Report to:
Jacobs Group (Australia) Pty Ltd

AGL Gas Import Jetty Project
Crib Point, Western Port

Marine Ecosystem Protected Matters Assessment

FINAL

30 August 2018

Environmental Scientists and Engineers
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Marine Ecosystem Protected Matters Assessment

EXECUTIVE SUMMARY

AGL Wholesale Gas Limited (AGL) is proposing to develop a Liquefied Natural Gas (LNG) import facility, utilising a Floating Storage and Regasification Unit (FSRU) to be located at Crib Point on Victoria's Mornington Peninsula. The project, known as the "AGL Gas Import Jetty Project" (the Project), comprises:

- The continuous mooring of the FSRU at the existing Crib Point Jetty, which will receive LNG carriers of approximately 300m in length
- The construction of ancillary topside jetty infrastructure (Jetty Infrastructure), including high pressure gas unloading arms and a high pressure gas flowline mounted to the jetty and connecting to a flange on the landside component to allow connection to the Crib Point Pakenham Pipeline Project.

The facility would be located in a section of Western Port (North Arm), which is a diverse but compact marine environment. It comprises vast intertidal mudflats with saltmarsh, seagrass and mangrove habitats as well as steep subtidal sloping banks with seagrass and deep channels that connect the north of the bay with the oceanic waters of Bass Strait in the south.

These characteristics contribute to the listing of a large part of Western Port as a Ramsar wetland of international significance and the allocation of distinct areas as National Parks. Many of the animal and plant species are not specifically protected or listed for conservation value, but the combination of mangroves and seagrasses, saltmarsh, fish, birds, crustaceans, worms and other unique invertebrates all form the Western Port marine ecosystem that is valued by the public.

The scope of this assessment was to review relevant Commonwealth and Victorian legislation for marine protected areas, protected marine species (flora and fauna, excluding birds and terrestrial fauna) and listed processes that may be relevant to the Project. Various marine species, habitats and ecological communities are protected by the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the State *Flora and Fauna Guarantee Act 1988* (FFG Act). In some cases, species or places are listed on both the EPBC and FFG Acts. The broader ecosystem values of Western Port outside of the area relevant to the Project are assessed in the context of Western Port's Ramsar values. These matters are relevant to decisions in relation to the Project referrals under the *Environment Effects Act 1978* (Vic) (EE Act) and the EPBC Act.

The Western Port Ramsar site was designated as a wetland of international significance in 1982. The Ramsar site covers 59,950 ha of Western Port including Crib Point. Western Port is one of eleven Victorian Ramsar sites in Victoria and is the third most important area for wading birds in Victoria. All Ramsar sites are a matter of national environmental significance (MNES) under the EPBC Act. Potential long-term change to the ecological character of a Ramsar wetland is also a trigger for referral of a project under the EE Act.

A review of marine Commonwealth EPBC Act MNES and the State FFG Act listed species has been completed for the Project. The assessment identified 33 threatened marine species and one marine community that the Acts list may occur in Western Port. This assessment excluded birds which are assessed in the Jacobs Flora and Fauna Assessment Report. The identified threatened marine species are listed in Table 1.

Table 1. Marine protected species and need for further information

Common name	Scientific name	EPBC	FFG	Further information required*
Mammals				
Blue Whale	*Balaenoptera musculus*	Endangered, Migratory	Listed	Unlikely
Southern Right Whale	*Eubalaena australis*	Endangered, Migratory	Listed	Unlikely
Humpback Whale	*Megaptera novaeangliae*	Vulnerable, Migratory	Listed	Unlikely
Brydes Whale	*Balaenoptera edeni*	Migratory		Unlikely
Pygmy Right Whale	*Caperea marginate*	Migratory		Unlikely
Killer Whale	*Orcinus orca*	Migratory		Unlikely
Dusky dolphin	*Lagenorhynchus obscurus*	Migratory		Unlikely
Burrunan Dolphin	*Tursiops australis*	Listed marine (NA)	Listed	Unlikely
Sharks				
White shark	*Carcharodon carcharias*	Vulnerable, Migratory	Listed	Unlikely
Grey nurse shark	*Carcharius Taurus*		Listed	Unlikely
Mackerel Shark	*Lamna nasus*	Migratory		Unlikely
Freshwater/Marine Migratory Fish				
Australian grayling	*Prototroctes maraena*	Vulnerable	Listed	YES
Australian mudfish	*Neochanna cleaver*		Listed	Unlikely
Marine Fish				
Pale Mangrove Goby	*Mugilogobius paludism*		Listed	YES
Southern Bluefin Tuna	*Thunnus maccoyii*		Listed	Unlikely
Australian Whitebait	*Lovettia sealii*		Listed	Unlikely
Reptiles				
Leatherback Turtle	*Dermochelys coriacea*	Endangered, Migratory	Listed	Unlikely
Loggerhead Turtle	*Caretta caretta*	Endangered, Migratory		Unlikely
Green Turtle	*Chelonia mydas*	Vulnerable, Migratory		Unlikely
Marine Invertebrates				
Southern hooded shrimp	*Athanopsis australis*		Listed	Unlikely
Ghost shrimp	*Pseudocalliax Tooradin*		Listed	YES
Ghost shrimp	*Michelea microphylla*		Listed	YES
Brittle star	*Amphiura triscacantha*		Listed	Unlikely
Sea-cucumber	*Apsolidium densum*		Listed	Unlikely
Sea-cucumber	*Apsolidium handrecki*		Listed	Unlikely
Brittle star	*Ophiocomina australis*		Listed	Unlikely
Sea-cucumber	*Pentocnus bursatus*		Listed	Unlikely
Sea-cucumber	*Thyone nigra*		Listed	Unlikely
Sea-cucumber	*Trochodota shepherdi*		Listed	Unlikely
Chiton	*Bassethullia glypta*		Listed	Unlikely
Opisthobranch	*Platydoris galbana*		Listed	Unlikely
Opisthobranch	*Rhodope* genus		Listed	Unlikely
Stalked Hydroid	*Ralpharia coccinea*		Listed	Unlikely

CEE's review found that many of the marine species listed under the State and Commonwealth Acts were relatively widely distributed, that Western Port represented a small component of their range and that Western Port was not recognised as a significant aggregation, breeding or feeding location or migratory path for most EPBC identified species and many FFG listed species (excluding water birds).

As shaded grey in the table above, the review identified four species that required further information to inform project risk screening and assessment:

- Australian Grayling *Prototroctes maraena*: EPBC Act 'Vulnerable'; FFG listed
- Pale Mangrove Goby *Mugilogobius paludis*: FFG listed
- Western Port ghost shrimp *Pseudocalliax tooradin*: FFG listed
- Small-gilled ghost shrimp *Michelea microphylla:* FFG listed

The potential impact pathways of the Project on these species were identified as:
- Cold water effects of the discharge of cold seawater from the FSRU to the waters of Western Port in the vicinity of Crib Point
- Toxicity effects of chlorine related chemicals in the discharge of the heat exchange water discharged from the FSRU to the waters of Western Port in the vicinity of Crib Point
- Entrainment of larvae (all four species) or juveniles (Grayling) into the heat exchange system of the regasification process on the FSRU

These pathways have been described and modelled in separate reports on hydrodynamic and discharge mixing modelling (CEE, 2018a), heat exchange seawater entrainment modelling (CEE, 2018b), the effects of cold-water discharge assessment on the marine ecosystem (CEE 2018c) and chlorine behaviour investigation and toxicity modelling (CEE, 2018d). Measures to mitigate the effects of the processes on the marine ecosystem also have been described in these reports. In summary:
- The extent of effect of these processes is likely to be restricted within the lower North Arm of Western Port.
- The extent of effects of cold-water and chlorine toxicity in the discharged waters are likely to be restricted to an area approximately 200 m north and south and 60 m east and west of the discharge point and species that are located at water depth greater than 12.5 m.
- Entrainment is unlikely to affect species:
  - that are capable of movement independent of tidal currents
    - with propagules that predominantly remain within intertidal or shallow water habitats,
    - disperse along the edges of the channels in Western Port and
    - disperse within 4 m of the surface or within 4 m of the seabed.
- Entrainment may affect planktonic populations within North Arm to an area of approximately 1 km north and south of the FSRU, however entrainment was predicted to be less than 1 percent over the whole of North Arm.

An examination of information about the Australian Grayling indicated that adult populations in the rivers and streams would not be exposed to impact pathways and that the proportion of larvae of these species that might disperse via North Arm and be affected by Project processes was low.

Museum of Victoria personnel advised that the Pale Mangrove goby *Mugilogobius paludis* was synonymous with the more common flatback goby *Mugilogobius platynotus,* which is not listed on the FFG Act threatened species list.

There is evidence of the Western Port ghost shrimp *Pseudocalliax tooradin* and the small-gilled ghost shrimp *Michelea microphylla* being known near Crib Point more than 50 years ago. The Western Port ghost shrimp *Pseudocalliax tooradin* is known only from a total of five records, and the ghost shrimp small-gilled *Michelea microphylla* from only one specimen. Further examination of information on both ghost shrimps indicated that they had restricted distributions in Western Port that may indicate susceptibility to entrainment, cold-water and chlorine toxicity effects of the FSRU seawater heat exchange processes if still present in the area. Further investigations of the present distribution of these species are recommended.

The general outcome of the reports indicates that the direct effects of the full-scale operation of the FSRU on the marine ecosystem in the Ramsar area relate to discharge of cold-water, discharge of residual chlorine and entrainment of larvae and plankton. As stated above, the extent of cold-water and chlorine toxicity effects are likely to be restricted to an area approximately 200 m north and south and 60 m east and west of the discharge point in water depth from approximately 12.5 m to 17 m. This represents an area of approximately 5 ha, which is less than 0.5 % of the seabed in North Arm[1].

Entrainment of up to 10 percent of some plankton and larvae may extend to 750 m north and south from the FSRU, but overall entrainment in the whole of North Arm is expected to be less than 1%. The modelling completed for this report and other supporting studies was based on the original FSRU seawater flow-through rate of 450,000 m^3/day (450 ML/day). AGL has advised that a seawater flow-through rate of 300,000 m^3/day (300 ML/day), corresponding to a lower regasification rate is more likely. In this case, the proportion of plankton entrained may be reduced by approximately one third.

The longer term effects of entrainment on planktonic populations (including some planktonic larvae and eggs) are uncertain due to the possible natural long term variability in plankton community composition and the intermittent and variable operation of the FSRU, which depends on uncertain national and State energy supply options and State energy demands in the near future and over the next decades. Further investigations are recommended to document the distributions of marine ecosystem components in the vicinity of the discharge, including planktonic populations, which were previously systematically documented more than 40 years ago. Further modelling is also recommended to determine residence times and the proportions of entrainment for different operational scenarios of the FSRU at Crib Point to further inform estimation of longer term effects of entrainment.

AGL is committed to further marine environmental studies prior to operation and is presently considering:

- Benthic invertebrate sampling to document the present characteristics and distribution of epibiota and infauna including targeted investigation to evaluate the existence of ghost shrimp species;
- Measurement of short-term and long-term water temperature variations to provide natural variation context for assessment of cold-water discharge differentials
- Refinement of North Arm hydrodynamic models to assist refinement of discharge dispersion models and entrainment estimation models
- Development of entrainment models for North Arm to provide plankton entrainment proportion contours
- A plankton and larval sampling program to provide information on spatial and temporal variations in plankton populations in North Arm focussing on the proposed location and position of the FSRU intake.
- Review of available literature on the effects of entrainment on semi-enclosed marine ecosystems to provide guidance on long-term ecosystem implications of plankton entrainment.

These studies will inform a works approval application under the *Environment Protection Act 1970* and in accordance with the relevant associated regulations, including the State Environment Protection Policy (Waters of Victoria).

[1] Percentage based on the area of North Arm which is greater than 10 m depth.

1 INTRODUCTION

1.1 Project overview

AGL Wholesale Gas Limited (AGL) is proposing to develop a Liquefied Natural Gas (LNG) import facility, utilising a Floating Storage and Regasification Unit (FSRU) to be located at Crib Point on Victoria's Mornington Peninsula. The project, known as the "AGL Gas Import Jetty Project" (the Project), comprises:

- The continuous mooring of the FSRU at the existing Crib Point Jetty, which will receive LNG carriers of approximately 300m in length
- The construction of ancillary topside jetty infrastructure (Jetty Infrastructure), including high pressure gas unloading arms and a high pressure gas flowline mounted to the jetty and connecting to a flange on the landside component to allow connection to the Crib Point Pakenham Pipeline Project.

Jacobs Group (Australia) Pty Ltd (Jacobs) was engaged by AGL to undertake planning and environmental assessments for the AGL Gas Import Jetty Project. Jacobs engaged CEE Environmental Scientists and Engineers to define the marine environmental characteristics and identify key potential risks to the marine environment from the development and operation of the Project.

There are several other activities that are related to the AGL Gas Import Jetty Project. These include the Jetty Upgrade and the Crib Point to Pakenham Gas Pipeline Project which are the subject of separate assessment and approval processes carried out by separate entities.

Jacobs engaged CEE to define the marine environmental characteristics with respect to protected matters legislation and identify key potential risks to the marine environment from the development and operation of the Project.

1.2 Introduction to Western Port marine environment

Western Port is a diverse but compact marine environment. It comprises vast intertidal mudflats with saltmarsh, seagrass and mangrove habitats as well as steep subtidal sloping banks with seagrass and deep channels that connect the north of the bay with the oceanic waters of Bass Strait in the south (Figure 1).

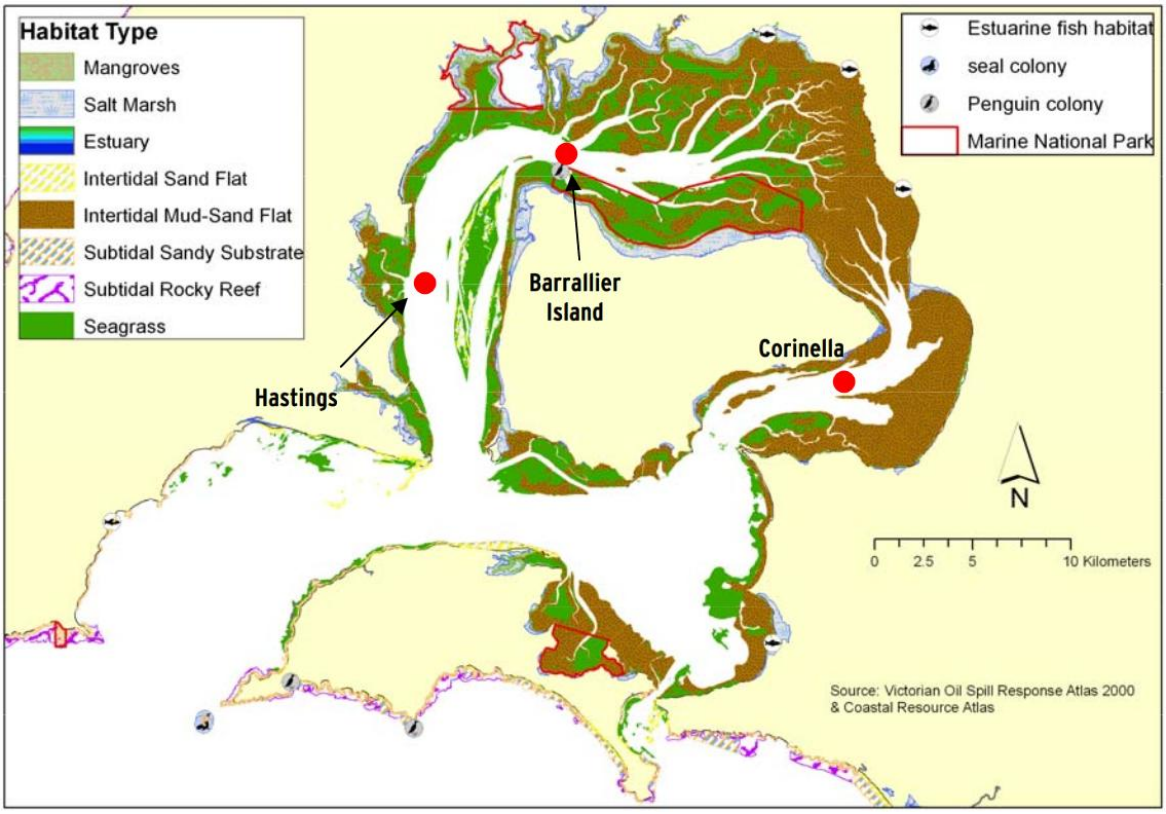

Figure 1. Marine habitat distribution in Western Port
(Red dots are EPA water quality monitoring sites)

The distribution of habitats (Figure 2) and conceptual model of the marine ecosystem in the vicinity of Crib Point (Figure 3) are based on CEE's understanding of the distribution and characteristics of North Arm from previous reviews and studies (Bok et al 2017, CEE 2009 and 2014, EPA 1996 and 2001, Kimmerer and McKinnon 1987a and 1987b, Melbourne Water 2011, Ministry for Conservation 1975). The figures show that the FSRU is more than 500 m offshore from intertidal and nearshore marine ecosystem components and is located in an area of the channel characterised by plankton, pelagic marine species and soft seabed invertebrate communities.

The ecosystem components associated with the habitats are closely connected by their relatively close spatial proximity and the strong tidal currents that transport water back and forth through the channels and over and off the intertidal flats.

These characteristics contribute to the listing of a large part of Western Port as a Ramsar wetland of international significance and the allocation of distinct areas as National Parks. Many of the animal and plant species are not specifically protected or listed for conservation value, but the combination mangroves and seagrasses, saltmarsh, fish, birds, crustaceans, worms and other strange invertebrates all form the Western Port marine ecosystem that is valued by the public.

