Marine Ecology | Appendix C

Aquatic Biodiversity Assessment

PROPOSED SOUTH EAST FIBRE EXPORTS 5.5 MW BIOMASS FIRED POWER PLANT, EDEN

DECEMBER 2009

nghenvironmental

Document Verification

Job title: Proposed South East Fibre Exports 5MW Biomass Fired Power Plant, Eden

Document Title	Aquatic Biodiversity Assessment
File Name	\\Sydney\Active\Projects\2009\URS\Powestation Eden-957\Report\Aquatic Biodiversity Assessment Draft.doc

Revision	Date	Prepared by Raphael Morgan		Checked by Natascha Arens		Approved by Natascha Arens	
Draft v1	9.12.09	name		name		name	
Draft v2	11.12.09	name		name		name	

206/410 elizabeth st surry hills nsw 2010 australia t *61 2 8202 8333* ***f*** *61 2 9211 1374*

web*: www.nghenvironmental.com.au* ***email****: ngh@nghenvironmental.com.au*

1/216 carp street (po box 470) ***bega*** *nsw 2550* ***australia t*** *61 2 6492 8333* ***f*** *61 2 6494 7773*

102/63-65 johnston st wagga wagga nsw 2650 australia t 61 2 6971 9696 f 61 2 6971 9693

suite 4/4, 234 naturaliste terrace ***dunsborough*** ***wa*** *6281* ***australia t*** *61 8 9759 1985* ***f*** *61 2 6494 7773*

Table of Contents

Figures

1 INTRODUCTION

1.1 PROPOSAL IDENTIFICATION

South East Fibre Exports Pty Ltd (SEFE) is proposing to build a 5.5 mega watt (MW) biomass fired power plant using wood waste as fuel. SEFE is a timber processing company that produces and exports both hardwood and softwood chips. The biomass power plant would be situated on SEFE's Munganno Point chip mill site, located on the southern shoreline of Twofold Bay (Figure 1-1).

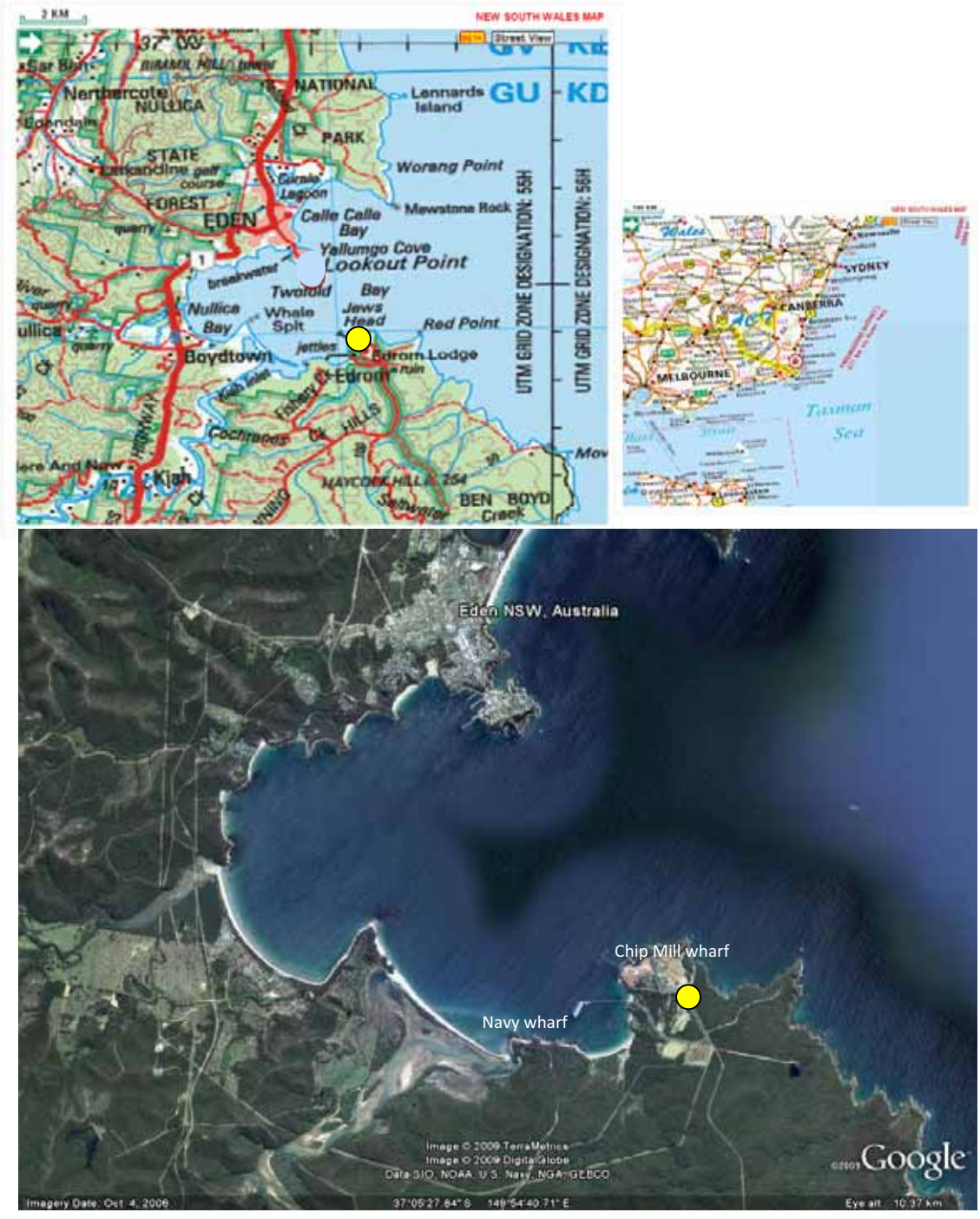

Figure 1-1. Location of SEFE chip mill (yellow) (Source: www.street-directory.com.au and Google Earth).

1.2 PROPOSED POWER PLANT

1.2.1 General layout and components

The construction of the proposed 5.5 MW biomass fired power plant would be undertaken in the area currently occupied by SEFE's mill waste burner. SEFE generates around 40,250 tonnes of mill waste in the form of wood fines and bark. This waste is either sold as landscaping material or disposed of in the on-site mill waste burner. The biomass-fired power plant would turn this waste into electricity for onsite use (9GWh), with 22GWh sold into the national electricity grid.

The proposed power plant would include the following components:

- An uncovered area for fuel storage, weatherproof fuel storage shed with 1000m^3 capacity; fuel reclaim bunker and fuel feed conveyor (reused from existing plant) and 90 tonne fuel storage dry bin (all of which will be in the area that screened fines and bark are currently stored).
- Boiler package including grate furnace, boiler make-up water treatment system, steam boiler incorporating a superheater, flue gas exhaust stack (around 35m high), 11KV electrical power generator and 15MW steam cooling/condensing system utilising sea water (all of which will be in the area currently occupied by the mill waste burner). The biomass power plant will consume water to make up for water expelled from the boiler as "blow-down water" at the rate of a maximum of 350 litres per hour or 3 mega litres (ML) annually. The water would be sourced from the chip mill's existing freshwater supply system.
- Reverse osmosis make-up water treatment system (situated between the proposed power plant and existing ship loading wharf).
- Seawater supply and disposal pipes for cooling water running from the ship loading wharf to the power plant within SEFE's site boundary fence.

A plan locating the proposed power plant is provided in **Figure 1-2**.

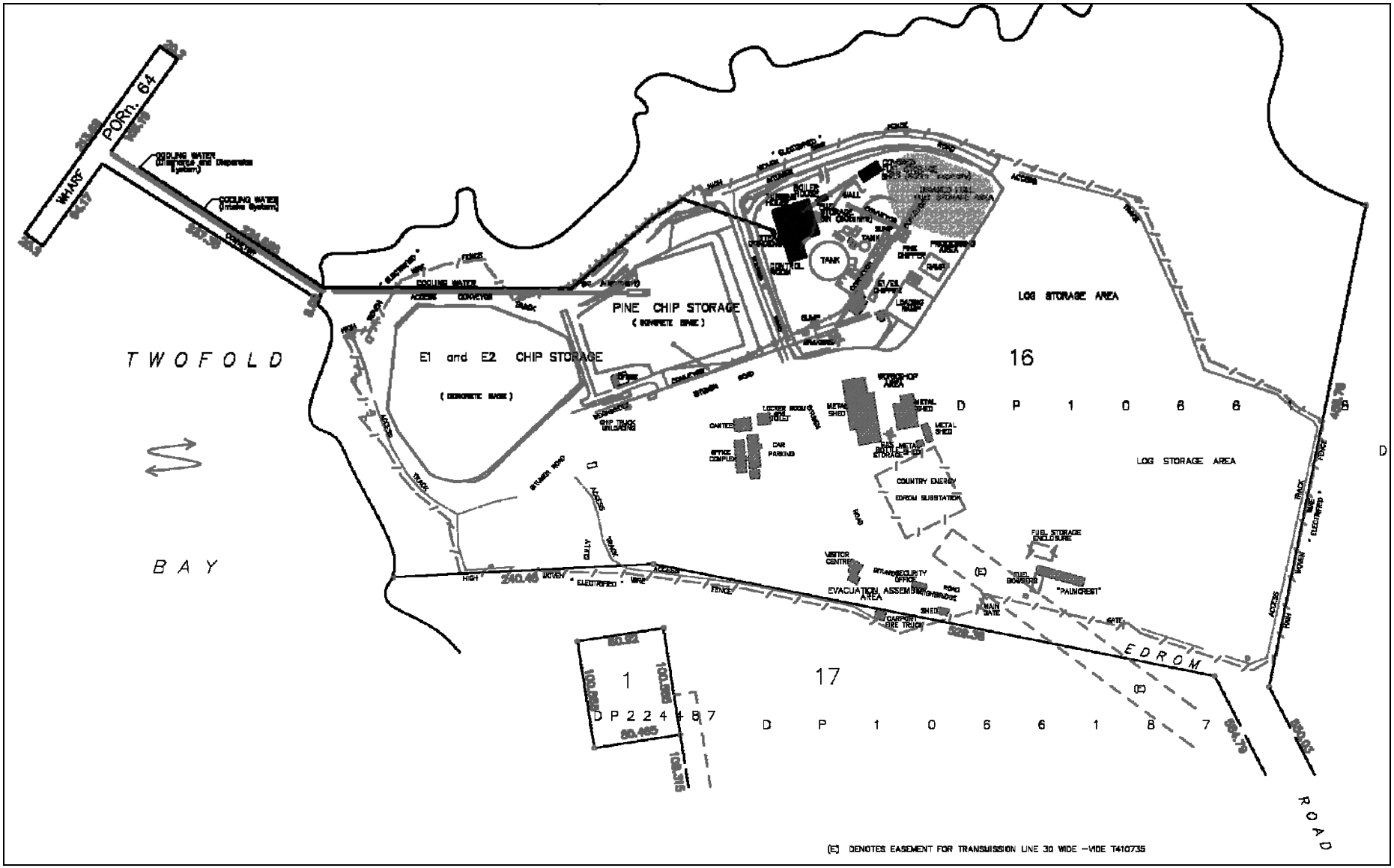

Figure 1-2. Schematic of proposed power plant

1.2.2 Seawater Cooling System

The power plant would use up to 29 Mega Litres per day (ML/d) of seawater for cooling (333L/s).

Seawater would be pumped to the condenser via a 450m long, 450mm diameter above ground delivery pipeline. It would pass once through the condenser and would be returned via a 400mm return pipeline to the discharge point. The intake and outlet structures would be installed on the existing jetty structure. A schematic of the cooling system is shown in **Figure 1-3**.

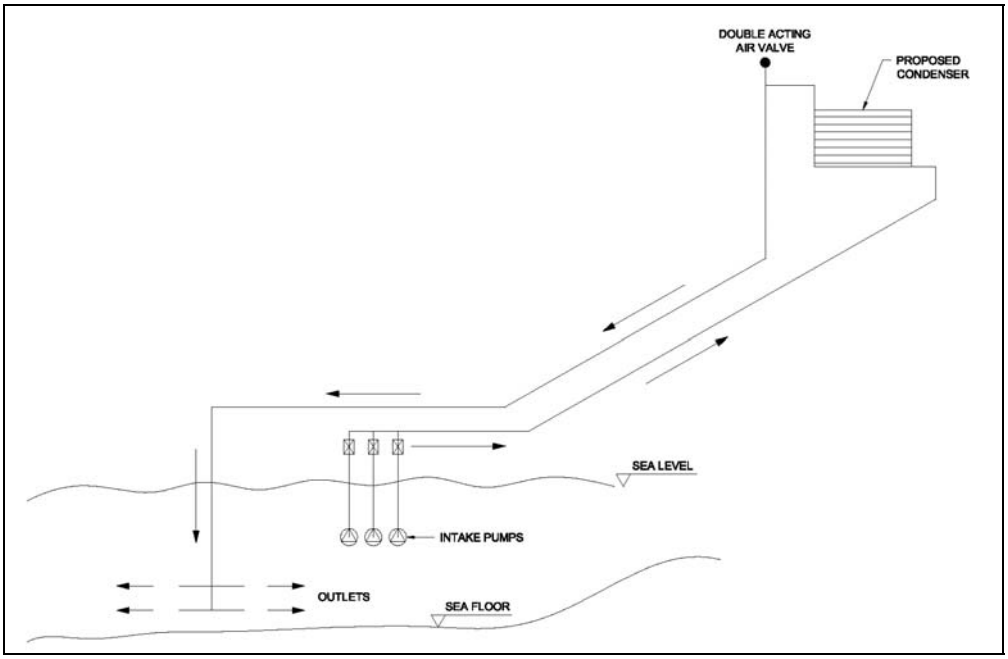

Figure 1-3. Schematic of the cooling system.

Intake structure

The inlets would be positioned approximately 90m from the shore where the average sea floor is at -9.2m datum level. The intake would be approximately midway between low tide level and the ocean floor, but not lower than 2m from the ocean floor.

The design incorporates three intake pumps with the capability for two duty pumps to deliver the full flow while the third pump is under maintenance.

The pumps would be located in a sleeve to stabilise the pump and the riser pipe against wave forces and to provide a mounting point for the intake screen. The sleeve would be supported by a concrete footing. This would anchor the bottom of the sleeve against wave forces. The proposed arrangement of the intake is indicated in Figure 1-4.

Wedge wire type screens would be used to remove suspended particles greater than 2mm in diameter. This type of screen provides continuous slot openings that widen inwardly, making the screen self-cleaning by allowing "near slot size" particles to pass through rather than plug the openings.

The maximum intake velocity through the intake screens would be 0.1 metres per second (m/s). To achieve this intake velocity the screens would have a diameter of 700mm and a length of 1717mm. Wedge wire screens have a high open area by comparison with other screen media, giving lower entrance velocities and higher flow rates through the screen.

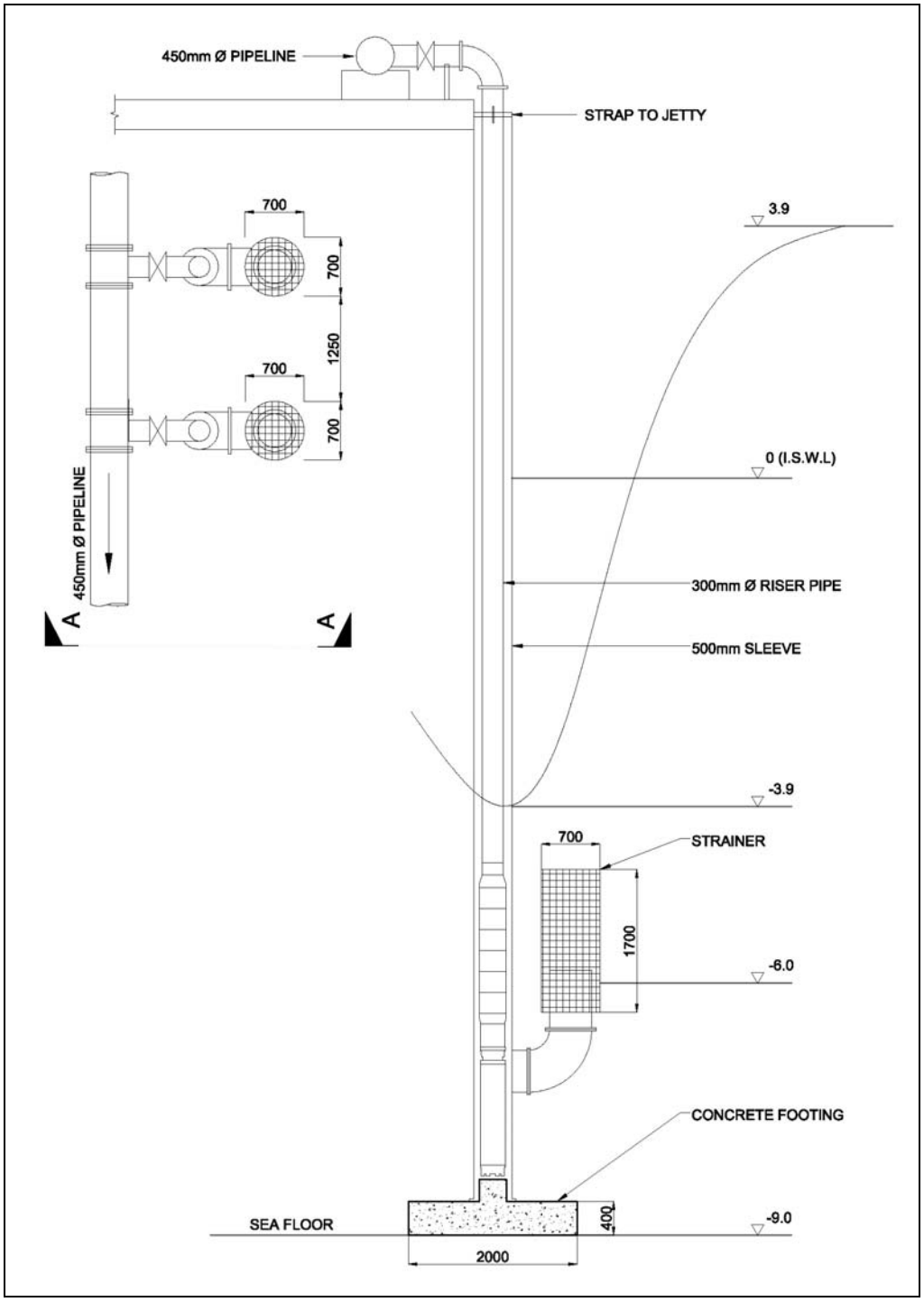

Figure 1-4. Intake structure

Outlet structure

The outlet would be located approximately 190m from the shore where the average sea floor is at -14m datum level. The outlet pipeline would end with a vertical section down to the sea floor with two 150mm outlets at 2m from sea bed and another two at 1m from the sea bed (**Figure 1-5**). The outlet pipe will angled at 30 degrees towards the surface.

