Report to:
Parks Victoria

Portarlington Safe Harbour Project

Marine ecosystem conditions and effects screening assessment

August 2015

Environmental Scientists and Engineers
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Cover photo:
Eleven arm seastars *Coscinasterias muricata* (native) feeding on mussels under existing access jetty to Portarlington Harbour, August 2015, CEE

Portarlington Safe Harbour Project

Marine ecosystem conditions and effects screening assessment

1 BACKGROUND

Parks Victoria proposes to expand the existing Portarlington Harbour on the Bellarine Peninsula in Port Phillip Bay (Figure 1). In October 2007, Parks Victoria commenced work on concept planning for the Portarlington Safe Harbour as part of the implementation of the Bays and Maritime Initiative (BMI). The upgrade to Portarlington pier is a State government election commitment to facilitate better and safe facilities for the aquaculture and commercial fishing industry. The stated aims of the safe harbour project at Portarlington are to:

- Provide necessary modern infrastructure to support growth in aquaculture activity in the area, with associated local employment and investment opportunities (noting that commercial aquaculture, particularly mussel farming, is synonymous with Portarlington and is a key economic activity in the region);
- Provide facilities for other commercial operators such as fishing charters, tour operators and passenger ferries;
- Improve space and safety for public maritime-based events, including the annual mussel festival.

The existing harbour provides facilities for aquaculture operators and a small number of recreational vessels (Figure 1). It consists of a 200 m offshore breakwater oriented approximately east-west joined to the foreshore by a 250 m jetty (on piles). Berths are provided along the south side of the breakwater and along a short finger jetty partway along the main jetty. A hardstand area is provided on the outer section of the pier. There is a short groyne extending from the start of the jetty to around 80 m offshore.

Figure 1 Location of the existing Portarlington Harbour

The development of the harbour will provide extra infrastructure to facilitate anticipated growth in the aquaculture industry in Port Phillip Bay. A ferry service operating out of Portarlington is a possibility in the future. The proposed safe harbour will be built around the existing infrastructure to provide safe haven for a larger number of vessels under all wind conditions (Figure 2).

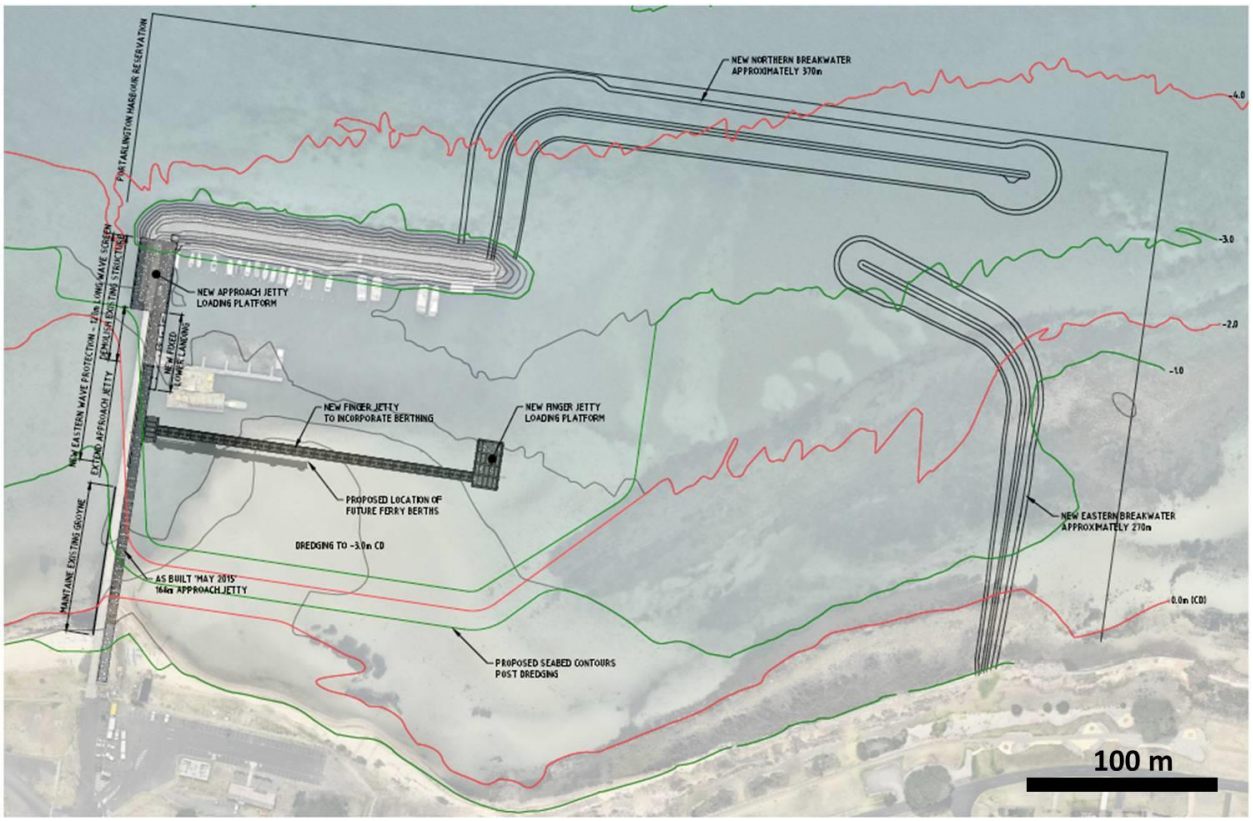

Figure 2 Proposed works for the Portarlington Safe Harbour (July 2015)

The upgrade includes:

- improved wave protection by installing a wave screen along the presently exposed western side of the jetty;
- a new extension to the offshore breakwater that will extend 70 m north from the existing rock breakwater and 300 m east southeast;
- a new 270 m long eastern rock breakwater aligned with Fisher Street;
- new jetties, landings and berths within the harbour;
- increasing the water depth of the harbour around the proposed new jetties, landings and berths

1.1 Scope of work

Planning permission for the extension is in the initial stage which involves lodging referrals to relevant state authorities and regulators CEE Consultants, under instruction from Envirome Consultants, were commissioned by Parks Victoria to review the existing marine environment condition assessments, prepared as part of the Portarlington Safe Harbour Master Plan project, with the aim of assessing the potential impacts of the proposed development on the marine environmental values.

The scope of works includes:

- Describing existing marine environmental values from existing information and a preliminary site visit
- Identifying the likelihood of state (Flora and Fauna Guarantee) or Commonwealth (Environment Protection and Biodiversity Conservation Act) flora and fauna of conservation significance likely to be present in the area
- Identifying impact pathways for the marine environment
- Preliminary assessment of risks to marine environmental values and conservation significant flora and fauna
- Identifying actions for further development in the project Adaptive Environmental Management and Monitoring Program

2 EXISTING INFORMATION SOURCES

The following literature relevant to the marine environment around the Portarlington Harbour were reviewed in compiling this report:

Marine Environmental Investigations

MSE (2007) Bellarine Safe Harbour Project: Marine Ecological Assessment. Report to Maunsell Australia by Marine Science and Ecology.

Maunsell Australia (2007) Bellarine Safe Harbour – Baseline Assessment Summary. Report to Parks Victoria, July 2007.

O'Hara and Barmby (2000) Victorian Marine Species of Conservation Concern: Molluscs, Echinoderms and Decapod Crustaceans. Museum Victoria report to Parks, Flora and Fauna Division, NRE.

Legislation

Commonwealth Environment Protection and Biodiversity Conservation Act 1999
Victorian Coastal Management Act 1995
Victorian Flora and Fauna Guarantee Act 1988
and associated action statements, listing details, threatening process lists

Databases

Species Profile and Threat Database (SPRAT), Commonwealth Department of Environment
Flora and Fauna Guarantee Act lists and associated information, Victorian Department of Environment, Land, Water and Planning
Atlas of Living Australia
Museum Victoria databases

3 MARINE ENVIRONMENTAL CONDITIONS

The Portarlington Safe Harbour project is located close to the northern tip of the Bellarine Peninsula, approximately 25 km east from Geelong and 40 km southwest of Melbourne.

The Bellarine Peninsula extends northward into Port Phillip Bay so that Portarlington is exposed to onshore winds from a range of directions. The longest fetch across the Bay is from the northeast to east-northeast. Winds from these directions are primarily in summer. Winds from the north to northwest are most common and strongest in winter. The shoreline is relatively sheltered from offshore southwesterly to southeasterly winds, including summer seabreezes. The present use of the harbour is primarily restricted by the limited shelter that the offshore breakwater provides from wind generated waves under onshore winds from the northwest to the east (Figure 3).