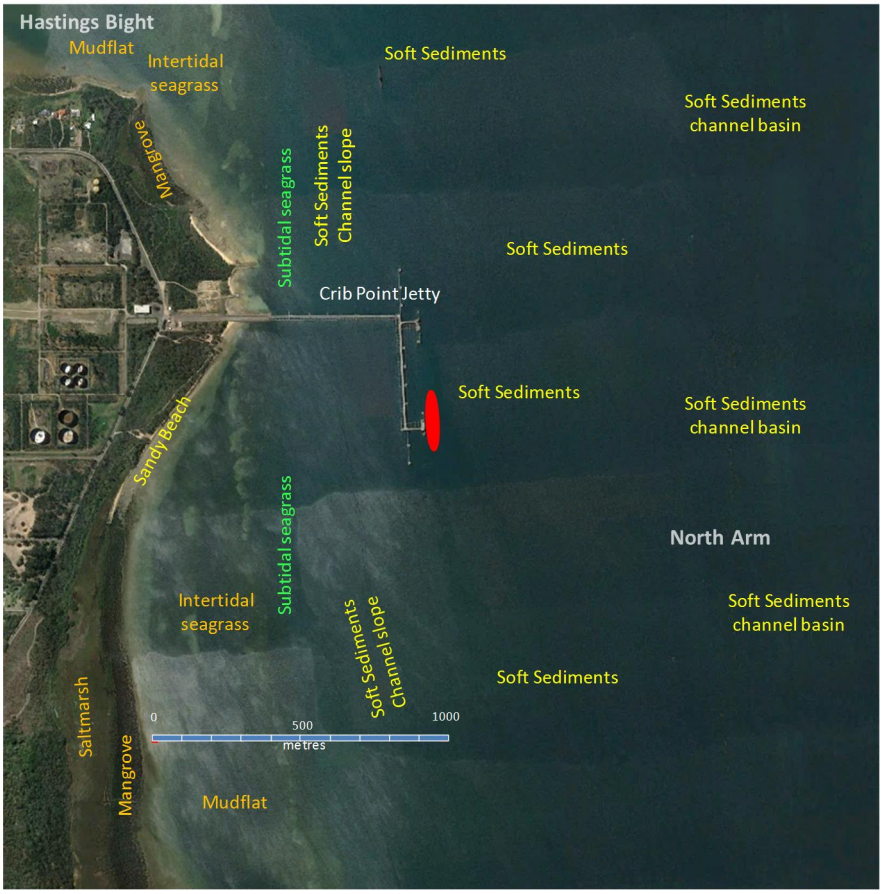

Figure 2. Natural marine ecosystem components at Crib Point
(Position of FSRU shown in red)

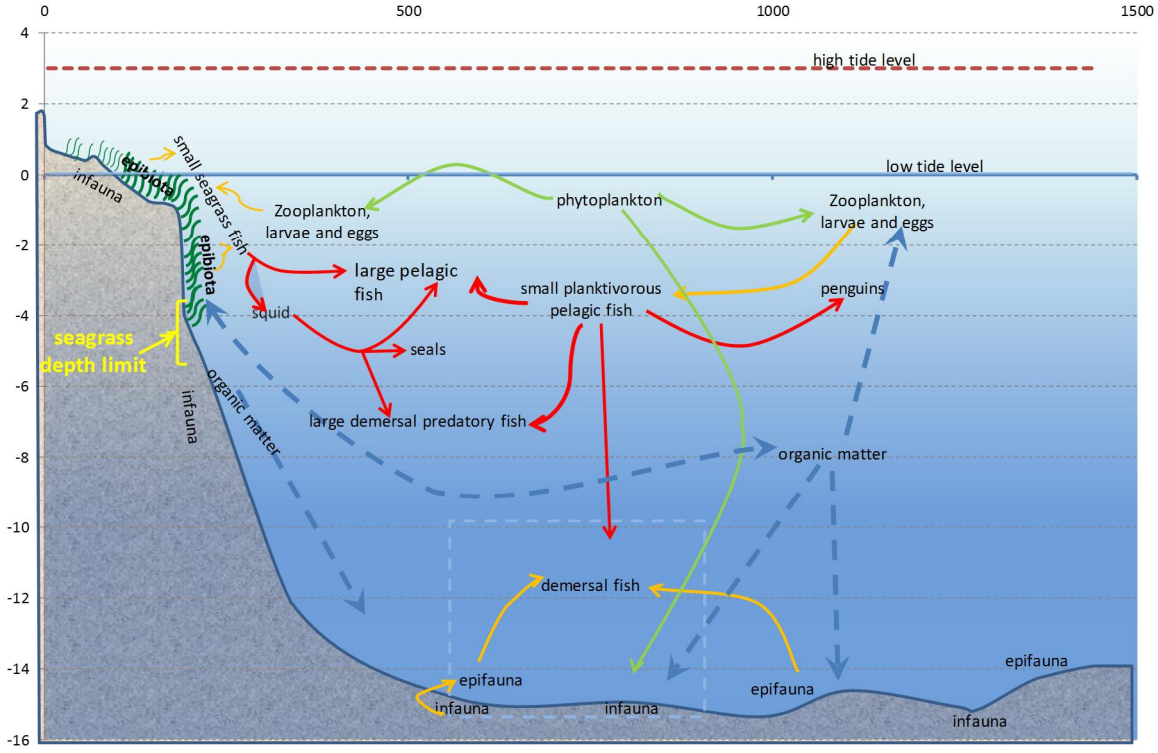

Figure 3. Conceptual model of Western Port marine ecosystem in Crib Point area

1.3 Purpose of this report

The purpose of this assessment is to provide a review of marine environmental matters protected under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the State *Flora and Fauna Guarantee Act 1988* (FFG Act) that may be affected by the Project. The report examines the impact pathways of the Project and assesses the associated risks to protected marine species.

This report has been prepared in support of:

- A referral under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act),
- A referral under the Victorian *Environment Effects Act 1978*, and
- Identification of requirements under the Victorian *Flora and Fauna Guarantee Act 1988* (FFG Act).

The report is expected to inform the preparation of a works approval application to be submitted to the Environment Protection Authority under the *Environment Protection Act 1970* and in accordance with the relevant associated regulations, including the State Environment Protection Policy (Waters of Victoria).

1.4 Scope

The scope of this study was to review relevant Commonwealth and State legislation for marine protected areas, protected marine species (flora and fauna, excluding birds and terrestrial fauna) and listed processes that may be relevant to the Project.

Terrestrial flora and fauna and waterbird species are not within the scope of this assessment. These aspects are addressed in the *Flora and Fauna Assessment Report* (Jacobs, 2018a).

Information on protected matters have been compiled from various sources including State and Commonwealth government web sites and publications and information from other development projects in the region.

2 LEGISLATIVE INSTRUMENTS

The key legislative instruments that this Protected Matters report addresses for the purposes of informing marine ecosystem descriptions in referral documents are described below. These matters are relevant to impact assessment under the EPBC Act, the EE Act and FFG Act.

2.1 Commonwealth EPBC Act 1999

The Commonwealth EPBC Act is a wide ranging legislative instrument that provides legal protection of the environment, particularly those features of Australia's environment, biodiversity and heritage that are listed matters of national environmental significance (MNES). The EPBC Act lists nine MNES and three of these are relevant to the Project:

- Wetlands of International Importance (listed under the Ramsar Convention)
- Listed threatened species and ecological communities
- Migratory species protected under international agreements

The Commonwealth Department of the Environment and Energy (DoEE) provides the Protected Matters Search Tool that facilitates searches of the Department's database for MNES in the area of a development.

The Commonwealth provides Guidelines to determine whether an action (project) is likely to have a significant impact on a MNES ("Significant Impact Guidelines") or whether an action constitutes a listed key threatening process, or entails processes known to be a threatening process for specific listed species or places.

2.2 Environment Effects Act 1978

The EE Act requires consideration to be given to projects which have significant impacts on the Victorian environment as described in the Act.

A project with potential adverse environmental effects that, individually or in combination, could be significant in a regional or State context should be referred. The criteria for referral are provided in the *Ministerial Guidelines for Assessment of Environmental Effects under the Environment Effects Act 1978* (Ministerial Guidelines).

The Ministerial Guidelines include referral criteria for:

- *potential long-term change to the ecological character of a wetland listed under the Ramsar Convention or in 'A Directory of Important Wetlands in Australia'*
- *potential extensive or major effects on the health or biodiversity of aquatic, estuarine or marine ecosystems over the long term*
- *potential long-term loss of a significant proportion (e.g. to 1 to 5 percent depending on the conservation status of the species) of known remaining habitat or population of a threatened species within Victoria*
- *matters listed under the FFG Act 1988 including:*
  - *potential loss of a significant area of a listed ecological community; or*
  - *potential loss of a genetically important population of an endangered or threatened species (listed or nominated for listing), including as a result of loss or fragmentation of habitats; or*
  - *potential loss of critical habitat; or*

- *potential extensive or major effects on beneficial uses of waterbodies over the long term due to changes in water quality.*

· potential extensive or major effects on beneficial uses of waterbodies over the long term due to changes in water quality

The Ministerial Guidelines provide guidance on the matters to be considered in determining the extent to which the Project is capable of having a significant effect on the environment.

2.3 Victorian FFG Act 1988

The Victorian FFG Act 1988 – sets out its objectives in section 1, Purpose:

> *"The purpose of this Act is to establish a legal and administrative structure to enable and promote 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."*

The processes to assess the Act objectives are to list threatened flora and fauna, ecological communities and threatening processes, as well as declare areas of "critical habitat" essential to the survival of flora or fauna taxa or ecological communities. The Department of Environment, Land, Water and Planning (DELWP) provides Action statements for individual taxa or communities using risk-based prioritisation.

Under the Act, a potentially threatening process "means a process which may have the capability to threaten the survival, abundance or evolutionary development of any taxon or community of flora or fauna". A number of action statements have been prepared for key flora and fauna taxa. No areas of critical habitat have been declared under the Act.

A review of the listed species under the FFG Act (last updated March 2017) revealed that there are 25 listed species that may occur in the vicinity of the Project at Crib Point and one protected community (San Remo Marine Community, around 23 km from the Project Site). Furthermore, aspects of the Project involving the ongoing operation of the FSRU within the Port require management and mitigation in order to avoid FFG listed threatening processes:

· Input of petroleum and related products into Victorian marine and estuarine environments;
· The discharge of human-generated marine debris into Victorian marine or estuarine waters; and
· The introduction of exotic organisms into Victorian marine waters.

3 MARINE ENVIRONMENT PROTECTED MATTERS

The DoEE Protected Matters Search Tool was used by CEE marine environmental scientists in September 2017 to list MNES within a 10 km radius of the Project Site at Crib Point, which includes all of North Arm of Western Port as well as the Western Entrance to Western Port (Figure 4).

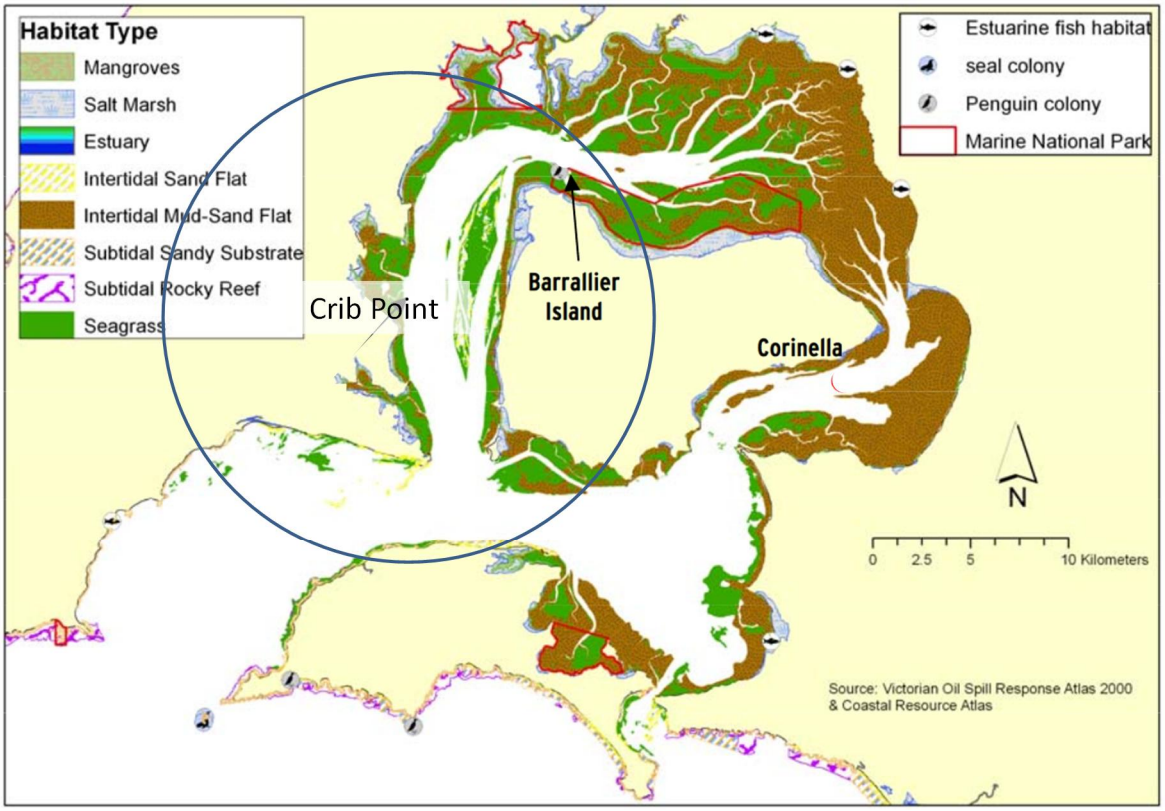

Figure 4. Protected Matters Search area

In practise, the Search Tool includes species that may occur over a substantially wider area than the nominated search perimeter. Hence a 10 km search radius was considered to be a conservative area for potential extent of the Project impact pathways on the marine environment in the vicinity of Crib Point. The search Summary table from the EPBC Act Protected Matters Report relevant to the marine environment is reproduced in Table 2.

Table 2. Summary of marine Protected Environmental Matters within 10 km of Crib Point

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	2
Listed Threatened Species:	59
Listed Migratory Species:	55

The results of this search returned four marine matters of national environmental significance within a 10 km radius of Crib point:

1. One wetland of International Importance: the Western Port Ramsar site
2. Two listed threatened ecological communities
3. Almost 60 listed threatened species
4. More than 50 listed migratory species

CEE environmental scientists screened the listing to determine: the relevance of each listing to the marine environment (excluding waterbirds and waders) and; the likelihood of occurrence of the species or community within the search area. The screening assessment revealed that:

1. The listed threatened ecological communities were the terrestrial communities and not within the scope of the marine assessment;
2. The listed threatened species included terrestrial biota, various bird species including waterbirds, shorebirds, waders and oceanic albatrosses and petrels. Six of the threatened species were considered to be endangered or vulnerable 'marine' species for further assessment.
3. The listed migratory species included various bird species including waterbirds, shorebirds, waders and oceanic albatrosses and petrels. Twelve of the listed migratory species were considered to be migratory 'marine' species (excluding birds) protected under international agreements for further assessment in this document.

4 WESTERN PORT RAMSAR SITE

The Western Port Ramsar site was designated as a wetland of international significance in 1982. The Ramsar site covers 59,950 ha of Western Port including Crib Point (Figure 5). Western Port is one of eleven Victorian Ramsar sites and the third most important area for wading birds in Victoria. All Ramsar sites are MNES under the EPBC Act. Ramsar areas are wetlands of international importance to waterbirds in any season.

Figure 5. Western Port Ramsar site

The Convention on Wetlands of International Importance especially as Waterfowl Habitat is a treaty negotiated between 18 countries and a number of NGOs at Ramsar, Iran in 1971. Australia became a Contracting Party in 1974 and the Ramsar Convention as it is now known entered into force in 1975. The Ramsar Convention established the criteria for declaring a site a Wetland of International Importance, which now include nine criteria covering species, ecological communities, waterbirds, fish and other taxa. The Ramsar Convention encourages signatory countries to designate wetland sites in order to conserve

their ecological, botanical, zoological, limnological or hydrological importance. By listing a Ramsar site, countries agree to establish and oversee a management framework to conserve a wetland and ensure its wise use.

The current management plan for the Western Port Ramsar site was released by DELWP in 2017. The Western Port Ramsar site comprises a large area of shallow intertidal mudflats, deep channels and some narrow strips of coastal land. The site includes all areas of Western Port north of a line between Point Leo (Mornington Peninsula) and Observation Point (Phillip Island) and a line between Newhaven and San Remo (The Narrows).

Western Port meets seven of the nine criteria for designation as a Ramsar site, as reviewed by KBR (2010) and DELWP (2017), and listed in the Australian Wetlands Database:

- Criterion 1: Western Port is a particularly good example of a natural wetland marine embayment with extensive intertidal flats, mangroves, saltmarsh, and seagrass beds within the South East Coastal Plain bioregion. Western Port is also a very good example of a saltmarsh-mangrove-seagrass wetland system.
- Criterion 2: The site supports the fairy tern which is a species of global conservation significance, in addition to the dense leek-orchid which is listed as vulnerable under the EPBC Act. Saltmarsh vegetation within the site provides important habitat for the orange-bellied parrot, listed as critically endangered under the EPBC Act.
- Criterion 3: Western Port is one of the most important areas for migratory waders in south-east Australia with wader surveys indicating that the Ramsar site supports up to 39 species, and includes 10 000 to 15 000 summer migrants (approximately 12 to 16 per cent of the Victorian population). It also supports seagrass and mangrove communities that are characteristic of the marine embayments of Southern Victoria.
- Criterion 4: The Ramsar site is one of the three most important areas in southeast Australia for migratory waders in total numbers and density. The site also provides important overwintering habitat for the orange bellied parrot. It also provides a number of important high tide roosts and breeding habitat.
- Criterion 5: The Ramsar site regularly supports about 10 000 to 15 000 migratory waders, and periodically supports 1000 to 3000 ducks and 5000 to 10 000 Black Swans.
- Criterion 6: The Ramsar site regularly supports more than one per cent of the estimated flyway population of five wader species. The site also regularly supports internationally significant numbers of several non-wader species.
- Criterion 7. Not considered applicable in KBR (2010) and DELWP (2017) reviews
- Criterion 8: Seagrass beds within the Ramsar site are known to provide important nursery habitat for a number of fish species, including commercially significant species.
- Criterion 9. Not considered applicable in KBR (2010) and DELWP (2017) reviews

In addition to fulfilling the majority of the Ramsar criteria for designation, Western Port contains a large number of Wetland Habitat types recognised under the Ramsar Convention. Wetland habitats include:

- Marine subtidal aquatic beds; such as seagrass and algae beds, including near Crib Point
- Rocky marine shores; such as the intertidal and subtidal rocky reefs
- Estuarine Waters; such as the areas around the mouths of the rivers and creeks that drain into Western Port
- Intertidal mud, sand or salt flats; such as the extensive vegetated and unvegetated mud and sand flats, including around Crib Point
- Intertidal forested wetlands; such as the extensive fringing mangroves around the north and west shores of Western Port, including near Crib Point. The White Mangroves (*Avicennia marina*) found in Western Port are the most southerly mangroves in the world.

- Intertidal marshes; such as the salt marshes behind the Mangroves in Western Port, including near Crib Point

The management plan for the Western Port Ramsar Site (DELWP, 2017) identified 17 priority threats to the values of Western Port as a Ramsar Site. Three of these threats are relevant to the Project:

- Invasive species: introduced marine pests (current and potential new invasions)
- Climate change: sea level rise
- Climate change: increased frequency and intensity of storms leading to shoreline erosion
- Climate change: increased frequency and intensity of storms leading to increased sediments

Industrial development resulting in habitat removal and associated impacts as well as emissions of toxicants from rural, agricultural and urban areas were also identified as priority threats. The Project does not involve removal of habitat within the Ramsar boundaries.

The management plan also identifies management strategies for protecting the Western Port Ramsar site. Those with most relevance to the Project are:

- 3.6 Develop and implement a strategic approach to development in areas adjacent to the Ramsar site that consider the cumulative impact of multiple actions on ecological character
- 3.14 Develop and implement a marine pest strategy for Western Port.

These two strategies have not yet been developed or published. An action statement on the introduction of exotic organisms into Victorian marine waters was produced under the FFG Act in 2004 and is discussed in section 5.5.1 of this report.

The high environmental, social and economic worth of Western Port is recognised further through the declaration of Western Port as an UNESCO Biosphere reserve and the presence of several Marine National Parks within the Ramsar site (Churchill Island, French Island, Yaringa, see Figure 6).

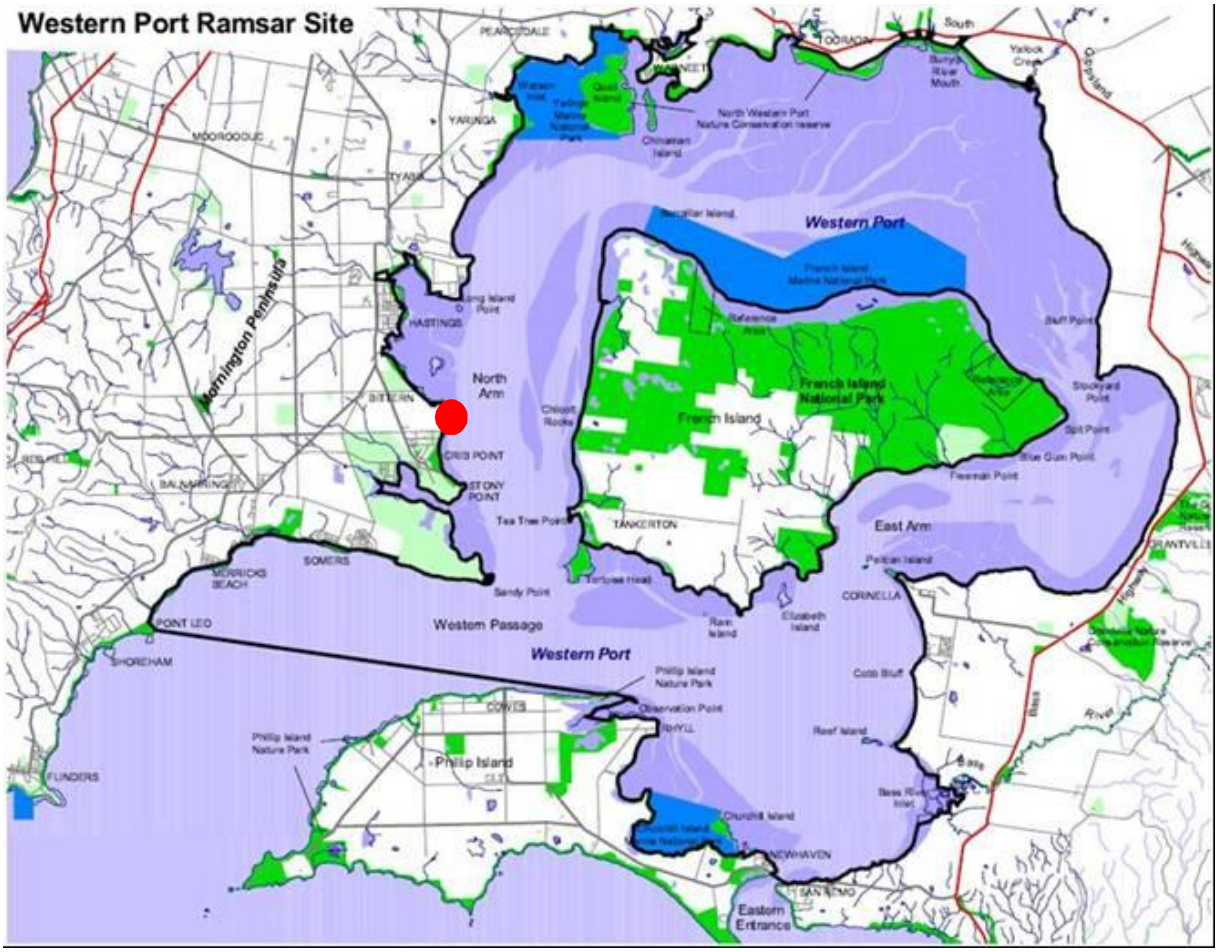

Figure 6. Marine National Parks within and adjacent to Western Port Ramsar site
Crib Point Jetty circled red.
Ramsar area bordered in black.
Marine National Parks are blue areas. Terrestrial National Parks and reserves are green areas.
(Source: "Western Port Ramsar site. Strategic management plan." DSE 2003)

4.1 Areas important for waterbirds

As discussed above, Criteria 3 to 6 of the nine criteria for designation as a Ramsar site directly relate to waterbirds, including wader and non-wader migratory and flyaway species.