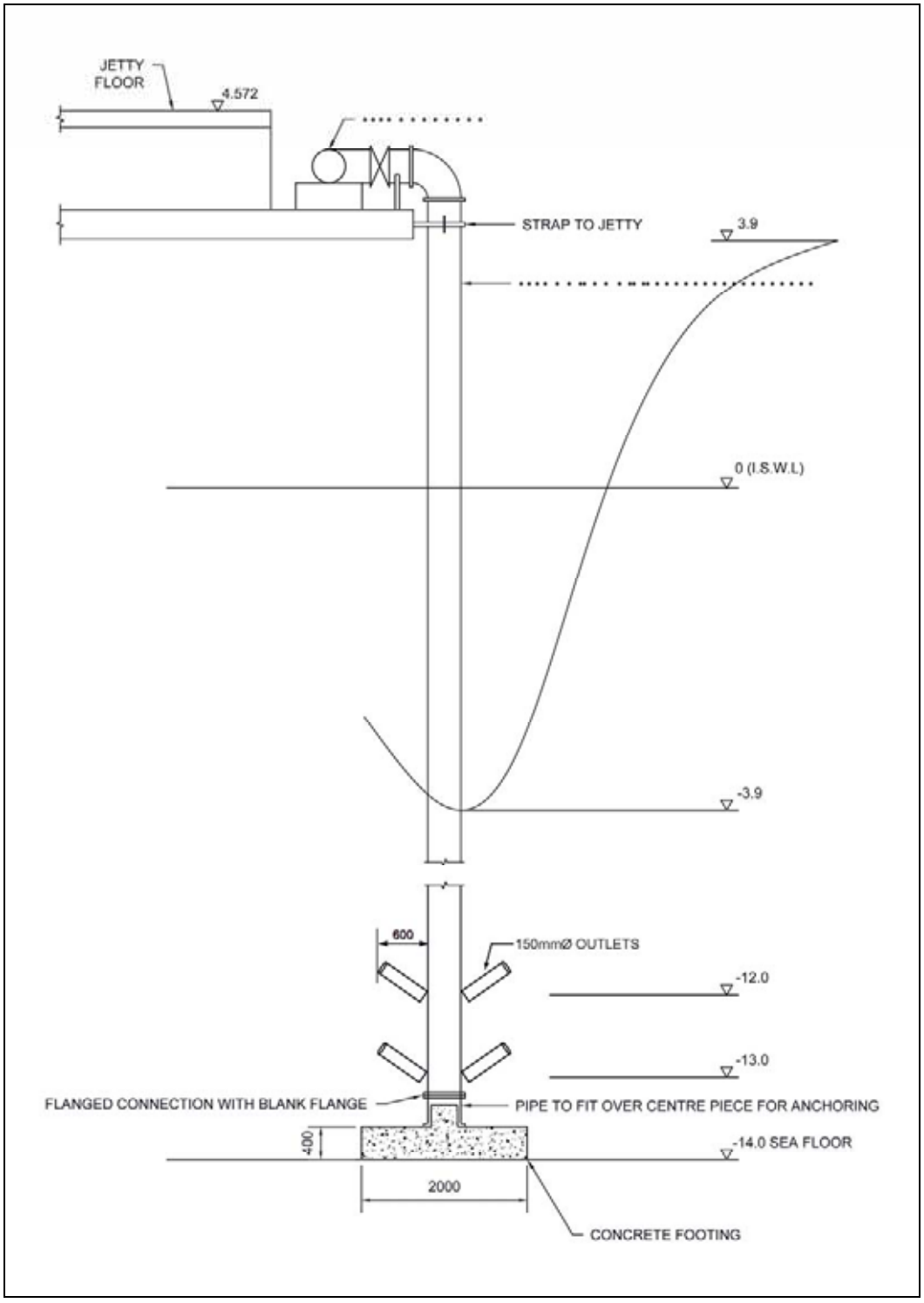

Figure 1-5. Outlet Structure

The return water would be between 10 to 21 ^{o}C warmer than the ambient seawater temperature in summer and winter respectively.

1.3 PURPOSE OF THIS REPORT

This report has been prepared by **ngh**environmental on behalf of SEFE to assess the potential impacts of the proposed power plant on the aquatic environments (freshwater and marine).

The purpose of this assessment is to describe the proposal, describe the existing aquatic environments, document the likely impacts of the proposal on the environment and detail protective measures to be implemented.

The description of the proposed works and associated environmental impacts have been undertaken in context of clause 228 of the *Environmental Planning and Assessment Regulation 2000*, the *Threatened Species Conservation Act 1995* (TSC Act), *the Fisheries Management Act 1994* (FM Act), and the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). In doing so, this report helps to fulfil the requirements of Section 111 of the *Environmental Planning and Assessment Act 1979* (EP&A Act), that SEFE examine and take into account to the fullest extent possible, all matters affecting or likely to affect the environment by reason of the activity. The project is being prepared under Part 3A of the EP&A Act and therefore this report has been prepared to address the requirements of 75F of the EP&A Act and the relevant Director Generals requirements.

To fulfil this requirement, this report has been divided in the following sections:

- Introduction: provides information on the proposed power plant and its location and details the purpose of this report.
- Legislative framework: details the legislative context of the proposed works and the assessment requirements of the various government agencies.
- Methodology: details the methodology used to assess the potential impacts of the proposed works.
- Results: details the results of background research and field surveys and describes the existing aquatic environments at the proposal site.
- Impact Assessment: details the potential construction and operational impacts of the proposed works on the aquatic environments.
- Environmental Management: details mitigation measures to remove or reduce potential construction and operational impacts and details any licensing/approval requirements in regards to aquatic environments.
- Conclusion: summarises the findings of the study and states whether or not significant impacts are likely to occur.

2 LEGISLATIVE FRAMEWORK

State Environmental Planning Policy (Major Projects) 2005 identifies the proposed development as a major project for which the assessment and approval process under Part 3A of the EP&A Act would apply.

The assessment requirements of the Department of Planning (DoP) Director General, Department of Primary Industry (DPI) and Department of Environment, Climate Change and Water (DECCW) as they relate to aquatic biodiversity are provided in **Table 2-1**.

Table 2-1. Department of Planning (DoP), Department of Primary Industry (DPI) and Department of Environment, Climate Change and Water (DECCW) aquatic biodiversity assessment requirements and responses

Assessment Requirement	Response
Director General	
The EA must include an assessment of all project components on flora and fauna and their habitat in accordance with the Threatened Species Assessment Guidelines (DECC 2007).	Section 5
Include details on the existing site conditions and quantity and likelihood of disturbance. Consider the likely impact on regionally significant protected and threatened species and their habitat.	Section 4 and 5, Appendix E
Consider the impacts (both temporary and permanent) of the proposal to the Twofold Bay region and adjoining Twofold Bay estuary and any associated threatened flora and fauna species including but not limited to: • Seagrass beds, including sensitive Posidonia seagrass populations and habitat • Macroalgae – seaweeds • Fish – including any threatened species and protected species listed under the Fisheries Management Act 1994 – eg. black cod (*Notothenia microlepidota*), seahorses (syngnathids), benthic organisms and the intertidal zone • Cetaceans – Including migratory species such as the humpback Whales (*Megaptera novaeangliae*), southern right whales (*Eubalaena australis*) and blue whales (*Balaenoptera musculus*) This should include assessment of both direct impacts (removal, disturbance) and indirect impacts (eg. water temperature changes) of the proposed development, especially impacts of the proposed extraction and discharge of cooling water and any anti-fouling agents to Twofold Bay.	Section 5, Appendix E
Details of how flora and fauna impacts would be managed during construction and operation including adaptive management and maintenance protocols.	Section 6
Describe measures to avoid, mitigate or offset impacts consistent with improve or maintain principles. Sufficient details must be provided to demonstrate the availability of viable and achievable options to offset the impacts of the project.	Section 6
For all chemicals used in the process such as biocides, corrosion inhibitors, antiscalants, etc an assessment should be undertaken of the potential for environmental impact at the discharge point	Section 5
An assessment of the direct and indirect impacts of the development (including cooling water extractions and discharges) on nearby aquaculture operations (mussel farms),	Section 5

Assessment Requirement	Response
and recreational and commercial fishing in Twofold Bay, especially in terms of water quality, food safety impacts, access issues or restrictions on fishing areas or boat movements.	
DPI	
Detailed description of aquatic environments located on the site or adjacent to the site of the proposed development and assessment of their regional significance and habitat values. A comprehensive aquatic survey should be undertaken to document the status of the aquatic environment (including extent and distribution of seagrass and macroalgae – seaweeds), fish communities and benthic invertebrates communities at the proposed cooling water intake and discharge areas.	Section 4
Analysis of any interactions of the proposed development and works with aquatic species and environments, including marine vegetation (eg, seagrass and macroalgae – seaweeds), fish including any aquatic threatened species or protected species listed under the Fisheries Management Act 1994 eg. black cod, syngnathids), benthic organisms and the intertidal zone.	Section 5
Predictions of any impacts (both temporary and permanent) upon aquatic species and environments, including marine vegetation (eg. seagrass and macroalgae – seaweeds), fish including any aquatic threatened species or protected species listed under the Fisheries Management Act 1994 eg. black cod, syngnathids), benthic organisms and the intertidal zone. This should include assessment of both direct impacts (removal, disturbance) and indirect impacts (eg. water temperature changes) of the proposed development, especially impacts of the proposed extraction and discharge of cooling water and any anti-fouling agents to Twofold Bay	Section 5
Safeguards to mitigate any impacts upon aquatic species and environments (eg. full details of proposed management regime for cooling water extractions and discharges including anti-fouling treatments, proposed monitoring program for aquatic species, etc).	Section 6
An assessment of the direct and indirect impacts of the development (including cooling water extractions and discharges) on nearby aquaculture operations (mussel farms), and recreational and commercial fishing in Twofold Bay, especially in terms of water quality, food safety impacts, access issues or restrictions on fishing areas or boat movements.	Section 5
DECCW	
Determine the impacts on aquatic flora and fauna from all intake and discharge points. This should include an assessment of impacts at the intake and discharge points, including, but not limited to, impingement of organisms on any screens, and impacts on organisms due to heat sterilisation in the processing system. The assessment should outline any proposed management and mitigation measures to protect aquatic flora and fauna from identified impacts.	Section 5 and 6
Determine the nature and degree of impact that any proposed discharges will have, individually and cumulatively, on the structure, composition and function of the aquatic ecosystem and organisms. The ANZECC and ARMCANZ (200) temperature guidelines in Volumes 1 and 2 and the protocol used to derive the appropriate temperature guidelines for Australian waters, outlined in section 8.2.3.4, should be referred to when predicting the impact of thermal discharges on the aquatic ecosystem.	Section 5
Develop a water quality and aquatic ecosystem monitoring program to monitor the responses for each component or process that affects the water quality objectives and includes:	Section 6

Assessment Requirement	Response
• key components or processes, including flow regime and the abundance and composition of phytoplankton, submerged and flowering aquatic vegetation, macro-invertebrates and fish	
A field survey of the site (including intake and discharge points) should be conducted and documented in accordance with the draft 'Guidelines for threatened species assessment'	Section 4
Likely impacts on regionally significant protected and threatened species and their habitat need to be assessed, evaluated and reported on. The assessment should specifically report on the considerations listed in Step 3 of the draft guidelines.	Section 5, Appendix E
The environmental assessment should clearly state whether it meets each of the key thresholds set out in Step 5 of the draft guidelines and describe the actions that will be taken to avoid or mitigate impacts or compensate to prevent unavoidable impacts of the project on threatened species and their habitat. This should include an assessment of the effectiveness and reliability of the measures and any residual impacts after these measures are implemented.	Section 6
The environmental assessment must consider the direct and indirect impacts of the proposal (both construction and operation phases) to the Twofold Bay region and adjoining Twofold Bay Estuary and any associated threatened flora and fauna species, including but not limited to: • Seagrass beds, including sensitive Posidonia seagrass populations and habitat • Cetaceans – Including migratory species such as the humpback Whales (*Megaptera novaeangliae*), southern right whales (*Eubalaena australis*) and blue whales (*Balaenoptera musculus*)	Section 5

2.1.1 Relevant legislation and policies relating to the aquatic environments

State Environmental Planning Policy No 71—Coastal Protection

This policy applies to the coastal zone and is relevant to the Proposal. The aims of this Policy are:

(a) to protect and manage the natural, cultural, recreational and economic attributes of the New South Wales coast, and

(b) to protect and improve existing public access to and along coastal foreshores to the extent that this is compatible with the natural attributes of the coastal foreshore, and

(c) to ensure that new opportunities for public access to and along coastal foreshores are identified and realised to the extent that this is compatible with the natural attributes of the coastal foreshore, and

(d) to protect and preserve Aboriginal cultural heritage, and Aboriginal places, values, customs, beliefs and traditional knowledge, and

(e) to ensure that the visual amenity of the coast is protected, and

(f) to protect and preserve beach environments and beach amenity, and

(g) to protect and preserve native coastal vegetation, and

(h) to protect and preserve the marine environment of New South Wales, and

(i) to protect and preserve rock platforms, and

(j) to manage the coastal zone in accordance with the principles of ecologically sustainable development (within the meaning of section 6 (2) of the Protection of the Environment Administration Act 1991), and

(k) to ensure that the type, bulk, scale and size of development is appropriate for the location and protects and improves the natural scenic quality of the surrounding area, and

(l) to encourage a strategic approach to coastal management.

This Policy:

(a) identifies State significant development in the coastal zone, and

(b) requires certain development applications to carry out development in sensitive coastal locations to be referred to the Director-General for comment, and

(c) identifies master plan requirements for certain development in the coastal zone.

This Policy also aims to further the implementation of the Government's coastal policy.

State Environmental Planning Policy 62 – Sustainable Aquaculture

This policy applies to all developments that may have an adverse effect on oyster aquaculture developments or a priority oyster aquaculture area. Before determining a development application for any development, a consent authority must consider whether, because of its nature and location, the development may have an adverse effect on oyster aquaculture development or a priority oyster aquaculture area. If it suspects that the development may have that effect, then it must give notice of the application to the Director-General of the Department of Primary Industries and consider any comments received. The development is not located in vicinity of oyster aquaculture leases and therefore this policy does not apply.

Threatened Species Conservation Act 1995 (TSC Act)

An assessment of the potential impacts of the Proposal on threatened species, populations, ecological communities and critical habitat listed in the TSC Act must be undertaken in accordance with section 5A of the EP&A Act (7 part test).

Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)

Approval by the environment minister is required if an action is likely to have a significant impact on a matter of national environmental significance.

Fisheries Management Act 1994 (FM Act)

To assist in the protection of key fish habitats, the Act enables the Minister for Fisheries to make Habitat Protection Plans (HPPs) for the protection of any fish habitat, "whether the habitat is critical for the survival of the species or required to maintain harvestable populations of fish". The following apply to the Proposal:

Habitat Protection Plan 1 – General. This plan includes management measures to protect various aquatic habitats such as seagrasses from damage. It outlines the process for individuals or agencies to follow when consent, notification or consultation is required.

Habitat Protection Plan 2 – Seagrass. The primary objective of this Plan is to ensure there is no net loss of seagrasses within the coastal and estuarine waters of NSW by providing guidance for certain activities.

Furthermore, a licence is required for the following relevant activities:

- Cutting, removal, damage or destruction of mangroves, seagrasses or any other prescribed marine vegetation.
- Dredging and reclamation

Also, an assessment of the potential impacts of the Proposal on threatened species, populations, ecological communities and critical habitat listed on the FM Act must be undertaken in accordance with section 5A of the EP&A Act (7 part test).