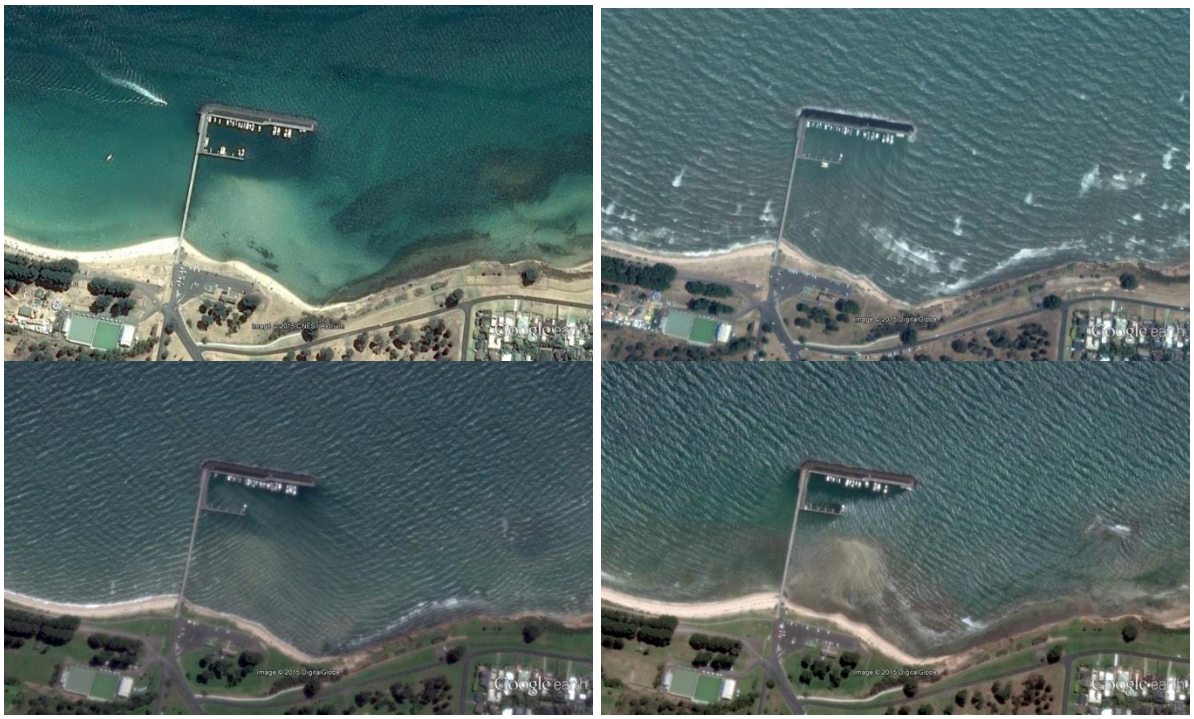

Figure 3. Portarlington harbour during different wind conditions

Marine water quality at Portarlington determined by the general clockwise circulation pattern of Port Phillip Bay as well as tidal currents that supply ocean water flushing from Port Phillip Heads. There are no significant freshwater inputs near Portarlington. Hence, nearshore water quality at Portarlington is generally very good.

Figure 4 Marine environmental values in the vicinity of the Portarlington Harbour

3.1 Marine ecosystem conditions

The distribution of large scale marine environmental values and habitats around the Portarlington Harbour is readily appreciated from remote images (Figure 4). Observations of the seabed by MSE in 2007 and CEE in 2015 (Figure 5, Appendix A:) confirm that marine habitats in the harbour area comprise:

- Artificial hard substrata: the wooden jetties and rock breakwater profile habitat for attached invertebrates and seaweeds as well as shelter for mobile species such as fish and squid
- Natural reef: The relatively low relief intertidal to shallow subtidal reef also provides natural habitat for attached invertebrates and seaweeds. The nearest substantial natural subtidal reef is at Governor Reef (around 9 km around the coast to the southeast).
- Extensive areas of sand: The soft sediments provide habitat for burrowing invertebrates, certain fish and seagrasses. The figure shows the formation of a sand spit inshore of the breakwater and the small dredged area around the boat facilities.

The natural habitats around the Portarlington harbour are typical of those along on the Bellarine Peninsula, with no unusual features or species (MSE, 2007).

Community values include the local aesthetics, recreational activities and commercial activities.

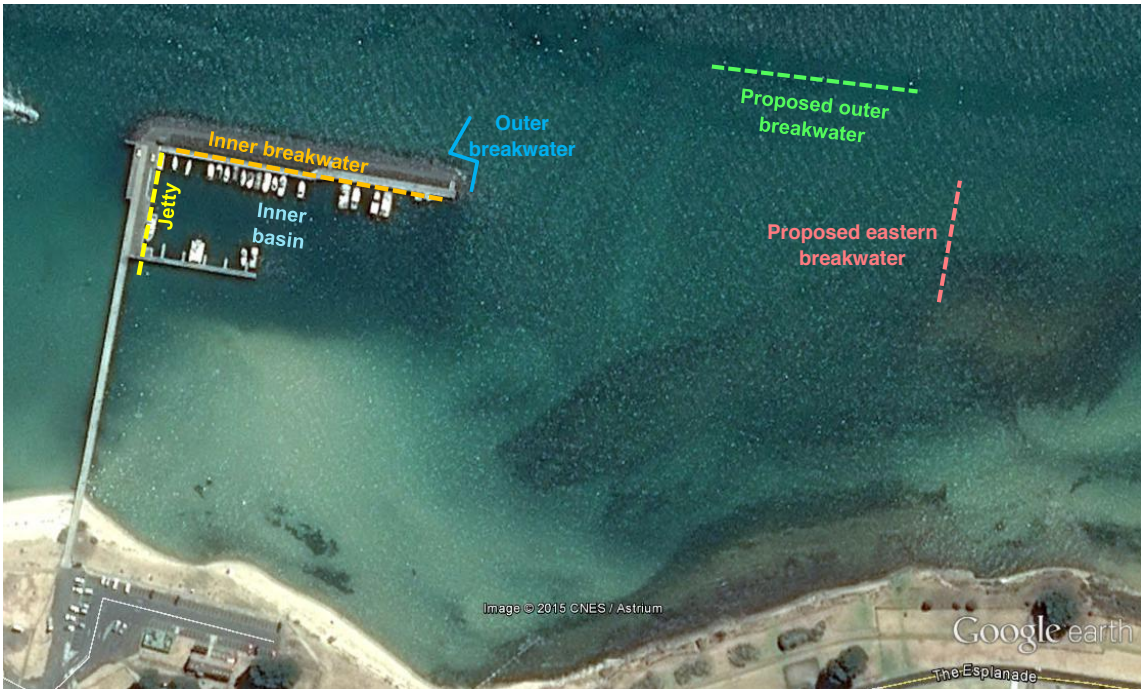

Figure 5. Locations inspected by CEE, August 2015

3.1.1 Soft sandy sediment

The predominant natural habitat type in the region is soft sandy seabed. Soft seabed accounts for around 99 per cent of Port Phillip Bay habitats.

The seabed at the outer proposed breakwater alignment was inspected by CEE in August 2015 (Appendix A:). The seabed was characterised by comprised steep, short sand waves with shell grit in the troughs and medium to coarse sands on the crests. Epibiota were very sparse and comprised small clumps cunjevoi (*Pyura dalbyi*) with associated growth of algae (*Caulerpa* spp and filamentous red algae) and other invertebrates including anemones and the fan worms the introduced *Sabella spallanzanii* and *Myxicola infundibulum*. Seagrasses *Heterozostera nigricaulis* and *Halophila australis* were sparse. Native eleven arm seastars (*Coscinaserias muricata*) were present and one small stingray Urolophus was seen. Few burrows were seen although the feeding proboscis of an echiuran worm was observed extending across the seabed.

This sand provides habitat for a range of burrowing invertebrate species (or 'infauna'). MSE found that the infauna community in sediments either side and under the Portarlington pier in 2007 was characterised polychaete worms, bivalve molluscs and crustaceans. The infauna community was typical of sheltered shallow sandy habitat in Port Phillip Bay. Notable species were the bivalves *Eumarcia fumigata, Tellina nigritacea, Fulvia tenuicostata, Mycella donaciformis* and one introduced species, *Corbula gibba*. A specimen of the snail *Polinices didymus*, which is at the south-eastern most extent of its range here, was found beneath the pier. Infauna characteristics are known to vary substantially over relatively small spatial distances and with sediment characteristics, which in turn is dependent on wave and current energy. The infauna around Portarlington Harbour showed substantial spatial variation, with different species and abundances between samples taken only 10s of metres apart. The number of infauna in samples ranged from 3,000 individuals per m^2 within the protected harbour to just 230-300 infauna/m^2 outside the harbour. The difference was mostly due to high numbers of polychaetes within the harbour and is likely to be due the more turbulent seabed conditions outside the harbour compared to the sheltered conditions within the protection of the existing breakwater.

The beaches are also home to infauna, though they have a remarkably patchy distribution (MSE, 2007). Samples taken from the beach in the lee of the breakwater had similar infauna numbers to the subtidal sample taken within the harbour. Infauna on the beach included nematode and polychaete worms, several groups of crustaceans, and bivalve molluscs. Polychaetes, isopods (beach hoppers such as *Mesanthura*) and bivalves (particularly *Soletillena alba*) were the most numerous infauna. All infauna were common temperate water species.

Seagrass in the area was limited to sparse patches of *Heterozostera nigricaulis* in deeper water (>2.5 m) and sparse and patchy macroalgae (such as *Caulerpa* spp) growing on benthic invertebrates such as cunjevoi (*Pyura dalbyi*). There are no seagrass 'beds' in the Portarlington area, the nearest being Pt Richards over 2 km west (Blake and Ball, 2001). There have been seagrass beds in the area in the past, but these were lost over 20 years ago (MSE, 2007, Bulthuis, 1982).