The key areas used by waterbirds in the Western Port Ramsar area are shown in Figure 7. The figure shows that all of the intertidal mudflats of the Western Port Ramsar area are considered to be suitable foraging area for waterbirds. Primary foraging areas for waterbirds extends over the intertidal mudflats to the north of Crib Point, while mudflats to the south of Crib Point are rated as secondary foraging areas. The closest roosting sites are located more than 4 km from Crib Point at Long Island Point to the north, or across North Arm at Fairhaven on French Island. The next closest roosting site is located at Sandy Point more than 6 km south of Crib Point. Effects of the Project on waterbird species is assessed in the "Flora and Fauna Assessment Report" (Jacobs, 2018a).

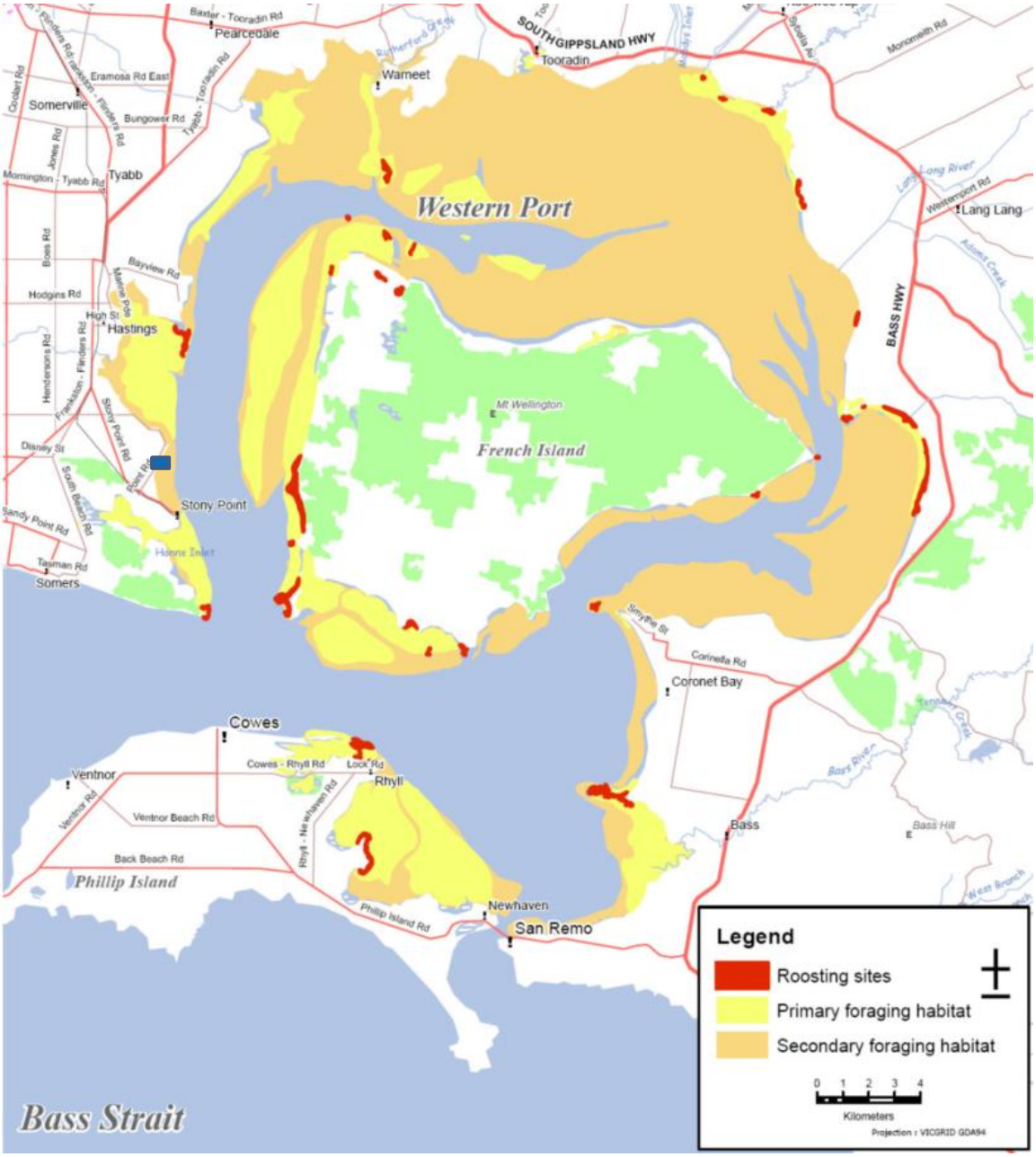

Figure 7. Key roosting, feeding and breeding habitat for waterbirds in Western Port (Hansen, Menkhorst and Loyn 2011)

The most commonly identified threats to wading birds in Western Port were listed (Hansen et al 2011) as:

- Habitat loss and modification
- Disturbance from beach users (walkers, joggers, dog walkers, etc.)
- Disturbance from water users (fishing, sailing, personal water craft and similar)
- Nest loss (trampling, storm or tidal inundation)
- Bird injury &/or mortality (predation, collision with vehicles or vessels, tangling in fishing line)
- Competition
- Aircraft activity.

5 EPBC ACT AND FFG ACT MARINE PROTECTED SPECIES

There are 33 threatened and migratory species listed under the EPBC Act and FFG Act that may occur in the vicinity of the Project at Crib Point, as shown in Table 3.

Table 3. Protected species in region of Crib Point Jetty (at September 2017)

Common name	Scientific name	EPBC	FFG
Mammals			
Blue Whale	*Balaenoptera musculus*	Endangered, Migratory	Listed
Southern Right Whale	*Eubalaena australis*	Endangered, Migratory	Listed
Humpback Whale	*Megaptera novaeangliae*	Vulnerable, Migratory	Listed
Brydes Whale	*Balaenoptera edeni*	Migratory	
Pygmy Right Whale	*Caperea marginata*	Migratory	
Killer Whale	*Orcinus orca*	Migratory	
Dusky dolphin	*Lagenorhynchus obscurus*	Migratory	
Burrunan Dolphin	*Tursiops australis*	Listed marine (NA)	Listed
Sharks			
White shark	*Carcharodon carcharias*	Vulnerable, Migratory	Listed
Grey nurse shark	*Carcharius taurus*		Listed
Mackerel Shark	*Lamna nasus*	Migratory	
Freshwater/Marine Migratory Fish			
Australian grayling	*Prototroctes maraena*	Vulnerable	Listed
Australian mudfish	*Neochanna cleaveri*		Listed
Marine Fish			
Mangrove Goby	*Mugilogobius platynotus* *M paludis***		Listed
Southern Bluefin Tuna	*Thunnus maccoyii*		Listed
Australian Whitebait	*Lovettia sealii*		Listed
Reptiles			
Leatherback Turtle	*Dermochelys coriacea*	Endangered, Migratory	Listed
Loggerhead Turtle	*Caretta caretta*	Endangered, Migratory	
Green Turtle	*Chelonia mydas*	Vulnerable, Migratory	
Marine Invertebrates			
Southern hooded shrimp	*Athanopsis australis*		Listed
Ghost shrimp	*Pseudocalliax tooradin*		Listed
Ghost shrimp	*Michelea microphylla*		Listed
Brittle star	*Amphiura triscacantha*		Listed
Sea-cucumber	*Apsolidium densum*		Listed
Sea-cucumber	*Apsolidium handrecki*		Listed
Brittle star	*Ophiocomina australis*		Listed
Sea-cucumber	*Pentocnus bursatus*		Listed
Sea-cucumber	*Thyone nigra*		Listed
Sea-cucumber	*Trochodota shepherdi*		Listed
Chiton	*Bassethullia glypta*		Listed
Opisthobranch	*Platydoris galbana*		Listed
Opisthobranch	*Rhodope* genus		Listed
Stalked Hydroid	*Ralpharia coccinea*		Listed

* Pipefish and seahorses that occur in lists in the EPBC Act are not relevant to this project. The list applies only to Commonwealth waters and Commonwealth agency proponents.

**Flatback or Pale mangrove goby is listed as *Mugilogobius paludis* in FFG, but is more correctly known as M *platynotus*

Each species listed under the EPBC Act or FFG Act is discussed below. Those species listed on both the EPBC Act and FFG Act are discussed first, followed by those species listed only on the FFG Act and not the EPBC Act.

5.1 Endangered species

The DoEE PMST identified that four endangered marine species may occur in the Western Port region: the Blue Whale, the Southern Right Whale, the Leatherback Turtle and the Loggerhead Turtle. Both whale species and the Leatherback Turtle are also listed under the FFG Act. Most of these species are unlikely to occur near Crib Point, except on very rare diversions from their regular migratory pathways. However, they are discussed below to thoroughly assess the potential impacts and demonstrate that that the Project at Crib Point presents negligible risk to these species.

5.1.1 Blue Whale

The Project Site at Crib Point is remote from Blue Whale aggregation areas and plausible migration pathways. It is highly unlikely that Blue Whales would enter the North Arm of Western Port. Overall, it is highly unlikely that the processes associated with the Project would have any effect on Blue Whales. The nearest record is for a decayed specimen that washed up on Flinders Beach (whales often drift great distances at sea after death). There are records of sightings offshore from Cape Schanck and east of Wilsons Promontory, but none in the vicinity of Western Port.

Blue Whales are the largest of whales growing to 33 m in length, with an average size of 25 m. Research at Deakin University (Dr Peter Gill) has shown that there is a population of Blue Whales which is resident for the summer period in western Victorian waters (Figure 8).

This population of Blue Whales is slightly smaller than their northern hemisphere counterparts and is therefore sometimes referred to as ‘pygmy’ Blue Whale. This term tends to misrepresent the members of the southern Australian population whose size of 22 m is substantially larger than other whale species in the region such as the Southern Right Whale (17 m) and Humpback Whale (15 m).

The southern Australian population of Blue Whales feed on krill in western Victorian and eastern South Australian waters over summer (Figure 8). The migration path of this population has not been established. It may migrate eastward and up the east Australian coast with the Eden population to spend winter in areas of productive southern Pacific tropical seas, or westward and up the West Australian coast with the Rottnest population.

The south-eastern Australian population of Blue Whales is small in number (probably around 50 individuals). The worldwide number of Blue Whales is also very small and so the southern Australian population forms a significant proportion of the world’s total population. The migration paths of the south-eastern Australian population have not been documented. It is likely that some individuals may pass through central Bass Strait during autumn and spring migrations between the Portland region and the tropics, including past the entrances to Western Port. These large whales generally inhabit deeper, offshore waters and will pass a considerable distance offshore from the coastline, and it is highly unlikely that they would enter the relatively shallow waters of Western Port.

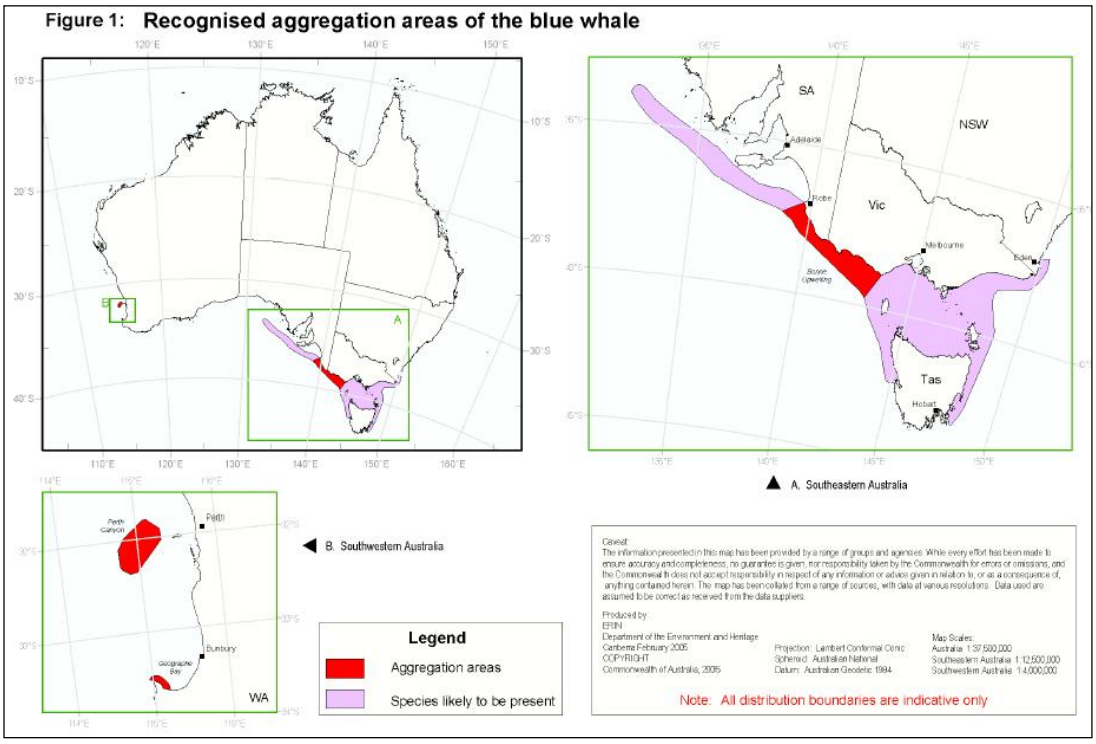

Figure 8. Distribution of Blue Whales
(Source: *Blue, Fin and Sei, Whale Recovery Plan,* DEWR)

5.1.2 Southern Right Whales

Southern Right Whales are encountered seasonally in Bass Strait, more frequently in western Bass Strait where they calve and intermittently in central Bass Strait. Southern Right Whales may pass close to the shore all along the central Victorian region including past the entrances to Western Port. Southern Right Whales have been sighted in Western Port, with two records in the vicinity of Crib Point, but the bay is not known to be an aggregation or breeding area for these whales. The distribution and recognised aggregation areas of the Southern Right Whale is shown in Figure 9.

Southern Right Whales are large whales measuring up to 17.5 m. They migrate each year from summer feeding grounds in the subantarctic to calve and mate in warmer waters off the southern Australian coast during winter. Southern Right Whales were hunted to near extinction by the early 1900's, but the number has slowly recovered resulting in increasing numbers of sightings along parts of the southern Australian coastline during winter and spring. The Australian total population of Southern Right Whales is estimated to be 800. Since the 1970's Southern Right Whale sightings along the Victorian coast have increased significantly (Warneke 1995), but the trend has not been quantified. The actual number of whales visiting Victoria is a very small fraction of the main population which over-winters along the coasts of South Australia and Western Australia.

In Victoria, pregnant females generally arrive in May-June and depart with their calves in October-November. Females with young calves may be found anywhere along the coast from Gabo Island in the east to Cape Bridgewater in the west, but most sightings are west of Port Phillip Bay. There is a major maternity site at Logans Beach, Warrnambool. Southern Right Whales may enter Western Port's western entrance and are observed from vantage points and wildlife cruises along Phillip Island's northwest, west and southern coast (Figure 13).

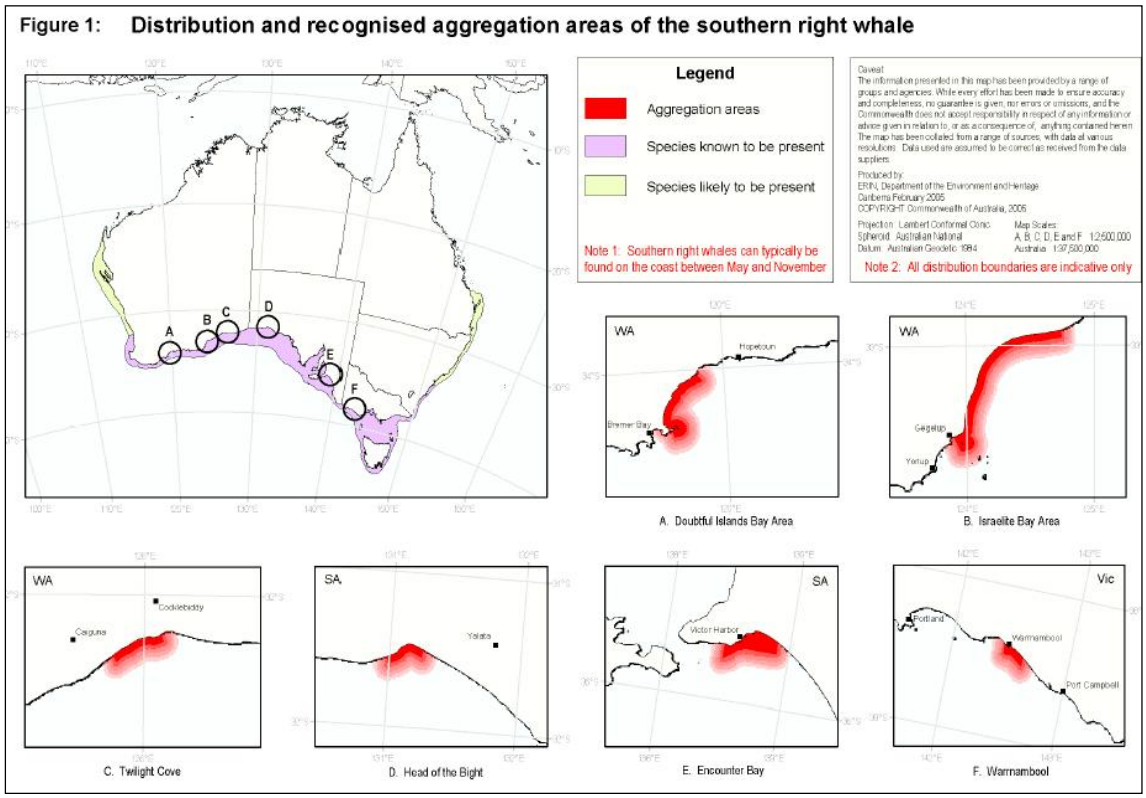

Figure 9. Distribution of Southern Right Whales
(Source: *Southern Right Whale Recovery Plan,* DEWR)

5.1.3 Leatherback Turtle

The Leatherback, Leathery, Luth or Trunkback Turtle (*Dermochelys coriacea*) is the largest of all the marine turtles and grows to 1.7 m long (carapace) and 600 kg. Leatherback Turtles pre-date other marine turtles by around 65 million years, they have inhabited the oceans for around 100 million years. The Leatherback Turtle is migratory and has a worldwide distribution in tropical, temperate and sub-polar waters down to 10°C. The Leatherback Turtle is listed as critically endangered under the Victorian FFG Act.

Adults live in ocean habitats and rarely come close to shore in Australia. Breeding occurs on tropical islands throughout the world. Leatherbacks found around Australia are understood to breed in the islands of Indonesia, Papua New Guinea, Torres Strait and Arnhem Land. The species is migratory, travelling thousands of kilometres between breeding and foraging areas. Leatherback Turtles feed mostly on pelagic invertebrates such as jellyfish and Bass Straight has one of the three largest concentrations of feeding Leathery Turtles in Australia. In Victoria, Leatherback Turtles are most commonly seen between April and May, when the waters of Bass Strait are warmest. Sightings and strandings have been recorded all along the Victorian Bass open coast, Port Philip Bay and the Gippsland Lakes (Figure 10). There are no records from Western Port, however there have been numerous sightings nearby, including around Port Phillip Heads.