3 METHODOLOGY

3.1 BACKGROUND RESEARCH

3.1.1 Database searches

Database searches for threatened, protected or other listed aquatic species listed on the TSC Act, EPBC Act and FM Act were undertaken using Bionet (TSC Act and FM Act listed species), Wildlife Atlas (TSC Act listed species) and EPBC Protected Matters search tool (EPBC Act listed species). Searches were undertaken within a 10km radius centred on the proposal site.

The Bionet and Wildlife Atlas search tools lists species previously recorded within the defined search area. The EPBC Act Protected Matters lists species whose habitat requirements have the potential to occur within the defined search area.

3.1.2 Literature Review

A literature review of previous studies relating to the following subject matters was undertaken:

- Aquatic fauna and flora of the Twofold Bay region.
- Impacts of thermal pollution on aquatic biodiversity.
- Impacts of impingement and entrainment on aquatic biodiversity.
- Intake and discharge pipe mitigation measures relating to aquatic biodiversity.
- Construction impacts on aquatic biodiversity with a particular focus on noise impacts on cetaceans.

3.2 FIELD SURVEYS

3.2.1 Marine environment

To assess the potential impacts of the proposal on aquatic biodiversity, intertidal and subtidal aquatic habitats were surveyed at five sites. Three sites within 100m of the proposal site (ie. Chip mill wharf and jetty; P1-P3) and two within Twofold Bay but at least 500m from the proposal sites were surveyed (reference sites R1-R2) (**Figure 3-1**).

Table 3-1. Site locations, transect descriptions and GPS coordinates

Site	Transect description	GPS coordinate
P1	Transect parallel and alongside chip mill jetty.	55H 760226 E 5889816 S
P2	Transect starting at the chip mill wharf, being perpendicular and centred on the chip mill wharf and going out into Twofold Bay	55H 760032 E 5889940 S
P3	Transect perpendicular to the shoreline and in vicinity of the chip mill jetty	55H 760202 E 5889672 S
R1	Transect perpendicular to the shoreline in vicinity of the navy wharf jetty	55H 760243 E 5889298 S
R2	Transect perpendicular to the shore line at Torarago Point	55H 757356 E 5890415 S

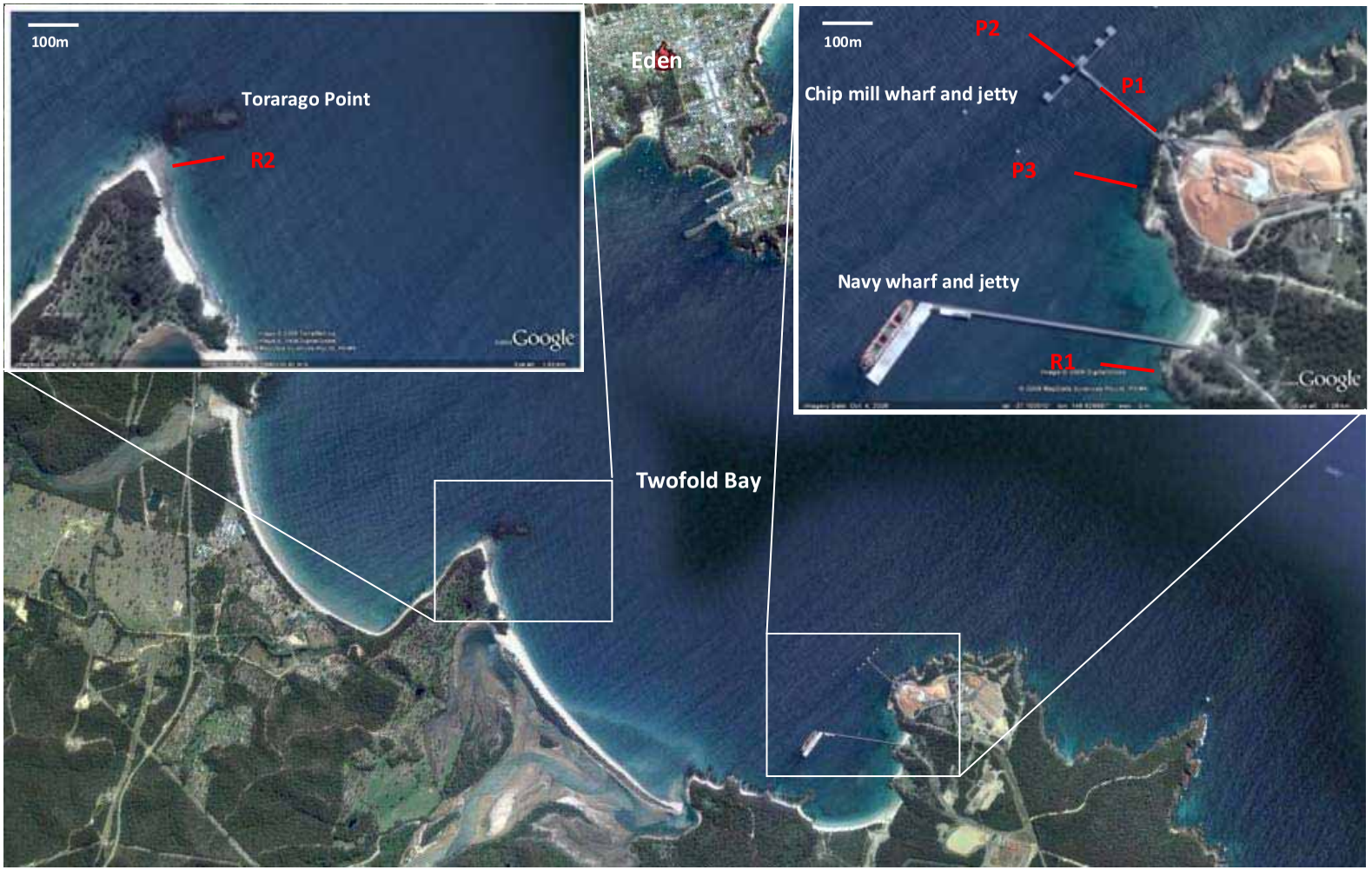

Figure 3-1. Locations of survey sites within Twofold Bay. Red lines: transects; R1-R2: reference sites, P1 – P3: Proposal sites.

Site surveys were undertaken the 3rd, 4th and 20th July 2009. Weather conditions on the 3rd and 4th July 2009 were poor with high winds and choppy sea conditions. Visibility was reduced to approximately 5 metres. Weather conditions on the 20th July were good, with calm sea conditions. Visibility was approximately 10m.

Habitat surveys

Intertidal habitat surveys

Intertidal habitats were determined through a combination of aerial photograph analysis and ground truthing. Habitats mapped using this method included rocky reefs, sand and a combination of both.

Subtidal habitat

At each site a transect ranging from 100 to 150m in length perpendicular to the shore line was surveyed. SCUBA divers noted the habitat type and depth every 5 metres or when habitat changed whichever came sooner. Underwater photography was used to record the various habitats encountered.

Where seagrass was encountered the species, percent cover and blade length of 10 random shoots within three replicate quadrats ($0.25m^2$) were recorded. Table 3-1 provides a brief description of the transects and Figure 3-1 illustrates their location.

Fish surveys

During the habitat surveys, SCUBA divers recorded the fish species and numbers within 2m of the transect line. The habitat of observed fish was also recorded.

Opportunistic sightings of fish outside the corridor were recorded.

Targeted searches for the weedy seadragon were undertaken in suitable habitats (macroalgal beds and seagrass beds).

At sites P1 and P2, five random pylons were surveyed and fish species within 1m recorded.

Invertebrate and macroalgal species surveys

During the habitat surveys, conspicuous invertebrate and macroalgal species observed were recorded. Furthermore, 3 random sediment cores (150mm deep x 100mm wide) were taken and sieved on 1mm and preserved in 70% ethanol. Sediment cores were taken at similar depths (4-8metres) at sites P1, R1 and R2. Species collected were identified to the family level when possible.

3.2.2 Freshwater environment

Three freshwater reservoirs/dams are located in the vicinity of the proposal site and would be used by the power plant to make up for water expelled from the boiler as “blow-down water”. The condition of the water bodies including riparian vegetation structure were assessed and photographs taken. No construction would occur in vicinity of the water bodies and operational impacts would be minor due to the limited amount of water required (refer to Section 5 for details). As such no detailed aquatic fauna and flora surveys were deemed necessary and only a habitat assessment was conducted.

4 RESULTS

4.1 BACKGROUND RESEARCH

4.1.1 Databases searches

The Bionet and Wildlife Atlas database searches revealed a total of ten threatened aquatic species including two amphibians, one fish, six mammals and one reptile previously recorded within 10km of the proposal site (Appendix A). Two species were found within Twofold Bay, the Australian fur seal and the humpback whale.

The EPBC Protected Matters search tool revealed a total of ten threatened aquatic species (three amphibians, one fish, three sharks, three mammals), 41 listed aquatic species (two mammals, 27 fish, 12 cetaceans) and nine aquatic migratory species (seven mammals and two sharks) with the potential to occur within a 10km radius of the proposal site (Appendix A).

4.1.2 Literature review

Aquatic habitat, fauna and flora of the Twofold Bay region

Twofold Bay, located to the west of a 5 km long line joining Worang Point (north) and Honeysuckle Point (south), comprises a twin sub-embayment system separated by a prominent central headland, Lookout Point. The northern sub-embayment is Calle Calle Bay, while that to the south is made up by numerous smaller embayments. The Nullica and Towamba Rivers enter the southern sub-embayment through permanently open, although severely shoaled, entrances. Aslings Beach forms a narrow barrier separating Curalo Lagoon and Calle Bay. Twofold Bay deepens to approximately 35 m below sea level between Worang Point and Honeysuckle Point. The major coastal town of Eden stretches from the southern shores of Curalo Lagoon to Lookout Point. The Port of Eden is located within Snug Cove, south-west of Lookout Point (Department of Natural Resources 2009). The proposal site is located on Jews Head on the southern side of Twofold Bay with the chip mill jetty and wharf located north of the navy jetty and wharf (Figure 1-1).

The Twofold Bay shoreline and depths are characterised by various habitats including sandy beaches, intertidal rocky shores, shallow subtidal rocky reefs, unvegetated sand beds and seagrass beds (Cumberland Ecology 2007, The Ecology Lab 1999, Williams et al 2006). Williams et al (2006) mapped the seagrass beds within the Bay using data collected in 1985. However, it is likely that this data is out of date. A more recent study mapped beds of *Posidonia australis* and *Zostera* sp. in the vicinity of the navy wharf (The Ecology Lab 1999).

Twofold Bay is historically known for its whaling industry. Since the closure of the industry, the Twofold Bay region attracts tourists who visit the area to see whales including humpback, southern right and killer whales. Whales migrate north from May to August and return south from late September to late November. Whales can sometimes be seen within the Bay, especially during the southern migration (Bega Valley Shire Council 2009).

Threatened species previously recorded in the Twofold Bay area and not found through database searches include the Australian grayling (*Prototroctes maraena*) which has been observed in the Towamba River (Faragher 1999). This species is protected under the FM Act and considered threatened under the EPBC Act. The FM Act and EPBC Act protected weedy seadragon (*Phyllopteryx taeniolatus*) is also known to occur in the bay (Booth and Sanchez-Camara pers. comm. 2009). A preliminary bioregional summary of weedy seadragon data for surveys undertaken between January 1998 and June 2000 showed

75 individuals recorded in Twofold Bay (Baker 2000). The data was mainly collected from the recreational diver community. As such it is to be noted that this number is highly dependent on the intensity of the search in a particular area (ie. some dive sites are more popular and/or more accessible than others) and it is possible that it is greatly underestimated, especially if extrapolated to a large area such as Twofold Bay.

Trawl surveys undertaken within Twofold Bay in June and August 1999 by the Ecology Lab (1999) revealed a total of 50 different fish species and five marine invertebrates. Benthic cores revealed 80 different families of infaunal invertebrates. The most common fish species recorded included school whiting (*Sillago bassensis*), eastern blue spotted flathead (*Platycephalus caeruleopunctatus*), kapala stingaree (*Urolophus sp.*), blue-striped goatfish (*Upeneichthys lineatus*), juvenile snapper (*Pagrus auratus*) and three-barred porcupinefish (*Dicotolichthys punctulatus*).

Introduced species

A number of studies have been undertaken on introduced marine species within the Twofold Bay area. The most recent was undertaken by DPI (Fisheries) (Pollard and Rankin 2003). The study confirmed the presence of four introduced marine pests (Australian Ballast Water Management Advisory Council (ABWMAC) listed) including the European shore crab (*Carcinus maenas*), the Mediterranean fan worm (*Sabella spallanzanii*), the toxic dinoflagellate *Alexandrium "catenella type"* and the New Zealand rosy screw shell (*Maoricolpus roseus*). Other introduced marine species included the bryozoans *Bugula neritina*, *Cryptosula pallasiana*, *Membranipora membranacea* and *Watersipora subtorquata*, the crab *Cancer noveazelandiae*, the Pacific oyster *Crassostrea gigas* and three other molluscs species *Maoricolpus roseus*, *Polycera capensis* and *Theora fragilis*. The New Zealand rosy screw shell was found in very high abundances on seagrass beds in vicinity of the navy wharf (up to 4000 per square metre).

Commercial fisheries and Aquaculture industry

The Port of Eden contains one of the largest fishing fleets in NSW and is a popular area for recreational fishermen. No commercial catch data could be sourced. The use by commercial fishers of an otter trawl net (fish) or a Danish seine trawl net (fish) is prohibited within Twofold Bay.

Mussel aquaculture farming is undertaken in the Twofold Bay area. Eden Shellfish Pty Ltd operates a 13.5 hectare farm at Oman Point and NSW Cultured Mussel Growers Association Incorporated operates a 2 hectare farm at Torarago Point (Figure 4-1, DPI 2005).

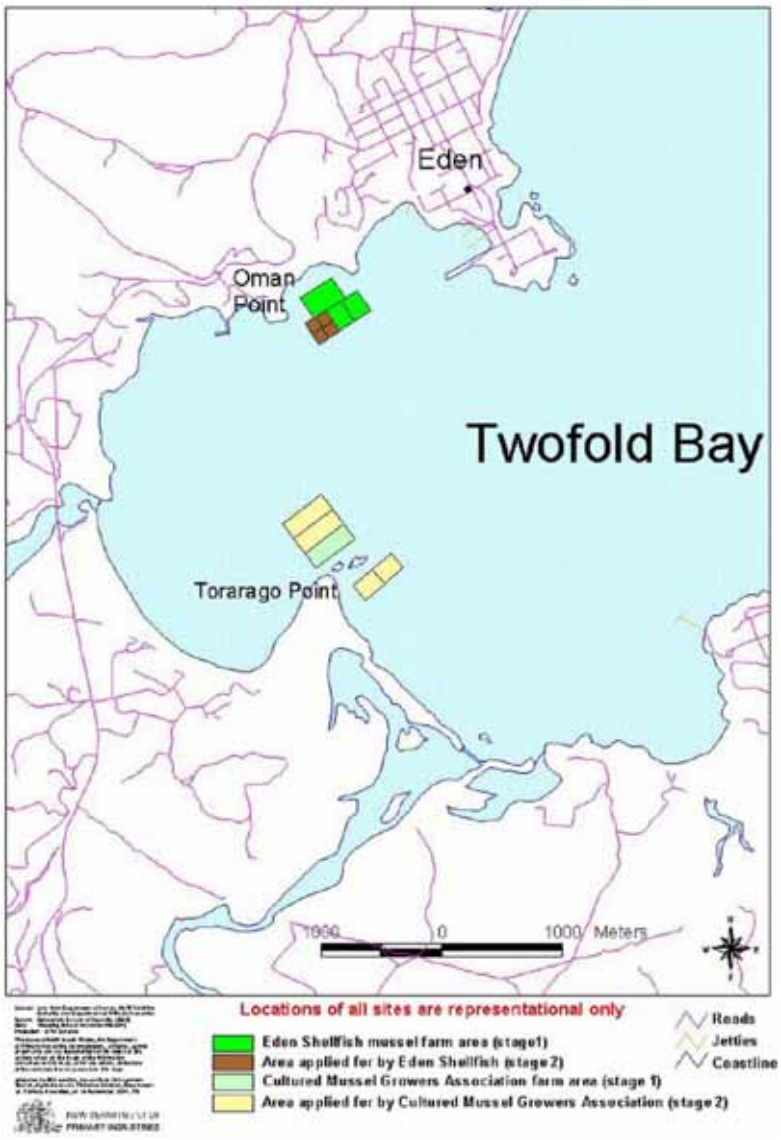

Figure 4-1. Locations of mussel aquaculture farms in Twofold Bay (Source: DPI 2005)

Recreational diving

Various sites within Twofold Bay are popular with recreational divers. The area around Fisheries Beach is popular as the weedy sea dragon can often be observed there. Other popular sites include Eden Cave, the chip mill wharf and the wrecks of the Henry Bolte and the Tasman Hauler.

