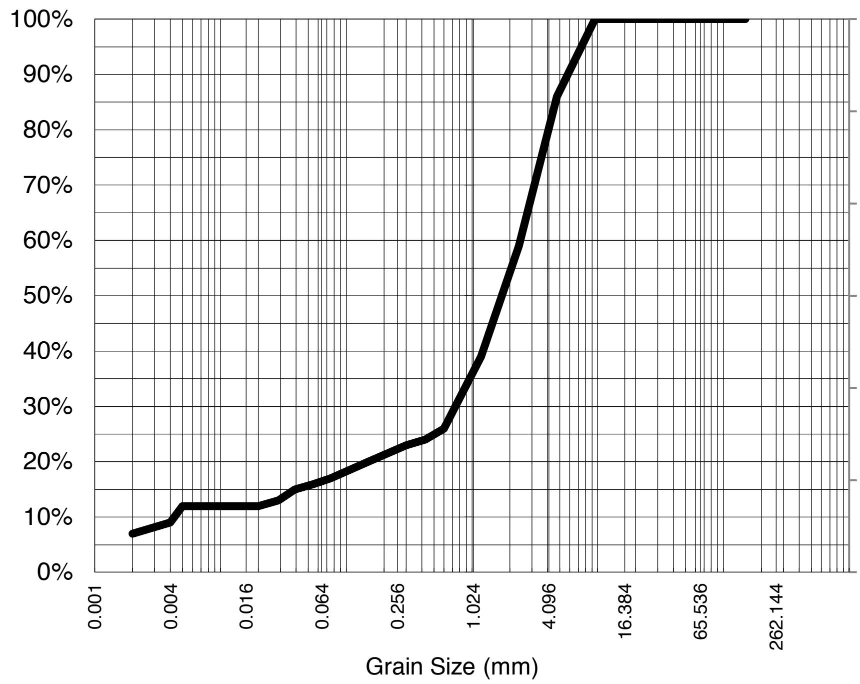
CLIENT:	TRAVIS WOOD	**DATE REPORTED:**	11-Mar-2022
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-025DUP / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SEDW4 0.8-1.0

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	86%
2.36	59%
1.18	39%
0.600	26%
0.425	24%
0.300	23%
0.150	20%
0.075	17%
Particle Size (microns)	
55	16%
39	15%
29	13%
20	12%
15	12%
10	12%
7	12%
5	12%
2	7%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	1.829

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.68

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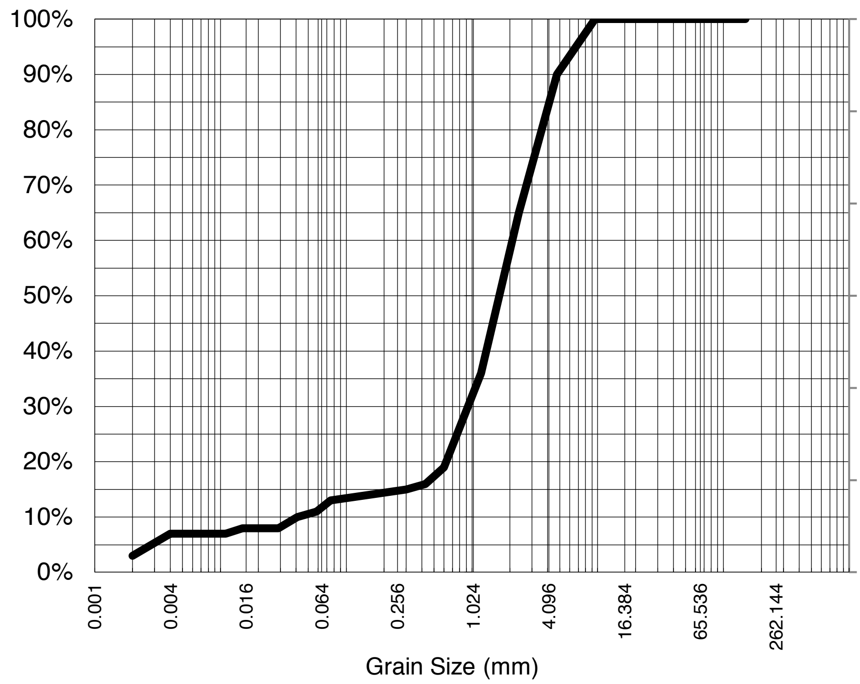
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-038 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SED_W5 0.0-0.2

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	90%
2.36	65%
1.18	36%
0.600	19%
0.425	16%
0.300	15%
0.150	14%
0.075	13%
Particle Size (microns)	
58	11%
41	10%
29	8%
21	8%
15	8%
11	7%
8	7%
5	7%
2	3%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	1.750

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.64

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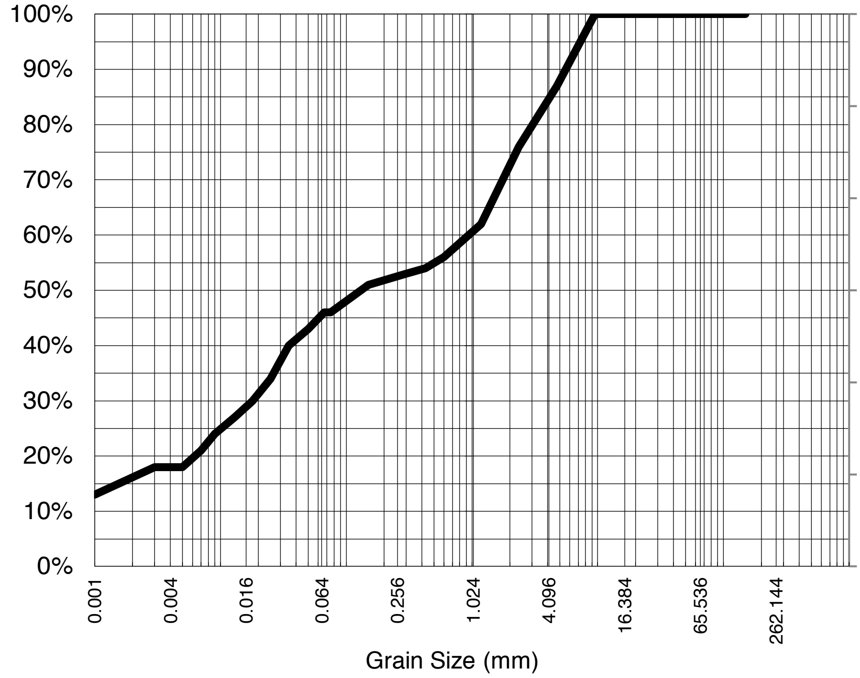
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-039 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SED_W5 0.4-0.6

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	87%
2.36	76%
1.18	62%
0.600	56%
0.425	54%
0.300	53%
0.150	51%
0.075	46%
Particle Size (microns)	
50	43%
35	40%
25	34%
18	30%
13	27%
9	24%
7	21%
5	18%
1	13%

Median Particle Size (mm)*	0.135

Analysis Notes

Samples analysed as received.
** Soil Particle Density results fell outside the scope of AS 1289.3.6.3. Typical sediment SPD values used for calculations and consequently, NATA endorsement does not apply to hydrometer results*

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.86 (2.85)*

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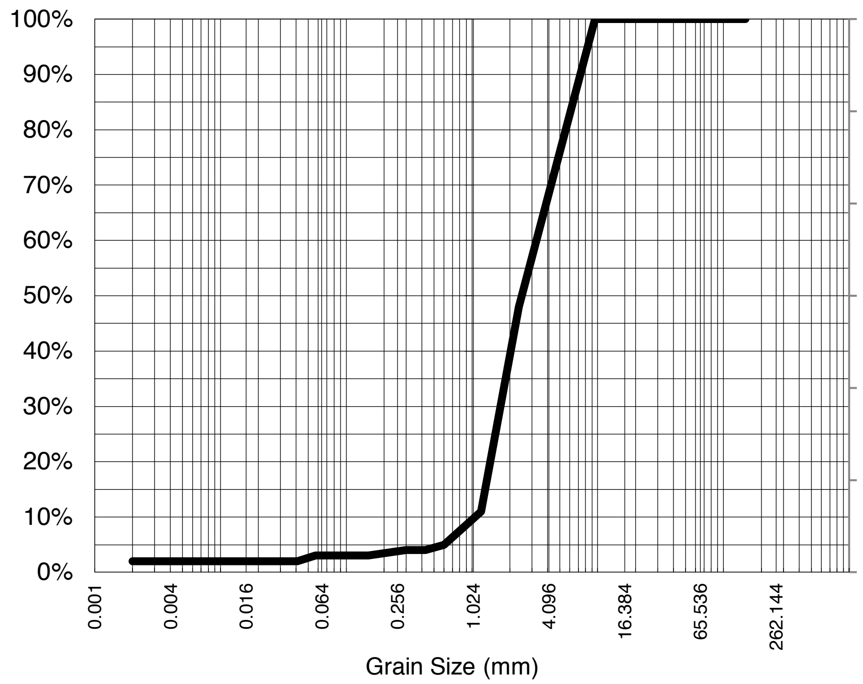
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-040 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SED_W1 0.1-0.25

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	74%
2.36	48%
1.18	11%
0.600	5%
0.425	4%
0.300	4%
0.150	3%
0.075	3%
Particle Size (microns)	
57	3%
41	2%
29	2%
20	2%
15	2%
10	2%
7	2%
5	2%
2	2%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	2.544

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments: AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.67

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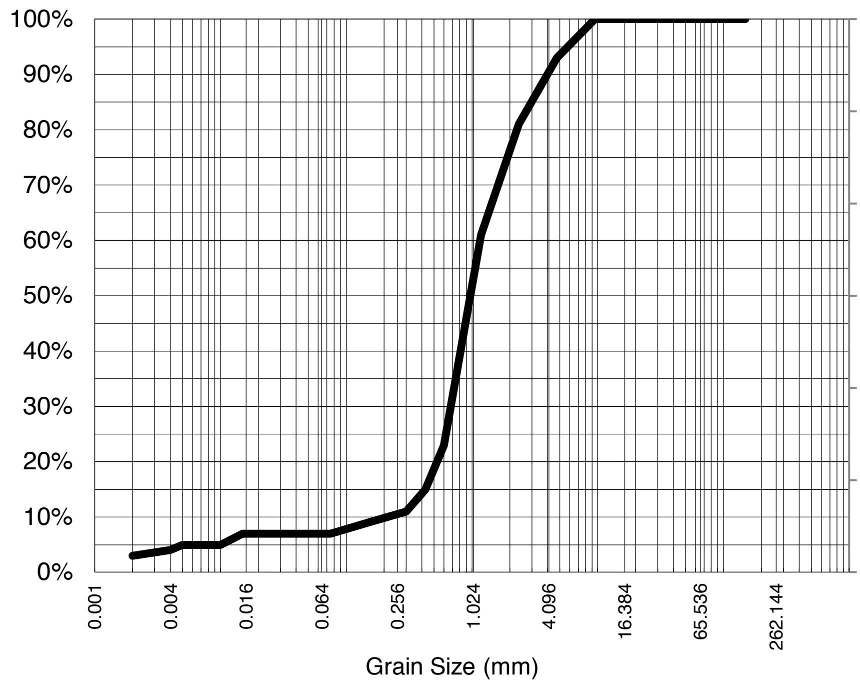
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-041 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SED_W1 0.4-0.6

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	93%
2.36	81%
1.18	61%
0.600	23%
0.425	15%
0.300	11%
0.150	9%
0.075	7%
Particle Size (microns)	
57	7%
41	7%
29	7%
20	7%
15	7%
10	5%
7	5%
5	5%
2	3%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	1.012

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments: AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.67

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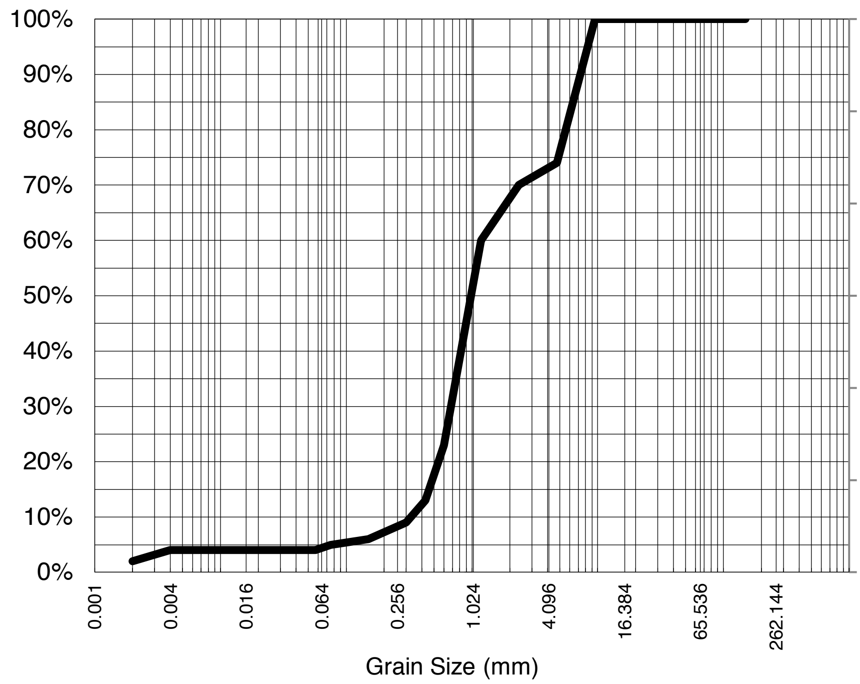
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-042 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SED_W1 0.65-0.72

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	74%
2.36	70%
1.18	60%
0.600	23%
0.425	13%
0.300	9%
0.150	6%
0.075	5%
Particle Size (microns)	
57	4%
41	4%
29	4%
20	4%
15	4%
10	4%
7	4%
5	4%
2	2%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	1.023

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments: AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.65

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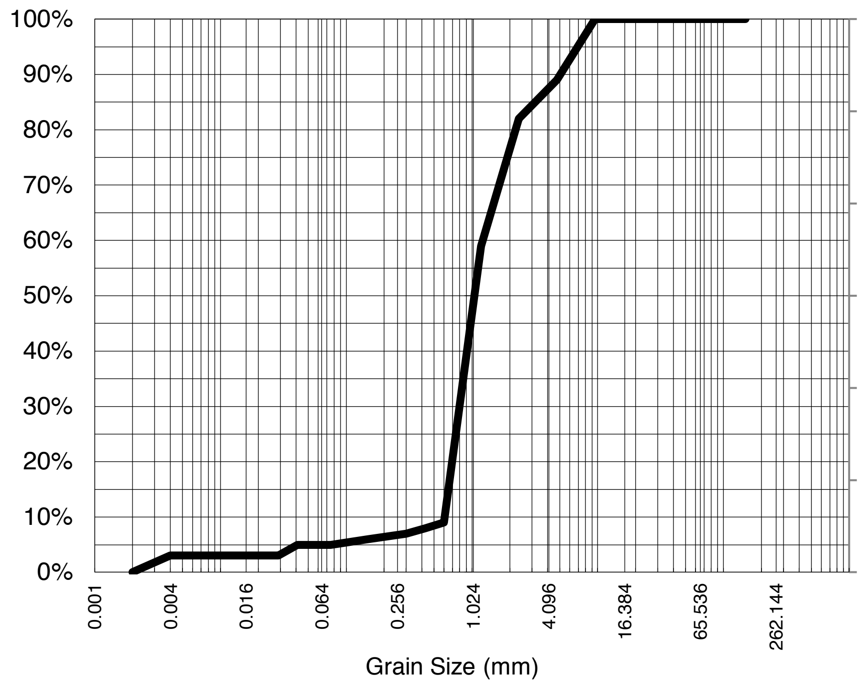
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-043 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SED_E1 0.0-0.1

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	89%
2.36	82%
1.18	59%
0.600	9%
0.425	8%
0.300	7%
0.150	6%
0.075	5%
Particle Size (microns)	
57	5%
41	5%
29	3%
20	3%
15	3%
10	3%
7	3%
5	3%
2	0%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	1.076

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments: AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.66

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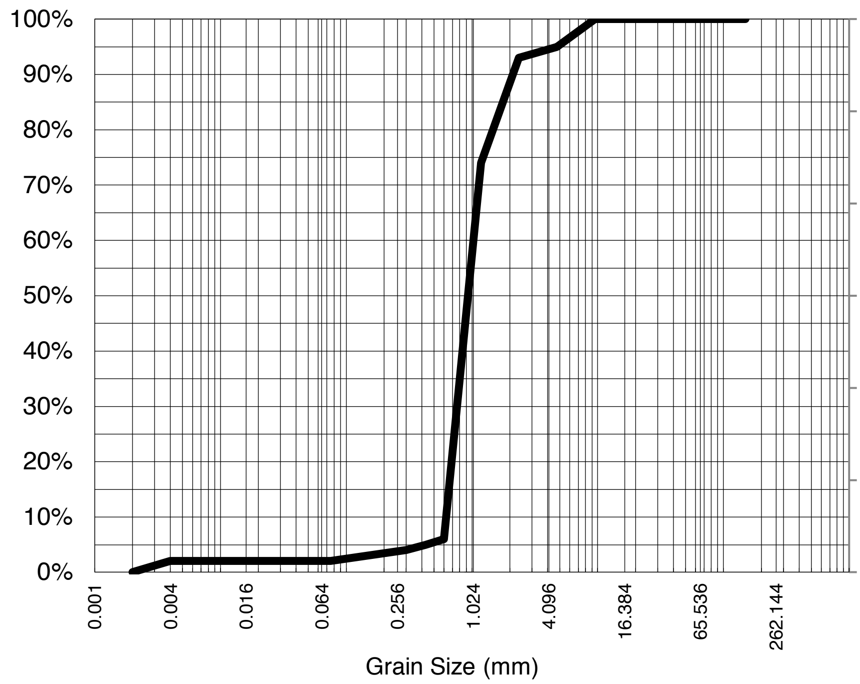
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-044 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SED_E1A 0.0-0.1

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	95%
2.36	93%
1.18	74%
0.600	6%
0.425	5%
0.300	4%
0.150	3%
0.075	2%
Particle Size (microns)	
57	2%
41	2%
29	2%
20	2%
15	2%
10	2%
7	2%
5	2%
2	0%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	0.975

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments: AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.68

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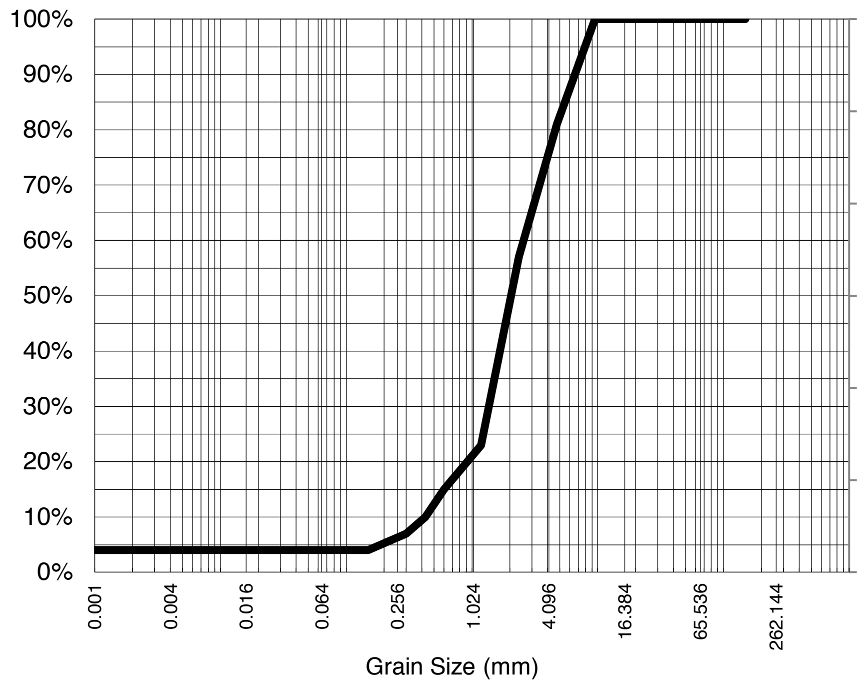
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-045 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SED_E2 0.0-0.25

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	81%
2.36	57%
1.18	23%
0.600	15%
0.425	10%
0.300	7%
0.150	4%
0.075	4%
Particle Size (microns)	
56	4%
40	4%
28	4%
20	4%
15	4%
10	4%
7	4%
5	4%
1	4%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	2.117

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments: AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.7

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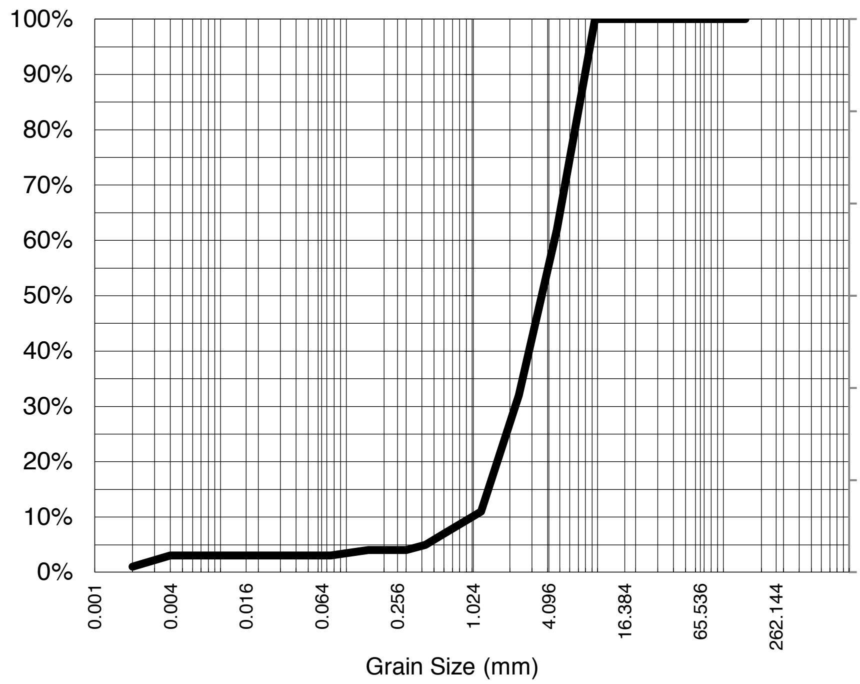
CLIENT:	TRAVIS WOOD	**DATE REPORTED:**	11-Mar-2022
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-046 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SED_E2A 0.0-0.25

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	62%
2.36	32%
1.18	11%
0.600	7%
0.425	5%
0.300	4%
0.150	4%
0.075	3%
Particle Size (microns)	
57	3%
41	3%
29	3%
20	3%
15	3%
10	3%
7	3%
5	3%
2	1%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	3.794

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments: AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.67

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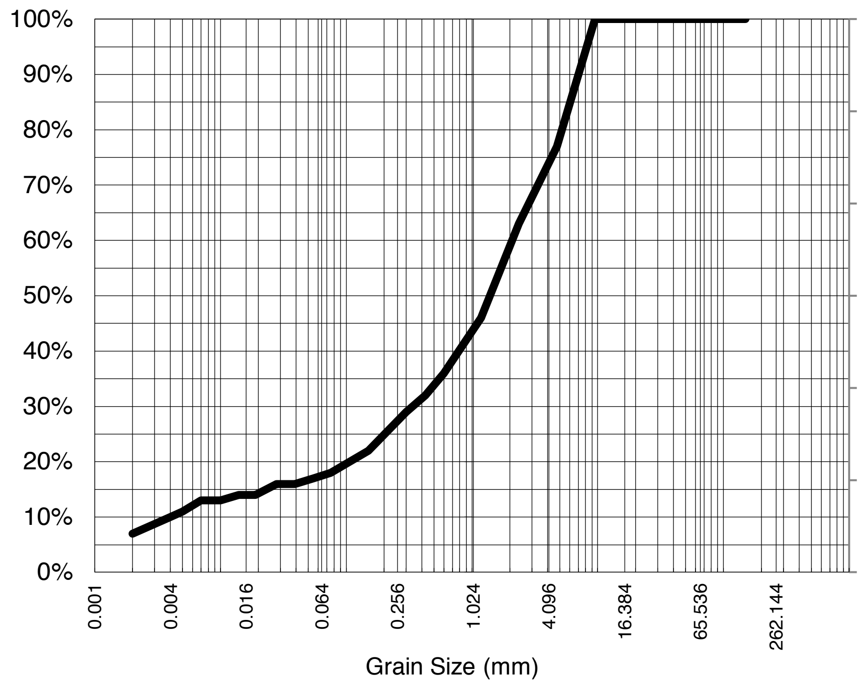
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-047 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SED_E3 0.0-0.20

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	77%
2.36	63%
1.18	46%
0.600	36%
0.425	32%
0.300	29%
0.150	22%
0.075	18%
Particle Size (microns)	
55	17%
39	16%
28	16%
19	14%
14	14%
10	13%
7	13%
5	11%
2	7%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	1.458

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.61 (2.65)*

NATA WORLD RECOGNISED ACCREDITATION

Satish Trivedi
Soil Senior Chemist
Authorised Signatory

Certificate of Analysis

ALS Laboratory Group Pty Ltd
2 Byth Street
Stafford, QLD 4053
pH 07 3243 7222
samples.brisbane@alsenviro.com

ALS Environmental

Brisbane QLD

CLIENT: TRAVIS WOOD

DATE REPORTED: 11-Mar-2022

COMPANY: TETRA TECH COFFEY PTY LTD

DATE RECEIVED: 17-Feb-2022

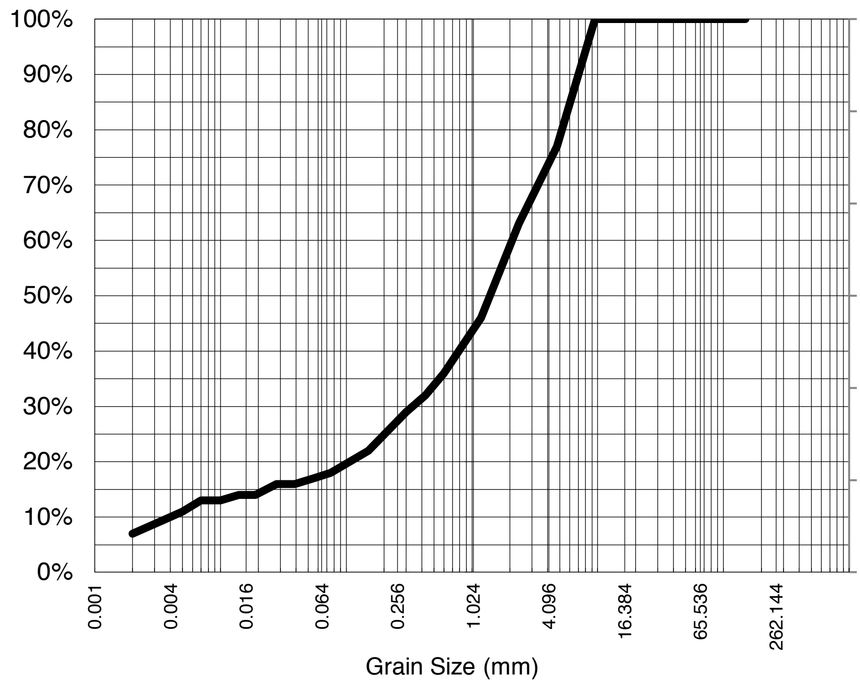
ADDRESS: 2-4 Westall Road
Springvale
Vic

REPORT NO: EB2204434-047DUP / PSD

PROJECT: Marinus Link Project

SAMPLE ID: SED_E3 0.0-0.20

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	77%
2.36	63%
1.18	46%
0.600	36%
0.425	32%
0.300	29%
0.150	22%
0.075	18%
Particle Size (microns)	
55	17%
39	16%
28	16%
19	14%
14	14%
10	13%
7	13%
5	11%
2	7%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	1.458

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.61 (2.65)*

NATA Accreditation: 825 Site: Brisbane
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NATA
WORLD RECOGNISED ACCREDITATION

Satish Trivedi
Soil Senior Chemist
Authorised Signatory

Certificate of Analysis

ALS Laboratory Group Pty Ltd
2 Byth Street
Stafford, QLD 4053
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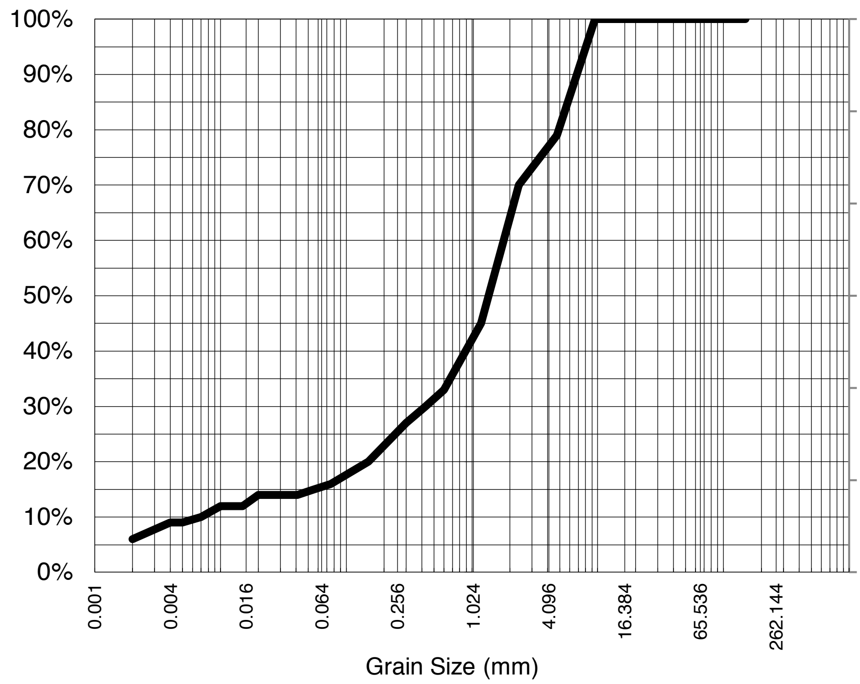
samples.brisbane@alsenviro.com

ALS Environmental

Brisbane QLD

CLIENT:	TRAVIS WOOD	**DATE REPORTED:**	11-Mar-2022
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-048 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SED_E3A0.0-0.20

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	79%
2.36	70%
1.18	45%
0.600	33%
0.425	30%
0.300	27%
0.150	20%
0.075	16%
Particle Size (microns)	
55	15%
41	14%
29	14%
20	14%
15	12%
10	12%
7	10%
5	9%
2	6%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	1.416

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments:

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.68 (2.65)*

NATA
WORLD RECOGNISED ACCREDITATION

Satish Trivedi
Soil Senior Chemist
Authorised Signatory

Certificate of Analysis

ALS Laboratory Group Pty Ltd
2 Byth Street
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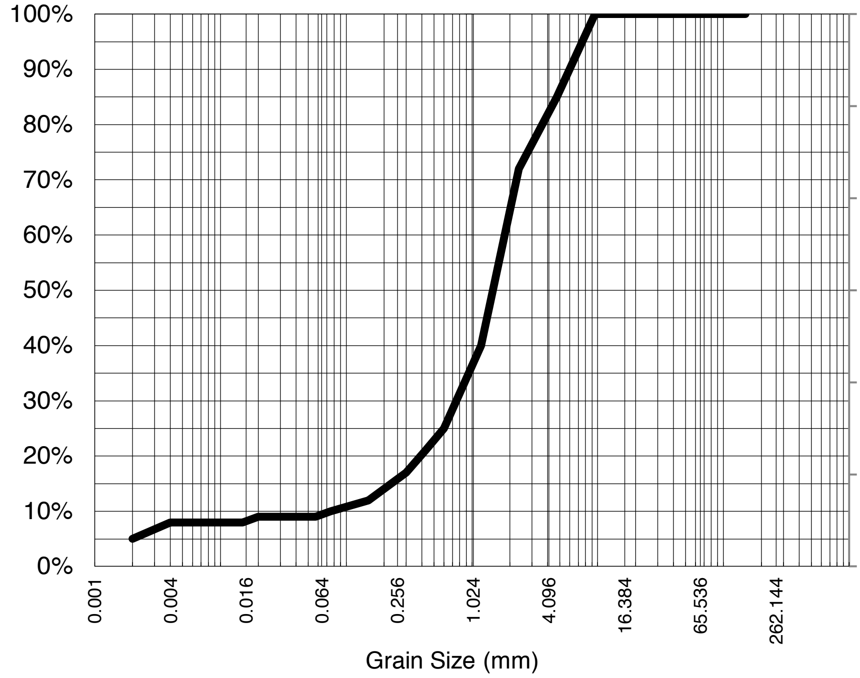
ALS Environmental

Brisbane QLD

CLIENT:	TRAVIS WOOD	**DATE REPORTED:**	11-Mar-2022
COMPANY:	TETRA TECH COFFEY PTY LTD	**DATE RECEIVED:**	17-Feb-2022
ADDRESS:	2-4 Westall Road Springvale Vic	**REPORT NO:**	EB2204434-049 / PSD
PROJECT:	Marinus Link Project	**SAMPLE ID:**	SED_E3A0.20-0.32

Particle Size Distribution



Particle Size (mm)	% Passing
9.50	100%
4.75	85%
2.36	72%
1.18	40%
0.600	25%
0.425	21%
0.300	17%
0.150	12%
0.075	10%
Particle Size (microns)	
57	9%
41	9%
29	9%
20	9%
15	8%
10	8%
7	8%
5	8%
2	5%

Analysis Notes

Samples analysed as received.

Median Particle Size (mm)*	1.549

Median Particle Size is not covered under the current scope of ALS's NATA accreditation.

Sample Comments: AS1289.3.6.3 states that hydrometer analysis is not applicable for samples containing <10% fines (<75um). Results should be assessed accordingly

Analysed: 26-Feb-22

Loss on Pretreatment NA

Limit of Reporting: 1%

Sample Description:

Dispersion Method Shaker

Test Method: AS1289.3.6.2/AS1289.3.6.3

Soil Particle Density (<2.36mm) 2.71 (2.65)*

NATA Accreditation: 825 Site: Brisbane
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WORLD RECOGNISED ACCREDITATION

Satish Trivedi
Soil Senior Chemist
Authorised Signatory

CERTIFICATE OF ANALYSIS

Work Order	: **EB2207272**	Page	: 1 of 6
Client	: **TETRA TECH COFFEY PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR TRAVIS WOOD	Contact	: Khaleda Ataei
Address	: LEVEL 1 436 JOHNSTON STREET ABBOTSFORD VIC, AUSTRALIA 3067	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 03 9290 7000	Telephone	: + 61 2 8784 8555
Project	: Marinus Link Project	Date Samples Received	: 16-Mar-2022 16:00
Order number	: ----	Date Analysis Commenced	: 23-Mar-2022
C-O-C number	: ----	Issue Date	: 04-Apr-2022 16:36
Sampler	: ----		
Site	: ----		
Quote number	: BN/476/21		
No. of samples received	: 9		
No. of samples analysed	: 8		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- ASS: EA033 (CRS Suite):Retained Acidity not required because pH KCl greater than or equal to 4.5
- EG005T (Total Metals by ICP-AES): Limit of reporting raised for some samples due to matrix interference.
- ASS: EA033 (CRS Suite): Laboratory determinations of ANC needs to be corroborated by effectiveness of the measured ANC in relation to incubation ANC. Unless corroborated, the results of ANC testing should be discounted when determining Net Acidity for comparison with action criteria, or for the determination of the acidity hazard and required liming amounts.
- ASS: EA033 (CRS Suite): Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime ($CaCO_3$) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil', multiply 'reported results' x 'wet bulk density of soil in t/m3'.

Analytical Results

Sub-Matrix: SOIL
(Matrix: SOIL)

Compound	CAS Number	LOR	Unit	SED-ESA 0-20	SED-ESA 40-60	SED-ESA 80-100	SED-ESA 0-20 < 2000µm Sieve	SED-ESA 40-60 < 2000µm Sieve
Sampling date / time				28-Feb-2022 02:54	28-Feb-2022 02:54	28-Feb-2022 02:54	28-Feb-2022 02:54	28-Feb-2022 02:54
				EB2207272-001	EB2207272-002	EB2207272-003	EB2207272-006	EB2207272-007
				Result	Result	Result	Result	Result
EA033-A: Actual Acidity								
pH KCl (23A)	----	0.1	pH Unit	9.6	9.5	9.2	----	----
Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	<2	----	----
sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	<0.02	----	----
EA033-B: Potential Acidity								
Chromium Reducible Sulfur (22B)	----	0.005	% S	0.075	0.085	0.081	----	----
acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	47	53	51	----	----
EA033-C: Acid Neutralising Capacity								
Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	20.1	12.2	3.49	----	----
acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	4010	2430	698	----	----
sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	6.43	3.89	1.12	----	----
EA033-E: Acid Base Accounting								
ANC Fineness Factor	----	0.5	-	1.5	1.5	1.5	----	----
Net Acidity (sulfur units)	----	0.02	% S	<0.02	<0.02	<0.02	----	----
Net Acidity (acidity units)	----	10	mole H+ / t	<10	<10	<10	----	----
Liming Rate	----	1	kg CaCO3/t	<1	<1	<1	----	----
Net Acidity excluding ANC (sulfur units)	----	0.02	% S	0.08	0.08	0.08	----	----
Net Acidity excluding ANC (acidity units)	----	10	mole H+ / t	47	53	51	----	----
Liming Rate excluding ANC	----	1	kg CaCO3/t	4	4	4	----	----
EA150: Particle Sizing								
+75µm	----	1	%	87	82	79	----	----
+150µm	----	1	%	85	80	76	----	----
+300µm	----	1	%	83	78	73	----	----
+425µm	----	1	%	81	77	71	----	----
+600µm	----	1	%	79	74	69	----	----
+1180µm	----	1	%	66	63	64	----	----
+2.36mm	----	1	%	32	31	53	----	----
+4.75mm	----	1	%	8	9	38	----	----
+9.5mm	----	1	%	<1	3	26	----	----
+19.0mm	----	1	%	<1	<1	<1	----	----
+37.5mm	----	1	%	<1	<1	<1	----	----
+75.0mm	----	1	%	<1	<1	<1	----	----

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SED-ESA 0-20	SED-ESA 40-60	SED-ESA 80-100	SED-ESA 0-20 < 2000µm Sieve	SED-ESA 40-60 < 2000µm Sieve
			Sampling date / time	28-Feb-2022 02:54	28-Feb-2022 02:54	28-Feb-2022 02:54	28-Feb-2022 02:54	28-Feb-2022 02:54
Compound	CAS Number	LOR	Unit	EB2207272-001	EB2207272-002	EB2207272-003	EB2207272-006	EB2207272-007
				Result	Result	Result	Result	Result
EA150: Soil Classification based on Particle Size								
Clay (<2 µm)	----	1	%	**3**	**7**	**8**	----	----
Silt (2-60 µm)	----	1	%	**8**	**10**	**12**	----	----
Sand (0.06-2.00 mm)	----	1	%	**46**	**42**	**24**	----	----
Gravel (>2mm)	----	1	%	**43**	**41**	**56**	----	----
Cobbles (>6cm)	----	1	%	<1	<1	<1	----	----
EA152: Soil Particle Density								
Soil Particle Density (Clay/Silt/Sand)	----	0.01	g/cm3	**2.56**	**2.70**	**2.67**	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	----	----	----	**4760**	**9860**
Antimony	7440-36-0	5	mg/kg	----	----	----	<5	<5
Arsenic	7440-38-2	5	mg/kg	----	----	----	**43**	**103**
Cadmium	7440-43-9	1	mg/kg	----	----	----	<1	**1**
Chromium	7440-47-3	2	mg/kg	----	----	----	**35**	**63**
Copper	7440-50-8	5	mg/kg	----	----	----	<5	**8**
Iron	7439-89-6	50	mg/kg	----	----	----	**23500**	**45500**
Lead	7439-92-1	5	mg/kg	----	----	----	<5	<5
Nickel	7440-02-0	2	mg/kg	----	----	----	**27**	**52**
Silver	7440-22-4	2	mg/kg	----	----	----	<2	**2**
Vanadium	7440-62-2	5	mg/kg	----	----	----	**68**	**168**
Zinc	7440-66-6	5	mg/kg	----	----	----	**21**	**27**
Titanium	7440-32-6	10	mg/kg	----	----	----	**320**	**760**
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	----	----	----	<0.1	<0.1
GEO26: Sieving								
-2000µm	----	0.01	%	----	----	----	**57.2**	**19.4**

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Sample ID	SED-ESA 80-100 < 2000µm Sieve	SED-ESA 0-100 < 63µm Sieve	----	----	----
			Sampling date / time	28-Feb-2022 02:54	28-Feb-2022 04:03	----	----	----
Compound	CAS Number	LOR	Unit	EB2207272-008	EB2207272-009	--------	--------	--------
				Result	Result	----	----	----
EG005(ED093)T: Total Metals by ICP-AES								
Aluminium	7429-90-5	50	mg/kg	**14700**	**5750**	----	----	----
Antimony	7440-36-0	5	mg/kg	<5	<5	----	----	----
Arsenic	7440-38-2	5	mg/kg	**108**	**39**	----	----	----
Cadmium	7440-43-9	1	mg/kg	**1**	<1	----	----	----
Chromium	7440-47-3	2	mg/kg	**95**	**30**	----	----	----
Copper	7440-50-8	5	mg/kg	**23**	**7**	----	----	----
Iron	7439-89-6	50	mg/kg	**50600**	**22100**	----	----	----
Lead	7439-92-1	5	mg/kg	<5	<5	----	----	----
Nickel	7440-02-0	2	mg/kg	**109**	**19**	----	----	----
Silver	7440-22-4	2	mg/kg	<2	<3	----	----	----
Vanadium	7440-62-2	5	mg/kg	**219**	**46**	----	----	----
Zinc	7440-66-6	5	mg/kg	**26**	**22**	----	----	----
Titanium	7440-32-6	10	mg/kg	**470**	**300**	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	----	----	----
GEO26: Sieving								
-2000µm	----	0.01	%	**18.1**	----	----	----	----
-63µm	----	0.01	%	----	**7.98**	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Sample ID	**RINSATE**	----	----	----	----
			Sampling date / time	28-Feb-2022 02:40	----	----	----	----
Compound	CAS Number	LOR	Unit	**EB2207272-005**	--------	--------	--------	--------
				Result	----	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.41**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	**0.003**	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.003**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	**0.003**	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.011**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	**0.002**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.007**	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----
Titanium	7440-32-6	0.01	mg/L	**0.02**	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.019**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.96**	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EB2207272**	Page	: 1 of 7
Client	: **TETRA TECH COFFEY PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR TRAVIS WOOD	Contact	: Khaleda Ataei
Address	: LEVEL 1 436 JOHNSTON STREET ABBOTSFORD VIC, AUSTRALIA 3067	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 03 9290 7000	Telephone	: + 61 2 8784 8555
Project	: Marinus Link Project	Date Samples Received	: 16-Mar-2022
Order number	: ----	Date Analysis Commenced	: 23-Mar-2022
C-O-C number	: ----	Issue Date	: 04-Apr-2022
Sampler	: ----		
Site	: ----		
Quote number	: BN/476/21		
No. of samples received	: 9		
No. of samples analysed	: 8		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted, unless the sampling was conducted by ALS. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ben Felgendrejeris	Senior Acid Sulfate Soil Chemist	Brisbane Acid Sulphate Soils, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **SOIL**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Acceptable RPD (%)*
EG005(ED093)T: Total Metals by ICP-AES (QC Lot: 4253360)									
EB2206088-003	Anonymous	EG005T: Cadmium	7440-43-9	1	mg/kg	<1	<1	0.0	No Limit
		EG005T: Titanium	7440-32-6	10	mg/kg	40	40	0.0	No Limit
		EG005T: Chromium	7440-47-3	2	mg/kg	4	4	0.0	No Limit
		EG005T: Nickel	7440-02-0	2	mg/kg	10	10	0.0	No Limit
		EG005T: Silver	7440-22-4	2	mg/kg	<2	<2	0.0	No Limit
		EG005T: Antimony	7440-36-0	5	mg/kg	<5	<5	0.0	No Limit
		EG005T: Arsenic	7440-38-2	5	mg/kg	15	16	0.0	No Limit
		EG005T: Copper	7440-50-8	5	mg/kg	30	32	5.4	No Limit
		EG005T: Lead	7439-92-1	5	mg/kg	21	23	6.8	No Limit
		EG005T: Vanadium	7440-62-2	5	mg/kg	6	6	0.0	No Limit
		EG005T: Zinc	7440-66-6	5	mg/kg	51	52	3.5	0% - 50%
		EG005T: Aluminium	7429-90-5	50	mg/kg	3780	4120	8.6	0% - 20%
		EG005T: Iron	7439-89-6	50	mg/kg	31300	33500	6.8	0% - 20%
EA033-A: Actual Acidity (QC Lot: 4263125)									
EB2207272-001	SED-ESA 0-20	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	<2	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	9.6	9.6	0.0	0% - 20%
EB2208090-019	Anonymous	EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	<0.02	0.0	No Limit
		EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	4	5	0.0	No Limit
		EA033: pH KCl (23A)	----	0.1	pH Unit	5.2	5.2	0.0	0% - 20%
EA033-B: Potential Acidity (QC Lot: 4263125)									
EB2207272-001	SED-ESA 0-20	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.075	0.073	3.2	0% - 50%
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	47	46	3.2	No Limit

Sub-Matrix: **SOIL**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
				Laboratory Duplicate (DUP) Report					
EA033-B: Potential Acidity (QC Lot: 4263125) - continued									
EB2208090-019	Anonymous	EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	0.030	0.027	10.8	No Limit
		EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	19	17	10.8	No Limit
EA033-C: Acid Neutralising Capacity (QC Lot: 4263125)									
EB2207272-001	SED-ESA 0-20	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	20.1	20.0	0.2	0% - 20%
		EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	6.43	6.42	0.2	0% - 20%
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	4010	4000	0.2	0% - 20%
EB2208090-019	Anonymous	EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	0.05	0.03	34.5	No Limit
		EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	0.01	0.01	0.0	No Limit
		EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	<10	<10	0.0	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 4253362)									
EB2207272-006	SED-ESA 0-20 < 2000µm Sieve	EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	<0.1	0.0	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
				Laboratory Duplicate (DUP) Report					
EG020T: Total Metals by ICP-MS (QC Lot: 4254193)									
EB2207878-003	Anonymous	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020B-T: Titanium	7440-32-6	0.01	mg/L	0.02	0.04	39.7	No Limit
EB2207878-012	Anonymous	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.0	No Limit
		EG020B-T: Titanium	7440-32-6	0.01	mg/L	0.06	0.09	42.7	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 4254194)									
EB2207878-003	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0006	0.0006	0.0	No Limit
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.005	<0.005	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.005	<0.005	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.003	0.003	0.0	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.334	0.341	2.2	0% - 20%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.003	0.003	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.024	0.025	0.0	0% - 20%
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.148	0.152	2.4	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.96	1.07	11.0	0% - 20%
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	2.37	2.56	7.8	0% - 20%
EB2207878-012	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	0.0002	0.0002	0.0	No Limit
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.005	<0.005	0.0	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.005	<0.005	0.0	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.015	0.014	0.0	0% - 50%

Sub-Matrix: **WATER**

Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Acceptable RPD (%)
EG020T: Total Metals by ICP-MS (QC Lot: 4254194) - continued									
EB2207878-012	Anonymous	EG020A-T: Copper	7440-50-8	0.001	mg/L	0.483	0.472	2.3	0% - 20%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.004	0.004	0.0	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.022	0.022	0.0	0% - 20%
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.159	0.156	1.6	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	1.83	1.73	5.9	0% - 20%
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.0	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	9.10	8.97	1.5	0% - 20%
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 4248870)									
EB2207251-025	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.0	No Limit

Method Blank (MB) and Laboratory Control Sample (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **SOIL**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 4253360)								
EG005T: Aluminium	7429-90-5	50	mg/kg	<50	12940 mg/kg	103	70.0	130
EG005T: Antimony	7440-36-0	5	mg/kg	<5	----	----	----	----
EG005T: Arsenic	7440-38-2	5	mg/kg	<5	83.4 mg/kg	120	84.0	123
EG005T: Cadmium	7440-43-9	1	mg/kg	<1	----	----	----	----
EG005T: Chromium	7440-47-3	2	mg/kg	<2	14.1 mg/kg	122	83.0	125
EG005T: Copper	7440-50-8	5	mg/kg	<5	50 mg/kg	101	86.0	122
EG005T: Iron	7439-89-6	50	mg/kg	<50	29422 mg/kg	106	70.0	120
EG005T: Lead	7439-92-1	5	mg/kg	<5	55.4 mg/kg	98.3	84.0	119
EG005T: Nickel	7440-02-0	2	mg/kg	<2	11.8 mg/kg	116	81.5	118
EG005T: Silver	7440-22-4	2	mg/kg	<2	2.72 mg/kg	128	70.0	130
EG005T: Vanadium	7440-62-2	5	mg/kg	<5	39.7 mg/kg	120	88.0	127
EG005T: Zinc	7440-66-6	5	mg/kg	<5	148.7 mg/kg	104	80.0	120
EG005T: Titanium	7440-32-6	10	mg/kg	<10	447 mg/kg	113	70.0	130
EA033-A: Actual Acidity (QCLot: 4263125)								
EA033: pH KCl (23A)	----	----	pH Unit	----	4.4 pH Unit	99.5	91.0	107
EA033: Titratable Actual Acidity (23F)	----	2	mole H+ / t	<2	19 mole H+ / t	80.5	70.0	124
EA033: sulfidic - Titratable Actual Acidity (s-23F)	----	0.02	% pyrite S	<0.02	----	----	----	----
EA033-B: Potential Acidity (QCLot: 4263125)								
EA033: Chromium Reducible Sulfur (22B)	----	0.005	% S	<0.005	0.246 % S	103	77.0	121
EA033: acidity - Chromium Reducible Sulfur (a-22B)	----	10	mole H+ / t	<10	----	----	----	----
EA033-C: Acid Neutralising Capacity (QCLot: 4263125)								
EA033: Acid Neutralising Capacity (19A2)	----	0.01	% CaCO3	<0.01	10 % CaCO3	102	91.0	112
EA033: acidity - Acid Neutralising Capacity (a-19A2)	----	10	mole H+ / t	<10	----	----	----	----
EA033: sulfidic - Acid Neutralising Capacity (s-19A2)	----	0.01	% pyrite S	<0.01	----	----	----	----
EA152: Soil Particle Density (QCLot: 4236090)								
EA152: Soil Particle Density (Clay/Silt/Sand)	----	----	g/cm3	----	2.68 g/cm3	98.1	80.0	120
EG035T: Total Recoverable Mercury by FIMS (QCLot: 4253362)								
EG035T: Mercury	7439-97-6	0.1	mg/kg	<0.1	0.087 mg/kg	124	70.0	125

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 4254193)								
EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	0.1 mg/L	99.3	84.0	117

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Acceptable Limits (%)	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EG020T: Total Metals by ICP-MS (QCLot: 4254193) - continued								
EG020B-T: Titanium	7440-32-6	0.01	mg/L	<0.01	0.1 mg/L	105	88.0	112
EG020T: Total Metals by ICP-MS (QCLot: 4254194)								
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	106	80.0	114
EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	0.1 mg/L	100	87.0	115
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	103	88.0	112
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	100	88.0	111
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	104	89.0	115
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	103	88.0	116
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	100	89.0	112
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	103	88.0	116
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	105	87.0	114
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	97.7	84.0	114
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	102	82.0	118
EG035T: Total Recoverable Mercury by FIMS (QCLot: 4248870)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	96.4	84.0	118

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **SOIL**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EG005(ED093)T: Total Metals by ICP-AES (QCLot: 4253360)							
EB2206088-004	Anonymous	EG005T: Arsenic	7440-38-2	50 mg/kg	93.9	70.0	130
		EG005T: Cadmium	7440-43-9	12.5 mg/kg	85.7	70.0	130
		EG005T: Chromium	7440-47-3	50 mg/kg	88.8	70.0	130
		EG005T: Copper	7440-50-8	50 mg/kg	91.2	70.0	130
		EG005T: Lead	7439-92-1	50 mg/kg	82.2	70.0	130
		EG005T: Nickel	7440-02-0	50 mg/kg	84.8	70.0	130
		EG005T: Vanadium	7440-62-2	50 mg/kg	92.6	70.0	130
		EG005T: Zinc	7440-66-6	50 mg/kg	77.9	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 4253362)							
EB2207272-007	SED-ESA 40-60 < 2000µm Sieve	EG035T: Mercury	7439-97-6	0.5 mg/kg	103	70.0	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	*Sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Acceptable Limits (%)	
Laboratory sample ID	Sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 4254194)							
EB2207878-004	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	97.7	70.0	130
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	91.1	70.0	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	99.0	70.0	130
		EG020A-T: Copper	7440-50-8	1 mg/L	82.2	70.0	130
		EG020A-T: Lead	7439-92-1	1 mg/L	98.4	70.0	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	86.0	70.0	130
		EG020A-T: Vanadium	7440-62-2	1 mg/L	105	70.0	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	76.7	70.0	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 4248870)							
EB2207272-005	RINSATE	EG035T: Mercury	7439-97-6	0.01 mg/L	92.1	70.0	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB2207272**	Page	: 1 of 6
Client	: **TETRA TECH COFFEY PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MR TRAVIS WOOD	Telephone	: + 61 2 8784 8555
Project	: Marinus Link Project	Date Samples Received	: 16-Mar-2022
Site	: ----	Issue Date	: 04-Apr-2022
Sampler	: ----	No. of samples received	: 9
Order number	: ----	No. of samples analysed	: 8

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

Matrix: **SOIL**

Quality Control Sample Type / Method	Count QC	Count Regular	Rate (%) Actual	Rate (%) Expected	Quality Control Specification
Laboratory Duplicates (DUP)					
Soil Particle Density	0	3	0.00	10.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EA033-A: Actual Acidity								
Snap Lock Bag - frozen (EA033) SED-ESA 0-20, SED-ESA 80-100	SED-ESA 40-60,	**28-Feb-2022**	**04-Apr-2022**	28-Feb-2023	✓	**04-Apr-2022**	03-Jul-2022	✓
EA033-B: Potential Acidity								
Snap Lock Bag - frozen (EA033) SED-ESA 0-20, SED-ESA 80-100	SED-ESA 40-60,	**28-Feb-2022**	**04-Apr-2022**	28-Feb-2023	✓	**04-Apr-2022**	03-Jul-2022	✓
EA033-C: Acid Neutralising Capacity								
Snap Lock Bag - frozen (EA033) SED-ESA 0-20, SED-ESA 80-100	SED-ESA 40-60,	**28-Feb-2022**	**04-Apr-2022**	28-Feb-2023	✓	**04-Apr-2022**	03-Jul-2022	✓
EA033-D: Retained Acidity								
Snap Lock Bag - frozen (EA033) SED-ESA 0-20, SED-ESA 80-100	SED-ESA 40-60,	**28-Feb-2022**	**04-Apr-2022**	28-Feb-2023	✓	**04-Apr-2022**	03-Jul-2022	✓
EA033-E: Acid Base Accounting								
Snap Lock Bag - frozen (EA033) SED-ESA 0-20, SED-ESA 80-100	SED-ESA 40-60,	**28-Feb-2022**	**04-Apr-2022**	28-Feb-2023	✓	**04-Apr-2022**	03-Jul-2022	✓
EA150: Particle Sizing								
Snap Lock Bag (EA150H) SED-ESA 0-20, SED-ESA 80-100	SED-ESA 40-60,	**28-Feb-2022**	**----**	----	----	**04-Apr-2022**	27-Aug-2022	✓

Matrix: **SOIL**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EA150: Soil Classification based on Particle Size							
Snap Lock Bag (EA150H) SED-ESA 0-20, SED-ESA 40-60, SED-ESA 80-100	**28-Feb-2022**	**----**	----	----	**04-Apr-2022**	27-Aug-2022	✓
EA152: Soil Particle Density							
Snap Lock Bag (EA152) SED-ESA 0-20, SED-ESA 40-60, SED-ESA 80-100	**28-Feb-2022**	**----**	----	----	**04-Apr-2022**	27-Aug-2022	✓
EG005(ED093)T: Total Metals by ICP-AES							
Pulp Bag (-2000µm) (EG005T) SED-ESA 0-20 - < 2000µm Sieve, SED-ESA 40-60 - < 2000µm Sieve, SED-ESA 80-100 - < 2000µm Sieve	**23-Mar-2022**	**29-Mar-2022**	19-Sep-2022	✓	**30-Mar-2022**	19-Sep-2022	✓
Pulp Bag (-63µm) (EG005T) SED-ESA 0-100 - < 63µm Sieve	**23-Mar-2022**	**29-Mar-2022**	19-Sep-2022	✓	**30-Mar-2022**	19-Sep-2022	✓
EG035T: Total Recoverable Mercury by FIMS							
Pulp Bag (-2000µm) (EG035T) SED-ESA 0-20 - < 2000µm Sieve, SED-ESA 40-60 - < 2000µm Sieve, SED-ESA 80-100 - < 2000µm Sieve	**23-Mar-2022**	**29-Mar-2022**	20-Apr-2022	✓	**31-Mar-2022**	20-Apr-2022	✓
Pulp Bag (-63µm) (EG035T) SED-ESA 0-100 - < 63µm Sieve	**23-Mar-2022**	**29-Mar-2022**	20-Apr-2022	✓	**31-Mar-2022**	20-Apr-2022	✓
GEO26: Sieving							
Snap Lock Bag - frozen (GEO26C) SED-ESA 0-100 - < 63µm Sieve	**28-Feb-2022**	**23-Mar-2022**	27-Aug-2022	✓	**----**	----	----
Soil Glass Jar - Unpreserved (GEO26) SED-ESA 0-20 - < 2000µm Sieve, SED-ESA 40-60 - < 2000µm Sieve, SED-ESA 80-100 - < 2000µm Sieve	**28-Feb-2022**	**23-Mar-2022**	27-Aug-2022	✓	**----**	----	----

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Natural (EG020B-T) RINSATE	**28-Feb-2022**	**31-Mar-2022**	27-Aug-2022	✓	**31-Mar-2022**	27-Aug-2022	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Natural (EG035T) RINSATE	**28-Feb-2022**	**----**	----	----	**25-Mar-2022**	28-Mar-2022	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **SOIL**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type / Analytical Methods	Method	Count QC	Count Regular	Rate (%) Actual	Rate (%) Expected	Evaluation	Quality Control Specification
Laboratory Duplicates (DUP)							
Chromium Suite for Acid Sulphate Soils	EA033	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Soil Particle Density	EA152	0	3	**0.00**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Chromium Suite for Acid Sulphate Soils	EA033	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Soil Particle Density	EA152	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Chromium Suite for Acid Sulphate Soils	EA033	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Total Mercury by FIMS	EG035T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-AES	EG005T	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type / Analytical Methods	Method	Count QC	Count Regular	Rate (%) Actual	Rate (%) Expected	Evaluation	Quality Control Specification
Laboratory Duplicates (DUP)							
Total Mercury by FIMS	EG035T	1	10	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	2	4	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Total Mercury by FIMS	EG035T	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Total Mercury by FIMS	EG035T	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Total Mercury by FIMS	EG035T	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Chromium Suite for Acid Sulphate Soils	EA033	SOIL	In house: Referenced to Ahern et al 2004. This method covers the determination of Chromium Reducible Sulfur (SCR); pHKCl; titratable actual acidity (TAA); acid neutralising capacity by back titration (ANC); and net acid soluble sulfur (SNAS) which incorporates peroxide sulfur. It applies to soils and sediments (including sands) derived from coastal regions. Liming Rate is based on results for samples as submitted and incorporates a minimum safety factor of 1.5.
Particle Size Analysis by Hydrometer	EA150H	SOIL	Particle Size Analysis by Hydrometer according to AS1289.3.6.3
Soil Particle Density	EA152	SOIL	Soil Particle Density by AS 1289.3.5.1: Methods of testing soils for engineering purposes - Soil classification tests - Determination of the soil particle density of a soil - Standard method
Total Metals by ICP-AES	EG005T	SOIL	In house: Referenced to APHA 3120; USEPA SW 846 - 6010. Metals are determined following an appropriate acid digestion of the soil. The ICPAES technique ionises samples in a plasma, emitting a characteristic spectrum based on metals present. Intensities at selected wavelengths are compared against those of matrix matched standards. This method is compliant with NEPM Schedule B(3)
Total Mercury by FIMS	EG035T	SOIL	In house: Referenced to APHA 3112 Hg - B (Flow-injection (SnCl2) (Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. Mercury in solids are determined following an appropriate acid digestion. Ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM Schedule B(3)
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite B	EG020B-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM Schedule B(3).

Preparation Methods	Method	Matrix	Method Descriptions
Drying at 85 degrees, bagging and labelling (ASS)	EN020PR	SOIL	In house

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
Hot Block Digest for metals in soils sediments and sludges	EN69	SOIL	In house: Referenced to USEPA 200.2. Hot Block Acid Digestion 1.0g of sample is heated with Nitric and Hydrochloric acids, then cooled. Peroxide is added and samples heated and cooled again before being filtered and bulked to volume for analysis. Digest is appropriate for determination of selected metals in sludge, sediments, and soils. This method is compliant with NEPM Schedule B(3).
Sieving (fine to -2mm)	GEO26	SOIL	In house: The dried sample is sieved to 2mm and the fines are then analysed per the client's request.
Sieving (fine to -63µm)	GEO26C	SOIL	In house: The sample is sieved to -63µm and the fines are then analysed per the client's request.
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM Schedule B(3)

Blue 45

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ADELAIDE 21 Burma Road Pooraka SA 5095 Ph: 07 3243 7222 E: samples.brisbane@alsglobal.com
☐GLADSTONE 46 Callemondah Drive Clinton QLD 4680 Ph: 07 7471 5600 E: gladstone@alsglobal.com
☐MACKAY 78 Harbour Road Mackay QLD 4740 ☐MELBOURNE Ph: 03 8549 9600 E: samples.melbourne@alsglobal.com
☐MUDGEE 27 Sydney Road Mudgee NSW 2850 Ph: 02 6372 6735 E: mudgee.mail@alsglobal.com
☐NEWCASTLE 5/585 Maitland Rd Mayfield West NSW 2304 ☐NOWRA Ph: 024423 2063 E: nowra@alsglobal.com
☐PERTH 10 Hod Way Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsglobal.com
☐SYDNEY 277-289 Woodpark Road Smithfield NSW 2164 ☐TOWNSVILLE Ph: 07 4796 0600 E: townsville.environmental@alsglobal.com
☐WOLLONGONG 99 Kenny Street Wollongong NSW 2500 Ph: 02 4225 3125 E: portkembla@alsglobal.com

CLIENT: Tetra Tech Coffey	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	☑ Standard TAT (List due date): ☐ Non Standard or urgent TAT (List due date):	FOR LABORATORY USE ONLY (Circle)
OFFICE:			Custody Seal Intact? Yes No N/A
PROJECT: Marinus Link Project	ALS QUOTE NO.: BN/476/21	COC SEQUENCE NUMBER (Circle)	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER:		COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Travis Wood	CONTACT PH: 03 93922903 COLIN CONVEY	OF: 1 2 3 4 5 6 7	Other comment:

SAMPLER:	SAMPLER MOBILE:	RELINQUISHED BY: RPHPPS	RECEIVED BY: Jock Sharman	RELINQUISHED BY:	RECEIVED BY:
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):				
Email Reports to: travis.wood@tetratech.com Jock.Sharman@tetratech.com		DATE/TIME: 4/3/22 13:05	DATE/TIME: 12:30 7/3/22	DATE/TIME: 15/3	DATE/TIME: 7/3. 15.00
Email Invoice to: travis.wood@tetratech.com Jock.Sharman@tetratech.com					

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE	SAMPLE DETAILS MATRIX: SOLID (S) WATER (W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL CONTAINERS	ASS (chromium suite)	PSD	Porewater analysis (metals)	Total metals (<2000 µm fraction)	Total metals (<63 µm fraction)	Weak acid metals (<2000 µm fraction) (1M HCL digest)	Weak acid metals (<63 µm fraction) (1M HCl digest)	Total metals (water)	Metals analytes: As, Al, Sb, Cd, Cr, Cu, Hg, Ni, Ag, Pb, Zn, Fe, Ti, V
6/ 1	SED-ESA-0-20	02:54 2022-02-28		2x GREEN, 1x ORANGE		✓	✓	✓	✓					
~~2~~				1x WHITE	4	✓	✓	✓	✓					
7/ 2	SED-ESA 40-60	-"-		2x GREEN, 1x ORANGE		✓	✓	✓	✓					
				1x WHITE	4	✓	✓	✓	✓					
8/ 3	SED-ESA 80-100	-"-		2x GREEN, 1x ORANGE		✓	✓	✓	✓					
				1x WHITE	4	✓	✓	✓	✓					
9/ 4	SED-WAA 0-100	4:03 2022-02-28		3 x GREEN	3					✓				
5	RINSATE	02:40 2022-02-28		1 RINSATE	1								✓	
				TOTAL	16									

Environmental Division Brisbane
Work Order Reference
EB2207272
Telephone : + 61-7-3243 7222

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

APPENDIX C: LIMITATIONS

IMPORTANT INFORMATION ABOUT YOUR TETRA TECH COFFEY ENVIRONMENTAL REPORT

Introduction

This report has been prepared by Tetra Tech Coffey for you, as Tetra Tech Coffey's client, in accordance with our agreed purpose, scope, schedule and budget.