The Leatherback Turtle is considered critically endangered worldwide, vulnerable under the EPBC Act and critically endangered in Victoria (DSE, 2007), though it is listed as threatened under the FFG Act. The key threat to the species, as for many turtles, is human disturbance of breeding habitats and harvesting of eggs. Leatherback Turtles do not nest in Victoria. Other threats include by-catch in commercial fisheries, and in Victoria the key by-catch threat is entanglement in cray pot buoy lines. Ingestion of marine debris is also a concern,

particularly of plastics, as Leathery Turtles tend to feed along drift lines where debris accumulates.

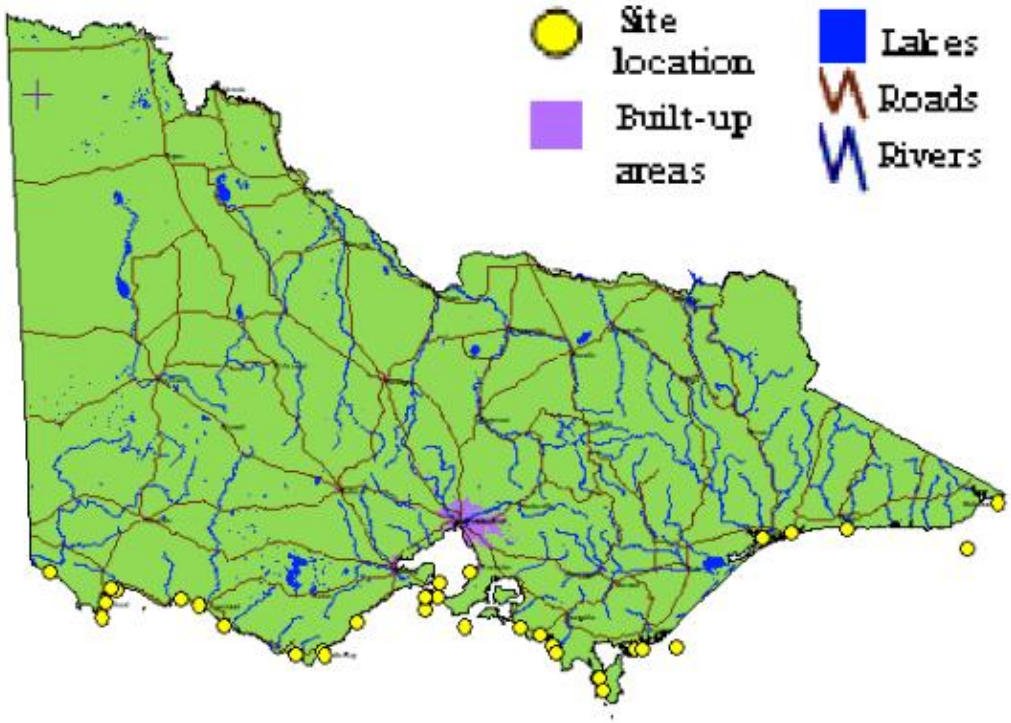

Figure 10. Sightings of Leatherback Turtles in Victoria (DSE, 2007)

5.1.4 Loggerhead Turtle

The Loggerhead Turtle (*Caretta caretta*) is smaller than the Leatherback Turtle at around 1 m carapace length. They inhabit primarily tropical and subtropical seas, though it is thought likely they occasionally occur in south-east Australia in the warmer months. Loggerhead Turtles are carnivorous, feeding on crabs, sea-urchins and jellyfish. There are two distinct populations in Australia, one which nests along the northwest coast of Western Australia and one that nests on islands and coasts of the southern Great Barrier Reef. Nesting does not occur in Victoria.

The key threats to Loggerhead Turtles are similar to those for Leatherback Turtles – they include threats to nesting success and commercial fishery by-catch mortality. Predation of eggs by foxes on mainland beaches is a key problem in Western Australia and Queensland. Mortality as fishery by-catch is a problem throughout their tropical and sub-tropical foraging range, with entanglement in lobster-pot buoy lines, long lines, and ghost nets the key issues.

There are 13 records of Loggerhead Turtles in Victoria (Atlas of Living Australia, 2017), the majority of which were recorded on the Victorian coastline west of Melbourne (Figure 11). Seven were of dead specimens and most others were live beach strandings. There are no records from Western Port.

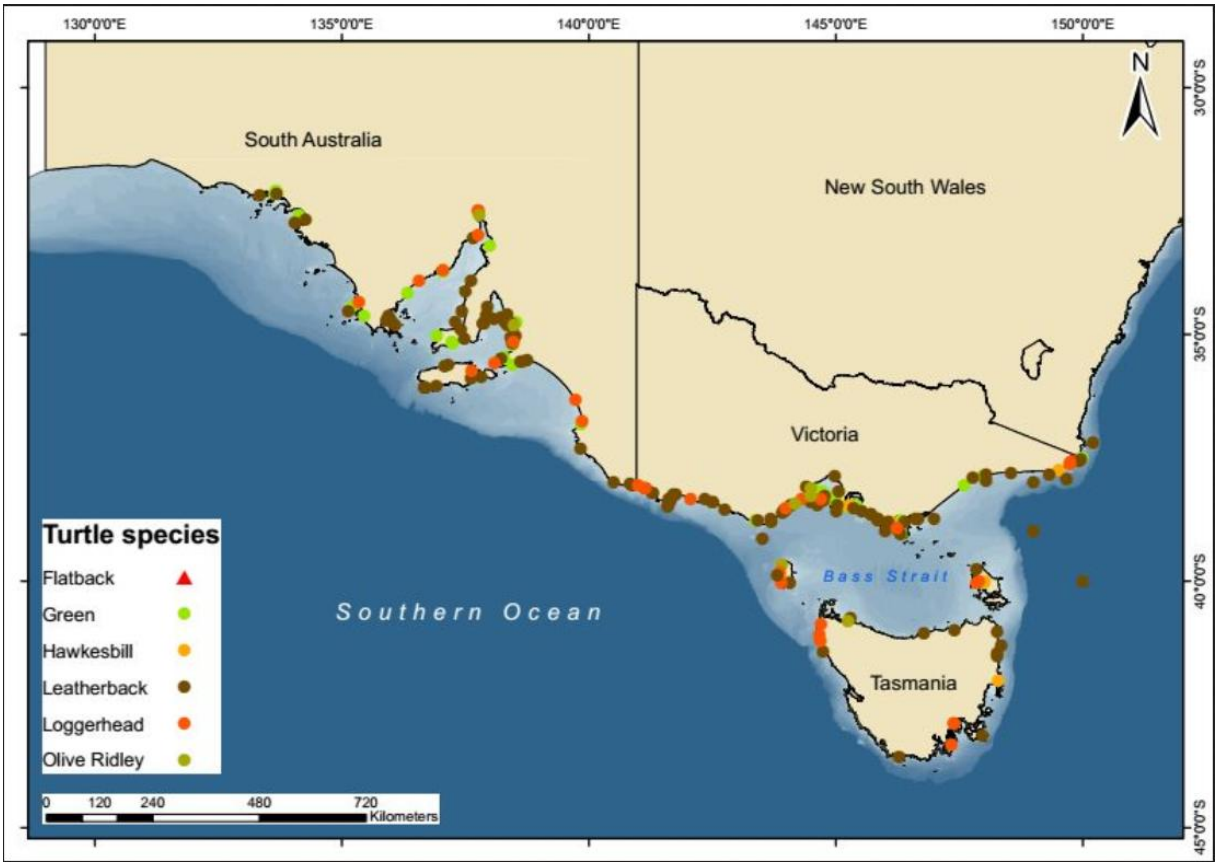

Figure 11. Turtle sightings in Southeastern Australia
(https://cie-deakin.com/about-sast/)

5.2 Vulnerable species

The DoEE PMST identified four vulnerable marine species that may occur in the Western Port region: Humpback Whales; Great White Shark, Australian Grayling and Green Turtle. The Humpback Whale, Great White Shark and Australian Grayling are also listed under the FFG Act.

5.2.1 Humpback Whales

Humpback Whales are large whales growing to approximately 18 m and have a worldwide distribution. Central Bass Strait including Western Port is generally outside Humpback Whales' migratory path, and is not a feeding, breeding or calving area (Figure 12). However, humpback whales migrating up the western side of Tasmania and then eastward through Bass Strait may wander from their migratory path into Western Port from time to time, and there are records of Humpback Whales in Western Port as far north as Crawfish Rock (ALA, 2017). Whale records collated for the Two Bays Project (Figure 13) show that, a total of 175 humpback whales were sighted in winter close to Phillip Island since records commenced in 2002. Considering the small number of Humpback whales that may occur in the area, the extremely small proportion of the population that those individuals represent and the low likelihood of interaction with the Project, the risk to these whales is very low.

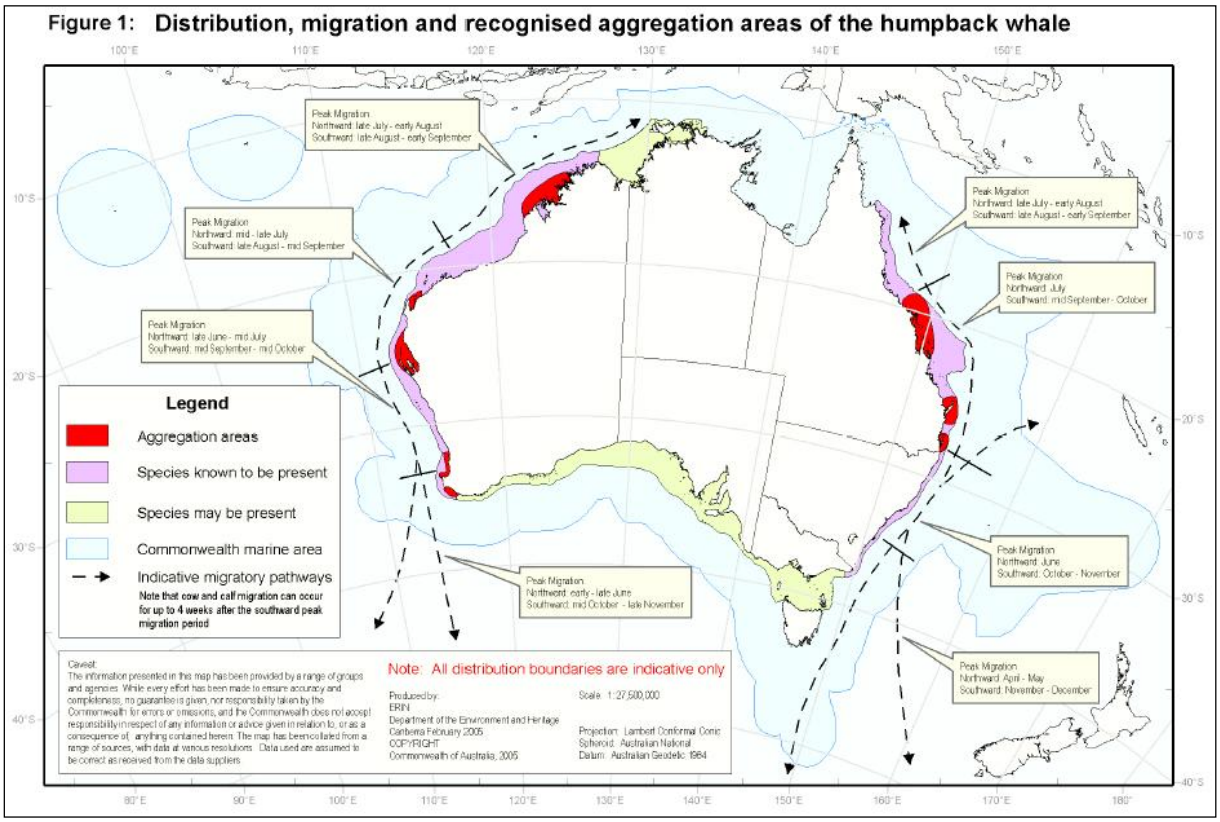

Figure 12. Distribution of Humpback Whales
(Source: *Humpback Whale Recovery Plan,* DEH)

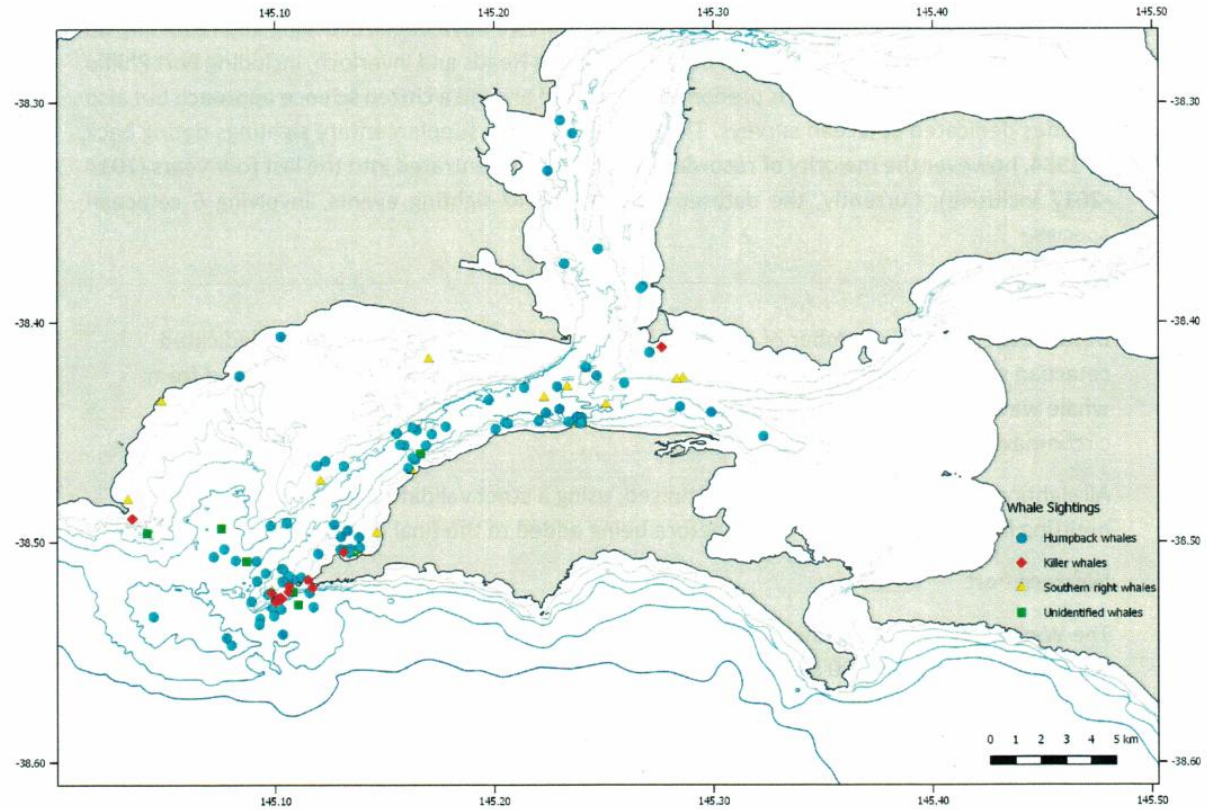

Figure 13. Whale sightings compiled for Two Bays Project 2014 to 2017
(Source: Victorian Dolphin Research Institute and Wildlife Coast Cruises)

5.2.2 White Shark

The key threats to White Shark (also known as Great White Shark) populations are commercial fishing, recreational fishing, shark control activities (beach meshing), trade (fins, jaws and teeth) and tourism (FFG Action Statement No. 185). The Project does not involve these threats, and it is unlikely that indirect effects of the development will detrimentally affect White Shark populations.

The White Shark is a very large shark. It occurs in all oceans of the world, including Bass Strait and Western Port. The seal breeding colony at Seal Rock at the Western Entrance to Western Port is a known feeding area for White Sharks and these sharks have been caught and observed in Western Port from time to time.

White Sharks are highly mobile with vast individual geographic ranges. Individuals typically remain resident in one locality only for periods of days or rarely weeks before moving to another area, according to observations of fishermen, divers and marine scientists. The breeding characteristics of whites is not known with "*only two pregnant females recorded in contemporary times*" (Last and Stevens 1994). White Sharks have been tagged with transmitters by various researchers including CSIRO. A shark (Neale) that was tagged near Corner Inlet in eastern Bass Strait travelled a total of 3,000 km over a 4 month period. The track included two Bass Strait crossings – probably east of Flinders Island – in the general region of Western Port. Neale's track concluded at Coffs Harbour in New South Wales. Other sharks have been tracked making repeat crossings of the Tasman Sea to New Zealand, and up and down the West and East Australian coasts. The risk to White Shark populations from the development and operation of the Project is considered to be negligible.

5.2.3 Australian Grayling

The Australian Grayling (*Prototroctes maraena*) is a small (300 mm long) freshwater fish that has larval and juvenile stages in the marine environment. The Bass River in south-eastern Western Port and the Bunyip River in north-eastern Western Port are the two most significant freshwater inputs to the Bay.

The population of the Australian Grayling has reduced substantially over the past 100 years. The current distribution is patchy over its former range from the Grose River west of Sydney throughout New South Wales, Victoria, eastern South Australia, Tasmania and on King Island in Bass Strait. In Victoria, Grayling are known to occur in most permanent rivers and streams with natural flow regimes, as well as rivers and streams with modified flow regimes (eg. Yarra, Barwon, Bunyip) and varying water quality. Large populations may occur in rivers in eastern Victoria such as the Tambo River. There appears to be some mixing between larval populations during their marine phase (*Crook* et al, 2006).

Studies have identified that in streams with modified flow regimes, such as the Bunyip River, provision of environmental flows timed to trigger spawning of Australian Grayling is likely to improve their populations (DELWP, 2016).

It is possible that larvae and juvenile Grayling disperse and migrate between freshwater streams in Western Port and Bass Strait via North Arm and the Western Entrance to Western Port. The importance of these pathways to the local Grayling populations is uncertain. The intake of seawater through the Crib Point regasification facility may entrain dispersing larvae and migrating juveniles and therefore may be considered to be a 'barrier to migration' (FFG Action Statement no. 257). Cold water and dilute biocide in the seawater discharged from the heat exchange system may also provide a thermal and chemical barrier for migrating juveniles and dispersing larvae.

The potential effects of these Project impact pathways is assessed in Section 6 of this report.

5.2.4 Green Turtle

The Green Turtle (*Chelonia mydas*) is a tropical species of turtle, and one of the most numerous of the seven turtle species found globally. It generally only occurs in waters where temperatures average 20°C or more, but may occasionally stray into temperate waters (following warm coastal currents) given its long migration ability. Their preferred habitat is coral reefs with abundant algae and seagrass beds, and adults are herbivorous. There are seven nesting populations in Australia, with all nesting occurring in tropical waters – from the southern Great Barrier Reef, around the Top End to the North West Shelf.

There are seven records of Green Turtles in Victorian waters, most of them for dead specimens found on beaches. There is one record of a dead Green Turtle on Reef Island in eastern Western Port.

Threats to the Green Turtle primarily relate to disturbance of nesting and foraging sites, collisions with boats and ships, habitat disturbance and by-catch in fishing operations.

5.3 Migratory species

The DoEE PMST identified that eight migratory marine species may occur in the Western Port region: The Blue Whale, Southern Right Whale, Humpback Whale, Bryde's Whale, Pygmy Right Whale, Dusky Dolphin, Killer Whale, White Shark and Mackerel Shark. In addition, three turtle species may occur in the Western Port region and are protected under the EPBC Act. Seven of these species are discussed in the preceding sections as they are also listed as endangered or vulnerable. The remaining five species are discussed below with reference to records in the Atlas of Living Australia.

5.3.1 Brydes Whale

Bryde's Whale is a large whale which grows to approximately 15 m and feeds on schooling fish such as anchovies and pilchards. It is generally confined to tropical and temperate waters from the equator to 40º north and south of the equator. In Australia it is mostly recorded from northern Western Australian waters and off Queensland. It is unlikely to occur frequently along the southern Australian coastline or in Bass Strait. There are no records of Brydes Whales in Western Port or Victorian waters.

5.3.2 Pygmy Right Whale

The Pygmy Right Whale is a small, planktivorous whale which grows to approximately 6.5 m length. It is widely distributed in the southern hemisphere. Pygmy Right Whales may be common in Bass Strait from time to time although they do not appear to follow seasonal migrations. There are a small number of observations near Warrnambool in Western Victoria, but none elsewhere in Victoria. There do not appear to be any significant breeding or feeding grounds for Pygmy Right Whales in the Western Port. A skull from the species was found near Cowes on Phillip Island.