4.2 FIELD SURVEYS

4.2.1 Freshwater environment

The freshwater supply system for the chip mill is composed of a series of interconnected dams and reservoirs located south of the site with water supplied to the mill via an underground pipeline. The system includes Tiniki Creek dam and reservoir and Bull Creek dam. Further details on the history of the freshwater supply system are provided in Section 5. Table 4-1 briefly describes the sites in terms of habitat. Appendix B contains site photos.

Table 4-1. Chip mill freshwater supply system and habitats

Site	Catchment area	Size	Habitat
Tiniki Creek Dam and Reservoir	8 hectares	70 mega litres	Tiniki Creek dam and the reservoir are large expanses of open water. Dense and continuous riparian vegetation surround the water bodies. Patches of emergent aquatic vegetation are located along the outside perimeter. The water levels of the dam and reservoir varies during the year as they are dependent on rain events and water pumped from Bull Creek Dam. Disturbances to the waterbodies were minimal. The waterbodies would provide good quality habitat for aquatic species.
Bull Creek Dam	2000 hectares	Swamp covers 70 hectares	Similar to Tiniki Creek dam and reservoir, Bull Creek dam offers a large expanse of open water. Dense and continuous riparian vegetation surround the water body and patches of emergent aquatic vegetation are located along the outside perimeter. Some large woody debris were also observed.Bull Creek downstream of the dam wall also contains dense and continuous riparian vegetation and the banks are lined with boulders protecting them against potential erosion during higher flows. The water body is permanent. The dam wall would impeach fish passage. Disturbances to the waterbody were minimal. The waterbodies would provide good quality habitat for aquatic species.

4.2.2 Marine environment

Habitat surveys

Intertidal habitats

Aerial photographs were analysed and habitats confirmed during field surveys. Intertidal habitats within 1km of the chip mill wharf include rocky shorelines and sandy beaches (**Figure 4-2**).

Figure 4-2. Intertidal habitats in vicinity of the chip mill wharf. Orange: rocky shoreline; Yellow: sandy beaches; Purple: mix of rocky shoreline and sandy beaches

Intertidal habitats in vicinity of the chip mill jetty and east of the bay were mostly exclusively rocky shorelines. Sandy beaches or a mix of rocky shores and sandy beaches were more common within the bay. The majority of the habitats were in very good condition with limited disturbances. Where disturbances were observed, mostly as a result of garbage accumulation, these were highly localised and mostly found in vicinity of man made structures (eg. chip mill jetty, navy jetty).

The intertidal habitats surrounding the chip mill jetty are similar to those found in other areas of Twofold Bay.

Subtidal habitats

SCUBA surveys identified a number of subtidal habitats including:

- Rocky reefs with macroalgal coverage
- Rocky barrens
- Seagrass beds
- Sandy beds

Appendix C contains the detailed results of the transect surveys undertaken at the five sites. These are summarised in **Table 4-2**.

Table 4-2. Subtidal habitats at five sites in Twofold Bay

Site	Transect length (m)	% cover along transect			
		Rocky reefs with macroalgal coverage	Rocky barrens	Seagrass beds	Sandy beds
P1	150	7%	73%	0%	20%
P2	100	5%	0%	0%	95%
P3	105	19%	48%	0%	33%
R1	110	36%	0%	18%	45%
R2	125	60%	0%	0%	40%

Sites P1, P3 and R1 included a subtidal rocky reef starting at the mean low water mark and extending from between 40 metres and 70 metres out to sea depending on site. Site P2 started at the chip mill wharf and thus did not include nearshore habitat. However, large boulders were located below the wharf which effectively served as a rocky habitat.

The rocky reefs included a dense cover of *Phyllaspora comosa* sometimes mixed with *Ecklonia radiata* close to shore with the mixed assemblage changing to mostly monospecific *E. radiata* cover further out to sea. At some sites, the macroalgal cover disappeared to only leave rocky barrens (P1 and P3). Passed the rocky reef, and depending on the site, the bottom either included sandy beds with (P1, R1, R2) or without sparse rocky outcrops (P2, P3) and/or with (R1) or without (P1, P2, P3, R2) seagrass beds.

Seagrass beds

Site R1 included small monospecific patches and/or sparse beds of the seagrass *Zostera* sp. Percent cover was low with a maximum cover of 10%. Shoot lengths averaged between 53mm and 93mm in the three replicate quadrats. No seagrass beds were observed below or within 150 metres of the chip mill jetty and wharf. Detailed results are provided in Appendix C.

Fish surveys

The results of the fish surveys at the five sites are included in Appendix C and summarised in **Table 4-3**.

Table 4-3. Fish survey results (EPBC Act: Environment Protection and Biodiversity Conservation Act; FM Act: Fisheries Management Act)

Site	Number of species			Number of individual fish			Protected species under the EPBC Act and FM Act
	Total	Rocky reef	Other habitat	Total	Rocky reef	Other habitat	
P1	22	22	2	406	343	63	Weedy sea dragon
P2	18	16	3	448	423	25	
P3	17	17	1	397	347	50	
R1	7	6	3	35	32	3	Weedy sea dragon
R2	8	6	2	83	81	79	

Rocky reefs were found to have the highest number of species and individuals. The amount of rocky reef habitat surveyed compared to other habitats for P1-P3 combined and R1-R2 combined was approximately the same. As such numbers of species and numbers of individuals are comparable.

The most common species in vicinity of the chip mill jetty and wharf (ie. sites P1-P3) for all habitats combined were:

- Yellow tailed scad (34%)
- Long finned pike (23%)
- Silver trevally (8%)

While the sandy/seagrass habitats had a lower species diversity compared to rocky reef habitats, a number of species were only observed within these. These were mostly benthic fish species such as the sparsley spotted stingaree and the banded stingaree.

The most common species at the reference sites (ie R1-R2) for all habitats combined were:

- Mado (33%)
- Yellow tailed scad (25%)
- Black tipped bulls eye (12%)

The weedy seadragon, protected under the FM Act and EPBC Act, was encountered at sites P1 and R1. Individuals were observed on the rocky reef (both sites) or within the sparse seagrass bed (site R1) (**Table 4-4**).

Table 4-4. Weedy Seadragon records

Site	Depth	Habitat	Numbers
P1	10 metres	Sandy bed with rocky outcrops/jetty	8
R1	4 metres	Seagrass bed	1
	3 metres	Rocky reef	4

No threatened species were observed.

Invertebrate surveys

Eighteen different species of conspicuous invertebrates were recorded during the transect surveys. The majority of invertebrates observed were located on rocky reefs and/or the pylons of the chip mill jetty and wharf. The most dominant conspicuous species included the sea urchin *Centrostephanus rodgersii* as well as smaller more sessile animals such as tunicates, limpets and mussels (Appendix C).

Only a very limited number of invertebrate infauna were collected through sediment cores. A total of 9 invertebrate families and 19 individuals were collected from the nine sediment cores combined (Appendix C).

5 IMPACT ASSESSMENT

5.1 CONSTRUCTION IMPACTS

5.1.1 Freshwater environment

Freshwater for the operation of the proposed power plant would be sourced from the existing dams and reservoirs. The freshwater system for the proposed power plant would be connected to the existing pipeline which currently transports water from the dams and reservoirs to the chip mill. As the connection would be undertaken at the chip mill site, no construction works would be required in the vicinity of the dams and reservoirs and therefore no construction impacts such as erosion and sedimentation in riparian or freshwater aquatic habitats would occur.

Freshwater could be required for dust suppression measures during construction. This would be sourced from the existing freshwater system of the mill. Due to the capacity of the freshwater system, this demand is unlikely to significantly impact the water levels of the dams and reservoirs located upstream.

5.1.2 Marine environment

Noise impacts

Underwater construction activities would be required to install the seawater cooling system for the proposed power plant. The pipeline would be installed along the chip mill jetty and wharf and construction activities are likely to generate underwater noise. Construction noise would likely arise from the use of barges and manual underwater works such as hand held drilling. Installation of the pipework along the jetty is likely to take 1-2 weeks.

Underwater noise is known to have an impact on marine fish and mammals creating various adverse behavioural and/or physiological responses (Richardson et al. 1995). These responses are highly dependent on the type and level of noise as well as the group of fauna affected. Behavioural effects of loud noises of either short (impulsive) or long (continuous) duration include fauna permanently leaving the area, tissue rupturing or haemorrhaging at close ranges to the acoustic source, temporary or permanent hearing loss, swimming off course, abandoning habitats, and aggressive behaviour (Allen 1991, Richardson et al 1995, Kastak et al. 2005).

Behavioural responses to noise are highly variable and dependent on a suite of internal and external factors (Ocean Studies Board 2003).

Internal factors include:

- individual hearing sensitivity, activity pattern, and motivational and behavioural state at time of exposure
- past exposure of the animal to the noise, which may have led to habituation or sensitization
- individual noise tolerance
- demographic factors such as age, sex, and presence of dependent offspring

External factors include:

- nonacoustic characteristics of the sound source, such as whether it is stationary or moving
- environmental factors that influence sound transmission
- habitat characteristics, such as being in a confined location
- location, such as proximity to a shoreline

The majority of studies undertaken on noise impacts on marine mammals and fish have been undertaken on northern hemisphere species. However, these may offer indications on the tolerance levels of similar fauna. Figure 5-1 illustrates the general hearing frequencies of some of the major groups of marine mammals and fish. As stated above, some minor deviations from these ranges could occur for certain species or individuals.

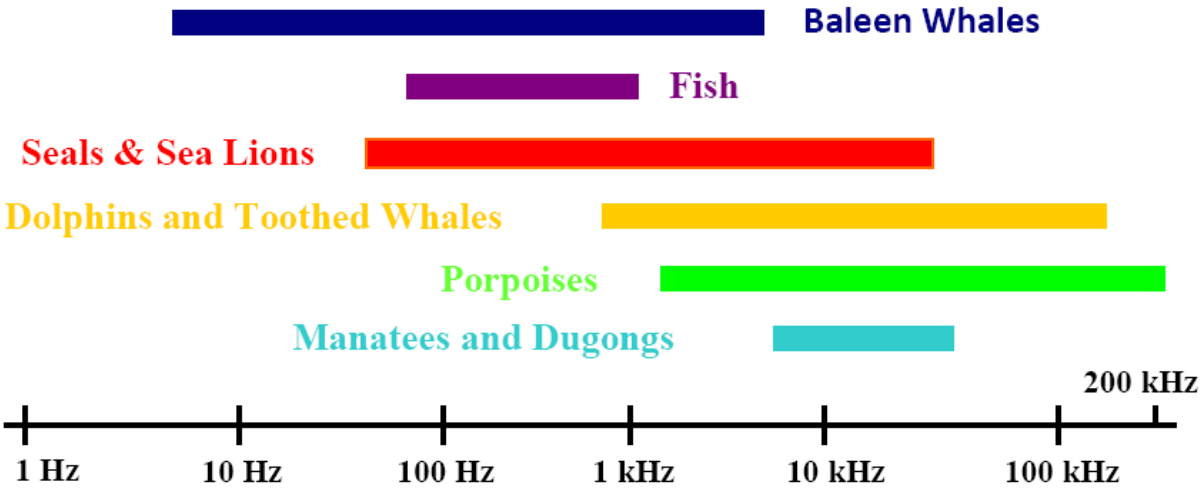

Figure 5-1. Hearing frequency of marine fauna (Okeanos 2008)

As stated, underwater noise during construction would mostly be related to shipping noise and manual construction activities. The majority of this construction noise would be in the low frequency range (Table 5-1). As such, these are unlikely to affect odontocetes (ie. toothed whales such as dolphins and killer whales) (Figure 5-1). However, construction noise frequencies would overlap with the hearing frequencies of seals, fish and mysticetes (ie. baleen whales such as the southern right whale and humpback whale).

Table 5-1. Underwater noise levels from potential construction activities

Activity	Type of noise	Frequency	Source level (dB re 1µPa) @ 1m
Shipping[*1]	Continual	100-1000Hz	120-180
Small drill[*2]	Impulse	100-1000Hz	147
Large drill[*2]	Impulse	100-1000Hz	143
Impact wrench[*2]	Impulse	100-1000Hz	180
Small grinder[*2]	Impulse	100-1000Hz	150
Large grinder[*2]	Impulse	100-1000Hz	146
Cox's bolt gun[*2]	Impulse	100-1000Hz	220 (peak)

[*1] Carlton and Dabbs (2009)

[*2] Nedwell J, Martin A, Mansfield N (1993)

The potential for marine fauna to be impacted by construction noise would depend on whether or not the construction noise levels are sufficient to create an adverse effect.

Duncan and McCauley (2008) assessed the impacts of construction works on a proposed ocean outfall on the northern Tasmanian coast. Based on the results of previous studies on the response of marine fauna as a result of noise, the received threshold levels for continuous noise at which set impacts were deemed to occur were:

- 120 dB re 1μPa (mean square pressure (msp)): level at which baleen whales will largely avoid the area for continual noise although some individuals may tolerate higher levels for some periods
- 144-151 dB re 1μPa2.s (Sound Exposure Level (SEL)): level at which great whales may avoid continual and approaching impulse noise
- 156 dB re 1μPa (msp) for continual noise or 145 dB re 1μPa2.s (SEL) for repetitive and approaching impulse noise: level at which fish will avoid the area
- 180 dB re 1μPa (msp): level at which temporary hearing threshold shifts (TTS) may begin to occur in cetaceans
- 190 dB re 1μPa (msp): level at which TTS may begin to occur in pinnipeds (eg. seals)
- 205 dB re 1μPa (msp) for continual noise or 190 dB re 1μPa2.s (SEL) for impulse noise: level at which we may begin to expect to see fish kills from explosive or pile driving like signals

Considering the noise levels generated by a variety of potential construction sources (Table 5-1) and the threshold noise levels above, behavioural effects on fish and whales have the potential to occur. Predicted highest impacts would be from shipping movements and use of impact wrenches.

The distance at which an effect would potentially occur is difficult to predict. Generally, the propagation of low frequency noise in water is such that the noise level can remain high even at a great distance from the source. However, the attenuation rate of the noise across a large distance is highly dependent on various external factors such as depth, substrate type and vicinity to other obstacles such as the shore line. It is therefore difficult to predict the distance from the construction site at which a response may occur as any noise propagation modelling undertaken at one site is not transferable to other sites.

A number of impact assessments of construction noise on marine fauna in Australia have been undertaken (Blewitt and Cato 2008, Duncan and McCauley 2008). For marine mammals in particular, these studies mostly relied on biological data from northern hemisphere species.

Blewitt and Cato (2008) predicted that marine drilling off Cape Solander, NSW as part of the Sydney desalination project could illicit some behavioural reaction on part of the migrating whale population at distances of three to four kilometres from the drilling site. However, the authors noted that whales are frequently exposed to various noise sources, the most frequent being shipping, and that there is no evidence to show that the long term survival or migration of the whales has been impacted. They concluded that that the exposure to drilling noise by part of the whale population is unlikely to have a long term effect.

Duncan and McCauley (2008) assessed the impacts of construction works on a proposed ocean outfall on the northern Tasmanian coast. Construction activities assessed to create the most noise were vessels, non-explosive rock fracturing charges and sheet piling and small explosive charges inside a dry berm. The authors concluded that most of these activities were only likely to elicit a behavioural response for some marine mammals up to 3km from the construction site and for fish up to 800 metres. Some physiological responses were possible during the use of explosive charges and rock fracturing cartridges for marine fauna located in close range (within 20 metres).

The majority of studies assessing the impacts of construction noise have dealt with major noise generating sources such as shipping and the use of explosives and drilling. The works proposed are unlikely to generate the levels of noise assessed in these studies. The proposed works would be undertaken at the chip mill wharf and in the vicinity of the multipurpose wharf. Both of these sites welcome a high number of large vessels every year. The Port of Eden is also one the largest fishing ports in NSW and shipping activity is high in Twofold Bay and further offshore. Marine mammals are prevalent in the region despite shipping activity, and whales migrating south can often be observed within Twofold Bay. It is not possible to rule out that the noise levels generated during construction activities would not elicit a behavioural response such as avoidance of the area. However, should there be any effect these would most likely be short term and would not have any long term effect on marine biodiversity (refer to Section 5.3 and Appendix E for assessment on threatened/migratory species). Should whales avoid the area during the construction works, this could have an impact on the whale watching industry.

Vessel interaction

Boat strikes are a cause of marine mammal injury and/or death. It is commonly accepted that vessel speed is the main factor affecting the risk of boat strikes. Furthermore, slower moving mammals such as large whales are more susceptible to being hit than faster moving dolphins. The potential for impacts on marine mammals at the site is therefore low as vessels used for the construction works would essentially be used around the chip mill jetty and wharf which would restrict the speed at which boats can operate. The chip mill jetty and wharf would also create a barrier which would restrict the larger whales from accessing the area reducing the chance of collisions.

Marine pests

The construction works would require the use of barges and other vessels. Barges and vessels are potential carriers of marine pests which can quickly become established in areas which are currently devoid of such species. Marine pests can out compete native species from their habitat and can impact on marine industries such as aquaculture and commercial and recreational fishing. Establishment of marine pests in Twofold Bay may occur should construction boats and barges from outside the area be used and not adequately checked for marine pests prior to their arrival. However, it is likely that all construction vessels will be sourced from the Eden area.