3.1.2 Natural nearshore reefs

Patches of low relief basalt reef are found along the coastline east of the harbour as far as Indented Head. They include intertidal reefs accessible shore, and shallow subtidal reefs within a few hundred metres of shore.

3.1.2.1 Intertidal reef

A narrow band of intertidal reef extends around 300 m east along the beach from a decommissioned stormwater pipe to the east of the pier. MSE in 2007 found that higher parts of the reef immediately adjacent to the beach were bare of plant growth and animals, due to a combination of exposure (desiccation and temperature stress), sand scour and intermittent sand inundation. At lower shore levels, patches of the brown seaweed Neptune's necklace (*Hormosira banksii)* were interspersed with bare rock and sand patches. Other species of green and brown turfing seaweed are found further towards the low tide mark. The sea-snail *Bembicium melanostomum* was the dominant invertebrate, with numbers as high as 180 per m^2 near the low tide mark. Other marine snails also occurred below mid-tide level including *Austrocochlea constricta* and *Velacumantis diemenensis*. MSE described the platform as having low biodiversity value relative to other intertidal reefs in Port Phillip Bay, (such as at Altona) due to wave exposure sand scout and lack of structural complexity. Similar areas of intertidal reef habitat occur to the east and west of Portarlington.

3.1.2.2 Subtidal reef

An area of shallow subtidal reef occurs within the harbour. It is likely that this is an extension of the intertidal reef flat, but the inshore part of the reef has been covered by the development of the sandspit in the lee of the breakwater. The reef flora was characterised by a limited range of filamentous brown and red seaweeds that are adapted to the wave exposed and sand scoured habitat. The reef continues east of the harbour area and is characterised by more permanent assemblages of invertebrates and macroalgae. *Sargassum* and *Cystophora* also characterised subtidal reef that was also silty/rocky habitat for a low diversity of attached invertebrates, filamentous algae and introduced wakame seaweed *Undaria pinnatifida*. Some parts of the subtidal reef were heavily grazed by sea urchins (*Heliocidaris erythrogramma*). . Fauna on the subtidal reef included the orange golfball-sponge *Tethya corticata*, some other small sponges (*Halicolona sp., Thorecta sp*), the seastars *Patiriella brevispina* and *Uniofora granifera* and the purple sea-urchin *Heliocidaris erythrogramma*. The shallow subtidal areas were characterised by a patchy distribution of mussels (*Mytilus galloprovincialis*) together with various seaweeds including green Ulva, brown (*Scytosiphon lomentaria*) and Neptune's necklace (*Hormosira banksii*). All these marine plant and animal species are common shallow water reef biota in Victoria.

3.1.3 Breakwater and pier (man-made habitat)

The breakwater and pier provide substantial additional hard substrate or reef habitat compared to the small amount of natural reef in the area. The pilings and boulders used to construct the breakwater and piers have been colonised by common Port Phillip Bay seaweed and invertebrate species.

The MSE survey in 2007 and CEE inspection in 2015 (Appendix A:) found a range of seaweed and invertebrate species totally covered the surfaces of the submerged pier pilings and breakwater rocks. Seaweeds such as *Ecklonia*, *Caulerpa* and filamentous algae comprised around covered approximately 55% of the surface of the submerged timber piles and rocks. The remaining half of the surfaces were occupied by *Pyura dalbyi* (cunjevoi), sponges, bryozoans and hydroids. The blue mussel *Mytilus galloprovincialis planulatus* was present on most piles though they were restricted to the uppermost subtidal parts of the piles (where they can avoid predation, particularly by the native seastar *Coscinasterias muricata).* MSE noted that the biota on pier pilings at Portarlington was essentially the same as that seen at St Leonards and Pt Wilson.

Several introduced species were present on the piles, including *Sabella spallanzanii* (feather-duster worm), *Undaria pinnatifida* (Wakame) and *Ciona intestinalis* (sea squirt), which are all broadly distributed in Port Phillip Bay.

The submerged breakwater structure provides a relatively complex reef habitat owing to the different orientations of boulder surfaces and the many crevices between boulders. Intertidal, shady areas of the boulders are colonised by sea lettuce (*Ulva sp*) and the limpets *Siphonaria diemenensis* and *Patelloida alticostata*. Subtidal boulders provide habitat for a range of seaweed and invertebrates. Dominant seaweeds include *Ecklonia radiata* (26 % cover) a range of other brown algae (*Cystophora spp, Caulocystis cephalornithos, Sargassum spp.* – 24 % cover), numerous unidentified brown and red algae (20% cover) and *Ulva* (11% cover). The proportion of different seaweed groups changes with depth – *Ulva* is dominant at shallower depths (0-1 m), *Ecklonia* around the middle of the depth range (1-3 m) and reds closer to the bottom (over 3 m).

3.1.4 Other marine natural values

MSE noted that the area is visited by dolphins, and several were seen during 2007 surveys. Dolphins in Port Phillip Bay (*Tursiops australis*) range throughout the bay but do not appear to leave the bay.

The existing harbour provides habitat for various species of fish and squid. Anglers fish from the breakwater for squid and flathead. The wider area is targeted for squid, whiting, snapper and flathead.

3.1.5 Commercial values

The harbour is currently used by aquaculture operators who base their vessels in the harbour to access their nearby mussel-farming leases. Mussels 'fresh off the boat' are also sold at the harbour.

The expansion of the harbour is intended to provide improved facilities for aquaculture operators and for growth in this industry. The harbour development may also provide a venue for ecotourism and fishing charter operators and a ferry service has been proposed for the area.

3.1.6 Recreational and aesthetic values

Figure 4 shows the area has a range of recreational and aesthetic values. Swimming, snorkelling, fishing and boating are important activities. Beach walking, beachcombing and rockpool rambling are popular activities.

For the most part these values will not be affected by the harbour redevelopment. Existing recreational activities such as beach walking, bathing, snorkelling, boating and fishing will still take place along the coast and around the harbour. Some of these opportunities, particularly fishing, the aquaculture industry, boating in general and possibly snorkelling, will be enhanced by the larger harbour.

The aesthetics of the area may be affected during construction and due to the increased size of the harbour and increase in vessel movements. Many regard active harbours as attractive places for sight-seeing.

4 PROTECTED MARINE SPECIES AND COMMUNITIES

The Victorian Flora and Fauna Guarantee Act 1988 (FFGA) lists threatened species and ecological communities in Victoria. The Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBCA) Matters of National Environmental Significance (MNES) lists migratory and threatened species and ecological communities throughout Australia. The current FFGA list (May 2015) and MNES database has been reviewed for species that may be present in the area of the Portarlington Harbour project. The likelihood of the project interacting with listed marine species or ecological communities is assessed in Section 5.

Victorian FFGA listed marine species and EPBCA marine protected species that may occur in the area are listed in Table 1. The table shows species' conservation status under the FFG and EPBCA which use the IUCN red list criteria. The following abbreviations are used to describe species conservation status: L=Listed, VU = vulnerable, NT = Near Threatened, EN = endangered, CR = critically endangered, DD = data deficient.

Table 1 FFG Act listed marine species and ecological communities

Species	Common name	FFG Status	EPBC Status	Habitat	Portarlington
Whales and dolphins					
Balaenoptera musculus	Blue Whale	CR	EN	Oceanic	Unlikely
Eubalaena australis	Southern Right Whale	CR	EN	Oceanic	Possible
Megaptera novaeangliae	Humpback Whale	VU	VU	Oceanic	Possible
Tursiops australis	Burrunan Dolphin	EN		Bays	Likely
Oceanic seabirds					
Diomedea cauta	Shy Albatross	VU	VU	Oceanic	Unlikely
Diomedea epomophora	Southern Royal Albatross	VU	VU	Oceanic	Unlikely
Diomedea exulans	Wandering Albatross	EN	VU	Oceanic	Unlikely
Macronectes giganteus	Southern Giant-Petrel	VU	EN	Oceanic	Unlikely
Macronectes halli	Northern Giant-Petrel	NR	VU	Oceanic	Unlikely
Thalassarche bulleri	Buller's Albatross	L		Oceanic	Unlikely
Thalassarche carteri	Indic Yellow-nosed Albatross	VU	VU	Oceanic	Unlikely
Thalassarche chrysostoma	Grey-headed Albatross	VU	EN	Oceanic	Unlikely
Coastal seabirds					
Ardea alba	Great Egret	L		Coastal/ inland	Possible
Ardea intermedia	Intermediate Egret	EN		Coastal/ inland	Possible
Sterna albifrons	Little Tern	VU		Coastal/ Estuarine	Possible
Sterna caspia	Caspian Tern	NR		Coastal/ Estuarine	Possible
Sterna nereis nereis	Fairy Tern	EN	VU	Coastal/ Estuarine	Possible