5.3.3 Dusky Dolphin

The Dusky Dolphin is a relatively small dolphin that occurs in the southern hemisphere in cool waters from 26º S to 55º S. They may migrate southward in summer. There are no records of Dusky Dolphins in Victorian waters and there does not appear to be any significant breeding or feeding grounds for Dusky Dolphins in the Western Port area.

5.3.4 Killer whale

The Killer Whale is a moderate sized, predatory whale that is distributed throughout the oceans of the world. Small pods of Killer Whales are observed in Bass Strait from time to time including the area offshore from Western Port, particularly around Seal Rocks. There is one recorded sighting inside Western Port off Ventnor on Phillip Island.

Killer Whales eat a wide range of marine species including seals and penguins. It is not known whether Killer Whales are attracted to the breeding colonies of penguins and seals at Phillip Island, but they have been recorded at and near Seal Rocks by the Two Bays Project (Figure 13).

5.3.5 Mackerel Shark

The Mackerel Shark or Porbeagle (*Lamna nasus)* is a medium sized (up to 2 m and 230 kg) found throughout temperate seas around the world and in Australia from southern Queensland to southwest Australia. It primarily inhabits waters near the continental shelf where it feeds on pelagic fish and cephalopods (squid). The key threat to the Mackerel Shark is overfishing due to the high value of its fins, long life-span and low fecundity. It is prohibited to target Mackerel Sharks in Australian waters. The Mackerel Shark may occasionally, and temporarily enter coastal waters. There are no records from Victorian Coastal Waters or Bass Strait.

5.4 Additional FFG Act listings

5.4.1 Grey Nurse Shark

Grey Nurse Sharks are most unlikely to be found in the central Bass Strait region or in Western Port.

The Grey Nurse Shark is listed as vulnerable under the EPBC Act, with the east coast population being listed as critically endangered. The Grey Nurse Shark is listed under the FFG Act. There are no recent confirmed records of Grey Nurse Sharks in Victoria south of Mallacoota. The distribution of Grey Nurse Sharks (western and eastern populations) in Australia is widely considered to be confined to Western Australia, southern Queensland and the entire New South Wales coast (DoEE, 2014).

The key threats to the species relate to recreational and commercial fishing and shark netting of bathing beaches (FFG Action Statement no. 186).

5.4.2 Southern Bluefin Tuna

Southern Bluefin Tuna are most unlikely to be found in central Bass Strait or in Western Port.

This oceanic species is widely distributed in southern oceans from New Zealand to southern Africa and into the South Atlantic Ocean. It is the basis of a valuable fishing industry. Southern Bluefin Tuna prefer deep ocean waters or the productive waters of the continental slope. Hence, in Victoria, they are only found in western and eastern Victoria where the continental shelf is narrow. The key threat to Southern Bluefin Tuna is commercial fishing (FFG Action Statement no. 197). Protection of this species in Victoria is managed by setting a commercial by-catch limit of 0 kg, and restricting recreational anglers to a bag limit of two fish.

5.4.3 Australian or Tasmanian Whitebait

The Australian Whitebait is a small (77 mm maximum length) fish which lacks scales and has translucent or silvery colouring, though adults may turn completely black in estuaries following spawning. Originally the fish was only known from Tasmania where it remains a

popular recreational fishing species in north coast estuaries. In Victoria (and the rest of mainland Australia) it has only been identified in the Tarwin River and Anderson Inlet, despite extensive sampling for fish in estuaries and inlets elsewhere in Victoria.

The Australian Whitebait was heavily fished commercially in Tasmania during the 20th century. The Tasmanian commercial fishery was closed in 1974 after it collapsed, and only limited, seasonal recreational fishing is now allowed. No commercial or recreational Australian Whitebait fishing has occurred in Victoria.

The key threats to the species in Victoria have been identified as by-catch during commercial glass eel fishing, impacts on fresh and estuarine water quality from runoff (pesticides, herbicides, fertilisers), oil spills and modification of habitat through the construction of marinas, dredging or stream modification (FFG Action Statement No. 259).

5.4.4 Australian Mudfish

The Australian Mudfish is a small, 80 mm long fish associated with coastal wetlands and streams. Larvae and juveniles of the mudfish are thought to spend some time in marine waters before migrating back into streams and wetlands. Only 29 adult specimens have been identified from seven sites in Victoria, ranging from the east side of Wilsons Promontory to rivers west of Cape Otway. None have been identified in Western Port, though suitable habitat may exist. The key threat to the population of Australian Mudfish in Victoria is the loss of suitable wetland habitat due to human modification, particularly in South Gippsland (FFG Action Statement No. 115).

5.4.5 Pale or flatback mangrove goby

The FFG Act lists the pale mangrove goby *Mugilogobius paludis* (Whitley,1930) as a threatened species in Victoria. Consultation with Curator of Fishes at Museums Victoria revealed that M *paludis* is the same species at M *platynotus*. Further, M platynotus (Gunther 1861) is the correct identification for the species as determined in the taxonomic literature (Larson 2001). M *platynotus* is known as the flatback mangrove goby, mangrove goby and pale mangrove goby.

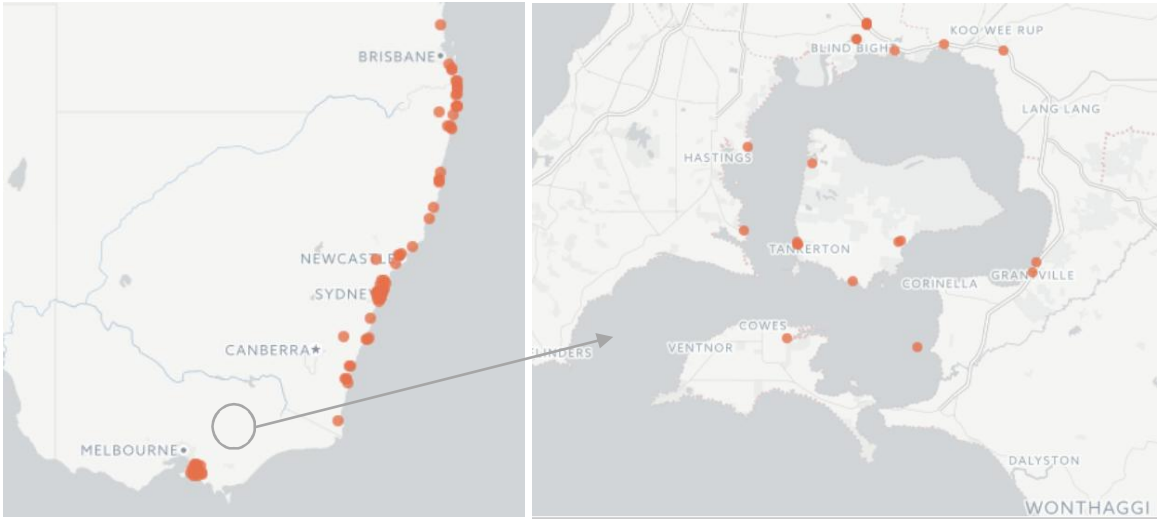

Figure 14. Distribution of flatback mangrove goby (*Mugilogobius platynotus)*
(http://bie.ala.org.au/species/urn:lsid:biodiversity.org.au:afd.taxon accessed September 2017)

The flatback mangrove goby is a small brown goby found in mangrove associated marine and estuarine bays and inlets from southeast Queensland to Victoria (Figure 14). M *platynotus* is known also to be widespread in Western Port (Figure 14), whereas M *paludis* is known only from one individual collected on unvegetated mudflat at Wooleys Beach near Crib Point in 2002 (Hindell and Jenkins 2003, Jenkins 2015). The record of M *paludis* should have been reported as M *platynotus*. The potential impact of the project on M *paludism/platynotus* is assessed in Section 6.5.1 of this report.

5.4.6 Marine Invertebrates

Thirteen marine invertebrates are listed under the FFG Act, including three species of crustacean, seven species of echinoderm, three species of mollusc and one cnidarian (hydroid). The location of specimens, and the environment and habitat of these esoteric marine species are described in O'Hara and Barmby (2000), and are summarised in Table 4.

Table 4. Flora and Fauna Guarantee Act 1988 - listed marine invertebrates

Taxa	Common Name	Environment	Habitat	Location
Crustaceans				
Athanopsis australis	Southern hooded shrimp	Bay	Sand, mud, reef (5-12 m)	Port Phillip Bay and Bridgewater Bay (Vic)
Pseudocalliax tooradin	Ghost shrimp	Bay	Fine sand (2-5m)	Swan Bay and Crib Point (Western Port) (Vic)
Michelea microphylla	Ghost shrimp	Bay	Sandy gravel (19 m)	Crib Point (Western Port) (Vic)
Echinoderms				
Amphiura triscacantha	Brittle star species	Bay and Channel	Posidonia and Heterozostera seagrass beds (subtidal)	Nooramunga 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 (Vic)
Apsolidium handrecki	Sea-cucumber species	Bay	Rocky shallows (on rock platforms)	Merricks (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) and Spencer & St Vincent Gulfs (SA)
Pentocnus bursatus	Sea-cucumber species	Open Coast	Found living on shallow water macroalgae (subtidal)	Cape Paterson (Vic), Beachport (SA) and Cockburn Sound (WA)
Thyone nigra	Sea-cucumber species	Bay	Bay habitats (subtidal)	Corio Bay (Vic), St Vincent Gulf (SA) and Bramble Pt, Princess Royal Harbour (WA)
Trochodota shepherdi	Sea-cucumber species	Channel	Posidonia seagrass beds (subtidal)	Nooramunga (Vic) and Spencer & St Vincent Gulfs (SA)
Molluscs				
Bassethullia glypta	Chiton	Bay and Open Coast	Under rocks in sand (intertidal to 10 m)	Southern Port Phillip Bay, Bass Strait (Port Phillip Heads), Flinders (Vic) and Stanley (Tas)

Taxa	Common Name	Environment	Habitat	Location
Platydoris galbana	Opisthobranch	Bay	Reef flat	San Remo (Vic)
Rhodope genus	Opisthobranch	Bay	Reef flat	San Remo (Vic)
Cnidarians				
Ralpharia coccinea	Stalked Hydroid	Bay	Reef	Crawfish Rock

Many of the marine invertebrates listed under the FFG Act are apparently Victorian endemic species (that is, only found in Victoria) and little is known about their biology (O'Hara and Barmby, 2000). These marine invertebrates are only known from between one and seven individual specimens which have been collected at between one and four different localities in Victorian waters.

Table 4 shows that eight listed species may occur in the general Western Port region, with two species of ghost shrimp found at Crib Point ("*Pseudocalliax tooradin* and *Michelea microphylla*). Five species are known from collections at locations in Western Port that are relatively remote from the direct activities associated with the Project. One species record (the brittle star *Amphiura triscacantha*) appears to have been a mis-identification. The eight species with recorded distributions in Western Port are discussed below.

The Western Port ghost shrimp *Pseudocalliax tooradin* (variously known as *Callianassa tooradin* 1979, *Calliax tooradin* Sakai 1988, *Paraglypturus tooradin* Turkay and Sakai 1995, *Eucalliax tooradin* O'Hara and Barmby 2000 and now *Pseudocalliax tooradin* Sakai 2011) and is known only from a total of less than 10 individuals. Four were collected subtidally in grab samples offshore from Crib Point in 1965 and since then have not been recorded in Western Port (Figure 15). The habitat where it was found at Crib Point comprised shallow, subtidal fine sand. It was also found in Swan Bay, a primarily shallow seagrass ecosystem. Its potential dependence on seagrass is not known.

Registration no	Location	Stn no	Latitude	Longitude	Depth	Date	No of specimens
MoV J16722	Swan Bay, near Edwards Point		38°14′S	144°39′E	2	1982	1
MoV J302	Western Port, off Crib Point	CPBS-N 11	38°20.23′S	145°13.28′E	5	31 Mar 1965	2 (paratypes)
MoV J303	Western Port, off Crib Point	CPBS-?	?	?	?	1965	1
MoV J301	Western Port, off Crib Point	CPBS-N 11	38°20.23′S	145°13.28′E	5	31 Mar 1965	1 (holotype)

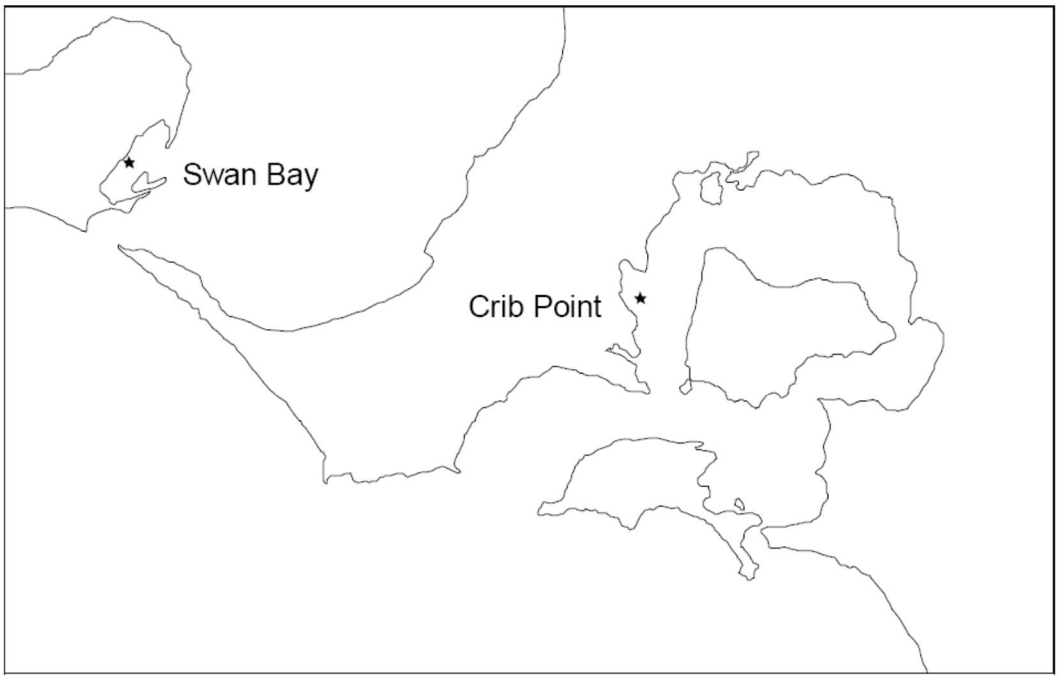

Figure 15. Distribution of Western Port ghost shrimp *Pseudocalliax tooradin*
(From O'Hara and Barmby 2000)

The ghost shrimp *Michelea microphylla* is known from only one specimen collected in sandy gravel in 19 m water depth offshore from Crib Point in 1965 (Figure 16). It is very rare as it has not been found anywhere else since 1965, including the comprehensive sampling program for the Western Port study in the 1970s (Coleman et al, 1978).

Registration no	Location	Stn no	Latitude	Longitude	Depth (m)	Date	No of specimens
MoV J1263	Western Port, off Crib Point	CPBS-N 52	38°19.92′S	145°13.95′E	19	31 Mar 1965	1 (holotype)

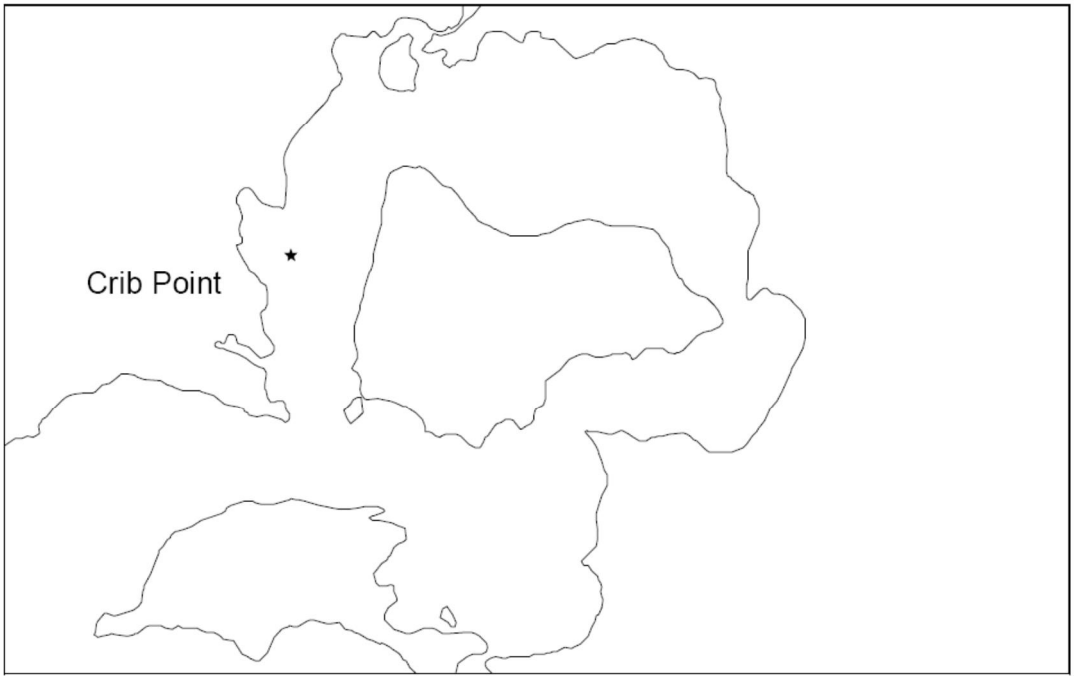

Figure 16. Distribution of ghost shrimp *Michelia microphylla*
(From O'Hara and Barmby 2000)

O'Hara and Barmby (2000) consider that the record of the brittle star *Amphiura triscacantha* from Western Port (Figure 17) is likely to be a mis-identification of another species, and that the species is likely to be confined to *Posidonia* seagrass beds in Corner Inlet and the South Australian Gulfs.

Registration no	Location	Latitude	Longitude	Depth (m)	Date	No of specimen
MoV	Nooramunga, channel south of Sunday Island	39°44′18"S	146°36'52"E	7	10 Jun 1986	1
NMNZ 2619	Western Port, North Arm	?	?	4	13 Jun 1976	1
SAM K212	Spencer or Gulf St Vincent	?	?	-	(pre 1928)	Holotype
NMNZ 2073	Upper Spencer Gulf	?	?	9	11 Sep 1973	1
SAM	Upper Spencer Gulf – various localities	-	-	-	1986-7	many
AM	Spencer Gulf, Port Pirie	33° 12′S	138° 00′E			10 lots

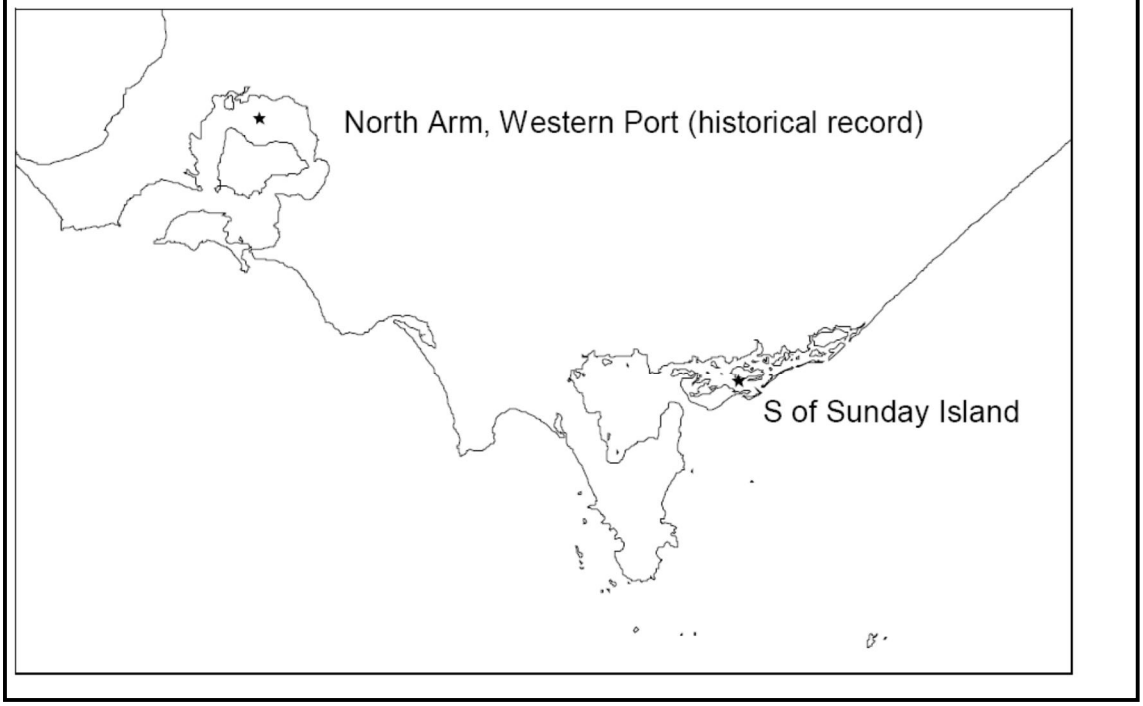

Figure 17. Distribution of brittle star (*Amphiura triscacantha)*
(From O'Hara and Barmby 2000)

The sea cucumber *Apsolidium densum* is known from only three individuals at Apollo Bay and one outside Western Port at Flinders (Figure 18). All four individuals collected were from rocky, wave exposed, intertidal habitats.