Disturbance of Habitat

The proposed works have the potential to disturb subtidal habitats during the installation of the intake and outtake pipes. Intertidal habitats are unlikely to be disturbed as all works would be undertaken from construction vessels and/or the jetty. The pipes would be installed along the chip mill jetty. The majority of the pipeline would be underneath the jetty platform and out of the water. Only the vertical section of the pipelines would be within the water column. The end of the pipeline would be fixed to a concrete footing on the sea bed. Concrete footing will be installed to anchor the three intake pipes and the outlet pipe to the sea floor. Four footings (approximately $2m^2$ x 400mm high) will be precast on-shore and lowered to the sea floor by crane from the jetty. Divers will be used to position the footings and to attach below sea pipework. Installation is expected to take one day. The placement of the block would kill the fauna and flora directly below it and disturb the sediment. Due to the limited size of the footings, impacts would be minor. Furthermore, it is likely that the concrete block would be colonised by marine fauna and flora following construction.

Commercial divers would be required to undertake the proposed works. These have the potential to disturb the habitats and associated fauna and flora during construction works.

Water quality Impacts

Potential impacts to water quality may arise during construction as a result of accidental chemical spills. Chemical spills, including potential hydrocarbon spills, could impact marine habitats and associated fauna and flora. Due to the nature of the works, the most likely source of chemical spills would be from the barges and other vessels and would mostly involve refined products. In the event of a hydrocarbon spill, impacts to biodiversity within the vicinity of the spill are often immediate. Generally, refined petroleum products (unleaded fuels and the like) tend to be more toxic to organisms but less persistent in the environment (AMSA 2009). Due to their high toxicity, fish and invertebrates that come in direct contact with refined products may be killed. Generally, such products disperse and evaporate within a couple of days and are completely degraded under natural conditions with a couple of months, especially for minor spills.

5.2 OPERATIONAL IMPACTS

5.2.1 Freshwater environment

The following has been summarised from information provided by Don Olsen (Project Manager, SEFE).

The original chip mill site and associated water supply system was developed in the late 1960's. The development of the original water supply system included the installation of an earthen dam on Tiniki Creek, located in the Ben Boyd National Park about 2km south of the mill site. In conjunction with this dam a pump set was installed to pump water uphill to a holding reservoir located adjacent to Edrom Road. The dam and reservoir provided adequate for the mill's operations at the time. Tiniki Creek reservoir is served by a small catchment area of 8 hectares and the reservoir has a capacity of about 70 megalitres (ML).

In the mid-1970's the mill was substantially upgraded to include hydraulic debarking and log washing systems, with only the log washing system now remaining. This upgrade increased water requirements to around 1.0 ML per day (approximately 365ML/year) which represented about twice the amount of water available from the Tiniki Creek reservoir in an average rainfall year. For this reason the Bull Creek dam was constructed about 11 km south of the mill and connected to both the existing dam and reservoir with a 150mm AC pipeline. This dam is sited in land administered by Forests NSW.

The catchment area for Bull Creek dam is about 2000 hectares and feeds into a swamp which covers about 70 hectares. The dam is located downstream of the swamp, which forms a large permanent reservoir which ensures a reliable flow even during periods of prolonged low rainfall. An average available flow of 16 ML per day (5840 ML/year) has been calculated for the discharge from the swamp.

The Tiniki Creek dam and reservoir and the Bull Creek Dam water supplies are authorised by licenses administered by the Department of Water and Energy.

Water is routinely used in and around the mill for cleaning purposes. Dirty water is recycled through a collection system into a clarifier with rain water also used to top up the clarifier. This method ensures that make-up water requirements from the dams are kept to a minimum.

Since the hydraulic debarking system was decommissioned, mill water usage has been stable at an annual estimated total of 32.25 ML, well below the design aggregate capacity of the two water supplies.

The proposed biomass power plant would consume water to make up for water expelled from the boiler as "blow-down water" at the rate of a maximum of 350 litres per hour or 3 ML annually. This would raise the current usage by approximately 8% to 35.25ML/year. This would still be well within the capacity of the water supply system (0.6% of the average annual flow available of Bull Creek dam). As such it is not

anticipated that the proposed works would impact the ecology of the freshwater systems either at a catchment or local level.

5.2.2 Marine environment

The ANZECC (2000) guidelines for fresh and marine water quality have been derived with the intention of providing some confidence that there would be no significant impact on the environmental values if they are achieved. It is important to note that while exceedance of the guidelines might indicate that there is potential for an impact to occur, it does not provide any certainty that an impact would occur.

Three levels of aquatic ecosystem condition are proposed as a basis for applying the guidelines:

- High conservation/ecological value systems (condition 1)
- Slightly to moderately disturbed systems (condition 2)
- Highly disturbed systems (condition 3)

According to the definitions provided in the guidelines and the results of the field surveys, the proposal site would be considered a slightly disturbed system.

For slightly to moderately disturbed ecosystems, maintenance of biological diversity relative to a suitable reference condition should be a key management goal. However, some relaxation of the stringent management approach used for condition 1 ecosystems may be appropriate and an increased level of change might be acceptable.

The following potential impacts to water quality resulting in effects on marine biodiversity could occur as a result of the proposed works:

- Thermal impacts
- Antifouling

These potential impacts are discussed in light of ANZECC (2000) guidelines and the level of protection required.

Thermal pollution

Temperature is an important factor that can affect metabolism, growth, feeding, spawning, recruitment and behaviour of marine organisms as well as affecting community structures. In France, seaweed assemblages encrusted on a rocky shore changed when water temperature increased slightly 0.5-1.0°C (Verlaque et al 1981). In winter, thermal discharges of power plants affected the assemblage structure, recruitment, mortality, demography, spawning age, gonad development, and net production of fishes in Baltic Sea (Sandstrom et al 1995). In contrast, in Taiwan, thermal discharge in a tropical environment did not impact the fish assemblages on coral reefs whether these were demersal or pelagic (Chen et al 2004). In Italy, the assemblage structure or spatial distribution of the meiobenthic and macrobenthic community was not influenced by thermal discharge from a power plant in the Gulf of Follonica in the Mediterranean (Lardicci et al 1999). These conflicting results show the difficulty in predicting a priori effect of a thermal discharge on the marine environment. Alterations brought about in a marine environment by discharge of heated effluents may vary greatly as a function of the quantity of heat discharged and of the climatic, hydrological and biological features of a particular study environment.

Bamber (1995) summarises the potential impacts of thermal effluent on the aquatic environment. While results can vary according to the various factors described above, nektonic animals are generally able to detect and avoid thermally enhanced waters while planktonic organisms would only be at risk when the effluent mixes with cooler waters. (Heated water is less dense and does not tend to mix with the cooler water which creates a barrier between the two. It is only as the effluent is dispersed and water temperature decreases that mixing occurs.) In general, benthic animals are the most likely to be

impacted by thermal discharge. Furthermore, in higher energy and open areas, such as the sea, heat is more rapidly lost which tends to localise the area of potential impacts.

The direct effects of thermal discharge on marine organisms fall into four categories, the mean temperature, the absolute temperature, short term fluctuations in temperature, and thermal barriers (Bamber 1995). All species of marine organisms have a preferred temperature range and a particular area would generally include species that are close to their cooler limit of distribution as well as species closer to their warmer limits. It is therefore likely that a thermal effluent would favour those species near their colder limit and disadvantage those species which are already close to their warmer limits. Community structures and the presence of certain species can therefore change in the zone of influence. It is also important to note that the thermal effluent would exacerbate the impact of the rise in mean sea water temperatures as a result of climate change. Secondly, mortality could occur should the absolute temperature of the effluent approach the upper incipient lethal temperature (UILT) levels of a species. This is more likely to occur in tropical regions where ambient temperatures are already high and potentially close to the UILT. (The UILT is used in certain power plants as an antifouling system to control organisms growing within the pipelines of the cooling system.) In regards to short term fluctuations in temperature these are normally tidal driven and a result of the density differential between the discharge and receiving water. The ebb and flow of the tide can move the interface between the two different temperatures which can cause great temperature variations in a short amount of time. Lastly, the temporary interface can create thermal barriers to fish migrations. However, this is rare and more likely to occur in confined areas.

At the proposal site, it has been estimated that the difference in water temperatures from the released water and the ambient water would be approximately 10^{o}C in Summer and 21^{o}C in Winter (Table 5-2). The behaviour of the thermal plume has been determined assuming different environmental and discharge characteristics (Table 5-2).

Table 5-2. Environmental and discharge characteristics

Scenario	Units	Scenario	
		Summer	Winter
Seawater temperature in	°C	23	13
Temperature rise	°C	10	21.1
Seawater temperature out	°C	33	34.1
Flow rate	litres/s	333	158
Outlet angle wrt horizontal	degrees	30	30
Ambient current(1)	m/s	0.105	0.105
Salinity (ambient & discharge)(2)	ppt	35.65	35.65

Note (1): Based on the 10th percentile current velocity

(2): Based on the average value

For the purpose of this assessment, calm, typical and worst case conditions in terms of wind and current have been considered (Table 5-3). URS (2009) contains a number of other intermediate scenarios.

Table 5-3. Calm , typical and worst case conditions and results of thermal plume behaviour.

Scenario	Current Speed (m/s)	Wind Speed (m/s)	Distance from ΔT = 2.4 °C (m)	ΔT at 10m
Summer				

Scenario	Current Speed (m/s)	Wind Speed (m/s)	Distance from ΔT = 2.4 °C (m)	ΔT at 10m
Calm	0.027	0.0	<0.5	0.45
Typical	0.130	2.7	<1	0.60
Worst case	0.229	14.7	<1	0.66
Winter				
Calm	0.027	0.0	<1	1.31
Typical	0.130	2.7	<3	0.92
Worst case	0.229	14.7	<3.5	1.14

A mixing zone sometimes occurs around a discharge point. A mixing zone is an explicitly defined area around a discharge where certain environmental values would not be protected. Calculations based on ambient water temperatures show that the mixing zone would be located where the final temperature from the discharge point is 2.4°C above the ambient temperature (URS 2009). The mixing zone for the proposed thermal discharge would be within 1 metre of the outlet under all scenarios in Summer and within 3.5 metres under all scenarios in Winter (Figure 5-2).

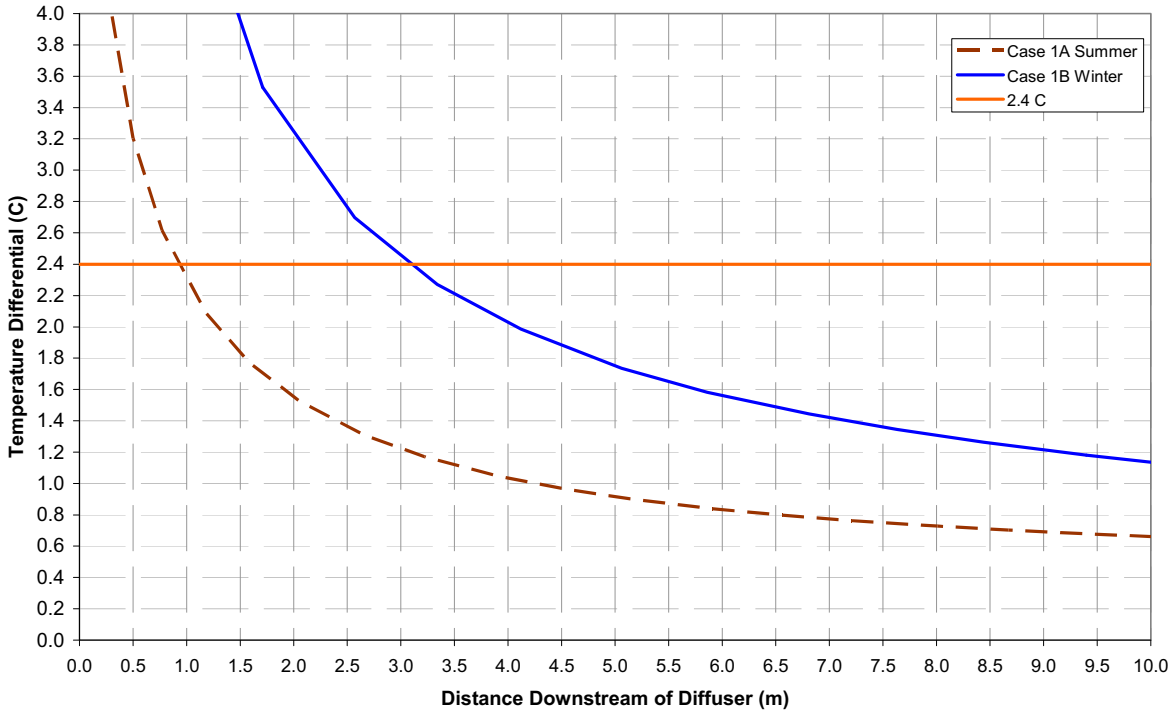

Figure 5-2. Mixing zone for worst case scenario (from URS 2009).

ANZECC (2000) guidelines state that low-risk trigger values for temperature would be respected if temperatures reached as a result of thermal pollution remain under the 80th percentile of ambient temperatures. Modelling under the various scenarios has shown this to be the case inside 3.5 metres of the discharge point.

Far field modelling has also determined that it is unlikely to reach the shore under various wind and current conditions and that the plume could touch the seabed at a distance greater than 200 metres from the outlet (Figure 5-3; URS 2009). At this distance the temperature rise would be 0.3 °C or less.

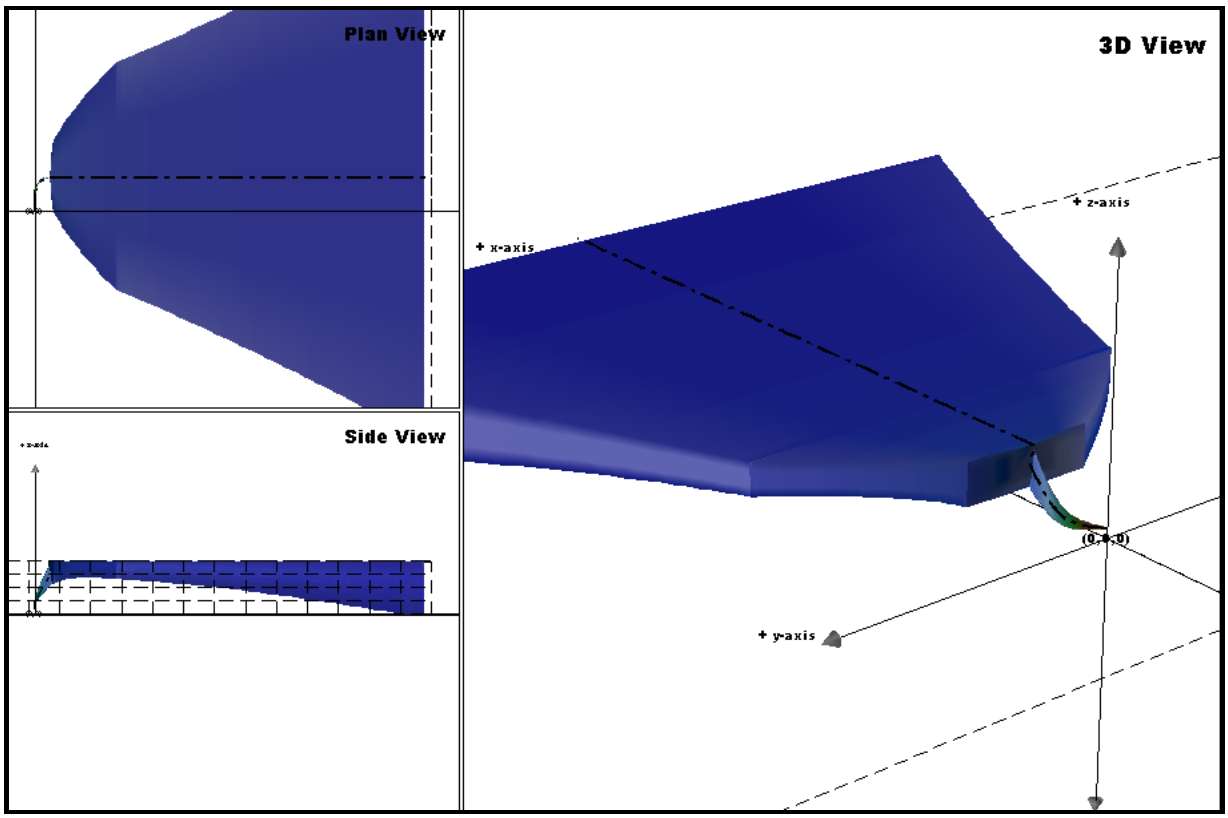

Figure 5-3. Thermal plume behaviour under the worst case scenario. Plume would touch the sea bed at a distance of 800 metres from the outlet. The Y axis is the approximate jetty axis.

No studies could be sourced on the impact of thermal effluents from power plants on marine biodiversity in Australia. The majority of studies undertaken to determine the impacts of thermal effluents on marine biodiversity have been undertaken in the United States and have used large power plants generating a few hundred to thousands of megawatts of energy with impact zones hundreds of metres from the outlets (California Energy Commission 2005). However, the largest impacts have occurred in bays and estuaries with reduced mixing or on open coast where heated water quickly contacts rocky habitat (California Energy Commission 2005). As such, based on the size of the proposed power plant and results of the thermal plume modelling, the site characteristics (ie. temperate open sea) and a review of the general impacts of thermal effluents, thermal impacts are likely to be highly restricted and contained to within 100m of the outlet with highest potential limited to a few metres from the outlet.