The report has been prepared using accepted procedures and practices of the consulting profession at the time it was prepared, and the opinions, recommendations and conclusions set out in the report are made in accordance with generally accepted principles and practices of that profession.

The report is based on information gained from environmental conditions (including assessment of some or all of soil, groundwater, vapour and surface water) and supplemented by reported data of the local area and professional experience. Assessment has been scoped with consideration to industry standards, regulations, guidelines and your specific requirements, including budget and timing. The characterisation of site conditions is an interpretation of information collected during assessment, in accordance with industry practice.

This interpretation is not a complete description of all material on or in the vicinity of the site, due to the inherent variation in spatial and temporal patterns of contaminant presence and impact in the natural environment. Tetra Tech Coffey may have also relied on data and other information provided by you and other qualified individuals in preparing this report. Tetra Tech Coffey has not verified the accuracy or completeness of such data or information except as otherwise stated in the report. For these reasons the report must be regarded as interpretative, in accordance with industry standards and practice, rather than being a definitive record.

Your report has been written for a specific purpose

Your report has been developed for a specific purpose as agreed by us and applies only to the site or area investigated. Unless otherwise stated in the report, this report cannot be applied to an adjacent site or area, nor can it be used when the nature of the specific purpose changes from that which we agreed.

For each purpose, a tailored approach to the assessment of potential soil and groundwater contamination is required. In most cases, a key objective is to identify, and if possible quantify, risks that both recognised and potential contamination pose in the context of the agreed purpose. Such risks may be financial (for example, clean up costs or constraints on site use) and/or physical (for example, potential health risks to users of the site or the general public).

Limitations of the Report

The work was conducted, and the report has been prepared, in response to an agreed purpose and scope, within time and budgetary constraints, and in reliance on certain data and information made available to Tetra Tech Coffey.

The analyses, evaluations, opinions and conclusions presented in this report are based on that purpose and scope, requirements, data or information, and they could change if such requirements or data are inaccurate or incomplete.

This report is valid as of the date of preparation. The condition of the site (including subsurface conditions) and extent or nature of contamination or other environmental hazards can change over time, as a result of either natural processes or human influence. Tetra Tech Coffey should be kept appraised of any such events and should be consulted for further investigations if any changes are noted, particularly during construction activities where excavations often reveal subsurface conditions.

In addition, advancements in professional practice regarding contaminated land and changes in applicable statues and/or guidelines may affect the validity of this report. Consequently, the currency of conclusions and recommendations in this report should be verified if you propose to use this report more than 6 months after its date of issue.

The report does not include the evaluation or assessment of potential geotechnical engineering constraints of the site.

Interpretation of factual data

Environmental site assessments identify actual conditions only at those points where samples are taken and on the date collected. Data derived from indirect field measurements, and sometimes other reports on the site, are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact with respect to the report purpose and recommended actions.

Variations in soil and groundwater conditions may occur between test or sample locations and actual conditions may differ from those inferred to exist. No environmental assessment program, no matter how comprehensive, can reveal all subsurface details and anomalies. Similarly, no professional, no matter how well qualified, can reveal what is hidden by earth, rock or changed through time.

The actual interface between different materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions.

For this reason, parties involved with land acquisition, management and/or redevelopment should retain the services of a suitably qualified and experienced environmental consultant through the development and use of the site to identify variances, conduct additional tests if required, and recommend solutions to unexpected conditions or other unrecognised features encountered on site. Tetra Tech Coffey would be pleased to assist with any investigation or advice in such circumstances.

Recommendations in this report

This report assumes, in accordance with industry practice, that the site conditions recognised through discrete sampling are representative of actual conditions throughout the investigation area. Recommendations are based on the resulting interpretation.

Should further data be obtained that differs from the data on which the report recommendations are based (such as through excavation or other additional assessment), then the recommendations would need to be reviewed and may need to be revised.

Report for benefit of client

Unless otherwise agreed between us, the report has been prepared for your benefit and no other party. Other parties should not rely upon the report or the accuracy or completeness of any recommendation and should make their own enquiries and obtain independent advice in relation to such matters.

Tetra Tech Coffey assumes no responsibility and will not be liable to any other person or organisation for, or in relation to, any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report.

This report should not be applied for any purpose other than that stated in the report.

Interpretation by other professionals

Costly problems can occur when other professionals develop their plans based on misinterpretations of a report. To help avoid misinterpretations, a suitably qualified and experienced environmental consultant should be retained to explain the implications of the report to other professionals referring to the report and then review plans and specifications produced to see how other professionals have incorporated the report findings.

Given Tetra Tech Coffey prepared the report and has familiarity with the site, Tetra Tech Coffey is well placed to provide such assistance. If another party is engaged to interpret the recommendations of the report, there is a risk that the contents of the report may be misinterpreted and Tetra Tech Coffey disowns any responsibility for such misinterpretation.

Data should not be separated from the report

The report as a whole presents the findings of the site assessment and the report should not be copied in part or altered in any way. Logs, figures, laboratory data, drawings, etc. are customarily included in our reports and are developed by scientists or engineers based on their interpretation of field logs, field testing and laboratory evaluation of samples. This information should not under any circumstances be redrawn for inclusion in other documents or separated from the report in any way.

This report should be reproduced in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.

Responsibility

Environmental reporting relies on interpretation of factual information using professional judgement and opinion and has a level of uncertainty attached to it, which is much less exact than other design disciplines. This has often resulted in claims being lodged against consultants, which are unfounded. As noted earlier, the recommendations and findings set out in this report should only be regarded as interpretive and should not be taken as accurate and complete information about all environmental media at all depths and locations across the site.

ATTACHMENT F

Project Marinus

Commercial fisheries data surrounding the proposed Marinus Link

Prepared by

Simon Boag
South East Trawl Fishing Industry Association (SETFIA)

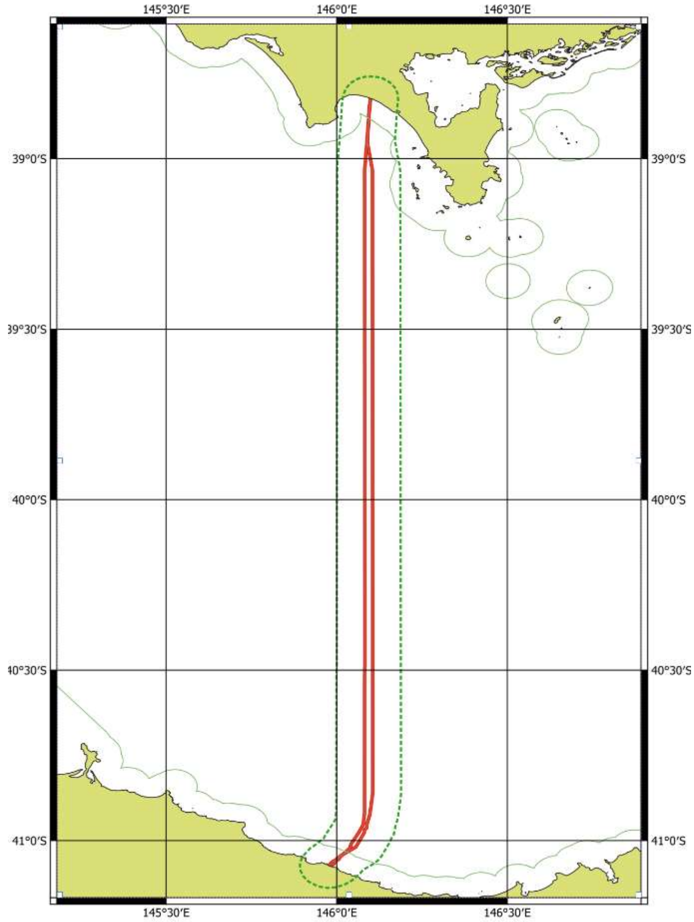
for

Tetra Tech Coffey Pty Ltd

2 May 2022

COMMERCIAL FISHERIES DATA

Surrounding the proposed Marinus Link



CLIENT: **Tetra Tech Coffey**

DATE: **2 May 2022**

CLIENT MANAGER: **Simon Boag (SETFIA)**

VERSION: **3.2**

SETFIA
SOUTH EAST TRAWL FISHING INDUSTRY ASSOCIATION
sustainable fishing practices protect our future

DISCLAIMER

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EXECUTIVE SUMMARY

Background

Marinus Link Pty Ltd (MLPL) is proposing to construct a high-voltage direct current (HVDC) electricity interconnector between Tasmania and Victoria, to be known as Marinus Link. Marinus Link will allow for the continued trading, transmission and distribution of electricity within the National Energy Market (NEM). It will stretch from Tasmania, across the Bass Strait to Victoria, up to and including the convertor station(s) in each of the states. The interconnector will provide a second link between the Tasmanian and Victorian electricity grids enabling energy transfer between these regions in the NEM.

Tetra Tech Coffey, on behalf of MLPL, has commissioned this report to understand the commercial fishing industries, activity and catch value in the study area and fishing industry experience with Basslink to inform the fisheries impact assessment to be completed as part of the Environment Effects Statement.

South East Trawl Fishing Industry Association (SETFIA) was engaged to undertake a project to identify the commercial fishing sectors present in the area of the proposed Marinus Link interconnector, commercial fishing sectors actually fishing there, the stakeholder organisations for these fisheries, and to provide general information about these fisheries. The scope also included noting any seasonal patterns to fishing as well as concerns or learnings from the similar Basslink cable project established more than a decade ago.

SETFIA is an incorporated not-for-profit entity funded through voluntary membership of stakeholders within the Commonwealth Trawl Sector (CTS), formerly called the South-East Trawl Fishery. Members include quota owners, catchers, processors, sellers and other stakeholders. The Commonwealth Trawl Sector is the main source of locally caught fish for the Melbourne and Sydney fish markets. SETFIA members hold and catch around 90% of the quota in the Commonwealth Trawl Sector.

This project was able to obtain fisheries data from the Victorian, Commonwealth and Tasmanian fishery managers for an area around a proposed subsea interconnector to run from the Heybridge area in Tasmania to Waratah Bay in Victoria. The study area for this scope is a 16 km wide polygon centred on Marinus Link. This study area was developed based on length of gillnets, to account for project vessel movements, and to account for vessel drift and levels of accuracy regarding fishing location.

The nature of commercial fishing stakeholders

The fishing industry is a *broad congregation*, divided initially by state or Commonwealth management. Agreements between the Commonwealth and states for how this division occurs are unique, with some states such as NSW divided geographically (i.e., by a line or lines on the water), while other states such as Victoria use both a line on the water and also allocate rights by species (or taxonomic group). This initial management division is then followed by management and rights issued by “fishery”. This complication has seen the development of a network of representative peak bodies without formal structural linkages. In South-East Australia this results in some fisheries being represented by more than one peak body. Peak bodies can also be divided into those where stakeholders pay voluntary levies, choosing to join or not, and those that are funded through compulsory levies or funded by (state) Government. In a rough order of informal hierarchy, the seafood and fishing industries are divided into a hierarchy of four as follows:

1. Seafood Industry Australia (SIA) is the peak body representing seafood production in Australia. It covers a variety of issues including social licence and media, exporting, shared marine space policy and labelling on behalf of the wildcatch and aquaculture industries. This body was initially Government funded but is now funded through voluntary levies.

2. Commonwealth Fisheries Association (CFA) represents Commonwealth licensed fishing in Australia, working on uniquely Commonwealth issues such as management strategies, cost recovery and Commonwealth Acts. The CFA is funded via voluntary levies.

Neither of these two associations are likely to take involvement in regional issues such as the Marinus Link unless they become of national significance (which is unlikely).

3. State fisheries are represented by various State funded bodies; the relevant association in Victoria being Seafood Industry Victoria (SIV) and in Tasmania the Tasmanian Seafood Industry Council (TSIC) and potentially the Tasmanian Rock Lobster Fishermen's Association (TRLFA).

4. A variety of fishery associations (some of which are significantly larger than the associations listed above) operate for both State and Commonwealth fisheries. Associations relevant to Marinus Link include Southern Shark Industry Alliance (SSIA), SETFIA, Victorian Rock Lobster Association (VRLA) and TRLFA. All are funded voluntarily. Victorian Rock Lobster Association has some form of linkage into SIV.

SETFIA, Southern Shark Industry Alliance, Seafood Industry Victoria, Victorian Rock Lobster Association, Tasmanian Seafood Industry Council and Tasmanian Rock Lobster Fishermen's Association will likely all have an interest in Marinus Link.

Whilst there is a potential conflict of interest with SETFIA being both a regional peak body potentially impacted by Marinus Link and the author of this report, SETFIA's executive officer also being a Director of CFA, and SETFIA's sharing of a Director with SIV; the authors of this report do not believe that this impacts the outcomes of the report. The report is grounded in data and is a factual representation of the fishing industry operation within the study area. It addresses the scope agreed to by Tetra Tech Coffey, on behalf of MLPL, with the knowledge and support of the fishing industry groups and without bias. SETFIA has operated successfully in providing relevant fishery data to a number of other (e.g., oil and gas) operators in the South-East.

Fisheries permitted to work and actually working in Bass Strait

There are 30 fisheries that are permitted to work in Bass Strait (nine Victorian, 12 Commonwealth and nine Tasmanian), but only 11 with data indicating that they fished in the vicinity of the Marinus Link within the last 10 years. Four of the 11 are Victorian state managed, four are Commonwealth managed and three are Tasmanian state managed. These *active* fisheries are:

- Victorian: Abalone (Central Zone) Fishery, Ocean General Fishery, Rock Lobster (Eastern Zone) Fishery and Wrasse (Ocean) Fishery,
- Commonwealth: SESSF Commonwealth Trawl sector, SESSF Shark Gillnet and Shark Hook sectors, Southern Squid Jig Fishery and Bass Strait Central Zone Scallop Fishery.
- Tasmanian: Abalone Fishery, Scalefish Fishery and Rock Lobster Fishery.

Combined, these 11 fisheries use 10 or more different fishing methods including: board trawling, Danish seining, cray potting, hand harvest, demersal gillnet, demersal longline, scallop dredging, auto-longline and hand line.

Fisheries agencies have confidentiality policies that restrict making public, data that is comprised of less than five vessels. This is often referred to as the "five-boat rule". Due to these confidentiality rules, data about the size of the catch from the study area was only obtained from four of the 11 active fisheries.

The annual total average catch over the last 10 years of these four fisheries in the study area was 42.5 tonnes. When multiplied by indicative current fish prices this catch has a value of just under $302,000. It is highly likely that some of the fisheries for which data could not be obtained do have some recent history in the study area. However, the fact that the number of vessels was insufficient to overcome the "five-boat" rule indicates that these fisheries are likely low contributors. Given that some fisheries are not quantified in the data, the catch and value is higher than stated in Table 1 and for this reason both figures are marked with a "+".

Most catch in the study area is taken by the Commonwealth managed Shark Gillnet and Shark Hook Sector (SGSHS) which use gillnets and longline to target gummy sharks. This sector takes 79% of the revenue and 36% of the catch weight discovered in the study area. The catch from this sector in the study areas is, on average, $182,400 per year and 15.2 tonnes; however, this only represents 0.7% of the total sector's catch.

Data obtained for the SESSF Commonwealth Trawl Sector showed that on average $37,363 worth of catch is caught from within the study area annually. The Commonwealth Trawl Sector can operate both Danish seine and board trawl fishing methods. However, much of the study area is a fishery closure that does not allow board trawling. Further, Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) effort data shows no board trawling in the study area, and it is therefore likely that the Commonwealth Trawl Sector data in the study area is from Danish seine fishing only.

Conversely, whilst the Tasmanian Scalefish Fishery has just $30,615 per year of catch from within the study area, this represents 4.4% of total catch from that fishery by weight. Therefore, the study area is an important fishing ground for this industry.

Seasonality

Seasonality is limited for most fishing sectors within the study area. Gummy shark fishing peaks each month around moon phase rather than a season within a year. The Tasmanian Scalefish Fishery and the Commonwealth Trawl Sector operate year-round. They are multi-species fisheries that do not have strong seasonality patterns of catch. There are, however, anecdotal reports on the Tasmanian Squid Jig sector, which suggest that this fishery predominately operates between December and January.

Basslink learnings

SETFIA has been in existence for nearly 35 years and under previous management was a key stakeholder involved in the establishment of the Basslink cable (which runs north-south to the east of the proposed Marinus link). Basslink became operational in 2006. A search of historical SETFIA files has returned several mentions in minutes from 2003-2004 relating to the development of a Code of Conduct about commercial fishing. This code is reproduced in Appendix A. This code:

a) offers free electronic chart overlays,

b) prior to installation, vessels using shark gillnets to fish in the area of the Basslink interconnector were offered alternative 'claw' type anchors, to reduce the likelihood of damage to the interconnector in the event of a hook-up and risk to vessel safety,

c) suggests anchoring around the cable should be avoided,

d) sets down that commercial fishers should know where the cable is,

e) states that shark gillnets should be set on the downwind side of the cable but notes that the cable is over-fishable with gillnets,

f) states that trawl and scallop gears should not over-fish the cable (note that trawl is present in the data),

g) states that if a fishing vessel's gear becomes fast (stuck) that they should not attempt to lift the cable but rather the gear should be buoyed and Basslink notified,

h) explains that fishing vessels can claim for lost anchors,

i) the code provides an emergency phone number to call if a fishing vessels experiences a problem. This number was answered in 2019 during a data project undertaken by SETFIA for a proposed windfarm.

SETFIA has not revisited the code in more than 17 years, but it is likely that many of the points above remain valid. The project recommends that during stakeholder engagement, information on the operational experience of the Basslink Code of Conduct should be followed up with the relevant fishing operators, and directly with Basslink as necessary, to inform a decision on the need to implement similar arrangements for the Marinus Link.

Table 1. Fisheries and fishing methods identified as operating in the study area, summary of annual average (over 10 year dataset 2011/12 – 2020/21) catch and revenue, total allowable catch (TAC) from 2020-21, total catch 2020/21 and percentage of catch within study area.

			A	B	C	D=C/B	E=C*price
Fishery (ordered by average catch in study area)	**Methods**	**Data**	**Fishery TAC 2020/21 (tonnes)**	**Fishery catch most recent year (tonnes)**	**10 yr. annual average catch in study area (tonnes)**	**% of catch from study area**	**Average annual revenue from the study area (AUD)**
SESSF – SESSF Shark Gillnet and Shark Hook Sector	Gillnet and Longline	Table 7	2,516	2,268	15.2	0.7	$182,400 (approx. 0.93% of GVP)
SESSF – SESSF Commonwealth Trawl Sector	Danish seine and Demersal trawl	Table 6	22,857	18,118	9.4	0.05	$37,363 (approx. 0.08% of GVP)
Southern Squid Jig Fishery	Squid jig	Table 8	NA	480	12.8	2.7	$51,495 (approx. 2.4% of GVP)
Tasmanian Scalefish Fishery	Various	Confidential	NA	115	5.1	4.4	$30,615
Victorian Abalone Fishery (Central Zone)	Hand Harvest	Confidential	256	233.5	Confidential	Confidential	Confidential
Victorian Ocean General Fishery	Various	Confidential	NA	NA	Confidential	Confidential	Confidential
Victorian Rock Lobster Fishery (Eastern Zone)	Pot	Confidential	40*	35	Confidential	Confidential	Confidential
Victorian Wrasse (Ocean) Fishery	Minor line	Confidential	NA	NA	Confidential	Confidential	Confidential
Victorian state fisheries	Various	Confidential	NA	NA	Confidential	Confidential	Confidential
Tasmanian Abalone Fishery	Hand Harvest	Confidential	1018.5	1011.1	Confidential	Confidential	Confidential
Tasmanian Rock Lobster Fishery	Pot	Confidential	1,051**	991	Confidential	Confidential	Confidential
TOTALS			**27,739+**	**23,252+**	**43+**		**$301,873+**

*2019/20 TAC
**2021/22 TAC
GVP = gross value of production
TAC = total allowable catch

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GLOSSARY

Abbreviation	Explanation
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
AFMA	Australian Fisheries Management Authority
AFZ	Australian Fishing Zone
BSCZSF	Commonwealth Bass Strait Central Zone Scallop Fishery
CFA	Commonwealth Fisheries Association
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTS	Commonwealth Trawl Sector
ECDTS	East Coast Deepwater Trawl Sector
GABTS	Great Australian Bight Trawl Sector
GHaT	Gillnet, Hook and Trap
GVP	Gross value of production
SESSF	Southern and Eastern Scalefish and Shark Fishery
SETFIA	South East Trawl Fishing Industry Association
SFR	Statutory fishing right
SGSHS	Shark Gillnet and Shark Hook Sector
SHS	Scalefish Hook Sector
SIV	Seafood Industry Victoria
SSIA	Southern Shark Industry Alliance
SSJF	Southern Squid Jig Fishery
TRLFA	Tasmanian Rock Lobster Fishermen's Association
TSIC	Tasmanian Seafood Industry Council
TAC	Total Allowable Catch
VFA	Victorian Fisheries Authority
VRLA	Victorian Rock Lobster Association
VZFS	Victorian Zone Scallop Fishery

1. PROJECT DESCRIPTION

Marinus Link Pty Ltd (MLPL), on behalf of the State of Tasmania and the Australian Government is progressing investigation into a new 1500-megawatt capacity electricity subsea interconnector between Victoria and Tasmania, known as *Marinus Link*. The route for the Marinus Link is demonstrated in orange in Figure 1 and red in Figure 2, and will run between Heybridge in Tasmania to Waratah Bay in Victoria.

Tetra Tech Coffey is undertaking approval activities on behalf of MLPL and is seeking to gain information from stakeholders to inform decisions on the project that will minimise disruption to other maritime stakeholders, as well as mitigate and minimise the mutual risk that the interconnector infrastructure and commercial fishing vessels present. In line with these aims, Tetra Tech Coffey has engaged SETFIA to assist them with understanding the:

a) fishing industry allowed to fish in the proposed Marinus Link study area,
b) fishing industry that actively fishes there and the extent and relative importance of these catches,
c) seasonal patterns of fishing and/or issues experienced during past (Basslink) cable installation,
d) metrics (catch value) for the identified fishing sectors.

As a first step in the project an agreed study area around the Marinus Link has been established, henceforth referred to as the "study area". This study area is a 16 km wide polygon centred on Marinus Link (Figure 2). This study area was developed based on length of gillnets, to account for project vessel movements, and to account for vessel drift and levels of accuracy regarding fishing location. It should also be noted that the predominantly north-south alignment of Marinus Link greatly simplifies identification of the relevant Victorian and Tasmanian fishery reporting grids – as opposed to an oblique alignment, where both the north-south and east-west coordinates would differ along the entire route and complicate the allocation of the lateral boundaries of effort.

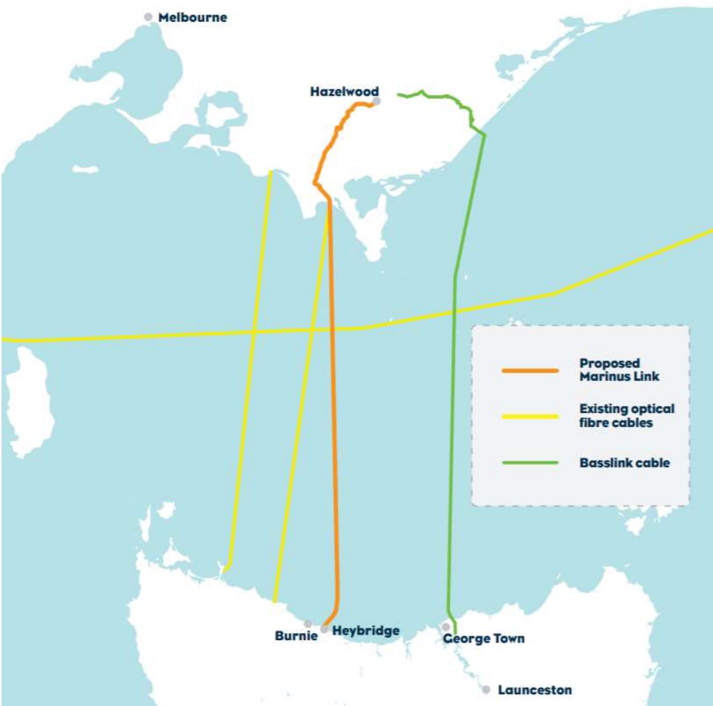


Figure 1. Marinus Link proposed route.

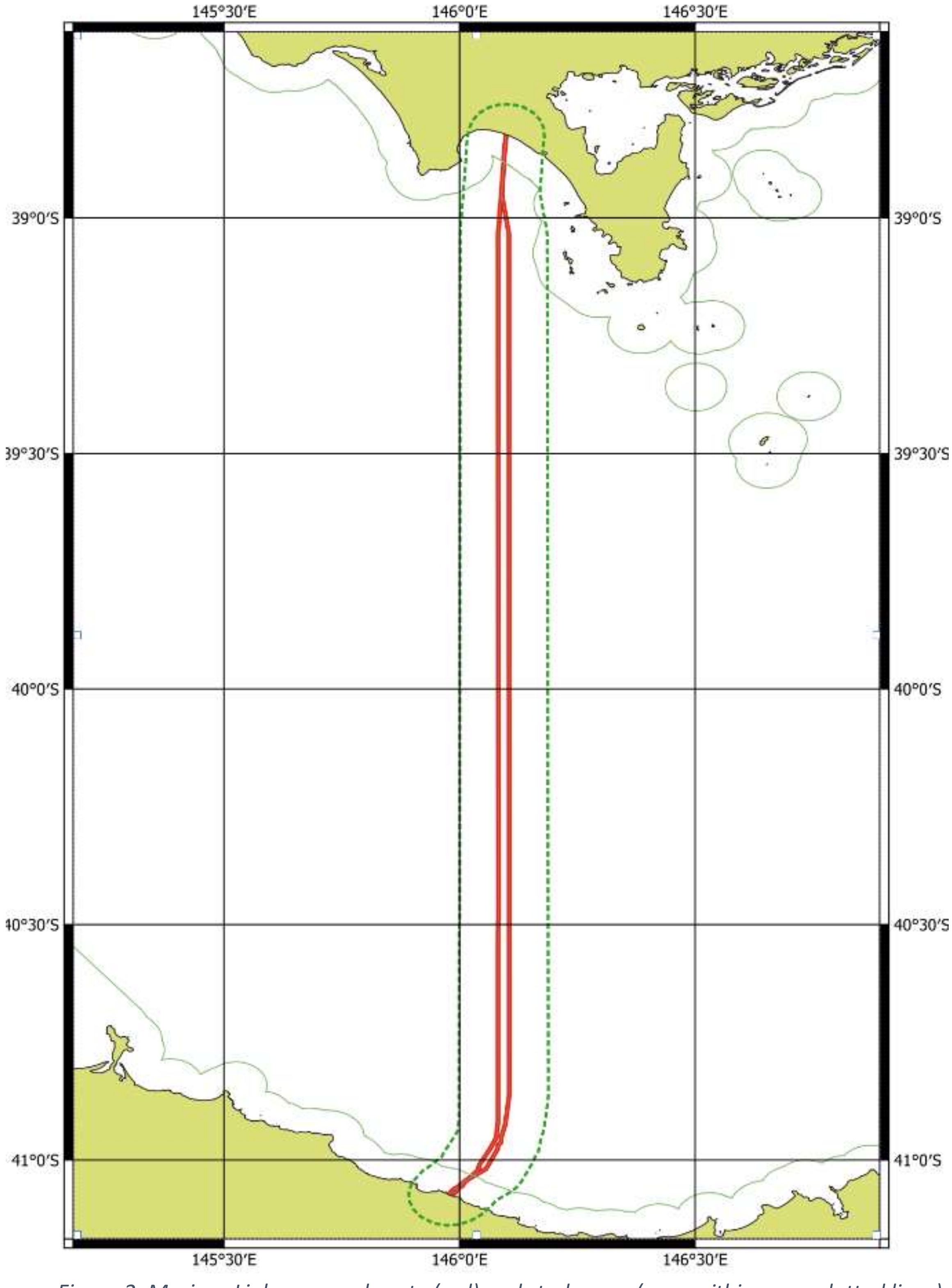


Figure 2. Marinus Link proposed route (red) and study area (area within green dotted lines)

1.1. Marinus Link background

The following extract from Project Marinus – Project overview (Marinus Link Pty Ltd, 2020) outlines the significance of the Marinus link and proposed works.

Marinus Link is a proposed 1500-megawatt (MW) capacity underground and subsea electricity interconnector between Victoria and Tasmania. It will increase energy exchange throughout the National Energy Market (NEM), as Australia continues its transition to cleaner energy. Marinus Link will also incorporate optical fibre capacity, strengthening telecommunications and data connectivity between Victoria and Tasmania.

As coal-fired power generation continues to retire, variable renewable energy generation such as large scale wind and solar is increasingly taking its place. To support these variable energy sources, the NEM also needs energy capacity that is available on-demand, known as 'dispatchable' energy, from forms such as batteries, pumped hydro long duration energy storage and existing hydroelectricity resources. Marinus Link will support Tasmanian and Victorian renewable energy development: for example, with Marinus Link in operation, excess energy generated by Victorian renewables can be transferred to Tasmania and stored in pumped hydro energy storage facilities, ready to be used when needed. Marinus Link and supporting transmission developments can help the national transition to renewable energy by providing greater market access to Tasmania's world class wind and hydro power and proposed pumped hydro long duration energy storage resources. By increasing energy exchange between Victoria and Tasmania, Marinus Link will unlock renewable energy generation opportunities and cost-effective energy storage, and support affordable, reliable and clean energy in Victoria, Tasmania and beyond. Marinus Link also includes optical fibre capacity, providing additional bandwidth and route paths between regional Victoria and Tasmania.

The Marinus Link Infrastructure

Marinus Link involves approximately 250 km of subsea HVDC cables and approximately 90 km of underground HVDC cables. A set of HVDC cables between Heybridge in North West Tasmania and the Latrobe Valley in Victoria, with a converter station site at each end, has been identified as best suited to manage the energy transfer capacity of Marinus Link. It is proposed that the link is built in two 750 MW capacity stages, and that the land cables for each stage are located in a common easement.

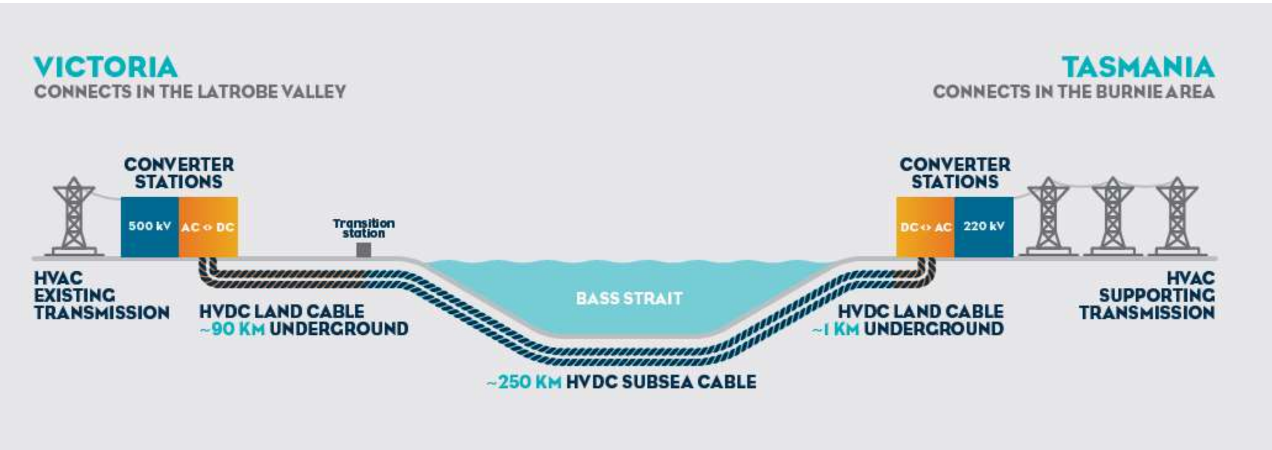


Figure 3 The Marinus Link proposed infrastructure pictorial, Source: TasNetworks

2. SCOPE AND DELIVERABLES

The tasks (numbered) for the scope of work are:

Deliverable 1 – Fishing industry stakeholder background

1. To agree on a study area with the Client
2. To identify the commercial fishing sectors (hereafter; sectors) legally allowed to operate in the study area
3. To identify the sectors with recent (10 years) fishing activity in the study area
4. To identify the sectors who do not fish (with the past 10 years) in the study area

Deliverable 2 – Stakeholder list, and fishing methods of fisheries permitted to work in the study area

5. To provide a comprehensive, but not exhaustive, stakeholder list of associations representing affected sectors identified
6. To provide some general information about vessel size, gear types, catches etc about affected sectors

Deliverable 3 – Fishery data in Marinus Link study area

7. To obtain data from Commonwealth, Tasmanian and Victorian fishery managers in order to provide some metrics (including 10-year average catch revenue, tonnes, % of total catches, total catches) to understand the overlap of the project with the affected sectors. This table to be ranked by highest revenue caught in study area to lowest

Deliverable 4 - Seasonality, Basslink and industry concerns

8. Opportunistically record information on the following, if raised by the fisheries during data collection:
    a. Information on any normal or predictable seasonal patterns of fishing in the study area that may be relevant during cable installation
    b. Anecdotal information on past experiences of those fisheries operation in the vicinity of the Basslink cable, including any impacts or issues experienced due to construction and operation of that cable
    c. Any significant concerns or issues of fisheries that are raised during the course of data acquisition.

The scope of work excludes:

1) Consultation with the commercial fishing industry
2) Obtaining data or reporting on the recreational fishing community
3) Detailed information about the impact energy of fishing gear on the cables
4) Work on additional or multiple study area polygons.

3. FISHING INDUSTRY STAKEHOLDER BACKGROUND

3.1. Fisheries permitted in the study area

A number of fisheries may be permitted to fish in the study area but in the past 10 years have not recorded any fishing effort. The lack of fishing effort may be due to areas being too rough to fish, areas being unproductive and not holding fish, or marine parks and fishery closures that prohibit some or all fishing methods. Table 2 lists all fisheries permitted to fish in the study area, and separates them by management body, as well as if there has been effort recorded in the study area in the past 10 years.

Table 2. List of fisheries permitted to fish in the study area

	Commonwealth-managed fisheries	Victorian-managed fisheries	Tasmanian-managed fisheries
Can legally fish and do	SESSF Commonwealth Trawl sector	Abalone (Central Zone) Fishery	Abalone Fishery
	SESSF Shark Gillnet and Shark Hook sectors	Ocean General Fishery	Rock Lobster Fishery
	Southern Squid Jig Fishery	Rock Lobster (Eastern Zone) Fishery	Scalefish Fishery
	Bass Strait Central Zone Scallop Fishery*	Wrasse (Ocean) Fishery	
Can legally fish but do not	Eastern Tuna and Billfish Fishery	Giant Crab Fishery	Giant Crab Fishery
	Skipjack Tuna Fishery	Bait (General) Fishery	Commercial Dive Fishery
	Southern Bluefin Tuna Fishery	Sea Urchin Fishery (Central Zone)	Mackerel Fishery
	Small Pelagic Fishery	Purse Seine (Ocean) Fishery	Scallop Fishery
	SESSF Scalefish Hook sector	Scallop (Ocean) Fishery	Seaweed Fishery
		Trawl (Inshore) Fishery	Shellfish Fishery
		Commercial permit	
		Octopus (Central Zone) Permit	

*The Bass Strait Central Zone Scallop Fishery fishes heavily but irregularly in Bass Strait including within 10 km of the Marinus Link study area, but there has been no effort over the past 10 years that overlaps with the study area. However, the highly sporadic nature of the scallop recruitment could potentially give rise to occasional effort.

4. STAKEHOLDER LIST, AND FISHING METHODS OF FISHERIES PERMITTED TO WORK IN THE STUDY AREA

Table 3 provides a list of key contacts for representative bodies for each affected sector.

Table 3. Key contacts for representative bodies for each affected sector.

FISHERIES	REPRESENTATIVE ORGANISATIONS	KEY CONTACT NAME	PHONE NUMBER	KEY CONTACT EMAIL ADDRESS
All Australian wildcatch fisheries and aquaculture	Seafood Industry Australia (SIA)	Veronica Papacosta	0409-220 788	ceo@seafodindustryaustralia.com.au
All Australian Commonwealth managed fisheries	Commonwealth Fisheries Association (CFA)	Andrew Sullivan	0408-131 204	ceo@comfish.com.au
Commonwealth Trawl Sector (CTS)	South East Trawl Fishing Industry Association (SETFIA)	Simon Boag	0428-141 591	simonboag@setfia.org.au
Shark Gillnet & Shark Hook Sector (GHaT)	Southern Shark Industry Alliance (SSIA)	Simon Boag	0428-141 591	simon@atlantisfcg.com
Victorian Rock Lobster Fishery (three zones)	Victorian Rock Lobster Association (VRLA)	Markus Nolle	Via SIV (03) 9687 0673	mnolle@bigpond.com
All Victorian Fisheries	Seafood Industry Victoria (SIV)	Joanne Butterworth-Gray	0412-703014	jbutterworthgray@gmail.com
All Tasmanian state managed fisheries	Tasmanian Seafood Industry Council (TSIC)	Julian Harrington	0407-242 933	chiefexecutive@tsic.org.au
Tasmanian Rock Lobster Fishery	Tasmanian Rock Lobster Fishermen's Association (TRLFA)	Rene Hidding	03 6376 1805	ceo@trlfa.com

4.1. General Information on fisheries overlapping with the study area

There are eleven different fisheries, sectors and sub-sectors with recent (within the last 10 years) fishing activity in the study area. These fisheries use at least ten different fishing gears and are managed by three different jurisdictions (regulators); Commonwealth, State (Victoria) and State (Tasmania). Table 4 outlines the fisheries, management authority and fishing methods used by each sector.

Table 4. Operation of Commonwealth and State managed fisheries who can legally fish within the study area.

			Fishery	Fishing methods
Commonwealth- managed	SESSF		Commercial Trawl Sector	Otter-board trawl (mid-water and demersal)
Commonwealth- managed	SESSF		Commercial Trawl Sector	Danish seine
Commonwealth- managed	SESSF	GHAT	Shark Gillnet and Shark Hook Sector	Demersal gillnet
Commonwealth- managed	SESSF	GHAT	Shark Gillnet and Shark Hook Sector	Demersal longline
Commonwealth- managed	SESSF	GHAT	Scalefish hook sectors	Demersal longline
Commonwealth- managed			Southern Squid Jig Fishery	Squid jig
Commonwealth- managed			Bass Straight Central Zone Scallop fishery	Scallop dredge
State- managed	Victoria		Abalone and Sea Urchin	Diving
State- managed	Victoria		Ocean General Fishery	Demersal longline; Demersal Gillnet; Squid Jig; Minor line; Purse seine
State- managed	Victoria		Rock Lobster Fishery	Rock Lobster Pots
State- managed	Victoria		Wrasse (Ocean) Fishery	Demersal longline; Minor line
State- managed	Tasmania		Abalone Fishery	Diving
State- managed	Tasmania		Rock Lobster Fishery	Rock Lobster Pots
State- managed	Tasmania		Scalefish Fishery	Various methods including; pot; hook and line; Gillnet; Squid Jig; beach seine; Danish seine; Purse seine

4.2. Commonwealth fisheries

The Southern and Eastern Scalefish and Shark Fishery (SESSF) extends from Cape Leeuwin in Western Australia to Fraser Island in Queensland and is comprised of five sectors: the Commonwealth Trawl Sector (CTS), Great Australian Bight Trawl Sector (GABTS), East Coast Deepwater Trawl Sector (ECDTS), Gillnet and Shark Hook Sector (SGSHS) and Scalefish Hook Sector (SHS) (Figure 4). Only Commonwealth Trawl Sector, Scalefish Hook Sector and Shark Gillnet and Shark Hook Sector operate within the Marinus study area. The Shark Gillnet and Shark Hook Sector and Scalefish Hook Sector together comprise a subsector of the SESSF called the Gillnet, Hook and Trap Sector (GHAT).

The Australian Fisheries Management Authority (AFMA) manages fisheries to maintain stocks at ecologically sustainable levels, while maximising the net economic returns to the Australian community (DAFF, 2007). The main management measures used in the SESSF include limited entry, gear restrictions, closed areas and Total Allowable Catch (TAC) limits. A limited number of statutory fishing right (SFR) vessel permits exist, with one required for each vessel operating in the fishery. However, this permit is transferable across vessels, and multiple vessels may use the same fishing permit over the period of a fishing season, as long as they are not out to fish at the same time. Additionally, any fish species managed under *quota* must be landed against quota SFRs. Annual TACs are set based on outcomes of stock assessments conducted for each quota species. Quota SFRs are converted to tonnes of quota (TAC) each year depending on the annual TAC that is set.

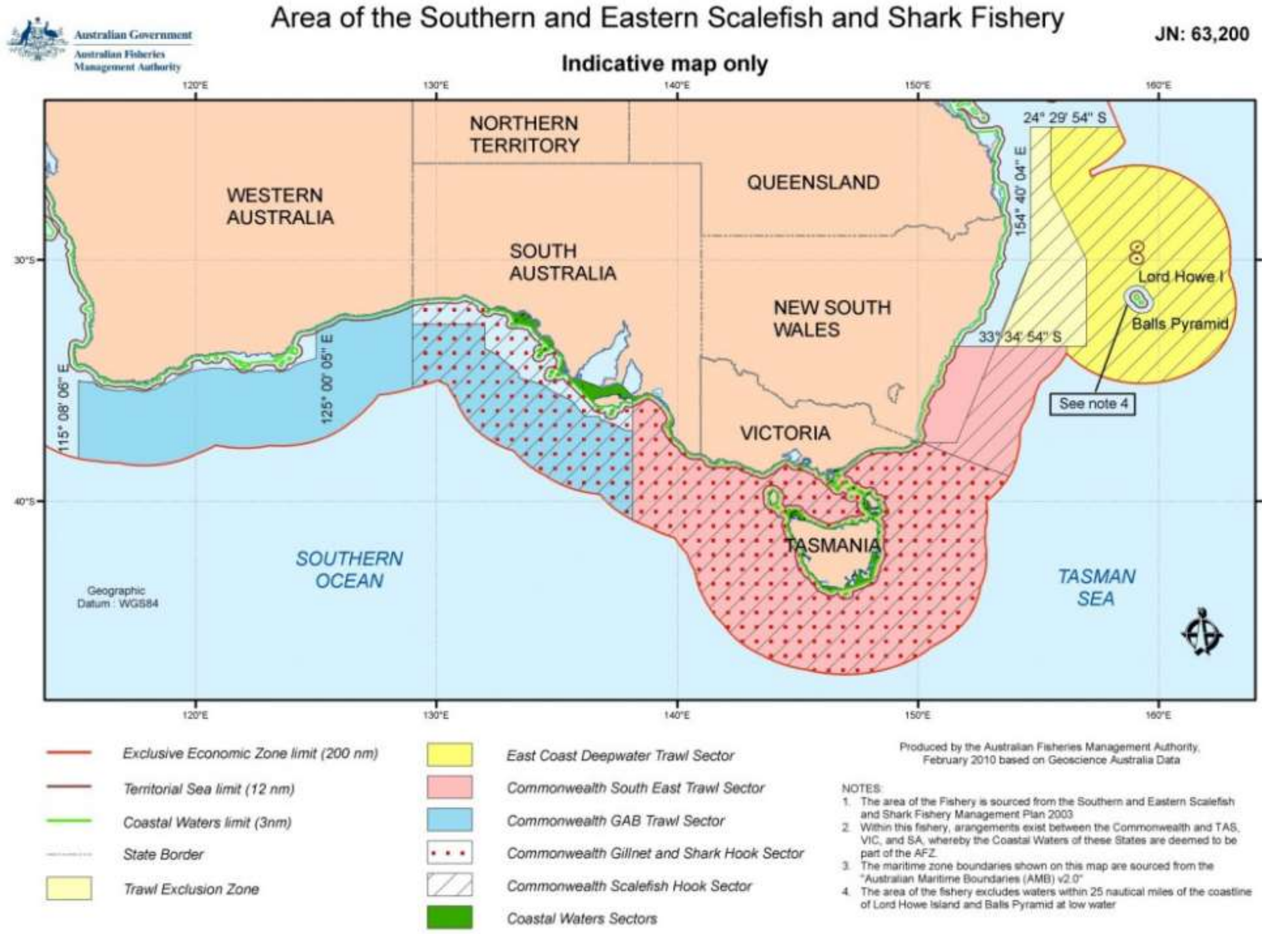


Figure 4. The Commonwealth Trawl Sector (pink) and the Commonwealth Shark Gillnet and Shark Hook sectors (dotted) as part of the larger Southern and Eastern Scalefish and Shark Fishery.

4.2.1. Commonwealth Trawl Fishing (Otter-board Trawl and Danish Seine)

The Commonwealth Trawl Sector is one of the oldest commercial fisheries in Australia, with over a 100-year catch history. The main fishing gears used in this sector are otter-board trawl and Danish seine nets. The Commonwealth Trawl Sector includes all waters inside the Australian Fishing Zone (AFZ) from Barrenjoey Point (north of Sydney, NSW) to Cape Jervis (SA) excluding Australian Marine Parks and fishery closures.

All Commonwealth licensed vessels must carry Vessel Monitoring Systems (VMS) so the exact locations of trawl vessel tracks are known. The CSIRO has used this data to determine that only about 6% of the seafloor between 3 nautical miles from shore (generally but not always state waters) and 1,000m deep in the Commonwealth Trawl Sector is trawled (Bax and Hedge 2015). This makes the fished area of the Commonwealth Trawl Sector particularly sensitive to the loss of fishing grounds.

4.2.1.1. Otter-board trawl

There are two forms of otter-board trawl trawling used in the Commonwealth Trawl Sector:

1. Demersal trawling (also known as bottom trawling shown in Figure 5 and,
2. Mid-water trawling (also known as pelagic trawling)

Almost all trawling in south-east Australia is demersal trawling, and it is unlikely that mid-water trawling occurs in the study area. Further, since all Marinus Link infrastructure is on/below the seabed, any midwater trawling which may occur in the area is unlikely to interact with Marinus Link infrastructure. For these reasons mid-water trawl has not been considered further in this report.

Otter-board trawl vessels are typically 18-28m and are powered by 250-700 HP engines. Demersal trawling involves towing two otter-boards (boards) behind the fishing vessel using two long steel cables called *warps*. Warps are set and hauled using hydraulic net drums on the deck of the vessel. At the other end, each warp is attached to one of the otter-boards, which are large, rectangular steel *boards* that are attached at an angle designed to provide the outward force needed to spread (open) the mouth of the net. While being towed, otter-boards on Commonwealth Trawl Sector trawlers can spread as wide as 100–120m. The otter-boards connect to the net via sweeps and bridles, which act to herd the fish into the wings, then the mouth of the net and eventually to the cod-end. The trawl, the boards and the cable connecting the boards to the trawl (sweeps) all contact the bottom. The vertical opening of the mouth is maintained using floats on the headline. The lower edge of the net is weighted and uses bobbins or rollers to help the net move across the seabed and protect it from damage.

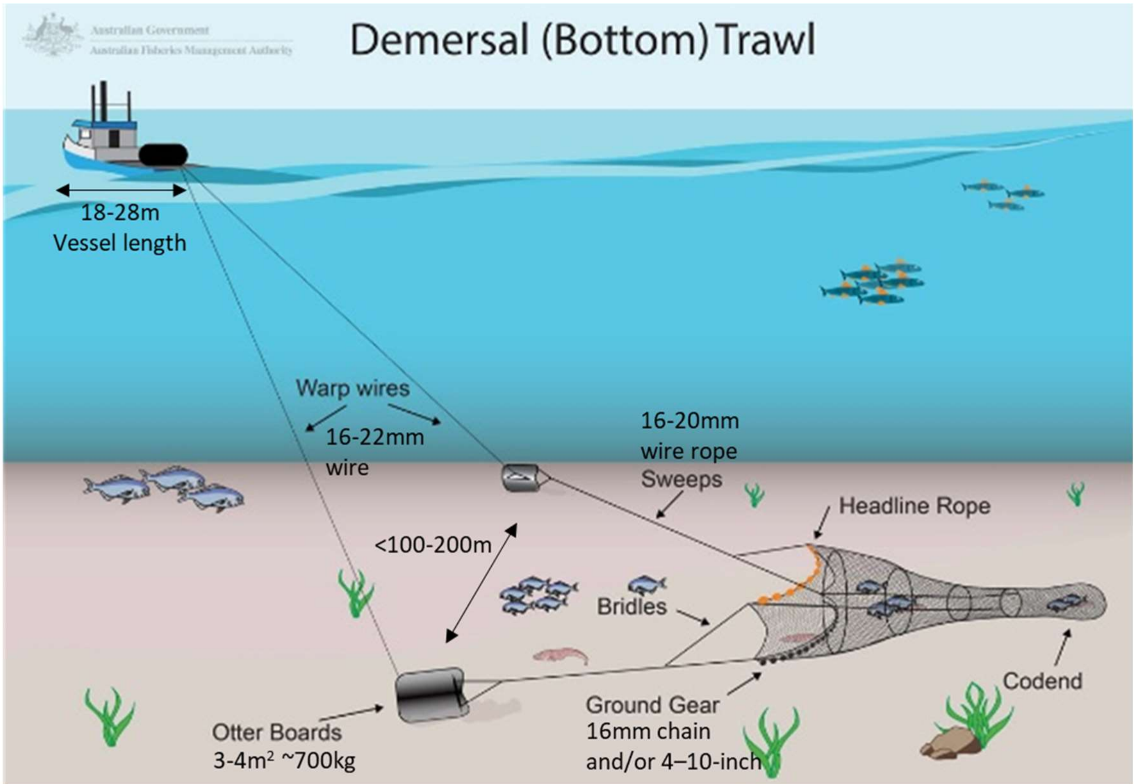


Figure 5, Demersal trawl method diagram (image source: afma.gov.au, with edits)

Trawl fishing is used by the Commonwealth Trawl Sector board trawl sub-sector to catch species such as grenadier, mirror dory, pink ling and many others in the area around the study area.

Trawl fishing gear is always at risk of becoming stuck (*fast*) on the seabed. Trawl fishing in the Commonwealth Trawl Sector does not generally occur over rough bottom. The trawl fishing footprint is limited by several factors:

- the permitted grounds (area allowed to be fished)
- unfishable ground that is too rough and too risky to fish (known as *natural refuges*)
- fish productivity – some areas are non-productive, grounds deeper than 1,200m are generally of low productivity for trawlers
- the ground's proximity to ports of domicile, markets and other services
- fishery closures
- marine parks
- other closures such as petroleum safety zones (PSZs).

4.2.1.2. Danish seine trawl

Commonwealth Trawl Sector Danish seine vessels are typically 15–20 m long and powered by 250–300 HP engines. Danish seine nets are conical in shape with two long wings, a bag where fish collect and warps that connect the net to the vessel and to surround an area fished (Figure 6).

Most Danish seining occurs shallower than 100m and is not a suitable method for working over rocky seabeds, whilst data does not allow for separating between Danish seine and demersal trawl, it is likely that both occur within the study area. Danish seines have no otter-boards, and they are not towed behind the boat. Rather, Danish seine gear is set in a circle over relatively flat seabeds and hauled slowly back to the vessel, only moving about 1nm (1.85km) while it surrounds a large, pear-shaped area. A Danish seine shot usually lasts around 70 minutes and can be described by three distinct phases: setting, towing and retrieval. Danish seine vessels can complete eight or more shots in a day.

The setting phase of the Danish seine trawl takes longer duration than for an otter trawl. For the first ~45 minutes of the shot, the tow ropes and wings of the net are let out in a pear shape and the ropes and net sink to the sea floor; the codend only moves very slowly through the water during this phase. The shoulders and wings of the net are vertically aligned for the first 15 minutes, before becoming concaved as the ropes start to tighten and the ropes and net starts to move on the seabed. The towing phase is characterised by the ropes moving across the seabed, herding the fish into the path of the now moving codend. The wings of the net are bowed over, and are being pulled forwards, as well as being drawn in towards the opposite wing. As the retrieval phase begins, the net begins to lift off the sea floor and is then retrieved and emptied on board the towing boat.

Danish seine warps are initially 22mm lead core rope with a breaking strain of 3.5t but taper down to lighter 12 mm rope with a breaking strain of 1.7t under the net, with the same 22 mm rope at the other end of the gear.

By nature of the operation of Danish seining (i.e., the seine ropes are dragged along the ocean bottom) this method is at higher risk of becoming fast on seabed obstructions and is used to catch species that primarily occur on sandy/muddy bottom such as flathead and school whiting.

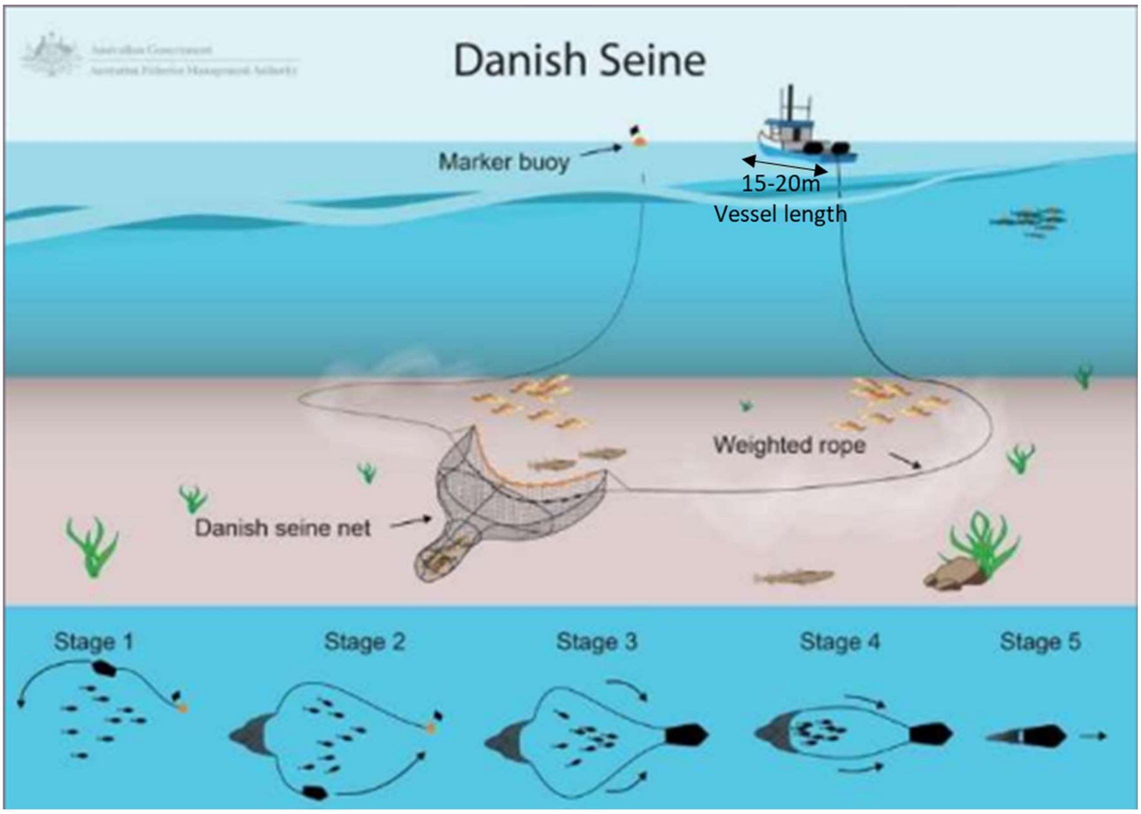


Figure 6. Danish seine method diagram (image source: afma.gov.au, with edits)

4.2.2. Shark Hook and Shark Gillnet Sector

The Shark Hook and Shark Gillnet Sector (SHSGS) includes waters of the Australian Fishing Zone (AFZ) between the New South Wales/Victorian border to the South Australian/West Australian border. Within this sector Demersal gillnet and demersal longline fishing methods are deployed.

4.2.2.1. Demersal gillnet fishing

Demersal gillnets are a passive fishing gear (i.e., they are not towed — the fish have to swim into the gear) comprising a series of long panels of diamond shaped mesh anchored at each end and weighted along the bottom rope to keep the net on the sea floor. It is held upright in the water column by a series of floats.

The SHSGS is managed by quota (the sustainable volume of fish that can be taken each year) and as such operators in the sub-sector can use gillnets of an unlimited length (provided video monitoring is present onboard) but most use between 4,000 m and 6,000 m. Many operators divide their maximum legal net length into two or three fleets of nets, which can either be fished together or separately.

Gillnets generally have the headline (top horizontal rope) set 2m above the seafloor. The headline is typically a 16mm rope, which as previously stated, is floated vertically using small floats. The monofilament net is connected to a ground rope on the lower horizontal edge. The ground rope is usually a 14mm weighted (lead core) rope with a breaking strain of 1.4t.

At either end of the gillnet, a 10mm down-line with a breaking strain of 1.1t runs from floats that indicate the position of the net on the surface, to 2.0m of chain attached to a 100kg J anchor or lead weights. Depending on tide and sea conditions there are often three or four other anchors set along the ground rope. The chain is attached to the anchor mid-way down the anchor shaft, and a lighter break-away cord is usually used.

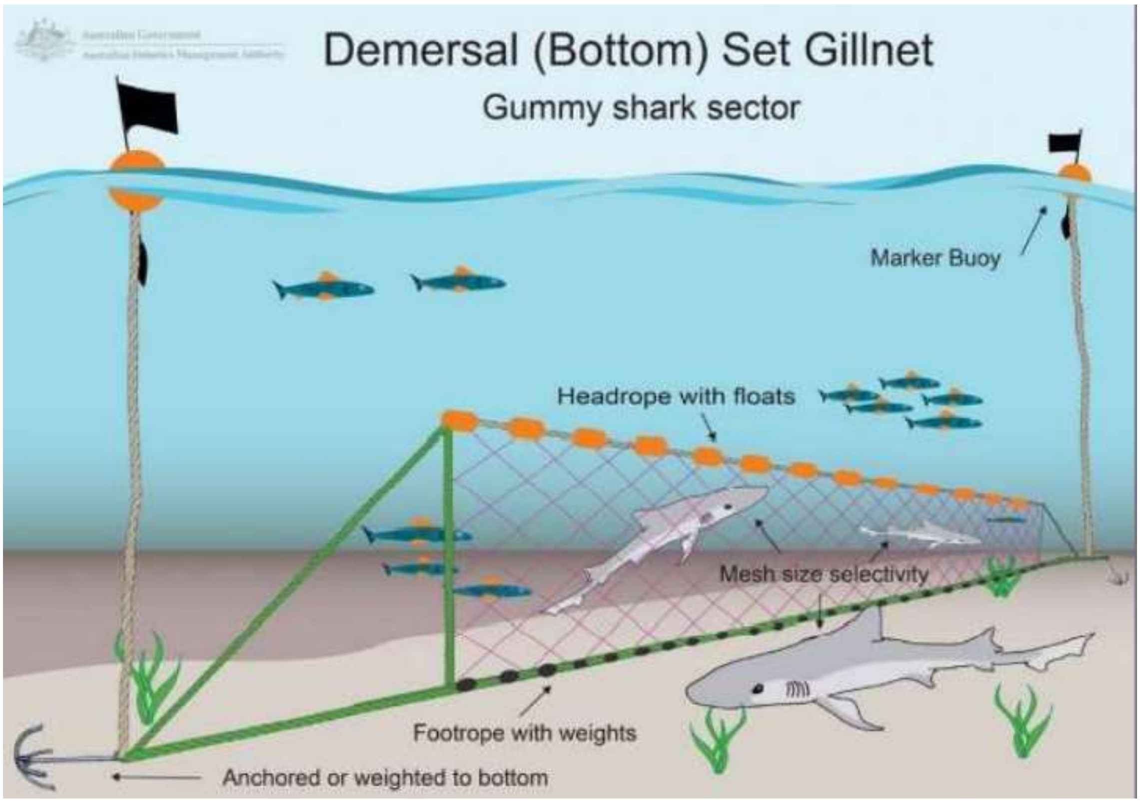


Figure 7. Demersal gillnet method diagram (image source: afma.gov.au)

Gillnets in the SHSGS are used to catch gummy and school shark and a few other by-product species in the study area. Catch is controlled by quotas set using scientific stock assessments.

Like trawl nets, gillnets are susceptible to snagging on rough bottom. However, they are not as sensitive to snagging as towed trawls so although operators record all start and end tows on electronic navigational software, they generally have known safe areas (*grounds*) that they work.

Much like trawl fishing, gillnet fishing is limited by marine parks, fishery closures, unfishable grounds, unproductive grounds and other closures. Gillnet fishing does not occur deeper than 183m (equivalent to 100 fathoms) because deeper waters are closed by Commonwealth rules in order to limit catches of some deeper water fish stocks that are less productive than those targeted in shallower waters.

4.2.2.2. Demersal longline fishing

The SHSGS includes waters of the Australian Fishing Zone (AFZ) from the New South Wales/Victorian border to the South Australian/West Australian border.

Bottom (demersal) longlines are set horizontally along the ocean floor and are held in place using anchors. There are two main methods used in the longline fishery: bottom longline fishing and auto longline fishing. The primary difference between bottom longline fishing and auto longline fishing is that hooks are baited by hand rather than a machine.

When set, the longline can be many kilometres in length (typically 1.5 – 5 km) and may have several thousand hooks. Bottom longline gear consists of a rope mainline with baited hooks spaced every 2 to 5m on monofilament or braided cord snoods. The mainline is attached at both ends to downlines which have a large buoy on the surface for locating gear, and anchors at the bottom to hold the gear in place. Some vessels use radio beacons to be able to find gear in low visibility or if it drifts in heavy current. Each line is normally left to 'soak' for around 6 to 8 hours before being hauled. Hauling is done using hydraulic winches which are fixed to the deck of the boat. The gear can be hauled from either end by retrieving the downline.

Demersal longline gear is much lighter than otter-board trawl or Danish Seine gear. Downlines (ropes connecting floats and the mainline) are generally made of 8 – 10mm rope with a breaking strain of 0.8 to 1.1t. Mainlines are thinner (e.g. 7mm) but are more abrasion resistant. Snoods are usually monofilament with very low breaking strain (approximately 50 kg). Anchors are only large enough to manage onboard by hand (~15–25 kg). The number of anchors used depends on many factors including, currents, sea condition, ground fished, and species targeted. Bottom longline fishing causes very little disturbance to the sea floor and has only a very limited level of bycatch. Gear can become snagged on the bottom and get broken off, although this is not a common occurrence.

Like other fishing vessels, longliners may lay-up at anchor during bad weather or while fishing gear soaks (fishes).

Auto longlining is a variation of demersal longlining in which some of the functions (for example baiting the hooks) are automated. Many "autoliners" set, haul and steam between lines on a continual basis.

Bottom longlines are used to catch shark species that live on or near the sea floor in shelf waters generally less than 100m deep. Although some auto longlines and bottom longlines are used to target deep water species such as blue eye trevalla and pink ling.