Registration no	Location	Latitude	Longitude	Depth (m)	Date	No of specimens
MoV F54237 & AM J22753	10 Km NE Apollo Bay	38°43′S	143°43′E	0.5	11 Jan 1984	2 (holotype & paratype)
MoV F54237	10 Km NE Apollo Bay	38°43′S	143°43′E	0.5	7 Jan 1985	1 (paratype)
MoV F53766	Flinders, Mushroom Reef	38°29′S	145°02′E	0.5	22 Jan 1982	1 (paratype)

Figure 18. Distribution of the sea cucumber (*Apsolidium densum)*
(From O'Hara and Barmby 2000)

The sea cucumber *Apsolidium handrecki* is known from three separate locations in Victoria, South Australia and Western Australia. At all locations, the sea cucumber was found in rocky, intertidal habitats. The six specimens from Victoria were restricted to small rock platforms at Merricks, in the western arm of Western Port (O'Hara and Barmby 2000).

Registration no	Location	Latitude	Longitude	Depth (m)	Date	No of specimens
MoV F54391 & MoV F54397	Merricks	38° 24′S	145° 06′E	0.5	27 May 1989	2 (holotype & paratype)
MoV F53765	Merricks	38° 24′S	145° 06′E	0.5	28 Jan 1983	2 paratypes
MoV F53763	Merricks	38° 24′S	145° 06′E	0.5	29 Oct 1980	2 paratypes
SAM K1815	Arno Bay, SA	33° 56′S	136° 35′E	2	22 Feb 1988	2
MoV F59225	Trigg Is WA	31° 52′S	115° 45′E	1	22 Nov 1969	2

Figure 19. Distribution of the sea cucumber *Apsolidium handrecki* in Victoria
(From O'Hara and Barmby 2000)

The chiton *Bassethullia glypta* is restricted to the central Victorian coast at the entrance to Port Phillip and Flinders near the entrance to Western Port and possibly at Stanley on the northwest coast of Tasmania (O'Hara and Barmby, 2000) (Figure 20). It is found under rocks in clean sand associated with high currents or wave exposed environments from the intertidal zone to 10 m water depth.

Museum registration no	Location	Latitude	Longitude	Date	No of specimens
MoV F680 & MoV F27307	Southern Port Phillip Bay	?	?	1888	2
MoV F54346	Sorrento, Port Phillip Bay	38° 20′S	144° 45′E	?	1
MoV F22339, F52976-7, F54347	Portsea, Port Phillip Bay	38° 19′S	144° 43′E	?	5
MoV	Southern Port Phillip Bay	38° 16.8′S	144° 38.3′E	1986	1
MoV	Southern Port Phillip Bay	38° 20.7′S	144° 45.8′E	1986	1
MoV F54346	Flinders	38° 29′S	145° 02′E	?	2
MoV F52975, SAM D18440	Bass Strait (?Port Phillip Heads)	?	?	?	2
SAM D10713 & D12800	?Tasmania, possibly Stanley	?	?	?	2

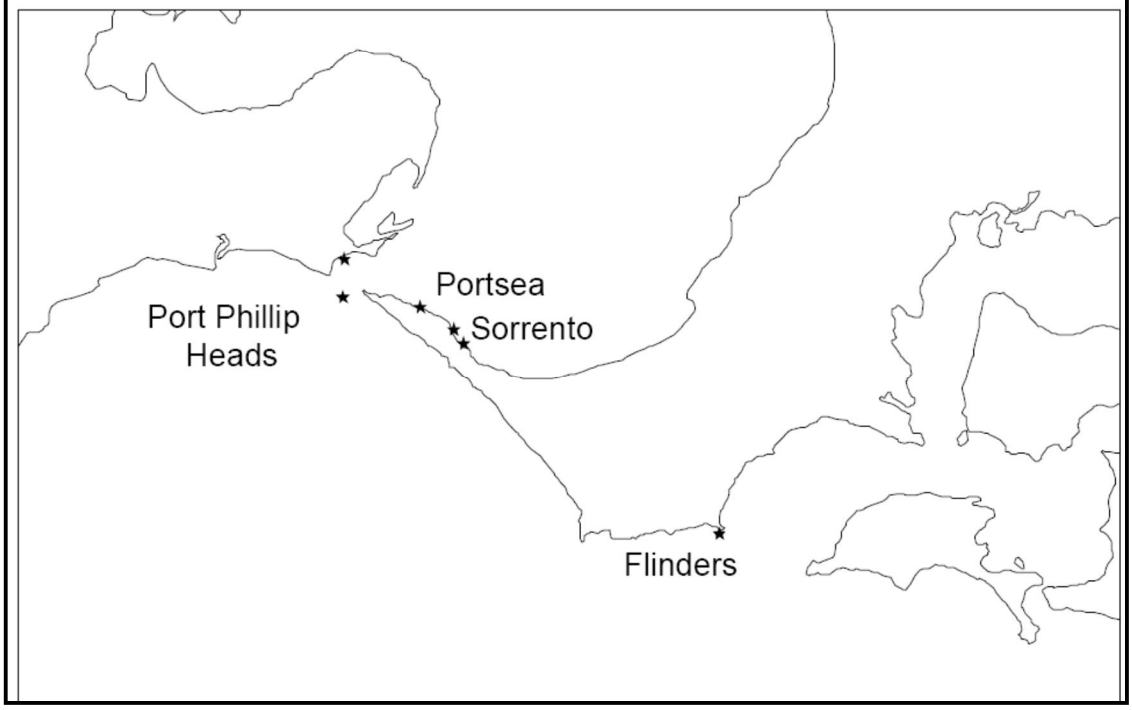

Figure 20. Distribution of the chiton (*Bassethullia glypta)* in Victoria
(From O'Hara and Barmby 2000)

Two nudibranchs (*Platydoris galbanus* and the genus *Rhodope*) from San Remo are listed under the FFG Act, as well as the 'San Remo Marine Community' (see below).

The Hydroid species *Ralpharia coccinea* has only been found growing epizoically on the soft coral *Parerythropodium membranaceum* (Watson, 2015) at Crawfish Rock, at the top of North Arm, Western Port. It is similar to the more common species *Ralpharia magnifica* that also commonly grows on *Parerythropodium membranaceum.* Observations over many years on Western Port jetties have not revealed the presence of either hydroid species on jetty piles (CEE, 2016).

5.4.7 San Remo Marine Community

The 'San Remo Marine Community' listed in the FFG Act is located just north of the Phillip Island Road bridge across the Narrows, near the eastern entrance to Western Port. It is around 23 km from Crib Point. The San Remo Marine Community was listed under the FFG Act due to the particularly high abundance and diversity of opisthobranch taxa (Nudibranch molluscs) in the 18 ha area that extends across an intertidal rock platform to the edge of the channel. Two opisthobranch taxa are listed individually on the FFG (*Platydoris galbanus*, *Rhodope* sp.) and a number of species are expected to be listed once they are described.

The San Remo Marine Community was listed under the FFG Act to protect it from coastal and marine development inconsistent with its survival (such as a marina proposed for the site). Identified threats include (FFG Action Statement No. 18): loss of all or part of the community due to dredging, invasion of the site by other species after physical disturbance, sedimentation from nearby dredging, changes to currents due to construction of breakwaters, and changes to water quality. The community was listed primarily to protect it from incompatible developments in the local area.

The effects of the Project are likely to be restricted within North Arm of Western Port. Hence, the San Remo Marine Community, located more than 16 km from North Arm is most unlikely to be affected by the Project.

5.5 EPBC Act threatening processes

Two threatening processes affecting marine species are listed under the EPBC Act:

- Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases; and,
- Injury and fatality to vertebrate marine life caused by ingestion of, or entanglement in, harmful marine debris.

Listed Threatening Processes listed under the EPBC Act are not matters of environmental significance, they are intended to provide official recognition of threatening processes and raise awareness of the significance of these threats to national biodiversity.

The Commonwealth Minister for the Environment and Energy may decide that a threat abatement plan is appropriate. In the case of climate change, the Threatened Species Scientific Committee advised the Minister that given that the Commonwealth, State and Territory governments have other greenhouse gas emission abatement plans in place, that a threat abatement plan under the EPBC Act was not appropriate (Threatened Species Scientific Committee, 2001). Nevertheless, the Project's contribution to climate change impacts on marine environments was assessed – refer to the *Greenhouse Gas Emissions Assessment Report* (Jacobs, 2018b).

The Threatened Species Scientific Committee advised the Minister on a threat abatement plan for marine debris, which is presently being revised. The Project does not entail the creation of marine debris, assuming activities accord with State, Commonwealth and international regulations for waste management in marine environments.

Aspects of the Project, could potentially result in threatening processes listed under the FFG Act, such as:

- Input of petroleum and related products into Victorian marine and estuarine environments
- The discharge of human-generated marine debris into Victorian marine or estuarine waters
- The introduction of exotic organisms into Victorian marine waters

The FFG Act listed potentially threatening processes should be managed using an appropriately designed and implemented Environmental Management Plan and operational controls which adhere to regulatory requirements regarding bilgewater, management of fuels and waste. An action statement has been prepared for the threat of the introduction of exotic organisms into Victorian Waters (FFG Action Statement No. 100). The threat of introduction of exotic marine species is discussed further below.

5.5.1 Introduced marine species

The anthropogenic translocation and establishment of non-indigenous marine species (NIMS) is considered to pose one of the greatest threats to marine biodiversity, as well as more specific environmental, economic and human health impacts. The coasts of Australia have proven to be particularly vulnerable to invasions of exotic marine species, and a recent assessment reports the number of introduced and cryptogenic marine species in Australia to be 429 (Hewitt and Campbell, 2008). Temperate harbours and embayments on the southern coasts are particularly vulnerable having been colonised by numerous species from temperate marine environments in the northern hemisphere, particularly the north-west Pacific and the Mediterranean/north-east Atlantic regions. While many of the exotic species now established in Australian waters are relatively benign in terms of impact, a number of species are perceived to have caused significant impact and are considered to be invasive marine pests. These include the Northern Pacific seastar (*Asterias amurensis*), the Japanese kelp (*Undaria pinnatifida*), the European shore crab (*Carcinus maenas*), and the Mediterranean fan worm (*Sabella spallanzanii*).

Shipping and other maritime vessel traffic is one of the most significant vectors for both the primary introduction and secondary dispersal of non-indigenous species. Ports, or the waters in the vicinity of ports, are therefore often “hot spots” for NIMS, and both ships’ ballast water discharge and hull biofouling (particularly sea-chests) are recognised as vectors for marine pest incursions. Once a pest becomes established in one port, this port can then become a source for secondary dispersal to nearby environments by natural means or to other domestic ports, marinas or harbours by maritime traffic. In Victoria this has occurred with both *Asterias amurensis* and *Undaria pinnatifida* – which have since been detected at various locations outside Port Phillip Bay.

The risk posed by maritime traffic depends largely on the type of vessel or ship. Those that spend large amounts of time in port, such as bulk carriers, barges and drilling rigs, mean NIMS have more opportunity to colonise the vessel or disperse from it. Those that spend little time in port, such as container ships, pose a lower threat. Older vessels pose a greater threat as they are less likely to have good antifouling or effective ballast water management systems (to minimise the likelihood of translocating pests), while newer ships increasingly have effective ballast water management systems and good antifouling.

Going back a decade or so, a national port baseline survey program was undertaken to determine the marine pest status of Australia’s waters, and 35 ports around Australia were surveyed. As part of this program, the Port of Hastings (including Crib Point) was surveyed in 1997 (Currie and Crookes, 1997), along with three other Victorian ports: Portland (Parry *et al* 1997), Geelong (Curry et al, 1998) and Melbourne (Cohen et al, 2001).

In addition to determining the pest status in the surveyed ports, these surveys formed the basis for assessment of ballast water uptake and discharge risk associated with domestic ship voyages. A more general survey on marine pests in Western Port was undertaken in 2000 (Cohen *et al,* 2000). This latter survey did not follow the structured sampling protocols prescribed for the port surveys (Hewitt and Martin, 1996) but, instead, employed qualitative survey techniques to enable the survey of regions throughout Western Port, although there

was still an emphasis on areas considered susceptible to infestation, such as marinas and aquaculture sites.

5.5.1.1 The Marine Pest Status of Western Port

During the 1997 baseline survey of the Port of Hastings, a total of 355 species were collected. Only seven of these were confirmed as introduced species:

- the European green crab *Carcinus maenus;*
- the European clam *Varicorbula gibba* (as *Corbula gibba*);
- the Asian bag mussel *Musculista senhousia*;
- the Asian bivalve *Theora lubrica*; and
- three cosmopolitan bryozoan species: *Bugula dentata*; *Bugula neritina*; and *Watersipora subtorquata*.

For comparison, nine exotic species were detected in the baseline port survey of Portland, 20 in Geelong, and 37 exotic or cryptogenic species in Melbourne. *Bugula dentata* was the only species considered abundant enough within the Port of Hastings to cause significant ecological impact, as its erect flexible growths were found on the surfaces of pier pylons of all commercial wharves. However, this species has since been reconsidered to be native (Hewitt *et al,* 1999), with a widespread distribution in the Indo-Pacific.

The 2000 survey of marine pests in Western Port increased the number of recorded exotic species in the bay to 14 (Cohen *et al,* 2000). Species additional to those in the 1997 port survey were:

- Four species of ascidians
  - *Ascidiella aspersa*, *Ciona intestinalis*, *Styela plicata* and *Styela clava*,
- the Mediterranean fanworm *Sabella spallanzanii*,
- the bivalve *Crassostrea gigas*; and
- two green algal species
  - *Codium fragile subsp. fragile and Ulva lactuca.*

Only the crab *Carcinus maenas* appeared to be widely distributed in the bay in 2000, with the remainder apparently limited in their distribution. *Sabella spallanzanii* and *Styela clava* were found on mussel ropes transferred to Flinders from Port Phillip Bay, but were not found on the nearby Flinders Pier or on the sea floor below the mussel farms.

A single occurrence of the Japanese kelp *Undaria pinnatifida* in Western Port is known from near Flinders Pier (G. Parry, *pers comm*.). These plants were removed and there were no further findings in subsequent monitoring of the site.

In late 2007 several juvenile New Zealand green-lipped mussels (*Perna canaliculus*) were found in the sea chests of one of the vessels that voyages between Port Kembla and Hastings when it was dry-docked for routine maintenance (Lewis *pers. obs*.). Although follow up searches found no mussels near the relevant wharf at Hastings, the finding demonstrates a potential pathway for marine pest introduction to Western Port.

None of the large pests found in Port Phillip Bay (*U. pinnatifida, A. amurensis, S. spallanzanii*) have ever been observed during the BlueScope marine biological monitoring program (MSE, 2009) or biological monitoring of the Crib Point, Long Island Point or BlueScope jetties (Bok *et al*, 2017). However, since the last marine pest surveys in 2000, no targeted marine pest survey has been conducted in Western Port.

5.5.1.2 Marine Pest Management Arrangements

The environmental and economic threat posed by marine pests to Western Port is recognised by the Port of Hastings Development Authority (PoHDA) and Parks Victoria. The PoHDA prohibits in-water cleaning of ship hulls and propellers. The discharge of ballast waters is prohibited in port waters (PoHDA, 2017). Parks Victoria manages the three Marine National Parks which protect representative areas of Victoria's marine biodiversity, and has identified marine pests as one of the major threats to the biodiversity of the parks.

Responsibility for the regulation of ballast water in Australia now lies with the Commonwealth. In 2016 the Commonwealth *Biosecurity Act 2015* came into force and this enabled Australia to ratify the International Maritime Organization (IMO) Ballast Water Management Convention, which came into force on 8 September 2017. Ships in Australian waters will now have to manage ballast water according to the Australian Ballast Water Management Requirements which align with the International Convention for the Control and Management of Ships Ballast Water and Sediments 2004. The *Biosecurity Act 2015* currently covers ballast water, but does not deal with the issue of biofouling, which is widely recognised as posing a similar or greater risk of introducing marine species to Australian waters.

A major review of Australia's marine pest management arrangements was undertaken in 2014-15 (DAWR, 2015). The review made a number of recommendations for improving the way Australia prevents, eradicates and manages the introduction of marine species in Australia. One of the key recommendations was that Australia introduce new biofouling regulations consistent with International Maritime Organisation Biofouling Guidelines. A revision of a 2011 biofouling regulation impact statement is currently in preparation, with consultation expected to start in early 2018 (DAWR, 2018).

Currently, biofouling risks are managed through the National Biofouling Management Guidelines (Commercial Vessels, 2009) and Anti-Fouling and In-Water Cleaning Guidelines (2015).

The contribution of the development to marine pest risks in Western Port will require management under present Port, State and Commonwealth regulations. Issues related to specific aspects of the FSRU, such as development of hull fouling and cleaning, will be addressed in subsequent stages of the project assessment.

6 PRELIMINARY ASSESSMENT OF PROJECT EFFECTS

This section assesses the potential for project specific processes to affect MNES and FFG listed species that may occur in the vicinity of the Crib Point Jetty and the operation of the FSRU.

6.1 Project processes and potential impact pathways

The potential impact pathways of the inclusion of the AGL Gas Import Jetty Project to the normal operations of the Port of Hastings can be divided into three categories:

(1) Shipping berthing, departing, loading and unloading operations in the working Port of Hastings, maintenance and minor improvement works associated with the jetty, jetty access, navigation, security and administration,
(2) Upgrades to the existing Port infrastructure at Crib Point Jetty that will be required for the mooring of the FSRU and LNG carriers and the unloading and transfer of LNG and high pressure natural gas (as part of the Jetty Upgrade project), and
(3) Operation of the heat exchange seawater intake and discharge associated with the regasification of LNG on-board the FSRU.

The category 1 impacts pathways are a consequence of the normal operation of the Port of Hastings. The Port of Hastings is operated by the PoHDA. PoHDA is responsible for environmental management of its own facilities and the general environmental management of ship-based activities (including the FSRU) within the Port boundaries. The operation of the Project will be subject to these existing operational environmental requirements and therefore has not been assessed further in this report.

The category 2 impact pathways are associated with the Jetty Upgrade, being undertaken by the PoHDA. The proposed upgrades have been subject to an environmental risk assessment (Jacobs, 2018c) and subsequently a draft Environmental Management Plan has been prepared for the construction activities. Category 2 impact pathways have not been assessed further in this report.

This assessment addresses the category 3 impact pathways − potential marine environmental impact pathways from the operation of the heat exchange system on-board the FSRU. The regulation of these impacts by EPA or DELWP will be determined in consultation with those agencies.

The impact pathways associated with regasification process on board the FSRU are listed below.

- Intake of up to 450,000 m^3 of seawater per day (0.29% the volume of the MCG) for heating of cold, liquid natural gas (LNG at -162^{o}C) as part of the regasification process
  - A range of small marine and some large biota (including fish, diving seabirds such as penguins, cormorants and gannets and mammals such as seals and native water rats) may be drawn into the heat exchange system from the surrounding water column (or seabed) in the intake current to the seawater pumps and heat exchange pipework of the regasification facility on the FSRU
  - Large biota may be caught and damaged or drowned on screens at intake
  - Small biota may pass through screens and suffer further damage in the pumps and pipework of the heat exchangers.
  - In addition to the mechanical damage and injury to biota, smaller biota that survive the passage through the pumps will be exposed to cold water (up to 7^{o}C below ambient and chlorine derived biocide, which is intended prevent biological growth on the internal walls of the heat exchange pipework.