Species	Common name	FFG Status	EPBC Status	Habitat	Portarlington
Sterna nilotica	Gull-billed Tern	EN		Coastal/ Wetland	Possible
Thinornis rubricollis	Hooded Plover	VU		Coastal	Possible
Terrestrial birds					
Haliaeetus leucogaster	White-bellied Sea-Eagle	VU		Terrestrial/ coastal	Unlikely
Lathamus discolor	Swift Parrot	EN	EN	Terrestrial/ oceanic	Unlikely
Neophema chrysogaster	Orange bellied parrot	CR	CR	Saltmarsh	Unlikely
Sharks					
Carcharias taurus	Grey Nurse Shark	DD	CR	Oceanic	No
Carcharodon carcharias	Great White Shark	VU	VU	Oceanic/ bays	Possible
Bony Fish					
Prototroctes maraena	Australian Grayling	VU	VU	Fresh/ saltwater	Unlikely
Thunnus maccoyii	Southern Bluefin Tuna	L		Oceanic	Unlikely
Mugilogobius paludis	Pale mangrove goby	VU		Mangrove forest	Unlikely
Lovettia sealii	Australian Whitebait	CR		Coastal/ Estuarine	Possible
Invertebrates					
Athanopsis australis	Southern Hooded Shrimp	VU		Table 2	Possible
Eucalliax tooradin	ghost shrimp species	VU		Table 2	Unlikely
Michelea microphylla	ghost shrimp species	VU		Table 2	Unlikely
Amphiura triscacantha	brittle star species	VU		Table 2	Unlikely
Apsolidium densum	sea-cucumber species	VU		Table 2	Unlikely
Apsolidium handrecki	sea-cucumber species	VU		Table 2	Unlikely
Ophiocomina australis	brittle star species	VU		Table 2	Unlikely
Pentocnus bursatus	sea-cucumber species	VU		Table 2	Unlikely
Thyone nigra	sea-cucumber species	VU		Table 2	Unlikely
Trochodota shepherdi	sea-cucumber species	VU		Table 2	Unlikely
Ralpharia coccinea	stalked hydroid species	L		Table 2	Unlikely
Bassethullia glypta	chiton species	VU		Table 2	Unlikely*
Platydoris galbana	marine opisthobranch	VU		Table 2	Unlikely
Rhodope genus	marine opisthobranch	VU		Table 2	Unlikely
Marine communities					
Port Phillip Bay Entrance Deep Canyon Marine Community					No
San Remo Marine Community					No

Species considered possible, likely or certain to be present in the area, or present from time to time, are highlighted. There are a large number of marine invertebrates listed on the FFG. Many are only found in very specific habitats (or have only been documented from very specific habitats). Details of their habitat requirements and records are provided in Table 2.

As discussed in Section 0, the Portarlington area includes embayment habitats (predominantly sandy seabed, some shallow reef and seagrass). Oceanic, estuarine, saltmarsh or mangrove associated species are unlikely to visit the area as such habitat is unavailable. The FFG listed ecological communities are remote from the area and their habitats are quite distinct from those found at Portarlington. Hence, Table 1 shows that most FFG and EPBCA listed marine species and ecological communities are unlikely to be found in the Portarlington area.

4.1 Marine species that may occur in Portarlington region

Nine species are listed as possibly present in the area and four species are listed as likely present in the area from time to time. The circumstances for the presence of each of these species in the Portarlington Harbour area are discussed below.

4.1.1 Species possibly present in Portarlington region

The southern Right and Humpback Whales are occasional visitors to Port Phillip Bay during their winter migration between Antarctic and sub-tropical waters. They do not feed nor breed in Port Phillip Bay and most records of these species are from the south of the Bay, nearer Bass Strait. Hence, it is possible that individual or pairs of these two whale species may be present in region of Portarlington from time to time during temporary detours from their annual migrations. Neither are known to feed or breed in Port Phillip Bay.

Two egret species, three tern species, and the Hooded Plover may also visit the area from time to time to forage. None of these species are known to nest in the area.

White Sharks are transient species and Port Phillip Bay is not a known aggregation, feeding or breeding area for the species. Museum Victoria has only one record of a White Shark in Port Phillip Bay – an undated specimen collected from Hobsons Bay. The next nearest record is from Point Impossible, in Bass Strait (2004, dead on the beach).

The Australian/Tasmanian whitebait has only recently been recorded from the Tarwin River in South Gippsland. The species migrates between estuaries and the sea. If it were present near Portarlington it would only be a transient visitor.

There is a single record of the Southern Hooded Shrimp from the Portarlington area, two others elsewhere in Port Phillip Bay and one from Bridgewater Bay near Portland. A live specimen is yet to be found (O'Hara and Barmby, 2000). The biology and ecology of this species is unstudied and while it is very rare, it is not known how human activities may impact on the species.

These species may be present in the Portarlington region over periods of years. The likelihood of them occurring during construction is very low as assessed in Section 5.

4.1.2 Species likely to be present Portarlington region

The Little Tern may be present from time to time in the area. It is most common in the Gippsland lakes but has been recorded from Port Phillip Bay to Mallacoota. No breeding sites have been recorded near Portarlington and the available habitat is not its preferred nesting habitat.

The dolphins in Port Phillip Bay were recently found to be a distinct species – the Burrunan Dolphin. They have an estimated population of around 100 animals in Port Phillip Bay. There is another small population of around 50 animals in the Gippsland Lakes and the species is also known from Tasmania. The Burrunan Dolphins in Port Phillip Bay forage throughout the Bay, and are likely to be found in the Portarlington area from time to time.

These species may be present in the Portarlington region over short periods as they travel around the Bay. The likelihood of them occurring during construction is low as assessed in Section 5.

Table 2 Distribution of FFG listed invertebrates in Victoria

Taxa	Common Name	Environment	Habitat	Records
Cnidarians				
Ralpharia coccinea	stalked hydroid	Bay	Reef (5-30 m)	Western Port (Crawfish Rock, 2 records)
Crustaceans				
Athanopsis australis	Southern hooded shrimp	Bay	Sand, mud, reef (5-12 m)	Port Phillip Bay and Bridgewater Bay (Vic)
Eucalliax tooradin	Ghost shrimp	Bay	Fine sand (2-5m)	Swan Bay (PPB) and Crib Point (Western Port)
Michelea microphylla	Ghost shrimp	Bay	Sandy gravel (19m)	Crib Point (Western Port)
Echinoderms				
Amphiura triscacantha	Brittle star species	Bay and Channel	*Posidonia* and *Heterozostera* seagrass beds (subtidal)	Nooramunga (1 record) and possibly Western Port (Vic) and Spencer & St Vincent Gulfs (SA).
Apsolidium densum	Sea-cucumber species	Open Coast	Rocky shallows (0-2 m)	Apollo Bay and Flinders (4 records)
Apsolidium handrecki	Sea-cucumber species	Bay	Rocky shallows (rock platforms)	Merricks (3 records, Vic), Arno Bay (SA) and Trigg Island (WA)
Ophiocomina australis	Brittle star species	Channel	*Posidonia* and *Heterozostera* seagrass beds and on *Pinna* bivalves (subtidal)	Nooramunga (Vic, 1 record) and Spencer & St Vincent Gulfs (SA)
Pentocnus bursatus	Sea-cucumber species	Open Coast	Found living on shallow water macroalgae (subtidal)	Cape Paterson (several records, Vic), Beachport (SA) and Cockburn Sound (WA)
Thyone nigra	Sea-cucumber species	Bay	Sheltered, silty sediment bay habitats (subtidal)	Corio Bay (2 records, Vic), St Vincent Gulf (SA) and Bramble Pt, Princess Royal Harbour (WA)
Trochodota shepherdi	Sea-cucumber species	Channel	*Posidonia* seagrass beds (subtidal)	Nooramunga (2 records, Vic) and Spencer & St Vincent Gulfs (SA)
Molluscs				
Bassethullia glypta	Chiton	Bay and Open Coast	Under rocks in sand (intertidal to 10 m)	Port Phillip Heads region (8 records), Flinders (1 record, Vic) and Stanley (Tas)
Platydoris galbana	Opisthobranch	Bay	Reef flat	San Remo (4.5 records, Vic), possibly Delray Beach (Vic)
Rhodope genus	Opisthobranch	Bay	Reef flat	San Remo (Vic)