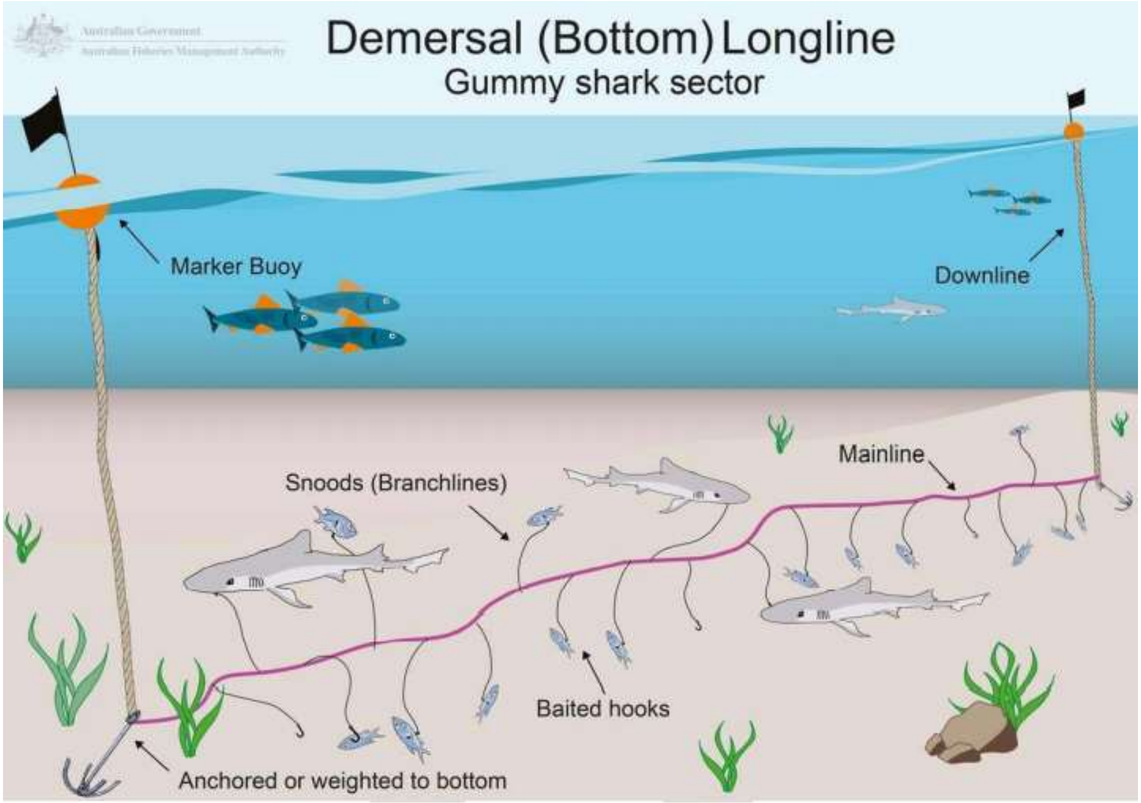


Figure 8. Demersal longline, gummy shark sector, method diagram (image source: afma.gov.au)

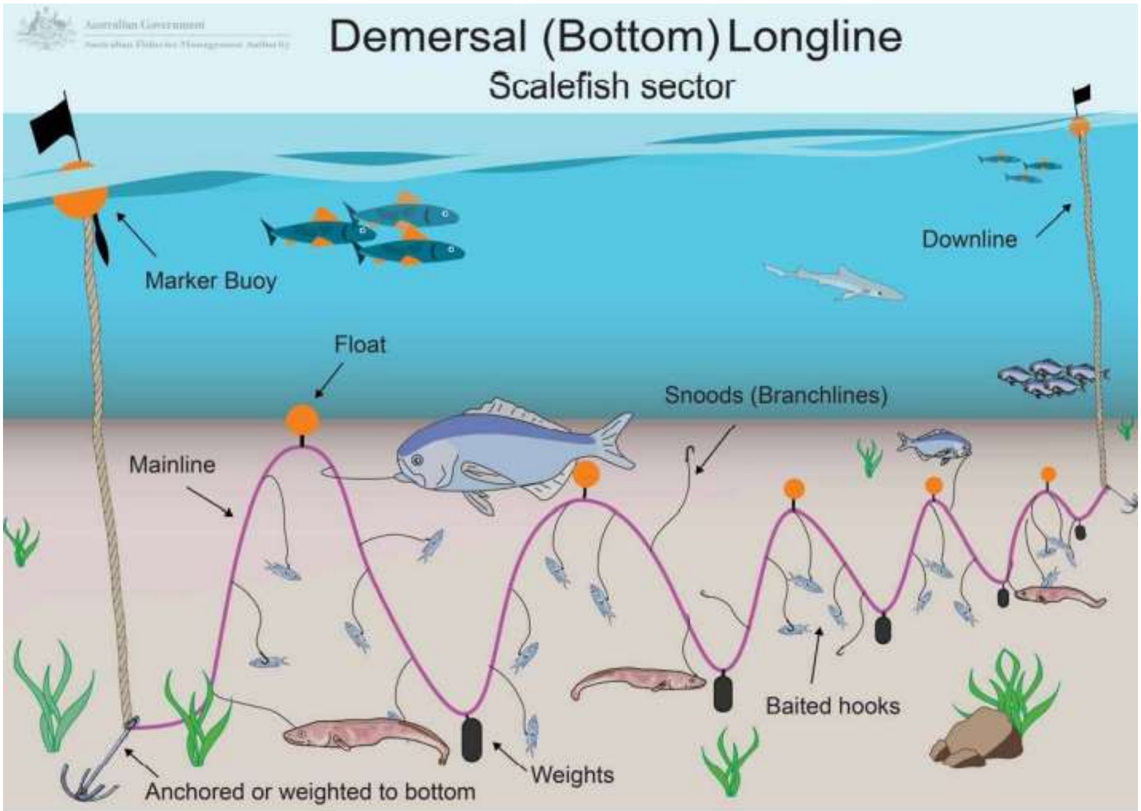


Figure 9. Demersal longline, scalefish sector, method diagram (image source: afma.gov.au).

4.2.3. Southern squid jig fishery

The Southern Squid Jig Fishery operates in Commonwealth waters off South Australia, Victoria, Tasmania, New South Wales and parts off Queensland (Figure 10), with most of the fishing effort occurring off the south-east of Australia. This fishery targets a single species — Gould's squid — using either hand operated or mechanically powered jigs (Patterson et al., 2021).

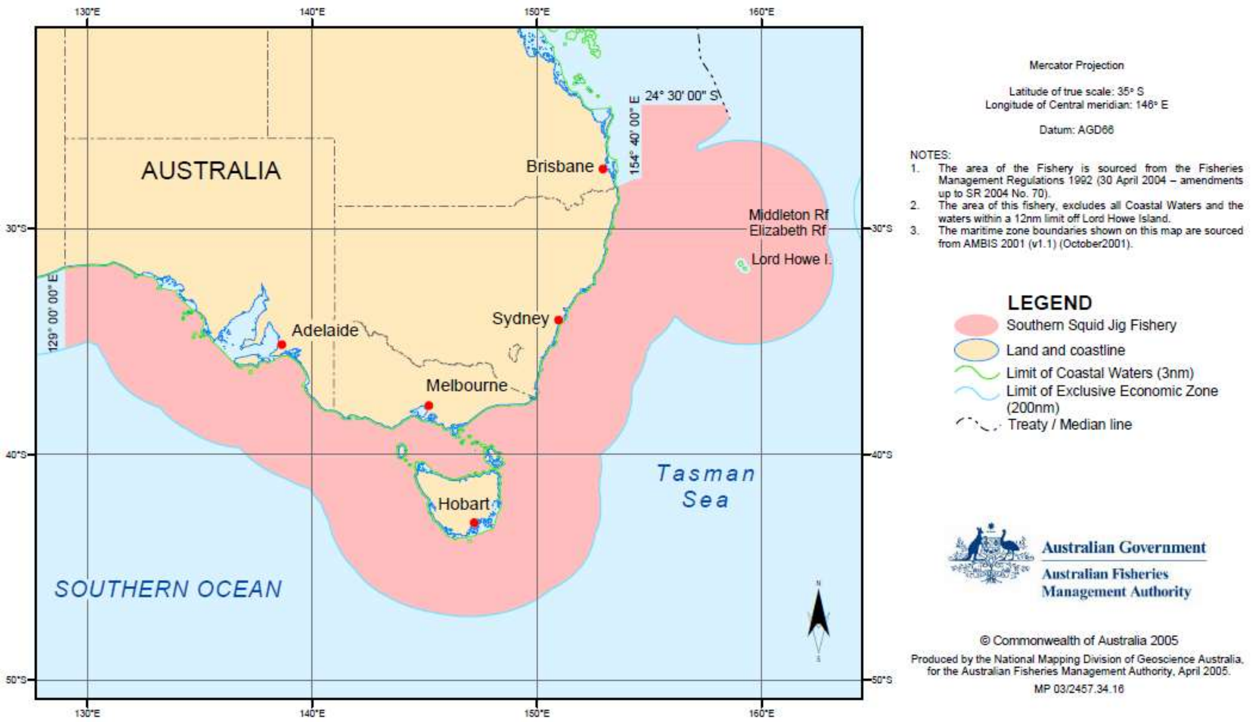


Figure 10. Southern squid jig fishery area (image source: afma.gov.au).

Fisheries operating squid jigging in the study area include; Commonwealth managed Southern Squid Jig Fishery, and to a much smaller extent the Tasmanian Scalefish Fishery and Victorian Ocean General Fishery. Squid jigging typically occurs midwater at depths between 50 and 100 m at night using large lights that illuminate the waters around a boat. Once a suitable site has been chosen, it is common for vessels to deploy a drogue or sea anchor to reduce the vessel's drift while fishing.

The light attracts small marine creatures and in turn the squid are attracted to the concentration of these prey species. One or more lines of hooks are then jigged up and down in the water column using a rotating elliptical spool. The jigging devices are fully automated running on a timed cycle of setting, jigging and then hauling. Squid attack the jigs as they are being retrieved and become caught on the barbless hooks. As the squid are hauled onto the boat the barbless hooks allow them to easily fall off the jig into a holding container.

Squid jigs are used in the water column and do not interact with the seafloor. The line used for the squid jig is monofilament with a low breaking strain of 100 – 200kg. Jig vessels sometimes use anchors during the day (rest periods) that are typical of those described for other fisheries; 20-22mm rope with breaking strain of 4.7t.

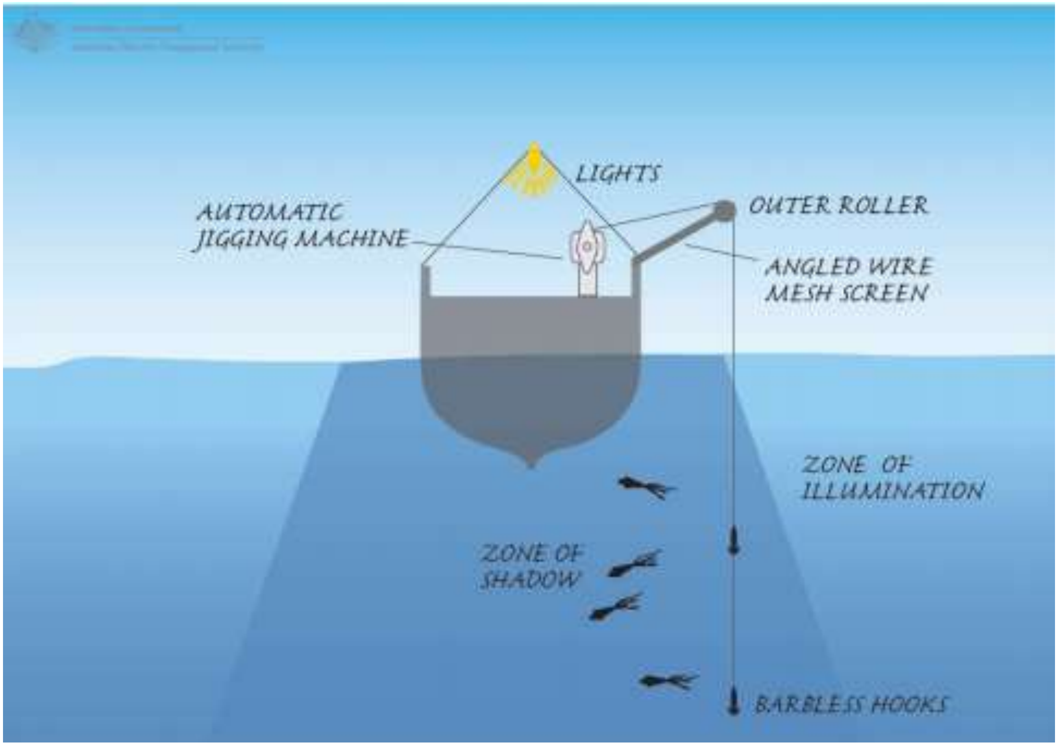


Figure 11. Squid jig method diagram (image source: afma.gov.au).

Figure 12. Left; Deck of an Australian squid jigging machine showing arrangement of jigging machines. Right; Commercial squid jigs wound around a jigging machine drum.

4.2.4. Scallop fishery

Fisheries licensed within the study area operating this fishing method include the Commonwealth Bass Strait Central Zone Scallop Fishery (BSCZSF), Tasmanian Scallop Fishery, and Victorian Zone Scallop Fishery (VZSF).

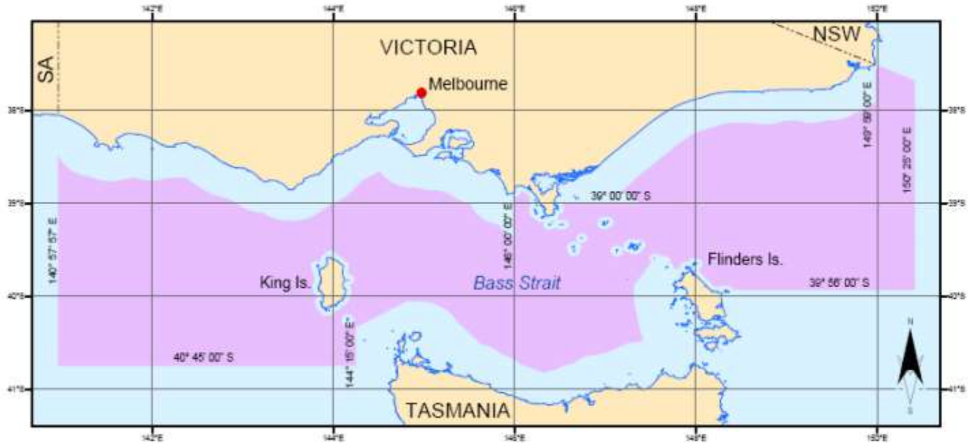


Figure 13. Commonwealth Bass Strait Central Zone Scallop Fishery extent shown in purple (image source: afma.gov.au).

Commercial scallop fishing in Bass Strait is managed under three jurisdictions. AFMA manages the Commonwealth Bass Strait Central Zone Scallop Fishery, and Victoria and Tasmania manage zones generally out to 20nm (37km) from their respective coastlines. Over the past ten years, fishing activity in the study area has only occurred in Commonwealth scallop fishery.

Commercial scallops in the Bass Strait Central Zone Scallop Fishery are mainly found at depths of 35 - 100 metres and are caught using a steel dredge that is towed by the vessel along muddy to coarse sand substrates. Scallops sit either on top of the seabed, or semi-buried with just the upper valve exposed. Scallops are mobile and can swim short distances in response to stimuli in an attempt to escape the dredge.

The average scallop vessel is 18 – 25 m long, weighs ~100 t, and is powered by 200–400 HP engines. Scallop dredges are a rigid steel cage that weigh about 600 kg. They have a tooth bar on the leading edge with teeth (tynes) that range 75 –100 mm long, which penetrate the seabed to depths to around 10 cm, depending on the compactness of the seabed, scooping scallops into the basket. The gear is towed along the seabed behind the vessel at a speed of ~3 to 5 knots using a 16–18 mm steel wire warp (6 x 19 ply) with a breaking strain of 15.3 to 19.3t.

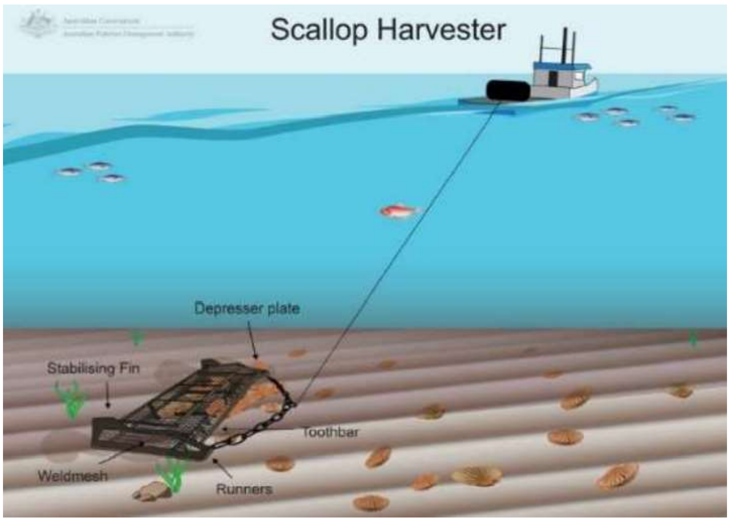


Figure 14. Scallop dredge method diagram (image source: afma.gov.au).

4.3. State managed fisheries

4.3.1. Rock lobster fisheries

The Victorian (Eastern Zone) Rock Lobster Fishery is bounded by Long. 143°30’E, Long. 150°20’E and Lat. 39°12”S, see (Figure 15). The Tasmanian Rock Lobster Fishery operates south of this area around the Tasmanian coast (Figure 16). The industry in Tasmania is represented by the Tasmanian Rock Lobster Fishermen's Association, a peak body with a strong voice on the Ministerial Advisory Committee for crustacean fisheries. Southern Rock Lobsters are found to depths of 150 metres, but most catch comes from inshore waters less than 100 metres deep.

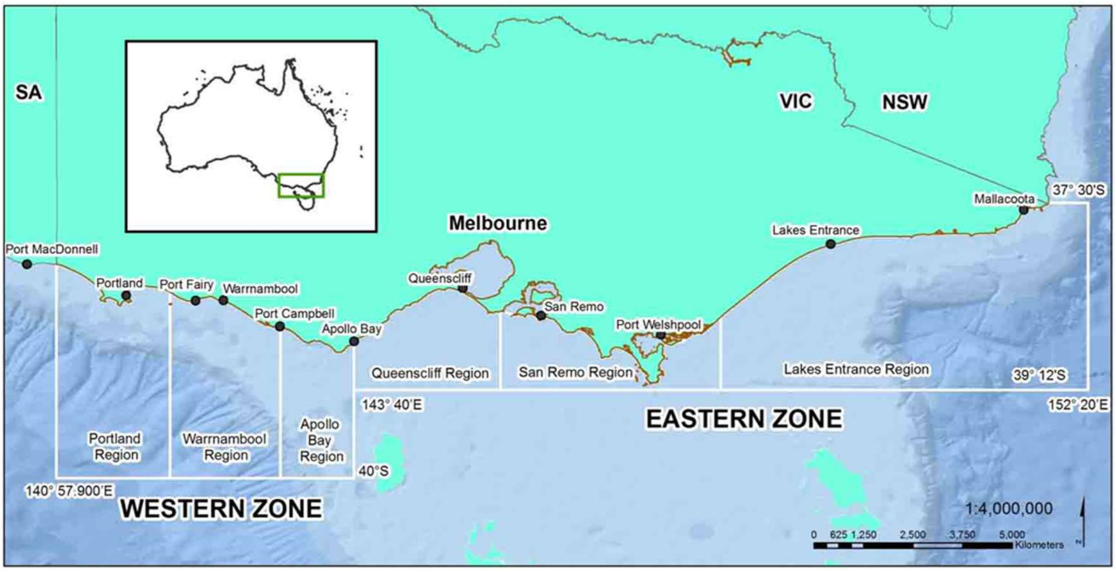


Figure 15. Victorian Rock Lobster Fishery map (image source: https://vfa.vic.gov.au).

Figure 16. Left; Map of Tasmanian Rock Lobster Fishery image source: (https://nre.tas.gov.au/). Right; Photo example of a Rock Lobster pot.

In both states this fishery is a pot fishery, with the pot designed in the form of cages, made from various materials (wood, wicker, metal rods, wire netting, plastic etc.) and weighs about 40 kg. Giant crab pots may weigh more than this due to the fishery being in deeper water (Wayne Dredge, pers comm) and therefore experiencing greater currents. Pot size is regulated and must not be more than 150 cm long by 150 centimetres wide by 120 cm high. Pots are set on rocky bottom and are used with bait. They are normally set singly and marked with a 3-strand 9-14 mm rope and surface buoys. The soaking time may vary from half to a full day (rock lobster) to ten or more days for giant crab fishers. Pots are hauled with a mechanised pot hauler.

4.3.2. Abalone fisheries

In the Victorian Abalone (Central Zone) Fishery and Tasmanian Abalone Fishery, abalone are caught by hand while diving, usually with the use of hookah breathing apparatus (Figure 17). Abalone inhabit rocky reefs and are removed using an abalone knife. Boats used in the fishery are generally small (6–8 m) and do not anchor while working. Abalone divers generally make single day trips. Abalone divers are generally restricted to depths less than 30 m.

Figure 17. Typical abalone diver with hookah breathing apparatus.

4.3.3. Victorian ocean general fishery & Tasmanian scalefish fishery

The Victorian Ocean General Access Licence authorises the 152 license holders (Victorian Fisheries Authority, 2020) to carry out fishing activities using a variety of gear types in marine waters other than Port Phillip Bay, Western Port, Gippsland Lakes and any inlet of the sea. Gear types permitted include line methods (dropline, long line, hand line), dip net, bait traps, octopus traps, landing nets, gaffs, seine nets, mesh nets and bait pumps. This fishery can land fish (mostly snapper, octopus and gummy shark) other than abalone, pipis, jellyfish, southern rock lobster, giant crab, commercial scallop and sea urchins. The main management methods are input controls including limited access and gear restrictions. The fishery usually conducts day trips operating out of small vessels (<10 m), and may fish at anchor or underway.

Victoria's Wrasse (Ocean) Fishery and Tasmanian scalefish fishery use a range of fishing methods including minor lines. Minor line is a general term used to describe a range of line fishing methods that use a small number of hooks. Minor line methods include poling (Figure 18), trolling (Figure 19), and rod and reel (often called hand-lining). Hooks are either baited or on lures or jigs and could either be fished near the bottom using a lead weight, slowly dragged through the water (trolling), of dragged through the water using the action of the rod or reel.

Hand lines are used in the Tasmanian Scalefish Fishery to target finfish including wrasse. Handlines are usually lowered and retrieved using fishing rod and reel equipped with 20 lb breaking strain monofilament of braided nylon mainline and 40 – 50 lb leader. Hand lines are usually fished from small 6 – 8 m vessels undertaking day trips. Vessels may anchor while fishing, and typically use a reef anchor attached to 3 – 5 m of chain (typically 8 mm link) and 12 mm polypropylene rope.

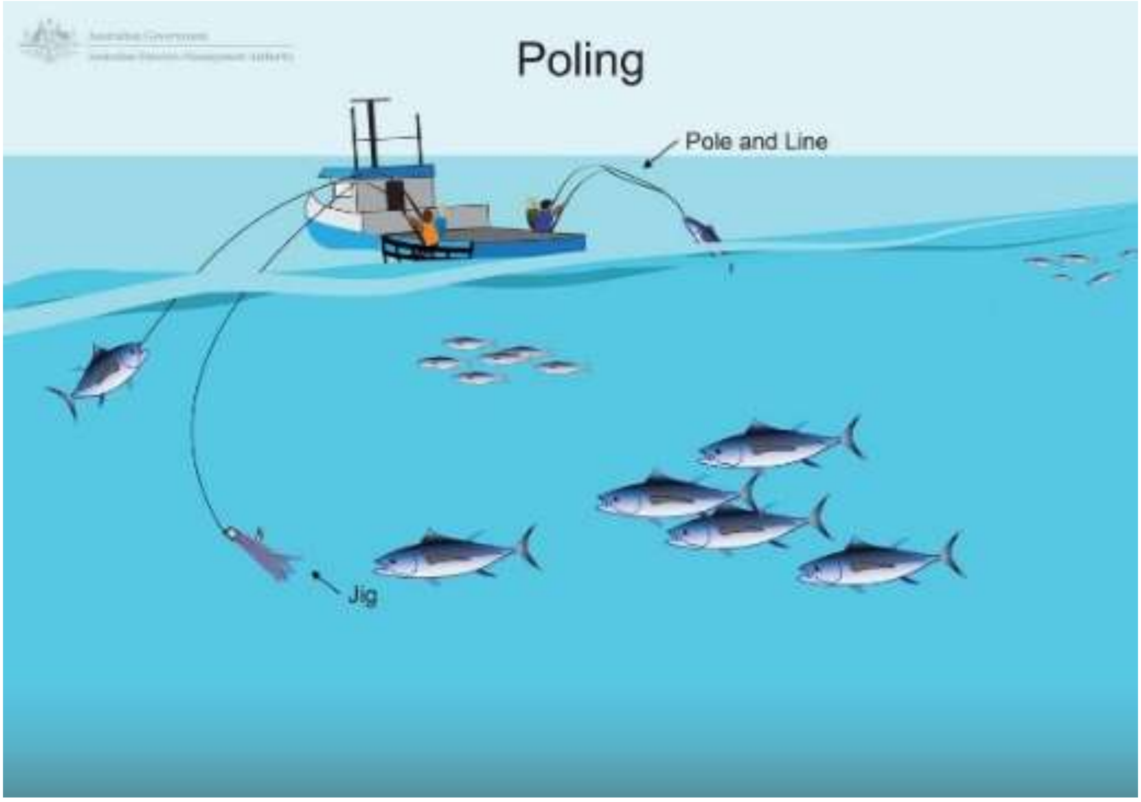


Figure 18. Poling minor line fishing method diagram (image source: afma.gov.au).

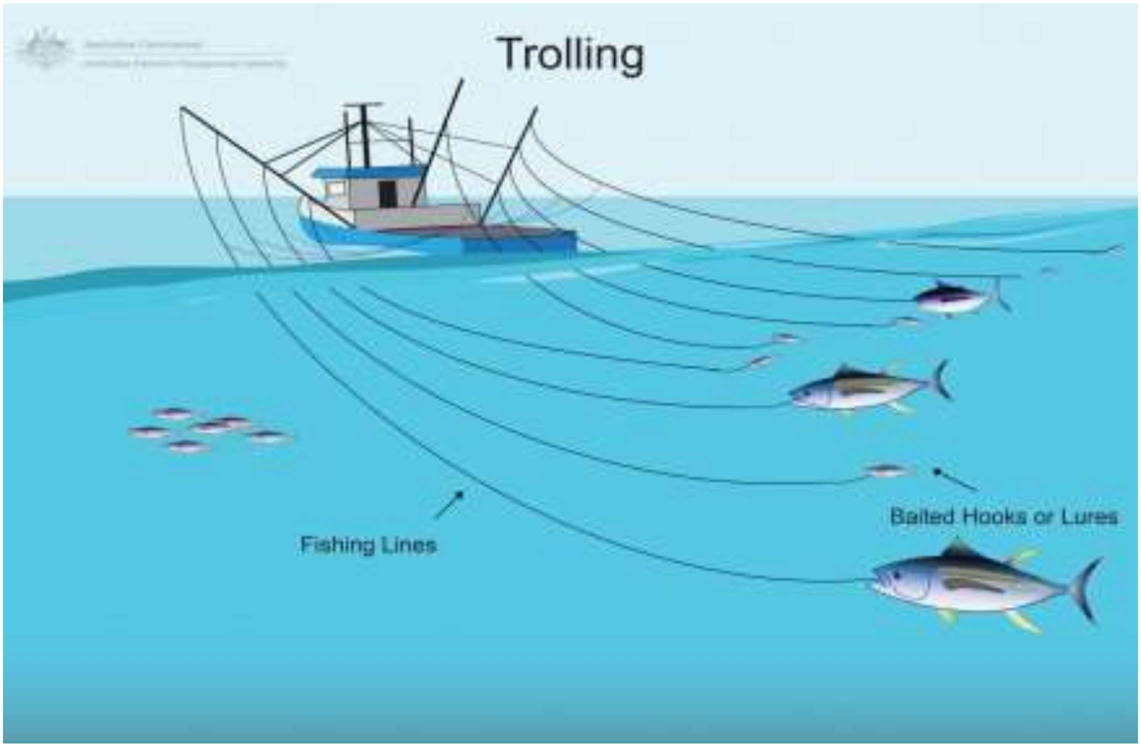


Figure 19. Trolling minor line fishing method diagram Poling line fishing method diagram (image source: afma.gov.au).

5. FISHERY DATA IN MARINUS LINK STUDY AREA

5.1. Southern and Eastern Scalefish and Shark Fishery (SESSF)

The SESSF gross value of production (GVP) was about $87 million in the 2018–19 financial year but catches have declined significantly from historical levels primarily due to a reduction in fishing effort (Figure 20 and Figure 26), largely associated with a 2006 Commonwealth Government-led *Structural Adjustment* which removed 50% of fishing concessions, but also from greatly reduced catches of Orange Roughy and Blue Grenadier (Patterson *et al.*, 2020). Whilst the SESSF is comprised of five sectors: the Commonwealth Trawl Sector (CTS), Great Australian Bight Trawl Sector (GABTS), East Coast Deepwater Trawl Sector (ECDTS), Gillnet and Shark Hook Sector (SGSHS) and Scalefish Hook Sector (SHS), only the Commonwealth Trawl Sector and Shark Gillnet and Shark Hook Sector operate within the Marinus Link study area.

More than 100 species are regularly landed in the SESSF but only the main species are managed under quotas. At present, there are 34 fish stocks subject to total allowable catches (TACs, Table 5). Only those in bold are generally found in the vicinity of the Marinus Link. Total landings of quota species by the Commonwealth Trawl Sector and Scalefish Hook Sector in 2020–21 was 18,118 t and 665 t, respectively (Patterson *et al.*, 2021). GVP of the 2019–20 catch by the Commonwealth Trawl Sector and Scalefish Hook Sector was $46.15 million and $5.19 million, respectively. The Shark Gillnet and Shark Hook Sector landed 2,268 t of shark during 2020–21 and had a GVP of $18.22 million during 2019–20.

Table 5. List of 2021-22 TACs (whole fish unless otherwise stated) for SESSF quota species (AFMA, 2021). Species that are likely to be caught within the study area are in bold.

Species	TAC (t)	Species	TAC (t)
Alfonsino	1,017	Orange roughy – (gab)	50
Bight redfish (gab)	893	Orange roughy – (cascade)	500
Blue eye trevalla	421	Orange roughy – (east)	1,277
Blue grenadier	12,183	Orange roughy – (south)	96[1]
Blue warehou	**50**	Orange roughy – (west)	60
Deepwater flathead (GAB)	1,128	Oreo (smooth cascade)	150
Deepwater shark (east)	24	Oreo (smooth other)	90
Deepwater shark (west)	235	Oreo (basket)	139
Elephant fish	**114**	Pink ling	1,121
Flathead	**2,333**	Redfish	50
Gemfish east	100	Ribaldo	396
Gemfish west	343	Royal red prawn	605
Gummy shark	**1,672**[2]	**Sawshark**	**509**
Jackass morwong	**463**	**School shark**	**194**
John dory	**60**	**School whiting**	**917**
Mirror dory	144	**Silver trevally**	**197**
Ocean perch	304	Silver warehou	450

[1] Plus 31 t incidental

[2] Trunk weight

5.1.1. SESSF Commonwealth Trawl Sector

The main fishing gears used in this sector are otter-board trawl and Danish seine nets. During the 2019–20 fishing season there were 30 otter-board trawl and 19 Danish seine vessels actively operating in the entire Commonwealth Trawl Sector fishery (Patterson *et al.*, 2020). Total annual catch (fishery wide) in the Commonwealth Trawl Sector peaked in 1990 at just over 60,000 t, but fell to 20,000–30,000 t during the late 1990s (Figure 20) mainly as a result of overfishing Orange Roughy. Catches again fell from about 30,000 t in 2000 to below 10,000 t in 2014, but increased to more than 18,000 t in 2020–21.

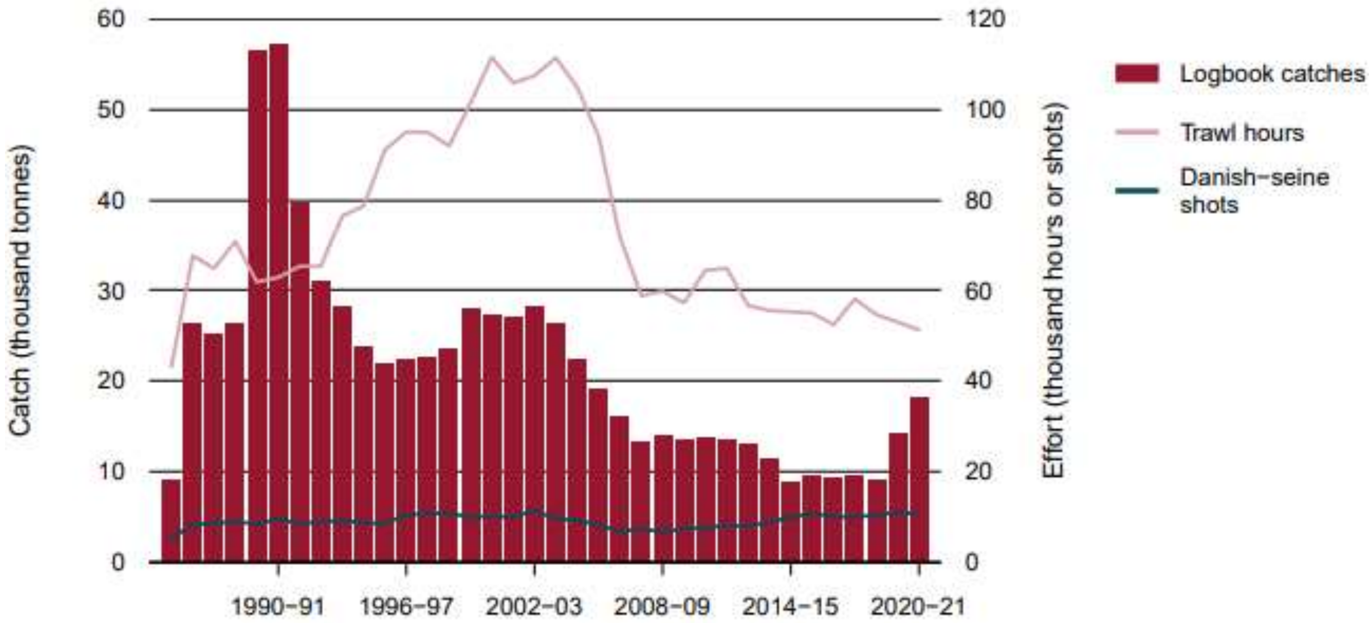


Figure 20. Total catch and effort by the Commonwealth Trawl Sector during 1985 - 2019 (Patterson et al., 2020).

The South East Trawl Fishing Industry Association (SETFIA) is the industry association for Commonwealth Trawl Sector operators, representing more than 80% of the catching and quota-owning sector through voluntary membership. Contact details for SETFIA are provided in Table 3.

5.1.1.1. Overlap between Commonwealth Trawl Sector grounds and the study area

The area of the Commonwealth Trawl Sector includes Bass Strait however the Trawl Closure (Figure 21) prohibits use of otter trawls in most of that area. Commonwealth Trawl Sector fishers using otter trawl fish record very little effort in Bass Strait between Flinders Island and King Island (Figure 22). That area is fished more by Danish seine fishers, although the main areas of the fishery do not overlap with the study area (Figure 22).

In the data provided by AFMA, there were records from only one otter trawl, and as many as four Danish seine vessels. A total of seven different Danish seine vessels and one otter trawl vessel have reported effort in the fishery since July 2021. Because of the small number vessels contributing to the data, data from otter trawl and Danish seine sub-sectors are combined so as to protect confidentiality, and annual data summaries cannot be reported.

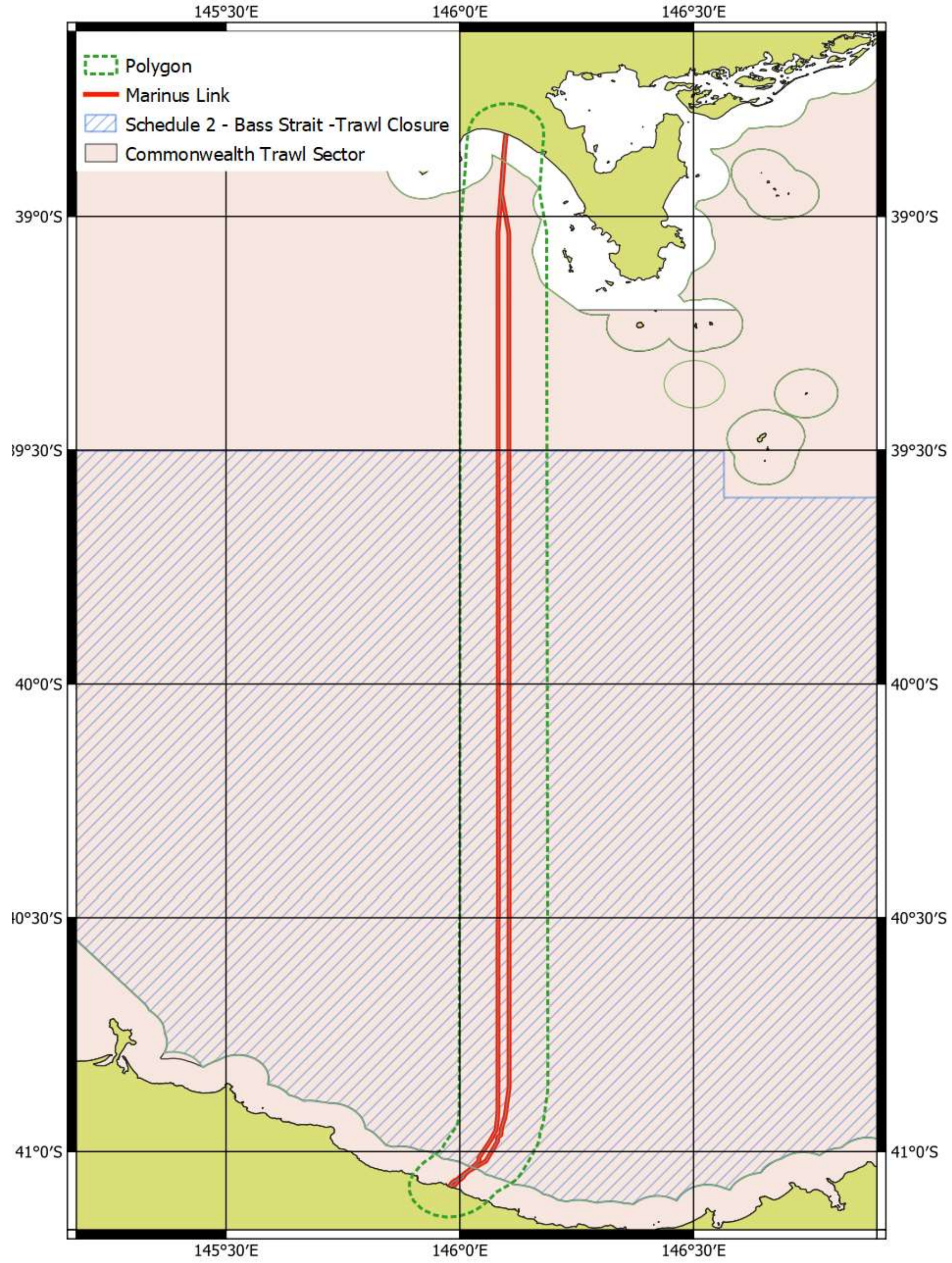


Figure 21. Trawl closure of otter trawl gear in the Bass Strait (blue shaded area), study area shown as green dotted line.

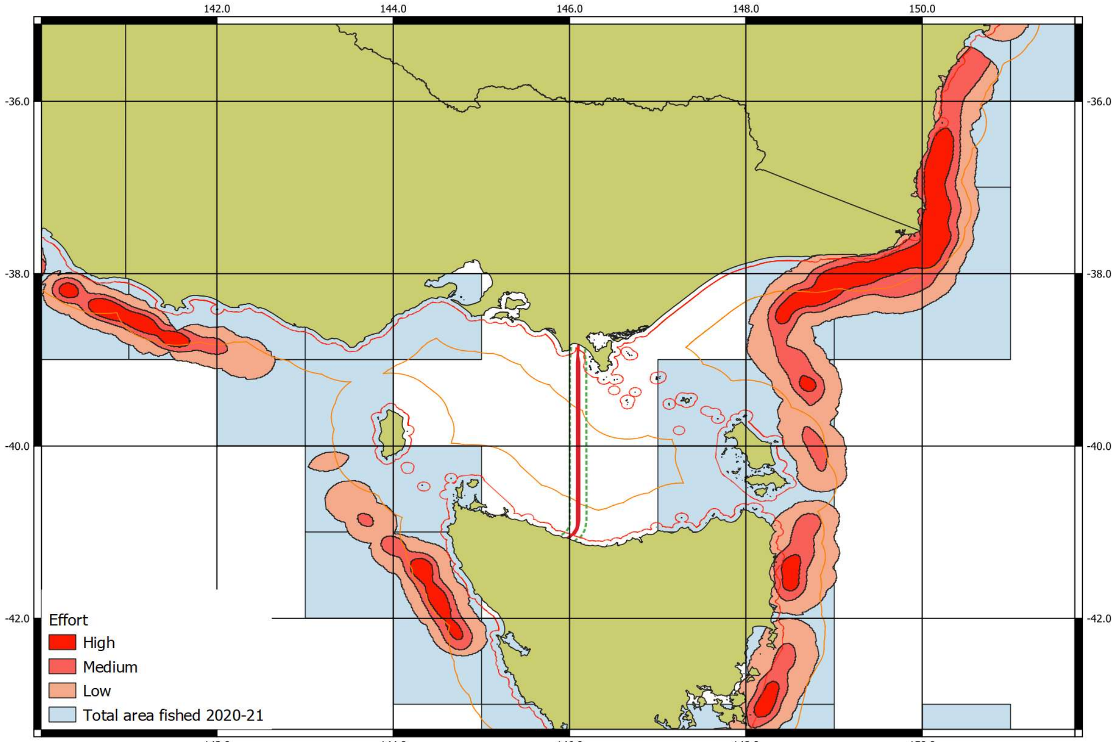


Figure 22. Relative fishing effort intensity by the Commonwealth Trawl Sector using otter-board trawl in relation to the study area during 2020–21. Note that effort comprising data of less than 5 vessels has been removed. Data provided by ABARES. Original data source: AFMA

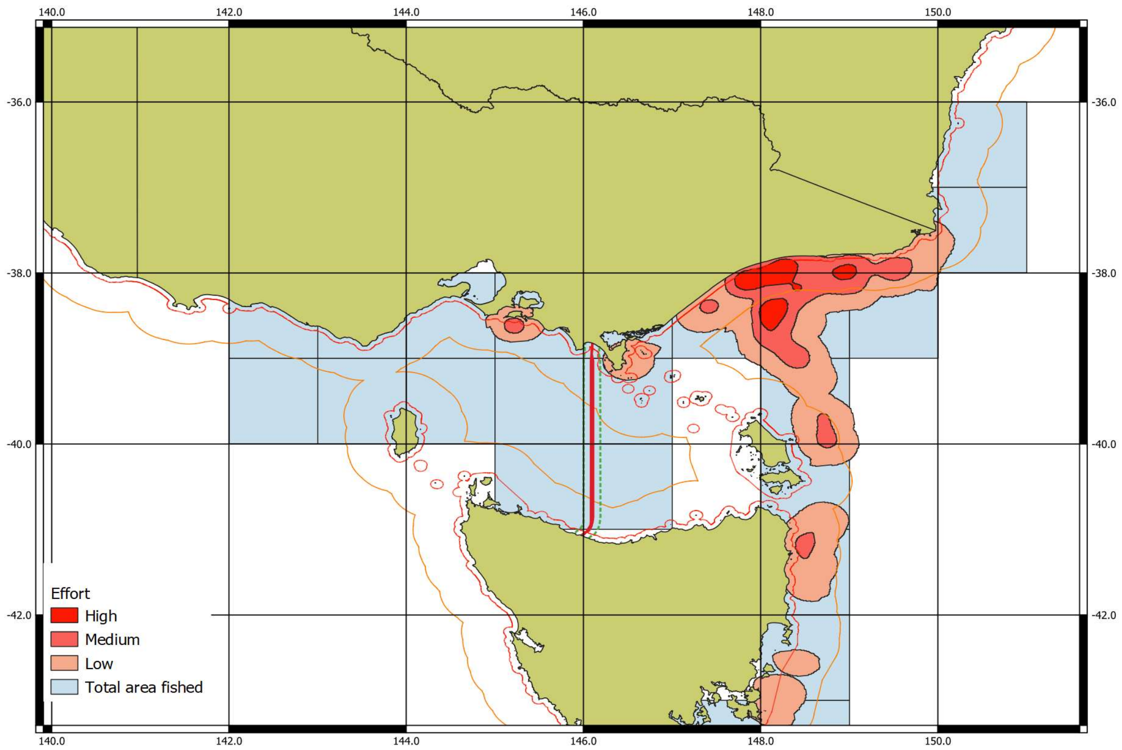


Figure 23. Relative fishing effort intensity by the Commonwealth Trawl Sector using Danish seine nets in relation to the study area during 2020–21. Note that effort comprising data of less than 5 vessels has been removed. Data provided ABARES. Original data source: AFMA

Commonwealth Trawl Sector vessels reported a total of 374 fishing events in the study area from 2011–12 to 2020–21 (Table 6). Total catch was 93.8 t with a value of $373,632. Catch was dominated by eastern school whiting (<5 vessels), tiger flathead (7 vessels, 26%) and gummy shark (<5 vessels).

Table 6. Commonwealth Trawl Sector effort, catch, catch value and main species caught in the study area from 2011-12 to 2020-21. Data source: AFMA

YEARS INCLUDED	2011–12 to 2020–21
Number of different vessels	8
Total shots	374
Total catch (t)	93.8 t
Total value	$373,632
Main species caught	Eastern school whiting Tiger flathead (24%) Mackerels
Fishing methods used	Danish seine Otter trawl

5.1.1.2. Likelihood of fishing grounds developing in the future

Fishing effort in the Commonwealth Trawl Sector has been more limited by the TAC's of a few key stocks than by the limited number of fishing licences. Improved technology and exploration saw expansion of fishing grounds over the decades since the 1980s, but subsequent to several Government-led structural adjustments and closures of many areas to trawling during the mid-2000s, there has been some contraction of fishing effort on both the shelf and shelf break. In recent years, effort in the otter-board trawl fleet fell to the lowest levels on record in 2016 and increased slightly in 2017 (apart from 1985 when logbooks were introduced), while based on anecdotal reports from Industry, Danish seine effort remains relatively high and may even be increasing. The fishing grounds in the study area are categorised as having low fishing effort from the Danish seine sub-sector. While the catch of some Commonwealth Trawl Sector species is limited by TACs, the fishery has been unable to catch that TAC in recent years. Thus, while there is some Commonwealth Trawl Sector catch and effort recorded from within the Marinus Link study area, it is unlikely that this will increase to any appreciable extent in the next 5 – 10 years.

5.1.2. SESSF Shark gillnet and shark hook sector (SGSHS)

The shark gillnet and shark hook sector targets gummy shark using demersal gillnets and demersal longlines (including auto-longlines) and is restricted to waters shallower than 183 m (100 fathoms). Both demersal gillnets and demersal longlines were used in one- degree boxes that overlap with the Marinus Link study area during 2020–21 (Figure 24 & Figure 25), and there have also been historical records of effort in that area.

These shark gillnet and shark hook sector sectors landed 2,268 t of shark in 2020–2021 and had a GVP of $18.22 million in 2019–20 (Patterson *et al.,* 2021). During 2020–2021 there were 31 active shark gillnet and shark hook sector vessels operating gillnets and 38 vessels using demersal longlines (Patterson *et al.,* 2021).

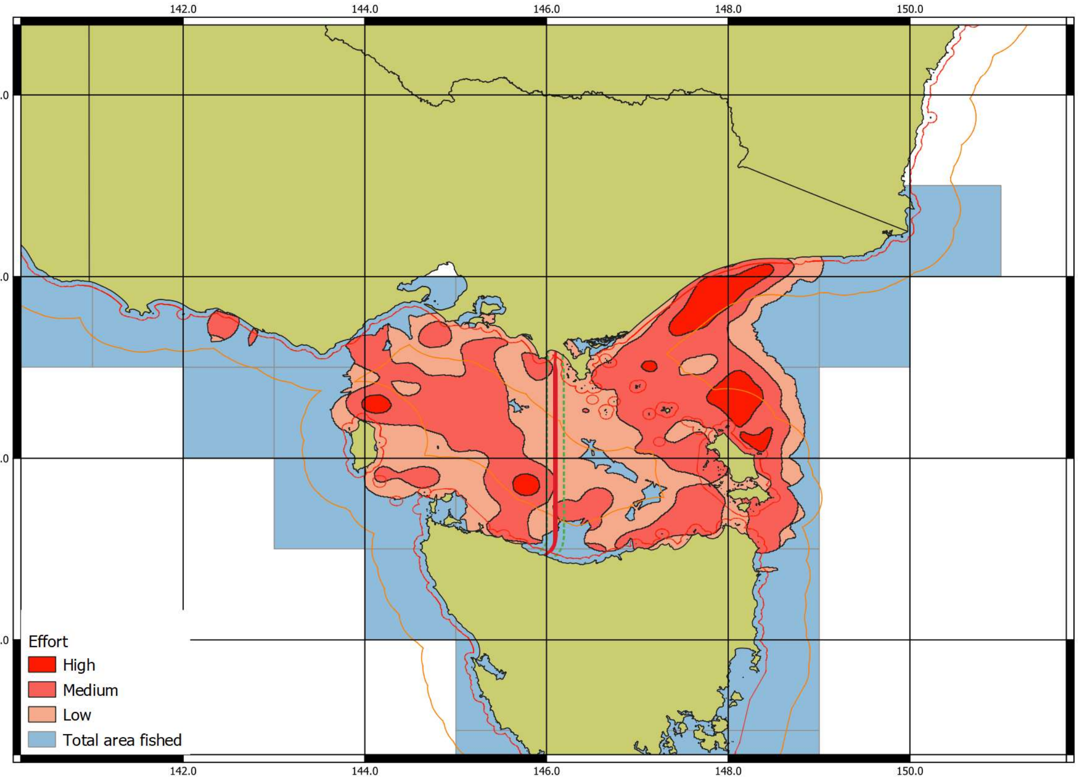


Figure 24. Relative fishing effort intensity by the Shark Gillnet Sector during 2020–2021 in relation to the study area. Note that effort comprising data of less than 5 vessels has been removed. Data provided by ABARES. Original data source: AFMA

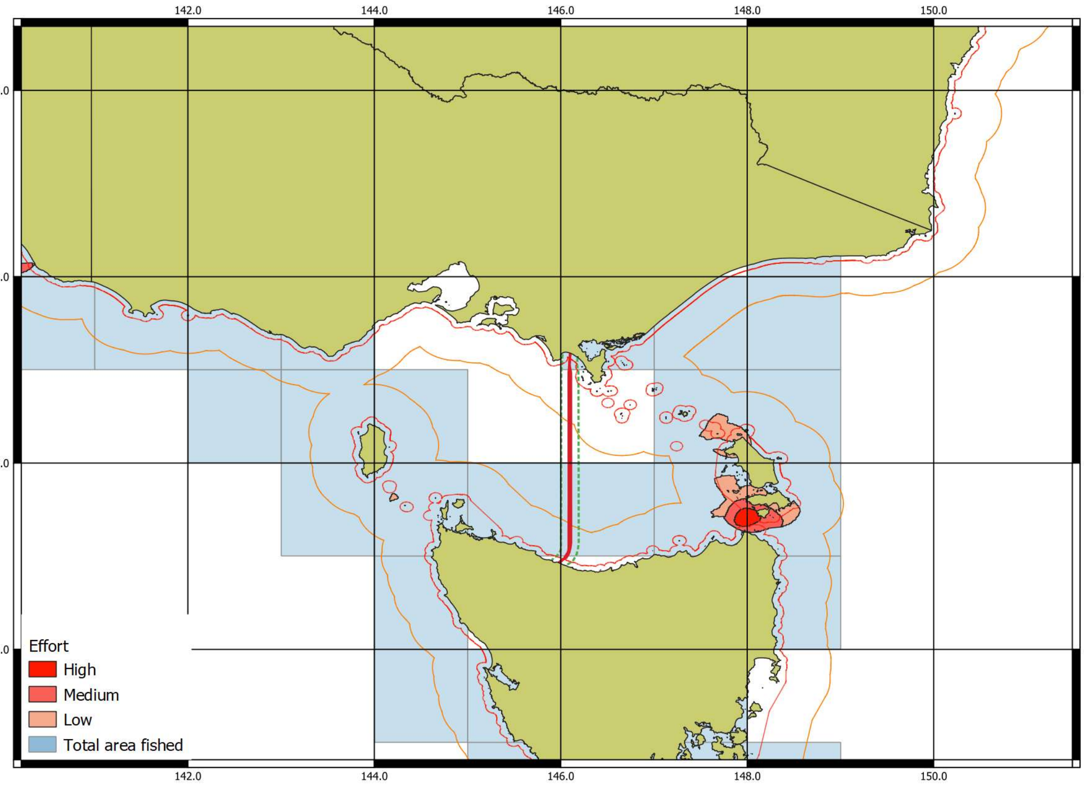
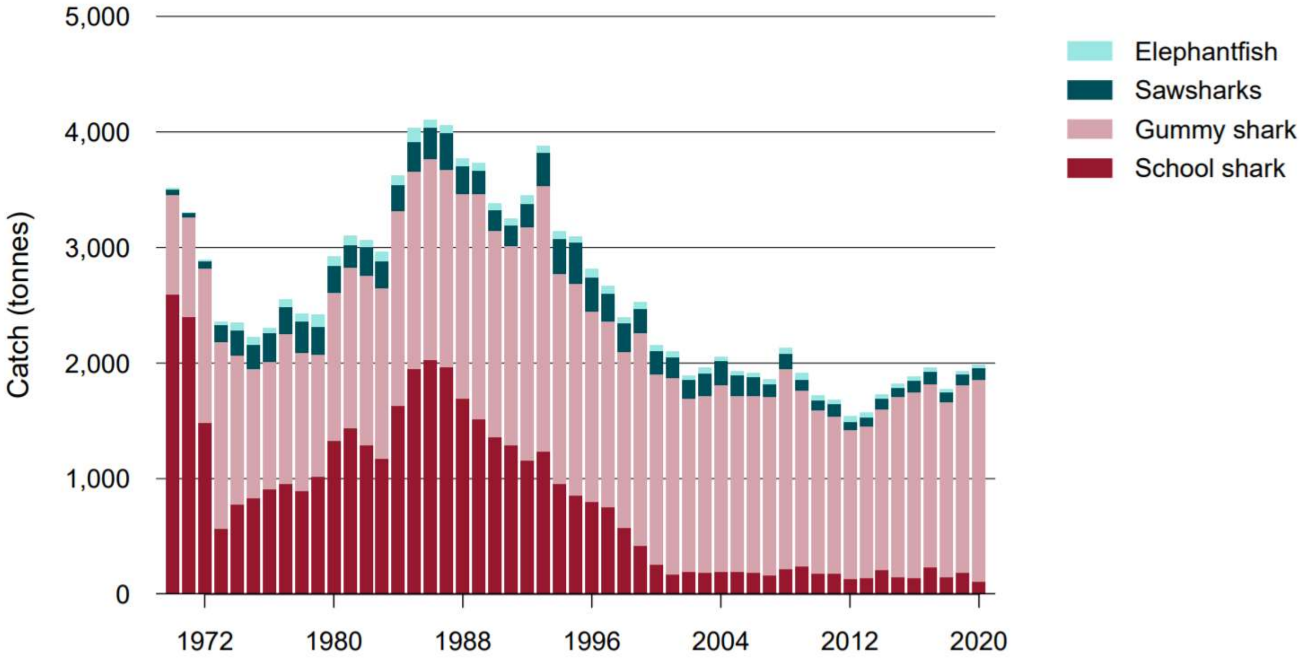


Figure 25. Relative fishing effort intensity by the Shark Hook Sector during 2020–2021 in relation to the study area. Note that effort comprising data of less than 5 vessels has been removed. Data provided by ABARES. Original data source: AFMA

5.1.2.1. Overlap between Shark gillnet and shark hook sector grounds and the study area

Catch in the Shark Gillnet and Shark Hook Sector peaked at more than 4,000 t during 1986, and effort peaked in the following year at more about 120,000 km-lifts (Figure 26) Catch and effort has decreased by more than 50% since, mainly due to declining stocks of School Shark, conservative School Shark management arrangements to promote recovery of that species, and removal of effort through Government-led structural adjustments and closures. Despite this decrease, Gummy Shark landings have increased from 1,288 t in 2012–2013 to 1,695 t in 2020–2021 (Patterson *et al.*, 2020).

Figure 24 shows there was significant recent effort around the study area using demersal gillnets, and some recent effort in the area recorded by shark fishers using demersal longlines (Figure 25). Only one vessel has reported effort using each of auto-longline and demersal longline within the study area since 2011-12, so to maintain confidentiality, data from this vessel was be combined with data from gillnet effort. A summary of catch and effort from the study area by shark gillnet and shark longlines combined is shown Table 7. Over 2011–12 to 2020–21, a total of 36 different shark gillnet and shark hook sector vessels fished in the study area. From 913 shots, 152 t with an estimated value of $1.1 million was caught. Main species caught were gummy shark (36 vessels, 69%), school shark (32 vessels, 14%) and elephant fish (29 vessels, 7%) (Table 7 and Figure 27).



Note: **SGSHS** Shark Gillnet and Shark Hook sectors
Source: Multiple sources (1970 to 2015); AFMA catch disposal records (2016 to 2020)

Figure 26. Catch and effort in the Shark Gillnet and Shark Hook Sector since 1970 (Patterson et al., 2021).

Table 7. Shark gillnet and shark hook sector effort, catch, catch value and main species caught within the AFMA data area from 2011–12 to 2020–2021. Original data (source: AFMA).

YEARS INCLUDED	2011–12 to 2020–21
Number of different vessels	36
Total shots	913
Total catch (t)	152 t
Total value	$1,122,574
Main species caught	Gummy shark (69%)
	School shark (14%)
	Elephant fish (7%)
Fishing methods used	Gillnet
	Longline
	Auto-Longline

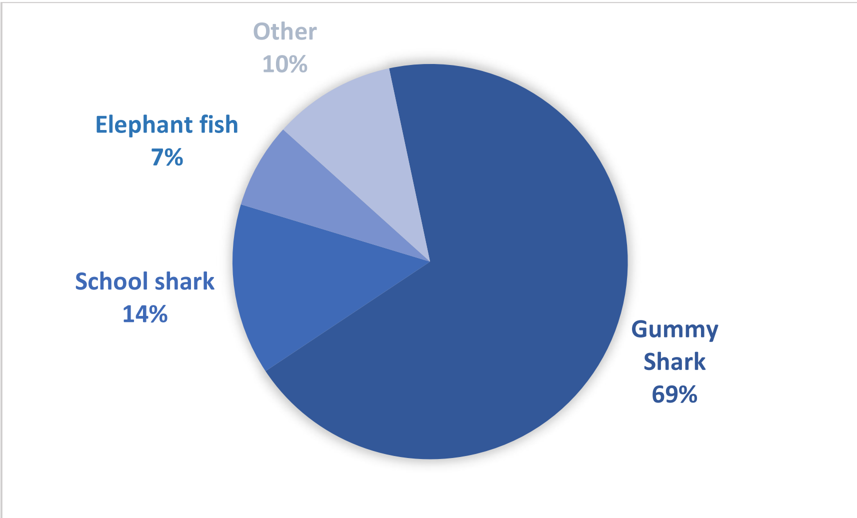


Figure 27. Main species caught in the study area from 2011–12 to 2020–21 by the Shark Hook and Shark Gillnet subsectors of the Gillnet, Hook and Trap Fishery. Note the minimum number of vessels that caught any one species shown was 28. Original data source: AFMA

The number of vessels fishing in the study area in any one year since 2011–12 ranged from 9 to 16 (Figure 28). Annual effort has fluctuated since 2011–12 in the study area, with a maximum of 131 shots in 2015-16 and a minimum of 62 in 2019–20. Annual catch has fluctuated in a similar way to effort (Figure 28). The highest annual catch was more than 27 t in 2015–16, and the lowest in 2013–14 at 6.6 t. Because of the small number of species dominating the catch, annual value closely follows catch (Figure 28). Since 2011– 12, annual catch value from the study area ranged about $47,000–$204,000.

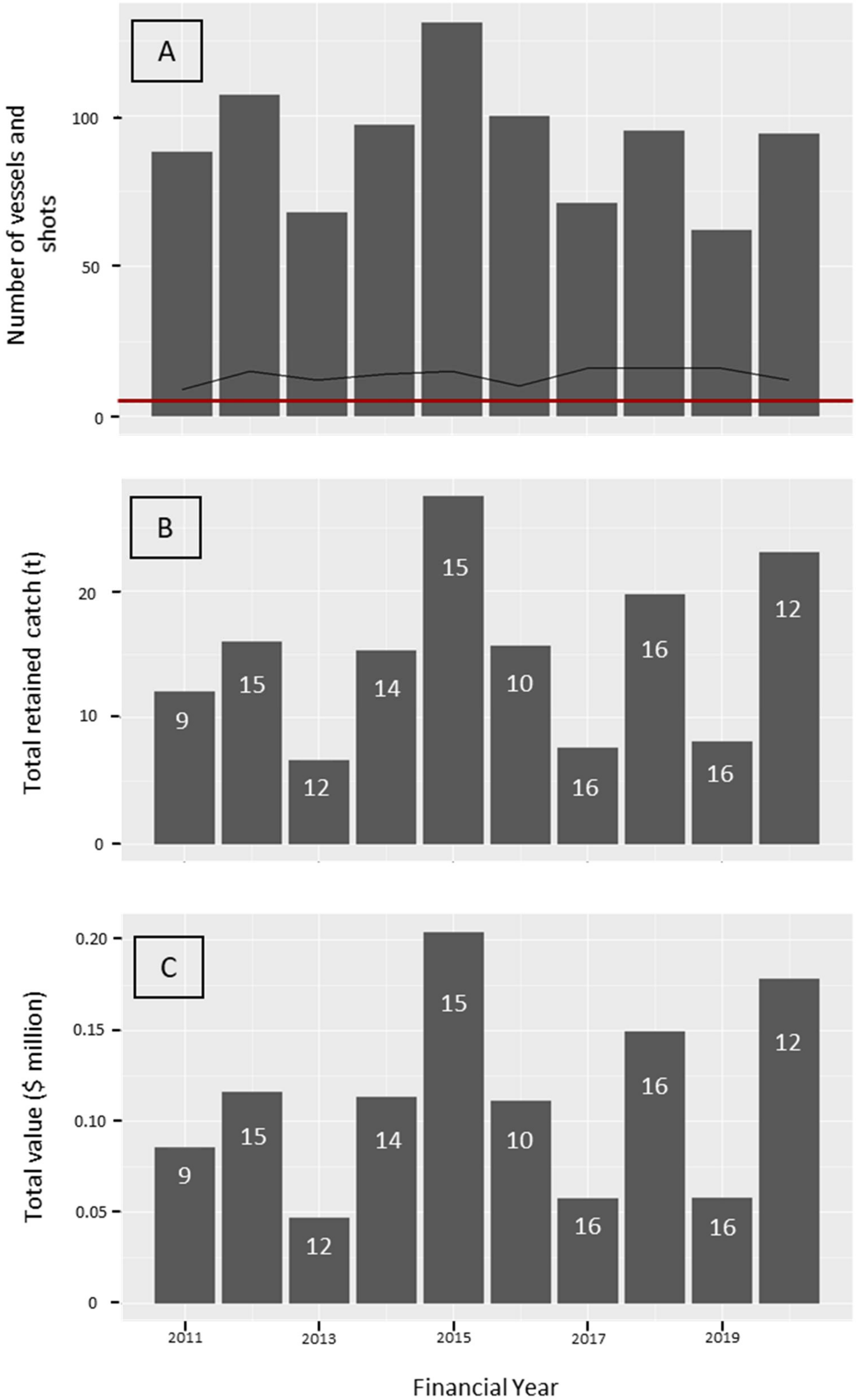


Figure 28. Effort, retained catch and annual value of Shark Gillnet and Shark Hook vessels in the Gillnet, Hook and Trap Fishery during 2011–12 to 2020–21. A) Number of vessels which recorded effort represented by the black line and bars representing number of shots, the horizontal red line intercepts the y-axis at 5 . B) Annual retained catch within the study area represented by bars. Estimated annual values ($ million) of fish landed within the study area in each year. Number of vessels annotated on bars in A, B and C. Financial year is displayed as the year in which the financial years started (i.e., the 2011–12 financial year is displayed as 2011). Original data source: AFMA

5.1.2.2. Likelihood of fishing grounds developing in the future

There are 74 shark fishery permits, 13 of which are shark hook specific, the remainder are shark gillnet and shark hook permits. In 2020-21 there were 61 permits used; 31 shark gillnet and 38 shark hook, offering considerable latent effort in the fishery (Patterson *et al.*, 2021). However, 100% of the gummy shark TAC was caught during the 2020–21 season and would likely be a limiting factor in the expansion of effort. Given that most (or all) of the TAC for gummy shark is caught, it is unlikely that there will be a significant increase in fishing effort in that area in the next 5 – 10 years. However, since 2016 there has been an increase of effort in the fishery off East Gippsland brought about by a displacement of effort from South Australia due to changes in management arrangements. Additional changes to management arrangements could further displace effort to the east.

The Southern Shark Industry Alliance (SSIA) is the relevant industry association. Contact details for these industry associations are provided in Table 3.

5.2. Southern Squid Jig Fishery

Both fishing effort and the number of vessels participating in the Southern Squid Jig Fishery have declined significantly since 1996 (Figure 29). Poor domestic prices and high fuel costs have resulted in many operators choosing to avoid fishing for squid (Wilson *et al.*, 2009), and consequently, there were only five active vessels out of 36 concessions (95% latency) used during 2020 (Patterson *et al.*, 2021). Together they landed 67 t of squid (Figure 30) with a GVP of $0.35 million in that year.