- Discharge of up to 450,000m^3 per day of cooled seawater at 7^{o}C below ambient seawater
  - The discharge of cooled seawater could create a denser colder layer on the seabed that may: affect physiological functions of temperature sensitive biota; affect reproductive responses of temperature sensitive species; affect migration or travel paths of temperature sensitive species.
- Discharge of up to 450,000m^3 per day of seawater containing residual chlorine
  - The discharge of seawater containing residual chlorine may: be toxic to chlorine sensitive species; affect physiological functions of chlorine sensitive biota; and/or affect reproductive responses of chlorine sensitive species.

The potential impact pathways from the operation of the FSRU on the marine environmental ecosystem have been described and modelled in separate reports, comprising: hydrodynamic and discharge mixing modelling (CEE, 2018a), heat exchange seawater entrainment modelling (CEE, 2018b), the effects of cold-water discharge assessment on the marine ecosystem (CEE, 2018c) and chlorine behaviour investigation and toxicity modelling (CEE, 2018d). The key impact pathways are summarised below.

6.1.1 Entrainment effects and mitigation

The operation of the heat exchange system on the FSRU will require a daily volume of up to 450,000 m^3 (450 ML/day) of seawater from Western Port to be pumped at a rate of 5.2 m^3/s through heat exchangers on-board the FSRU. This is a similar volume of seawater withdrawn by the Victorian Desalination Plant at Wonthaggi (currently at 11.6 m^3/s), except that the FSRU will operate continuously for most of the year with downtime for maintenance and variations in flow depending on LNG supply and gas demand.

The heat exchanger intake will be designed to minimise potential effects of seawater entrainment on mobile animals in the water column as shown in Figure 21.

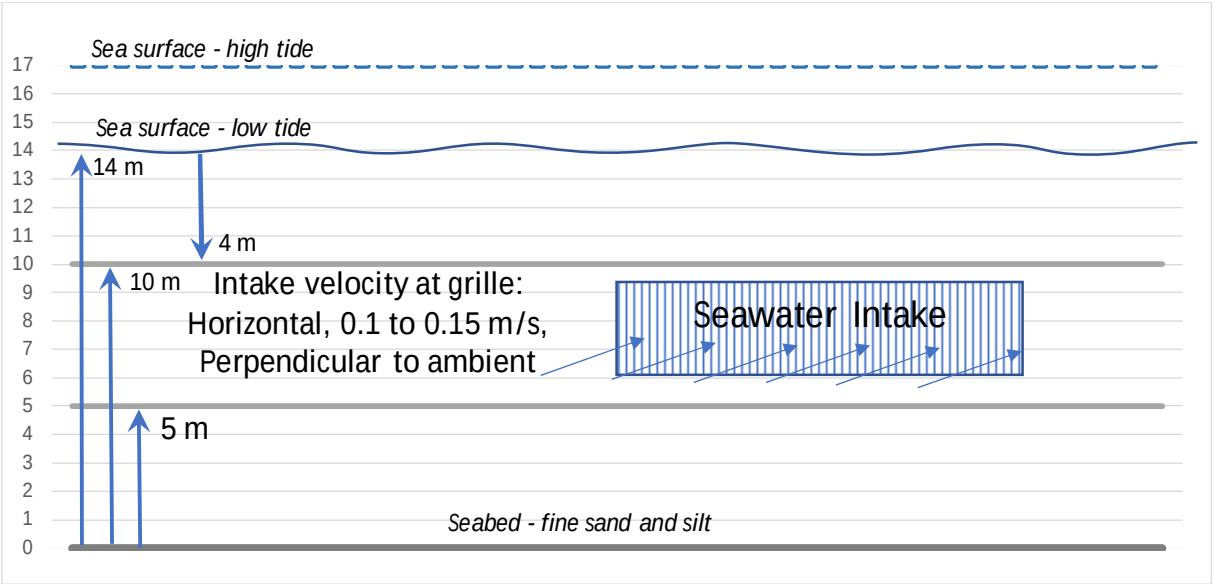

Figure 21. Seawater intake environmental parameters at Crib Point facility

As a result of the design features described above, large and small mobile animals can avoid being drawn into the intake by detecting the intake and swimming away from the screens. This mitigation process has been shown to be very effective in seawater cooling systems and desalination plant systems throughout the world, including the Victorian Desalination Plant at Wonthaggi.

The main unavoidable adverse effect of the heat exchanger system is the potential for *entrainment* of all the smaller marine organisms (zooplankton and phytoplankton), drifting eggs, larvae and larval fish) in the central part of the water column adjacent to the intake. It is assumed that all of these biota will not survive as a result of mechanical damage and exposure to chlorine biocide (CEE, 2018b).

Estimation of the proportion of planktonic populations that may be entrained are dependent on a range of factors including (1) the nature, distribution and annual variation of planktonic populations in North Arm of Western Port, which are currently undocumented and (2) hydrodynamic model configurations specific to entrainment. It has been recommended that:

- Particle entrainment modelling for North Arm be developed to provide entrainment proportion contours
- A plankton and larval sampling program be designed and implemented to provide information on spatial and temporal variations in plankton populations in North Arm focussing on the proposed location and position of the FSRU intake.
- Available information of literature on the effects of entrainment on semi-enclosed marine ecosystems be reviewed to provide guidance on long-term ecosystem implications of plankton entrainment.

6.1.2 Effects of cold seawater discharge

The operation of the heat exchange system on the FSRU will result in the discharge of up to 450,000 m^3 per day (450 ML/day) of seawater that is initially 7^oC cooler than the surrounding ambient Western Port seawater. The modelling based on a conservative single-port discharge showed that the cold, and therefore dense, seawater leave the single (or double) discharge port of the FSRU and descend towards the seabed where it would form a cool layer during periods of low currents during the turn of the tide (Figure 22). It will mix into the surrounding water column during stronger mid-tidal currents.

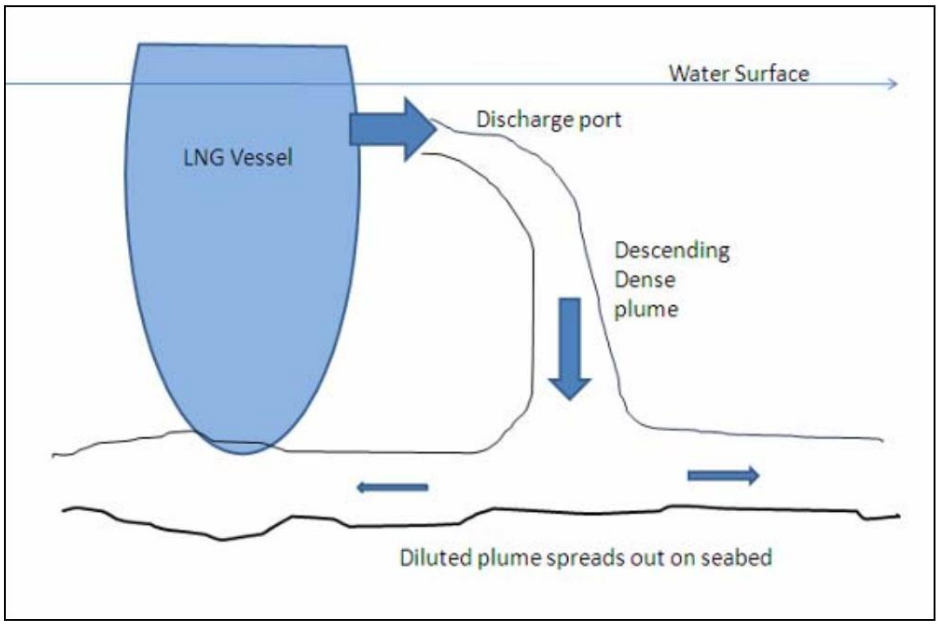

Figure 22. Behaviour of cold-water discharge from FSRU at Crib Point

Under this scenario, the maximum temperature difference between ambient seawater and the temperature in the plume after it has undergone the process of 'initial dilution' reached the seabed is predicted to be 0.8^oC and 0.3^oC below ambient for single port and six-port discharges, respectively. The pool of cold-water may extend up to 600 m north during the

early stage of a rising tide or 600 m south during the early stage of a falling tide and may be up to 250 m wide at the FSRU. The cool pool may be up to 2.5 m thick above the seabed for a single-port discharge, but is less likely to form for a six-port discharge (Figure 23).

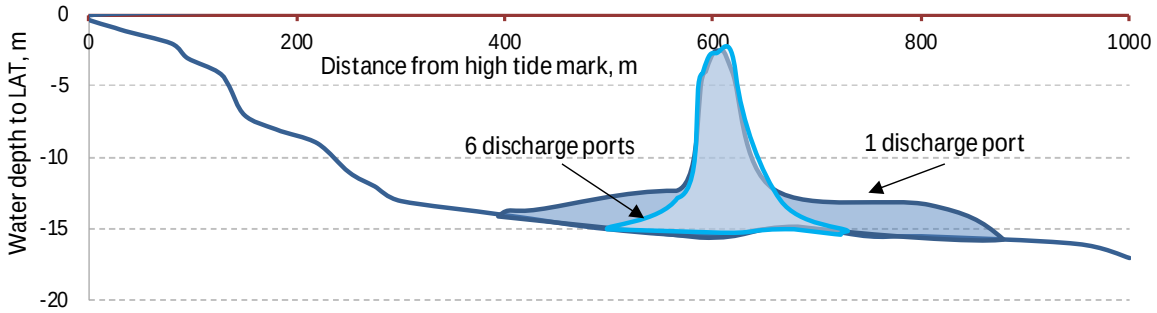

Figure 23. Maximum extent of cold water field cross-section (concept)

Seawater temperature above 2.5 m from the seabed will be unaffected by the discharge except for the column of cold-water descending from the depth of the FSRU discharge.

The AGL preferred design for discharge of the cold seawater is through a six-port discharge arrangement, instead of the alternate single (or double) discharge port/s. This optimises dilution of the discharge and results in a smaller temperature difference closer to the discharge point being an area approximately 200 m north and south and 60 m east and west of the discharge point, representing a total seabed area of approximately 5 ha.. No cold-water pool forming on the seabed is likely at any stage of the tide with the six-port discharge.

6.1.3 Chlorine residual in seawater discharge

Chlorine will be generated by electrolysis of seawater at the inlet to the seawater exchange system to prevent the settlement and growth of encrusting biota on the interior of the heat exchange pipework (CEE, 2018d). This is standard procedure for heat exchange systems in seawater applications and intakes to desalination plants. The initial concentration of chlorine will be controlled so that the concentration of chlorine at the discharge will be 0.1 mg Cl_2/L. The process of initial dilution from the single (or double) discharge port/s will reduce the concentration of free chlorine residual from 0.1 mg Cl_2/L at the outlet to 0.01 Cl_2/L at the seabed. Reduction of chlorine residual concentration after initial dilution is mixing, time, organic content, salinity and water temperature dependent. After six hours mixing with tidal currents, the chlorine concentration in seawater at ambient temperature of 12^{o}C is estimated to reduce to 0.006 Cl_2/L, while in warmer seawater (16^{o}C to 18^{o}C) the chlorine concentration is estimated to reduce to 0.003 mg Cl_2/L. A toxicity test at 16^{o}C using Crib Point seawater found that the fertilisation of a local genus of sea urchin was affected after one hour exposure to 0.059 mg Cl_2/L.

Agency ecosystem protection guidance values for free chlorine are shown in Table 5.

Table 5. Chlorine ecosystem protection guidance values

Agency	Protection level	Value, mg/L
ANZECC 2000	95 % species protection, freshwater and marine*	0.003
USEPA 1985, 1991	Four day mean (chronic), marine	0.0075
USEPA 1985, 1991	One hour mean (acute), marine	0.013

*Value for marine ecosystem “indicative interim working value”.

6.2 Endangered species – preliminary assessment

In relation to endangered species (Blue Whales, Southern Right Whales, Leatherback Turtles and Loggerhead Turtles in this case), the EPBC Act Policy Statement 1.1 - Significant Impact Guidelines state that:

> *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.*

There are no apparent direct or indirect pathways related to the Project that are likely to affect Blue Whales, Southern Right Whales, Leatherback Turtles or Loggerhead Turtles: population size; area of occupancy; population continuity; critical habitat, breeding cycle; or species recovery.

6.3 Vulnerable species – preliminary assessment

In relation to vulnerable species (Humpback Whales, White Shark, Australian Grayling and Green Turtles), the EPBC Act Policy Statement 1.1- Significant Impact Guidelines state that:

> *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.*

There are no apparent direct or indirect pathways related of the Project that may affect Humpback Whales, White Sharks, or Green Turtles: population size; area of occupancy; population continuity; critical habitat, breeding cycle; or species recovery.

6.3.1 Australian Grayling

The potential for effect of the heat exchange system of the Project on Australian Grayling larval dispersion and juvenile migration is assessed on the basis of available information (DELWP Action Statement No 257 DELWP 2015, National Recovery Plan for Australian Grayling *Prototroctes maraena,* and Victorian Fisheries Authority fish species notes).

Grayling biology

The Grayling, although rare, is found in most Victorian coastal rivers and streams from East Gippsland to the Hopkins River in Western Victoria. The National Recovery Plan lists Western Port's Lang Lang River, Cardinia Creek and Bunyip River among the 35 Victoria, three New South Wales and 30 Tasmanian streams that contain populations important for the long-term survival and of the Grayling. The Victorian Fisheries Authority (vfa.vic.gov.au/education/fish-species/australian-grayling) notes that very large populations of grayling occur in the Mitchell, Tambo and Barwon Rivers.

Adult Grayling live in freshwater rivers and streams and live for two to three years. Mature females produce large quantities of eggs, 25,000 to 68,000 eggs per female. During periods of high flow in April and May, adult males and females migrate downstream to lower reaches where they form spawning aggregations. Eggs are laid in gravel streambeds. The slender and buoyant larvae hatch from the gravel and are swept downstream into estuaries, bays and coastal seas. In the absence of high flows, adults do not migrate downstream, and females reabsorb the eggs they are carrying. Hence, adults may only spawn once in their lives.

The coincidence of spawning and high river flows may assist in broader dispersion of larvae in the nearshore marine environment, where the larvae develop into juveniles and live for six to ten months. The young 'whitebait' juvenile grayling migrate back to coastal streams to spend the remainder of their lives in fresh water reaches up to 100 km inland.

Adults appear to remain in the same stream their entire, short lives. Genetic studies of Grayling concluded that there is a single genetic stock along the Victorian coastal distribution. This indicates a high degree of dispersion and mixing during marine stage of the larvae and juveniles along the entire coast. This is further indicated in the National Recovery Plan conclusion that the species appears to be "able to recolonise rivers from which it has been excluded…for decades."

Assessment of effect

The Project processes that may affect Grayling are related to

1. Potential entrainment of:
    a. larvae during dispersion from freshwater streams into the marine environment, and
    b. juveniles that may live in or migrate through Western Port during their six to ten month marine phase.
2. Potential effects of the cold water discharge on dispersing larvae and migrating juveniles.
3. Potential toxic effects of free chlorine in the cold water discharge on dispersing larvae and migrating juveniles.

Larvae

Larvae may disperse into the marine environment during high freshwater flows from the Cardinia Creek, Bunyip River and Lang Lang River in the Embayment Head of Upper North Arm. The larvae are buoyant and will be located in the surface freshwater layer of the northern part of the Bay during wet weather events.

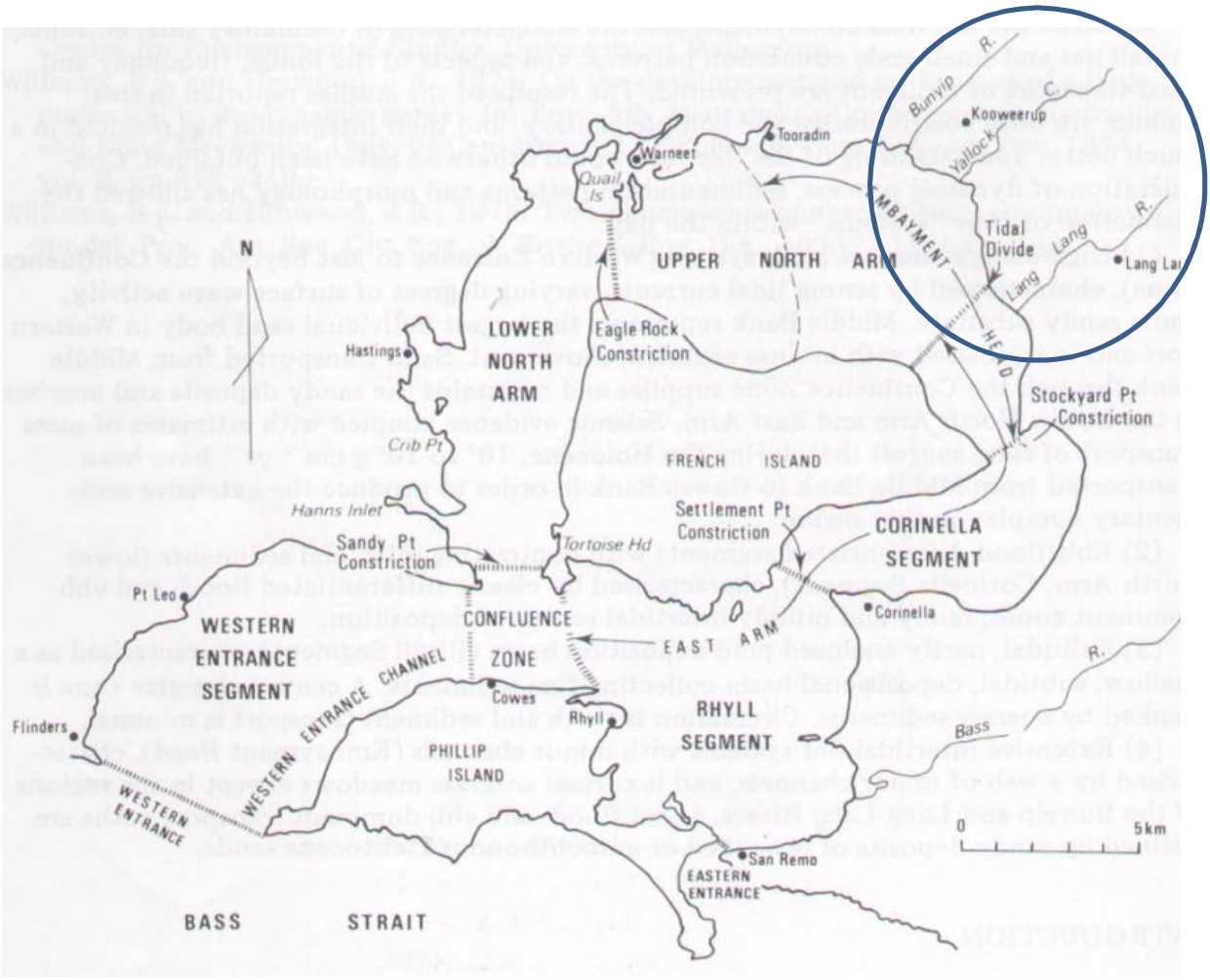

Figure 24. Location of grayling waterways in Upper North Arm

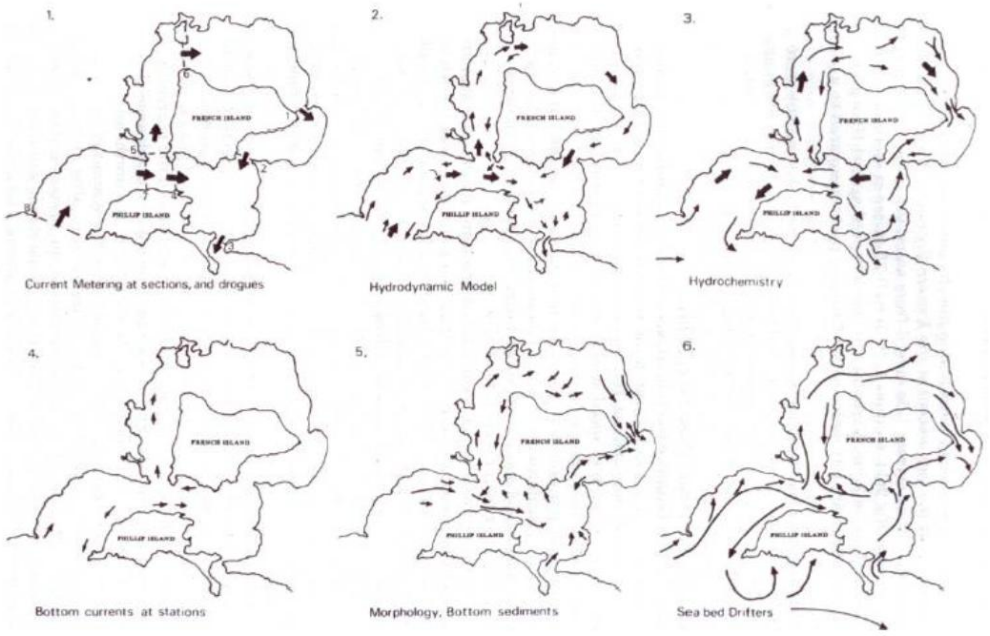

Figure 4.28: Independently developed net circulation patterns, taken from Harris et al. (1979).
1 = Hinwood and Jones (1979); 2 = Hinwood (1979); 3 = Harris and Robinson (1979); 4 = Sternberg (1979); 5 = Marsden et al. (1979); 6 = Marsden (1979).