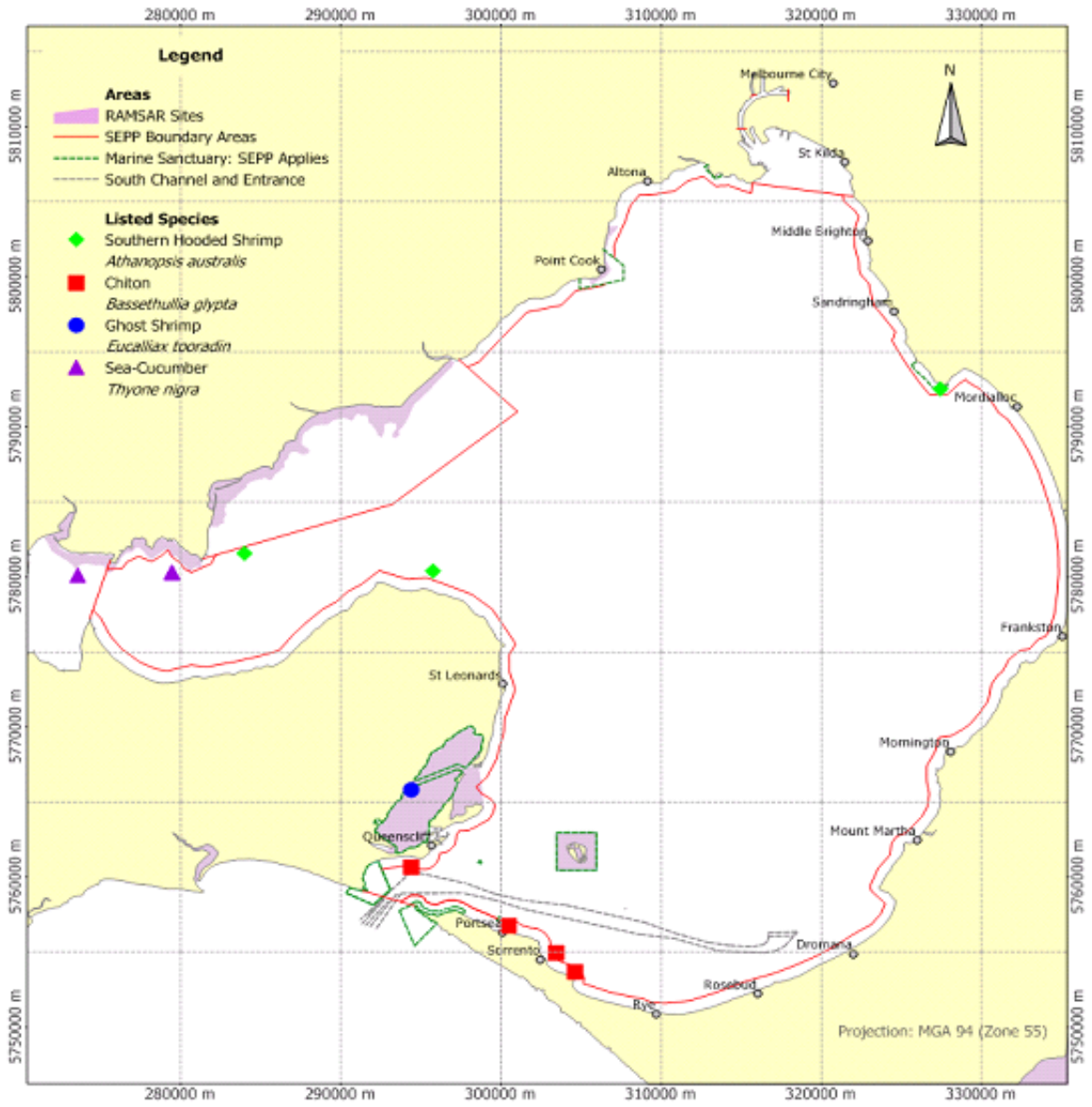

Figure 6 Distribution of FFG listed marine invertebrates in Port Phillip Bay

5 POTENTIAL IMPACT PATHWAYS AND RISK SCREENING

The potential impact pathways for construction and operational activities at the Portarlington Safe Harbour to affect marine environmental values are listed below for the purpose of discussions with regulators and inform preliminary assessment of effects.

5.1 Construction activities

Construction of the Portarlington Safe Harbour will require the following activities:

- Piling – to install the new 150 m pier and floating pontoons
- Rock placement – to construct the breakwaters (approximately 17,100 m^2 footprint)
- Dredging/excavation – to provide up to 3 m water depth in the harbour (approximately 34,000 m^2 footprint corresponding to approximately33,000 m^3 of material)
- Spoil disposal – to dispose of material dredged from the harbour
- Placement of floating berths
- Towing and transport of materials by construction vessels and vehicles

5.1.1 Potential construction impact pathways

The construction activities may result in pathways of effect to various environmental values and specific ecosystem components as described below.

5.1.1.1 Loss of habitat and associated biota

Identifiable areas existing habitats will be lost due to:

- Excavation/dredging of soft seabed habitat and associated biota to increase water depth within prescribed areas on the harbour.
- Covering of existing seabed by 17,100 m^2 of new rock breakwater on soft sediment habitat (81 percent) and nearshore and intertidal reef habitat (19 percent) and associated biota
- Removal of existing pier piles with associated biota

Most of the marine habitat affected directly by construction will be replaced by new or similar marine habitat (see Section 5.1.1.2) that will be colonised by marine biota from the surrounding area (Section 5.2.3). The loss of marine habitat as a whole will be negligible.

5.1.1.2 Creation of new habitat:

New habitat for colonisation by a range of species including will be created in the form of:

- Placed dredged material
- New rock breakwaters
- New pier and jetty piles
- Floating berth pontoons

The effect will be permanent and localised to the area of the construction activities.

5.1.1.3 Underwater noise

Construction activities will produce various levels of marine noise. Most noise will be low level (rock placement, dredging) or similar to existing sources (vessels). Piling activities will produce the highest level marine noise. Construction activities will produce various levels of marine noise. Most noise will be low level or similar to existing sources (vessels). Piling activities within the harbour will the highest level marine noise. The effect will be relatively localised due to the soft nature of the sediments and the barriers of transmittal through the water provided by the rock breakwaters. There have been no reports of incidents associated with pile driving of the scale proposed for the Portarlington expansion, including the construction of the 'May 2015 Approach Jetty'. Hence, construction noise effects are expected to be minor and managed according to a project specific Environment Management and Monitoring program, which will include a marine mammal management procedure.

5.1.1.4 Cables and anchors
Cables and anchors will be used to tow and secure vessels, barges and pontoons. Anchors may drag across the seabed and disturb or remove seabed biota. The effect will be temporary during construction activities, with extent likely to be limited to less than 50 m from the activity.

5.1.1.5 Change of water depth
Dredging the seabed within the harbour will result in removal of the existing seabed and creation of deeper water in the dredged area. The effect will be permanent and localised to the area of the construction activities.

5.1.1.6 Turbidity
Dredging using a cutter suction dredger will result in a small increase in turbidity in the area being dredged and more extensive turbidity in the area that the dredged material is placed. The effect will be intermittent and temporary during construction activities, with extent likely to be limited to less than 500 m from the activity. Pile driving does not produce turbidity.

5.1.1.7 Spills
Refuelling and use of lubricants and hydraulic fluids on construction vessels and vehicles may result in accidental spills to the marine environment. The event is unlikely and limited to less than 500 m from the activity due to the relatively small volumes and nature of the hydrocarbon fluids typically used in these operations.

5.1.1.8 Litter
Wrappings, containers, excess construction material or removed material may accidentally be released to the marine environment from vessels, vehicles or the workplace in general. The amount of material on the site will be limited and managed. Accidental events would be small, temporary and limited to less than 200 m from the activity.

5.1.1.9 Lighting
Lighting of the construction area at night may create a source of attraction or avoidance for some marine biota. Any effect will be temporary during construction activities, with extent likely to be limited to less than 50 m from the activity.

5.1.1.10 Pests
Vessels and equipment brought to the site may be contaminated by marine pests from other areas. The effect will depend on the nature of the pest transported to the area. Introduced species are widely spread and common in Port Phillip Bay, including some marine species classified as pests. It is unlikely that the project will involve the use of equipment that has recently been used overseas. Hence, there is low likelihood that the project will result in new pest species being introduced to Port Phillip or the Portarlington area.

5.1.1.11 TBT Antifouling paints
Antifouling paints containing TBT were banned from use on vessels less than 25 m in Victoria in 1989. TBT paints were subsequently banned worldwide in 2008. It is most unlikely that TBT remains on the hulls of vessels likely to be used in construction of the harbour.

5.1.1.12 Vessel strike
Vessels travelling to and from activities may strike marine mammals. The effect will depend on the speed of the vessel and nature of the impact. There is presently a range of vessel traffic in the area. The increase in traffic due to construction vessel activity will be minor and localised.

Table 3 Screening of construction risks to FFG and EPBC species in Portarlington region

Hazard/effect	Plausible receptor group		Interaction likelihood	Population consequence	Risk	Management action	Residual Risk
	FFG	EPBC					
Loss of habitat	Marine invertebrate	Nil	Negligible	Minor	Low	No action necessary	Low
New habitat	Marine invertebrate	Nil	Negligible	Minor	Low	No action necessary	Low
Underwater noise	Whales, dolphins, fish	Whales, dolphins, shark	Possible	Minor	Moderate	Monitor and manage	Low
Cables and anchors	Marine invertebrate	Whales, dolphins, shark	Negligible	Minor	Low	Monitor and manage	Low
Increase water depth	Marine invertebrate	Nil	Negligible	Minor	Low	No action necessary	Low
Turbidity	Whales, dolphins, fish Marine invertebrate	Whales, dolphins, shark	Unlikely Unlikely	Minor Minor	Low Low	Manage hazard Manage hazard	Low Low
Spills	Whales, dolphins, fish, bird Marine invertebrate	Whales, dolphins, shark, bird	Unlikely Unlikely	Minor Minor	Low Low	Manage hazard Manage hazard	Low Low
Litter	Whales, dolphins Marine invertebrate	Whales, dolphins	Unlikely Unlikely	Minor Minor	Low Low	Monitor and manage Manage hazard	Low Low
Lighting	Whales, dolphins, shark	Whales, dolphins, shark	Negligible	Minor	Low	No action necessary	Low
Pests	Marine invertebrate		Unlikely	Minor	Low	Manage hazard	Low
TBT paints	Marine invertebrate		Negligible	Insignificant	Low	Manage hazard	Low
Vessel strike	Whales, dolphins, shark	Whales, dolphins, shark	Unlikely	Minor	Low	Monitor and manage	Low

5.1.2 Screening assessment and mitigation of construction impacts

The potential construction impacts listed above can be minimised or negated through the implementation measures in an Environmental Management and Monitoring Plan for construction of the harbour.