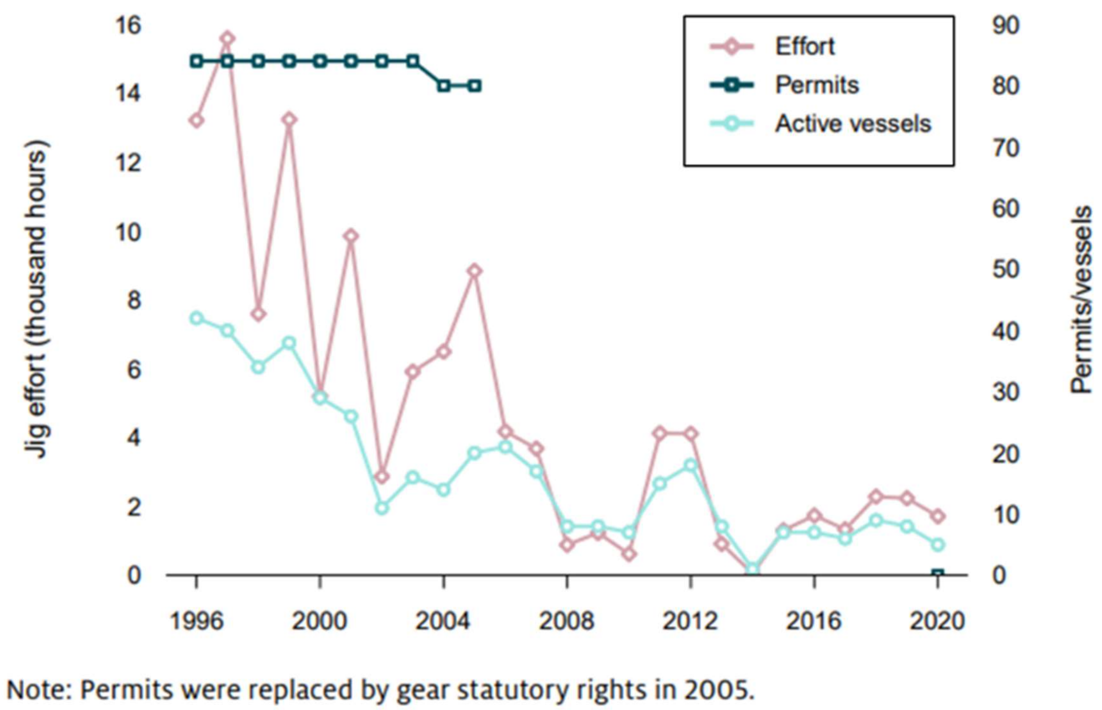


Figure 29. Number of permits, active vessels and fishing effort by the Southern Squid Jig Fishery since 1996 (Patterson et al., 2021).

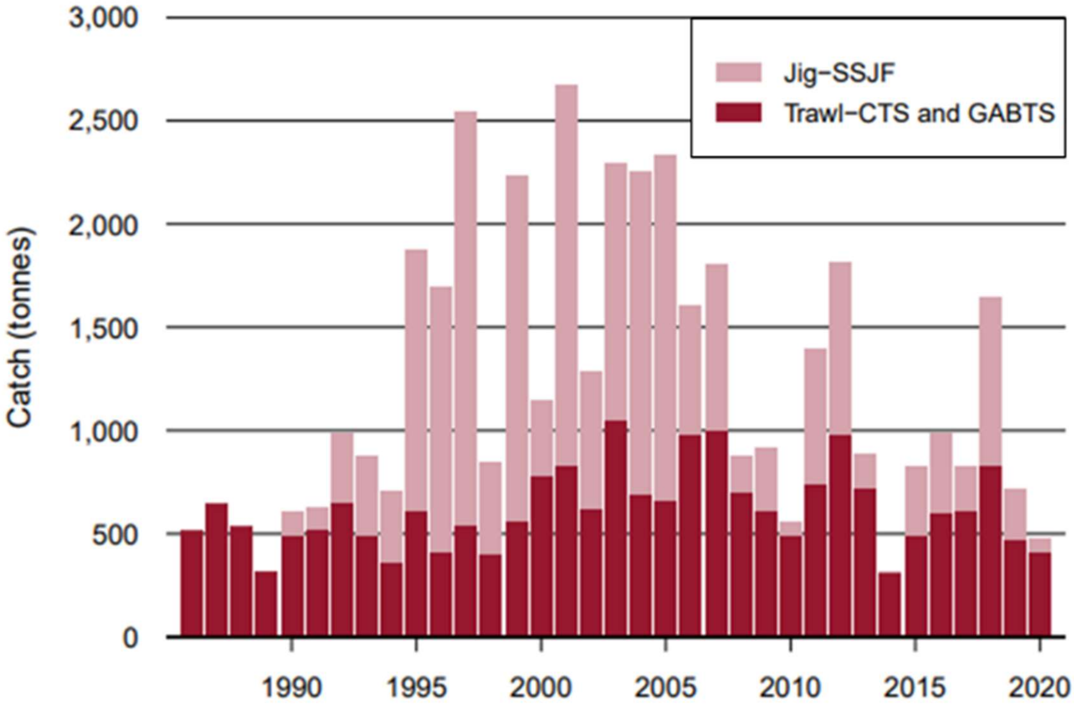


Figure 30. Catch and effort they the Southern Squid Jig Fishery, Commonwealth Trawl Sector and Great Australian Bight Trawl Sector since 1986 (Paterson et al., 2021).

5.2.1. Overlap between Southern Squid Jig Fishery and the study area

Since 2011–12, 10 Southern Squid Jig Fishery vessels have recorded effort that overlapped with the study area (Figure 31, Table 8). From 46 days of fishing, 129 t of Gould squid was landed valued at $514,948.

Table 8. Southern Squid Jig Fishery effort, catch, catch value and main species caught within the AFMA data area. Original data source: AFMA

YEARS INCLUDED	2011–2012 to 2020–2021
Number of different vessels	10
Total days fished	46
Total catch (t)	128.7 t
Total value	$514,948
Main species caught	Gould's squid
Fishing methods used	squid jigs

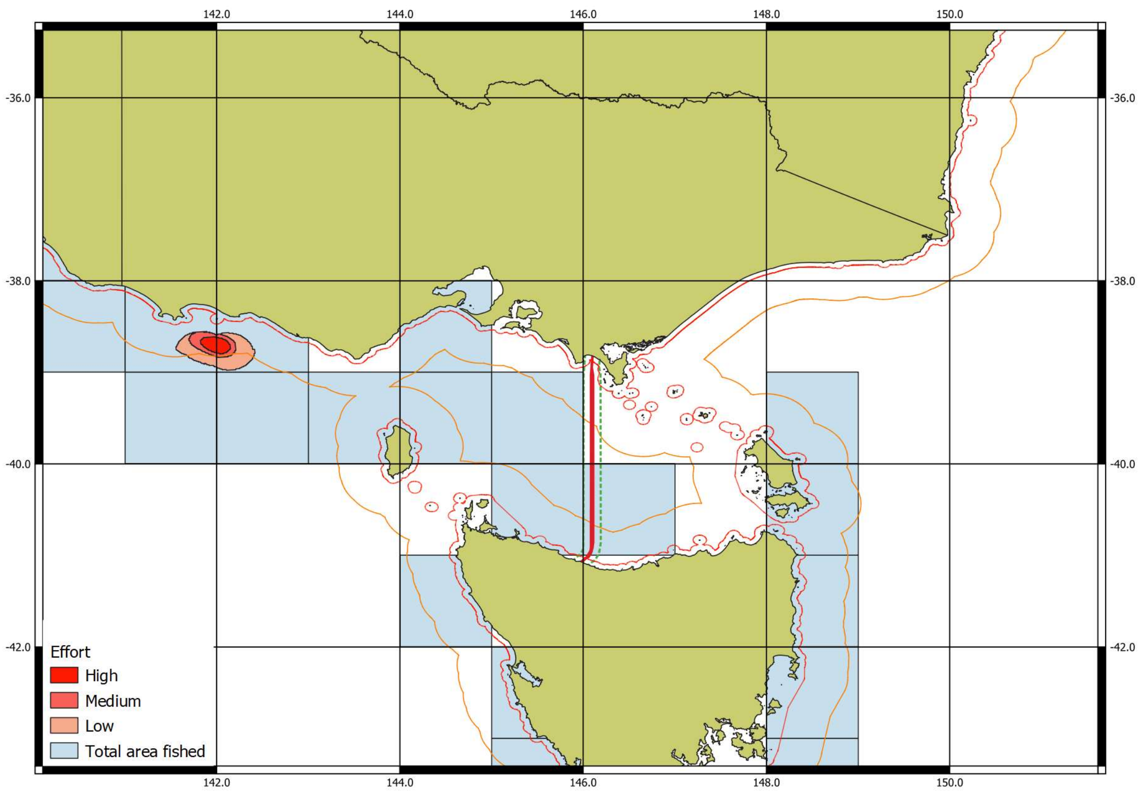


Figure 31. Area fished by the Southern Squid Jig Fishery in relation to the Marinus Link study area during 2020. Note that effort comprising data of less than 5 vessels has been removed. Data provided by ABARES. Original data source: AFMA

5.2.2. Likelihood of fishing ground developing in the future

The development of this fishery will depend on squid prices and the cost of fishing in Australia. Being short lived, squid are a "boom or bust" fishery, and if environmental conditions are right, fishing effort could increase greatly in a short amount of time. Very recent anecdotal information suggests that the price for Gould's squid has increased, and this has resulted in some increase in effort in the fishery in recent years. It is uncertain if this effort is taking place inside the study area.

There is no Southern Squid Jig Fishery Association, but we have provided contact details for some operators in the fishery in Table 3.

5.3. Victorian Abalone Fishery

The area of the Victorian abalone fishery extends along the Victorian coast below the low water mark. While the area available extends into Commonwealth waters (greater than 3 nm offshore), most fishing is conducted in State waters, at depths shallower than 30 m (Anon, 2009), but mostly 5–20 m. The Victorian coastline is split into three zones, and multiple management areas called reef codes.

5.3.1. Overlap between Victorian Abalone Fishery and the study area

The study area is in the Central Zone and overlaps with reef codes 16.07, 16.06 and 16.05; however, the study area only directly overlaps with reef code 16.07 (Figure 32). Since 2011–12, only one fisher has reported effort from one or two days' fishing in reef code 16.07 in any one year and so the catch cannot be reported here due to confidentiality. Years fished were 2013–14, 2014–15, 2016–17 and 2020–21. The total catch on those years was less than 2.2 t.

The contact details for the Executive Officer of Abalone Victoria (Central Zone) is listed in Table 3.

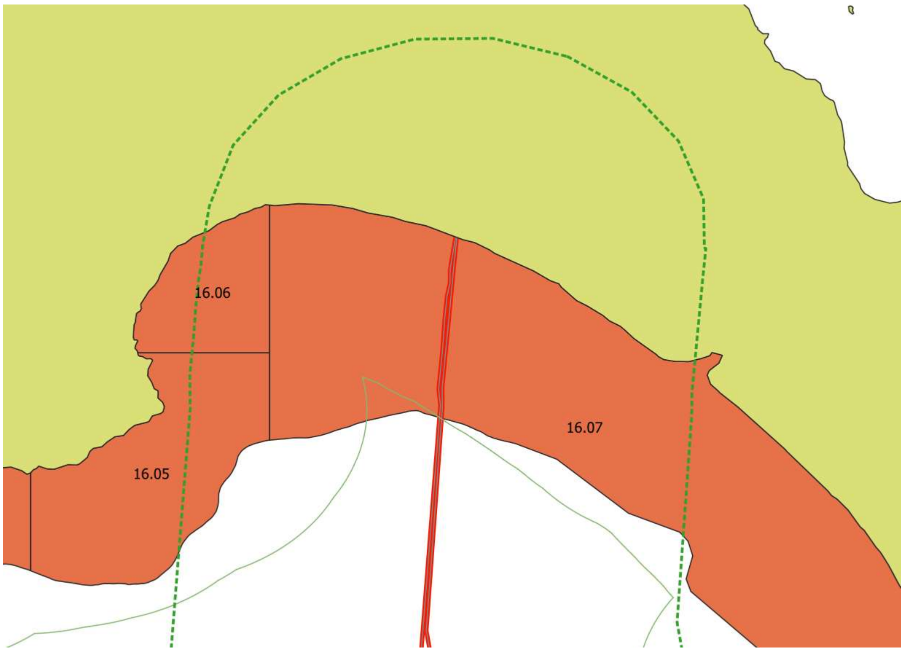


Figure 32. The study area in relation to Victorian abalone reporting reef codes. The study area overlaps with reef codes 16.05, 16.06 and 16.07. The proposed Marinus Link only overlaps with 16.07

5.3.2. Likelihood of fishing ground developing in the future

The coastline at the Marinus Link's location is a sandy shoreline with scattered offshore reefs. This is not habitat that supports a highly productive abalone fishery, as evidenced by the lack of effort in the area. It is unlikely that the level of fishing effort in this reef code will increase in the future.

The 34 Central Zone Victorian abalone fishery licence holders are represented by Abalone Victoria. Contact details are shown in Table 3.

5.4. Victorian Ocean General Fishery

The Victorian Ocean General Access Licence authorises the 152 licence holders (Victorian Fisheries Authority, 2020) to carry out fishing activities using a variety of gear types in marine waters other than Port Phillip Bay, Western Port, Gippsland Lakes and any inlet of the sea. Gear types permitted include line methods (dropline, long line, hand line), dip net, bait traps, octopus traps, landing nets, gaffs, seine nets, mesh nets and bait pumps. This fishery can land fish (mostly snapper, octopus and gummy shark) other than abalone, pipis, jellyfish, southern rock lobster, giant crab, commercial scallop and sea urchins. The main management methods are input controls including limited access and gear restrictions. The fishery usually conducts day trips operating out of small vessels (<10 m) and may fish at anchor or underway.

5.4.1. Overlap between Victorian Ocean General Fishery and the study area

Effort from the Ocean General Fishery was recorded from reporting grids that overlapped with the study area in 2011–12, 2013–14, 2014–15, 2016–17 and 2019–20. In each of those years, only one fisher reported one or two days of fishing for each species caught. Species caught were pipi, King George whiting, unspecified mullet, unspecified flathead, unspecified pike, leatherjacket, red mullet, Australian salmon and barracouta. Of these species, pipis were caught in the greatest quantities and fishing was only reported from reporting grids H31 and J31 (see Figure 33).

5.4.2. Likelihood of fishing ground developing in the future

There is considerable latent effort in the Ocean Fishery General Access, and it is uncertain what might trigger those licenses to become active.

Victoria's Ocean Fishery General is represented by Seafood Industry Victoria (SIV). Contact details for this industry association are provided in Table 3.

5.5. Victorian Wrasse Fishery

There are 22 Victorian Ocean Wrasse Fishery licence holders (Victorian Fisheries Authority, 2020). They use hand lines to target bluethroat wrasse and purple wrasse from reef habitats. Main management methods are input controls including limited access and gear restrictions. Fishers usually conduct day trips operating out of small vessels (<10 m) and may fish at anchor or underway. Wrasse are generally caught in relatively shallow water.

5.5.1. Overlap between Victorian Wrasse Fishery and the study area

In each of 2016–17, 2018–19 and 2019–20 only one fisher reported effort in the Ocean Wrasse Fishery. In those years, 2, 10 and 8 days of fishing were reported respectively. Only bluethroat wrasse were landed. Of all species caught by Victorian fisheries in reporting grids that overlapped with the study area, bluethroat wrasse were caught in the greatest quantity.

5.5.2. Likelihood of fishing ground developing in the future

Wrasse are associated with reefs and other structures. Rock mattresses which may cover unburied sections of the Marinus Link could provide a habitat for wrasse. If this is the case, Ocean Wrasse Fishers may target wrasse over the Marinus Link.

Victoria's Ocean Wrasse Fishery is represented by Seafood Industry Victoria (SIV). Contact details for this industry association are provided in Table 3.

5.6. Victorian Rock Lobster Fishery

The Total Allowable Catch (TAC) for the VIC Rock Lobster Eastern Zone was 40 t in 2019–2020 (Victorian Fisheries Authority, 2020). Catches in the Eastern zone have ranged between 35–149 t since 1982–1983 (Victorian Fisheries Authority, 2020). During 2019–2020, a total of 35 t of Southern Rock Lobster was landed from the Eastern Zone with a value of $4,112,000 (Victorian Fisheries Authority, 2020). In comparison, 222 t was landed from the Western Zone.

Effort during 2019–2020 in the Eastern Zone was highest in December (14,000 pot-lifts), and apart from the closed season, effort was lowest during April (3,000 pot-lifts) (Victorian Fisheries Authority, 2020). As of June 2020, there were 32 Fishery Access Licences in the Eastern Zone (Victorian Fisheries Authority, 2020).

5.6.1. Overlap between Victorian Rock Lobster Fishery and the study area

Only one Victorian Rock Lobster Fishery operator fished in reporting grids that overlapped with the study area in any one year during 2015–16 and 2017–18, fishing a total of four days. Reporting grids from which effort was reported were J31 and K31 (reporting grids demonstrated in Figure 33).

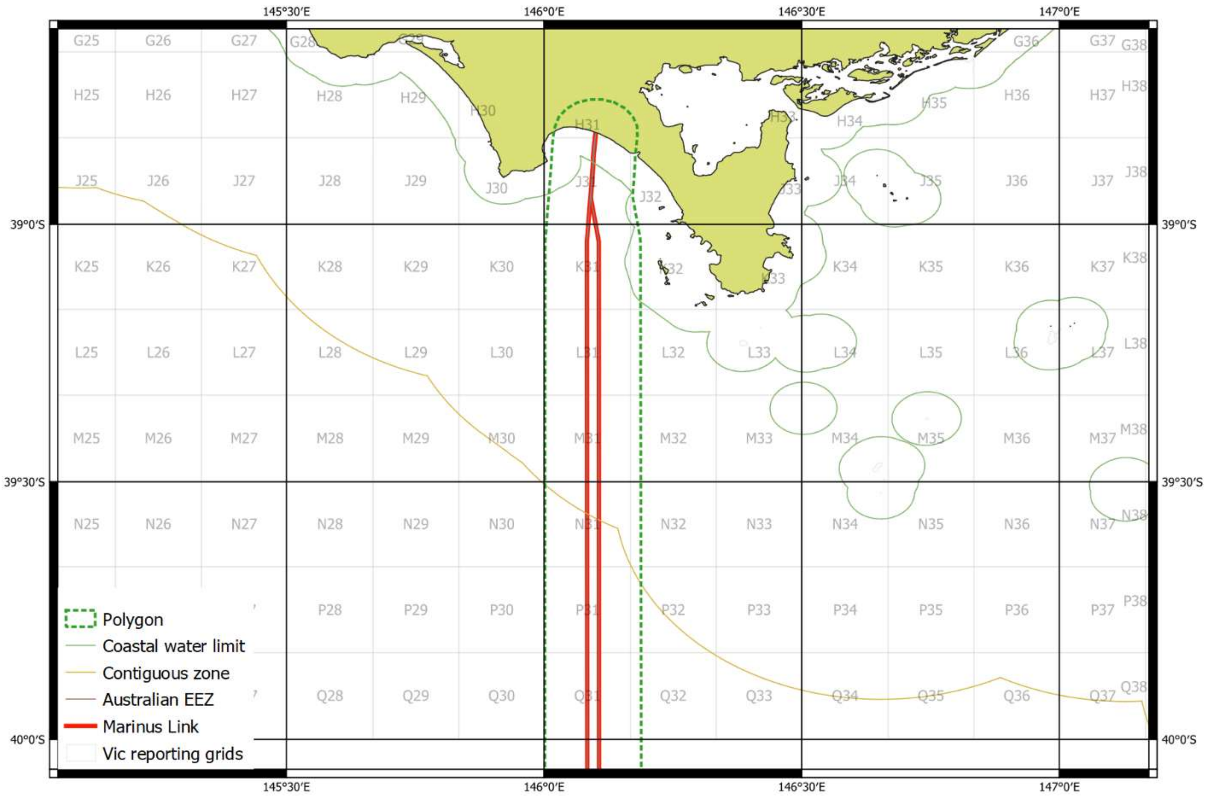


Figure 33. Study area with Victorian reporting grids

5.6.2. Likelihood of fishing ground developing in the future

The TAC for the Victorian Rock Lobster Fishery in the Eastern Zone has decreased from 66 t in 2011–2012 to 40 t in 2019–2020 (Victorian Fisheries Authority, 2020). The fishery is considered to have recovered after over-exploitation and was assessed as sustainable by Linnane *et al.* (2021), but it is unlikely that there will be large increases in the TAC in the near future because of continued decrease in catch per unit effort (CPUE) (from 0.56 kg/pot-lift in 2014–2015 to 0.41 kg/pot-lift in 2019–2020). Therefore, it is unlikely that there will be significant expansion of fishing effort in the study area in the next 5-10 years, especially considering the decline in effort in the area since 2006.

The Victorian Rock Lobster Association and Seafood Industry Victoria represent Victorian Rock Lobster Fishery. Eastrock represented quota owners and some operators in the eastern zone of the Rock Lobster Fishery. Contact details for these associations are provided in Table 3.

5.7. Tasmanian rock lobster fishery

The TAC for the 2021–22 season is 1050.7 t, and as of 30 November 2021, 63% of that TAC had been caught. There were less than 200 active fishers during 2016–17 (Hartmann *et al.*, 2019). Annual catch of Southern Rock Lobster has decreased from nearly 1,500 t in 2008–09, to just over 1000 t during the 2017–18 quota year (Figure 34). Percent of TAC caught dropped to 91% in 2010–11, but has since been about 98% with the exception of the 2019–20 season when the TAC was about 8.5% under caught. Most of the catch comes from 0–40 m depth, some catch is taken from as deep as 200 m (Environment Australia, 2001).

5.7.1. Overlap between Tasmanian Rock Lobster Fishery and the study area

Only a small amount of catch and effort was reported by the Tasmanian Rock Lobster Fishery in reporting blocks that overlap with the study area. Data cannot be reported to maintain confidentiality.

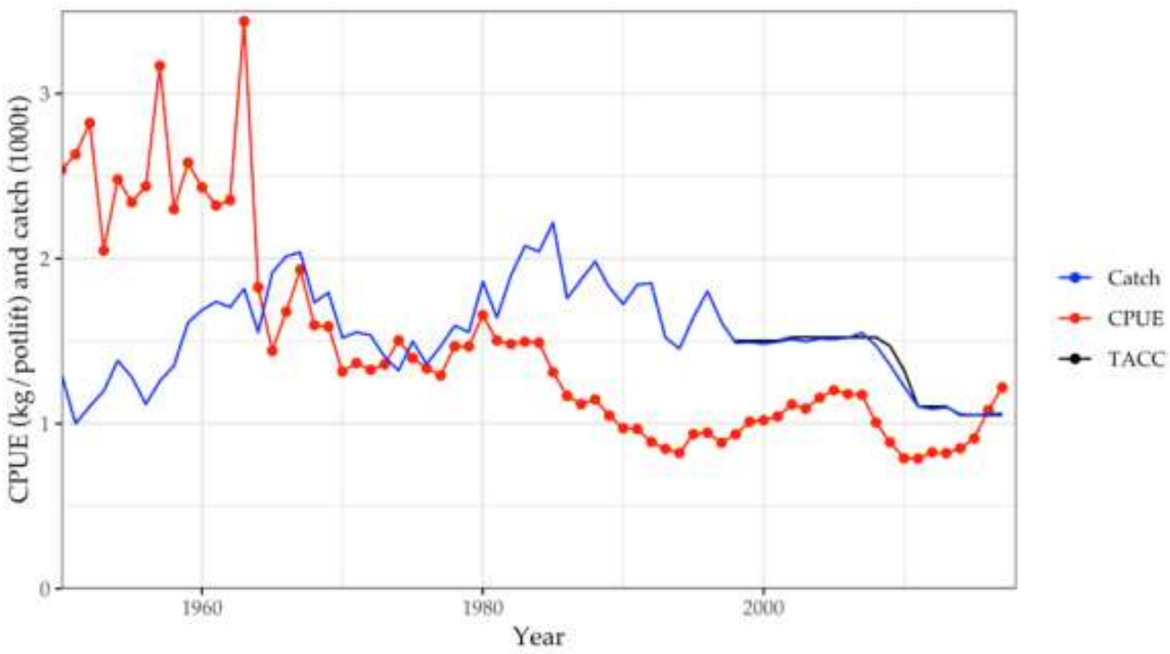


Figure 34. Annual catch, TAC and catch per unit effort (CPUE) of Southern Rock Lobster by the Tasmanian Rock Lobster Fishery since the inception of the ITQ system. From Hartmann et al., (2019)

5.8. Tasmanian Abalone fishery

From a TAC of 1018.5 t in 2020, 925.7 t and 85.4 t of blacklip and greenlip abalone, respectively, were landed (Mundy and McAllister, 2021). Catches by the Tasmanian Abalone Fishery reached as high 4,500 t in 1984, dropping to about 2000 t 1989 to 1996 (Figure 35). Annual catches then averaged at around 2,500 t until 2011, after which they steadily declined to about 1,000 t due to declining stocks.

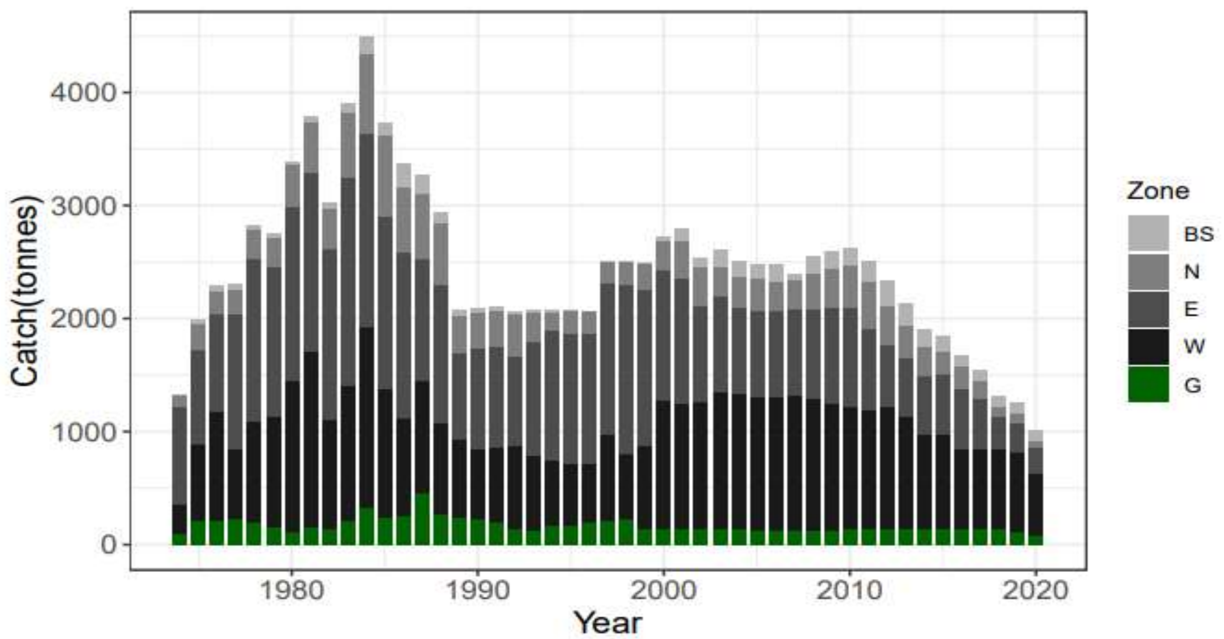


Figure 35. Annual catch of Blacklip ana Greenlip abalone since 1974 (Mundy and McAllister, 2021).

5.8.1. Overlap between Abalone and the study area

Marinus link overlaps with abalone reporting blocks 44 and to a very small extent 45 (Figure 36). Annual catches of Blacklip abalone reported from each of those blocks has been up 1.5 t since 2011, and in 2019 was 0.1 and 0.4 t respectively (Mundy and McAllister, 2021). Annual time series of catches from block 45 is shown in Figure 37.

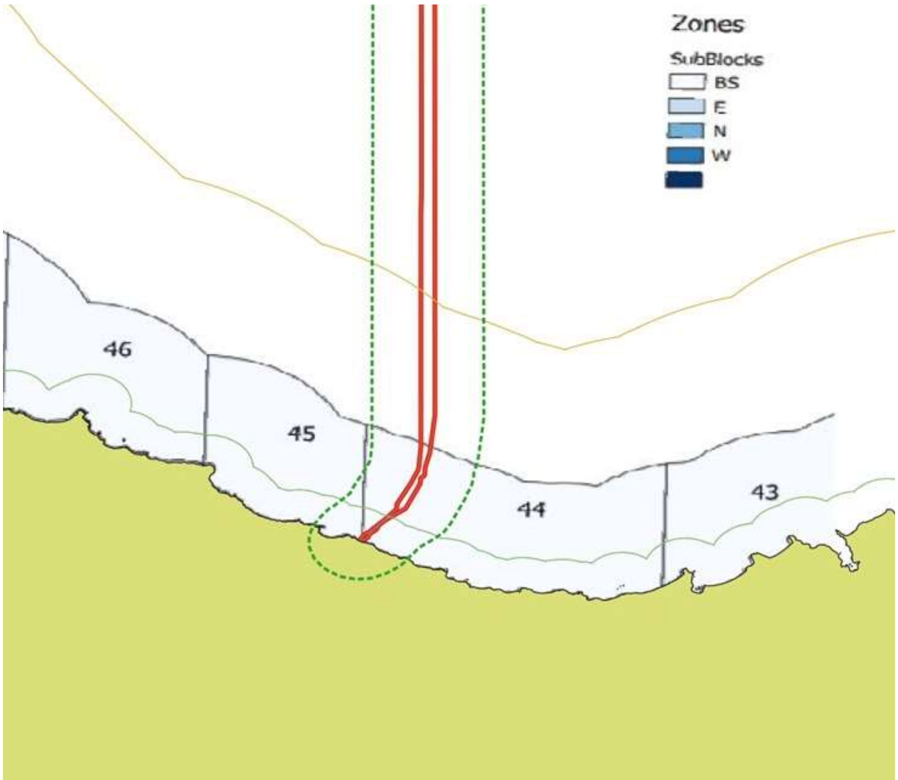


Figure 36. Overlap of Marinus link and study area and the Tasmanian abalone reporting grids

No greenlip abalone has been landed in block 45 since 2011, while only a small amount has been landed in block 44. Mundy and McAllister (2021) round catches reported in tables to the nearest whole tonne, and for block 44 they report 0 t (less than 500 kg) of catch in five years since and including 2011.

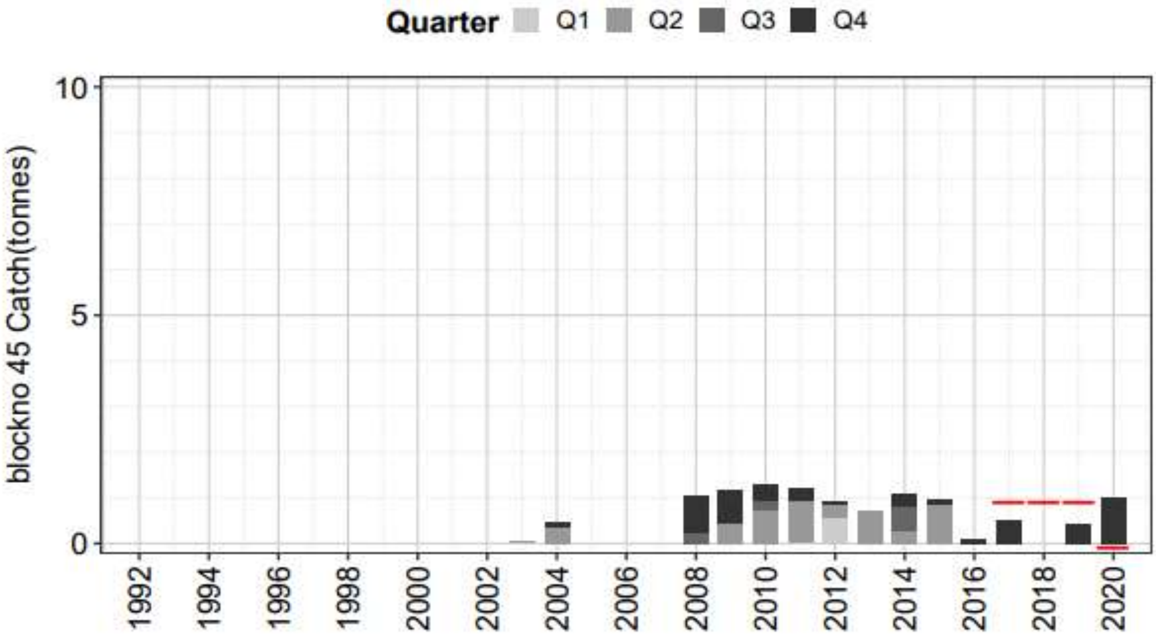


Figure 37. Annual catch of blacklip abalone since 1992 in block 45, red line depicts the un-standardised CPUE (from Mundy and McAllister, 2021). Note that Mundy and McAllister (2021) did not include a figure for block 44.

5.9. Tasmanian Scalefish Fishery

More than 90 different species are reported in the TAS Scalefish Fishery catch logbook. Catch of scalefish has been declining since the late 1990s from about 1,300 t to 178 t in 2019–20 (Fraser, *et al*., 2021). Catch of cephalopods (mostly Southern Calamari and Gould's squid) has fluctuated annually, being as high as 1140 t in 2012–13 and as low as 27 t in 1996–97. Annual catch of small pelagics has also fluctuated largely from year to year. In 2008–09, 1,456 t of small pelagics (mostly Jack Mackerel and Redbait) was landed, while in 2018–19 only 0.4 t was landed. These numbers are likely from Danish seine, since there is no state licensed trawling. Shark catch has decreased from 1,221 t in 1995–96 to less than 20 t since 2007–08.

5.9.1. Overlap between TAS Scalefish Fishery and the study area

A total of 25 different vessels reported catch and effort in reporting blocks (overlap shown in Figure 38) that overlapped with the study area during 2011–12 to 2020–21. Those fishers reported 482 days of fishing and caught 50.8 t of fish valued at $306,145. Catch and effort fluctuates annually, largely influenced by catches of Gould's squid and southern calamari. Gould's squid (58%) dominated the catch followed by southern calamari (28%), bluethroat wrasse (10%) and gummy shark (3%) (Figure 39).

Both squid species are caught by a variety of methods including squid jigging, Danish seine, purse seine, and beach seine, there was no fishing under Tasmanian trawling licences.

While dominating the catch, Gould's Squid were only reported during two years since 2011, including 2019–20 (Figure 40) Annual catches of Southern Calamari were more consistent (Figure 41) being caught in each year since 2011-12. Both bluethroat wrasse and purple wrasse were caught in reporting grids that overlapped with the study area, with consistent catches reported in each year since 2011–12 (Figure 42)

Figure 38. Overlap of Marinus link and study area and the Tasmanian Scalefish Fishery reporting grids

Table 9. Tasmanian Scalefish Fishery effort, catch, catch value and main species caught within the AFMA data area. Original data source; AFMA.

YEARS INCLUDED	2011–2012 to 2020–2021
Number of different vessels	25
Total days fished	482
Total catch (t)	50.8 t
Total value	$306,145
Main species caught	Gould's squid Southern Calamari Bluethroat Wrasse
Fishing methods used	Squid jigs Minor line

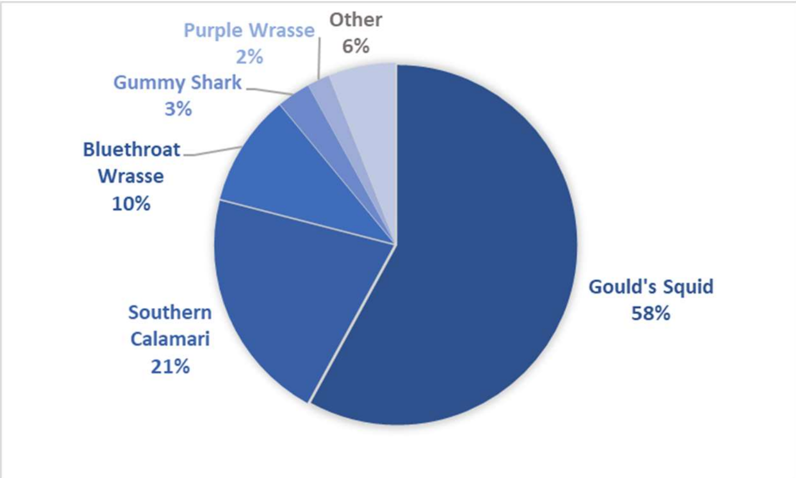


Figure 39. Catch of main species from grids that overlap with the study area from 2011-12 to 2019-20

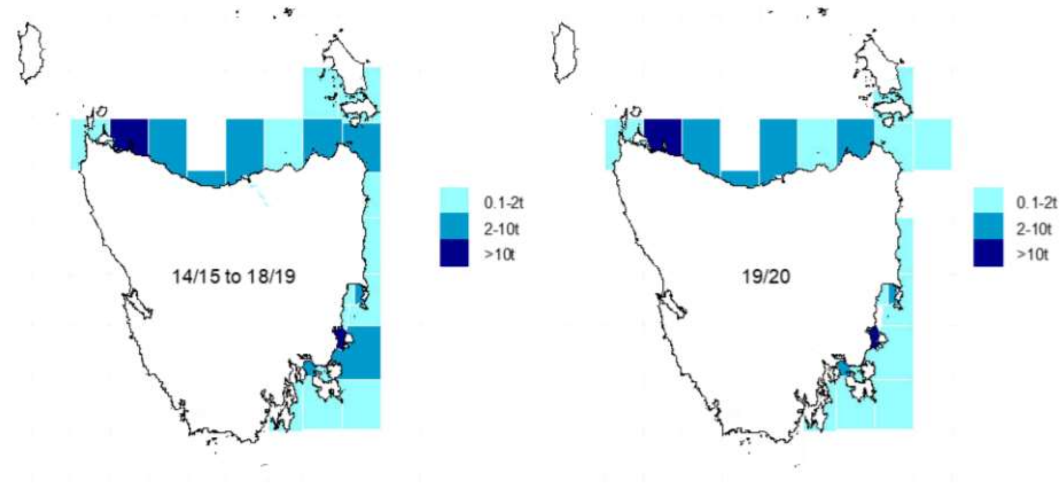


Figure 40. Catch of Gould's squid from 2014–15 to 2018–19 (left) and 2019–20 (right). Data includes Australian Fisheries Management Authority (AFMA) catch in Tasmanian state waters. From Fraser et al., 2021.

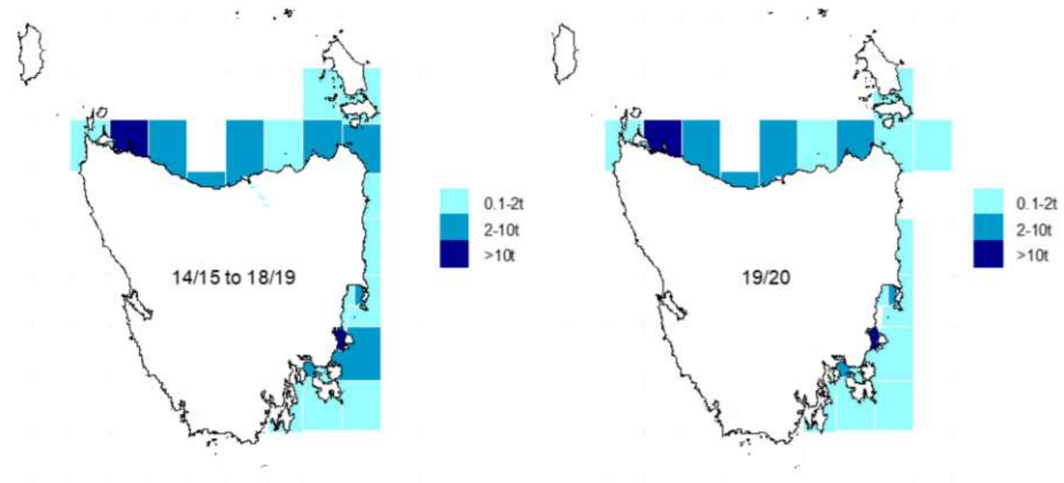


Figure 41. Catch of southern calamari from 2014–15 to 2018–19 (left) and 2019–20 (right). From Fraser et al., 2021.

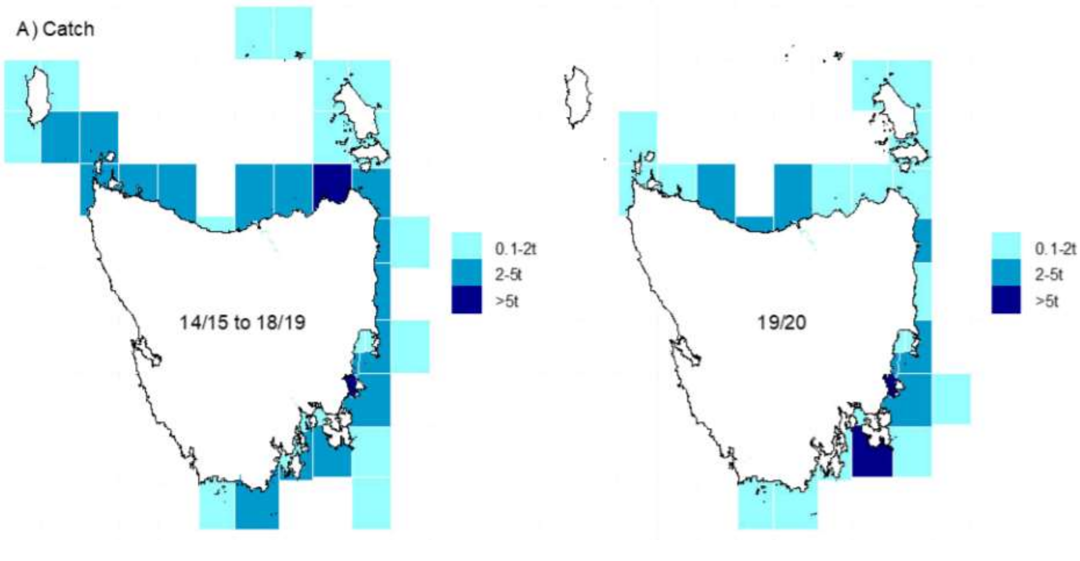


Figure 42. Catch of wrasse from 2014–15 to 2018–19 (left) and 2019–20 (right). From Fraser et al., 2021.

6. SEASONALITY, BASSLINK AND INDUSTRY CONCERNS

6.1. Seasonality

Seasonality is limited for most fishing sectors within the study area. Gummy shark fishing peaks each month around moon phase rather than a season within a year. The Tasmanian Scalefish Fishery and the Commonwealth Trawl Sector operate year-round. They are multi-species fisheries that do not have strong seasonality patterns of catch. There are, however, anecdotal reports on the Tasmanian Squid Jig sector, which suggest that this fishery predominately operates between December and January.

6.2. Basslink learnings

SETFIA has been in existence for nearly 35 years and under previous management was a key stakeholder involved in the establishment of the Basslink cable (which runs north-south to the east of the proposed Marinus link). Basslink became operational in 2006. A search of historical SETFIA files has returned several mentions in minutes from 2003-2004 relating to the development of a Code of Conduct about commercial fishing. This code is reproduced in Appendix A. This code:

a) offers free electronic chart overlays,

b) prior to installation, vessels using shark gillnets to fish in the area of the Basslink interconnector were offered alternative 'claw' type anchors, to reduce the likelihood of damage to the interconnector in the event of a hook-up and risk to vessel safety,

c) suggests anchoring around the cable should be avoided,

d) sets down that commercial fishers should know where the cable is,

e) states that shark gillnets should be set on the downwind side of the cable but notes that the cable is over-fishable with gillnets,

f) states that trawl and scallop gears should not over-fish the cable (note that trawl is present in the data),

g) states that if a fishing vessel's gear becomes fast (stuck) that they should not attempt to lift the cable but rather the gear should be buoyed and Basslink notified,

h) explains that fishing vessels can claim for lost anchors,

i) the code provides an emergency phone number to call if a fishing vessels experiences a problem. This number was answered in 2019 during a data project undertaken by SETFIA for a proposed windfarm.

SETFIA has not revisited the code in more than 17 years, but it is likely that many of the points above remain valid. The project recommends that during stakeholder engagement, information on the operational experience of the Basslink Code of Conduct should be followed up with the relevant fishing operators, and directly with Basslink as necessary, to inform a decision on the need to implement similar arrangements for the Marinus Link.

6.3. Industry concerns

Data acquisition was via fishery management agencies, therefore there was no opportunity to accept anecdotal comments from fishermen about any potential concerns. The scope of the project was not to undertake consultation directly with fisheries. The nature of this deliverable was opportunistic and yielded no data.

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APPENDIX A

Code of Conduct

1. Know Where the Cables are

The cables are laid between McGaurans Beach in Victoria and Four Mile Bluff (east of Low Head at the mouth of the river Tamar) in Tasmania. They run from McGaurans Beach to the west of the Hogan group and from there almost due south to Tasmania. *Basslink* is one of many cables in Bass Strait and is marked on marine charts in the standard way.

Highly accurate chart overlays for many types of GPS plotters can be obtained free of charge from *Basslink Pty Ltd*.

The map on this brochure shows the approximate position of *Basslink*. Please take the time to study its location and mark up your official charts using the appropriate Notice to Mariners.

2. Anchoring

Anchoring in the vicinity of the cables should be avoided unless absolutely essential as this is one of the main causes of damage to cables around the world.

Basslink Pty Ltd are keen to encourage the use of anchors that minimize dragging and reduce the risk of contact with the cables. Of the various types of anchors in use in Bass Strait, the Bruce and Manson Ray designs provide optimum security with high holding capacity with a low penetration profile.

Mariners should ensure that they use a proprietary brand anchor that is the correct size and design. It is imperative that 'home made' anchors are not used and that adequate chain and warp is laid out for the depth of water.

AMSA's National Code for Commercial Vessels Part C, Section 7, Subsection 7D specifies anchoring equipment for effective at sea mooring.

As a further precaution, the anchor drag alarm on your vessel's GPS system should be set.

3. Fishing and Sailing

Before setting out, check the position of *Basslink* in relation to your intended fishing and sailing area. *Basslink* is buried to minimise the risk of damage from fishing gear and anchors but does not eliminate it.

The seabed is a dynamic environment and it is possible that buried sections of the cables will become unburied over time, particularly after major storms. Although there are checks made by *Basslink Pty Ltd* of the burial status of the cables from time to time, this doesn't mean that all cable exposures will be identified. Mariners are always advised to be extremely cautious if in the vicinity of the cable route.

The *Basslink Pty Ltd* website and Notice to Mariners are sources of information about any exposure of the cables. http://www.basslink.com.au/responsibility/marine

4. Shark Fishing

When shark fishing and anchoring between hauls assess the risk of your vessel's anchor dragging and deploy a prudent distance from the cables on the lee side according to wind and current.

Basslink can be fished over with shark nets. The nets are to be rigged with Bruce or Manson Ray anchors on the ends and stabilized in between with lead clump anchors. Other stabilizer anchor designs with scrap scallop dredge tooth-bars as flukes should not be used.

5. Fish Trawls and Scallop Dredges

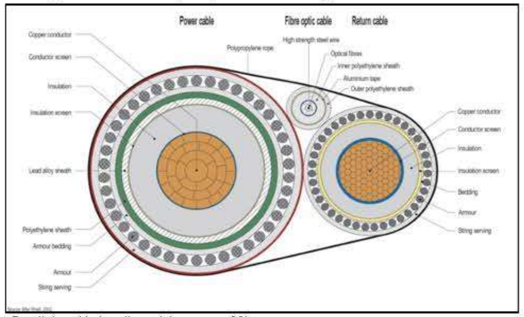
Basslink is buried to reduce the risk of contact with other marine gear but this does not eliminate risk completely. Although the cable is extremely heavy and subsides into sediment, the extreme nature of the Bass Strait environment and its potential to expose the cables is never ignored. Exposure can increase the risk of entanglement with mobile fishing gear, damage the cables, damage the gear and is a danger to people.

Subsea cable repairs are time consuming, costly, require exclusion zones for repair vessels and can be high profile to the public and media because they affect the essential services of the communities they connect. Mariners should be precautionary and not operate mobile gear in the vicinity of the cables.

The *Basslink Pty Ltd* website and Notice to Mariners are sources of information about any exposure of the cables. http://www.basslink.com.au/responsibility/marine.

6. Snagged? What Should I do?

In the unlikely event that you become snagged, be prepared. Know beforehand what to do, how to do it and who to inform. Remember, power cables are extremely heavy and can easily capsize a fishing vessel.



Basslink cable bundle weight approx. 62kg per meter

If you suspect your vessel has become snagged the following steps should be taken to ensure safety of all involved. Avoid using extreme winch power and never attempt to steam away rapidly to jolt free. Either of these actions will result in increased danger to crew, vessel and cables.

If vertical lifting with normal power does not release the gear or anchor then it must be buoyed, position noted, and anchor left, with *Basslink Pty Ltd* notified at the earliest

SETFIA SOUTH EAST TRAWL FISHING INDUSTRY ASSOCIATION sustainable fishing practices protect our future moment on its 24 hour emergency number **1800008767**. There is free replacement of anchors in these circumstances; the claims procedure is listed in section 7 of this brochure.

The discarded anchor assembly will be a navigation hazard so its position should be reported to other mariners in the area, local coast guards, relevant port authorities and fishing co-operatives.

7. How to Claim for Discarded Gear

Basslink Pty Ltd has a free replacement policy to discourage efforts to recover anchors snagged on the cables because of the risk of causing damage to it.

Record as much information as possible about how the incident occurred; it will help speed the process and may help others in the future.

Claim forms are available direct from Basslink Pty Ltd and can be downloaded from:

http://www.basslink.com.au/responsibility/marine

Claims should be submitted for consideration within 14 days of the incident.

Know your location. Catch fish not cables.

8. Map of Basslink

NB: Map provided for illustration purposes. Reference should be made to current information as explained in this brochure.

9. Useful Contacts

Emergency

Australian Maritime Safety Authority Search and Rescue
1800 641 792 (24hr Emergency)

Coast Guard Search and Rescue
(03) 9598 7003

Basslink
1800 008 767 (24hr Emergency)

Information

Basslink Pty Ltd
(03) 96074700 (general enquiries)
www.basslink.com.au

Basslink

International Cable Protection Committee www.iscpc.org
Oceania Submarine Cable Association www.oscagroup.com

Revision Date: September 2017

Code of Conduct for Fishing and Anchoring Safely with Basslink

Overview

Basslink connects Tasmania and Victoria across Bass Strait via two high voltage and one telecommunications cable combined in a very heavy bundle 290km long. It is critical infrastructure for the Tasmanian economy and it is an essential service for the energy security of Victoria.

This voluntary ***Code of Conduct*** is important to your safety as a fisherman or recreational sailor and as well as the economic wellbeing of the community generally.

The ***Code*** was developed by the owners of *Basslink*, *Basslink Pty Ltd*, in consultation with fishing industry bodies and State and Commonwealth Government Agencies during the project's approval phase.

All parties were unanimous that a voluntary ***Code of Conduct*** was a better outcome than an official exclusion zone around *Basslink*. Nevertheless mariners are advised to be extremely cautious within 500 meters of the cable route.

Similar ***Codes of Conduct*** have operated successfully in other heavily fished areas of the world with the support of the local industry.

Please take time to read this ***Code*** carefully.

The key messages are:

- Keep safe
- Know where the cables are
- Avoid the cables
- Do not allow anchors to drag near the cables
- Don't try to lift the cables. They are far too heavy, and you risk capsizing your vessel

SETFIA SOUTH EAST TRAWL FISHING INDUSTRY ASSOCIATION
sustainable fishing practices protect our future

ATTACHMENT G

Marinus Link

Subsea Cable Construction Underwater Noise Modelling

Prepared by

Marshall Day Acoustics

for

Tetra Tech Coffey Pty Ltd

16 August 2023

MARSHALL DAY Acoustics

MARINUS LINK
SUBSEA CABLE CONSTRUCTION
UNDERWATER NOISE MODELLING

Rp 004 20191171 | 16 August 2023

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Project: **MARINUS LINK – SUBSEA CABLE CONSTRUCTION UNDERWATER NOISE MODELLING**

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Report No.: **Rp 004 20191171**

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MARSHALL DAY Acoustics

GLOSSARY AND ABBREVIATIONS

Term	Description
Decibel (dB)	The unit of sound level determined from the logarithmic ratio of the sound pressure relative to a reference pressure.
EIS	Environmental Impact Statement
EIS project description	Marinus Link, Chapter 2 *Project Description*
Frequency	The number of pressure fluctuation cycles per second of a sound wave. Measured in units of Hertz (Hz).
Hertz (Hz)	Hertz is the unit of frequency. One hertz is one cycle per second. One thousand hertz is a kilohertz (kHz).
Marine ecology report	Marine Ecology and Resource Use Impact Assessment, EnviroGulf Consulting 2023
MDA	Marshall Day Acoustics Pty Ltd
MLPL	Marinus Link Pty Ltd
NOAA	US Department of Commerce National Oceanic and Atmospheric Administration
ppt	Parts per thousand (used as a measure of salinity)
PTS	Permanent Threshold Shift (PTS) is the permanent loss of hearing caused by acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the ear
RMS	Root Mean Square (RMS) is the equivalent continuous (time-averaged) sound level commonly referred to as the average level (period matches the event duration).
SEL	Sound exposure level (SEL) is the total sound energy of an event, normalised to an average sound level over one second. It is the time-integrated, sound-pressure-squared level. SEL is typically used to compare transient sound events having different time durations, pressure levels and temporal characteristics.
The project	The proposed Marinus Link interconnector between Tasmania and Victoria, comprising land-based infrastructure in both Tasmania and Victoria, and subsea cable connections.
TasNetworks	Tasmanian Networks Pty Ltd
TTC	Tetra Tech Coffey
TTS	Temporary Threshold Shift (TTS) is the temporary loss of hearing caused by sound exposure. The duration of TTS varies depending on the nature of the stimulus, but there is generally recovery of full hearing over time. TTS in humans can be likened to the 'muffled' effect on hearing after being exposed to high noise levels such as at a concert. The effect eventually goes away, but the longer the exposure, the longer the threshold shift lasts. Eventually, the TTS becomes permanent (PTS).

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1.0 INTRODUCTION

Marinus Link (the project) comprises a high voltage direct current (HVDC) electricity interconnector between Tasmania and Victoria, to allow for the continued trading and distribution of electricity within the National Energy Market (NEM).

On 12 December 2021, the Victorian Minister for Planning under the *Environment Effects Act 1978* (EE Act) determined that the project requires an Environment Effects Statement (EES) under the EE Act, to describe the project's effects on the environment to inform statutory decision making.

Similarly, the project was referred to the Australian Minister for the Environment on 5 October 2021. On 4 November 2021, a delegate of the Minister for the Environment determined that the proposed action has the potential to have a significant impact on the environment and requires assessment and approval under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) before it can proceed. The delegate determined the project will be assessed under the EPBC Act by an environmental impact statement (EIS).

In July 2022 a delegate of the Director of the Environment Protection Authority Tasmania determined that the project be subject to environmental impact assessment by the Board of the Environment Protection Authority (the Board) under the *Environmental Management and Pollution Control Act 1994* (Tas) (EMPCA).

As the project is proposed to be located within three jurisdictions, the Victorian Department of Environment, Land, Water and Planning, Tasmanian Environment Protection Authority and Australian Department of Climate Change, Energy, Environment and Water have agreed to coordinate the administration and documentation of the three assessment processes. A single EIS has been prepared to address the requirements of the three jurisdictions.

This report has been prepared by Marshall Day Acoustics Pty Ltd for the subsea component of the project as part of the EIS being prepared for the whole project.

1.1 Purpose of this report

This document presents the results of underwater noise modelling of activities associated with construction of the subsea cable. The modelling was conducted to provide data to inform an assessment of potential noise impacts on marina fauna, documented in a separate marine ecology report[1] prepared by EnviroGulf.

Noise levels associated with decommissioning activities (i.e. decommissioning of Marinus Link) are expected to be similar to or lower than those generated during the construction phase. A separate assessment for the decommissioning phase is therefore not warranted.

Construction of the project would involve transitory noise generating activities which occur along, and in the vicinity of, the route of the subsea cable. The main sources of noise that are relevant to the assessment of underwater noise levels are:

- The cable laying and burial vessel which will move along the ocean surface; and
- The plant used to create a seabed trench for the cable, where required.

[1] Marine Ecology and Resource Use Impact Assessment, EnviroGulf Consulting 2023

This report presents:

- Background information comprising the species of interest identified in the marine ecology report, and criteria that may be referenced for the assessment of underwater noise impacts on marine fauna (the criteria in this report are provided for context and an indication of the range of predicted noise levels to be modelled – the impact assessment is presented in the marine ecology report);
- A description of the underwater noise modelling method; and
- The predicted underwater noise levels from construction activity at a range of distances for different species of marine fauna.

An important aspect of the modelling is the extent of the project and, particularly with respect to underwater construction noise, the large area that needs to be considered to assess the potential impacts along the project route. The modelling has therefore been conducted to support an assessment which informs strategic decision making about the project with respect to underwater noise considerations.

1.2 Project overview

The project is a proposed 1500 megawatt (MW) high voltage direct current (HVDC) electricity interconnector between Heybridge in northwest Tasmania and the Latrobe Valley in Victoria (Figure 1). Marinus Link would provide a second link between the Tasmanian renewable energy resources and the Victorian electricity grids enabling efficient energy trade, transmission and distribution from a diverse range of generation sources to where it is most needed, and would increase energy capacity and security across the National Electricity Market (NEM).

Marinus Link Pty Ltd (MLPL) is the proponent for the project and is a wholly owned subsidiary of TasNetworks. TasNetworks is owned by the State of Tasmania and owns, operates and maintains the electricity transmission and distribution network in Tasmania.

Tasmania has significant renewable energy resource potential, particularly hydroelectric power and wind energy. The potential size of the resource exceeds both the Tasmanian demand and the capacity of the existing Basslink interconnector between Tasmania and Victoria. The growth in renewable energy generation in mainland states and territories participating in the NEM, coupled with the retiring of baseload coal-fired generators, is reducing the availability of dispatchable generation that is available on demand.

Tasmania's existing and potential renewable resources are a valuable source of dispatchable generation that could benefit electricity supply in the NEM. Marinus Link would allow for the continued trading, transmission and distribution of electricity within the NEM. It would also manage the risks of a single interconnector across the Bass Strait and complement existing and future interconnectors on mainland Australia. Marinus Link is expected to facilitate the reduction in greenhouse gas emissions at a state and national level.

Interconnectors are a key feature of the future energy landscape. They allow power to flow between different regions to enable the efficient transfer of electricity from renewable energy generation zones to where the electricity is needed. Interconnectors can increase the resilience of the NEM and make energy more secure, affordable and sustainable for customers. Interconnectors are common around the world including in Australia. They play a critical role in supporting Australia's transition to a clean energy future.

Figure 1: Project overview (figure courtesy of Tetra Tech Coffey)

1.3 Assessment context

Construction of the project may result in noise impacts on marine fauna.

Noise impacts on marine fauna may range from communication interference and behaviour changes (e.g. avoidance of areas), through to temporary or even permanent changes to hearing sensitivity, and ultimately risks of mortality from very high noise levels.

Underwater noise is therefore an important consideration to be addressed as part of the EIS. Specifically, an assessment is required to identify and quantify the risk of impacts, and determine the types of environmental performance requirements that should apply to the project to minimise the risks. The modelling presented in this report is provided to inform an assessment of these risks.

2.0 BACKGROUND INFORMATION

This section presents background information concerning:

- The species of interest;
- Hearing sensitivity criteria for different marine species; and
- Guidance on behavioural responses of marine fauna.

This information is provided for context and an indication of the range of predicted noise levels to be addressed by the underwater noise modelling.

2.1 Species of interest and hearing groups

The marine ecology report identifies the marine species of interest that may be found in the Bass Strait. The species are grouped in this section according to the typical range of frequencies which can be heard by each species. These hearing groups were defined using guidance from:

- The US Department of Commerce National Oceanic and Atmospheric Administration '*Technical Guidance for Assessing the Effects on Anthropogenic Sound on Marine Mammal Hearing*' (April 2019). It provides guidance for assessing the physiological impacts of anthropogenic (human-made) sound on marine mammals (referred to as the 'NOAA Guidelines'); and
- The JASCO Applied Sciences '*Underwater Acoustics: Noise and the Effects on Aquatic Life'* pocket handbook (4th edition (interim)).

The species hearing groups and species of interest are:

- Low-frequency cetaceans (LFC):
  - Baleen whales (e.g. Southern right, Humpback, Blue whale, Sei and fin whales, Minke whale)
- Mid-frequency cetaceans (MFC):
  - Dolphins (e.g. Bottlenose dolphins, Common dolphins)
  - Whales (e.g. Sperm whale, False killer whale, Long finned pilot whale, Killer whale, Gray's beaked whale, Strap-toothed whales)
- High-frequency cetaceans (HFC):
  - Whales (e.g. Pygmy sperm whale, Pygmy right whale)
  - Dolphins (e.g. Dusky dolphin)
- Phocid pinnipeds (PW) (true seals i.e., earless seals. E.g. Leopard seal, Crab-eater seal)
- Otariid pinnipeds (OW) (eared seals, e.g. Australian fur seal, Long-nosed fur seal)
- Sea turtles (e.g. Loggerhead turtle, Green turtle, Olive ridley turtle (assumed group), Leatherback turtle)
- Fish
- Invertebrates

2.2 Hearing sensitivity criteria

2.2.1 Marine mammals

The NOAA Guidelines identify the noise levels above which individual marine mammals are predicted to experience changes in hearing sensitivity (termed onset thresholds subsequently). These changes are either temporary ('Temporary Threshold Shift' or TTS), or permanent ('Permanent Threshold Shift' or PTS)[2]. Auditory threshold shifts can be caused from peak exposure (high-level impulsive events such as striking rock) or from cumulative exposure (lower noise levels over an extended period such as seabed trenching).

The NOAA Guidelines provide TTS and PTS onset thresholds for non-impulsive sources (e.g. trenching) for the species of interest using the 'SEL_{cum}' assessment descriptor. SEL_{cum} is the species-weighted cumulative sound exposure level over a 24-hour period.

Table 1 summarises the relevant species-weighted onset thresholds for non-impulsive sounds (the mains sources of noise associated with construction of the project are non-impulsive).

Table 1: Summary of NOAA thresholds[3] for non-impulsive sources

Hearing groups	TTS cumulative	PTS cumulative
Low-frequency cetaceans	179 dB $SEL_{cum(lf)}$	199 dB $SEL_{cum(lf)}$
Mid-frequency cetaceans	178 dB $SEL_{cum(mf)}$	198 dB $SEL_{cum(mf)}$
High-frequency cetaceans	153 dB $SEL_{cum(hf)}$	173 dB $SEL_{cum(hf)}$
Phocid pinnipeds	181 dB $SEL_{cum(pw)}$	201 dB $SEL_{cum(pw)}$
Otariid pinnipeds	199 dB $SEL_{cum(ow)}$	219 dB $SEL_{cum(ow)}$

2.2.2 Fish

The publication '*An overview of fish bioacoustics and the impacts of anthropogenic sounds on fishes'* (Popper (2019)) provides interim sound exposure guidelines for fish[4].

The most stringent thresholds are for fish which have a swim bladder involved in hearing:

- TTS: 186 dB re. 1 μPa^2s $SEL_{cum\ (unweighted)}$
- Mortality: 207 dB re. 1 μPa^2s $SEL_{cum\ (unweighted)}$ or >207 dB re. 1 µPa L_{peak}

Note that these guidelines are based on pile driving signals and as such are not directly applicable to the types of construction activities associated with the project. However, they are useful to reference as a conservative guide for contextual purposes.

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[2] As a guide to the concept of TTS, in humans this can be likened to the 'muffled' effect on hearing after being exposed to high noise levels such as at a concert. The effect eventually goes away, but the longer the exposure, the longer the threshold shift lasts. Eventually, the TTS becomes permanent.

[3] SEL thresholds have a reference of 1 μPa^2s and L_{peak} thresholds have a reference of 1 µPa

[4] These thresholds are the same as in Section 7.5.2 of the 2014 publication *'Sound Exposure Guidelines: for Fish and SeaTurtles'*. These criteria were prepared by an ANSI-accredited Standards Committee Working Group of experts and was sponsored by the Acoustical Society of America.

2.2.3 Sea Turtles

There is very little research on sea turtles and their hearing sensitivities. Popper (2019) provides a relative risk assessment for TTS. If a turtle is close to the work, then there is a high risk of TTS. While further afield (intermediate and far), the risk becomes low (note, the actual distances are not provided in the research data). Popper provides levels for mortality:

- 210 dB re. 1 μPa2s SEL_{cum} (unweighted); or
- 207 dB re. 1 μPa L_{peak}.

2.2.4 Invertebrates

We are not aware of any studies regarding hearing sensitivities of invertebrates but acknowledge that they have sensitivity to noise. For example, we are aware of one study that provides a risk assessment to invertebrates from seismic air gun surveys[5].

2.3 Guidance on behavioural responses

2.3.1 Marine Mammals

Behavioural responses to underwater noise can vary significantly depending on species, the noise environment, and the frequency content of the noise source. These effects can include temporary avoidance of the noisy area, disorientation, or communication masking.

Relatively little is known about the thresholds above which there are likely to be behavioural impacts. As interim guidance, NOAA states that behavioural impacts can occur at 160 dB re. 1 μPa RMS for impulsive sources, and as low as 120 dB re. 1 μPa RMS non-impulsive sources (depending on the noise environment).