Figure 25. General water movement in Western Port

General water movement in Western Port (Figure 25) shows a clockwise pattern of movement, with net current in the embayment head in the region of the rivers containing Grayling populations towards the east and then down the Corinella Segment. Hence a high proportion of larvae are likely to follow the currents down the eastern side of French island not past Crib Point.

Any proportion of larvae that may drift past Crib Point are likely to be in the surface layer as they are buoyant, and are therefore unlikely to be entrained by the intake located at least 4 m below the surface or be exposed to cold water or chlorine that are located within 2.5 m of the seabed.

Juveniles
Juvenile Grayling that live in the marine environment and migrate to suitable river systems are independent swimmers and are likely to avoid the intake current.

Adults
Based on the extent of potential impact pathways and the distribution of adult Grayling, the Project will have negligible effect on adult Grayling populations in freshwater reaches of Victorian streams.

6.4 Migratory species – preliminary assessment

In relation to migratory species that are not listed as threatened species (Bryde's Whale, Pygmy Right whale, Dusky Dolphin, Killer Whale and Mackerel Shark), the EPBC Act Policy Statement 1.1- Significant Impact Guidelines state that:

> *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 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.*

Based on the EPBC Act Policy Statement 1.1- Significant Impact Guidelines and the potential impact pathways described for the AGL Gas Import Jetty Project, there are no apparent direct or indirect pathways related of the Project that may affect Bryde's Whale, Pygmy Right whale, Dusky Dolphin, Killer Whale and Mackerel Shark: population size; area of occupancy; population continuity; critical habitat, breeding cycle; or species recovery.

6.5 Preliminary assessment of FFG marine listed species and communities

Most of the marine species and communities listed under the FFG Act are relatively remote from Crib Point and the possible risk to those species and communities from development and operation of the natural gas facility at Crib Point is negligible. Project risk screening will finalise the risk level for these species based on the above review information and project specific potential impact pathways.

6.5.1 Pale mangrove goby or flatback mangrove goby

The pale mangrove goby *Mugilogobius paludis* is listed as under the FFG Act as threatened and was recorded near Crib Point. However, as discussed in Section 5.4.5, this species is actually the flatback mangrove goby M *platynotus*, which is not listed as threatened under the FFG Act. The flatback mangrove goby is found only along the coast of eastern Australia and Western Port is the southeastern limit of its distribution.

The pale mangrove goby lives mostly in burrows among mangrove roots in the upper intertidal zone. Goby species vary considerably in their reproductive characteristics. Eggs may remain close to the position they are laid and fertilized, where they may be protected by the male. Hatched larvae, however, disperse from the mangrove habitats and have multiple stages that drift with ambient currents for weeks or months before they return to occupy suitable habitat as adults.

The location and positioning of the intake in the mid-water column will minimize entrainment of larvae if they have a preference for dispersal along natural boundaries. Further clarification of the status of this species on the FFG threatened species list is required.

6.5.2 Ghost shrimps

Two species of ghost shrimp are known from collections near Crib Point more than 50 years ago: the Western Port ghost shrimp *Pseudocalliax tooradin* and the small-gilled ghost shrimp *Michelea microphylla*. The location of the collections in Western Port are shown in Figure 26.

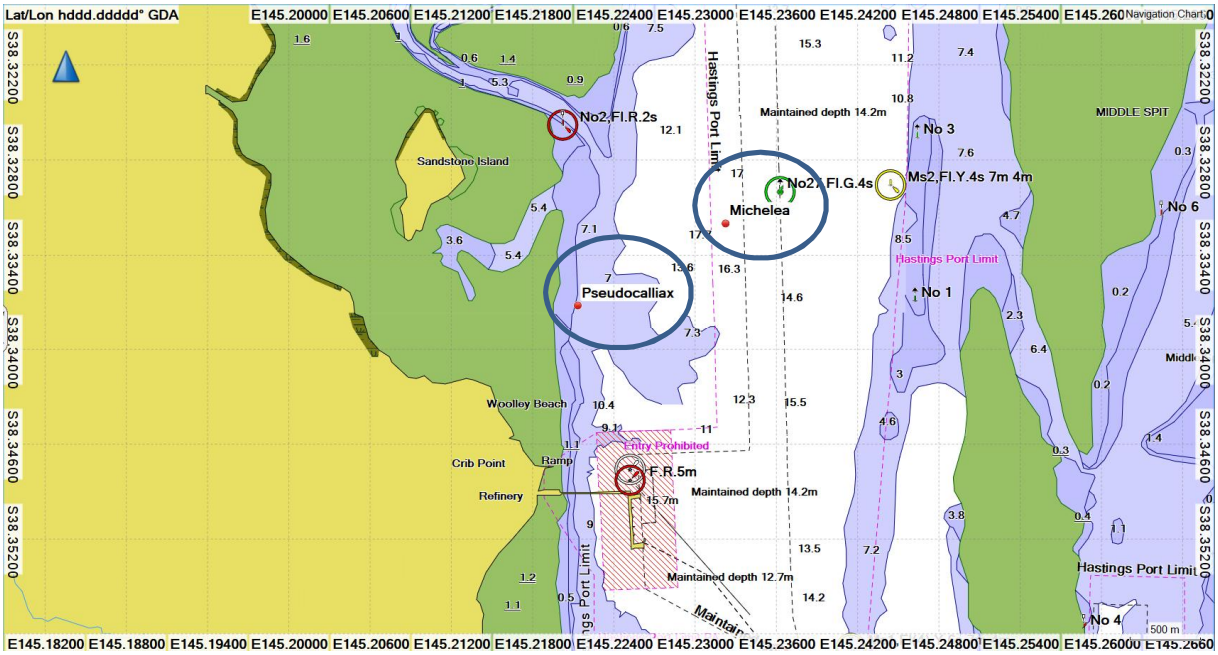

Figure 26. Locations of collection of FFG listed ghost shrimps near Crib Point

The local significance of both species is noted in the Western Port Ramsar Site Management Plan 2017.

Four individuals of *Pseudocalliax tooradin* were collected in grab sampling at 5 m depth (with one specimen collected from an unknown depth) during a survey in 1965. One other specimen of this species was collected at 2 m depth in Swan Bay in Port Phillip in 1982. Hence, this species is reasonably documented as a rare species.

One individual of *Michelea microphylla*, the only individual of this species known to exist, was found at 19 m depth. Dr Gary Poore, Emeritus Curator at the Museum of Victoria and the taxonomist who scientifically described this crustacean as a species, advised that the specimen he examined was complete, had features that were notably distinct from other ghost shrimp species and was definitely a separate and rare species. Dr Poore explained that, like *Pseudocalliax* and other ghost shrimps, this shrimp is a burrowing species and may occupy a deep burrow. This specimen was found in relatively deep water in sediments that is not often sampled to the depth of sediment occupied by the animal and its general location in Western Port. In conclusion, even though no specimens have been identified in more than 50 years, Dr Poore considered that it is still likely to be present in low numbers in suitable habitat.

Victorian Regional Channels Authority (VRCA) is responsible for maintaining navigational water depths into Geelong, Western Port and Portland. VRCA intend to level 95 m^2 of isolated high points at Berth 2 of Crib Point Jetty and engaged CEE to investigate the presence of threatened ghost shrimps in the vicinity of the high points (CEE 2018e). The investigation was designed by experienced marine biologists from CEE in consultation with Dr J Watson (Marine Science and Ecology) and Dr G Poore from the Museums of Victoria. The area was surveyed on 13 July 2018. No threatened species of ghost shrimp were found during the survey.

6.5.2.1 Assessment of entrainment effect

Both of these shrimps may have planktonic larvae with planktonic durations that could result in their susceptibility to entrainment. For example, some species of ghost shrimps in Western Port to related to *Pseudocalliax tooradin* and *Michelea microphylla* have larval periods (with four or five stages) totalling more than 15 days, while others have larval periods (with only two or three planktonic stages) totalling less than 14 days, while other have been estimated at six weeks (Butler, Reid and Bird, 2009). The behaviour of larvae in the water column is not known.

The adults of *Pseudocalliax tooradin* and *Michelea microphylla* have distributions that are restricted to the proximity of Crib Point. Preliminary modelling of biological entrainment by CEE for this Project (CEE, 2018b) shows that up to 10 per cent of larvae released on the western edge of the channel (including the adjacent mudflats) within about 750 m of Crib Point may be entrained into the heat exchange system of the FSRU. These levels may represent a significant proportion for these rare species if they are present within the Crib Point region.

6.5.2.2 Assessment of cold water and chlorine toxicity effect

Pseudocalliax tooradin was found at 5 m depth in Western Port and 2 m depth in Swan Bay. This would indicate that the species may be restricted to depths shallower than the cold water plume. Hence it may not be affected by temperature or chlorine toxicity effects. However, its distribution is only known from two samples. Hence, it may occur sparsely over a greater depth range.

Michelea microphylla was found approximately 2.4 km north of Crib Point Jetty, in gravelly seabed, at 19 m depth in the main North Arm channel. Its proximity to the FSRU, its presence close to the footprint of the cold-water pool and its occupancy of burrows indicates that it is susceptible to the cold-water discharge and residual chlorine toxicity exposure.

The impact of the discharge in seabed biota may be mitigated by discharge through a multi-port discharge that would increase dilution of the discharge and reduce the extent of possible toxicity effects.

6.5.2.3 Combined effect and recommendation

The combined effect of the cold-water discharge (including residual chlorine) and entrainment may be sufficient to affect populations of benthic species in the near proximity of the discharge. However, the distribution of benthic invertebrates including ghost shrimps in the channels of Western Port, including North Arm, has not been documented for more than 50 years. Hence, it is recommended that targeted sampling for these particular threatened ghost shrimps (as well as infauna and epifauna in general) be designed and implemented to document the present status of threatened species and character of the benthic invertebrate community. The study would also guide further assessment of the effects of the proposal on the marine ecosystem habitat of the channel soft sediment seabed.

6.6 Ramsar area

The designation of a Ramsar area is primarily based on its international importance to waterbirds. The marine environmental impact pathways described in Section 6.1 are highly unlikely to directly affect the activities of waterbirds in the intertidal areas and roosting areas of the Western Port Ramsar area.

As discussed in Section 4, Western Port meets seven of the nine criteria, but may meet eight of the criteria if Criterion 9 (below) includes FFG threatened species discussed in Section 5. The potential effects of impact pathways described in Section 6.1 on the Ramsar selection Criteria relevant to Western Port are summarised in Table 6.

Table 6. Assessment of Ramsar Selection Criteria

Ramsar criteria (based on DEE Criteria)	Potential effect
Criterion 1: Representative, rare, or unique example of a natural or near-natural wetland type.	Project does not involve physical changes to Western Port beyond jetty berths
Criterion 2: Supports vulnerable, endangered, or critically endangered species or threatened ecological communities.	Possible localised effects on some state listed threatened marine invertebrate species in North Arm
Criterion 3: Supports populations of plant and/or animal species important for maintaining the biological diversity.	Negligible effect on seagrasses and mangroves. Potential localised effects on channel soft seabed communities
Criterion 4: Supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.	Possible effects on plankton and planktonic life stages of some marine invertebrate species
Criterion 5: Regularly supports 20,000 or more waterbirds.	Marine pathways are unlikely to directly affect waterbirds in North Arm and most unlikely to affect waterbirds elsewhere in Western Port
Criterion 6: Regularly supports 1% of the individuals in a population of one species or subspecies of waterbird.	Marine pathways are most unlikely to directly affect waterbirds
Criterion 7: Supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and contributes to global biological diversity.	N/A
Criterion 8: Important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.	Possible effects on plankton and planktonic life stages of some marine invertebrate species
Criterion 9. Regularly supports 1% of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.	Possible effect on small-gilled ghost shrimp population

The table indicates that there is negligible to low risk to five of the Ramsar criteria. There is negligible risk to those criteria directly involving waterbird populations. There is possible interaction of the Project (cold-water discharge and entrainment pathways) with aspects of four Ramsar Criteria. This interaction is expected to occur within a confined part of North Arm within the larger Western Port Ramsar area and is unlikely to affect waterbird populations.

The level of potential effect on marine ecosystem values in the vicinity of the proposal within North Arm has been discussed in more detail in the plume dispersion report and modelling and assessment of biological entrainment reports. Benthic habitats in water depths less than less than 12.5 m will be unaffected by the direct effects of FSRU operation. These unaffected

habitats include intertidal saltmarsh, mangroves, seagrass and mudflat habitats, which are valuable foraging and roosting habitats for waterbirds. Subtidal seagrass and shallow, bare seabed habitats will also be unaffected by direct effects.

CEE marine ecosystem assessment reports (including this one) have recommended mitigation measures to minimise potential effects on the marine ecosystem including intake design for heat exchange system and multi-port discharge arrangement.

The general outcome of the reports indicates that the direct effects of the full-scale operation of the FSRU on the marine ecosystem in the Ramsar area will relate to discharge of cold-water, discharge of residual chlorine and entrainment of larvae and plankton. As stated above, the extent of cold-water and chlorine toxicity effects are likely to be restricted to an area approximately 200 m north and south and 60 m east and west of the discharge point in water depth from approximately 12.5 m to 17 m. This represents an area of approximately 5 ha, which is less than 0.5 % of the seabed depth in North Arm. Entrainment of up to 10 percent may extend to 750 m north and south from the FSRU, but overall entrainment in North Arm is expected to be less than 1 % of the whole of the North Arm.

The predominant habitats in the area are: bare soft seabed habitats occupied by invertebrate communities (infauna and epibiota) and some mobile fish, and; planktonic communities in the constantly moving water column of the main North Arm channel.

The longer term effects of entrainment on planktonic populations (including some planktonic larvae and eggs) are uncertain due to the possible intermittent and variable operation of the FSRU which depends on uncertain national and state energy supply options and state energy demands in the near future and over the next decades.

The modelling completed for this report and other supporting studies was based on the original FSRU seawater flow-through rate of 450,000 m^3/day (450 ML/day). AGL has advised that a seawater flow-through rate of 300,000 m^3/day (300 ML/day), corresponding to a lower regasification rate is more likely. In this case, the proportion of plankton entrained may be reduced by approximately one third.

CEE marine ecosystem assessment reports (including this one) have recommended further studies to inform assessment of the nature and extent of potential effects on the North Arm Ramsar marine ecosystem. The recommended studies from the marine ecosystem reports are:

- Benthic invertebrate sampling to document the present characteristics and distribution of epibiota and infauna including targeted investigation to evaluate the existence of ghost shrimp species;
- Measurement of short-term and long-term water temperature variations to provide natural variation context for assessment of cold-water discharge differentials
- Refinement of North Arm hydrodynamic models to assist refinement of discharge dispersion models and entrainment estimation models
- Development of entrainment models for North Arm to provide plankton entrainment proportion contours
- A plankton and larval sampling program to provide information on spatial and temporal variations in plankton populations in North Arm focussing on the proposed location and position of the FSRU intake.
- Review of available literature on the effects of entrainment on semi-enclosed marine ecosystems to provide guidance on long-term ecosystem implications of plankton entrainment.

7 CONCLUSION

The review of marine Commonwealth EPBC Act matters of national environmental significance and the State FFG Act listed species has been completed for the AGL Gas Import Jetty Project. The assessment identified 33 threatened marine species (excluding birds) and one marine community that the Acts list may occur in Western Port.

CEE's review found that many of the species in the State and Commonwealth Acts were relatively widely distributed, that Western Port represented a small component of their range and that Western Port was not recognised as a significant aggregation, breeding or feeding location or migratory path for most EPBC identified species and many FFG listed species (excluding water birds).

The initial review identified four species where further investigations have been undertaken to inform this assessment:

- Australian Grayling *Prototroctes maraena*: EPBC Act 'Vulnerable'; FFG listed
- Pale Mangrove Goby *Mugilogobius paludis*: FFG listed
- Western Port ghost shrimp *Pseudocalliax tooradin*: FFG listed
- Ghost shrimp *Michelea microphylla:* FFG listed

Further examination of information about the Australian Grayling indicated that adult populations in the rivers and streams would not be exposed to impact pathways and that the proportion of larvae of these species that might disperse via North Arm and be affected by Project processes was low.

Museums of Victoria personnel advised that the Pale Mangrove goby *Mugilogobius paludis* was synonymous with the more common flatback goby *Mugilogobius platynotus,* which is not listed on the FFFG threatened species list.

The Western Port ghost shrimp *Pseudocalliax tooradin* and the ghost shrimp *Michelea microphylla* are known from collections near Crib Point more than 50 years ago. The Western Port ghost shrimp *Pseudocalliax tooradin* is known from a total of five records, and the ghost shrimp Michelea microphylla is known from only one specimen. No further records of the ghost shrimp species have been recorded since 1965 in Western Port or elsewhere (with the exception of Western Port ghost shrimp with one additional record outside of Western Port in 1982). This is despite a comprehensive sampling program for the Western Port study in the 1970s (Coleman et al, 1978).

Benthic habitats in water depths less than less than 12.5 m of the Ramsar area will be unaffected by the direct effects of the seawater heat exchange discharge from the FSRU operation. These unaffected habitats include intertidal saltmarsh, mangroves, seagrass and mudflat habitats, which are valuable foraging and roosting habitats for waterbirds. Subtidal seagrass and shallow, bare seabed habitats in the Ramsar area will also be unaffected by direct effects.

CEE marine ecosystem assessment reports (including this one) have recommended mitigation measures to minimise potential effects on the marine ecosystem including intake design for heat exchange system to minimise entrainment of biota from the water column and multi-port discharge arrangement to minimise effects of cold-water discharge on marine biota.

The general outcome of the reports indicates that the direct effects of the full-scale operation of the FSRU on the marine ecosystem in the Ramsar area relate to discharge of cold-water, discharge of residual chlorine and entrainment of larvae and plankton. As stated above, the

extent of cold-water and chlorine toxicity effects are likely to be restricted to an area approximately 200 m north and south and 60 m east and west of the discharge point in water depth from approximately 12.5 m to 17 m. This represents an area of approximately 5 ha, which is less than 0.5 % of the seabed in North Arm[2]. Entrainment of up to 10 percent of some plankton and larvae may extend to 750 m north and south from the FSRU, but overall entrainment in North Arm is expected to be less than 1% of the whole of the North Arm. The predominant habitats in the area that may be affected are: bare soft seabed habitats occupied by invertebrate communities (infauna and epibiota) and some mobile fish, and; planktonic communities in the constantly moving water column of the main North Arm channel.

The longer term effects of entrainment on planktonic populations (including some planktonic larvae and eggs) are uncertain due to the possible intermittent and variable operation of the FSRU which depends on uncertain national and state energy supply options and state energy demands in the near future and over the next decades. The duration of operation will depend in multiple factors including security of energy supply and raw energy supply markets.

AGL is committed to further marine environmental studies prior to operation and is presently considering:

- Benthic invertebrate sampling to document the present characteristics and distribution of epibiota and infauna including targeted investigation to evaluate the existence of ghost shrimp species;
- Measurement of short-term and long-term water temperature variations to provide natural variation context for assessment of cold-water discharge differentials
- Refinement of North Arm hydrodynamic models to assist refinement of discharge dispersion models and entrainment estimation models
- Development of entrainment models for North Arm to provide plankton entrainment proportion contours
- A plankton and larval sampling program to provide information on spatial and temporal variations in plankton populations in North Arm focussing on the proposed location and position of the FSRU intake.
- Review of available literature on the effects of entrainment on semi-enclosed marine ecosystems to provide guidance on long-term ecosystem implications of plankton entrainment.

These studies will inform a works approval application under the *Environment Protection Act 1970* and in accordance with the relevant associated regulations, including the State Environment Protection Policy (Waters of Victoria).

[2] Percentage based on the area of North Arm which is greater than 10 m depth.

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