It is anticipated that should any impacts occur these would mostly relate to minor changes in species composition due to a slight increase in the average temperature. Temperate marine organisms with low tolerance for high temperatures (eg. weedy seadragon, see below for further discussion) may avoid the area around the outlet while species with higher temperature tolerances may be attracted. Due to the rapid dilution of the temperature, it is unlikely that a UILT would be reached as organisms would tend to avoid the immediate vicinity of the mixing zone. Invertebrates, in particular sessile organisms, in the vicinity of the outlet (eg. attached to the jetty pylons) would be the most affected with some mortality to be expected where temperatures fluctuate greatly. This would impact the community structure in the vicinity of the outlet which, in the long term, would likely be composed of species adapted to such changes. As the plume would be above the sea floor, impacts to invertebrates would be minimal. A temperature barrier is unlikely to result from the proposed cooling system due to the open sea and the comparatively limited size of the plume.

No thermal impacts to seagrass or macroalgal beds are envisaged as a result of thermal effluents. The thermal plume would be above the seabed and no extensive seagrass beds were encountered within 100 metres of the chip mill jetty and wharf. The thermal plume would not reach the shoreline where the macroalgal covered reefs are located.

Biofouling

The intake and outtake pipes and screens are likely to become covered in biofouling fauna and flora if left unchecked. This could reduce the effectiveness of the cooling system. For maintenance purposes, a number of options were considered including the provision for mechanical pigging of the delivery and return pipelines for attached marine growth as well as a preventive copper-based antifouling system.

The mechanical pigging proposal involves forcing a plug (ie. pig) through the pipeline which would remove all attached marine growth. All maintenance water will be collected in a received pit. Water will be allowed to infiltrate with solids periodically removed to the onsite land fill. There will be no discharge to the marine environment.

One of the solutions for the copper-based antifouling system is called the Vandervelde Protection anti-fouling system. The system operates through the controlled continuous dissolution of copper located in the water intake of the system. Metallic copper is oxidised to cupro ions (Cu+) which dissolve to create a temporary toxic medium for fouling. Cupro ions are also unstable and rapidly react with oxygen dissolved in water to produce copper(II) oxides. This system is based on copper based paints which have long been employed to protect hulls of ships from fouling organisms. These types of paints were commonly used in the past as antifouling agents before they were replaced by the more effective Tributylin (TBT) based paint. The use of TBT based paints was later abolished in many countries due to its toxicity and the copper based paints have since been used as one of the more effective methods to limit biofouling.

Cupro ions are known to be toxic to marine life at high concentrations, generally above 10µg/l (Neff 2002). Copper (II) oxides are much less bioavailable and therefore less toxic than cupro ions. In invertebrates, effects include but are not limited to decreased survival, decrease in reproductive success, and abnormal larval development (Watson et al 2008, Nadella et al 2009, Canli and Furness 1993). In fish, like in certain invertebrates such as oysters, copper is bioaccumulated and at high concentrations, affects include histopathological changes in intestinal epithelia and reduced growth (Neff 2002). Due to the toxic effects of copper and its bioaccumulation potential, countries generally have regulations and standards in regards to copper concentrations in seawater and food. However, the thresholds are rarely exceeded except in oysters and edible tissue of marine animals (Neff 2002). This generally occurs in areas where intensive agricultural and/or industrial activities occur.

In Australian waters, background levels of copper range from 0.025 to 0.38 µg/l in marine waters and 0.06 to 1.3µg/l in estuarine waters (ANZECC 2000). In NSW coastal water, average copper concentrations are 0.031µg/l (Apte et al 1998). In Perth coastal waters, copper concentrations ranged from 0.046ug/l to 0.145µg/l (McAlpine et al 2005). In comparison, the mean concentration of copper in Sydney Harbour is 6.5 µg/l (Hatje et al 2003). Estuaries generally have higher concentrations of dissolved copper compared to other waters.

No data on copper concentrations for Twofold Bay could be sourced. However, due to its location, the background levels of dissolved copper within the marine waters of the chip mill jetty are likely to be very low. It is estimated that the concentration of dissolved copper from the use of the Vandervelde system would be relatively small within the pipelines (circa 10µg/l)) and that significant copper accumulation is unlikely to occur in the open sea at the construction site. As such it is unlikely that the release of copper would have detrimental impact on the local marine life or fisheries resources, except from inhibiting fouling of the pipelines. ANZECC (2000) guidelines state that trigger values for copper in slightly to

moderately modified marine systems should be below 1.3µg/l. It is unlikely this value would be exceeded outside the pipeline.

Impingement and Entrainment

Seawater is proposed to be pumped via a 450mm diameter pipeline which would be located 90 metres from the shore along the chip mill jetty with the intake located at least 2 metres above the sea floor. The intake pipe would be screened with a 2mm wedge wire screen. The intake would be located within a sandy bed with rocky outcrops approximately 50 metres from the rocky barrens and 80 metres from the rocky reef.

Potential impacts of the intake pipe on local marine biodiversity include impingement and entrainment. Impingement is the entrapment of organisms on the intake screen while entrainment results when organisms small enough to fit through the intake screen are taken through the intake system and exposed to mechanical stress, heated water and chemicals (ie. antifouling system). It is generally accepted that mortality rate of entrained organisms is close to 100%.

Impingement and entrainment rates at power plants using once through cooling systems have been studied for the last 30 years (see review of studies on Californian impact studies in California Energy Commission 2005). The majority of these studies have been undertaken in the northern hemisphere and no data could be sourced for power plants in Australia. As with thermal impacts, the results can vary greatly according to the climatic, hydrological and biological features of the study environments and it is therefore difficult to infer impacts a priori for a particular site. (Low rates of impingement and/or entrainment may still have significant impacts on particularly sensitive environments.) Furthermore, a recent review of studies that have been conducted to determine the impacts of entrainment and impingement has shown that the majority of these were flawed due to poor study designs and analyses and that only a few recent studies have provided a reasonable understanding of impacts (California Energy Commission 2005, Steinbeck et al 2007)

Impingement

The impingement rate depends on the intake velocity as well as the size of the intake screen. The higher the intake velocity and the smaller the size of the screen the higher number and wider range of organism sizes have the potential to be impinged. Table 5-4 provides impingement rate estimates at various power plant sites in California (USA).

Table 5-4. Impingement rates of fish at various power plants in the California (USA). (ML/d: Mega litres per day) (Source: Foster and Steinbeck undated).

Power plant	Location	Environment	Fish protection device	Average flow based on 2000-2005 data (ML/d)	Impingement rates (fish/year)
El Segundo Generating Station Units 1&2	Southern California	Ocean	Velocity Cap, Bar Racks, Travelling Screens	314	260
Encina Power Plant	Southern California	Bay/Harbour	Bar Racks, Travelling Screens	2825	138,932
Harbor Generating Station	Southern California	Bay/Harbour	Bar Racks, Travelling Screens	268	10,666
Huntington Beach Generating Station	Southern California	Ocean	Velocity Cap, Bar Racks, Travelling	814	26,666

Power plant	Location	Environment	Fish protection device	Average flow based on 2000-2005 data (ML/d)	Impingement rates (fish/year)
			Screens		
Moss Landing Power Plant Units 1&2	Northern California	Bay/Harbour	Bar Racks, Travelling Screens	878	40,816
Ormond Beach Generating Station	Southern California	Ocean	Velocity Cap, Bar Racks, Travelling Screens	2370	13,534
Potrero Powerplant	Northern California	Bay/Harbour	Bar Racks, Travelling Screens	878	106,182
San Onofre Nuclear Generating Station Unit 2 and Unit 3	Southern California	Ocean	Velocity Cap, , Structures inside intake to divert fishes, fish elevator, Bar Racks, Travelling Screens	10,364	1,322,490
Scattergood Generating Station	Southern California	Ocean	Velocity Cap, Bar Racks, Travelling Screens	1406	92,829
South Bay Powerplant	Southern California	Bay/Harbour	Bar Racks, Travelling Screens	1897	242,401

While Table 5-4 lists only impingement of fish, intake pipes are also known to trap large marine organisms such as seals and turtles (Foster and Steinbeck undated). However, this generally occurs at the larger power plants where the size of the intake pipes and intake flows would allow such entrapment. Due to the limited size of the intake at the proposed power plant this is highly unlikely to occur and therefore impacts as a result of the impingement of large organisms such as mammals and marine turtles are not discussed further.

It is difficult to assess the actual impacts of impingement based on the numbers of impinged organisms alone as these have to be compared to local fish stock populations. To determine the impact of impingement on local fish populations, the general method used is to compare impingement rates of commercially important species with local fisheries catch data. Impingement at individual power plants, especially in open coastal areas, is generally considered to have a minor impact on local fish stock populations since fish protection devices have been introduced to reduce the rate of impingement. However, the cumulative impact of 11 coastal power plants along the southern Californian coast line has been assessed as maybe being as high as 8% to 30% of the fish caught as a result of recreational fishery (MBC/Tenera 2005 in California Energy Commission 2005).

Due to the intake velocity playing an important role in the impingement rate, reducing intake flow is one of the more widely recommended methods for reducing its impact. A state wide water quality control policy on the use of coastal and estuarine waters for power plant cooling in California has recently been drafted which would require all existing power plants using once through cooling system to upgrade their system so that intake velocities do not exceed 0.15m/s. Reducing inflow velocities has been shown to considerably reduce impingement rates by up to 99% in some cases (Thomas and Johnson 1980).

The intake velocity of the cooling system of the proposed power plant would be 0.1m/s at the intake screen. Furthermore, the intake pipe would be located in vicinity of an exposed rocky reef. The majority of the fish and other marine organisms in such an environment would be adapted to relatively strong and/or turbulent currents. It is estimated that current velocities at the site varies from 0.027 m/s to 0.229 m/s (URS 2009). Less adapted species would be found within protective habitats such as below the jetty, amongst the boulders or close to the sea bed. Considering these results, and comparing the low impacts of impingement at individual power plants in California with much high inflows (Table 5-3), it is highly unlikely that the single 5MW power plant would result in major impacts to local fisheries from impingement.

Entrainment

Impacts of entrainment are difficult to assess as entrained organisms are part of larger source water populations that may extend over large areas or be confined to limited habitats, making it difficult to determine the effects of entrainment losses. The early life histories of most marine organisms are also poorly described, limiting the usefulness of demographic models for assessing entrainment effects. Table 5-5 provides entrainment rate estimates at various power plant sites in the US.

Table 5-5. Entrainment rates for larval fishes at various power plants in California (USA) (ML/d: Mega litres per day) (Source: Foster and Steinbeck undated)

Power plant	Location	Environment	Average flow based on 2000-2005 data (ML/d)	Entrainment rate (larval fish/year)
El Segundo Generating Station Units 1&2	Southern California	Ocean	314	35,743,328
Diablo Canyon Power Plant	Northern California	Ocean	10,405	1,481,948,383
Encina Power Plant	Southern California	Bay/Harbour	2825	3,627,641,744
Harbor Generating Station	Southern California	Bay/Harbour	268	65,298,000
Huntington Beach Generating Station	Southern California	Ocean	814	344,570,635*
Morro Bay Power Plant	North California	Bay/Harbour	1169	859,337,744*
Moss Landing Power Plant Units 1&2	Northern California	Bay/Harbour	878	522,319,740*
Ormond Beach Generating Station	Southern California	Ocean	2370	6,351,783
Potrero Powerplant	Northern California	Bay/Harbour	878	289,731,811*
San Onofre Nuclear Generating Station Unit 2	Southern California	Ocean	5182	3,555,787,272
Scattergood Generating Station	Southern California	Ocean	1406	365,258,133

Power plant	Location	Environment	Average flow based on 2000-2005 data (ML/d)	Entrainment rate (larval fish/year)
South Bay Powerplant	Southern California	Bay/Harbour	1897	2,420,527,779*

*Based on design flows and not average flow from 2000-2005 data

As the results in Table 5-5 indicate, the number of larval fishes entrained is not necessarily correlated to the average flow of water through the cooling system. The location of the intake pipe in particular environments can have a more pronounced effect on entrainment rates than the volume of water used.

Recent studies on entrainment impacts have been undertaken for three power plants along the California coast including South Bay Power Plant, Morro Bay Power Plant and Diablo Canyon Power Plant. The results have been summarised in Steinbeck et al (2007). The studies assessed the impacts of entrained fish larvae on stock populations. The method used to assess this impact was the Empirical Transport Model which requires an estimate of both entrained and source water larval populations (ie. abundance of organisms at risk of entrainment as determined by biological and hydrodynamic/oceanographic data). The results for the Empirical Transport Model ranged from very small levels (<1.0 percent) of proportional mortality due to entrainment for wide ranging pelagic species such as northern anchovy to levels as high as 50 percent for fish with more limited habitat that were spawned near power plant intake structures. The results of the Empirical Transport Model were generally consistent with the biology and habitat distributions of the fishes analysed.

Various methods have been used to reduce entrainment and these include:

- Moving the intake to an area of lower productivity
- Use of wedge wire screens

The proposed intake screen would have a 2mm wedge type wire mesh screen which would limit entrainment to those organisms below this size, mostly fish larvae, phytoplankton and zooplankton. No data on fish larvae and plankton could be obtained for the Twofold Bay region. However, considering the high species richness found through the field surveys and literature review and the fact that whales are known to feed off Twofold Bay, it is highly likely that the area has high primary and secondary productivity levels. Furthermore, Eden is the largest fishing port in NSW and therefore it can be assumed the region has relatively high fish stocks.

The power plant would use up to 10,585 ML of seawater per year for cooling. For comparison purposes, Twofold bay holds approximately 700,000 ML if considering an average depth of 20 metres and a surface area of 35km^2. It would therefore take approximately 66 years for the cooling system to filter the volume of the bay. The coastal location could also potentially reduce the impacts of entrainment compared to a closed system. Inflow velocity would be 0.1m/s which would also limit entrainment potential. As per the results of recent studies undertaken at Californian power plants, it is likely that should any impacts occur these would be restricted to species occurring in the specific habitats located around the intake pipe. The rocky reefs, sandy bed and rocky outcrop habitats are well represented within Twofold Bay and surrounding areas and the majority of species encountered at the proposal site were common and found at other locations. It is therefore unlikely that entrainment would have a significant impact on the regional or local plankton population. The potential impacts on protected species such as the weedy sea dragon and threatened organisms are discussed below.

5.3 THREATENED PROTECTED AND MIGRATORY SPECIES

5.3.1 Threatened and migratory species

An assessment of the potential for threatened and migratory species to be impacted by the proposed works has been undertaken. Refer to Appendix D for results. Seven threatened species and one migratory species have been assessed to have the potential to be impacted by the proposed works (Table 5-6).

Table 5-6. Threatened and Migratory species with the potential to be impacted by the proposed works

Common Name	Scientific Name	Status
Fish		
Black cod	*Epinephelus daemelii*	V-FM
Australian grayling	*Prototroctes maraena*	V-EPBC
Great White Shark	*Carcharodon carcharias*	V-EPBC, V-FM, Migratory
Mammals		
Southern right whale	*Eubalaena australis*	V-TSC, E-EPBC, Migratory
Humpback whale	*Megaptera novaeangliae*	V-TSC, V-EPBC, Migratory
Australian fur seal	*Arctocephalus pusillus doriferus*	V-TSC
Killer whale	*Orcinus orca*	Migratory
Reptile		
Green turtle	*Chelonia mydas*	V-TSC, V-EPBC, Migratory

7-part tests and assessments of significance have been undertaken for those species listed on the FM and/or TSC Acts and EPBC Act respectively. The details of the tests are provided in Appendix E.

The 7-part tests concluded that no FM Act and/or TSC Act species listed as threatened are likely to incur a significant impact as a result of the proposed works.

The assessments of significance concluded that no EPBC Act listed threatened or migratory species are likely to incur a significant impact as a result of the proposed works.

5.3.2 Weedy seadragon

The weedy sea dragon (*Phyllopteryx taeniolatus*) was observed at the proposal site amongst the boulders on the sandy bed at a depth of 10m approximately 75 metres from the shore below the chip mill jetty. Individuals were also observed within the seagrass bed and the rocky reefs in vicinity of the navy wharf at site R1. Weedy seadragons have also been recorded at Fisheries Beach and the area between the navy jetty and chip mill jetty (Sanchez-Camara pers. comm.). Therefore, the proposal site offers habitat for this species listed as protected under the FM Act and the EPBC Act.