We note that these thresholds are widely recognised to be conservative in most cases, particularly for non-impulsive sources and elevated noise environments such as in this project vicinity. The responses vary with sound type/level, species, age/sex class, individual behaviour state (e.g. feeding or travelling), biological and ecological context. Behavioural responses are context specific, and it is unrealistic to specify a specific threshold at which behavioural effects occur (on the other hand, physiological effects can be tested and examined and can therefore be narrowed down with some confidence)[6].

2.3.2 Fish

Studies on the behavioural impacts from noise on fish are very limited and there are no widely accepted or validated guideline criteria. This lack of information is partly due to the practicalities of conducting such studies in the field, as well as the potential for large variations in responses across all fish species.

Given the lack of available evidence or validated criteria, quantitative guidelines for the behavioural impact of noise on fish are not provided in Popper (2019), and instead a subjective risk assessment approach is used. It notes there is a moderate to high potential for masking and changes in behavioural response close to work activities, reducing to low/moderate potential at distance.

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[5] Webster, Fiona & Wise, Brent & Fletcher, Warrick & Kemp, Hans. (2018). Risk Assessment of the potential impacts of seismic air gun surveys on marine finfish and invertebrates in Western Australia.

[6] Southall et al. 2021 '*Marine Mammal Noise Exposure Criteria: Assessing the Severity of Marine Mammal Behavioural Responses to Human Noise*'. https://doi.org/10.1578/AM.47.5.2021.421

2.3.3 Sea Turtles

Similarly to the physiological aspects, there is a dearth of research for sea turtles' behavioural responses. In the Popper (2019) paper, a relative risk assessment is provided. At a close distance to the works, there is a high risk of behavioural response, reducing to moderate at an intermediate distance, then low risk further afield.

3.0 MODELLING METHOD

3.1 Modelling overview

The objective of the noise modelling is to provide an indication of underwater noise levels associated with construction of the subsea cable to inform an assessment of the risks of impacts on marine fauna.

Given the large scale of the project, and the transitory nature of the underwater noise which would be generated during construction of the subsea cable, a high-level modelling approach has been adopted. The following considerations are also relevant to this choice:

- Detailed modelling methods provide high accuracy for the specific environmental condition being assessed. However, in practice, propagation is highly variable. It is sensitive to temporal and spatial variations in environmental conditions which are more complex than the characterisations used for practical modelling purposes; and
- Seabed conditions, depth, and water profile are relevantly consistent across the Bass Strait, meaning that the large computational effort associated with preparing a detailed model of the entire route would be disproportionate to the value of such an approach.

In light of the above considerations, the overall modelling approach for the study comprised 3D noise modelling for a selection of conditions to determine an appropriate general relationship for characterising underwater noise propagation in the vicinity of the project.

There are no defined Australian or international standards for calculating underwater noise propagation. However, a number of established analytical methods are representative of current industry practice and are routinely used for impact assessment purposes. These methods, referred to as solvers, have been implemented in the proprietary dBSea software used for this study, which enables noise propagation to be calculated in complex underwater environments. Two different solvers have been used for this study; the parabolic equation solver for low and mid frequency sounds (2 kHz and below), and a ray trace solver for higher frequency sounds (above 2 kHz). Further information about these solvers is provided in Appendix A. From our experience, this solver configuration has produced the closest correlation between prediction and measurements.

3.2 Noise modelling inputs and parameters

The key inputs and parameters to the 3D modelling are:

- Bathymetry from Geoscience Australia[7];
- Seafloor consisting of sand to an assumed depth of 1.5 m, with basalt below based on the marine ecology report[8];
- Water temperature of approximately 15 degrees Celsius based on the marine ecology report;
- Water salinity of 35 ppt based on the marine ecology report;
- The speed of sound is assumed to be constant in the water column;
- Calculation grid size of 10 m x 10 m x 1 m (x-axis, y-axis, z-axis);
- The noise source is at a depth of 1 m at a point along the cable route that is representative of deep sea conditions;
- Noise emission data for a cargo ship with a source level of 185 dB re 1 µPa at 1 m to represent the cable laying and burial vessels travelling at speeds up to 15 knots, with frequency characteristics illustrated by the spectrum presented in Appendix B; and
- The vessel noise is assumed to be omni-directional, providing predictions which are generally conservative as it assumes the noise spreads equally in all directions.

The noise emission data described above was used for both the 3D modelling and broader prediction of underwater noise levels using the general propagation relationship established from the 3D modelling.

3.3 General noise propagation relationship

Based on the 3D modelling inputs, the dBSea software was used to calculate the propagation relationship curves shown in Figure 2. The curves depict the predicted reduction in noise levels with increasing distance for each of the 360 radial slices calculated around the noise source location. For this purpose, the reduction in noise level is the difference between the source noise level and the predicted noise level at the height within the water column where the predicted noise level is highest.

Also shown on Figure 2 are two reference curves which depict the reduction in noise levels for spherical and cylindrical underwater noise propagation.

The trend of the predicted propagation curves is mathematically characterised by a 15.74 x log (distance) relationship. This result supports the use of a more general '15 x log' approach for high-level modelling of noise levels in the vicinity of the project for all noise sources associated with the project. The 15 x log approach is slightly more conservative than indicated by the detailed modelling, but corresponds to a general relationship which is used for broadly characterising intermediate locations where the sound wave spreads nether spherically nor cylindrically. Our experience also indicates this general relationship is suitable for sources located near both the surface and seabed, and in shallower waters (e.g. less than 30 m depth).

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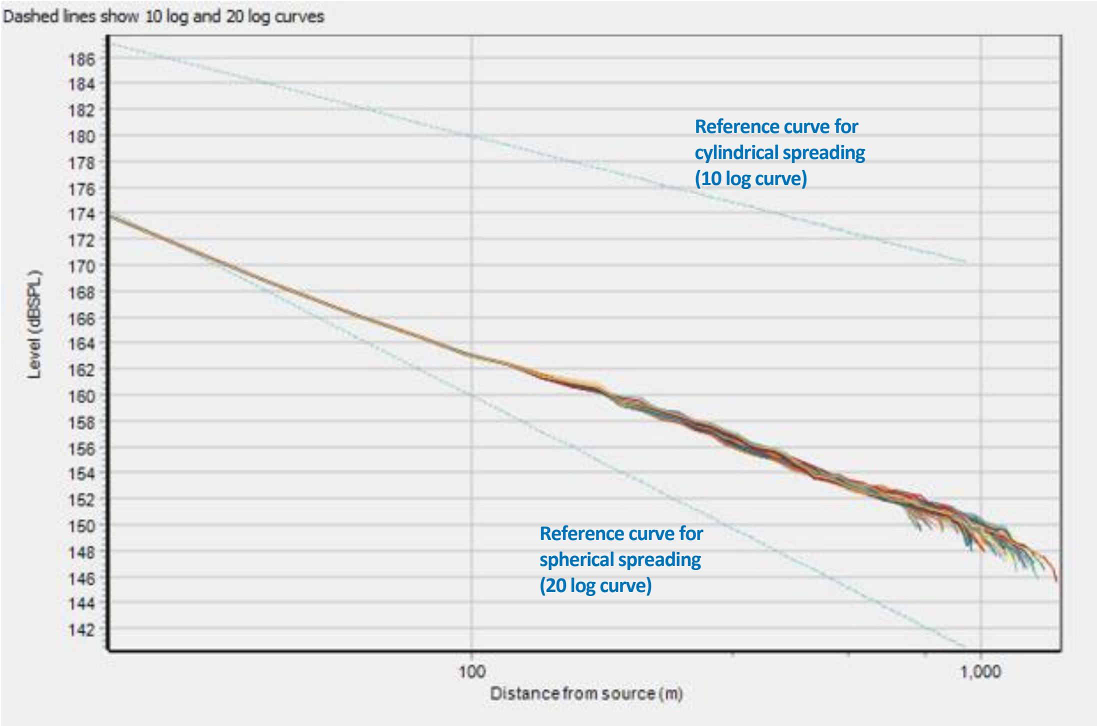
[7] Whiteway, T. 2009. Australian Bathymetry and Topography Grid, June 2009. Record 2009/021. Geoscience Australia, Canberra. http://dx.doi.org/10.4225/25/53D99B6581B9A

[8] The Tasmania nearshore side is noted to consist of soft seabed sediments (i.e. mud). This provides more attenuation than sand but also means that the cable may be laid on the seabed and allowed to self-bury. As such, trenching would not be required.

Figure 2: Change in noise level with distance, dB SPL (logarithmic distance scale & 360 radial slices)



4.0 PREDICTED NOISE LEVELS

To inform the marine ecology report, EnviroGulf requested an assessment of the distances to a series of isopleths (contour lines of equal predicted noise levels).

The following sections provide calculated distances for a range of isopleths, based on linear (unweighted) and species-weighted noise emissions. The species-weighted values are adjusted for the hearing response of each hearing group (the hearing thresholds for each hearing group are illustrated graphically in Appendix A).

4.1 Cable laying and burial vessels

4.1.1 RMS sound pressure levels – unweighted

The distances to different RMS isopleths are provided in Table 2, down to a level of 120 dB re 1µPa which corresponds to the conservative value at which the NOAA guidelines indicate that behavioural responses to non-impulsive sounds can occur.

The relationship between RMS noise levels and distance is also shown graphically in Appendix C.

Table 2: Calculated distances to received SPL RMS isopleths during cable laying

Source level: 185 RMS dB re 1µPa at 1m							
Isopleth, RMS dB re 1 µPa	180	170	160	150	140	130	120
Distance to isopleth, m	2	10	46	215	1,000	4,642	21,544

4.1.2 Sound exposure levels – species-weighted

The isopleths for a range of species-weighted SEL_{cum} sound pressure levels are presented in Tables 3 to 9. Shaded cells identify an isopleth corresponding to one of the thresholds presented earlier in Section 2.2 and Section 2.3. The relationship between species-weighted SEL_{cum} levels and distance are also shown graphically in Appendix C.

To predict the SEL_{cum} isopleths, the fauna exposure levels were calculated based on a one hour vessel pass-by interval and negligible noise exposure during the remaining 23 hours.

All of the isopleth distances are based on fixed source and marine animal positions. This approach is conservative (i.e. the actual distances would be greater in practice) as neither would remain in a fixed location, and the noise level would be lower than the assumed one hour value factored in the SEL_{cum} levels. To demonstrate this, we have predicted the change in noise level during a vessel pass-by as depicted in Appendix D for a high-frequency cetacean; the most sensitive species in the Bass Strait. For simplicity, we have assumed the HF cetacean swimming in the same general area (i.e. we have assumed no behavioural change which is conservative) while a vessel approaches then moves away.

Cetaceans

Table 3: Calculated distances to isopleths during cable laying - LF Cetaceans

Species-weighted source level: 210 $SEL_{cum(LF)}$ dB re 1 µPa^{2}s at 1 m							
Isopleth, $SEL_{cum(LF)}$ dB re 1 µPa^{2}s	180	179	160	150	140	130	120
Distance to isopleth, m	98	114	2,103	9,760	45,304	210,283	976,047
Threshold isopleth	-	TTS	-	-	-	-	-

Table 4: Calculated distances to SEL_{cum} isopleths during cable laying – MF Cetaceans

Species-weighted source level: 202 $SEL_{cum\ (MF)}$ dB re 1µPa²s at 1 m							
Isopleth, $SEL_{cum(MF)}$ dB re 1 µPa²s	180	178	160	150	140	130	120
Distance to isopleth, m	32	43	680	3,157	14,653	68,012	315,685
Threshold isopleth	–	TTS	–	–	–	–	–

Table 5: Calculated distances to SEL_{cum} isopleths during cable laying - HF Cetaceans

Species-weighted source level: 200 $SEL_{cum(HF)}$ dB re 1µPa²s at 1 m							
Isopleth, $SEL_{cum(HF)}$ dB re 1 µPa²s	180	173	160	153	140	130	120
Distance to isopleth, m	23	67	489	1,433	10,541	48,928	227,105
Threshold isopleth	–	PTS	–	TTS	–	–	–

Fishes

Table 6: Calculated distances to SEL_{cum} isopleths during cable laying – fishes

Species-weighted source level: 221 SEL_{cum} dB re 1µPa²s at 1m							
Isopleth, SEL_{cum} dB re 1 µPa²s	207	200	190	186	180	170	160
Distance to isopleth, m	8	23	109	201	506	2349	10,903
Threshold isopleth	Mortality	-	-	TTS	–	–	–

Sea turtles

Table 7: Calculated distances to SEL_{cum} isopleths during cable laying – sea turtles

Species-weighted source level: 210 $SEL_{cum(T)}$ dB re 1µPa²s at 1m							
Isopleth, $SEL_{cum(T)}$ dB re 1 µPa²s	210	200	190	186	180	170	160
Distance to isopleth, m	1	5	21	98	453	2,103	9,760
Threshold isopleth	Mortality	-	-	-	-	-	-

Pinnipeds

Table 8: Calculated distances to SEL_{cum} isopleths during cable laying – phocid pinnipeds

Species-weighted source level: 207 $SEL_{cum(PW)}$ dB re 1µPa²s at 1m							
Isopleth, $SEL_{cum(PW)}$ dB re 1 µPa²s	181	170	160	150	140	130	120
Distance to isopleth, m	56	301	1,397	6,483	30,092	139,677	648,323
Threshold isopleth	TTS	-	-	-	-	-	-

Table 9: Calculated distances to SEL_{cum} isopleths during cable laying – otariid pinnipeds

Species-weighted source level: 207 $SEL_{cum(OW)}$ dB re 1µPa²s at 1m							
Isopleth, $SEL_{cum(OW)}$ dB re 1 µPa²s	199	170	160	150	140	130	120
Distance to isopleth, m	4	306	1419	6,586	30,569	141,888	658,586
Threshold isopleth	TTS	-	-	-	-	-	-

4.2 Cable laying and burial vessels – Tasmanian and Victorian nearshore inputs

The predicted noise levels at 30 m water depth are presented in Table 10.

Table 10: Predicted SEL_{cum} noise level at 30m depth based on one hour exposure time

Species	Species weighted cumulative source level (1hr exposure time in 24hr period) [1]	TTS Threshold for non-impulsive sources	Predicted noise level at 30m
Low-frequency cetaceans	210 dB $SEL_{cum(lf)}$	179 dB $SEL_{cum(lf)}$	188 dB $SEL_{cum(lf)}$
Mid-frequency cetaceans	202 dB $SEL_{cum(mf)}$	178 dB $SEL_{cum(mf)}$	180 dB $SEL_{cum(mf)}$
High-frequency cetaceans	200 dB $SEL_{cum(hf)}$	153 dB $SEL_{cum(hf)}$	178 dB $SEL_{cum(hf)}$
Phocid pinnipeds	207 dB $SEL_{cum(pw)}$	181 dB $SEL_{cum(pw)}$	185 dB $SEL_{cum(pw)}$
Otariid pinnipeds	207 dB $SEL_{cum(ow)}$	199 dB $SEL_{cum(ow)}$	185 dB $SEL_{cum(ow)}$
Fish	221 dB SEL_{cum}	186 dB SEL_{cum}	198 dB SEL_{cum}
Sea turtles	210 dB $SEL_{cum(T)}$	179 dB $SEL_{cum(T)}$	188 dB $SEL_{cum(T)}$

Note 1: source levels at 1m from source and re 1 $\mu Pa^2 s$.

4.3 Jet Trencher

Data for jet trenching activities have been sourced from noise measurements conducted by Subacoustech during cable trenching at the North Hoyle offshore windfarm[9]. This source was described to be a mixture of broadband noise, tonal machinery noise, and transients likely to have been associated with rock breakage. The report indicates an RMS source level of 178 dB re 1µPa at 1 m based on a measurement at 160 m and assuming a 22log distance attenuation factor on site. We note that the activity was carried out in shallow water where, in our experience, a 15log distance attenuation factor is typically more appropriate. As such, we would expect the calculated source level to be closer to 156 dB re 1µPa at 1 m based on Subacoustech's measurements.

A source level of 156 dB re 1µPa at 1 m is very low. Once adjusted for the one-hour machine on-time and to the 24-hr period of the NOAA criteria, the level would be below the TTS criteria for all species.

[9] Nedwell, J.; Langworthy, J.; Howell, D. (2004). *Measurements of Underwater Noise During Construction of Offshore Wind Farms and Comparison with Background Noise* (Report No. 544R0411). Report by Subacoustech Ltd. Report for Collaborative Offshore Wind Research into the Environment (COWRIE), Report for The Crown Estate.

5.0 SUMMARY

Activities associated with construction of the subsea cable for the project would result in underwater noise levels and requires assessment of the potential impact on marine fauna.

The main sources of noise that are relevant to the assessment of underwater noise levels are:

- The cable laying and burial vessels which would move along the ocean surface; and
- The plant which would be used to create a seabed trench for the cable, where required.

Under water noise modelling has to been conducted to calculate the distances from construction activities where certain noise levels will occur, including noise levels that are commonly referenced for the assessment of potential impacts on the hearing sensitivity of marine fauna.

The predicted noise levels and distances documented in this report are provided to inform the impact assessment presented in the marine ecology report.

APPENDIX A PROPAGATION SOLVERS

Underwater acoustic propagation is commonly described mathematically by a partial differential equation called the “Helmholtz Wave Equation”. The different solvers available in dBSea each employ various methods and approximations to yield a solution to the wave equation, i.e. the propagation loss. The propagation loss is used to make predictions of acoustic levels. As such each solver has specific scenarios of applicability.

The 3D levels predicted by dBSea are interpolated from 2D slices. All the solvers in dBSea can calculate propagation loss for range-dependent environments. A range-dependant is an environment where parameters such as, bathymetry, sound speed and/or seabed geoacoustic properties, may vary in range away from the source. dBSea does not yet support elastic geoacoustic properties in the seabed. Approximations can be made where necessary to best derive equivalent fluid parameters to represent elastic seabed layers.

Table 11 provides a summary of environment types where dBSea’s numerical solvers are applicable, in general the table follows a similar form to that presented in standard underwater acoustic textbooks[10].

Table 11: Applicability of dBSea solver types

	Shallow water		**Deep water**	
Propagation Solver Type	**Low Frequency**	**High Frequency**	**Low Frequency**	**High Frequency**
Parabolic Equations	●	◍	◍	◍
Normal Modes	●	◍	◍	◍
Rays	○	◍	●	●

Symbol Key:

●	Applicable solver type, fit for purpose and widely used and numerically benchmarked
◍	Applicable solver type, however there may be limitation due to excessive computation time or accuracy
○	None applicable

Shallow water and deep water environments are distinguished by the extent that acoustic waves interact with the seabed. Acoustic wave interact significantly with the seabed in shallow water environments. Typical transition water depths are 50 m – 100 m. Similarly, the cross over between high and low frequencies is not precisely defined and is also dependent on the water depth. Typical cross over frequencies would be between 100 – 500 Hz, this frequency can be estimated using the equation below,

$$f_{crossover} = 10 * \frac{c_w}{H}$$

Where c_w is the water column wave speed and *H* is the thickness of the duct or water column.

[10] Etter, P. C. (2013). *Underwater Acoustic Modelling and Simulation*. CRC Press.

The dBSea solvers have been validated and benchmarked against accepted analytical solutions. Information on the benchmarking results can be found on dBSea's website[11]. A description of the three main propagation solvers is presented below. Refer to textbooks like Jensen et al. (2011)[12] for further detailed information numerical implementations and description of each solver type.

A1 dBSeaModes

dBSeaModes propagation solver is a finite difference implementation of a normal mode algorithm. The solver can be used in range-dependent scenarios where there is variation in bathymetry, sound speed and/or seabed geoacoustic properties in range away from the source. Range dependent calculations are based on the outward propagating adiabatic approximation. The adiabatic method is not applicable to scenarios where significant range-dependant variations in parameters occur. Care must be taken in applying dBSeaModes to range-dependent environments.

A2 dBSeaPE

dBSea's parabolic equation solver (dBSeaPE) is a finite difference implementation of the parabolic equation method. Parabolic equation methods are the preferred low frequency solvers for range-dependent scenarios and have been used extensively in research and commercial applications for underwater propagation modelling. The solver can incorporate range-dependent environmental parameters in bathymetry, sound speed and seabed geoacoustic properties into the propagation loss predictions.

The algorithm is implemented by calculating an initial starting sound field, which is source depth dependent, and is stepped out in range from the source using the PE method. dBSeaPE will use the dBSeaModes solver to generate the starting field. If the modal solver fails to converge to a results Greene's starter is used. If the modal starter fails, the software will prompt with a message 'PE solver used analytical starter', which indicates that the software is using an analytical starter (i.e. Greene's starter) for the specified frequencies and slice numbers.

A3 dBSeaRay

Ray tracing methods are family of numerical solvers that use a frequency approximation to reduce the Helmholtz equation to a form that can be solved numerically. The ray solver forms a solution by tracing rays from the source out into the sound field. A large number of rays leave the source covering a range of angles, and the sound level at each point in the receiving field is calculated by combining the components from each individual ray.

When multiple seafloor layers are present, rays are not split and traced into the seafloor. A complex reflection coefficient is calculated which is representative of the underlying layers, and this coefficient is applied to the ray at the point of seafloor reflection.

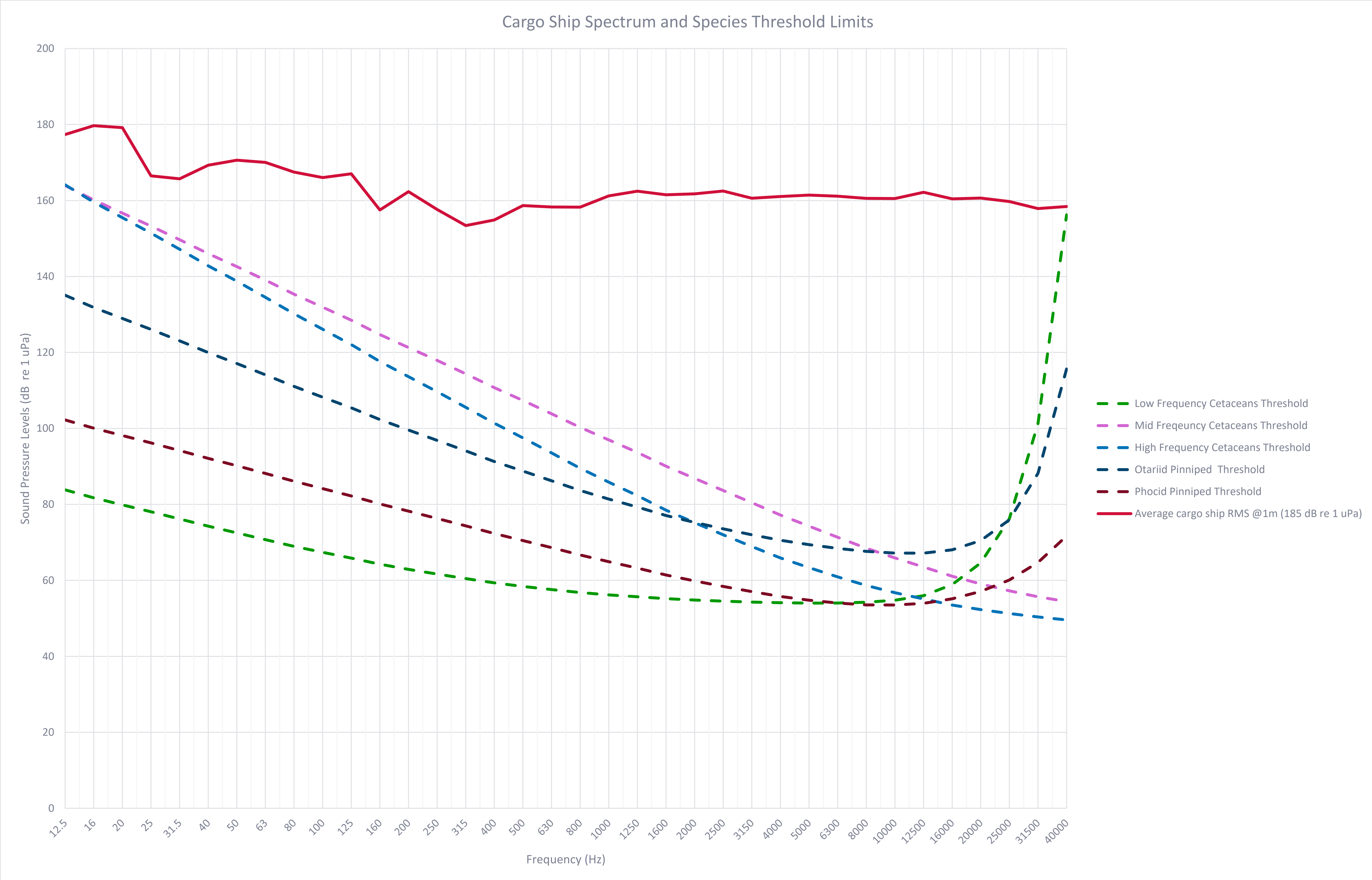
dBSeaRay is used for time domain calculations. Instead of returning a transmission loss at each point in the slice, a list of ray arrivals is returned (with separate entries for each frequency). These arrivals lists can be used to calculate the effective time series at each point in the slice, which is then used to calculate peak, peak to peak, and frequency band SEL levels.

---

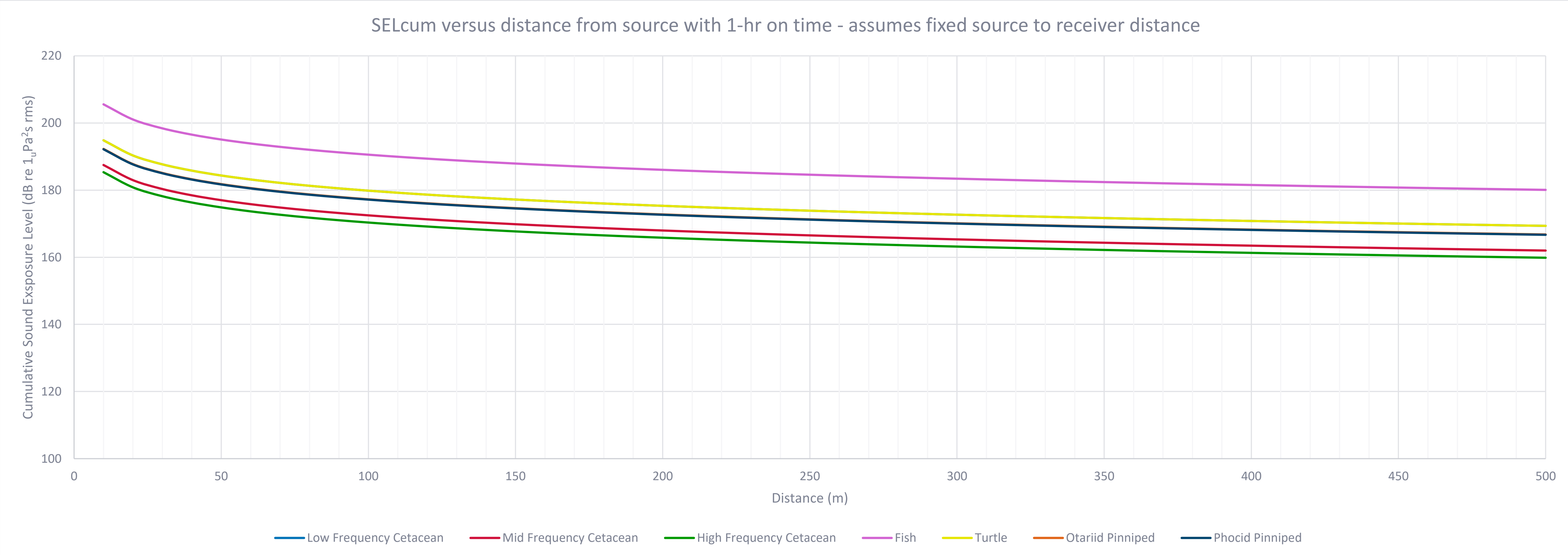
[11] http://www.dbsea.co.uk/validation/

[12] Jensen, F. B., Kuperman, W. A., Porter, M. B., & Schmidt, H. (2011). Computational ocean acoustics. Springer Science & Business Media.

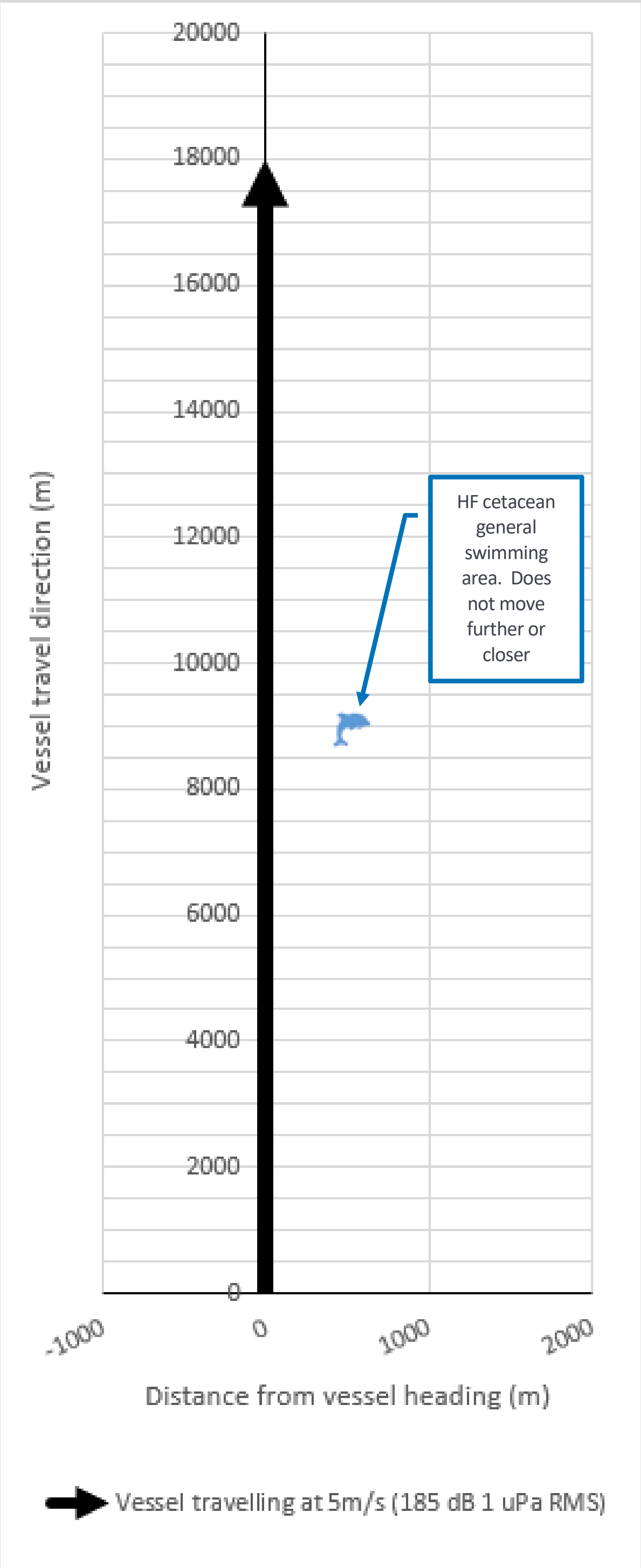
APPENDIX B SOURCE SPECTRUM AND SPECIES GROUP HEARING THRESHOLDS

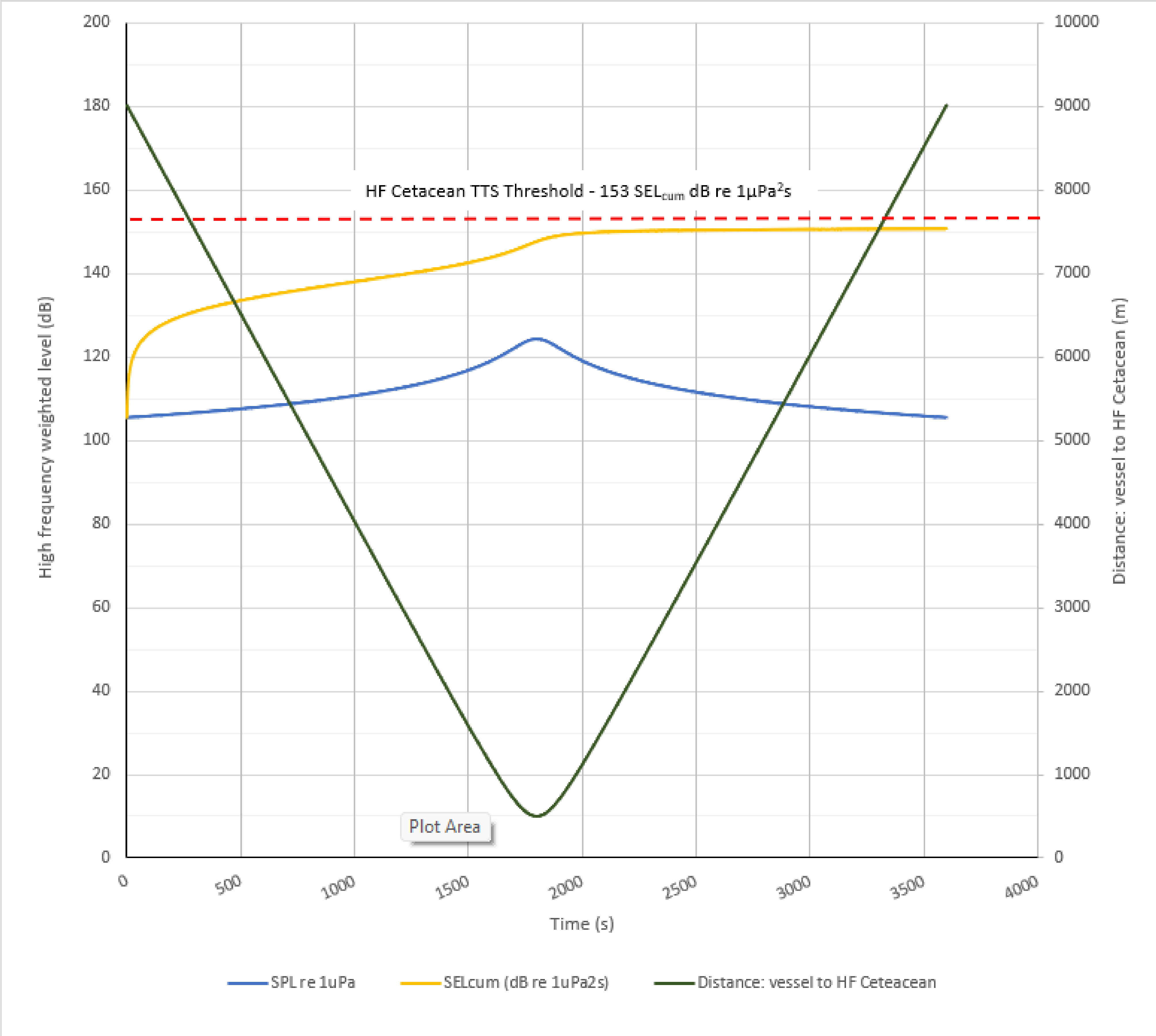


APPENDIX C SOUND PROPAGATION PLOTS



APPENDIX D CHANGE IN NOISE LEVEL FOR A HIGH-FREQUENCY CETACEAN AS A VESSEL PASSES BY (CALCULATED OVER ONE HOUR)





ATTACHMENT H

Project Marinus

TECHNICAL MEMORANDUM

Additional EMF modelling for use by the Marine Ecology and Resource Use Scope

Prepared by
Tom Lancaster

of

Jacobs Group (Australia) Pty Limited

21 December 2022

Memorandum

Jacobs

Additional EMF modelling for use by the Marine Ecology and Resource Use scope

Date:	21 December 2022	
Project name:	Project Marinus	
Project no:	IS360356	
Attention:	David Balloch	
Company:	EnviroGulf Consulting:	
Prepared by:	Tom Lancaster	
Document no:	IS360356-SO56-EE-MEM-002	
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To whom it may concern,

This memorandum has been prepared for use by EnviroGulf Consulting in their scope of works pertaining to the Marine Ecology and Resource Use section of the Marinus Link Environmental Impact Statement (EIS).

1.1 Background

Jacobs has performed and authored an Electric and Magnetic Fields (EMF) and Electromagnetic Interference (EMI) study for the proposed Marinus Link. This assessment has been performed to inform the Environmental Impact Statement (EIS) currently being drafted for the project.

In authoring the EMF & EMI study, modelling was undertaken to calculate the magnetic flux density levels generated by the Marinus Link HVDC subsea and land cables. EnviroGulf Consulting is presently undertaking the Marine Ecology and Resource Use study for the same EIS and has requested the calculation of magnetic flux density levels at multiple sample points along the subsea cable route through the Bass Strait. This memorandum has been drafted to present the results of this additional modelling.

1.2 Inputs & Methodology

1.2.1 Sample Points

The magnetic flux density calculations provided in this memo have been calculated at three sample points. The sample points are illustrated below in Figure 1.

Figure 1: Sample Point locations

The first sample point (Sample Point 1) is located near the Victorian shore (nearshore at Waratah Bay). The distance between the eastern monopole (ML1) and western monopole (ML2) at this location is approximately 75 m. The second sample point (Sample Point 2) is located in the Bass Strait approximately halfway between the Tasmanian and Victorian shores. The distance between the eastern monopole (ML1) and western monopole (ML2) at this location is approximately 2 km. The third sample point (Sample Point 3) is located near the Tasmanian shore. The distance between the eastern monopole (ML1) and western monopole (ML2) at this location is approximately 600 m.

The magnetic flux density modelling at these sample points is based on the latest cable route alignment at the time of drafting this memo. This cable route alignment information indicates that the inter-cable separation (between the positive and negative cables) of each circuit is negligible (i.e. the cables are bundled together). The modelling reflects this arrangement.

The cables have been modelled at their minimum burial depth. The minimum burial depth assumed for the purposes of this assessment is 1 m below seabed level. The cables have been modelled with a horizontal flat geometry.

1.2.2 Geomagnetic Field

For the purposes of the modelling documented in this memo, the magnitude of the geomagnetic field has been included in the calculations. The magnitude of the geomagnetic field assumed at each of the sample points is documented in Table 1. The geomagnetic field has been assumed to be orientated entirely in the Z-axis (i.e. vertically orientated away from the earth's surface).

Table 1: Geomagnetic field intensity assumed at each of the sample points

Subsea Location	Sample Point	Average Geomagnetic Field Intensity (μT)
Waratah Bay Shore Crossing (Victoria)	1	60.35
Off-shore	2	60.87
Heybridge Shore Crossing (Tasmania)	3	61.39

1.2.3 Calculations

The calculations for Sample Point 1, 2, and 3 are presented in Appendix A, B, and C below, respectively. The calculations for Sample Points 1 and 3 contain the following information:

- Four operating scenarios:
  - One circuit (ML1) in operation at half power (375 MW)
  - Both circuits in operation at half power (375 MW)
  - One circuit (ML1) in operation at full power (750 MW)
  - Both circuits in operation at full power (750 MW)
- For each operating scenario, three plots are produced:
  - Graphical representation of the calculated magnetic flux density at different heights above the sea floor for ML1
  - Graphical representation of the calculated magnetic flux density at the sea floor for ML1 and ML2
  - Tabular representation of the calculated magnetic flux density levels at different heights above the sea floor for ML1. The magnetic flux density levels are presented in the table at various horizonal and vertical distances from the cable, as requested by EnviroGulf Consulting

The calculations for Sample Point 2 contain the following information:

- Two operating scenarios:
  - One circuit (ML1) in operation at full power (750 MW)
  - Both circuits in operation at full power (750 MW)
- For each operating scenario, three plots are produced:
  - Graphical representation of the calculated magnetic flux density levels at different heights above the sea floor for ML1
  - Graphical representation of the calculated magnetic flux density levels at the sea floor for ML1 and ML2
  - Tabular representation of the calculated magnetic flux density at different heights above the sea floor level for ML1. The magnetic flux density levels are presented in the table at various horizonal and vertical distances from the cable, as requested by EnviroGulf Consulting

Finally, a cross section of ML1 in the Bass Strait (Sample Point 2) operating at full power has been produced and is shown in Figure 2. This plot does not include the contribution of the ambient geomagnetic field.

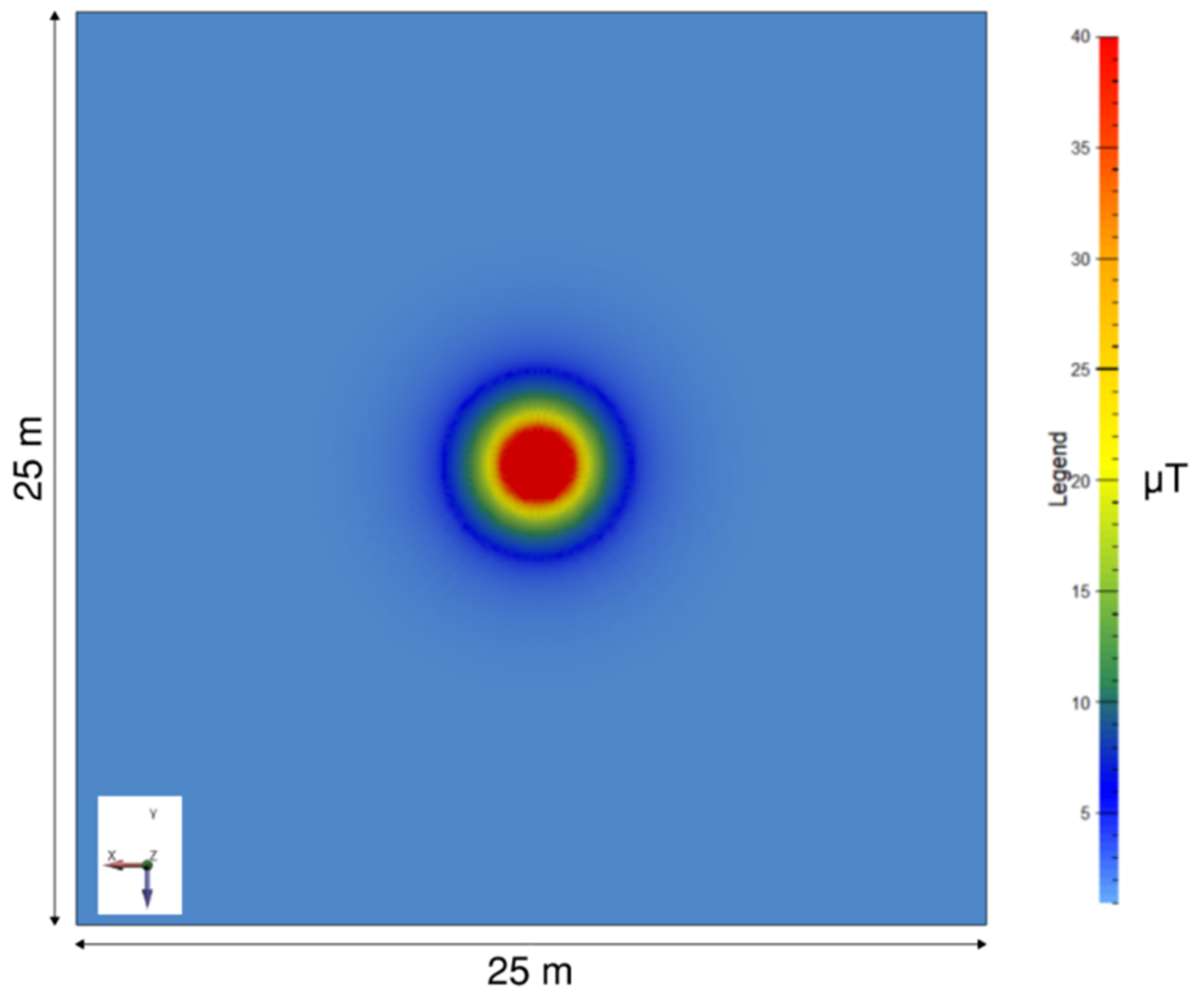

Figure 2: Cross-section plot of ML1 in the Bass Strait (Sample Point 2) operating at full power, showing the calculated magnetic flux density from the ML1 cables

Appendix A - Sample Point One Plots

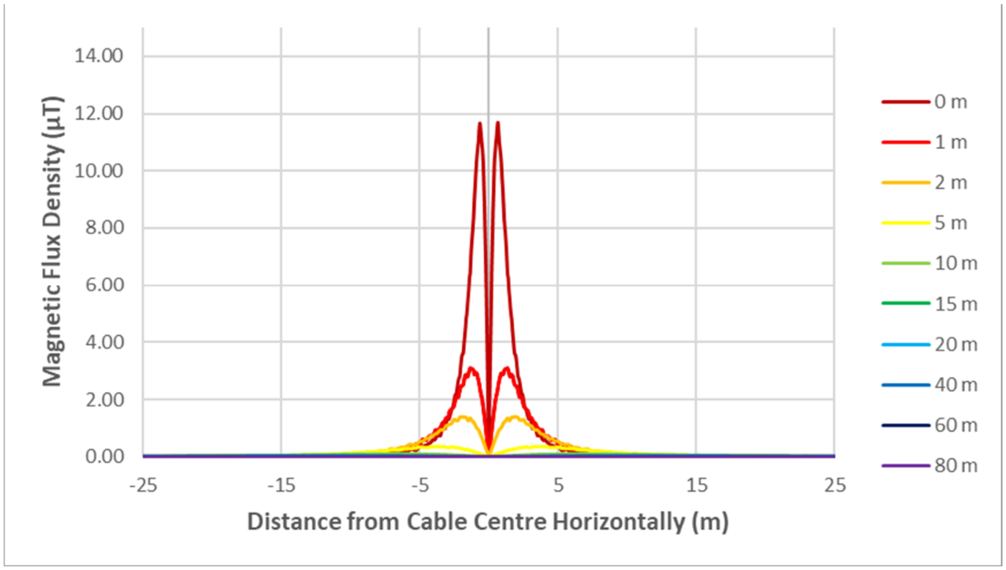

Figure 3: Sample Point1 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – X axis

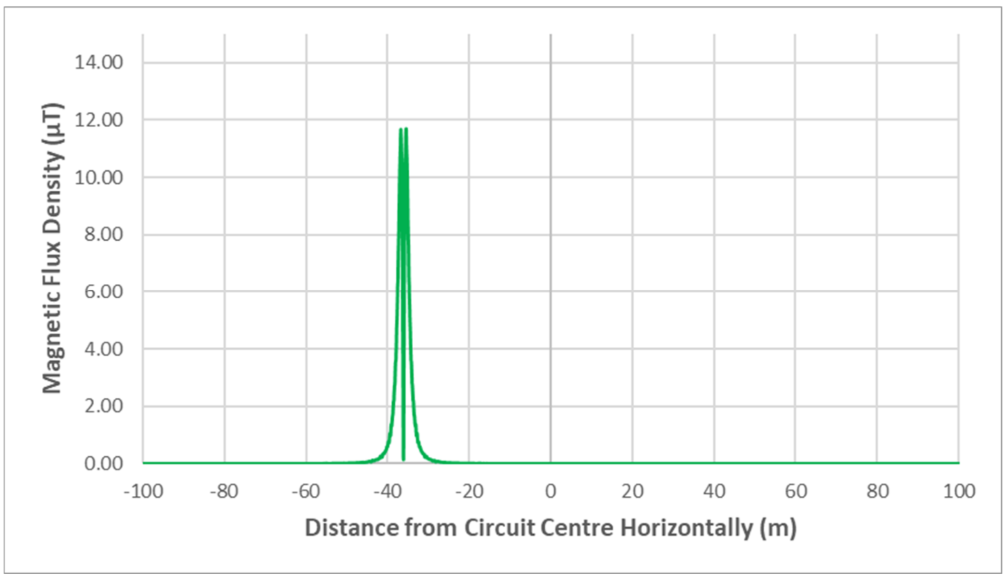

Figure 4: Sample Point1 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – X axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00002	0.00011	0.00070	0.00566	0.04497	0.33741	0.13902	0.33304	0.04568	0.00590	0.00089	0.00011	0.00003
1	0.00001	0.00016	0.00130	0.00930	0.08704	0.44589	0.01792	0.43962	0.08102	0.01179	0.00075	0.00010	0.00001
2	0.00001	0.00006	0.00150	0.01374	0.10152	0.52638	0.00581	0.53522	0.09642	0.01582	0.00106	0.00009	0.00002
5	0.00002	0.00032	0.00209	0.02350	0.13107	0.33974	0.00042	0.33578	0.12985	0.02120	0.00202	0.00017	0.00001
10	0.00003	0.00055	0.00288	0.03103	0.08605	0.10045	0.00019	0.09898	0.08437	0.03168	0.00318	0.00049	0.00004
15	0.00006	0.00064	0.00396	0.03065	0.04987	0.03984	0.00005	0.03955	0.05141	0.03092	0.00443	0.00055	0.00007
20	0.00008	0.00079	0.00482	0.02415	0.02849	0.01963	0.00001	0.01937	0.02874	0.02496	0.00453	0.00070	0.00009
40	0.00017	0.00109	0.00483	0.00723	0.00528	0.00275	0.00001	0.00274	0.00517	0.00729	0.00497	0.00114	0.00018
60	0.00026	0.00127	0.00325	0.00284	0.00163	0.00084	0.00001	0.00085	0.00162	0.00281	0.00313	0.00124	0.00027
80	0.00029	0.00121	0.00202	0.00127	0.00074	0.00039	0.00000	0.00038	0.00074	0.00132	0.00208	0.00125	0.00029

Figure 5: Sample Point 1 - 375 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – X axis

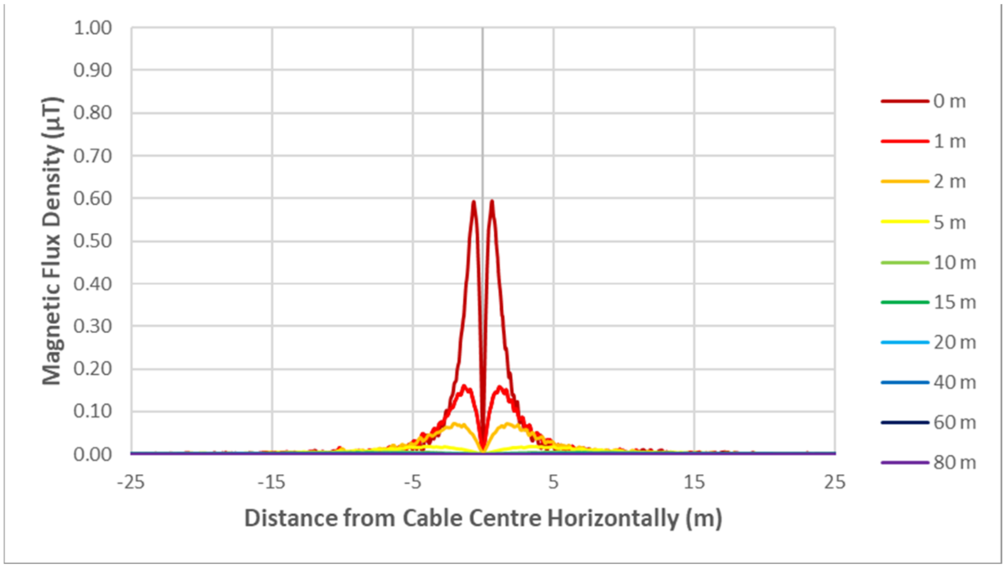

Figure 6: Sample Point1 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Y axis

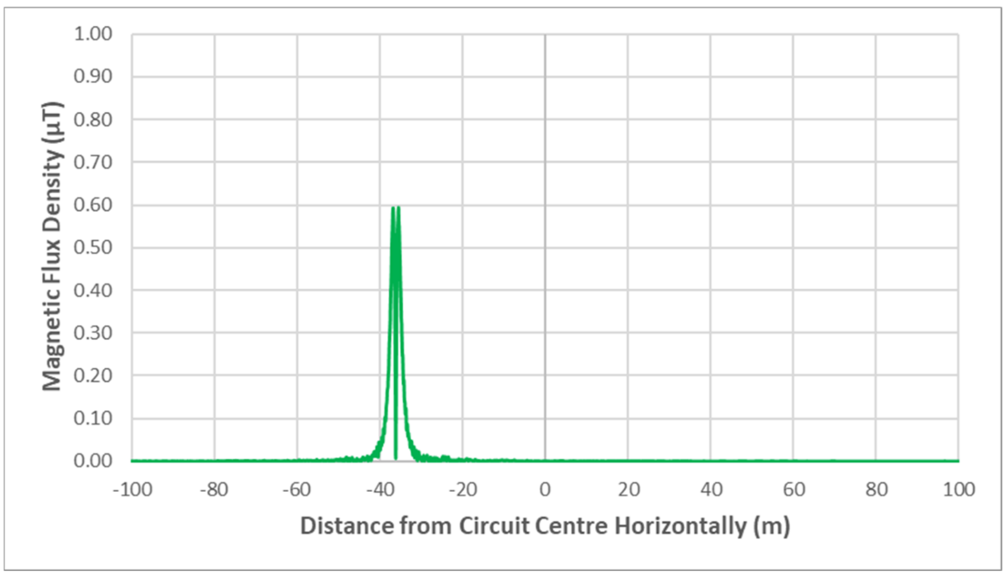

Figure 7: Sample Point1 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – Y axis

Height Above Seabed	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00001	0.00003	0.00008	0.00091	0.00212	0.01182	0.00673	0.02397	0.00470	0.00029	0.00037	0.00010	0.00002
1	0.00001	0.00017	0.00014	0.00038	0.00318	0.02814	0.00089	0.01917	0.00824	0.00075	0.00072	0.00005	0.00000
2	0.00001	0.00007	0.00008	0.00051	0.01321	0.02243	0.00021	0.02800	0.00086	0.00014	0.00044	0.00007	0.00001
5	0.00004	0.00006	0.00010	0.00329	0.00709	0.01671	0.00001	0.01797	0.00695	0.00012	0.00013	0.00028	0.00001
10	0.00000	0.00012	0.00032	0.00139	0.00462	0.00494	0.00005	0.00505	0.00443	0.00149	0.00017	0.00004	0.00001
15	0.00000	0.00005	0.00035	0.00137	0.00259	0.00196	0.00002	0.00197	0.00261	0.00177	0.00008	0.00010	0.00001
20	0.00000	0.00007	0.00026	0.00104	0.00143	0.00095	0.00000	0.00103	0.00145	0.00138	0.00032	0.00008	0.00001
40	0.00001	0.00005	0.00020	0.00039	0.00028	0.00014	0.00000	0.00015	0.00025	0.00039	0.00028	0.00004	0.00001
60	0.00002	0.00008	0.00016	0.00014	0.00008	0.00004	0.00000	0.00005	0.00008	0.00015	0.00017	0.00006	0.00002
80	0.00001	0.00006	0.00010	0.00007	0.00004	0.00002	0.00000	0.00002	0.00004	0.00007	0.00010	0.00006	0.00001

Figure 8: Sample Point 1 - 375 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Y axis

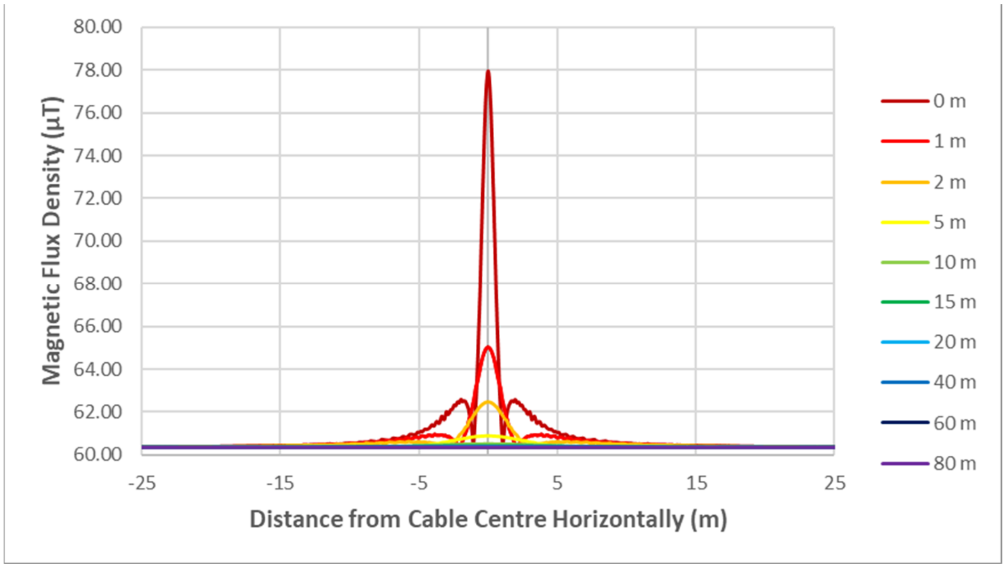

Figure 9: Sample Point1 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Z axis

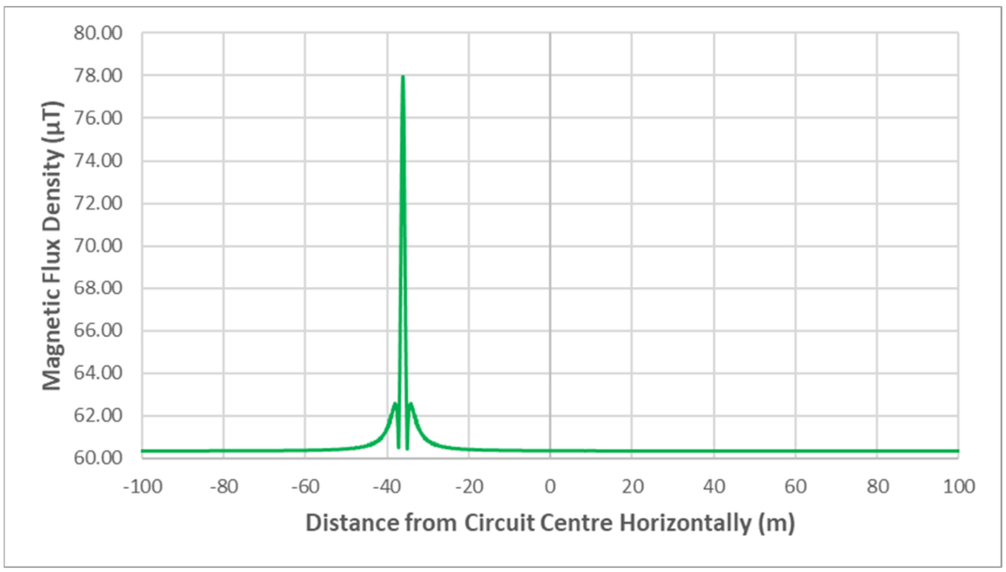

Figure 10: Sample Point1 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – Z axis

Height Above Seabed	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	60.35047	60.35199	60.35805	60.39751	60.54623	61.04621	77.96242	61.04618	60.54301	60.39746	60.35840	60.35188	60.35043
1	60.35048	60.35200	60.35903	60.39980	60.55061	60.80680	65.03045	60.80420	60.54444	60.40201	60.35868	60.35220	60.35050
2	60.35051	60.35201	60.35882	60.39802	60.49946	60.61425	62.47259	60.61809	60.49440	60.39990	60.35842	60.35224	60.35053
5	60.35051	60.35225	60.35723	60.38534	60.41683	60.41656	60.89137	60.41675	60.41645	60.38335	60.35742	60.35203	60.35058
10	60.35047	60.35185	60.35637	60.36945	60.35925	60.43903	60.51242	60.43849	60.35979	60.36948	60.35655	60.35172	60.35049
15	60.35047	60.35174	60.35560	60.35678	60.37516	60.40801	60.42704	60.40775	60.37548	60.35676	60.35579	60.35164	60.35048
20	60.35046	60.35167	60.35463	60.35120	60.37346	60.38810	60.39482	60.38798	60.37352	60.35098	60.35454	60.35157	60.35048
40	60.35043	60.35113	60.35095	60.35563	60.35985	60.36127	60.36178	60.36126	60.35984	60.35581	60.35100	60.35113	60.35044
60	60.35039	60.35065	60.35060	60.35382	60.35493	60.35521	60.35532	60.35521	60.35492	60.35379	60.35061	60.35065	60.35039
80	60.35031	60.35026	60.35105	60.35250	60.35288	60.35298	60.35301	60.35298	60.35287	60.35251	60.35103	60.35027	60.35031

Figure 11: Sample Point 1 - 375 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Z axis

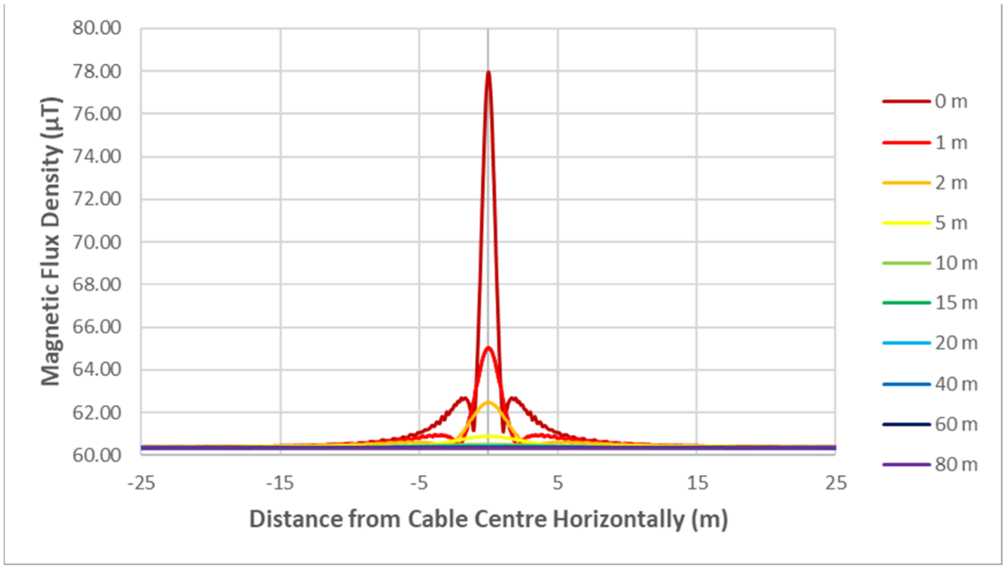

Figure 12: Sample Point1 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Resultant

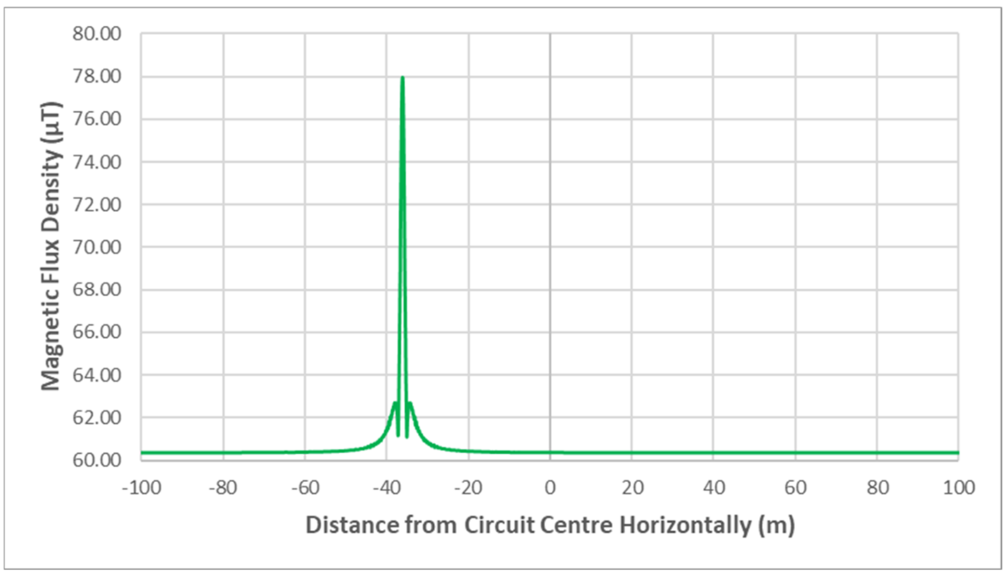

Figure 13: Sample Point1 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – Resultant

Height Above Seabed	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	60.35047	60.35199	60.35805	60.39751	60.54625	61.04714	77.96254	61.04710	60.54303	60.39746	60.35840	60.35188	60.35043
1	60.35048	60.35200	60.35903	60.39981	60.55067	60.80844	65.03046	60.80579	60.54450	60.40201	60.35868	60.35220	60.35050
2	60.35051	60.35201	60.35882	60.39802	60.49955	60.61654	62.47259	60.62046	60.49448	60.39990	60.35842	60.35224	60.35053
5	60.35051	60.35225	60.35723	60.38535	60.41697	60.41752	60.89137	60.41769	60.41659	60.38335	60.35742	60.35203	60.35058
10	60.35047	60.35185	60.35637	60.36946	60.35931	60.43911	60.51242	60.43857	60.35985	60.36949	60.35655	60.35172	60.35049
15	60.35047	60.35174	60.35560	60.35679	60.37518	60.40802	60.42704	60.40776	60.37550	60.35677	60.35579	60.35164	60.35048
20	60.35046	60.35167	60.35464	60.35120	60.37347	60.38810	60.39482	60.38798	60.37353	60.35099	60.35454	60.35157	60.35048
40	60.35043	60.35113	60.35095	60.35563	60.35985	60.36127	60.36178	60.36126	60.35984	60.35581	60.35100	60.35113	60.35044
60	60.35039	60.35065	60.35060	60.35382	60.35493	60.35521	60.35532	60.35521	60.35492	60.35379	60.35061	60.35065	60.35039
80	60.35031	60.35026	60.35105	60.35250	60.35288	60.35298	60.35301	60.35298	60.35287	60.35251	60.35103	60.35027	60.35031