5.1.2.1 Construction impacts on FFG and EPBC protected species and communities

A preliminary assessment of the likelihood and extent of the construction impacts listed above is provided in Table 3. The assessment is based on the known distribution and characteristics of FFG and EPBC protected species and communities at Portarlington and the magnitude of likely effect based on experience at comparable or larger projects (particularly Blairgowrie, Brighton and Sandringham Harbours and at Webb Dock) where similar construction methods were used. The risk assessment matrix is shown in Table 4.

Table 4 Qualitative risk assessment matrix (after AS/NZS 4360:2004)

Likelihood	Consequence				
	Catastrophic	Major	Moderate	Minor	Insignificant
Almost certain	Extreme	Extreme	Extreme	High	High
Likely	Extreme	Extreme	High	High	Moderate
Possible	Extreme	Extreme	High	Moderate	Low
Unlikely	Extreme	High	Moderate	Low	Low
Negligible	High	High	Moderate	Low	Low

Table 3 shows that the risks to FFG and EPBCA species and communities from managed construction of the safe harbour at Portarlington are low. Management and monitoring procedures will be fully described in an Environmental Management and Monitoring Plan for construction of the harbour.

5.1.2.2 FFG listed species and communities

The effects construction of the Portarlington Harbour does not intentionally include any Potentially Threatening Processes listed in July 2012 relating to Section 10 of the FFGA. Listed Potentially Threatening Processes that may accidentally be considered such as:

- Input of petroleum and related products into Victorian marine and estuarine environments;
- Invasion of native vegetation by ‘environmental weeds’;
- The discharge of human-generated marine debris into Victorian marine or estuarine waters;
- The introduction of exotic organisms into Victorian marine waters and;
- Input of organotins to Victorian marine and estuarine waters

are unlikely to occur, are unlikely to interact with FFG listed species and have minor consequence on individuals of species populations in the event of interaction because of the characteristics of the construction methods, the distribution of marine species and the incorporation of management measures during the construction program. Hence there is negligible potential for the project to threaten populations of FFG listed species or sub-communities.

5.1.2.3 EPBC listed species and communities

The effects construction of the Portarlington Harbour does not include any of the “Significant Impact Criteria” listed in the Significant Impact Guidelines 1.1 – Matters of National Environmental Significance for critically endangered, endangered, vulnerable or migratory listed species. Project specific processes have also been shown to pose low risk to EPBCA listed protected species that may occur in the Portarlington region. Hence there is negligible potential for the project to threaten populations of EPBCA listed species populations.

5.1.3 Construction impacts on general marine biodiversity values

As discussed in Section 0, the existing biodiversity values in the vicinity of the existing harbour comprised those associated with the natural soft seabeds and low relief reefs and those associated with the artificial substrata and environment created by the existing harbour facilities.

5.1.3.1 Effects on natural habitat communities

As discussed in Section 0, general natural marine biodiversity values in the vicinity of the Portarlington harbour development area are characterised by soft seabed habitats and associated biota that are represented over a considerable area of coastline on the Bellarine Peninsula and species are common throughout Port Phillip Bay. The reef habitat and associated biota are relatively low in biodiversity value when compared with other reefs on the Bellarine Peninsula or particularly when compared to reefs in Marine Parks elsewhere in Port Phillip Bay.

The construction activities and impact pathways described in Section 5.1.1 will be have a localised effect on the existing low natural value biological communities within the harbour. These communities are widespread in Port Phillip Bay, and are species are better represented in protected marine parks around the Bay. Hence, the effect of construction activities on Bellarine Peninsula or Baywide marine biodiversity will be negligible.

5.1.3.2 Effects of artificial habitat communities

The pier pilings, breakwater rocks and jetty decks provide a greater range of permanent habitat and a diversity of environmental conditions for a range of marine biota in the existing harbour than the natural habitats. Hence, biodiversity value associated with the harbour infrastructure increases the number of marine species and general biodiversity within in the footprint of the existing harbour. All species are common to Port Phillip Bay and are associated with natural reefs and artificial structures all around the Bay.

The construction activities and impact pathways described in Section 5.1.1 will have a temporary and localised effect on the existing value of biological communities associated with artificial habitats within the harbour.

The construction of the new facilities will add further range to the habitats (floating pens, decks, piles, wave screens) and environmental conditions (increased depth range, calmer conditions) within the harbour, which is expected to provide conditions suitable for a wider range of species and assemblages than presently occupy the harbour.

5.1.4 Summary of construction effects on marine biological values

The effects of construction activities associated with the Portarlington Safe Harbour development are well understood from similar developments around Port Phillip Bay. The marine ecosystem values at Portarlington are known to be typical of the Bellarine Peninsula and there are no unusual or protected species that are known or likely to be particularly associated with the Harbour area. Preliminary assessment of the construction activities indicates that risks to the marine ecosystem values including FFG and EPBC listed species are low and can be further managed with an appropriate Environmental Management and Monitoring Plan for construction of the harbour.

5.2 Operation of the harbour

The operation of the harbour will be limited to the berthing, loading and unloading of recreational and commercial fishing vessels. There will be no fixed refuelling facilities, no maintenance or slipping facilities. The ongoing impact pathways associated with the operation of the safe harbour include:

- Harbour operations and increased vessel movement
- Loss of existing habitat
- Changed habitat and environment within the harbour
- Changed hydrodynamic and coastal processes

5.2.1 Harbour operations and increased vessel movement

Effects of the operation of the harbour will be those affects associated with the locally increased movement of vessels, increased human visitation, litter, spills of relatively small volumes of fuel and lubricants from manual fuelling or in-vessel maintenance. The potential effect of most of these hazards will be confined to the inside of the harbour due to the containment effect of the harbour breakwaters. These hazards can be managed and risks substantially reduced through the development and implantation of an Environmental Management Plan for the operation of the harbour and inclusion of appropriate facilities.

Increased vessel movement outside the harbour due to the presence of the improved facilities at Portarlington will be a small proportion of the vessel movement in Geelong Arm and Port Phillip Bay, which is increasing with improved boat ramp and marina facilities around the Bay, increasing popularity of boating and general population increase. The environmental risks associated with increased traffic from Portarlington can be managed through education, advisory notices and conditions of use described in an Environmental Management Plan for the operation of the harbour.

5.2.2 Loss of existing habitat

The placement of additional the new northern and eastern rock breakwaters to enclose the proposed harbour will result in approximately 17,100 m^2 (1.7 ha) of subtidal and intertidal seabed being covered with new rock breakwater. Approximately 80 percent of the area covered with new habitat comprises mobile sands and the remaining 20 percent comprises shallow and intertidal rocky reef. Approximately 34,000 m^2 (3.4 ha) of soft seabed in the Harbour will be dredged to 3 m depth. As discussed previously, the sands and associated biota that will be affected are typical of large areas of Port Phillip Bay including the Bellarine Peninsula. The rocky reefs are relatively low in physical complexity with species common to most reefs in Port Phillip Bay. The existing habitats will be replaced by rock habitat (breakwater material) and dredged basin (fine sediments). These habitats will be colonised by species from the pool of biota that presently exists in similar habitats in the Portarlington area – including the existing breakwater and the dredged basin. The effect of the replacement of this proportion of the Bay's existing habitats on Bay biodiversity is minor to negligible.

5.2.3 New habitat and modified environment within the harbour

The new harbour will enclose approximately 11 ha of water, with an additional total area of 2.5 ha of new and existing breakwater and jetty around the perimeter of the harbour. Hence the total footprint of the harbour will be approximately 13.5 ha.

The construction of the new facilities will add further range to the habitats (floating pens, decks, piles, wave screens) and environmental conditions (increased depth range, calmer conditions) within the harbour, which is expected to provide suitable conditions for a wider range of species and assemblages than presently occupy the harbour.

Small boat harbours elsewhere in Port Phillip provide marine environments that contain a diversity of marine life that is usually distributed over a wider area in the 'outside environment' of Port Phillip Bay. The characteristics of the Portarlington harbour ecosystem will be shaped by the diversity of habitats and water depth, and also the water movement and quality within the harbour. The characteristics of other harbours around Port Phillip Bay are noticeably different from each other due to differences in this combination of factors at each location.

Regardless of the mix of marine assemblages that develop in the proposed Harbour, the overall species richness will be greater than the existing harbour and will comprise species found elsewhere in Port Phillip Bay including both native and introduced species.

Seagrasses (*Zostera nigricaulis* and *Halophila australis*) are present in small patches in the existing harbour and are likely to become more abundant in the quieter conditions.