Weedy seadragons are endemic to southern Australian waters and recent research has brought to light some valuable information on their ecology (Sanchez-Camara and Booth 2004, Sanchez-Camara et al 2005, Sanchez-Camara et al 2006). A study on weedy sea dragon populations in the Sydney area, shows the species to potentially have restricted home ranges varying from 50 metres to 150 metres in length and high site fidelity, though horizontal and vertical movement were observed in some individuals

related to reproduction (Sanchez-Camara and Booth 2004). The depth of the home ranges seems to be correlated to a number of factors, with the swell, strong tide currents and habitats dominated by boulders likely to limit their number in shallower waters. Weedy seadragons seem to prefer the interface between sandy beds and macroalgal beds (Sanchez-Camara et al 2006). Brooding males can be observed from June to early January with peaks in November-December and reproduction could potentially be linked to a rise in sea water temperature and lengthening of day light hours and the moon cycle (Sanchez-Camara et al 2005). The breeding season seems to also be correlated with the breeding of mysids with newly hatched seadragons mostly reported in areas with high concentrations of small mysidaceans (Kuiter 1988). A significantly high number of seadragon recruits (ie. recently hatched) were observed at the interface between kelp covered reefs and sand flats compared to all other habitats (Sanchez-Camara et al 2006).

The proposal has the potential to impact on the weedy seadragon through thermal pollution, impingement and entrainment.

As an essentially temperate organism, it is estimated that the upper thermal tolerance for weedy seadragons in summer would be in the vicinity of 22 ^{o}C and it is unlikely that individuals would survive sustained temperatures of this level all year round (Sanchez-Camara pers. comm.). The proposed release of heated water would raise the ambient water temperature by up to 10 to 21^{o}C in Summer and Winter respectively within the first metre of the outlet, though this temperature would reduce rapidly away from it. Due to its mobility it is highly likely that adult weedy seadragons would avoid the zone immediately around the outlet while recruits would mostly be found in the vicinity of the macroalgal covered rocky reef away from the outlet zone.

Entrainment is unlikely to directly impact weedy seadragon recruits. Adult males incubate the eggs in a brood pouch and recruits would mostly be found in the vicinity of the macroalgal covered rocky reef away from the inlet zones. However, entrainment has the potential to have some indirect impacts on the weedy seadragon through entrainment of its food source, mysids. Mysids actively swim and this ability would reduce the potential for entrainment (Buskey 1998). While mysids have the potential to be entrained, the impact on the overall mysid population at the site is unlikely to be significant due to their swimming capability and the low inflow velocity at the intake screen.

Due to the low velocity of the intake pipe, it is unlikely that adult weedy seadragons would be impinged on the intake screen. As previously mentioned, recruits would most likely be located away from the outtake and therefore are unlikely to be impacted.

Weedy seadragons are generally observed near the sea bed (Morgan pers. obs.). Some limited protection would be offered by the inlet and outlet being raised above the sea bed by 2 metres and 1 metre respectively.

Due to the relatively small home ranges of weedy seadragons and the limited amount of information on its ecology and sensitivity to habitat disturbance, it is difficult to predict the impacts the cooling system would have on the chip mill jetty population though, as previously discussed, impacts are likely to be minor. In a worst case scenario it is possible the weedy seadragons at the chip mill jetty would move away from the zone of influence of the intake and outtake pipes, most likely staying closer to the rocky reef environment located along the shore.

5.4 OTHER IMPACTS

5.4.1 Aquaculture

As previously discussed, should impacts occur as a result of the operation of the cooling system these would be highly localised. As such it is unlikely that impacts to the aquaculture industry would result. The closest mussel aquaculture farm is located approximately 2.5km to the north west of the proposal site. Entrainment of plankton is unlikely to result in a depletion of the mussels food source or a reduction in larval stock due to the minimal amount of water to be used for cooling and the open coastal location of the cooling system. The copper antifouling system is unlikely to impact larval stocks. Embryo development appears to be the most copper sensitive stage in the life cycle of mussels (*Mytilus edulis)*, with concentrations causing a 50% reduction in the production of larvae estimated at around 5.8 µg/l (Martin et al 1981). The larval stage, however, is considered to have the highest resistance to copper, with high levels of mortality only observed at very high concentrations (>100 µg/l) but with some sub-lethal effects such as reduced growth observed at around 20 µg/l (Beaumont et al 1987, Hoare and Davenport 1994). Studies undertaken on mussels in the UK have shown that relatively low concentrations of copper can increase their resistance at higher copper concentrations (Hoare et al 1995). Levels of copper within the pipeline would not be above 10ug/l and would be much less in the open environment (refer to Section 5.2.2 for further details).

5.4.2 Recreational divers

The proposal site is currently used by recreational scuba divers. It is likely that a restriction will be placed on divers in regards to the distance they will be able to approach the outlet and inlet pipes. This restriction would be of around 10 metres which is unlikely to have a major impact on accessibility.

6 ENVIRONMENTAL MANAGEMENT

6.1 SAFEGUARDS

Impacts would be managed through best practice guidelines in the relevant industry and through the following management measures (Table 6-1).

Table 6-1. Construction and Operational management measures

Safeguards
Construction
• Works on the sea water cooling facility along the chip mill jetty would be avoided during the southern migratory cetacean period.
• A management plan would be prepared to mitigate any potential encounters with marine mammals such as seals, dolphins and other cetaceans.
• A spill management plan would be prepared in the event of spill.
• Divers would be inducted and made aware of the ecology of the site, the importance of working in a manner to limit habitat disturbance and disturbance to weedy sea dragons and on avoiding contact with marine mammals.
• Only the minimal amount of attached flora and fauna on the jetty should be removed during the installation of the inlet and outlet pipes.
• The concrete footings for the inlet and outlet pipe would be placed in an area with limited habitat potential (eg. sandy bed). Any visible benthic invertebrates on the footprint would be relocated in nearby habitat prior to the placement of the footing.
• All works should be undertaken so as to limit sediment disturbances.
• Construction workers would be inducted on the importance of maintaining the area clean and devoid of marine debris. Emphasis should be made on how the impact of plastics and other debris can affect marine fauna (eg. asphyxiation of marine mammals, turtles).
Pre-construction
• During detailed design, the inlet and outlet design will be optimised taking into account mixing characteristics and ecological considerations.
Operation

• Due to the limited information on sea water cooling facility impacts on marine environments in Australia it is recommended that a 'beyond BACI' monitoring program be prepared for the proposed works. The monitoring program and inclusions would need to be prepared in consultation with DECCW and DPI (Fisheries). Inclusions to be considered may include:
  ◦ Potential impacts to weedy seadragons
  ◦ Changes in fish and invertebrate community composition
  ◦ Changes in plankton (incl. fish larvae) composition

Safeguards
• Impingement rates • Entrainment rates
• Monitoring of copper concentrations is recommended in the area surrounding the outlet.

7 CONCLUSIONS

The proposed power plant would include the provision of a once through cooling system. Following a review of the cooling system, including the design, intake velocities and volumes and thermal discharge modelling and a survey of the proposal site an assessment of the potential impacts on marine biodiversity was undertaken. A lack of data on entrainment, impingement and thermal pollution impacts on marine biodiversity in Australian waters was found during the preparation of this assessment. The principles of Ecologically Sustainable Development have been used to prepare this assessment and in the development of appropriate management measures. In particular, the precautionary principle (ie. lack of scientific certainty should not preclude cautious action) has been adopted.

It was determined that the cooling system is unlikely to have any significant impacts on marine biodiversity at a regional or local level and significant impacts to threatened marine species would be unlikely. The majority of potential impacts would likely be confined to within 3.5 metres of the site. Impacts anticipated include:

- Changes in fish and invertebrate community structures in the vicinity of the outlet
- Potential mortality of sessile organisms in close proximity of the outlet
- Potential avoidance of the site by the weedy seadragon and other species with low upper temperature ranges
- Potential temporary avoidance of the construction site by marine mammals as a result of construction noise
- Reduced access to the chip mill jetty for recreational divers

8 REFERENCES

Allen GR (1991) Damselfishes of the world. Mergus Publishers, Melle

ANZECC (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality.

Apte, S.C., Batley, G.E., Szymczak, R., Rendell, P.S., Lee, R. and Waite, T.D. (1998): Baseline trace metal concentrations in New South Wales coastal waters. *Mar. Freshwater Res. 49:* 203–214.

Australian Maritime Safety Authority (AMSA) website. T*he effects of Maritime oil spills on wildlife including Non-avain marine life (accessed 2009)*

Bamber, R.N. (1995). The Influence of rising background temperature on the effects of marine thermal effluents. J. Therm. Boil. 20(1/2):105-110.

Beaumont, A. R., Tserpes, G., Budd, M. D (1987). Some effects of copper on the veliger larvae of the mussel Mytilus edulis and the scallop Pecten maximus (Molluscs, Bivalvia). Mar. environ. Res. 21. 299-309

Blewitt, M.L. and Cato, D.H. (2008). Impact of marine drilling on whales of Cape Solander, NSW. Prepared for Sydney Water.

Buskey, E.J. (1988). Energetic cost of position-holding behaviour in the planktonic mysid Mysidium clumbiae. Mar. Ecol. Prog. Ser. 172:139-147.

California Energy Commission (2005). Issues and Environmental Impacts Associated with Once-through Cooling at California's Coastal Power Plants.

Canli, M. And Furness, R.W. (1993). Toxicity of Heavy Metals Dissolved in Sea Water and Influences of Sex and Size on Metal Accumulation and Tissue Distribution in the Norway Lobster *Nephrops norvegicus. Marine Environmental Research 36:* 217-236

Carlton, JS, and Dabbs, E, 2009, *The influence of ship underwater noise emissions on marine mammals,* Lloyd's Register Technology Day Proceedings, February 2009.

Chen, C-Y, Shao, K-T and Tu, Y-Y. Effect of thermal discharges on the fish assemblages of a nuclear power plant in northern Taiwan. *Journal of Marine Science and Technology, Vol. 12, No. 5, pp. 404-410 (2004)*

Cumberland Ecology (2007). Cattle Bay, Eden. Assessment of Impacts on Aquatic Marine Species for a Major Project Application.

DEH (2002). White shark (*Carcharodon carcharias*) Recovery Plan.

DEH (2005). Southern Right Whale Recovery Plan 2005-2010.

DEH (2005). Humpback Whale Recovery Plan 2005-2010.

DPI 2005. Mussel Aquaculture in Twofold Bay. Stage 1 review report and determination of progression to stage 2, prepared in accordance with the mussel aquaculture in Twofold Bay determination dated 1998.

Duncan, A.J. and McCauley, R.D. (2008). Prediction of underwater noise and associated environmental impacts from a proposed ocean outfall on the northern Tasmanian coast. Report prepared for Bell Bay Alliance.

Faraghers, R.A. (1999). A survey of the threatened fish species, Australian grayling *Prototroctes maraena Gunther*: distribution and abundance in New South Wales. CRC for Freshwater Ecology, NSW Fisheries Research Institute, NSW, Australia.

Foster, M. And Steinbeck, J. (undated). Compilation of California Coastal Power Plant Entrainment and Impingement Estimates for California State Water Resources Control Board Staff Draft Issue Paper on Once-Through Cooling.

Hatje, V., Apte, S.C., Hales, L.T., Birch, G.F. (2003). Dissolved trace metal distributions in Port Jackson estuary (Sydney Harbour) Australia. *Marine Pollution Bulletin* 46, 719-730.

Hoare K., Davenport J. And Beaumont A.R. (1995). Effects of exposure and previous exposure to copper on growth of veligers larvae and survivorship of Mytilus edulis juveniles. Mar. Ecol. Prog. Ser. 120:163-168.

Hoare, K., Davenport, J. (1994). Size-related variation in the sensitivity of the mussel. Mytilus edulis, to copper. J. mar. biol. Ass. U.K. 74 971-973

Kaskat, D., Southall, B.L., Schusterman, R.J. and Kastak, C.R. (2005). Underwater temporary threshold shift in pinnipeds: Effects of noise level and duration. J. Acoust. Soc. Am. 118(5): 3154-3163.

Lardicci, C., Rossi, F. And Maltagliati, F. (1999). Detection of thermal pollution: Variability of benthic communities at two different spatial scales in an area influenced by a coastal power station. Marine Pollution Bulletin 38(4): 296-303.

MacAlpine, K.W., Wenziker, K.J., Apte, S.C. and Masini, R.J. (2005). Background Quality for Coastal Marine Waters of Perth,Western Australia.

Martin, M,Osborn, K. E., Billig, P., Glickstein, N. (1981). Toxicities of ten metals to *Crassostrea gigas* and *Mytilus edulis* embryos and *Cancer magister* larvae. Mar. Pollut. Bull. 12: 305-308

Nadella,S.R., Fitzpatrick, J.L., Franklin, N., Bucking, C., Smith, S., Wood, C.M. (2009). Toxicity of dissolved Cu, Zn, Ni and Cd to developing embryos of the blue mussel (Mytilus trossolus) and the protective effect of dissolved organic carbon. Comparative Biochemistry and Physiology, Part C 149 340–348

Nedwell J, Martin A, Mansfield N (1993) '*Underwater tool noise: implications for hearing loss*'. Subtech '93, pp267-275, Kluwer Academic Publishers, Dordrecht, The Netherlands.

Neff, J.M. (2002). Bioaccumulation in Marine Organisms: Effect of Contaminants from Oil Well Produced Waters.

Ocean Studies Board (2003). Ocean Noise and Marine Mammals.

Pollard and Rankin (2003). Port of Eden Introduced Marine Pest Species Study. Report to Coasts & Clean Seas Program. NSW Fisheries Final Report Series No. 46

R.J. Williams, G. West, D. Morrison and R.G. Creese, (2006), "Estuarine Resources of New South Wales", prepared for the Comprehensive Coastal Assessment (DoP) by the NSW Department of Primary Industries, Port Stephens.

Richardson, W.J., Greene Jr., C.R., Malme, C.I. and Thomson, D.H. (1995). *Marine Mammals and Noise*. Academic Press, San Diego, California.

Sanchez-Camara, J. And Booth, D.J. (2004). Movement, home range and site fidelity of the weedy seadragon *Phyllopteryx taeniolatus* (Teleostei: Syngnathidae). *Environmental Biology of Fishes* 70: 31–41.

Sanchez-Camara, J., Booth, D.J. and Turon, X. (2005). Reproductive cycle and growth of Phyllopteryx taeniolatus. Journal of Fish Biology (2005) 67, 133—148

Sanchez-Camara, J., Booth, Murdoch, J., Watts, D. And Turon, X. (2006). Density, habitat use and behaviour of the weedy seadragon *Phyllopteryx taeniolatus* (Teleostei : Syngnathidae) around Sydney, New South Wales,Australia. Marine and Freshwater Research 57, 737–745

Sandstrom, O., Neuman, E., and Thoresson, G., "Effects of Temperature on Life History Variables in Perch," *J. Fish Biol.*, Vol. 47, pp. 652-670 (1995).

Steinbeck, J., Hedgepeth, J., Raimondi, P., Cailliet, G. And Mayer, D. (2007). Assessing Power Plant Cooling Water Intake System Entrainment Impacts. Report prepared for the California Energy Commission.

The Ecology Lab (1999). Twofold Bay Multi Purpose Wharf and Naval Ammunitions Storage Facility. Marine Ecology Technical Report.

Thomas, G. L., and R. L. Johnson. 1980. Density dependence and vulnerability of fish to entrapment by offshore-sited cooling water intakes. Oceans IEEE Journal. 15:504−508.

URS (2009). Technical Report – Near Field and Far-Field Modelling of Discharge From the Twofold Bay Bio-Mass Fired Power Station Memorandum.

Verlaque, M., Giraud, G., and Boudouresque, C.F., "Effects of a Thermal Power Plant on the Mediterranean Marine Phythobenthos: The Area of High Frequency Temperature Charges," *Bot. Mar.*, Vol. 24, pp.69-87 (1981).

Watson, G.J., Leach, A., Fones, G. (2008). Effects of copper and other metals on fertilization, embryo development, larval survival and settlement of the polychaete Nereis (Neanthes) virens. Invertebrate Reproduction and Development 52 (1-2):101-112.

9 GLOSSARY

Benthic - relating to or characteristic of the bottom of a sea, lake, or deep river, or the animals and plants that live there

Demersal - living or found in the deepest part of a body of water

Infauna - organisms that live in tubes or burrows beneath the surface of the sea floor

Intertidal - occurring within, or forming, the area between the high and low tide levels in a coastal zone

Macrobenthos – benthic organisms large enough to be seen with the naked eye.

Meiobenthos - benthic organisms whose shortest dimension is less than 0.5 mm but greater than or equal to 0.1 mm

Mysticete – baleen whales (eg. humpback whale, southern right whale)

Nekton - an organism such as a fish that lives in water and can actively swim against currents, as opposed to microorganisms that are simply carried along

Odontocete – toothed whales (eg. sperm whale, dolphins)

Phytoplankton - very small free-floating plants such as one-celled algae found in plankton.

Pinniped - aquatic mammals that includes the seals, walruses, and similar animals having finlike flippers as organs of locomotion.

Plankton - the collection of small or microscopic organisms, including algae and protozoans, that float or drift in fresh or salt water

Sessile - permanently attached or fixed and not free-moving

Subtidal - continuously submerged in the area of a tidal system

Zooplankton - plankton that is made up of microscopic animals such as protozoans

10 APPENDICES

Appendix A DATABASE SEARCH RESULTS

Table B-1. **Results of database searches**. Numbers in parentheses indicate number of species records within search area from relevant database.