Figure 14: Sample Point 1 - 375 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Resultant

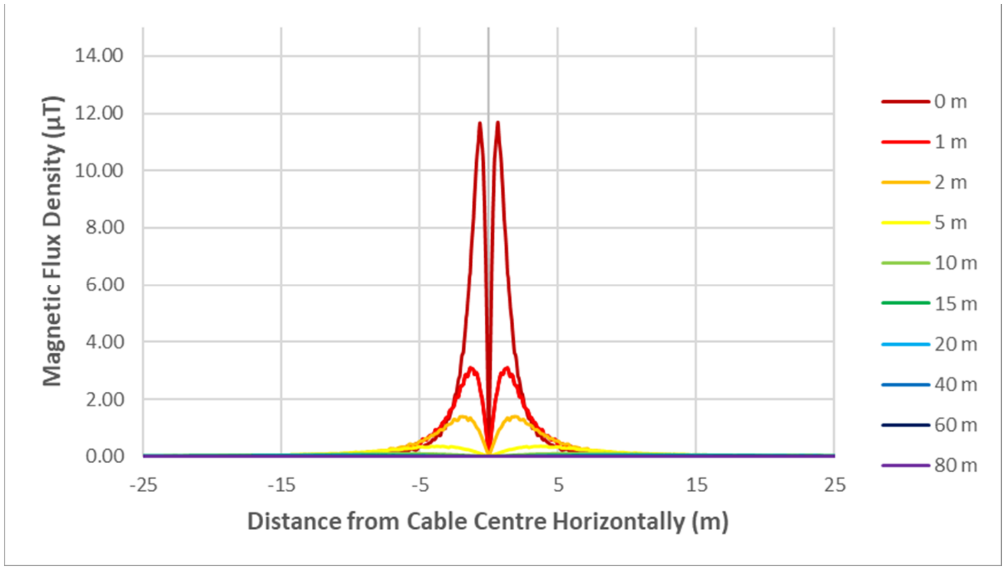

Figure 15: Sample Point1 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – X axis

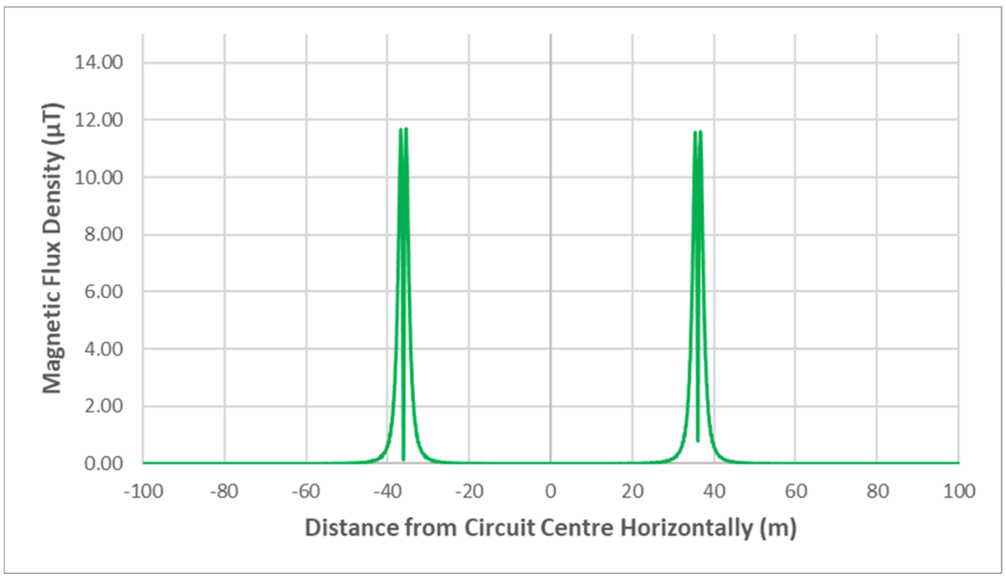

Figure 16: Sample Point1 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – X axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	μT												
0	0.00001	0.00010	0.00064	0.00554	0.04479	0.33714	0.13914	0.33337	0.04580	0.00602	0.00682	0.00194	0.00003
1	0.00002	0.00015	0.00122	0.00916	0.08674	0.44570	0.01809	0.43977	0.08143	0.01234	0.01093	0.00390	0.00013
2	0.00000	0.00005	0.00139	0.01364	0.10133	0.52614	0.00631	0.53548	0.09698	0.01658	0.01530	0.00638	0.00011
5	0.00001	0.00028	0.00199	0.02316	0.13061	0.33931	0.00108	0.33646	0.13067	0.02299	0.01927	0.01089	0.00010
10	0.00001	0.00045	0.00259	0.03051	0.08532	0.09950	0.00094	0.10049	0.08631	0.03476	0.03041	0.01469	0.00019
15	0.00002	0.00050	0.00357	0.02984	0.04875	0.03839	0.00170	0.04133	0.05418	0.03478	0.03009	0.01720	0.00021
20	0.00004	0.00063	0.00442	0.02318	0.02720	0.01788	0.00220	0.02162	0.03173	0.02974	0.02556	0.01523	0.00028
40	0.00010	0.00080	0.00409	0.00574	0.00336	0.00055	0.00239	0.00565	0.00836	0.01145	0.01263	0.00646	0.00052
60	0.00015	0.00086	0.00236	0.00127	0.00022	0.00119	0.00216	0.00325	0.00424	0.00589	0.00614	0.00205	0.00061
80	0.00015	0.00078	0.00116	0.00002	0.00071	0.00120	0.00172	0.00221	0.00263	0.00322	0.00351	0.00041	0.00046

Figure 17: Sample Point1 - 375 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – X axis

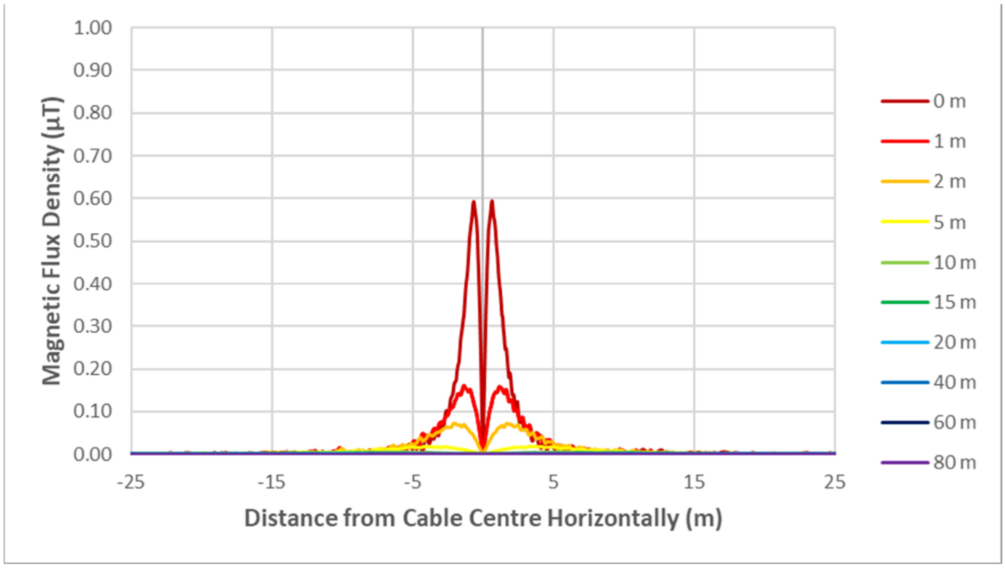

Figure 18: Sample Point1 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Y axis

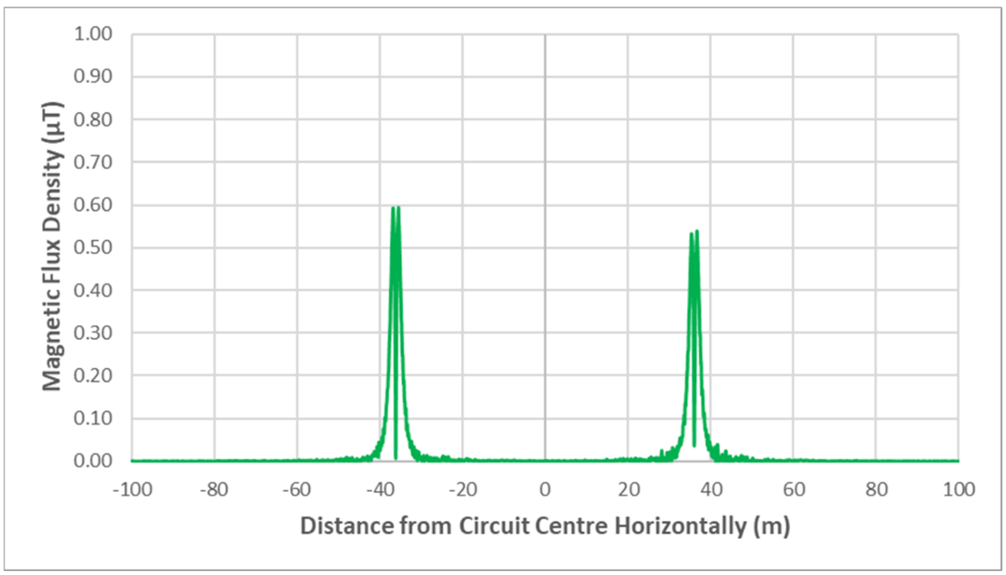

Figure 19: Sample Point1 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Y axis

Height Above Seabed	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00001	0.00001	0.00007	0.00069	0.00192	0.01197	0.00681	0.02426	0.00474	0.00062	0.00022	0.00048	0.00005
1	0.00003	0.00009	0.00022	0.00044	0.00320	0.02796	0.00113	0.01879	0.00842	0.00018	0.00015	0.00071	0.00001
2	0.00002	0.00008	0.00012	0.00052	0.01346	0.02221	0.00046	0.02773	0.00061	0.00075	0.00167	0.00006	0.00004
5	0.00006	0.00011	0.00009	0.00316	0.00699	0.01680	0.00022	0.01818	0.00727	0.00039	0.00136	0.00033	0.00002
10	0.00001	0.00008	0.00033	0.00137	0.00461	0.00474	0.00015	0.00523	0.00475	0.00141	0.00093	0.00078	0.00002
15	0.00001	0.00001	0.00036	0.00135	0.00257	0.00178	0.00002	0.00228	0.00285	0.00167	0.00120	0.00060	0.00001
20	0.00001	0.00002	0.00029	0.00095	0.00127	0.00085	0.00001	0.00122	0.00167	0.00153	0.00129	0.00074	0.00000
40	0.00003	0.00002	0.00015	0.00030	0.00017	0.00003	0.00008	0.00032	0.00038	0.00061	0.00064	0.00031	0.00003
60	0.00002	0.00006	0.00011	0.00005	0.00001	0.00006	0.00009	0.00017	0.00019	0.00028	0.00029	0.00007	0.00003
80	0.00001	0.00004	0.00006	0.00000	0.00002	0.00006	0.00008	0.00010	0.00013	0.00016	0.00017	0.00002	0.00003

Figure 20: Sample Point1 - 375 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Y axis

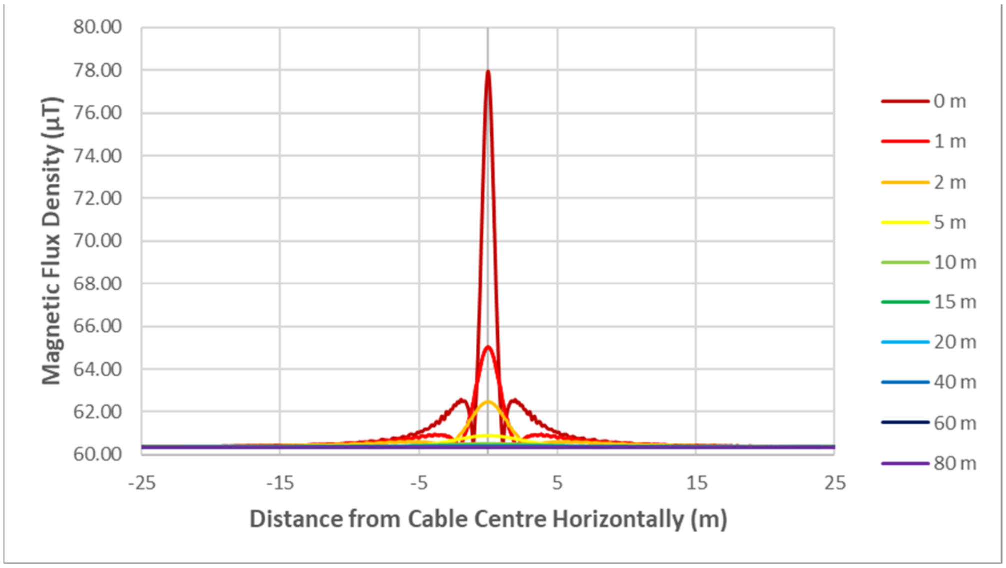

Figure 21: Sample Point1 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Z axis

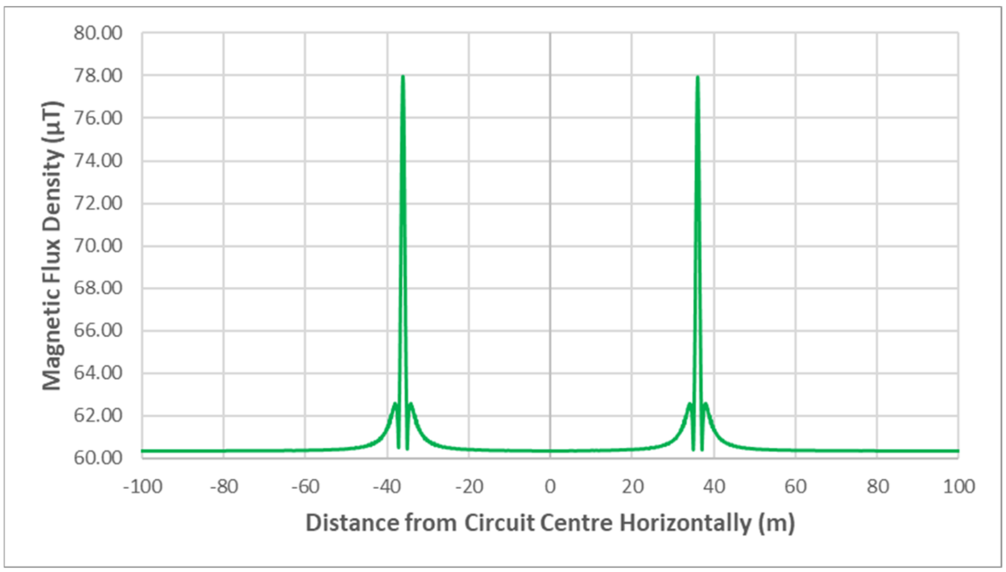

Figure 22: Sample Point1 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Z axis

Height Above Seabed	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	60.35022	60.35125	60.35677	60.39514	60.54333	61.04261	77.96624	61.04180	60.53796	60.39005	60.38221	60.37454	60.35090
1	60.35019	60.35128	60.35757	60.39739	60.54742	60.80386	65.03438	60.79993	60.53933	60.39514	60.38546	60.37134	60.35063
2	60.35021	60.35142	60.35740	60.39578	60.49629	60.61121	62.47673	60.61365	60.48959	60.39287	60.38523	60.37155	60.35060
5	60.35023	60.35159	60.35594	60.38315	60.41412	60.41966	60.89540	60.42061	60.41157	60.37604	60.37207	60.37085	60.35063
10	60.35017	60.35118	60.35506	60.36728	60.36191	60.44233	60.51634	60.44243	60.36468	60.36283	60.36326	60.36443	60.35072
15	60.35017	60.35108	60.35431	60.35468	60.37772	60.41113	60.43071	60.41128	60.37998	60.35090	60.35264	60.35831	60.35069
20	60.35016	60.35101	60.35341	60.35316	60.37574	60.39083	60.39818	60.39111	60.37743	60.35583	60.35343	60.35296	60.35067
40	60.35015	60.35055	60.35001	60.35696	60.36127	60.36276	60.36322	60.36276	60.36121	60.35681	60.35614	60.35436	60.35052
60	60.35014	60.35016	60.35127	60.35449	60.35549	60.35570	60.35568	60.35543	60.35496	60.35329	60.35303	60.35356	60.35029
80	60.35009	60.35010	60.35141	60.35267	60.35291	60.35291	60.35281	60.35265	60.35234	60.35162	60.35140	60.35237	60.35004

Figure 23: Sample Point1 - 375 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Z axis

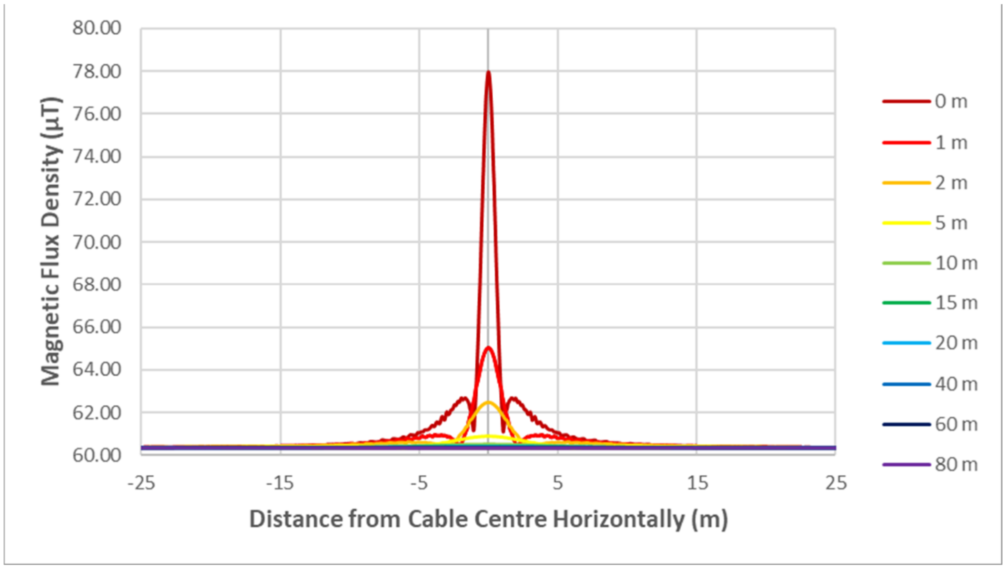

Figure 24: Sample Point1 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Resultant

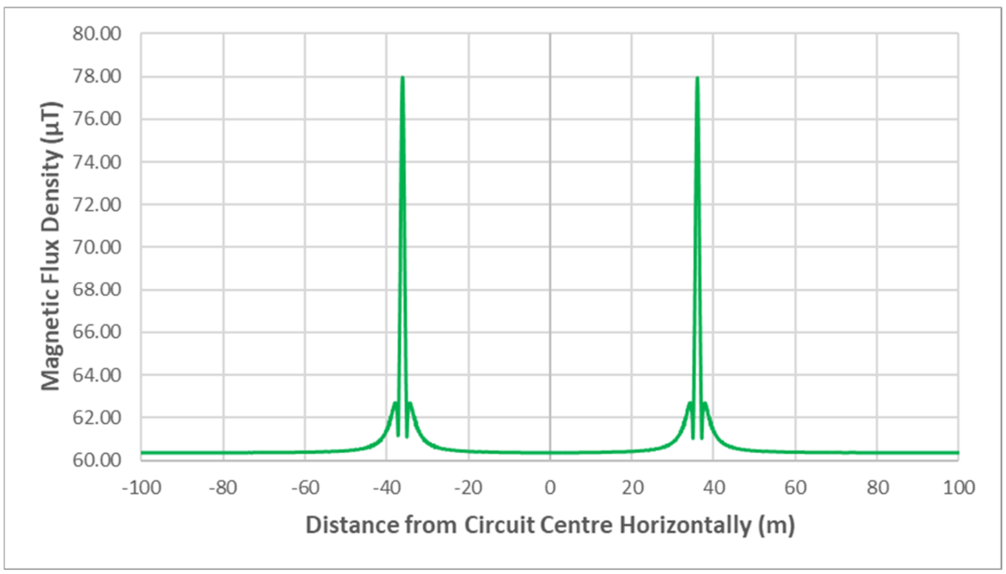

Figure 25: Sample Point1 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Resultant

Height Above Seabed	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	60.35022	60.35125	60.35677	60.39514	60.54335	61.04355	77.96636	61.04271	60.53797	60.39005	60.38221	60.37454	60.35090
1	60.35019	60.35128	60.35757	60.39739	60.54749	60.80550	65.03438	60.80152	60.53939	60.39514	60.38546	60.37134	60.35063
2	60.35021	60.35142	60.35740	60.39578	60.49638	60.61349	62.47673	60.61602	60.48966	60.39287	60.38523	60.37156	60.35060
5	60.35023	60.35159	60.35594	60.38315	60.41426	60.42062	60.89540	60.42154	60.41171	60.37604	60.37207	60.37086	60.35063
10	60.35017	60.35118	60.35506	60.36729	60.36197	60.44241	60.51634	60.44252	60.36474	60.36284	60.36326	60.36443	60.35072
15	60.35017	60.35108	60.35431	60.35468	60.37774	60.41114	60.43071	60.41129	60.38000	60.35091	60.35265	60.35831	60.35069
20	60.35016	60.35101	60.35341	60.35316	60.37575	60.39083	60.39818	60.39111	60.37744	60.35584	60.35344	60.35297	60.35067
40	60.35015	60.35055	60.35001	60.35696	60.36127	60.36276	60.36322	60.36276	60.36121	60.35681	60.35614	60.35436	60.35052
60	60.35014	60.35016	60.35127	60.35449	60.35549	60.35570	60.35568	60.35543	60.35496	60.35330	60.35303	60.35356	60.35029
80	60.35009	60.35010	60.35141	60.35267	60.35291	60.35291	60.35281	60.35265	60.35234	60.35162	60.35140	60.35237	60.35004

Figure 26: Sample Point1 - 375 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Resultant

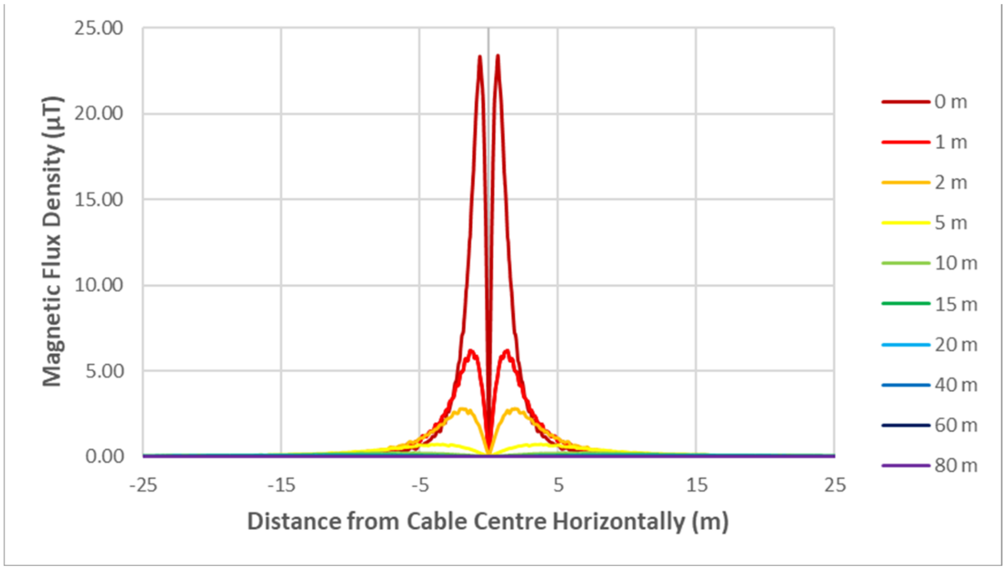

Figure 27: Sample Point1 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – X axis

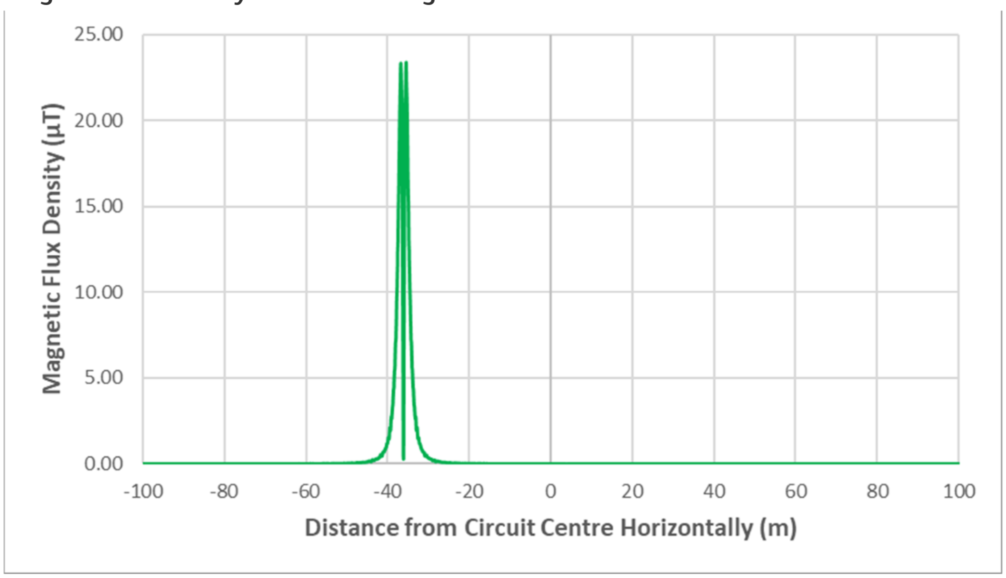

Figure 28: Sample Point1 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – X axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00003	0.00023	0.00140	0.01133	0.08995	0.67482	0.27804	0.66607	0.09136	0.01181	0.00178	0.00021	0.00005
1	0.00002	0.00031	0.00259	0.01861	0.17408	0.89178	0.03585	0.87924	0.16204	0.02359	0.00149	0.00019	0.00001
2	0.00002	0.00012	0.00299	0.02748	0.20304	1.05277	0.01163	1.07043	0.19285	0.03164	0.00213	0.00017	0.00003
5	0.00004	0.00063	0.00418	0.04701	0.26215	0.67947	0.00084	0.67155	0.25971	0.04240	0.00405	0.00033	0.00003
10	0.00006	0.00110	0.00575	0.06207	0.17210	0.20091	0.00038	0.19796	0.16875	0.06337	0.00635	0.00099	0.00008
15	0.00011	0.00128	0.00793	0.06129	0.09975	0.07968	0.00011	0.07910	0.10282	0.06184	0.00887	0.00110	0.00013
20	0.00016	0.00159	0.00964	0.04830	0.05699	0.03925	0.00001	0.03873	0.05747	0.04991	0.00907	0.00141	0.00019
40	0.00034	0.00218	0.00966	0.01446	0.01056	0.00550	0.00001	0.00547	0.01034	0.01458	0.00994	0.00227	0.00035
60	0.00052	0.00254	0.00651	0.00568	0.00325	0.00169	0.00001	0.00169	0.00324	0.00562	0.00626	0.00248	0.00054
80	0.00059	0.00242	0.00404	0.00255	0.00149	0.00077	0.00000	0.00076	0.00149	0.00263	0.00416	0.00250	0.00058

Figure 29: Sample Point 1 - 750 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – X axis

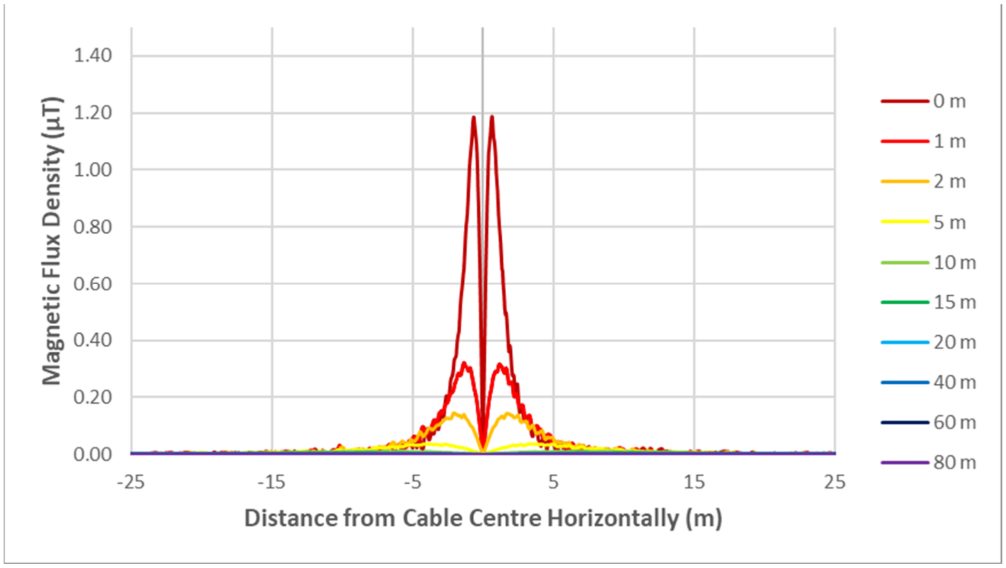

Figure 30: Sample Point1 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Y axis

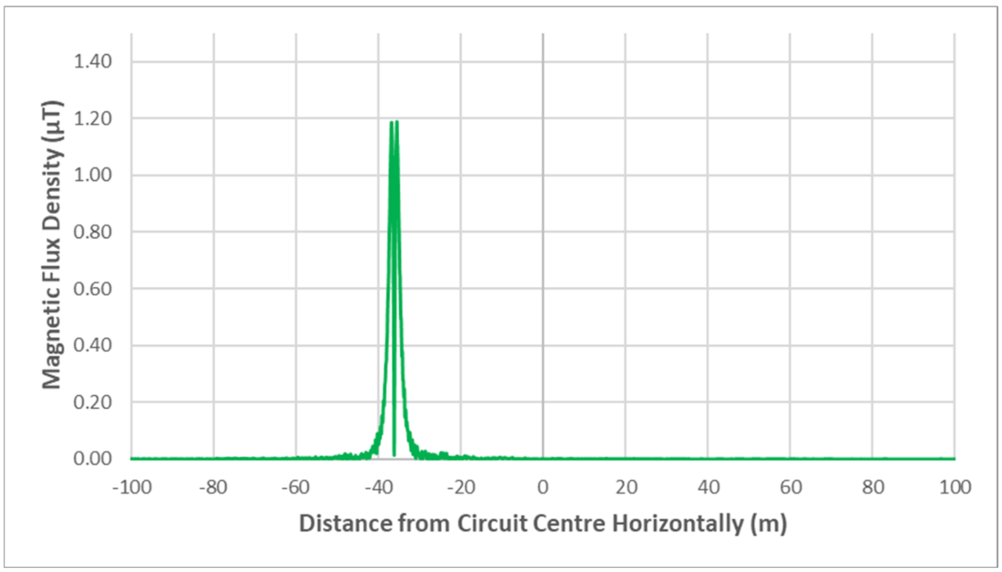

Figure 31: Sample Point1 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – Y axis

Height Above Seabed	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00001	0.00005	0.00016	0.00182	0.00424	0.02365	0.01346	0.04795	0.00941	0.00058	0.00075	0.00019	0.00004
1	0.00003	0.00034	0.00028	0.00076	0.00635	0.05627	0.00178	0.03834	0.01649	0.00150	0.00144	0.00010	0.00001
2	0.00003	0.00015	0.00015	0.00101	0.02642	0.04487	0.00042	0.05599	0.00172	0.00028	0.00088	0.00015	0.00001
5	0.00009	0.00013	0.00019	0.00659	0.01419	0.03341	0.00003	0.03593	0.01391	0.00025	0.00026	0.00056	0.00001
10	0.00000	0.00025	0.00064	0.00278	0.00925	0.00988	0.00010	0.01009	0.00886	0.00297	0.00035	0.00008	0.00001
15	0.00000	0.00010	0.00069	0.00275	0.00519	0.00392	0.00003	0.00394	0.00521	0.00353	0.00016	0.00019	0.00001
20	0.00001	0.00015	0.00051	0.00208	0.00287	0.00189	0.00000	0.00206	0.00291	0.00275	0.00063	0.00015	0.00002
40	0.00002	0.00009	0.00041	0.00078	0.00055	0.00027	0.00000	0.00030	0.00049	0.00078	0.00056	0.00008	0.00002
60	0.00003	0.00016	0.00033	0.00027	0.00016	0.00008	0.00000	0.00009	0.00017	0.00029	0.00034	0.00011	0.00003
80	0.00003	0.00011	0.00020	0.00013	0.00008	0.00004	0.00000	0.00004	0.00007	0.00014	0.00021	0.00012	0.00002

Figure 32: Sample Point 1 - 750 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Y axis

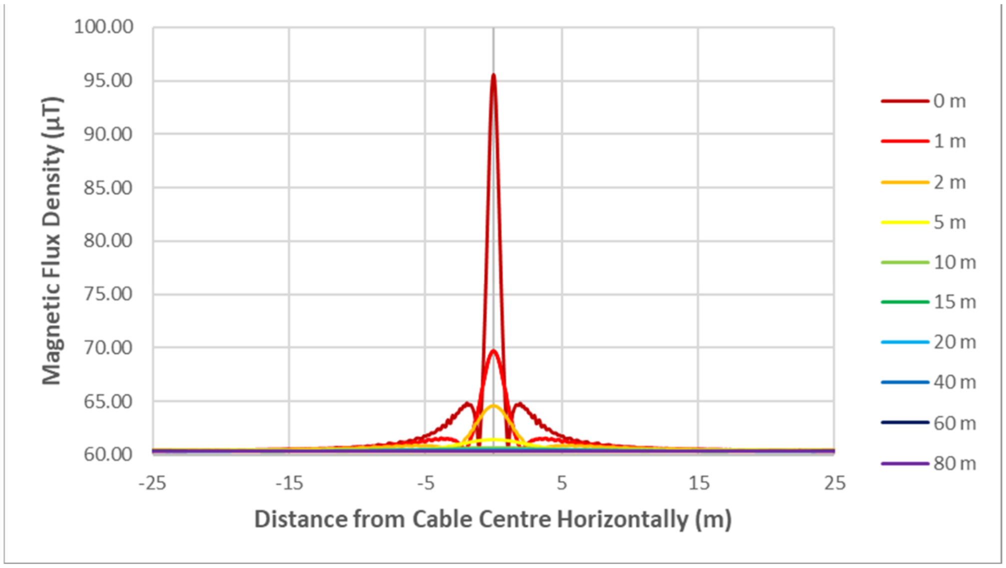

Figure 33: Sample Point1 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Z axis

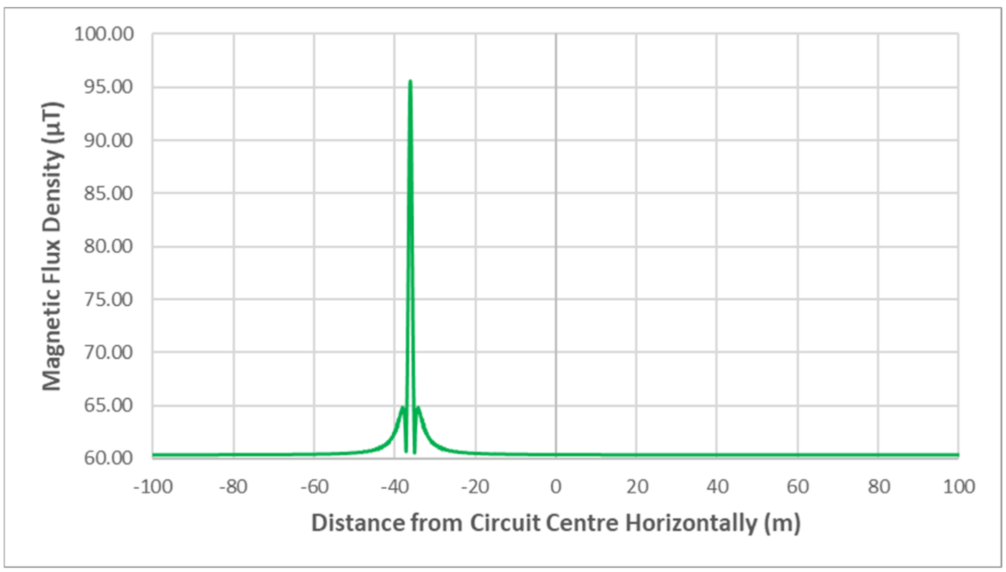

Figure 34: Sample Point1 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – Z axis

Height Above Seabed	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	60.35093	60.35398	60.36611	60.44502	60.74246	61.74242	95.57484	61.74237	60.73602	60.44491	60.36681	60.35375	60.35086
1	60.35097	60.35399	60.36807	60.44961	60.75121	61.26360	69.71091	61.25840	60.73889	60.45402	60.36736	60.35441	60.35100
2	60.35102	60.35402	60.36765	60.44604	60.64892	60.87851	64.59518	60.88618	60.63880	60.44979	60.36685	60.35448	60.35106
5	60.35103	60.35450	60.36446	60.42068	60.48365	60.48313	61.43275	60.48351	60.48291	60.41669	60.36485	60.35405	60.35116
10	60.35094	60.35371	60.36275	60.38890	60.36849	60.52805	60.67485	60.52698	60.36958	60.38897	60.36310	60.35345	60.35098
15	60.35094	60.35349	60.36120	60.36356	60.40031	60.46602	60.50409	60.46550	60.40096	60.36352	60.36158	60.35328	60.35097
20	60.35093	60.35333	60.35927	60.35239	60.39693	60.42620	60.43963	60.42596	60.39704	60.35197	60.35908	60.35313	60.35096
40	60.35086	60.35226	60.35190	60.36127	60.36969	60.37254	60.37356	60.37252	60.36967	60.36162	60.35200	60.35227	60.35088
60	60.35077	60.35131	60.35120	60.35764	60.35985	60.36042	60.36064	60.36042	60.35983	60.35759	60.35121	60.35129	60.35079
80	60.35062	60.35053	60.35209	60.35501	60.35575	60.35596	60.35603	60.35596	60.35575	60.35502	60.35205	60.35054	60.35062

Figure 35: Sample Point 1 - 750 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Z axis

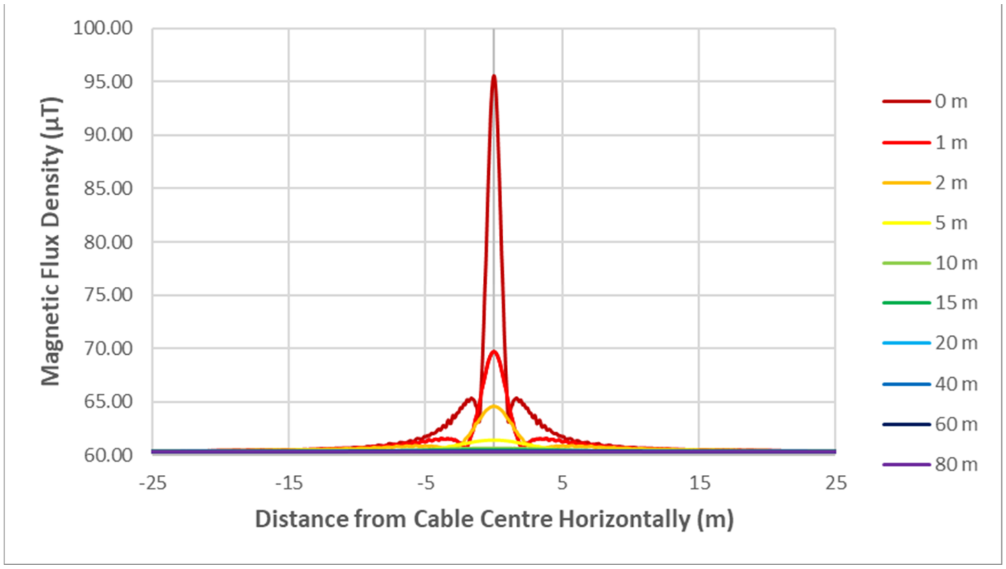

Figure 36: Sample Point1 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Resultant

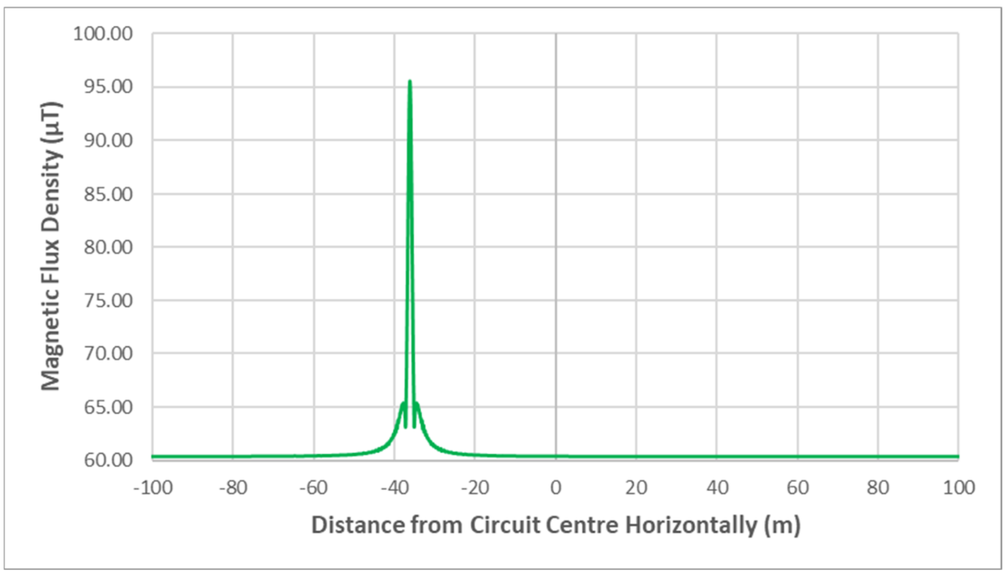

Figure 37: Sample Point1 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – Resultant

Height Above Seabed	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	60.35093	60.35398	60.36611	60.44502	60.74253	61.74611	95.57525	61.74598	60.73609	60.44491	60.36681	60.35375	60.35086
1	60.35097	60.35399	60.36807	60.44961	60.75146	61.27012	69.71092	61.26472	60.73911	60.45403	60.36737	60.35441	60.35100
2	60.35102	60.35402	60.36765	60.44605	60.64927	60.88762	64.59518	60.89561	60.63910	60.44980	60.36685	60.35448	60.35106
5	60.35103	60.35450	60.36446	60.42070	60.48422	60.48695	61.43275	60.48725	60.48347	60.41671	60.36485	60.35405	60.35116
10	60.35094	60.35371	60.36275	60.38893	60.36874	60.52839	60.67485	60.52731	60.36981	60.38900	60.36310	60.35345	60.35098
15	60.35094	60.35349	60.36120	60.36359	60.40039	60.46607	60.50409	60.46555	60.40104	60.36355	60.36158	60.35328	60.35097
20	60.35093	60.35333	60.35927	60.35241	60.39695	60.42622	60.43963	60.42597	60.39707	60.35199	60.35908	60.35313	60.35096
40	60.35086	60.35226	60.35190	60.36127	60.36969	60.37254	60.37356	60.37252	60.36967	60.36162	60.35200	60.35227	60.35088
60	60.35077	60.35131	60.35120	60.35764	60.35985	60.36042	60.36064	60.36042	60.35983	60.35759	60.35121	60.35129	60.35079
80	60.35062	60.35053	60.35209	60.35501	60.35575	60.35596	60.35603	60.35596	60.35575	60.35502	60.35206	60.35054	60.35062

Figure 38: Sample Point 1 - 750 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Resultant

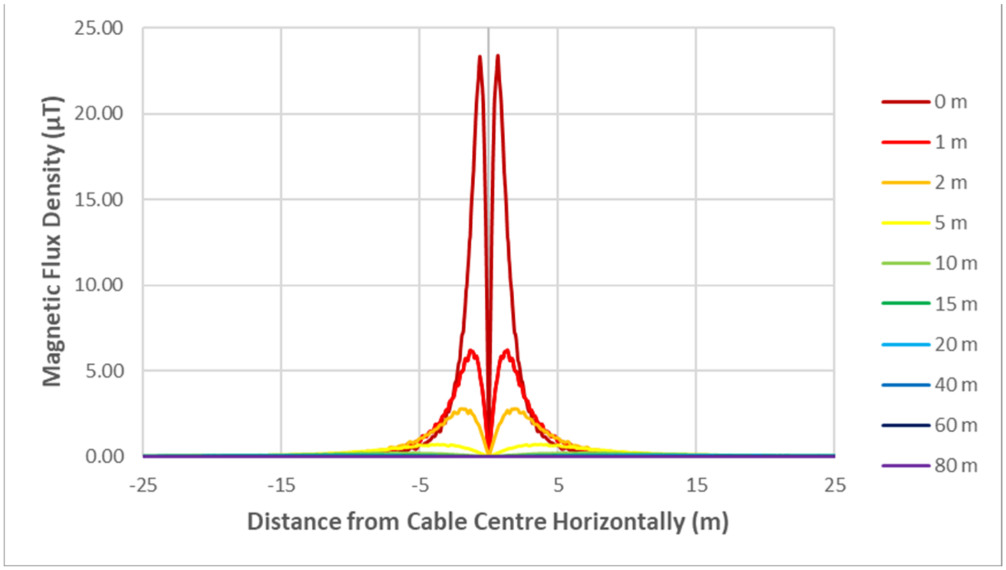

Figure 39: Sample Point1 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – X axis

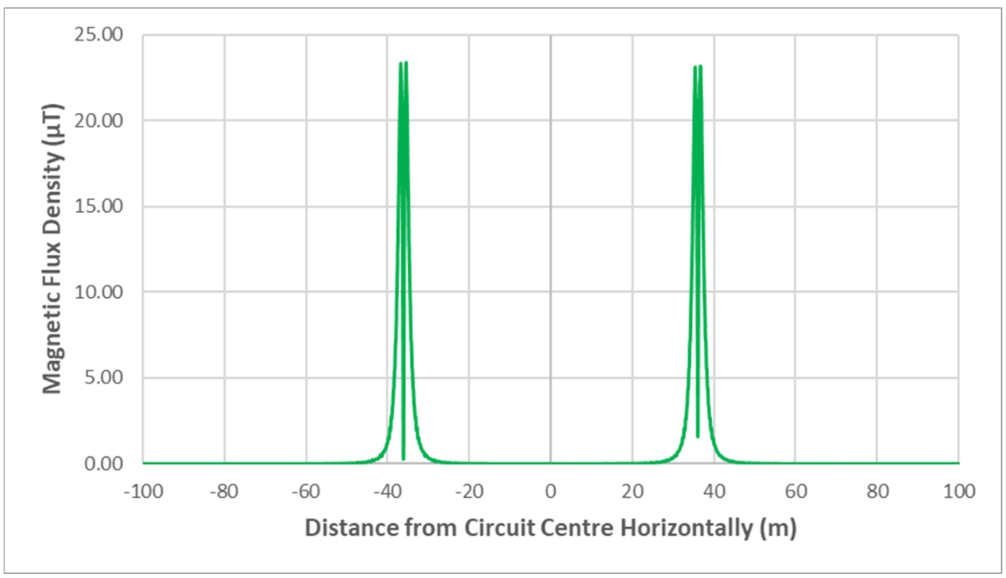

Figure 40: Sample Point1 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – X axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00003	0.00020	0.00127	0.01108	0.08959	0.67427	0.27827	0.66674	0.09159	0.01204	0.01363	0.00388	0.00005
1	0.00004	0.00030	0.00244	0.01831	0.17349	0.89139	0.03618	0.87953	0.16287	0.02469	0.02187	0.00780	0.00026
2	0.00000	0.00010	0.00279	0.02729	0.20267	1.05228	0.01261	1.07096	0.19397	0.03316	0.03061	0.01275	0.00022
5	0.00002	0.00055	0.00398	0.04632	0.26123	0.67862	0.00216	0.67293	0.26134	0.04598	0.03854	0.02177	0.00021
10	0.00002	0.00089	0.00518	0.06102	0.17064	0.19901	0.00187	0.20098	0.17261	0.06952	0.06082	0.02939	0.00039
15	0.00005	0.00099	0.00715	0.05969	0.09750	0.07678	0.00339	0.08265	0.10835	0.06957	0.06017	0.03441	0.00042
20	0.00007	0.00127	0.00884	0.04637	0.05440	0.03577	0.00439	0.04323	0.06345	0.05948	0.05111	0.03045	0.00055
40	0.00019	0.00160	0.00819	0.01148	0.00673	0.00110	0.00478	0.01131	0.01672	0.02291	0.02526	0.01292	0.00105
60	0.00031	0.00171	0.00472	0.00254	0.00045	0.00238	0.00431	0.00649	0.00848	0.01179	0.01229	0.00410	0.00122
80	0.00030	0.00156	0.00233	0.00004	0.00143	0.00239	0.00345	0.00441	0.00527	0.00643	0.00702	0.00083	0.00092

Figure 41: Sample Point 1 - 750 MW – Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – X axis

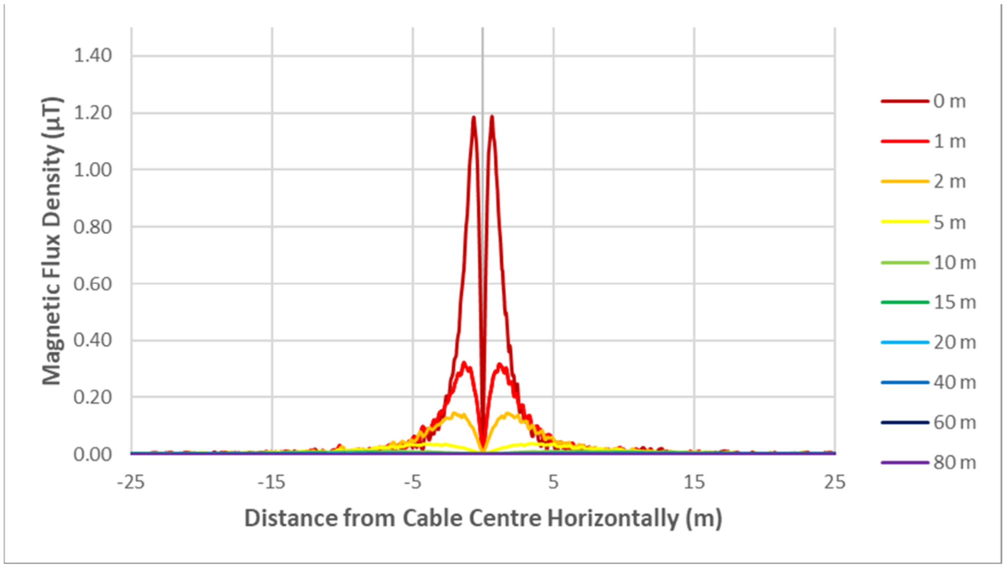

Figure 42: Sample Point1 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Y axis

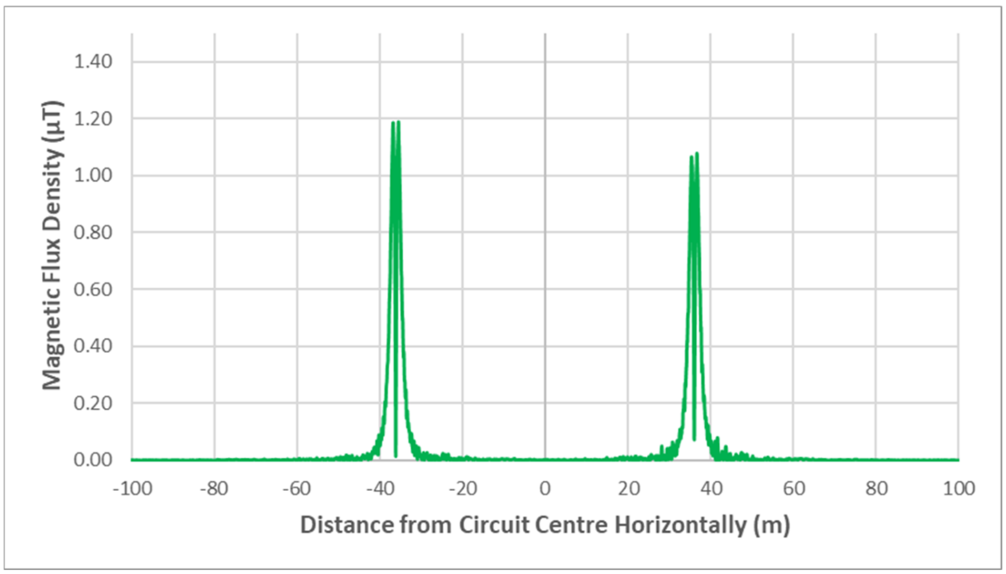

Figure 43: Sample Point1 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Y axis

Height Above Seabed	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00002	0.00001	0.00014	0.00137	0.00385	0.02394	0.01362	0.04853	0.00947	0.00123	0.00045	0.00096	0.00010
1	0.00007	0.00018	0.00044	0.00087	0.00640	0.05592	0.00225	0.03758	0.01683	0.00036	0.00029	0.00142	0.00003
2	0.00004	0.00017	0.00023	0.00105	0.02691	0.04442	0.00092	0.05547	0.00122	0.00150	0.00334	0.00011	0.00007
5	0.00012	0.00021	0.00018	0.00631	0.01397	0.03360	0.00043	0.03637	0.01455	0.00078	0.00271	0.00066	0.00004
10	0.00003	0.00016	0.00067	0.00274	0.00922	0.00948	0.00030	0.01046	0.00949	0.00282	0.00185	0.00157	0.00004
15	0.00003	0.00001	0.00071	0.00270	0.00513	0.00356	0.00003	0.00457	0.00570	0.00333	0.00240	0.00120	0.00002
20	0.00003	0.00005	0.00057	0.00190	0.00255	0.00169	0.00002	0.00245	0.00334	0.00306	0.00257	0.00147	0.00000
40	0.00006	0.00004	0.00029	0.00060	0.00034	0.00006	0.00016	0.00065	0.00075	0.00122	0.00127	0.00062	0.00007
60	0.00003	0.00011	0.00023	0.00010	0.00003	0.00013	0.00018	0.00034	0.00037	0.00056	0.00058	0.00014	0.00006
80	0.00002	0.00008	0.00012	0.00001	0.00005	0.00013	0.00016	0.00019	0.00025	0.00033	0.00033	0.00004	0.00006

Figure 44: Sample Point1 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Y axis

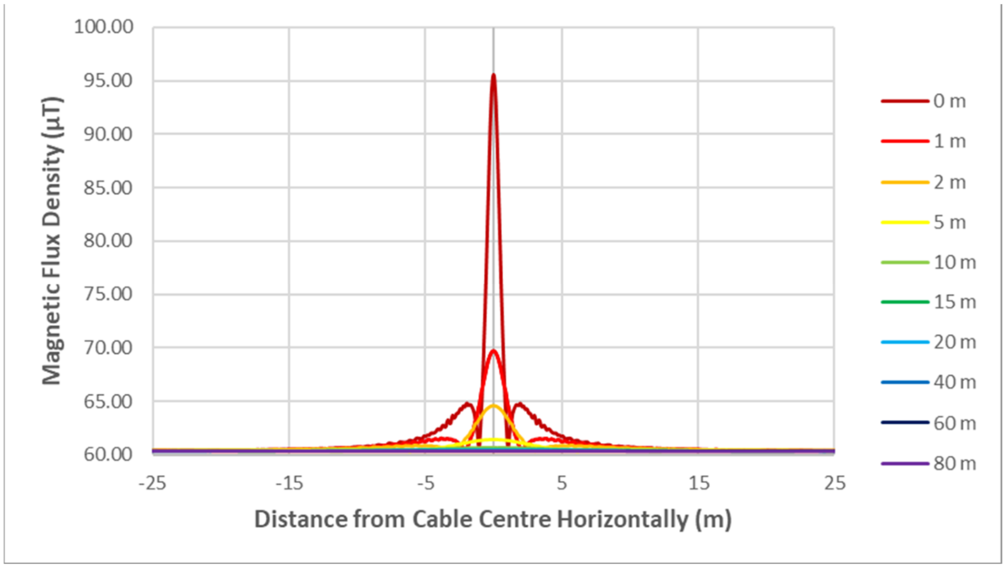

Figure 45: Sample Point1 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Z axis

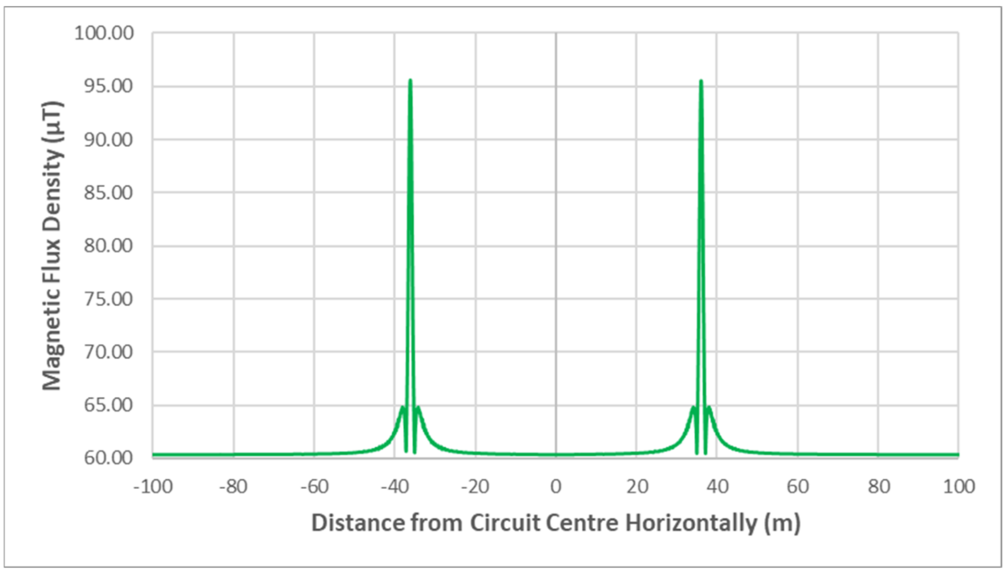

Figure 46: Sample Point1 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Z axis

Height Above Seabed	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	60.35044	60.35249	60.36355	60.44028	60.73666	61.73523	95.58248	61.73360	60.72591	60.43010	60.41442	60.39907	60.35181
1	60.35039	60.35255	60.36514	60.44479	60.74485	61.25772	69.71875	61.24986	60.72867	60.44028	60.42092	60.39267	60.35125
2	60.35043	60.35285	60.36480	60.44155	60.64258	60.87241	64.60346	60.87730	60.62917	60.43573	60.42045	60.39311	60.35120
5	60.35046	60.35317	60.36188	60.41629	60.47824	60.48933	61.44081	60.49121	60.47313	60.40208	60.39414	60.39171	60.35126
10	60.35033	60.35236	60.36012	60.38456	60.37382	60.53466	60.68267	60.53486	60.37935	60.37565	60.37651	60.37886	60.35145
15	60.35033	60.35215	60.35863	60.35935	60.40543	60.47226	60.51142	60.47256	60.40996	60.35180	60.35528	60.36661	60.35138
20	60.35032	60.35203	60.35681	60.35631	60.40149	60.43166	60.44635	60.43222	60.40486	60.36166	60.35687	60.35593	60.35133
40	60.35029	60.35110	60.35002	60.36393	60.37254	60.37552	60.37645	60.37552	60.37243	60.36362	60.36228	60.35871	60.35104
60	60.35028	60.35032	60.35253	60.35897	60.36098	60.36139	60.36136	60.36086	60.35992	60.35659	60.35606	60.35713	60.35058
80	60.35017	60.35020	60.35282	60.35535	60.35582	60.35581	60.35563	60.35529	60.35468	60.35324	60.35281	60.35474	60.35009

Figure 47: Sample Point1 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Z axis

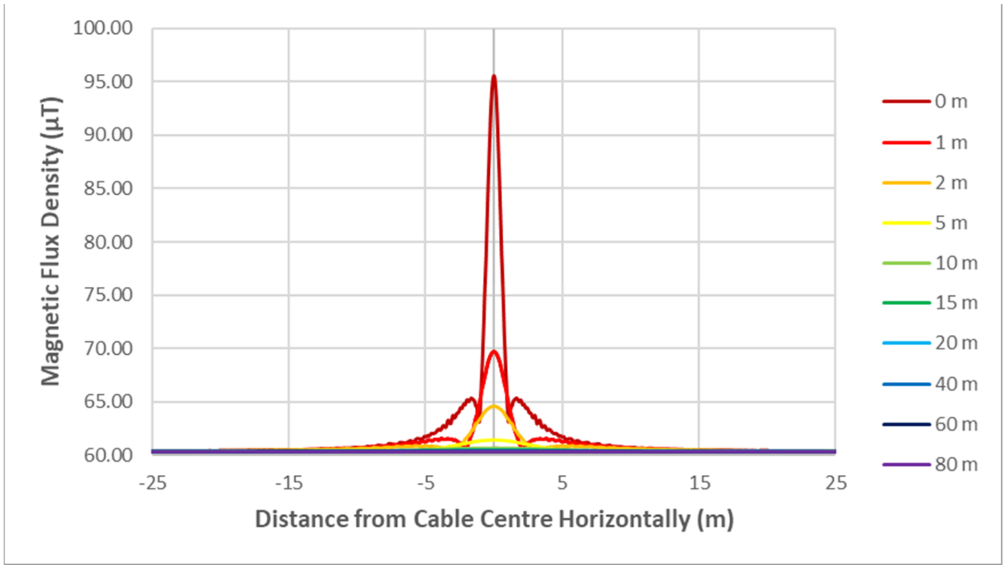

Figure 48: Sample Point1 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Resultant

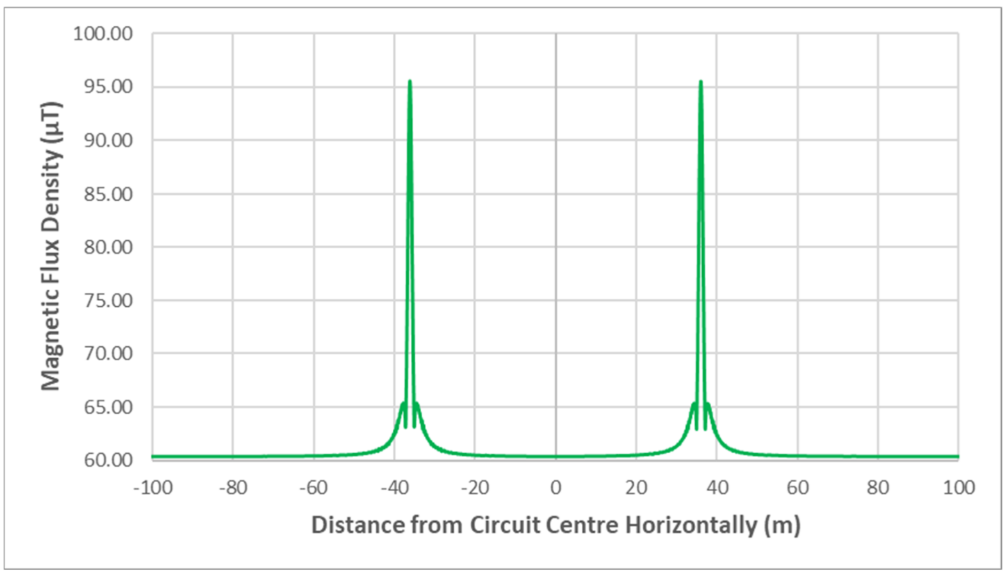

Figure 49: Sample Point1 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Resultant

Height Above Seabed	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	60.35044	60.35249	60.36355	60.44028	60.73673	61.73892	95.58289	61.73722	60.72598	60.43010	60.41442	60.39908	60.35181
1	60.35039	60.35255	60.36514	60.44479	60.74509	61.26423	69.71876	61.25618	60.72889	60.44028	60.42093	60.39267	60.35125
2	60.35043	60.35285	60.36480	60.44156	60.64293	60.88152	64.60346	60.88674	60.62948	60.43574	60.42046	60.39311	60.35120
5	60.35046	60.35317	60.36188	60.41631	60.47881	60.49314	61.44081	60.49496	60.47370	60.40209	60.39415	60.39171	60.35126
10	60.35033	60.35236	60.36012	60.38459	60.37406	60.53498	60.68267	60.53520	60.37960	60.37569	60.37654	60.37886	60.35145
15	60.35033	60.35215	60.35863	60.35938	60.40551	60.47230	60.51142	60.47262	60.41005	60.35184	60.35531	60.36662	60.35138
20	60.35032	60.35203	60.35681	60.35633	60.40151	60.43167	60.44635	60.43223	60.40489	60.36169	60.35689	60.35594	60.35133
40	60.35029	60.35110	60.35002	60.36393	60.37254	60.37552	60.37645	60.37553	60.37243	60.36362	60.36229	60.35871	60.35104
60	60.35028	60.35032	60.35253	60.35897	60.36098	60.36139	60.36136	60.36086	60.35992	60.35659	60.35606	60.35713	60.35058
80	60.35017	60.35020	60.35282	60.35535	60.35582	60.35581	60.35563	60.35529	60.35468	60.35324	60.35281	60.35474	60.35009