The undersides of pontoons and lower parts of piles will develop rich invertebrate assemblages – particularly where water exchange between the harbour and bay is optimal. The sides of pontoons and upper parts of piles exposed to the sun will develop diverse seaweed assemblages. Fish and squid will take refuge among the piles and under the pontoons. Water birds (cormorants, terns and penguins) and water rats may forage within the harbour.

Water quality within the harbour will be influenced by the amount of flushing with surrounding Bay waters. Water quality within the Harbour will vary around the harbour according to local water movement and flushing. Water quality will also vary over the year and algal blooms may occur within the Harbour from time to time.

The quieter conditions within the Harbour will result in the deposition of fine suspended material, drifting seagrass and associated macroalgae and other marine flotsam on the harbour floor and harbour beaches. The deposition will result in the fine sediments characterising the seabed as they presently do immediately behind the existing breakwater. Drifting seagrasses, macroalgae and other organic material may accumulate in quiet locations within the harbour including the dredged basin. This material may decompose and create unpleasant conditions in those areas - as occurs at some other location in Port Phillip Bay. This material may require removal from time to time to restore the amenity of the Harbour.

It is possible that the marine ecosystem that develops around the breakwater and piles at Portarlington Harbour will provide a focus for snorkelers and underwater photographers. The attractiveness will depend on the complexity of the habitats provided, the flushing regime and the amount of light available. The use of the area by snorkelers and photographers has the potential to result in conflict of use between swimmers and boat movement, with associated safety issues. As a public facility, it is possible to accommodate both uses of the

environment with appropriate incorporations into the final design of the harbour and Environmental Management Plan for the operation of the harbour.

5.2.4 Changed hydrodynamics and coastal processes

The breakwaters and wavescreens of the new infrastructure will further change the hydrodynamics and coastal processes around the harbour. The existing breakwater has changed the wave pattern and sand transport along the coast at Portarlington. This has resulted in the accumulation of sand inshore of the breakwater and sand starvation at beaches 'downstream' of the harbour. The existing condition has been managed by sand dredging in the harbour and renourishing the starved beaches with the dredged material.

This management practice is likely to continue with the same minor, temporary and localised effects on the marine ecosystem.

6 SUMMARY OF POTENTIAL CONSTRUCTION AND OPERATION EFFECTS ON MARINE BIOLOGICAL VALUES

The effects of construction and operation of Portarlington Safe Harbour development are well understood from similar developments around Port Phillip Bay. The marine ecosystem values at Portarlington are known to be typical of the Bellarine Peninsula and there are no unusual or protected species that are known or likely to be particularly associated with the Harbour area.

The risks to protected and threatened State Flora and Fauna Guarantee Act and Commonwealth Environment Protection and Biodiversity Conservation Act have been assessed as low and can be further mitigated during construction by an appropriate Environmental Management and Monitoring Plan.

Preliminary assessment of the construction and operation of the Portarlington Harbour indicates that risks to the marine ecosystem values are low and can be further managed with appropriate Environmental Management Plans for construction and operation of the harbour.

APPENDIX A:
MARINE HABITAT AND ECOSYSTEM CONDITIONS 2015

Conditions in the existing Portarlington Harbour area were assessed by CEE in August 2015 to supplement observations and descriptions by MSE in 2007. This section provides a pictorial summary of ecosystem conditions on 23 August 2015 at the locations shown in Figure 7.

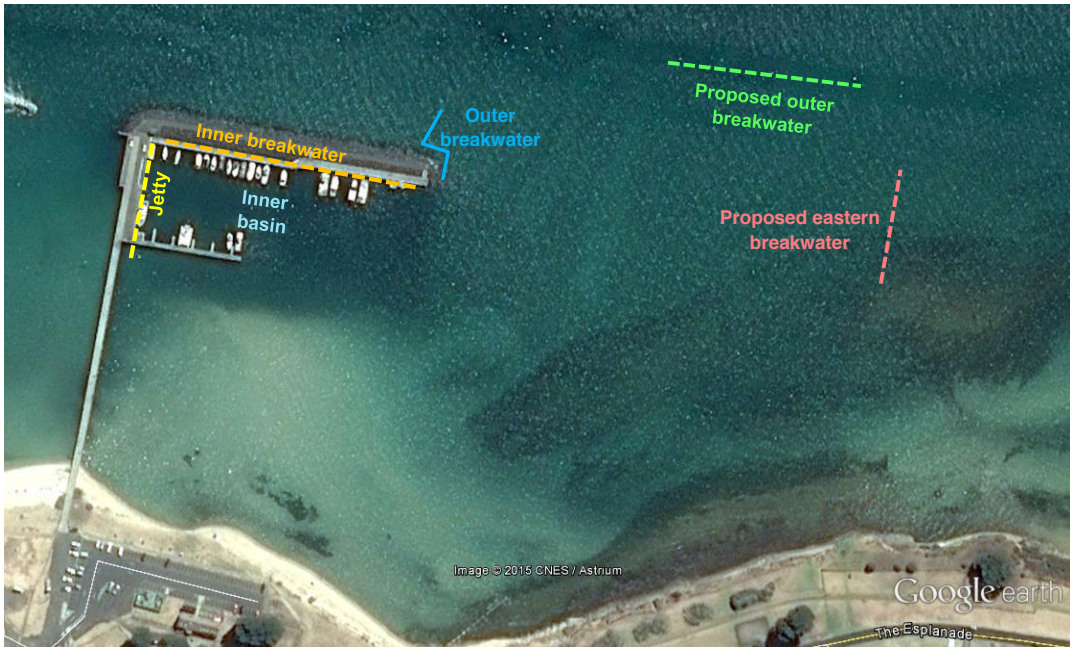

Figure 7. Locations inspected by CEE

6.1 Sandy seabed of proposed outer and eastern breakwater alignments

The seabed at the outer proposed breakwater alignment comprised steep, short sand waves with shell grit in the troughs and medium to coarse sands on the crests (Figure 8). Epibiota were very sparse and comprised small clumps cunjevoi (*Pyura dalbyi*) with associated growth of algae (*Caulerpa* spp and filamentous red algae) and other invertebrates including anemones and the fan worms the introduced *Sabella spallanzanii* and *Myxicola infundibulum*. Seagrasses *Heterozostera nigricaulis* and *Halophila australis* were sparse. Native eleven arm seastars (*Coscinaserias muricata*) were present and one small stingray Urolophus was seen. Few burrows were seen although the feeding proboscis of an echiuran worm was observed extending across the seabed.

6.2 Reef seabed of inner end of proposed eastern breakwater

The sandy seabed close to the transition between sand and rock along the proposed eastern breakwater provides habitat for sparse seagrass and cunjevoi, with partially buried rocks providing for attachment of the brown seaweed *Sargassum* spp (Figure 9). *Sargassum* and *Cystophora* also characterised subtidal reef that was also silty/rocky habitat for a low diversity of attached invertebrates, filamentous algae and introduced wakame seaweed *Undaria pinnatifida*. Some parts of the subtidal reef were heavily grazed by sea urchins (*Heliocidaris erythrogramma*). The shallow subtidal areas were characterised by a patchy distribution of mussels (*Mytilus galloprovincialis*) together with various seaweeds including green Ulva, brown (*Scytosiphon lomentaria*) and Neptune's necklace (*Hormosira banksii*).