Figure 50: Sample Point1 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Resultant

Appendix B - Sample Point Two Plots

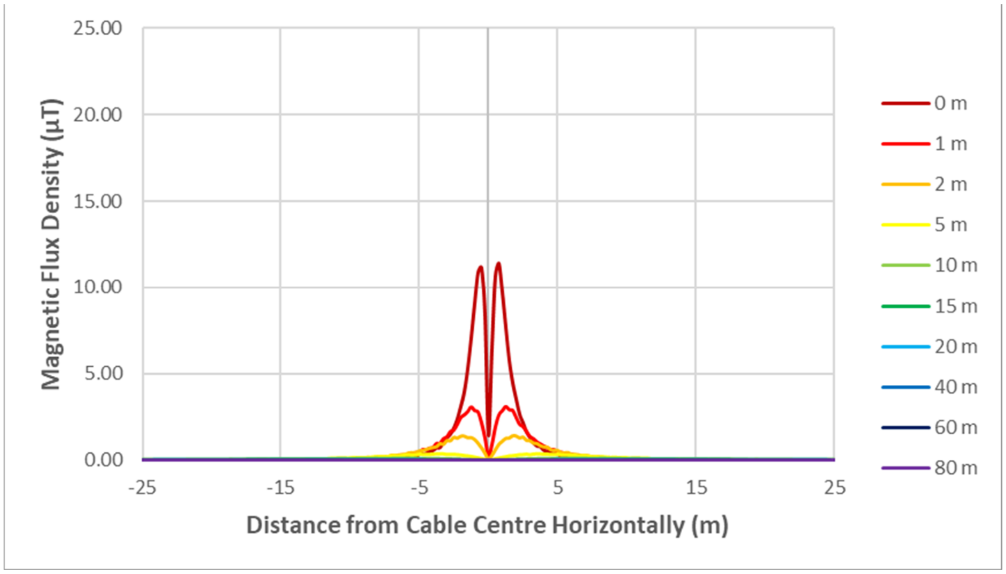

Figure 51: Sample Point 2 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – X axis

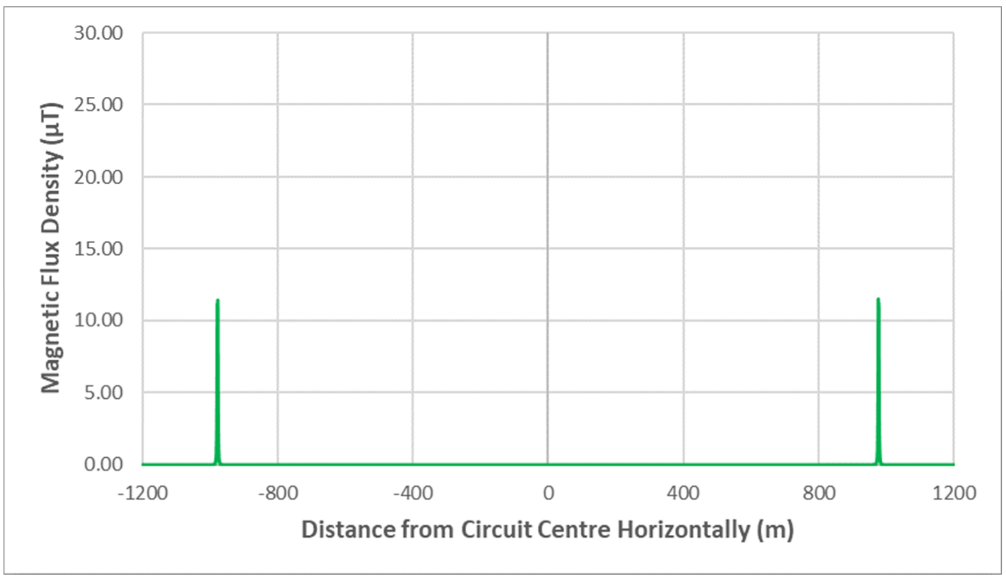

Figure 52: Sample Point 2 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – X axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00006	0.00010	0.00072	0.00506	0.05375	0.33695	1.44160	0.35877	0.04643	0.00730	0.00103	0.00020	0.00012
1	0.00002	0.00008	0.00093	0.00847	0.07409	0.42966	0.19587	0.43457	0.08795	0.00888	0.00110	0.00017	0.00004
2	0.00003	0.00000	0.00098	0.01370	0.08114	0.52948	0.05939	0.55725	0.09065	0.01327	0.00097	0.00003	0.00009
5	0.00003	0.00025	0.00220	0.01963	0.13145	0.34255	0.00765	0.34419	0.13768	0.01996	0.00241	0.00042	0.00010
10	0.00000	0.00045	0.00287	0.03046	0.08287	0.09948	0.00120	0.09829	0.08314	0.03160	0.00295	0.00059	0.00012
15	0.00003	0.00059	0.00369	0.03125	0.05090	0.03997	0.00037	0.03977	0.05237	0.03179	0.00381	0.00080	0.00016
20	0.00006	0.00073	0.00464	0.02505	0.02928	0.01969	0.00011	0.01956	0.02933	0.02514	0.00474	0.00088	0.00017
40	0.00014	0.00105	0.00498	0.00713	0.00515	0.00264	0.00007	0.00278	0.00529	0.00727	0.00514	0.00117	0.00026
60	0.00022	0.00117	0.00311	0.00274	0.00155	0.00078	0.00007	0.00092	0.00169	0.00289	0.00324	0.00128	0.00033
80	0.00025	0.00116	0.00200	0.00122	0.00068	0.00031	0.00007	0.00046	0.00083	0.00136	0.00212	0.00128	0.00038

Figure 53: Sample Point 2 - 375 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – X axis

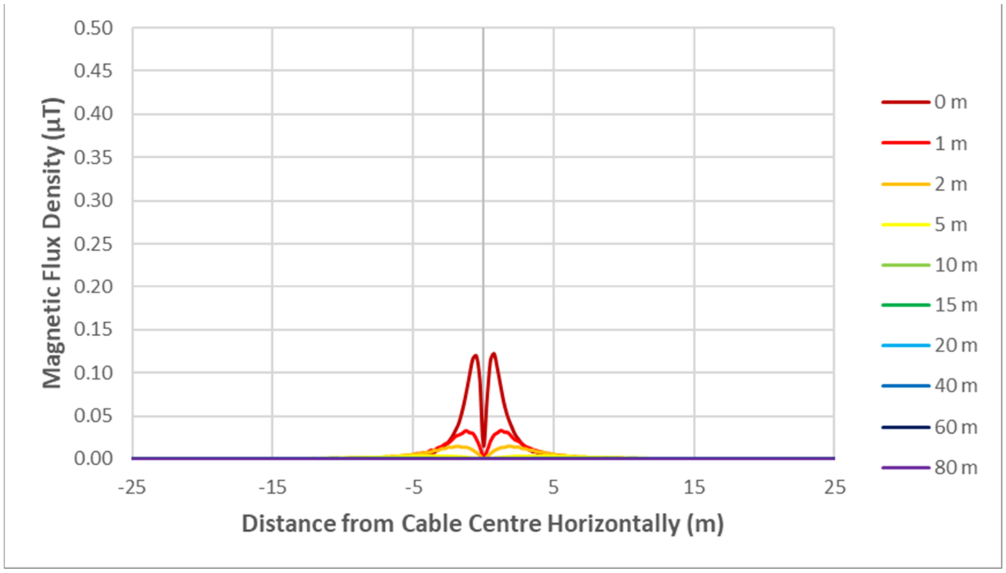

Figure 54: Sample Point 2 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Y axis

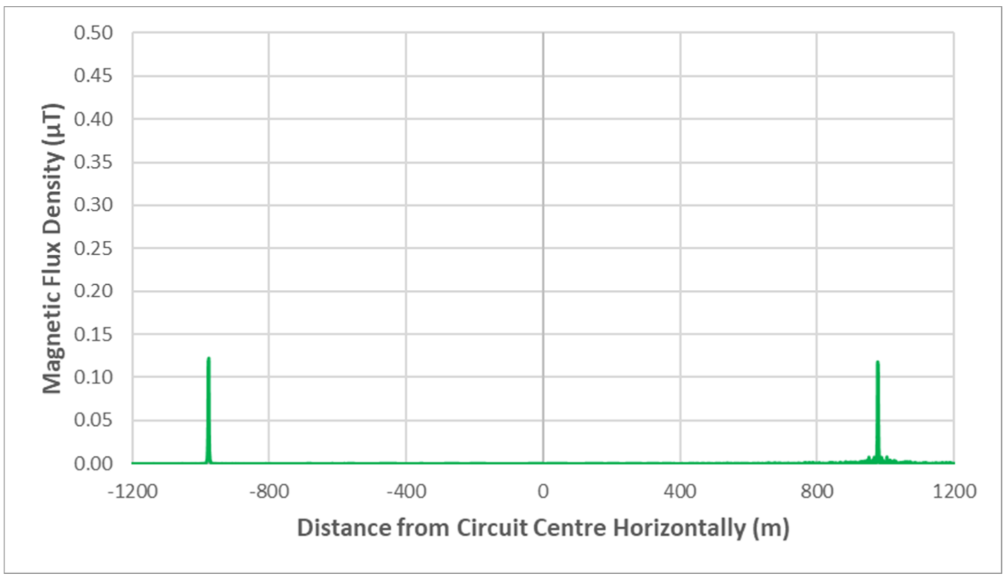

Figure 55: Sample Point 2 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Y axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00000	0.00001	0.00001	0.00008	0.00059	0.00359	0.01542	0.00383	0.00046	0.00004	0.00001	0.00002	0.00001
1	0.00000	0.00000	0.00001	0.00006	0.00082	0.00459	0.00210	0.00464	0.00095	0.00013	0.00004	0.00004	0.00002
2	0.00000	0.00001	0.00002	0.00018	0.00090	0.00569	0.00064	0.00594	0.00093	0.00013	0.00004	0.00001	0.00001
5	0.00002	0.00000	0.00003	0.00021	0.00141	0.00367	0.00008	0.00369	0.00147	0.00021	0.00002	0.00000	0.00000
10	0.00001	0.00001	0.00002	0.00033	0.00088	0.00106	0.00001	0.00106	0.00089	0.00032	0.00003	0.00001	0.00000
15	0.00000	0.00001	0.00002	0.00033	0.00053	0.00042	0.00000	0.00043	0.00057	0.00034	0.00005	0.00002	0.00001
20	0.00000	0.00001	0.00004	0.00026	0.00031	0.00021	0.00000	0.00021	0.00032	0.00028	0.00006	0.00002	0.00000
40	0.00001	0.00001	0.00004	0.00007	0.00005	0.00003	0.00000	0.00003	0.00006	0.00007	0.00005	0.00002	0.00001
60	0.00000	0.00002	0.00002	0.00002	0.00002	0.00001	0.00000	0.00001	0.00002	0.00003	0.00003	0.00002	0.00001
80	0.00000	0.00001	0.00001	0.00001	0.00000	0.00000	0.00000	0.00001	0.00001	0.00001	0.00002	0.00002	0.00000

Figure 56: Sample Point 2 - 375 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Y axis

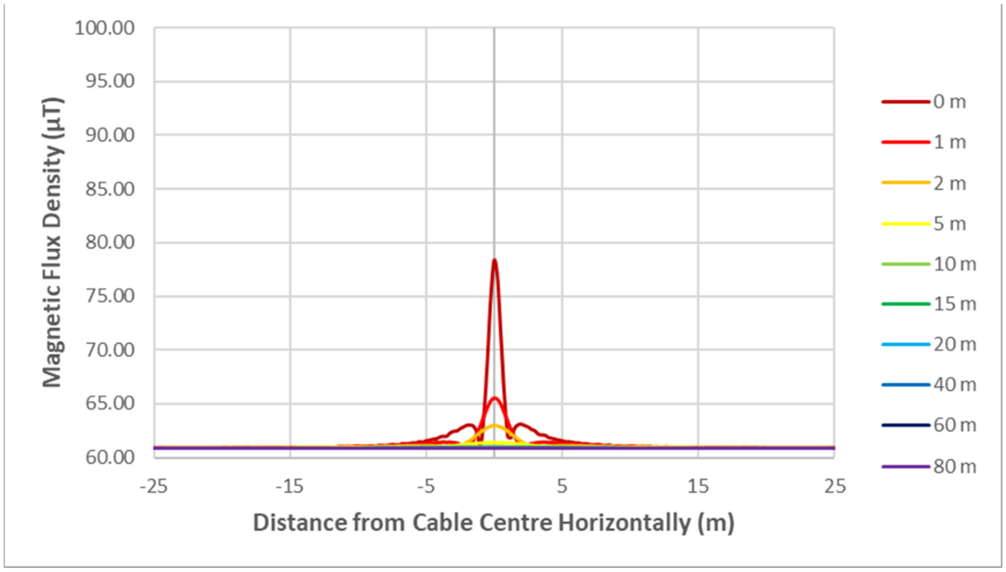

Figure 57: Sample Point 2 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Z axis

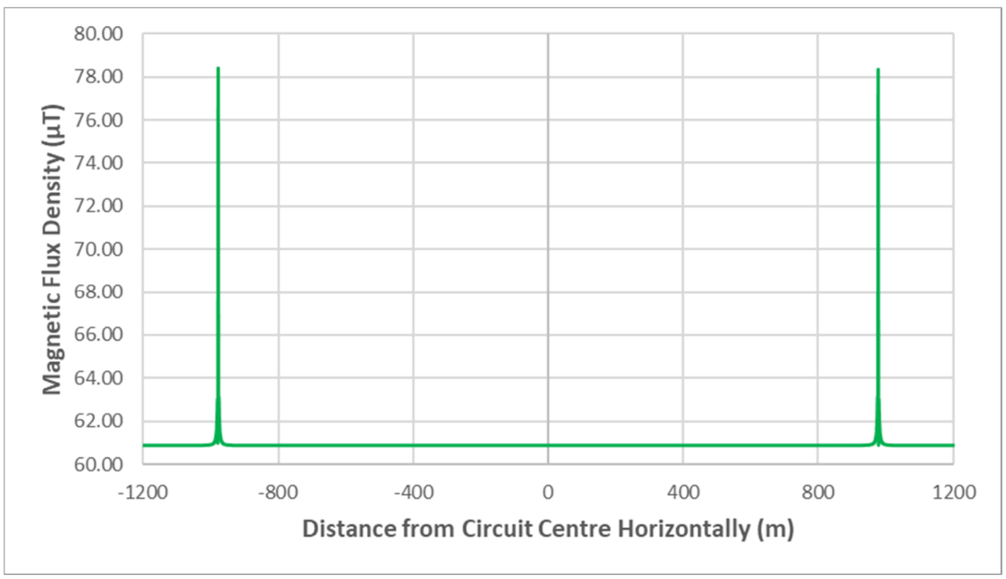

Figure 58: Sample Point 2 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Z axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	60.87048	60.87186	60.87781	60.91595	61.07115	61.57910	78.38704	61.58139	61.06457	60.91656	60.87787	60.87199	60.87039
1	60.87047	60.87217	60.87938	60.92369	61.05010	61.32284	65.54325	61.32649	61.07794	60.92292	60.87933	60.87215	60.87052
2	60.87052	60.87210	60.87922	60.91723	60.99683	61.13927	62.99103	61.13665	61.00992	60.92058	60.87916	60.87215	60.87051
5	60.87059	60.87229	60.87715	60.90246	60.93883	60.93274	61.41123	60.93793	60.93794	60.90196	60.87732	60.87239	60.87061
10	60.87050	60.87172	60.87606	60.88895	60.87911	60.95781	61.03256	60.95889	60.88016	60.88924	60.87602	60.87171	60.87051
15	60.87049	60.87165	60.87533	60.87701	60.89544	60.92789	60.94704	60.92819	60.89609	60.87692	60.87528	60.87166	60.87046
20	60.87047	60.87160	60.87455	60.87083	60.89374	60.90808	60.91485	60.90822	60.89388	60.87095	60.87452	60.87157	60.87047
40	60.87044	60.87110	60.87103	60.87571	60.87989	60.88133	60.88184	60.88134	60.87992	60.87574	60.87100	60.87110	60.87045
60	60.87039	60.87062	60.87061	60.87383	60.87492	60.87522	60.87533	60.87523	60.87493	60.87382	60.87057	60.87062	60.87041
80	60.87031	60.87024	60.87104	60.87252	60.87288	60.87299	60.87303	60.87300	60.87289	60.87251	60.87101	60.87023	60.87034

Figure 59: Sample Point 2 - 375 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Z axis

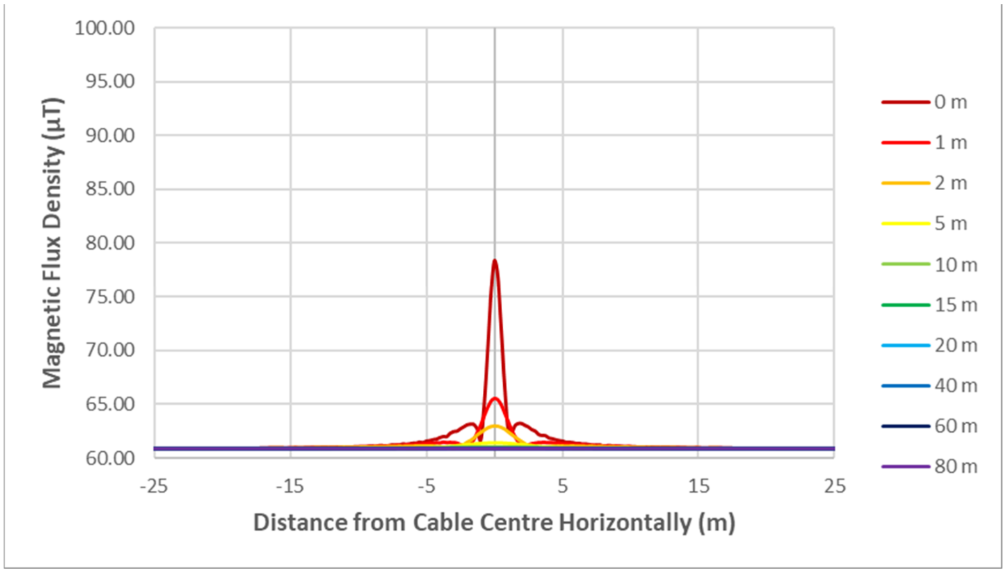

Figure 60: Sample Point 2 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Resultant

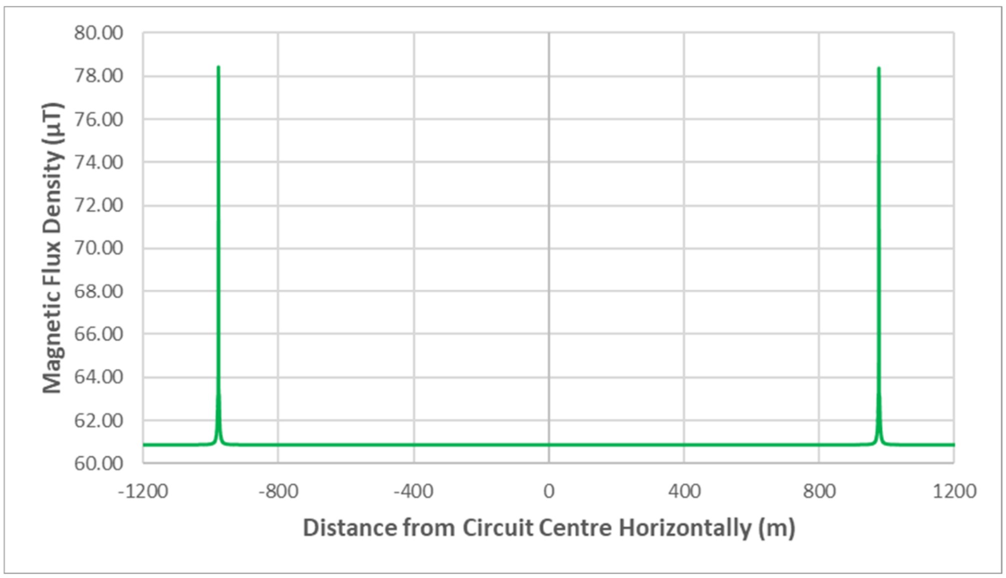

Figure 61: Sample Point 2 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Resultant

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	60.87048	60.87186	60.87781	60.91595	61.07118	61.58002	78.40030	61.58243	61.06459	60.91656	60.87787	60.87199	60.87039
1	60.87047	60.87217	60.87938	60.92369	61.05015	61.32434	65.54354	61.32803	61.07801	60.92292	60.87933	60.87215	60.87052
2	60.87052	60.87210	60.87922	60.91724	60.99688	61.14156	62.99106	61.13919	61.00998	60.92059	60.87916	60.87215	60.87051
5	60.87059	60.87229	60.87715	60.90246	60.93897	60.93370	61.41123	60.93890	60.93809	60.90196	60.87732	60.87239	60.87061
10	60.87050	60.87172	60.87606	60.88896	60.87917	60.95789	61.03256	60.95897	60.88021	60.88924	60.87602	60.87171	60.87051
15	60.87049	60.87165	60.87533	60.87702	60.89546	60.92790	60.94704	60.92820	60.89611	60.87693	60.87528	60.87166	60.87046
20	60.87047	60.87160	60.87455	60.87084	60.89375	60.90808	60.91485	60.90822	60.89388	60.87096	60.87452	60.87157	60.87047
40	60.87044	60.87110	60.87103	60.87571	60.87989	60.88133	60.88184	60.88134	60.87992	60.87574	60.87100	60.87110	60.87045
60	60.87039	60.87062	60.87061	60.87383	60.87492	60.87522	60.87533	60.87523	60.87493	60.87382	60.87057	60.87062	60.87041
80	60.87031	60.87024	60.87104	60.87252	60.87288	60.87299	60.87303	60.87300	60.87289	60.87251	60.87101	60.87023	60.87034

Figure 62: Sample Point 2 - 375 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Resultant

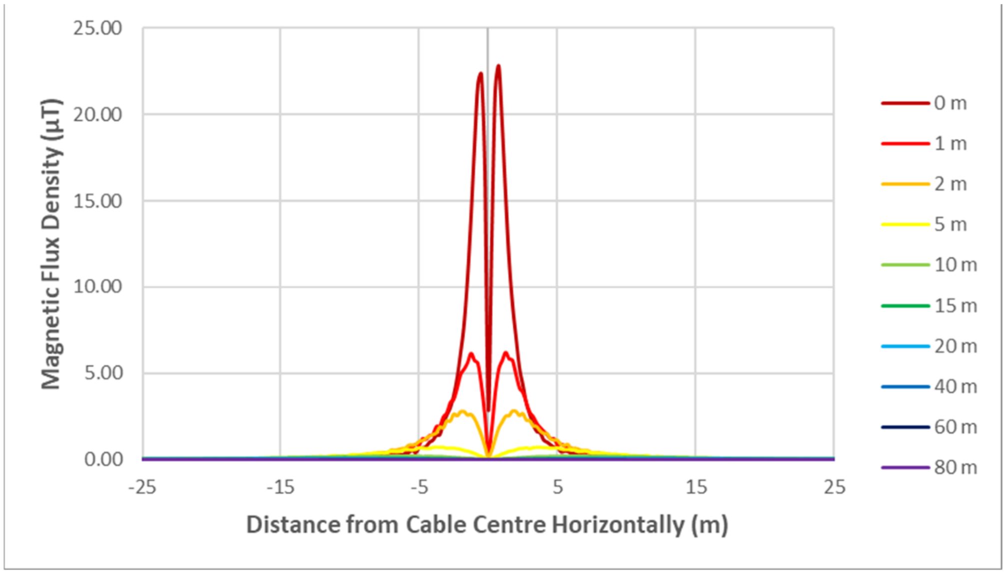

Figure 63: Sample Point 2 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – X axis

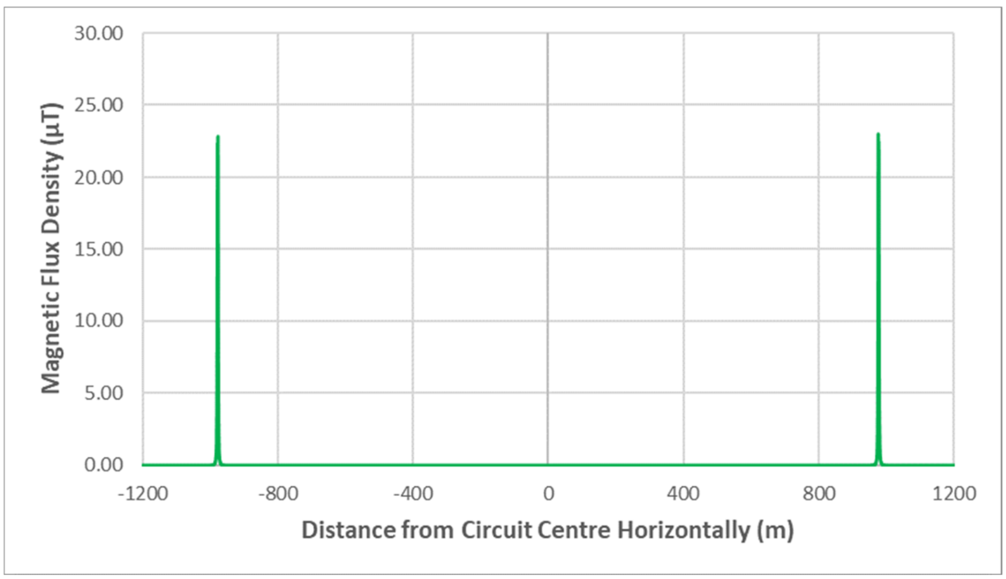

Figure 64: Sample Point 2 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – X axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00012	0.00020	0.00143	0.01012	0.10750	0.67390	2.88320	0.71755	0.09286	0.01460	0.00206	0.00039	0.00024
1	0.00004	0.00015	0.00186	0.01695	0.14818	0.85931	0.39173	0.86914	0.17590	0.01776	0.00220	0.00033	0.00008
2	0.00006	0.00000	0.00197	0.02741	0.16229	1.05896	0.11878	1.11450	0.18129	0.02654	0.00193	0.00007	0.00017
5	0.00005	0.00050	0.00439	0.03926	0.26290	0.68509	0.01529	0.68839	0.27536	0.03991	0.00483	0.00084	0.00021
10	0.00001	0.00090	0.00574	0.06091	0.16575	0.19896	0.00240	0.19657	0.16627	0.06319	0.00590	0.00118	0.00024
15	0.00007	0.00117	0.00738	0.06250	0.10180	0.07995	0.00074	0.07955	0.10473	0.06359	0.00762	0.00160	0.00031
20	0.00012	0.00145	0.00928	0.05011	0.05855	0.03938	0.00023	0.03912	0.05865	0.05028	0.00949	0.00176	0.00035
40	0.00028	0.00209	0.00996	0.01426	0.01029	0.00528	0.00014	0.00557	0.01057	0.01454	0.01028	0.00233	0.00052
60	0.00045	0.00234	0.00622	0.00549	0.00311	0.00157	0.00013	0.00184	0.00337	0.00577	0.00648	0.00256	0.00067
80	0.00050	0.00231	0.00401	0.00245	0.00137	0.00062	0.00015	0.00091	0.00166	0.00273	0.00424	0.00255	0.00075

Figure 65: Sample Point 2 - 750 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – X axis

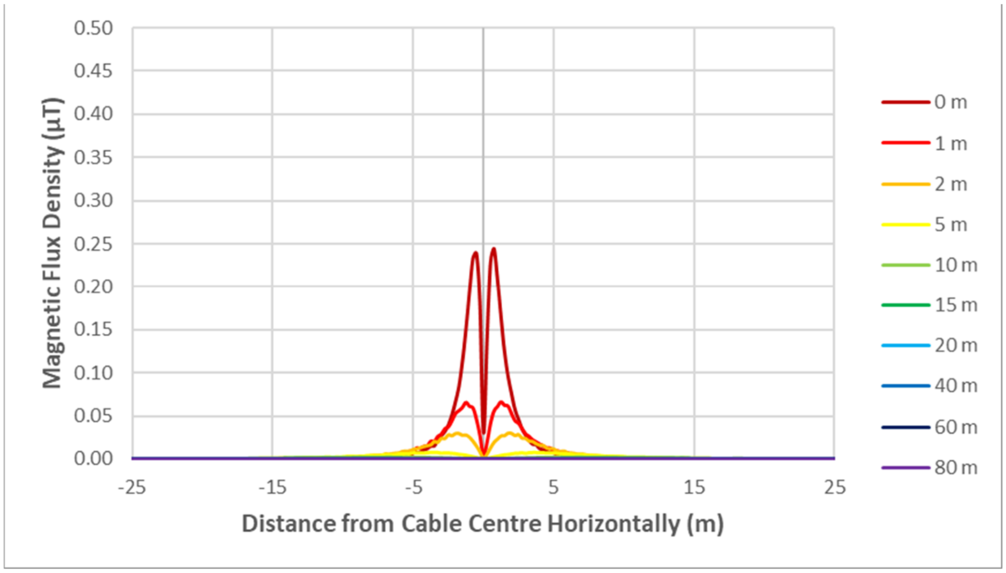

Figure 66: Sample Point 2 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Y axis

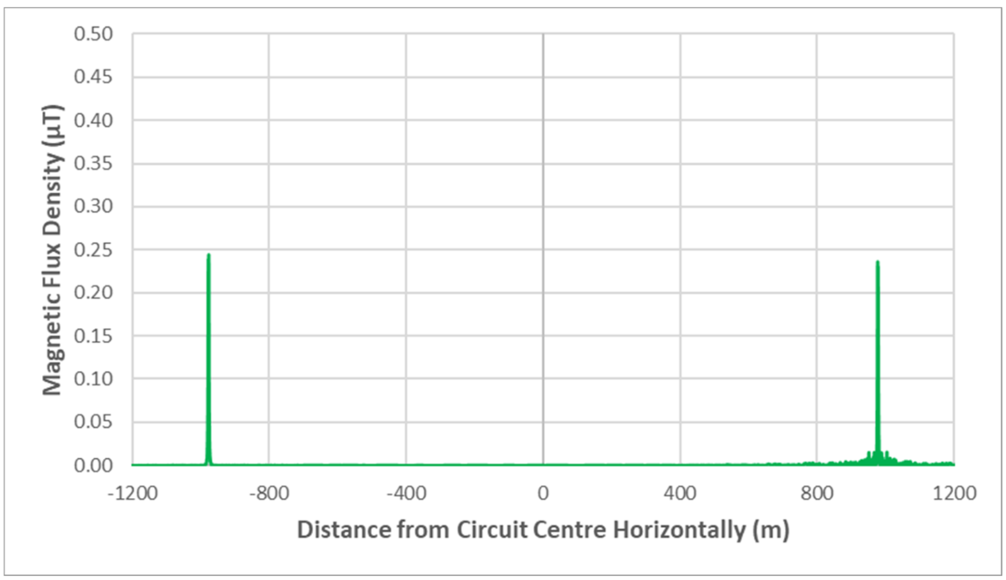

Figure 67: Sample Point 2 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Y axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00001	0.00003	0.00002	0.00016	0.00119	0.00717	0.03085	0.00765	0.00092	0.00008	0.00003	0.00003	0.00002
1	0.00001	0.00000	0.00001	0.00013	0.00163	0.00919	0.00420	0.00929	0.00190	0.00025	0.00008	0.00008	0.00005
2	0.00000	0.00002	0.00004	0.00036	0.00181	0.01137	0.00129	0.01189	0.00185	0.00026	0.00007	0.00001	0.00002
5	0.00004	0.00001	0.00007	0.00041	0.00282	0.00733	0.00016	0.00737	0.00294	0.00041	0.00003	0.00000	0.00001
10	0.00001	0.00001	0.00005	0.00065	0.00176	0.00211	0.00002	0.00212	0.00179	0.00065	0.00005	0.00002	0.00001
15	0.00001	0.00001	0.00004	0.00066	0.00107	0.00084	0.00001	0.00087	0.00115	0.00069	0.00011	0.00004	0.00002
20	0.00000	0.00002	0.00009	0.00052	0.00062	0.00042	0.00000	0.00043	0.00063	0.00055	0.00012	0.00004	0.00001
40	0.00001	0.00002	0.00009	0.00014	0.00010	0.00006	0.00000	0.00006	0.00011	0.00014	0.00011	0.00003	0.00002
60	0.00000	0.00003	0.00005	0.00005	0.00003	0.00002	0.00000	0.00002	0.00004	0.00005	0.00007	0.00003	0.00002
80	0.00001	0.00002	0.00003	0.00002	0.00001	0.00001	0.00000	0.00001	0.00002	0.00002	0.00004	0.00004	0.00001

Figure 68: Sample Point 2 - 750 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Y axis

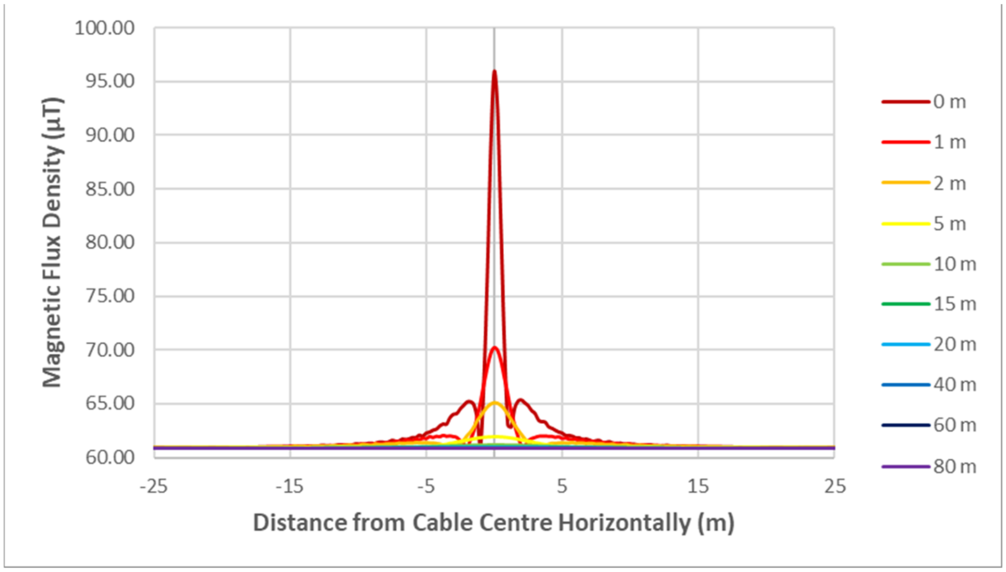

Figure 69: Sample Point 2 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Z axis

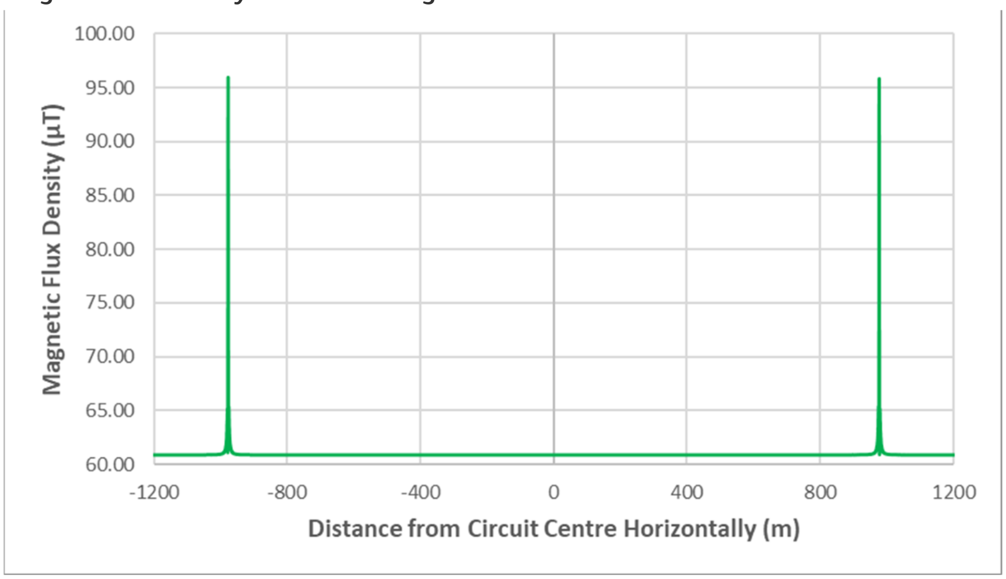

Figure 70: Sample Point 2 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Z axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	60.87095	60.87373	60.88563	60.96189	61.27231	62.28820	95.90408	62.29278	61.25914	60.96311	60.88574	60.87397	60.87078
1	60.87094	60.87435	60.88876	60.97738	61.23021	61.77567	70.21650	61.78298	61.28589	60.97584	60.88866	60.87430	60.87104
2	60.87104	60.87421	60.88844	60.96447	61.12366	61.40854	65.11206	61.40331	61.14983	60.97117	60.88831	60.87430	60.87102
5	60.87118	60.87457	60.88429	60.93491	61.00765	60.99548	61.95246	61.00586	61.00587	60.93392	60.88464	60.87478	60.87123
10	60.87100	60.87344	60.88211	60.90791	60.88823	61.04561	61.19511	61.04777	60.89032	60.90847	60.88204	60.87343	60.87101
15	60.87097	60.87330	60.88067	60.88403	60.92087	60.98578	61.02408	60.98637	60.92217	60.88384	60.88056	60.87332	60.87092
20	60.87093	60.87320	60.87910	60.87167	60.91748	60.94616	60.95971	60.94644	60.91776	60.87190	60.87903	60.87313	60.87094
40	60.87087	60.87219	60.87206	60.88141	60.88977	60.89265	60.89367	60.89268	60.88983	60.88148	60.87200	60.87220	60.87091
60	60.87077	60.87125	60.87122	60.87765	60.87983	60.88045	60.88066	60.88046	60.87985	60.87763	60.87114	60.87124	60.87083
80	60.87062	60.87048	60.87209	60.87505	60.87576	60.87599	60.87605	60.87599	60.87578	60.87503	60.87202	60.87045	60.87068

Figure 71: Sample Point 2 - 750 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Z axis

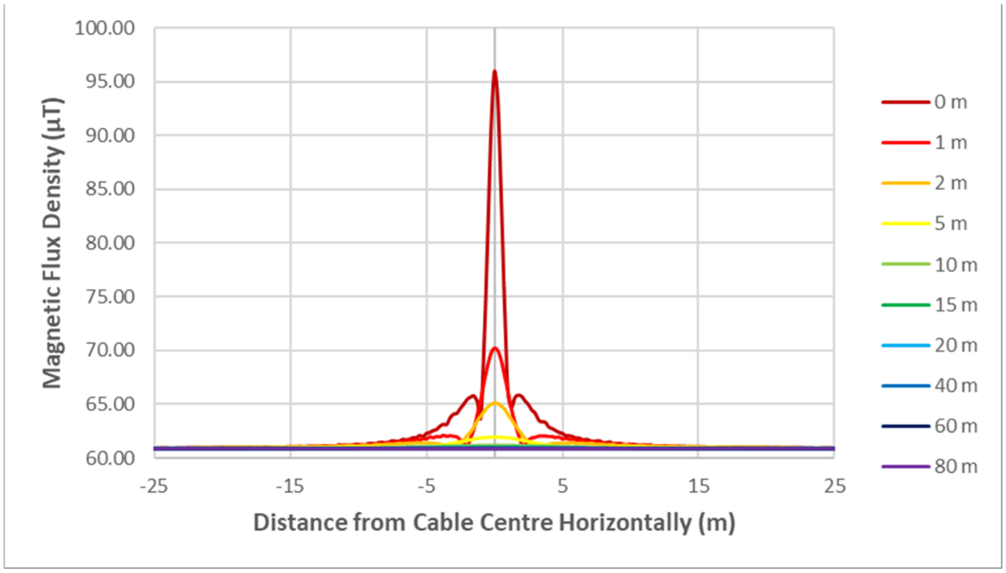

Figure 72: Sample Point 2 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Resultant

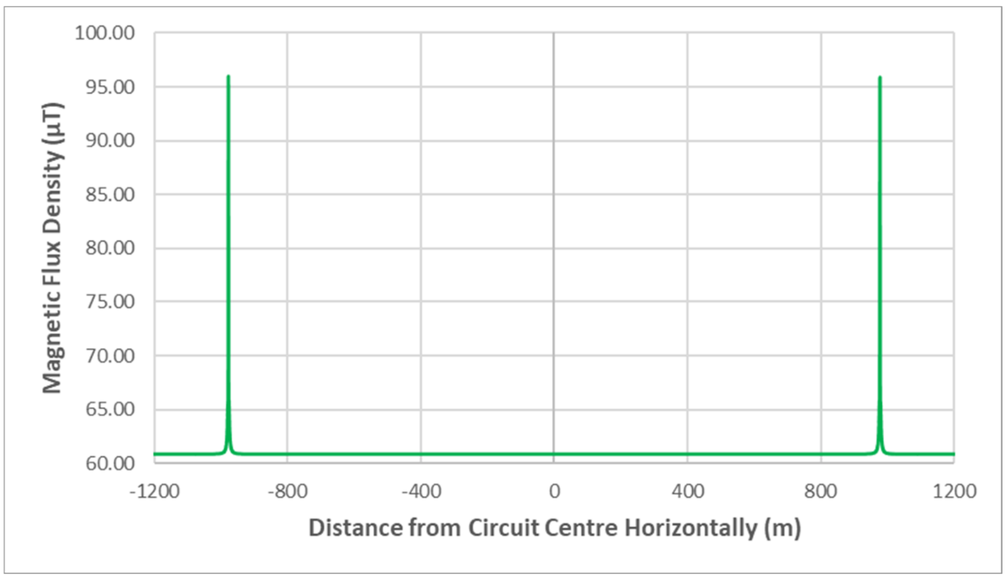

Figure 73: Sample Point 2 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Resultant

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	60.87095	60.87373	60.88563	60.96189	61.27240	62.29185	95.94741	62.29691	61.25921	60.96311	60.88574	60.87397	60.87078
1	60.87094	60.87435	60.88876	60.97739	61.23039	61.78165	70.21759	61.78910	61.28614	60.97584	60.88866	60.87430	60.87104
2	60.87104	60.87421	60.88844	60.96447	61.12388	61.41767	65.11217	61.41342	61.15010	60.97118	60.88831	60.87430	60.87102
5	60.87118	60.87457	60.88429	60.93492	61.00822	60.99932	61.95246	61.00975	61.00649	60.93393	60.88464	60.87478	60.87123
10	60.87100	60.87344	60.88211	60.90794	60.88845	61.04594	61.19511	61.04809	60.89054	60.90851	60.88204	60.87343	60.87101
15	60.87097	60.87330	60.88067	60.88406	60.92096	60.98583	61.02408	60.98642	60.92226	60.88387	60.88056	60.87332	60.87092
20	60.87093	60.87320	60.87910	60.87169	60.91751	60.94617	60.95971	60.94645	60.91778	60.87192	60.87903	60.87313	60.87094
40	60.87087	60.87219	60.87206	60.88141	60.88978	60.89265	60.89367	60.89268	60.88983	60.88148	60.87200	60.87220	60.87091
60	60.87077	60.87125	60.87122	60.87765	60.87983	60.88045	60.88066	60.88046	60.87985	60.87763	60.87115	60.87124	60.87083
80	60.87062	60.87048	60.87209	60.87505	60.87576	60.87599	60.87605	60.87599	60.87578	60.87503	60.87202	60.87045	60.87068

Figure 74: Sample Point 2 - 750 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Resultant

Appendix C - Sample Point Three Plots

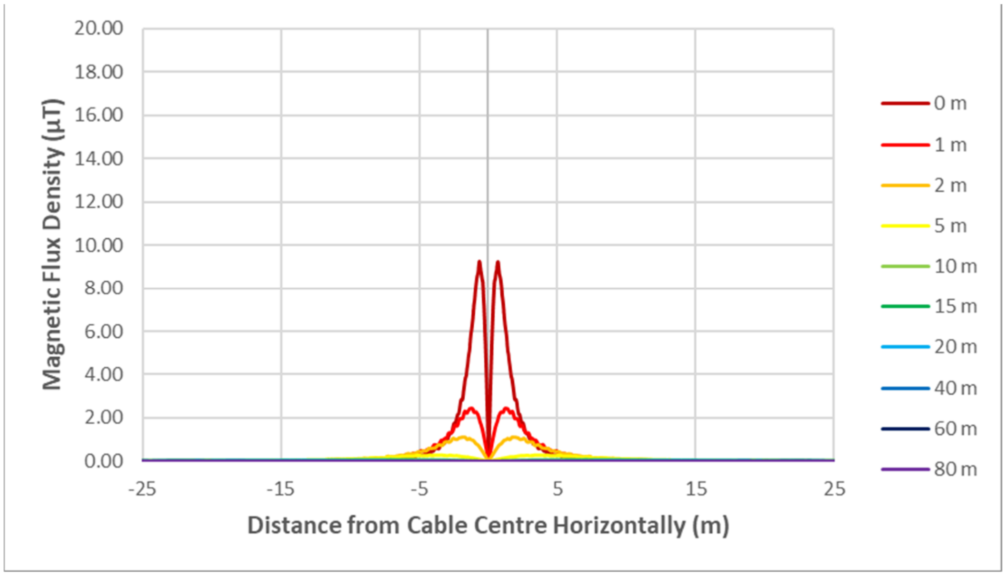

Figure 75: Sample Point3 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – X axis

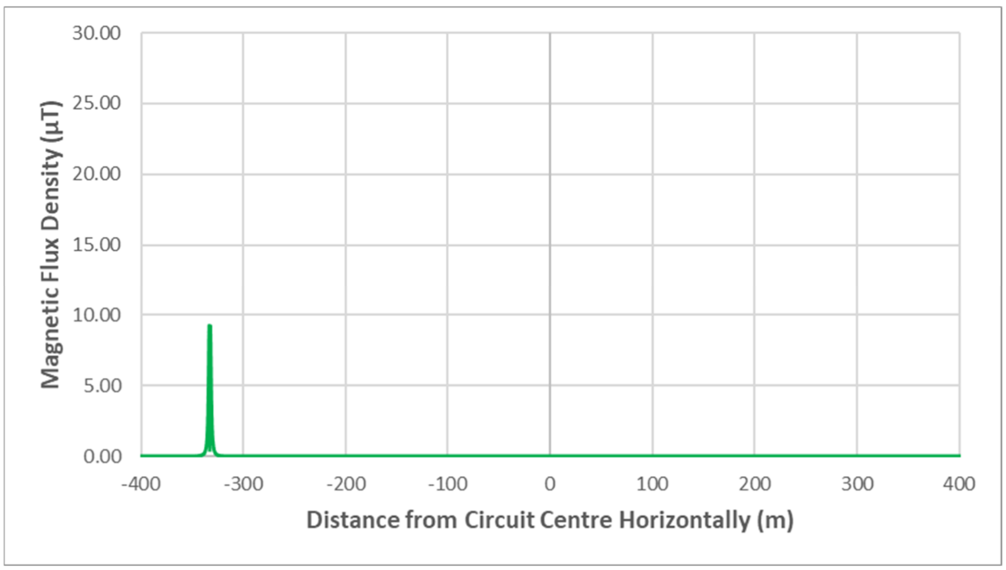

Figure 76: Sample Point3 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – X axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00025	0.00033	0.00097	0.00747	0.04282	0.28366	0.48029	0.27987	0.04191	0.00657	0.00022	0.00029	0.00036
1	0.00020	0.00024	0.00088	0.00994	0.07564	0.39363	0.06519	0.43308	0.07659	0.00874	0.00027	0.00032	0.00039
2	0.00026	0.00027	0.00127	0.01402	0.10073	0.44287	0.02005	0.44690	0.10364	0.01417	0.00059	0.00030	0.00036
5	0.00005	0.00020	0.00215	0.02111	0.11073	0.26865	0.00283	0.26594	0.11081	0.02175	0.00162	0.00013	0.00028
10	0.00008	0.00051	0.00268	0.02656	0.06605	0.07789	0.00063	0.07676	0.06509	0.02595	0.00242	0.00010	0.00024
15	0.00006	0.00063	0.00349	0.02392	0.04093	0.03131	0.00032	0.03077	0.04016	0.02361	0.00323	0.00027	0.00021
20	0.00006	0.00077	0.00406	0.01948	0.02231	0.01495	0.00021	0.01466	0.02192	0.01917	0.00382	0.00046	0.00016
40	0.00008	0.00102	0.00372	0.00567	0.00401	0.00220	0.00006	0.00207	0.00394	0.00556	0.00370	0.00093	0.00002
60	0.00009	0.00093	0.00236	0.00211	0.00123	0.00062	0.00004	0.00070	0.00130	0.00219	0.00242	0.00107	0.00018
80	0.00007	0.00080	0.00145	0.00087	0.00043	0.00016	0.00013	0.00042	0.00069	0.00112	0.00169	0.00107	0.00030

Figure 77: Sample Point 3 - 375 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – X axis

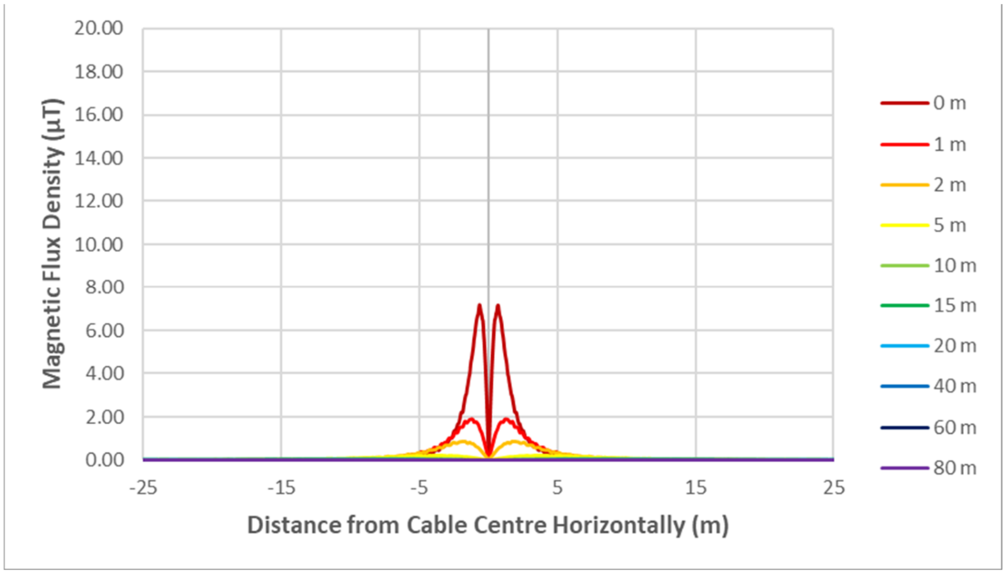

Figure 78: Sample Point 1 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Y axis

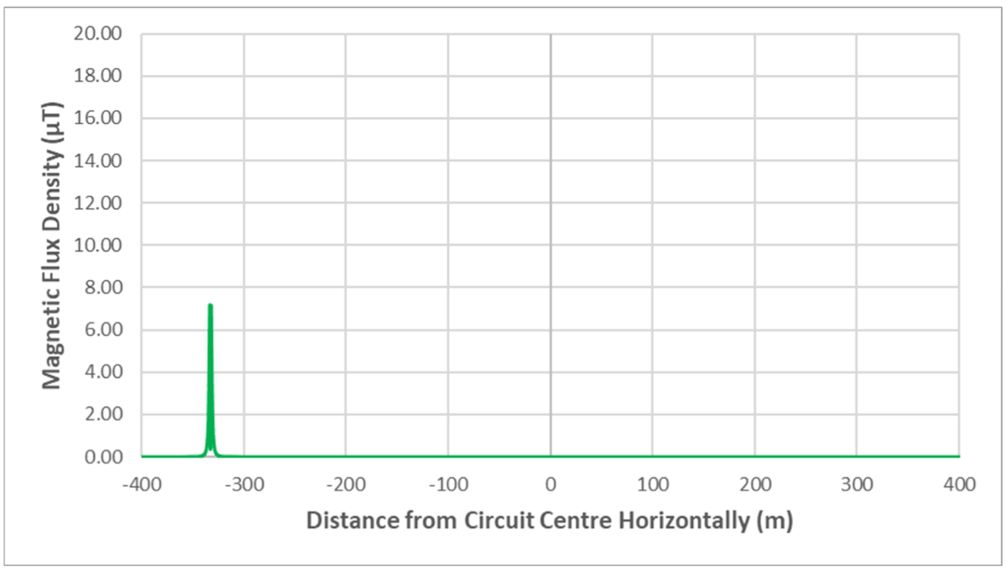

Figure 79: Sample Point 3 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – Y axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00048	0.00042	0.00023	0.00523	0.03257	0.21940	0.37204	0.21780	0.03307	0.00570	0.00067	0.00039	0.00028
1	0.00047	0.00039	0.00007	0.00744	0.05807	0.30478	0.04995	0.33678	0.06051	0.00791	0.00099	0.00046	0.00031
2	0.00044	0.00034	0.00038	0.00991	0.07754	0.34302	0.01493	0.34730	0.08093	0.01133	0.00130	0.00047	0.00031
5	0.00046	0.00021	0.00115	0.01573	0.08537	0.20790	0.00162	0.20695	0.08666	0.01763	0.00200	0.00058	0.00033
10	0.00039	0.00001	0.00145	0.02016	0.05076	0.05994	0.00001	0.06008	0.05103	0.02076	0.00227	0.00063	0.00030
15	0.00034	0.00014	0.00222	0.01809	0.03133	0.02387	0.00019	0.02431	0.03163	0.01875	0.00288	0.00072	0.00028
20	0.00028	0.00028	0.00280	0.01475	0.01694	0.01123	0.00021	0.01174	0.01739	0.01525	0.00337	0.00080	0.00027
40	0.00004	0.00065	0.00276	0.00427	0.00298	0.00157	0.00009	0.00174	0.00320	0.00445	0.00301	0.00087	0.00022
60	0.00018	0.00082	0.00193	0.00174	0.00106	0.00058	0.00007	0.00044	0.00091	0.00160	0.00180	0.00078	0.00016
80	0.00036	0.00095	0.00146	0.00101	0.00066	0.00045	0.00022	0.00001	0.00021	0.00055	0.00102	0.00056	0.00008

Figure 80: Sample Point 3 - 375 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Y axis

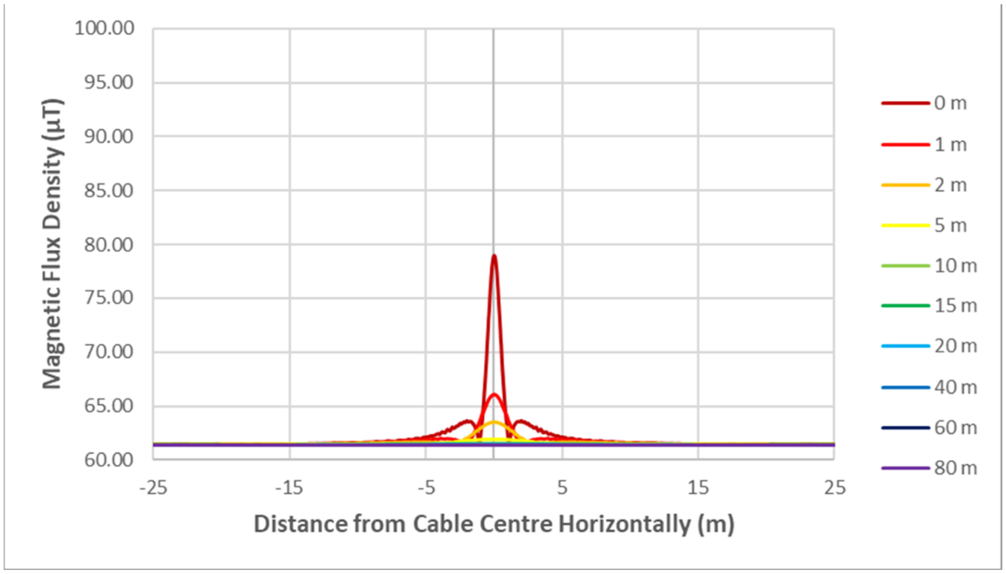

Figure 81: Sample Point3 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Z axis

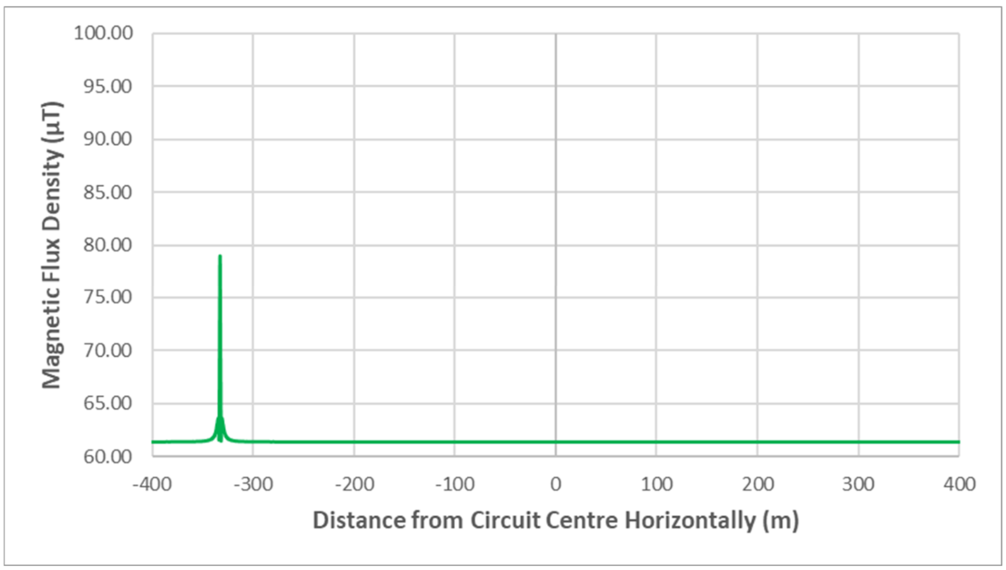

Figure 82: Sample Point3 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – Z axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	61.39356	61.39525	61.40082	61.44082	61.58699	62.12769	78.98299	62.14019	61.58751	61.44253	61.40071	61.39513	61.39316
1	61.39355	61.39506	61.40173	61.44600	61.59906	61.88251	66.06609	61.90544	61.59930	61.44551	61.40163	61.39483	61.39315
2	61.39355	61.39514	61.40208	61.44561	61.56967	61.65604	63.50932	61.65466	61.57200	61.44606	61.40195	61.39490	61.39317
5	61.39351	61.39524	61.40256	61.43490	61.46075	61.45869	61.92837	61.46116	61.46048	61.43591	61.40245	61.39510	61.39315
10	61.39351	61.39530	61.40008	61.41274	61.39882	61.47645	61.54950	61.47691	61.39918	61.41254	61.40031	61.39510	61.39314
15	61.39349	61.39519	61.39894	61.39888	61.41372	61.44538	61.46403	61.44553	61.41390	61.39881	61.39891	61.39500	61.39313
20	61.39348	61.39506	61.39777	61.39110	61.41120	61.42531	61.43184	61.42538	61.41128	61.39104	61.39771	61.39488	61.39312
40	61.39341	61.39427	61.39380	61.39279	61.39696	61.39832	61.39882	61.39834	61.39704	61.39283	61.39373	61.39412	61.39306
60	61.39331	61.39361	61.39229	61.39091	61.39199	61.39229	61.39240	61.39231	61.39201	61.39094	61.39220	61.39346	61.39297
80	61.39319	61.39314	61.39184	61.39038	61.39000	61.39011	61.39014	61.39012	61.39002	61.39034	61.39175	61.39297	61.39284

Figure 83: Sample Point 3 - 375 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Z axis

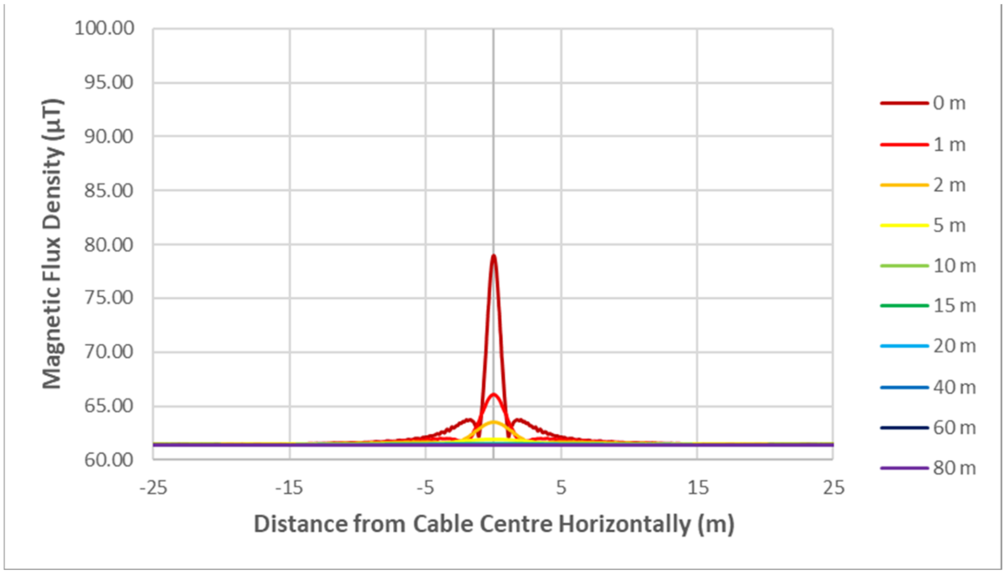

Figure 84: Sample Point 3 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Resultant

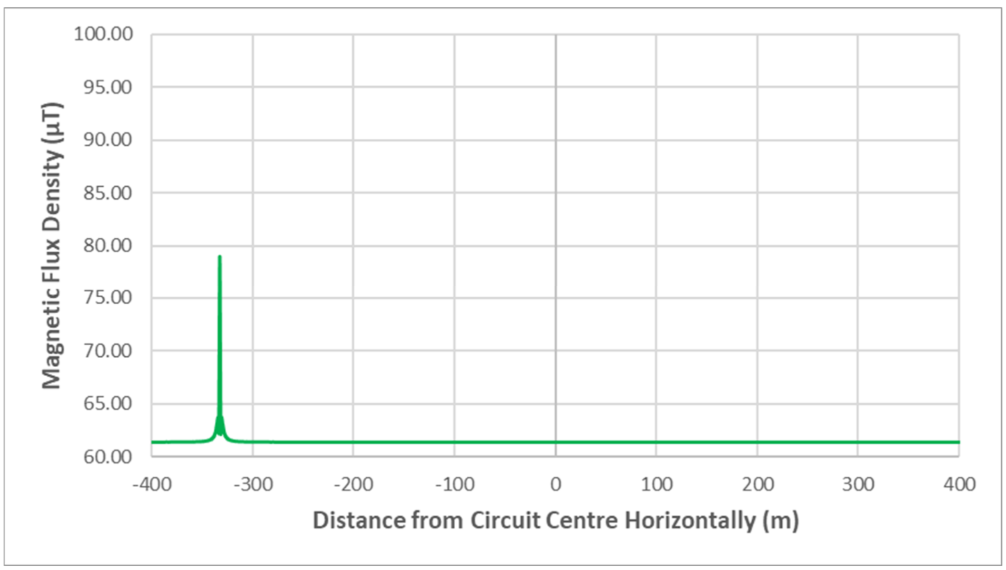

Figure 85: Sample Point 3 - 375 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – Resultant

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	61.39356	61.39525	61.40082	61.44082	61.58702	62.12872	78.98533	62.14120	61.58754	61.44253	61.40071	61.39513	61.39316
1	61.39355	61.39506	61.40173	61.44600	61.59913	61.88451	66.06614	61.90787	61.59938	61.44551	61.40163	61.39483	61.39315
2	61.39355	61.39514	61.40208	61.44561	61.56980	61.65858	63.50932	61.65726	61.57214	61.44606	61.40195	61.39490	61.39317
5	61.39351	61.39524	61.40256	61.43491	61.46091	61.45963	61.92837	61.46209	61.46064	61.43592	61.40246	61.39510	61.39315
10	61.39351	61.39530	61.40009	61.41275	61.39888	61.47653	61.54950	61.47698	61.39924	61.41255	61.40031	61.39510	61.39314
15	61.39349	61.39519	61.39895	61.39889	61.41375	61.44539	61.46403	61.44554	61.41392	61.39882	61.39891	61.39500	61.39313
20	61.39348	61.39506	61.39777	61.39111	61.41121	61.42532	61.43184	61.42538	61.41129	61.39104	61.39772	61.39488	61.39312
40	61.39341	61.39427	61.39380	61.39279	61.39696	61.39832	61.39882	61.39834	61.39704	61.39283	61.39373	61.39412	61.39306
60	61.39331	61.39361	61.39229	61.39091	61.39199	61.39229	61.39240	61.39231	61.39201	61.39094	61.39220	61.39346	61.39297
80	61.39319	61.39314	61.39184	61.39038	61.39000	61.39011	61.39014	61.39012	61.39002	61.39034	61.39175	61.39297	61.39284

Figure 86: Sample Point 3 - 375 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Resultant