Figure 8. Sandy seabed of proposed outer and eastern breakwater alignments

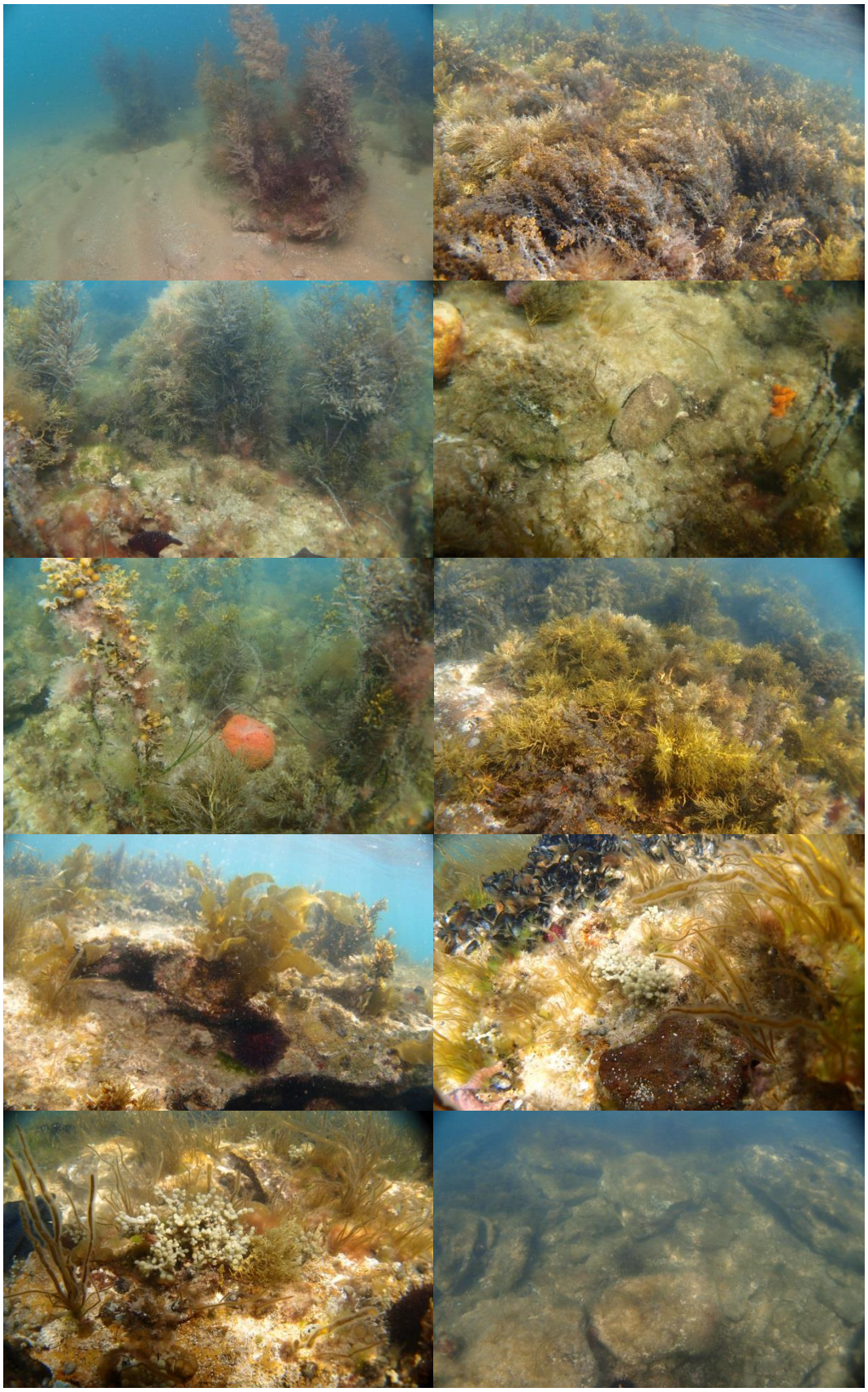

Figure 9. Rocky subtidal seabed of proposed eastern breakwater alignment

6.3 Jetty

The piles of the existing jetty provide habitat for an invertebrate and algal community that is typical of pile communities around Port Phillip Bay. The upper parts of the piles are characterised by blue mussels and cunjevoi and various red, green and brown algae including native kelp *Ecklonia radiata* and introduced Wakame. A range of other invertebrates included bryozoans, sponges, ascidians and hydroids. The native eleven arm seastar was exceptionally abundant ins some places on the seabed where it was observed feeding on mussels and fish carcasses that appeared to have been dropped from the jetty.

Figure 10. Jetty pile community

6.4 Inner Breakwater

The habitats behind the existing breakwater included hard substrata such sheetpile, breakwater rocks and piles (Figure 11) and soft silty seabed that has accumulated in the quiet conditions behind the breakwater (Figure 12). The biota associated with the hard substrata along the southern side of the existing breakwater comprised typical macroalga and invertebrate assemblages found elsewhere in Port Phillip Bay. The deeper and shaded hard substrata were characterised by invertebrates, while the shallower areas and those exposed to sufficient light were characterised by macroalgae.

Figure 11. Biota of hard substrates behind existing breakwater

Figure 12. Soft seabed habitat behind existing breakwater

The biota associated with the soft substrata along the southern side of the existing breakwater comprised patches of *H nigricaulis* and *Halophila* seagrasses on the sunlit seabed close to breakwater and 'bare' seabed under the jetty and in the deeper water south of the jetty (Figure 12). The 'bare' seabed to approximately 2.5 m deep was, in fact, coated with a brown layer of microscopic unicellular algae known as microphytobenthos or 'MPB'. 'MPB' is found on most seabed in Port Phillip Bay that is infrequently disturbed by waves or tidal currents. A variety of detached seagrasses, seaweeds and other detritus had accumulated in the deeper, dredged area of seabed under the moored vessels.

6.5 Outer existing breakwater

The habitats on the east and north of the existing breakwater included hard substrata breakwater rocks, with sandy seabed immediately offshore of the breakwater. The rocks of the breakwater were characterised by dense growth of large brown algae including the native leather kelp *Ecklonia radiata* and various species of *Sargassum* (Figure 13). The soft seabed appeared to be generally finer material than the seabed at the proposed breakwater to the northeast (), although sand waves were similar in size. The finer sediments at the existing breakwater showed active track and burrows of burrowing biota, which were not visible at the proposed breakwater site (Figure 14). Examination of the remote image indicates possible spatial differences in the seabed character around the harbour area.

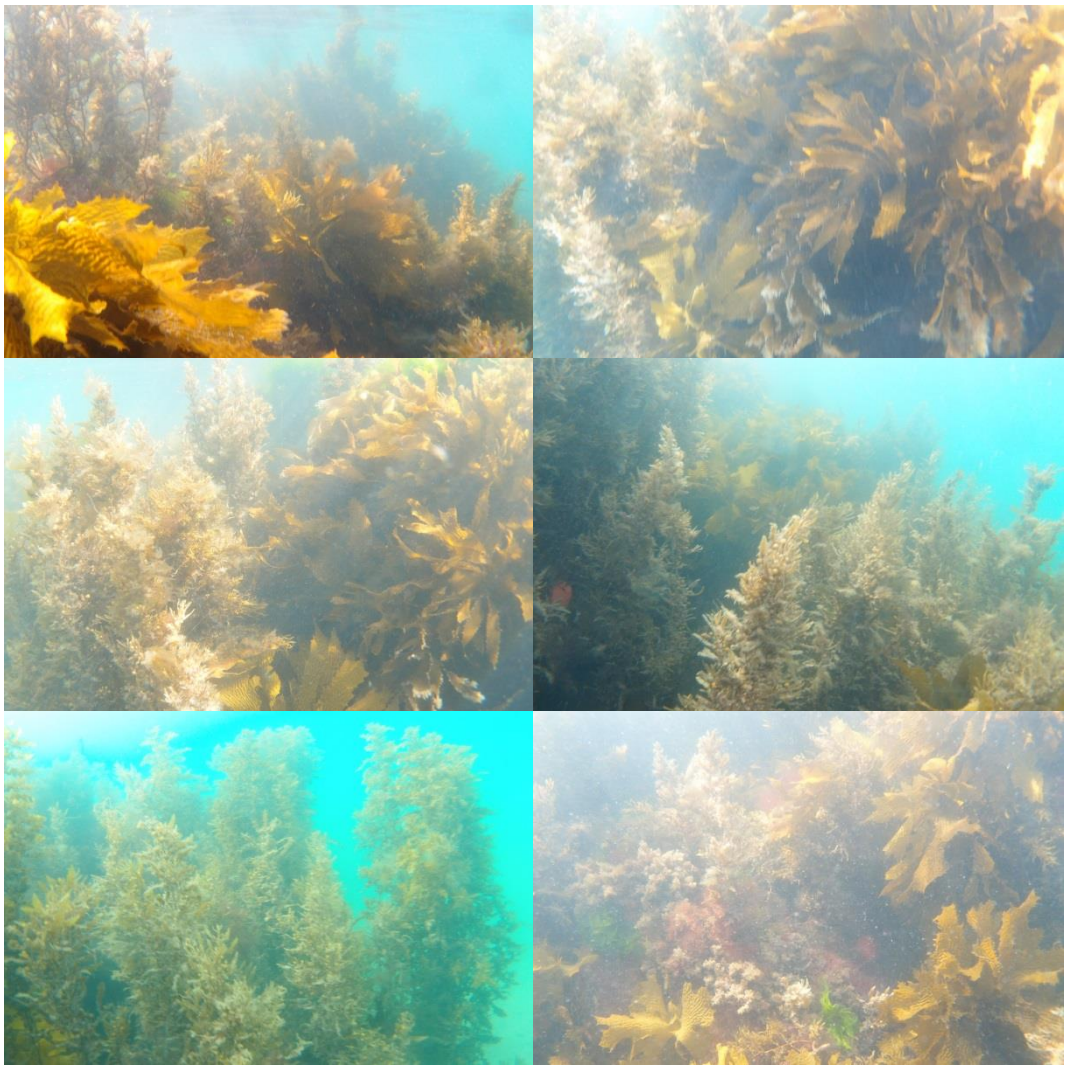

Figure 13. Hard seabed habitat on wave exposed existing breakwater

Figure 14. Soft seabed habitat beyond existing breakwater

6.6 Harbour basin

The existing dredged seabed behind the breakwater ranges in depth from 2 m to 3 m with an accumulation of unattached seagrasses and algae and other material in the basin formed by the dredging as discussed above. The composition of the seabed inshore of the dredged area including the seabed at the existing finger jetty comprises soft vegetated and bare sediments of silts and fine sands (Figure 15). Patches of the seagrass *Heterozostera nigricaulis* were observed on the shallower sandy areas, while sparse *Halophila australis* were observed on some of the silty seabed. MPB was observed on the seabed in the more quiescent areas. Algal and invertebrate growth was abundant on the finger jetty piles. The tombola inshore of the finger jetty was characterised by bare fine to medium sand.

Figure 15. Seabed habitat inshore of existing breakwater and finger jetty