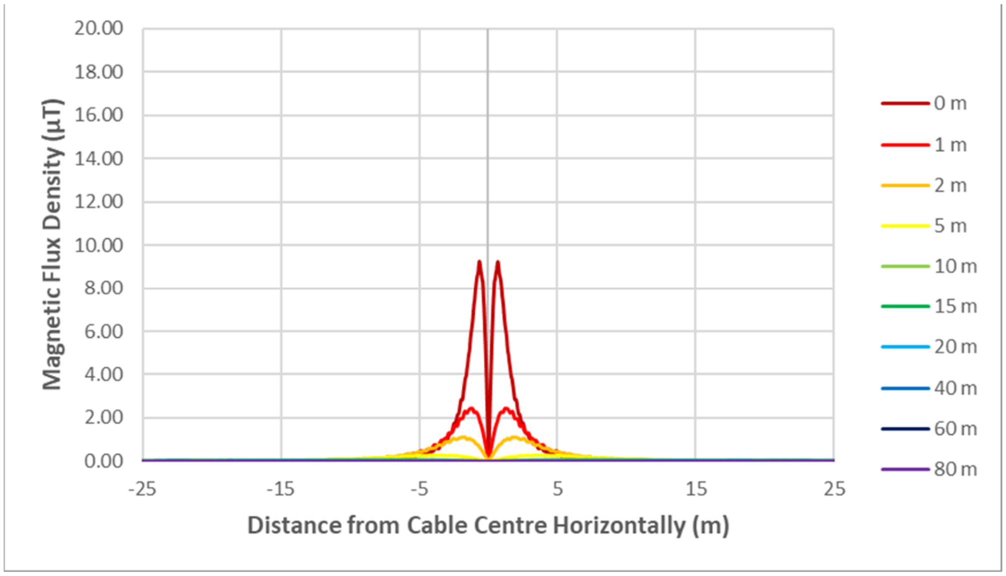

Figure 87: Sample Point3 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – X axis

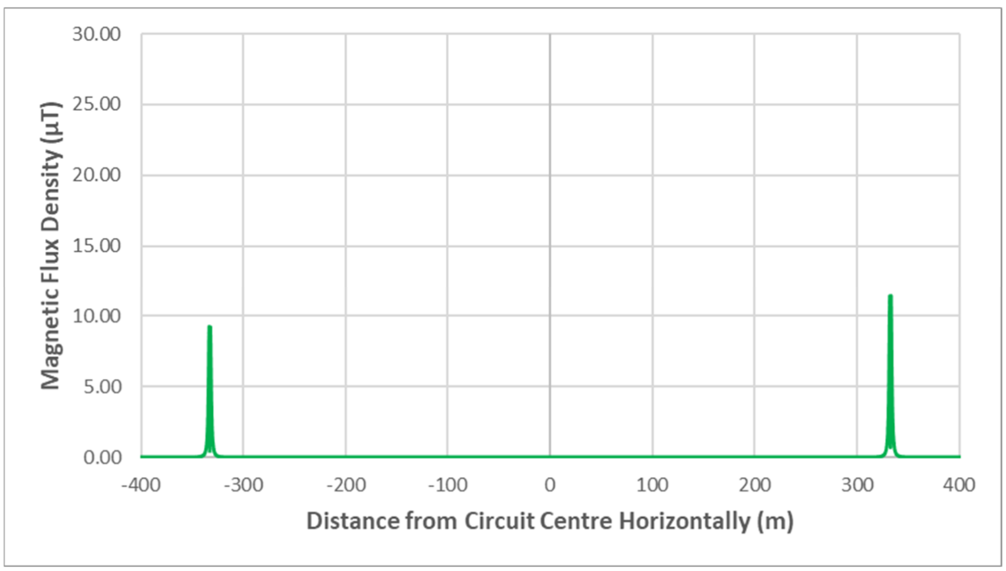

Figure 88: Sample Point3 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – X axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00016	0.00020	0.00086	0.00734	0.04268	0.28352	0.48013	0.28003	0.04207	0.00675	0.00040	0.00004	0.00002
1	0.00013	0.00016	0.00072	0.00979	0.07549	0.39347	0.06504	0.43323	0.07676	0.00893	0.00050	0.00014	0.00010
2	0.00019	0.00015	0.00111	0.01385	0.10057	0.44270	0.01989	0.44706	0.10379	0.01433	0.00084	0.00008	0.00002
5	0.00005	0.00009	0.00198	0.02096	0.11057	0.26849	0.00267	0.26610	0.11098	0.02190	0.00174	0.00026	0.00009
10	0.00002	0.00040	0.00248	0.02634	0.06585	0.07770	0.00044	0.07694	0.06527	0.02611	0.00251	0.00046	0.00014
15	0.00007	0.00054	0.00331	0.02372	0.04074	0.03113	0.00014	0.03094	0.04032	0.02377	0.00332	0.00063	0.00017
20	0.00007	0.00067	0.00387	0.01927	0.02211	0.01476	0.00003	0.01483	0.02209	0.01933	0.00391	0.00082	0.00022
40	0.00007	0.00089	0.00350	0.00543	0.00379	0.00198	0.00015	0.00227	0.00414	0.00574	0.00382	0.00130	0.00040
60	0.00009	0.00078	0.00212	0.00185	0.00099	0.00038	0.00027	0.00092	0.00152	0.00240	0.00256	0.00145	0.00056
80	0.00013	0.00062	0.00117	0.00058	0.00016	0.00011	0.00039	0.00067	0.00093	0.00136	0.00186	0.00146	0.00068

Figure 89: Sample Point3 - 375 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – X axis

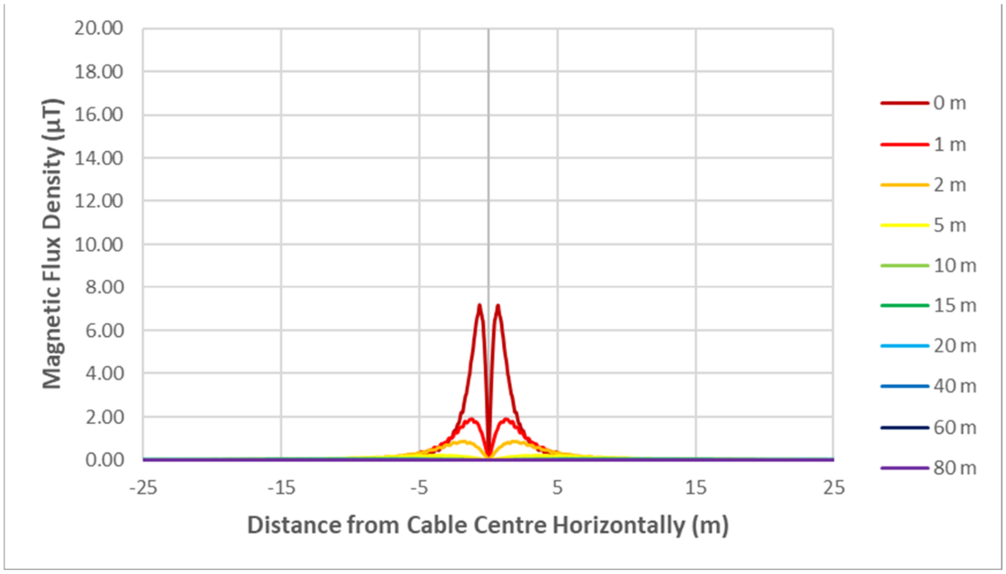

Figure 90: Sample Point3 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Y axis

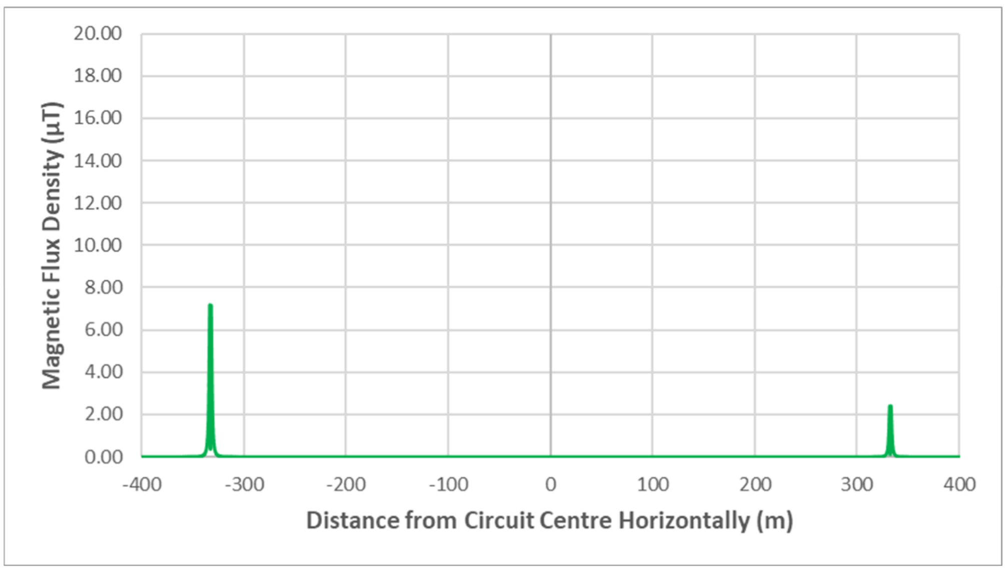

Figure 91: Sample Point3 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Y axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00005	0.00011	0.00024	0.00571	0.03303	0.21986	0.37250	0.21734	0.03261	0.00523	0.00023	0.00006	0.00009
1	0.00003	0.00012	0.00055	0.00791	0.05853	0.30524	0.05040	0.33633	0.06005	0.00744	0.00052	0.00005	0.00006
2	0.00007	0.00017	0.00085	0.01037	0.07800	0.34348	0.01538	0.34685	0.08049	0.01089	0.00083	0.00006	0.00006
5	0.00003	0.00025	0.00164	0.01615	0.08576	0.20829	0.00202	0.20655	0.08626	0.01726	0.00162	0.00016	0.00005
10	0.00007	0.00040	0.00190	0.02056	0.05113	0.06030	0.00034	0.05975	0.05071	0.02045	0.00200	0.00027	0.00005
15	0.00008	0.00051	0.00261	0.01845	0.03165	0.02418	0.00011	0.02403	0.03135	0.01849	0.00267	0.00042	0.00010
20	0.00012	0.00061	0.00315	0.01505	0.01722	0.01149	0.00004	0.01150	0.01716	0.01503	0.00320	0.00056	0.00017
40	0.00024	0.00084	0.00293	0.00439	0.00307	0.00165	0.00002	0.00168	0.00315	0.00442	0.00304	0.00088	0.00044
60	0.00034	0.00088	0.00193	0.00167	0.00097	0.00048	0.00004	0.00057	0.00105	0.00176	0.00202	0.00104	0.00069
80	0.00042	0.00087	0.00129	0.00076	0.00040	0.00017	0.00007	0.00031	0.00053	0.00089	0.00143	0.00106	0.00091

Figure 92: Sample Point3 - 375 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Y axis

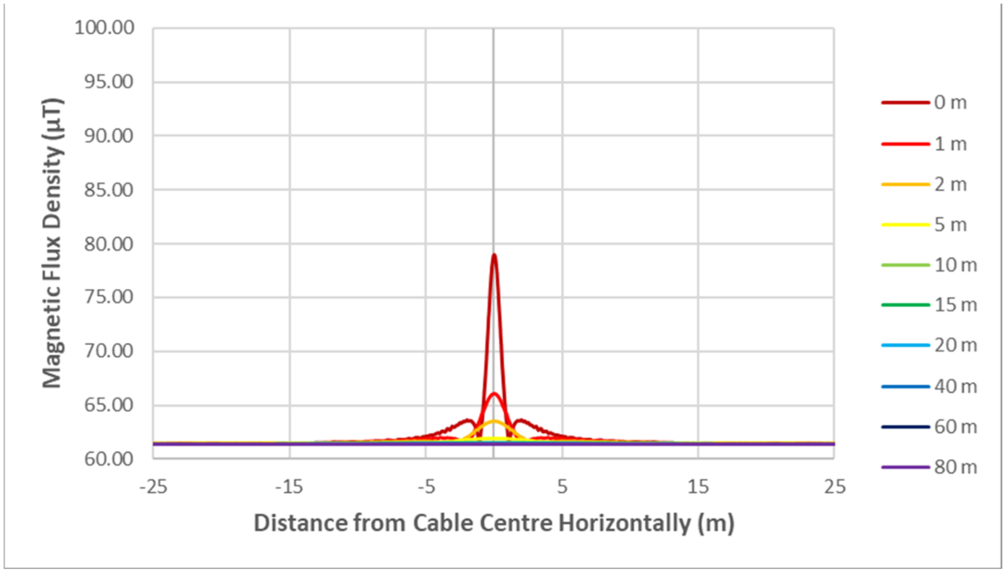

Figure 93: Sample Point3 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Z axis

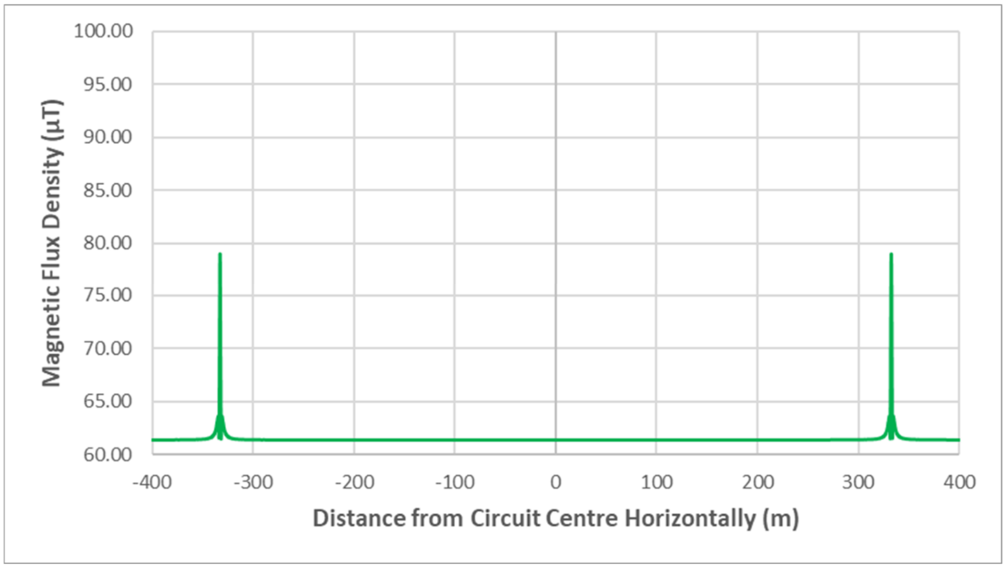

Figure 94: Sample Point3 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Z axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	μT												
0	61.39105	61.39236	61.39779	61.43760	61.58374	62.12441	78.98629	62.13686	61.58415	61.43909	61.39714	61.39127	61.39133
1	61.39111	61.39222	61.39863	61.44276	61.59578	61.87920	66.06942	61.90209	61.59591	61.44202	61.39794	61.39102	61.39134
2	61.39106	61.39226	61.39898	61.44237	61.56636	61.65271	63.51267	61.65130	61.56864	61.44262	61.39825	61.39104	61.39138
5	61.39102	61.39242	61.39931	61.43169	61.45753	61.46193	61.93164	61.46447	61.45714	61.43254	61.39884	61.39110	61.39138
10	61.39104	61.39252	61.39683	61.40939	61.40215	61.47977	61.55281	61.48021	61.40249	61.40921	61.39689	61.39110	61.39145
15	61.39101	61.39243	61.39571	61.39555	61.41704	61.44868	61.46732	61.44882	61.41719	61.39550	61.39550	61.39101	61.39146
20	61.39100	61.39230	61.39454	61.39223	61.41451	61.42861	61.43513	61.42866	61.41457	61.39228	61.39431	61.39089	61.39146
40	61.39095	61.39153	61.39058	61.39610	61.40025	61.40160	61.40209	61.40160	61.40031	61.39612	61.39035	61.39016	61.39148
60	61.39087	61.39088	61.39090	61.39418	61.39525	61.39554	61.39564	61.39553	61.39525	61.39420	61.39114	61.39044	61.39150
80	61.39076	61.39045	61.39130	61.39285	61.39321	61.39331	61.39334	61.39330	61.39321	61.39287	61.39154	61.39087	61.39153

Figure 95: Sample Point3 - 375 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Z axis

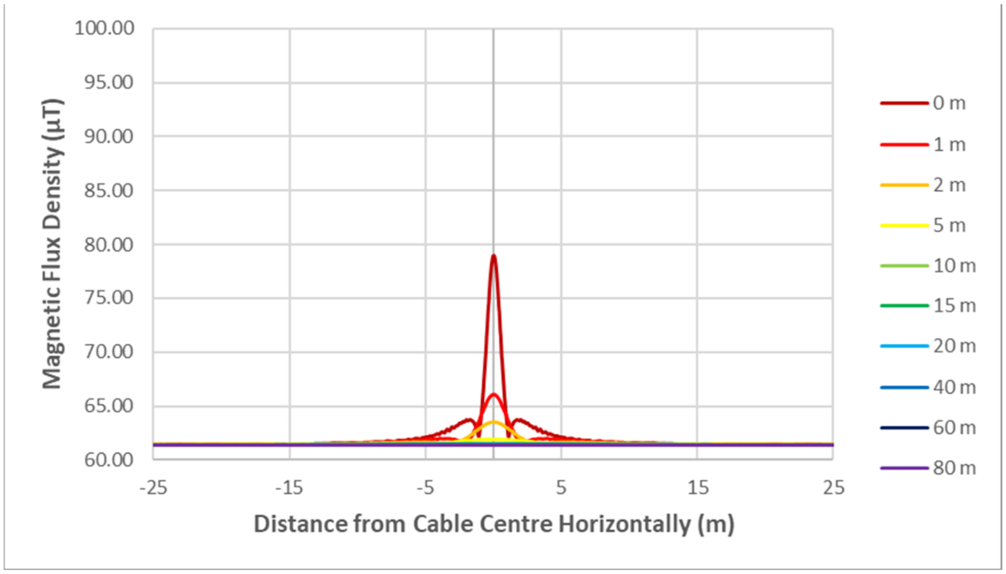

Figure 96: Sample Point3 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Resultant

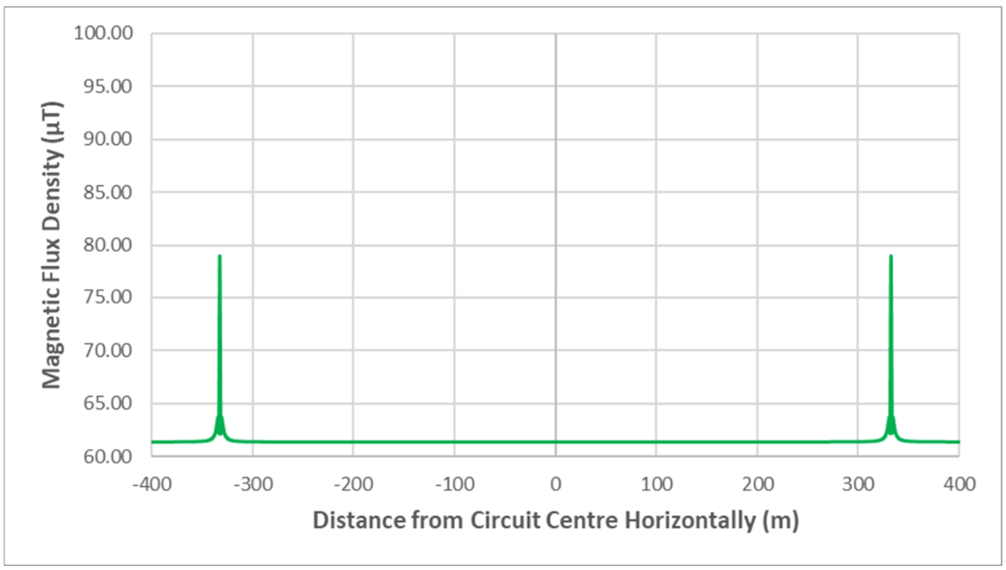

Figure 97: Sample Point3 - 375 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Resultant

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	61.39105	61.39236	61.39779	61.43760	61.58377	62.12545	78.98863	62.13787	61.58417	61.43909	61.39714	61.39127	61.39133
1	61.39111	61.39222	61.39863	61.44276	61.59585	61.88121	66.06947	61.90452	61.59599	61.44202	61.39794	61.39102	61.39134
2	61.39106	61.39226	61.39898	61.44238	61.56649	61.65526	63.51267	61.65390	61.56878	61.44263	61.39825	61.39104	61.39138
5	61.39102	61.39242	61.39931	61.43170	61.45769	61.46287	61.93164	61.46539	61.45731	61.43255	61.39884	61.39110	61.39138
10	61.39104	61.39252	61.39683	61.40940	61.40221	61.47985	61.55281	61.48028	61.40254	61.40922	61.39689	61.39110	61.39145
15	61.39101	61.39243	61.39571	61.39555	61.41706	61.44870	61.46732	61.44883	61.41721	61.39551	61.39550	61.39101	61.39146
20	61.39100	61.39230	61.39454	61.39223	61.41452	61.42862	61.43513	61.42866	61.41458	61.39228	61.39431	61.39089	61.39146
40	61.39095	61.39153	61.39058	61.39610	61.40025	61.40160	61.40209	61.40160	61.40031	61.39612	61.39035	61.39016	61.39148
60	61.39087	61.39088	61.39090	61.39418	61.39525	61.39554	61.39564	61.39553	61.39525	61.39420	61.39114	61.39044	61.39150
80	61.39076	61.39045	61.39130	61.39285	61.39321	61.39331	61.39334	61.39330	61.39321	61.39287	61.39154	61.39087	61.39153

Figure 98: Sample Point3 - 375 MW - Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Resultant

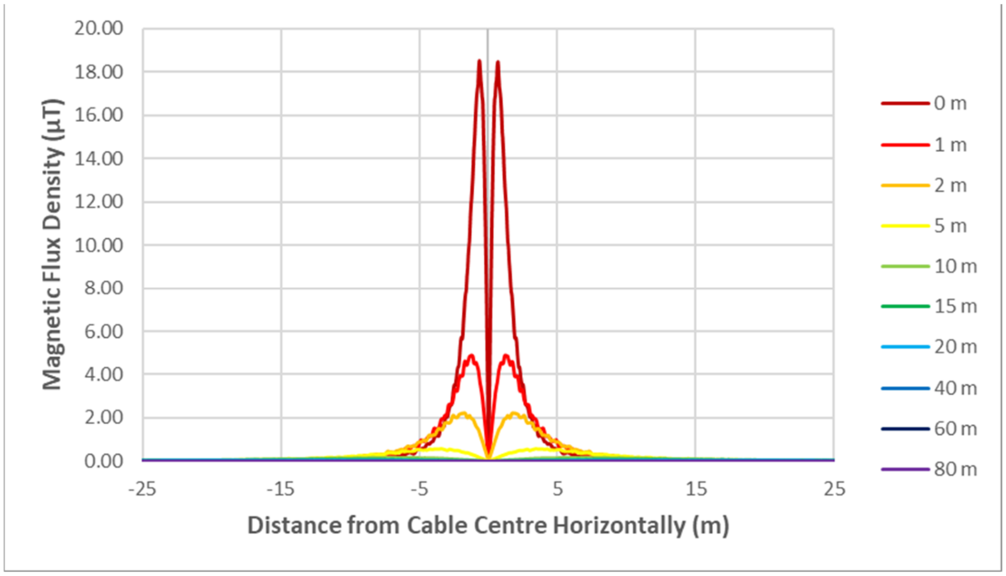

Figure 99: Sample Point3 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – X axis

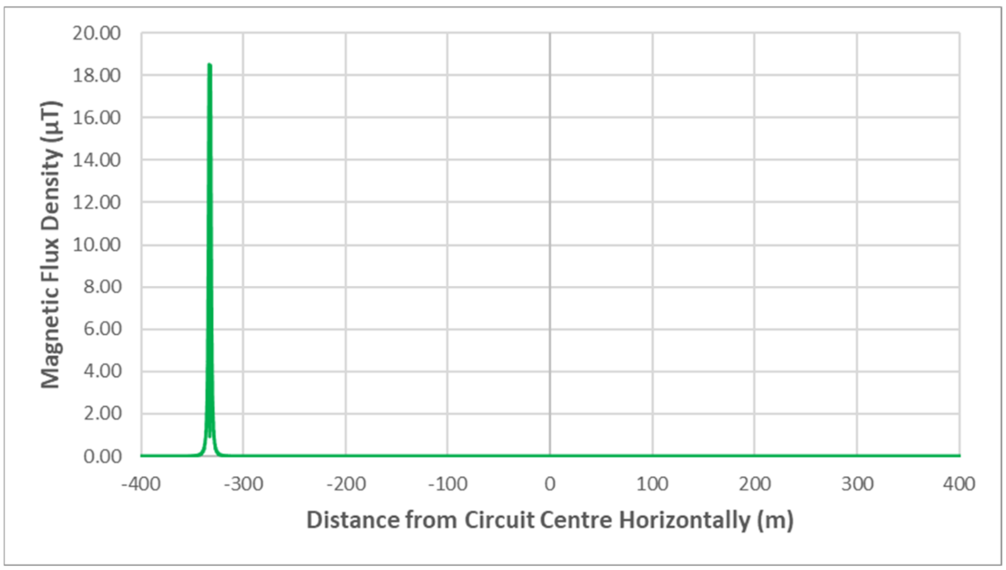

Figure 100: Sample Point3 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – X axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	μT												
0	0.00049	0.00066	0.00193	0.01494	0.08563	0.56733	0.96057	0.55974	0.08382	0.01314	0.00045	0.00058	0.00073
1	0.00040	0.00047	0.00176	0.01988	0.15129	0.78725	0.13039	0.86615	0.15318	0.01748	0.00053	0.00064	0.00078
2	0.00053	0.00053	0.00255	0.02804	0.20146	0.88573	0.04010	0.89379	0.20728	0.02833	0.00118	0.00060	0.00073
5	0.00011	0.00039	0.00431	0.04221	0.22146	0.53729	0.00565	0.53187	0.22162	0.04350	0.00323	0.00027	0.00057
10	0.00017	0.00101	0.00535	0.05311	0.13209	0.15579	0.00126	0.15352	0.13019	0.05190	0.00483	0.00020	0.00049
15	0.00011	0.00127	0.00698	0.04784	0.08185	0.06263	0.00063	0.06154	0.08032	0.04722	0.00646	0.00054	0.00041
20	0.00013	0.00154	0.00812	0.03896	0.04462	0.02989	0.00042	0.02931	0.04384	0.03833	0.00764	0.00092	0.00032
40	0.00017	0.00203	0.00744	0.01134	0.00802	0.00440	0.00012	0.00413	0.00789	0.01112	0.00740	0.00186	0.00004
60	0.00018	0.00186	0.00473	0.00422	0.00246	0.00124	0.00008	0.00139	0.00261	0.00438	0.00483	0.00213	0.00036
80	0.00014	0.00161	0.00289	0.00174	0.00086	0.00031	0.00026	0.00084	0.00139	0.00225	0.00337	0.00213	0.00061

Figure 101: Sample Point 3 - 750 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – X axis

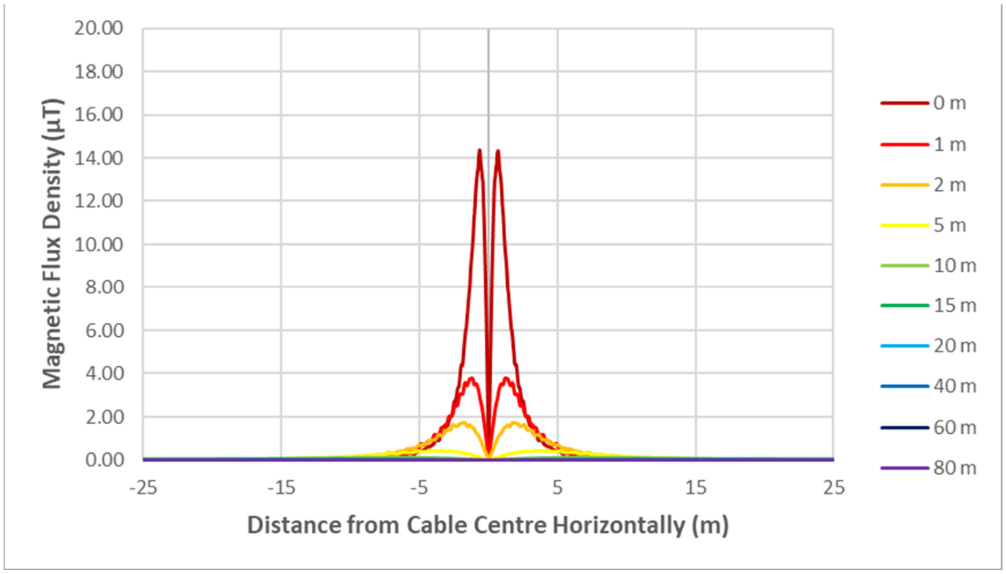

Figure 102: Sample Point3 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Y axis

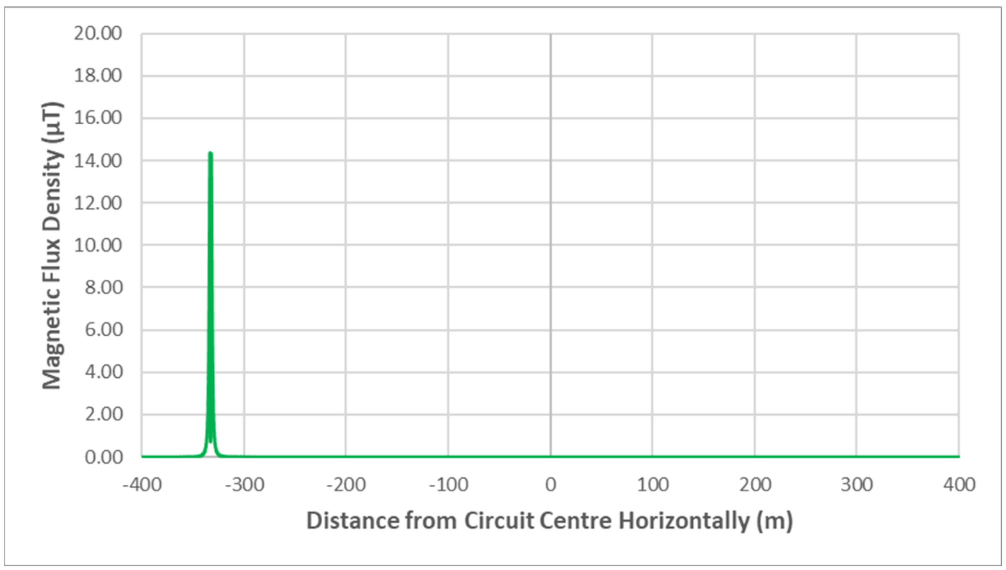

Figure 103: Sample Point3 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – Y axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00095	0.00085	0.00045	0.01045	0.06514	0.43880	0.74409	0.43560	0.06614	0.01140	0.00134	0.00077	0.00056
1	0.00094	0.00077	0.00015	0.01488	0.11613	0.60955	0.09990	0.67356	0.12102	0.01581	0.00199	0.00091	0.00062
2	0.00088	0.00068	0.00075	0.01982	0.15508	0.68605	0.02985	0.69461	0.16186	0.02265	0.00259	0.00094	0.00062
5	0.00092	0.00043	0.00230	0.03147	0.17074	0.41581	0.00325	0.41391	0.17332	0.03527	0.00400	0.00115	0.00065
10	0.00078	0.00002	0.00291	0.04032	0.10152	0.11989	0.00002	0.12016	0.10206	0.04151	0.00454	0.00126	0.00060
15	0.00069	0.00028	0.00443	0.03619	0.06266	0.04774	0.00038	0.04862	0.06325	0.03750	0.00577	0.00143	0.00056
20	0.00057	0.00055	0.00560	0.02950	0.03389	0.02245	0.00042	0.02349	0.03478	0.03050	0.00674	0.00160	0.00054
40	0.00009	0.00130	0.00552	0.00854	0.00596	0.00315	0.00017	0.00347	0.00639	0.00890	0.00601	0.00174	0.00044
60	0.00036	0.00165	0.00387	0.00348	0.00212	0.00117	0.00014	0.00088	0.00182	0.00321	0.00359	0.00156	0.00032
80	0.00073	0.00190	0.00292	0.00201	0.00133	0.00090	0.00045	0.00001	0.00043	0.00110	0.00203	0.00113	0.00017

Figure 104: Sample Point 3 - 750 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Y axis

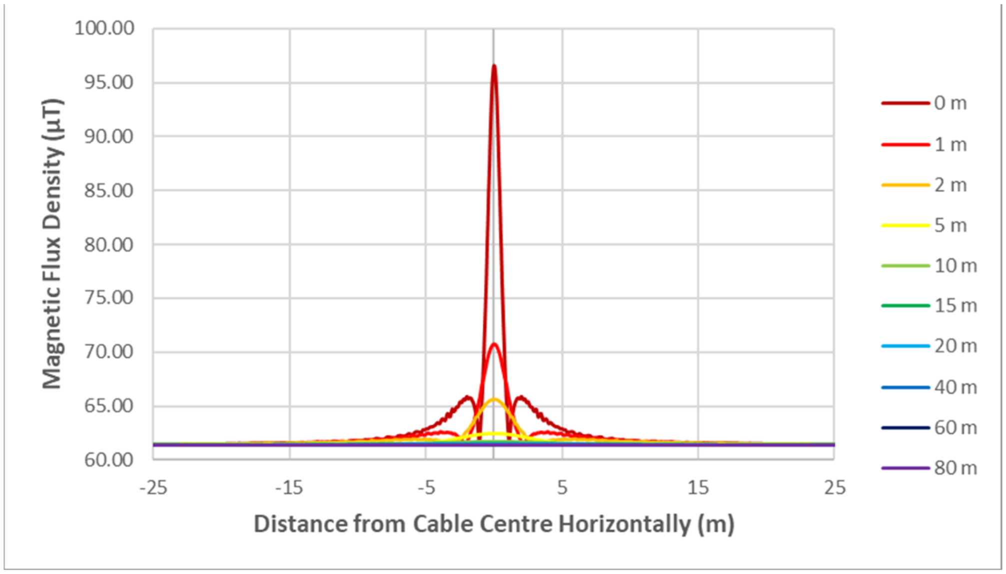

Figure 105: Sample Point3 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Z axis

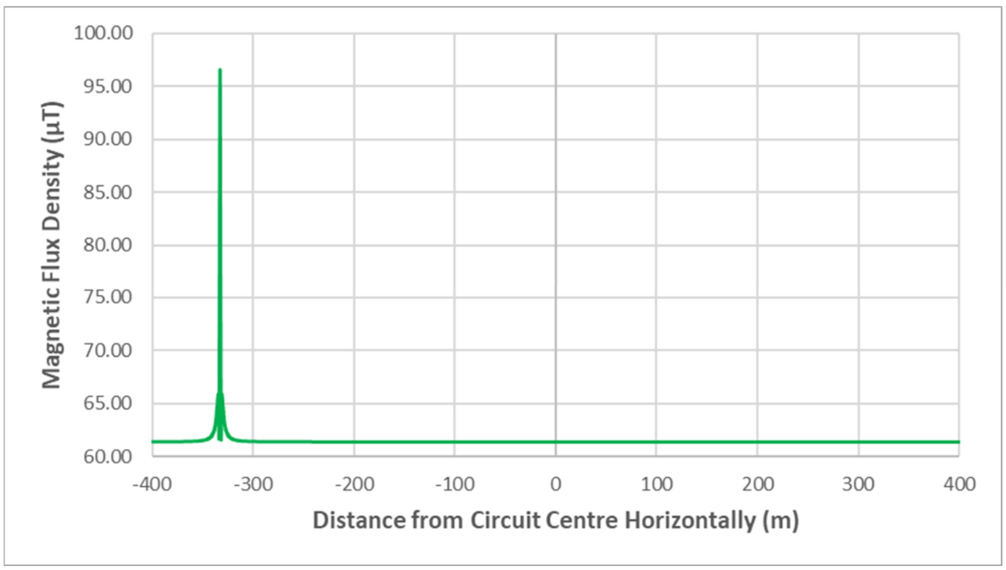

Figure 106: Sample Point3 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – Z axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	61.39711	61.40049	61.41164	61.49164	61.78398	62.86537	96.57599	62.89038	61.78503	61.49506	61.41141	61.40025	61.39633
1	61.39710	61.40013	61.41346	61.50200	61.80812	62.37503	70.74218	62.42089	61.80861	61.50102	61.41325	61.39966	61.39630
2	61.39710	61.40027	61.41416	61.50122	61.74934	61.92207	65.62864	61.91933	61.75401	61.50211	61.41391	61.39979	61.39635
5	61.39701	61.40047	61.41512	61.47980	61.53150	61.52739	62.46674	61.53233	61.53097	61.48182	61.41491	61.40020	61.39630
10	61.39701	61.40059	61.41017	61.43547	61.40764	61.56290	61.70900	61.56381	61.40836	61.43509	61.41062	61.40020	61.39628
15	61.39698	61.40038	61.40789	61.40776	61.43745	61.50076	61.53806	61.50106	61.43779	61.40763	61.40782	61.39999	61.39626
20	61.39696	61.40011	61.40554	61.39220	61.43241	61.46063	61.47367	61.46076	61.43256	61.39207	61.40543	61.39975	61.39624
40	61.39683	61.39855	61.39760	61.39558	61.40391	61.40664	61.40764	61.40668	61.40408	61.39566	61.39745	61.39823	61.39612
60	61.39663	61.39721	61.39457	61.39181	61.39399	61.39459	61.39480	61.39461	61.39403	61.39188	61.39440	61.39692	61.39593
80	61.39637	61.39629	61.39368	61.39075	61.39000	61.39021	61.39029	61.39024	61.39004	61.39067	61.39351	61.39594	61.39569

Figure 107: Sample Point 3 - 750 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Z axis

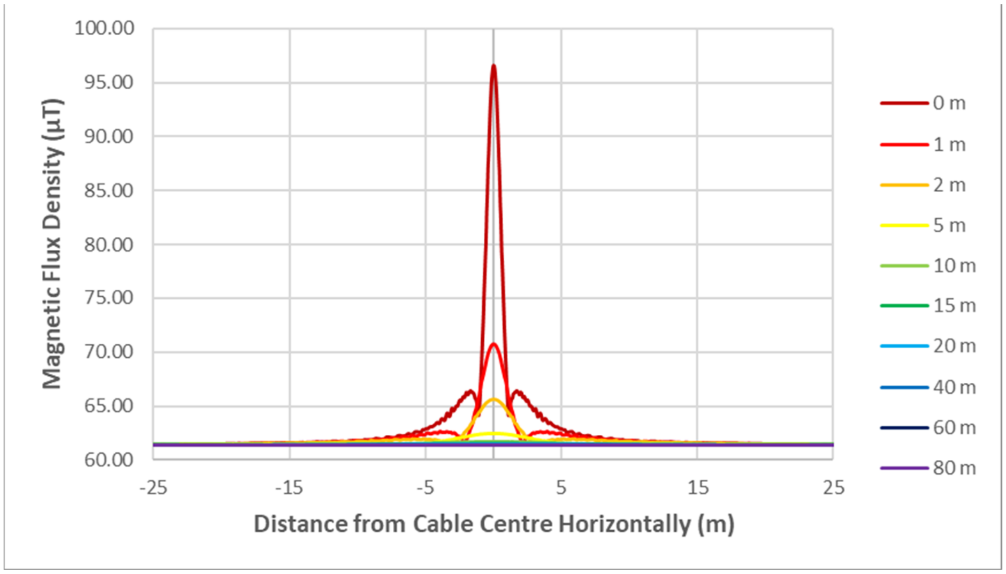

Figure 108: Sample Point3 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Resultant

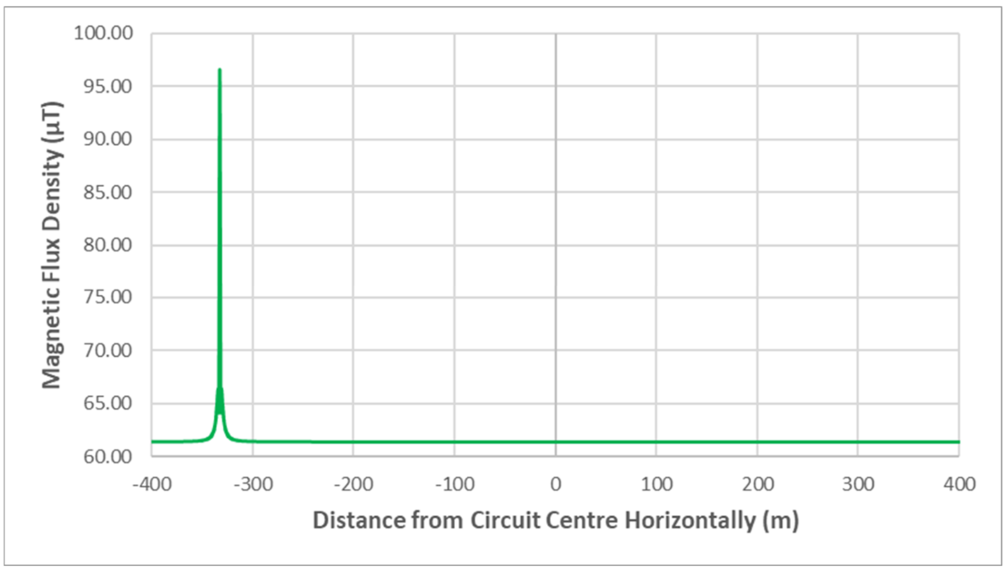

Figure 109: Sample Point3 - 750 MW - One circuit in operation - Graphical representation of calculated magnetic flux density at sea floor level – Resultant

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	61.39711	61.40049	61.41164	61.49164	61.78408	62.86946	96.58363	62.89438	61.78512	61.49507	61.41141	61.40025	61.39633
1	61.39710	61.40013	61.41346	61.50200	61.80842	62.38297	70.74237	62.43053	61.80892	61.50103	61.41325	61.39966	61.39630
2	61.39710	61.40027	61.41416	61.50123	61.74986	61.93221	65.62866	61.92967	61.75457	61.50212	61.41391	61.39979	61.39635
5	61.39701	61.40047	61.41512	61.47983	61.53214	61.53114	62.46674	61.53602	61.53161	61.48185	61.41491	61.40020	61.39630
10	61.39701	61.40059	61.41017	61.43551	61.40787	61.56321	61.70900	61.56412	61.40859	61.43512	61.41062	61.40020	61.39628
15	61.39698	61.40038	61.40789	61.40779	61.43753	61.50081	61.53806	61.50111	61.43788	61.40766	61.40782	61.39999	61.39626
20	61.39696	61.40011	61.40554	61.39222	61.43243	61.46064	61.47367	61.46077	61.43259	61.39209	61.40543	61.39975	61.39624
40	61.39683	61.39855	61.39760	61.39558	61.40391	61.40664	61.40764	61.40668	61.40409	61.39566	61.39746	61.39823	61.39612
60	61.39663	61.39721	61.39457	61.39181	61.39399	61.39459	61.39480	61.39461	61.39403	61.39188	61.39440	61.39692	61.39593
80	61.39637	61.39629	61.39368	61.39075	61.39000	61.39021	61.39029	61.39024	61.39004	61.39067	61.39351	61.39594	61.39569

Figure 110: Sample Point 3 - 750 MW - One circuit in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – Resultant

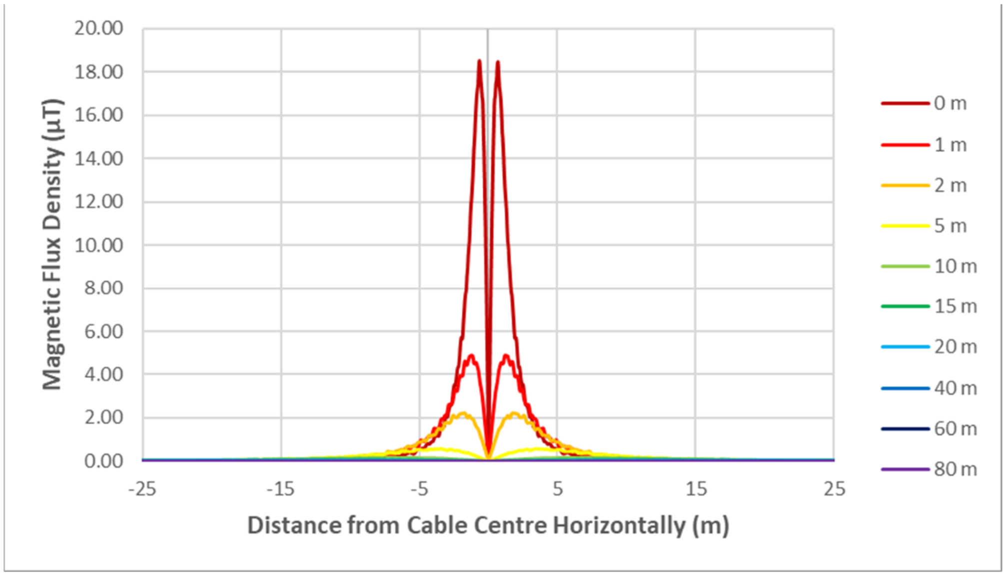

Figure 111: Sample Point3 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – X axis

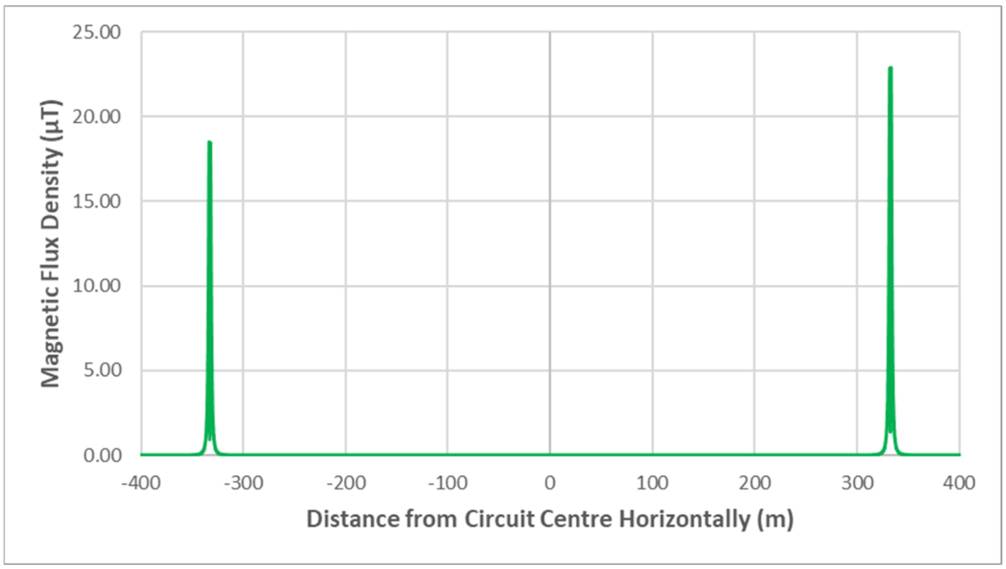

Figure 112: Sample Point3 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – X axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	0.00032	0.00041	0.00172	0.01467	0.08536	0.56704	0.96027	0.56005	0.08415	0.01350	0.00079	0.00008	0.00004
1	0.00027	0.00032	0.00145	0.01957	0.15098	0.78694	0.13008	0.86646	0.15351	0.01786	0.00099	0.00028	0.00020
2	0.00037	0.00030	0.00221	0.02770	0.20113	0.88540	0.03977	0.89412	0.20758	0.02866	0.00169	0.00017	0.00004
5	0.00010	0.00018	0.00396	0.04191	0.22115	0.53698	0.00533	0.53220	0.22196	0.04379	0.00349	0.00053	0.00019
10	0.00003	0.00079	0.00496	0.05268	0.13169	0.15540	0.00089	0.15388	0.13054	0.05222	0.00502	0.00093	0.00027
15	0.00014	0.00108	0.00662	0.04744	0.08147	0.06226	0.00028	0.06188	0.08065	0.04753	0.00664	0.00125	0.00035
20	0.00014	0.00133	0.00774	0.03854	0.04423	0.02951	0.00006	0.02967	0.04418	0.03865	0.00782	0.00164	0.00044
40	0.00015	0.00178	0.00700	0.01086	0.00758	0.00397	0.00030	0.00453	0.00827	0.01149	0.00764	0.00260	0.00080
60	0.00018	0.00156	0.00423	0.00369	0.00197	0.00076	0.00054	0.00184	0.00304	0.00480	0.00513	0.00291	0.00111
80	0.00027	0.00125	0.00234	0.00117	0.00032	0.00021	0.00077	0.00133	0.00187	0.00271	0.00372	0.00292	0.00135

Figure 113: Sample Point 3 - 750 MW – Both circuits in operation - Tabular representation of calculated magnetic flux density at different heights above sea floor level – X axis

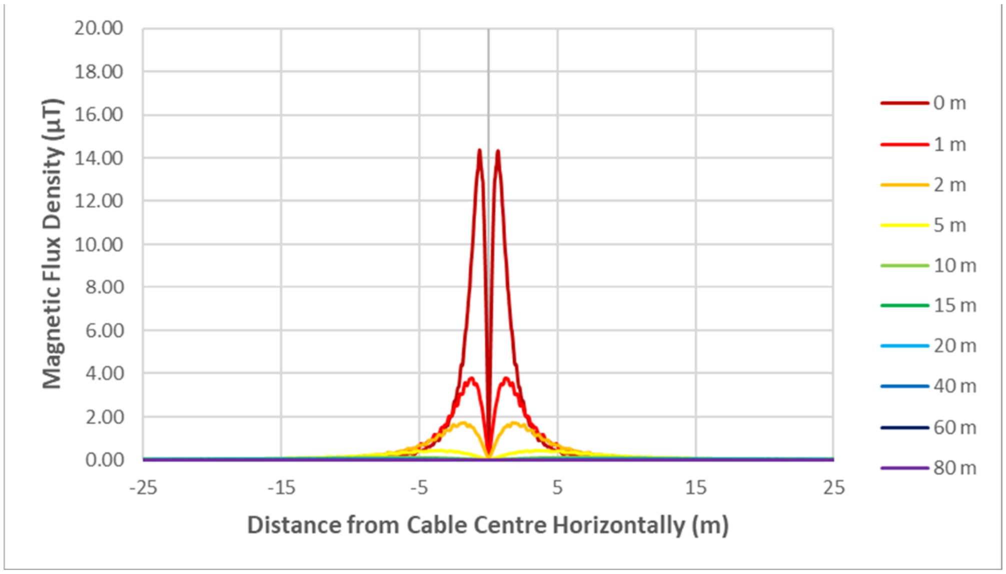

Figure 114: Sample Point3 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Y axis

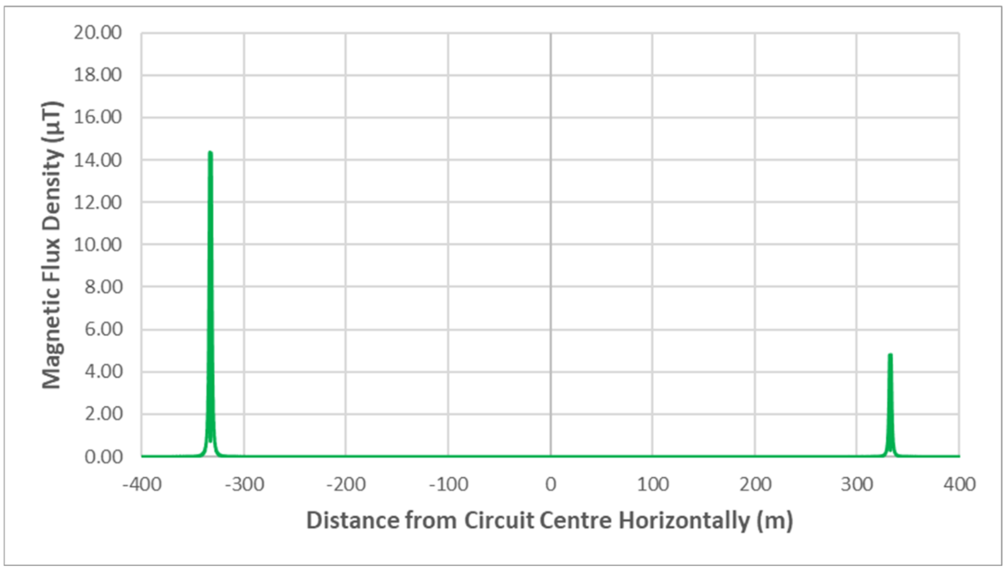

Figure 115: Sample Point3 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Y axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	μT												
0	0.00010	0.00022	0.00047	0.01142	0.06607	0.43972	0.74500	0.43468	0.06522	0.01046	0.00045	0.00013	0.00019
1	0.00006	0.00024	0.00111	0.01582	0.11707	0.61049	0.10081	0.67266	0.12011	0.01488	0.00104	0.00010	0.00012
2	0.00014	0.00035	0.00170	0.02073	0.15600	0.68697	0.03077	0.69370	0.16098	0.02179	0.00166	0.00013	0.00011
5	0.00006	0.00050	0.00329	0.03230	0.17153	0.41659	0.00403	0.41311	0.17253	0.03451	0.00323	0.00033	0.00010
10	0.00014	0.00081	0.00379	0.04112	0.10226	0.12061	0.00068	0.11950	0.10142	0.04089	0.00400	0.00053	0.00010
15	0.00017	0.00102	0.00523	0.03689	0.06331	0.04836	0.00022	0.04805	0.06271	0.03697	0.00533	0.00083	0.00021
20	0.00023	0.00122	0.00630	0.03011	0.03444	0.02298	0.00009	0.02301	0.03432	0.03007	0.00641	0.00112	0.00035
40	0.00048	0.00169	0.00587	0.00878	0.00615	0.00331	0.00004	0.00336	0.00631	0.00884	0.00607	0.00177	0.00088
60	0.00069	0.00176	0.00387	0.00335	0.00193	0.00096	0.00009	0.00114	0.00211	0.00352	0.00404	0.00208	0.00137
80	0.00083	0.00173	0.00258	0.00153	0.00079	0.00033	0.00014	0.00061	0.00107	0.00178	0.00286	0.00213	0.00181

Figure 116: Sample Point3 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Y axis

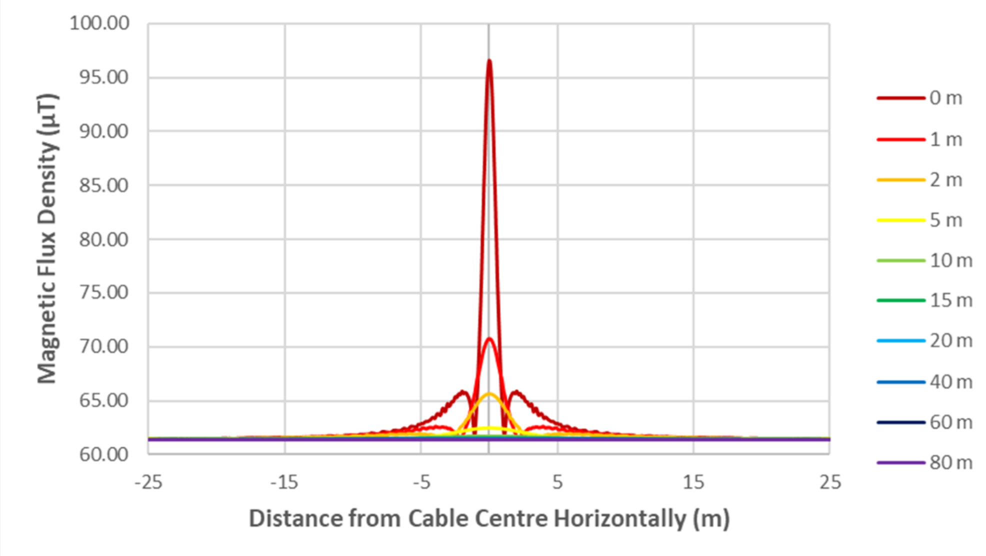

Figure 117: Sample Point3 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Z axis

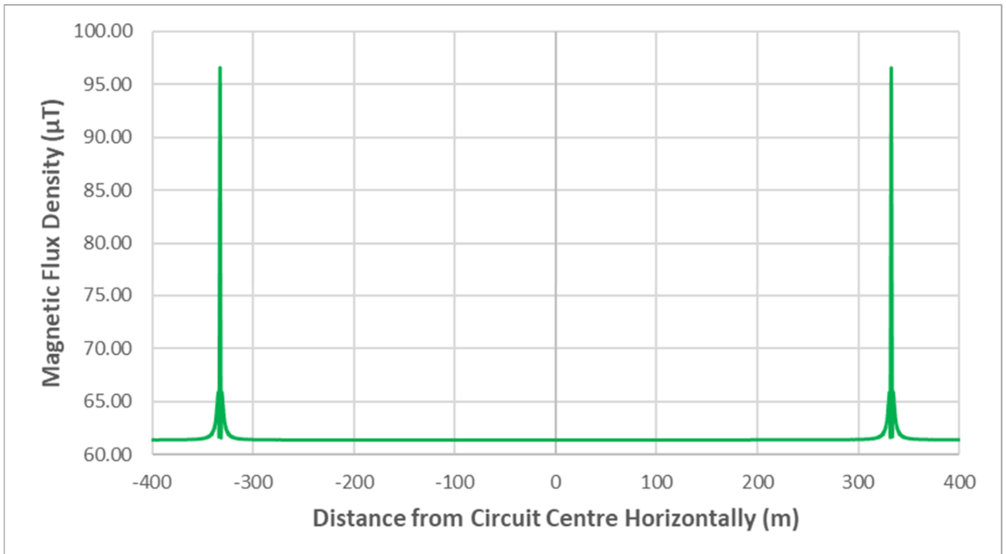

Figure 118: Sample Point3 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Z axis

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	μT												
0	61.39209	61.39473	61.40557	61.48519	61.77749	62.85882	96.58258	62.88371	61.77830	61.48818	61.40428	61.39253	61.39265
1	61.39222	61.39445	61.40727	61.49551	61.80155	62.36840	70.74883	62.41419	61.80182	61.49404	61.40589	61.39205	61.39269
2	61.39212	61.39452	61.40796	61.49475	61.74273	61.91542	65.63533	61.91260	61.74728	61.49525	61.40650	61.39209	61.39276
5	61.39205	61.39485	61.40862	61.47338	61.52506	61.53387	62.47328	61.53894	61.52429	61.47509	61.40768	61.39219	61.39277
10	61.39207	61.39503	61.40366	61.42878	61.41430	61.56954	61.71562	61.57041	61.41497	61.42843	61.40378	61.39221	61.39290
15	61.39203	61.39486	61.40141	61.40110	61.44407	61.50737	61.54465	61.50763	61.44437	61.40100	61.40101	61.39201	61.39291
20	61.39201	61.39460	61.39907	61.39445	61.43903	61.46723	61.48026	61.46732	61.43914	61.39455	61.39862	61.39178	61.39292
40	61.39190	61.39306	61.39117	61.40220	61.41049	61.41320	61.41418	61.41320	61.41062	61.40224	61.39069	61.39032	61.39296
60	61.39174	61.39177	61.39180	61.39836	61.40050	61.40108	61.40128	61.40107	61.40050	61.39840	61.39229	61.39089	61.39301
80	61.39153	61.39091	61.39260	61.39571	61.39642	61.39662	61.39667	61.39660	61.39642	61.39575	61.39308	61.39174	61.39306

Figure 119: Sample Point3 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Z axis

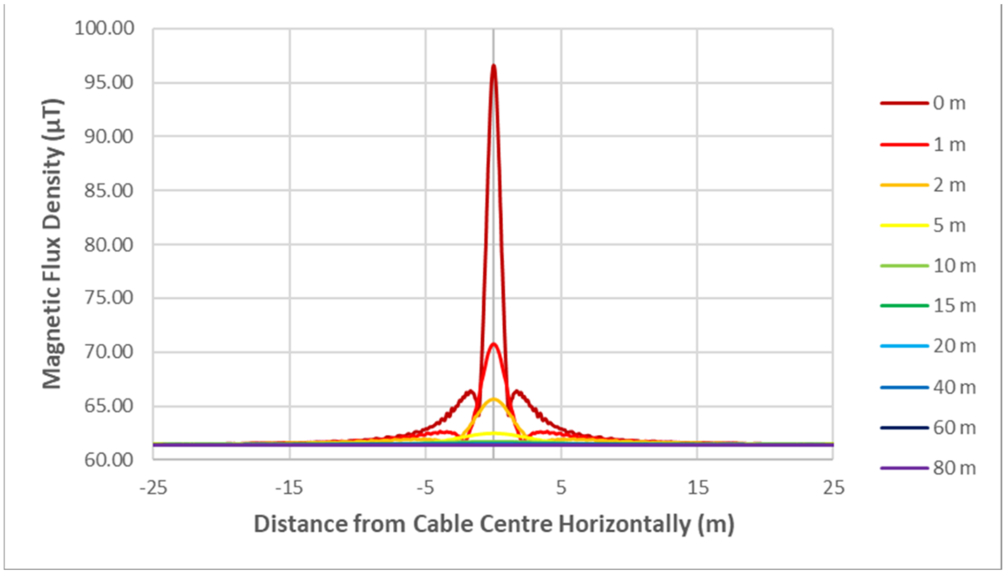

Figure 120: Sample Point3 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at different heights above sea floor level – Resultant

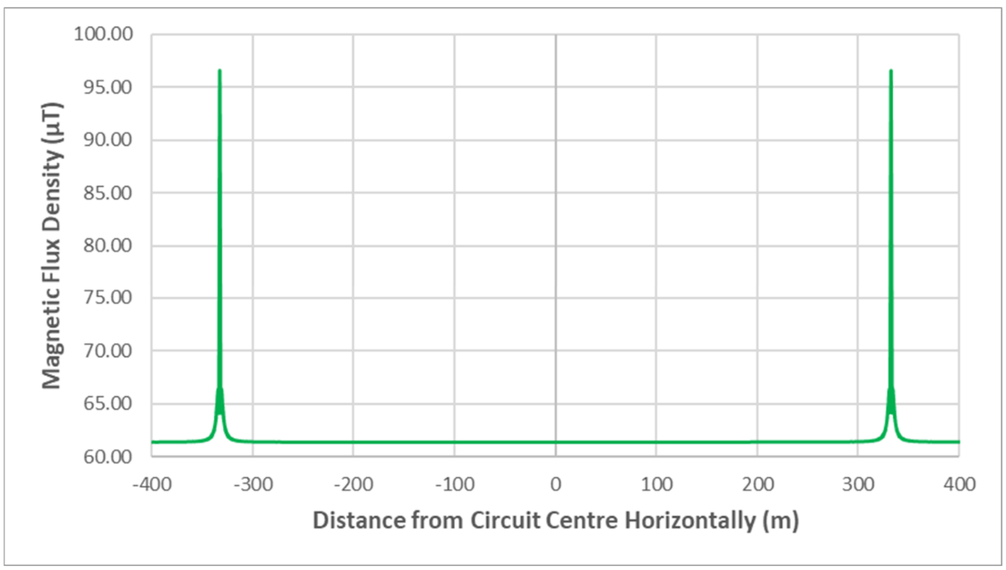

Figure 121: Sample Point3 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Resultant

Height Above Seabed (m)	Horizontal Distance from Cable (m)												
	-200	-100	-50	-20	-10	-5	0	5	10	20	50	100	200
	µT												
0	61.39209	61.39473	61.40557	61.48520	61.77758	62.86292	96.59023	62.88771	61.77839	61.48818	61.40428	61.39253	61.39265
1	61.39222	61.39445	61.40727	61.49552	61.80185	62.37636	70.74902	62.42383	61.80213	61.49405	61.40589	61.39205	61.39269
2	61.39212	61.39452	61.40796	61.49476	61.74325	61.92556	65.63535	61.92294	61.74784	61.49526	61.40650	61.39209	61.39276
5	61.39205	61.39485	61.40862	61.47340	61.52569	61.53762	62.47328	61.54263	61.52493	61.47511	61.40768	61.39219	61.39277
10	61.39207	61.39503	61.40366	61.42882	61.41452	61.56985	61.71562	61.57072	61.41520	61.42846	61.40378	61.39221	61.39290
15	61.39203	61.39486	61.40141	61.40112	61.44416	61.50742	61.54465	61.50768	61.44446	61.40103	61.40101	61.39201	61.39291
20	61.39201	61.39460	61.39907	61.39447	61.43905	61.46724	61.48026	61.46733	61.43916	61.39457	61.39863	61.39178	61.39292
40	61.39190	61.39306	61.39117	61.40220	61.41049	61.41320	61.41418	61.41320	61.41062	61.40225	61.39070	61.39032	61.39296
60	61.39174	61.39177	61.39180	61.39836	61.40050	61.40108	61.40128	61.40107	61.40050	61.39840	61.39229	61.39089	61.39301
80	61.39153	61.39091	61.39260	61.39571	61.39642	61.39662	61.39667	61.39660	61.39642	61.39575	61.39308	61.39174	61.39306

Figure 122: Sample Point3 - 750 MW - Both circuits in operation - Graphical representation of calculated magnetic flux density at sea floor level – Resultant