Bionet Search tool: Lists records of threatened species on the schedules of the TSC Act or FM Act within a defined search area

Wildlife Atlas: Lists records of threatened species on the schedule of the TSC Act within a defined search area

EPBC Protected Matters Search tool: Lists items/species on the Schedules of the EPBC Act with the potential to occur within a defined search area

ACRONYMS

EPBC: Environment Protection and Biodiversity Conservation Act

FM: Fisheries Management Act

TSC: Threatened Species Conservation Act

E: Endangered

V: Vulnerable

CE: Critically Endangered

Species	NSW Bionet (10km search radius) 15/07/2009	NSW Wildlife Atlas (10km search radius) 15/07/2009	EPBC Act Protected Matters (10km search radius) 15/07/2009
Amphibians			
Heleioporus australiacus Giant Burrowing Frog	V-TSC (4)	V-TSC (7)	V-EPBC
Litoria aurea Green and Golden Bell Frog	E-TSC (3)	E-TSC (3)	V-EPBC (E-TSC)
Litoria littlejohni Littlejohn's Tree Frog, Heath Frog			V-EPBC (V-TSC)

Species	NSW Bionet (10km search radius) 15/07/2009	NSW Wildlife Atlas (10km search radius) 15/07/2009	EPBC Act Protected Matters (10km search radius) 15/07/2009
Fish			
Epinephelus daemelii Black Cod	V-FM (1)		
Prototroctes maraena Australian Grayling			V-EPBC (P-FM)
Carcharias taurus (east coast population) Grey Nurse Shark (east coast population)			CE-EPBC (CE-FM)
Carcharodon carcharias Great White Shark			V-EPBC
Rhincodon typus Whale Shark			V-EPBC
Galeorhinus galeus *School shark, eastern school shark, snapper shark, tope, soupfin shark*			Conservation dependent
Mammals			
Eubalaena australis Southern right whale	V-TSC (1)	V-TSC (1)	E-EPBC
Megaptera novaeangliae Humpback whale	V-TSC (43)	V-TSC (42)	V-EPBC
Balaenoptera musculus Blue whale	E-TSC (5)	E-TSC (5)	E-EPBC
Arctocephalus pusillus doriferus Australian fur seal	V-TSC (2)	V-TSC (2)	

Species	NSW Bionet (10km search radius) 15/07/2009	NSW Wildlife Atlas (10km search radius) 15/07/2009	EPBC Act Protected Matters (10km search radius) 15/07/2009
Arctocephalus forsteri New Zealand fur seal		V-TSC (1)	
Dugong dugong Dugong	E-TSC (1)		
Reptiles			
Chelonia mydas Green turtle	V-TSC (1)	V-TSC (1)	V-EPBC
Migratory Marine Species (Mammals)			
Balaenoptera edeni Bryde's Whale			Migratory
Balaenoptera musculus Blue Whale			Migratory
Caperea marginata Pygmy Right Whale			Migratory
Eubalaena australis Southern Right Whale			Migratory
Lagenorhynchus obscurus Dusky Dolphin			Migratory
Megaptera novaeangliae Humpback Whale			Migratory
Orcinus orca Killer Whale, Orca			Migratory
Migratory Marine Species (Fish)			

Species	NSW Bionet (10km search radius) 15/07/2009	NSW Wildlife Atlas (10km search radius) 15/07/2009	EPBC Act Protected Matters (10km search radius) 15/07/2009
Carcharodon carcharias Great White Shark			Migratory
Rhincodon typus Whale Shark			Migratory
Other EPBC Act listed			
Arctocephalus pusillus doriferus Australian fur seal			Listed
Arctocephalus forsteri New Zealand fur seal			Listed
Syngnathids (seahorses, seadragons) 27 species			Listed
Cetaceans			
Balaenoptera edeni Bryde's Whale			Listed
Balaenoptera acutorostrata Minke whale			Listed
Balaenoptera musculus Blue Whale			Listed
Caperea marginata Pygmy Right Whale			Listed
Eubalaena australis Southern Right Whale			Listed
Lagenorhynchus obscurus Dusky Dolphin			Listed

Species	NSW Bionet (10km search radius) 15/07/2009	NSW Wildlife Atlas (10km search radius) 15/07/2009	EPBC Act Protected Matters (10km search radius) 15/07/2009
Megaptera novaeangliae Humpback Whale			Listed
Orcinus orca Killer Whale, Orca			Listed
Tursiops truncates s. str. Bottlenose dolphins			Listed
Tursiops aduncus Indian Ocean bottlenose dolphin			Listed
Grampus griseus Risso's dolphin			Listed
Delphinus delphis Common dolphin			Listed

Appendix B SITE PHOTOS

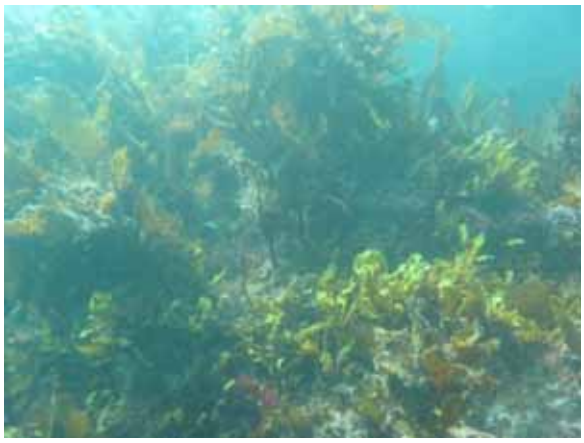

Photo 1. Site P1 – Rocky reef and macroalgal habitat

Photo 2. Site P1 – Rocky reef barren showing sea urchins and draughtboard shark

Photo 3. Site P1 - Jetty pile overgrown with macroalgae

Photo 4. Site P1 – Jetty pile devoid of macroalgae

Photo 5. Site P1 – Weedy seadragon within rocky reef habitat

Photo 6. Site P2 – Wharf pile showing attached fauna

Photo 7. Site P2 – Close up photo of attached fauna on wharf pile

Photo 8. Site P2 – Some fish life in vicinity of wharf

Photo 9. Site P2 – Ray on sandy bed

Photo 10. Site P3 – Rocky reef and macroalgae habitat

Photo 11. Site P3 – Rocky reef barren

Photo 12. Site P3 – sandy bed with sparse seagrass

Photo 13. Site R1 – Rocky reef with macroalgal bed

Photo 14. Site R1 – Rocky reef barren

Photo 15. Site R1 – Seagrass bed and sandy bed with weedy seadragon

Photo 16. Site R2 – Rocky reef with sparse macroalgae

Photo 17. Site R2 – Rocky reef with macroalgae

Photo 18. Site R2 – Ray on sandy bed

Photo 19. View of chip mill jetty and wharf

Photo 20. Chip mill wharf

Photo 21. Holding Reservoir.

Photo 22. Tiniki Creek Dam.

Photo 23. Bull Creek Dam

Photo 24. Bull Creek Dam

Appendix C FIELD SURVEY RESULTS

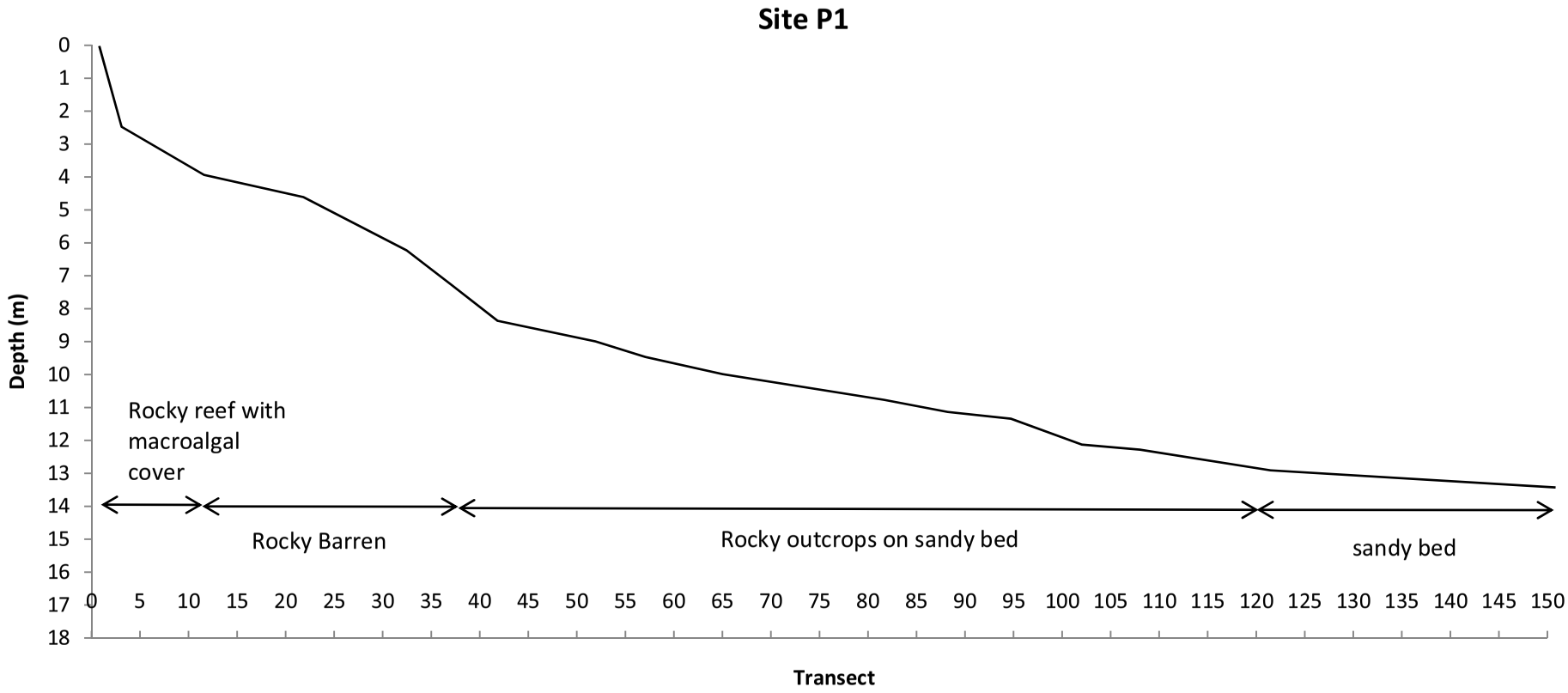

Figure C-1. Subtidal habitat surveys. Site P1.

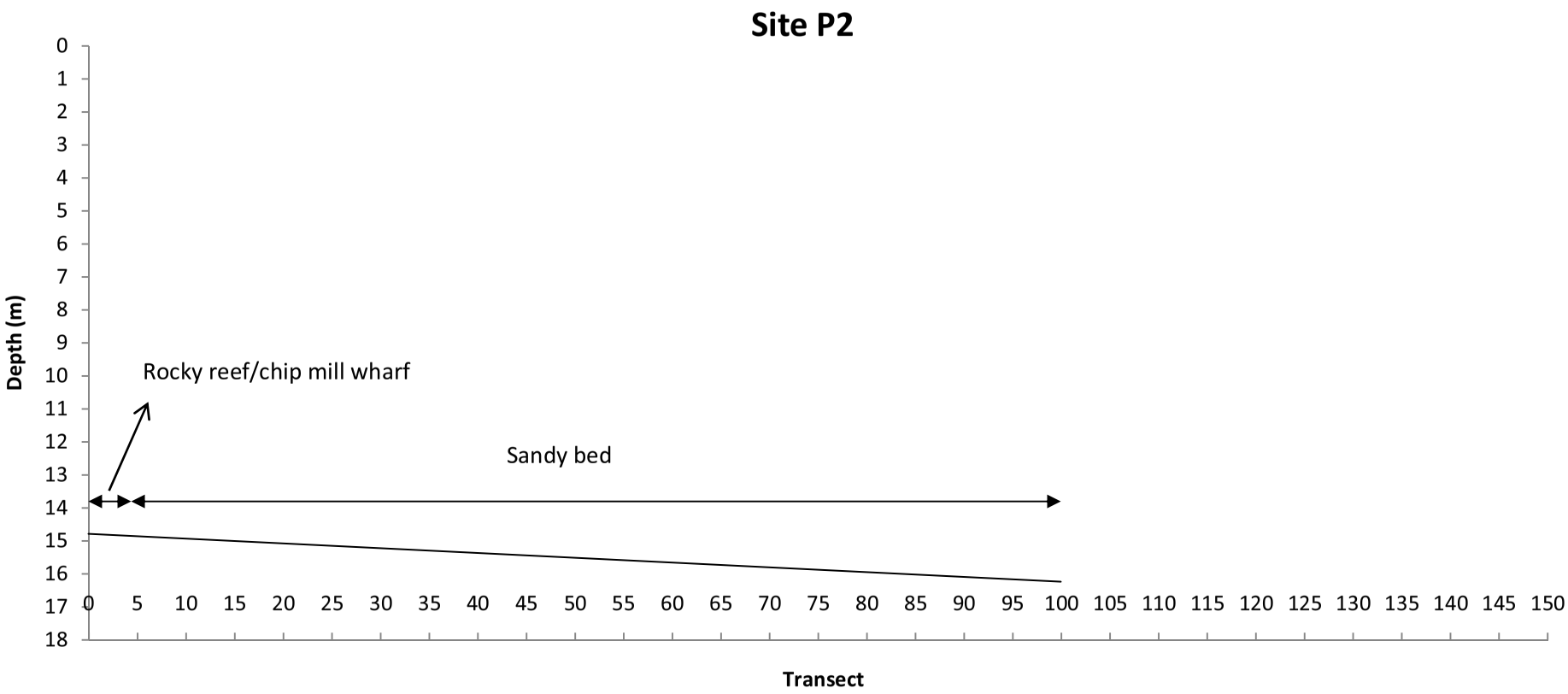

Figure C-2. Subtidal habitat surveys. Site P2.

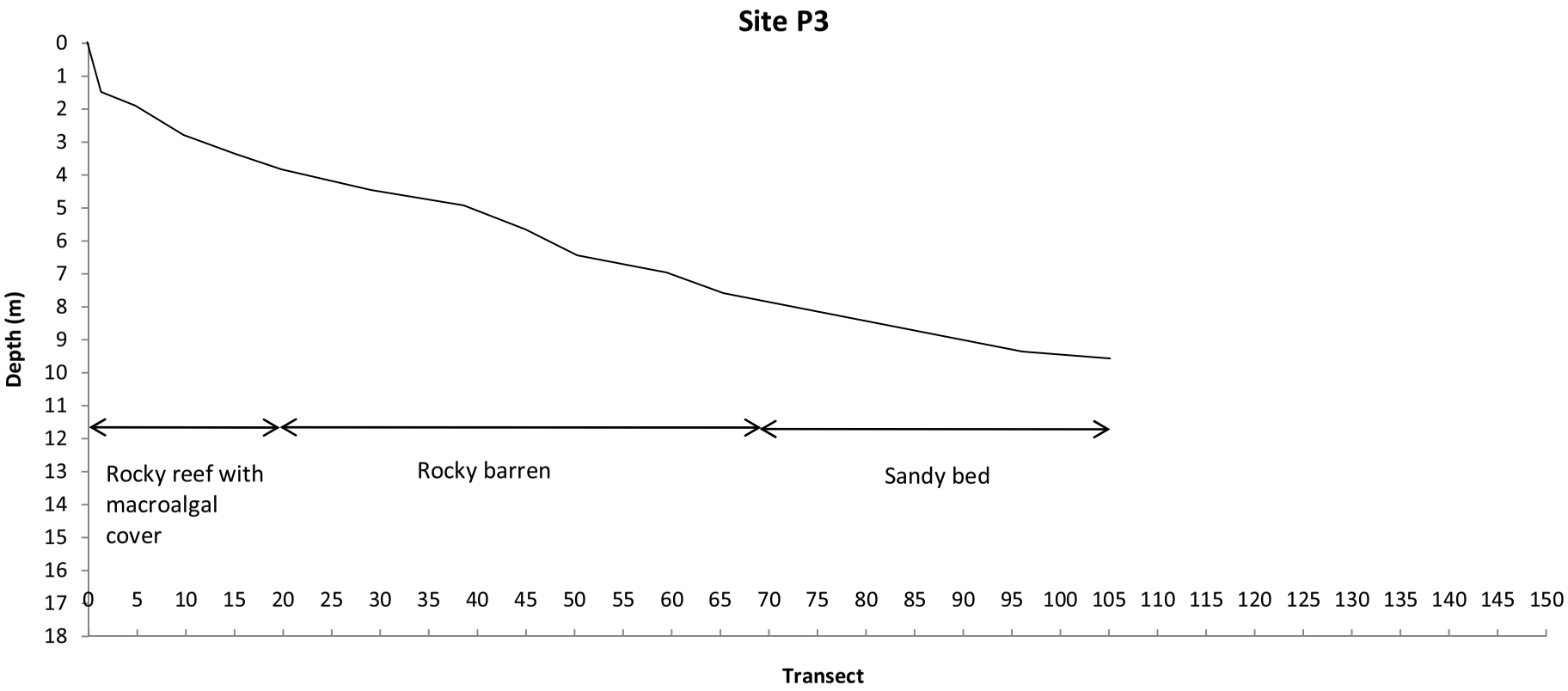

Figure C-3. Subtidal habitat surveys. Site P3.

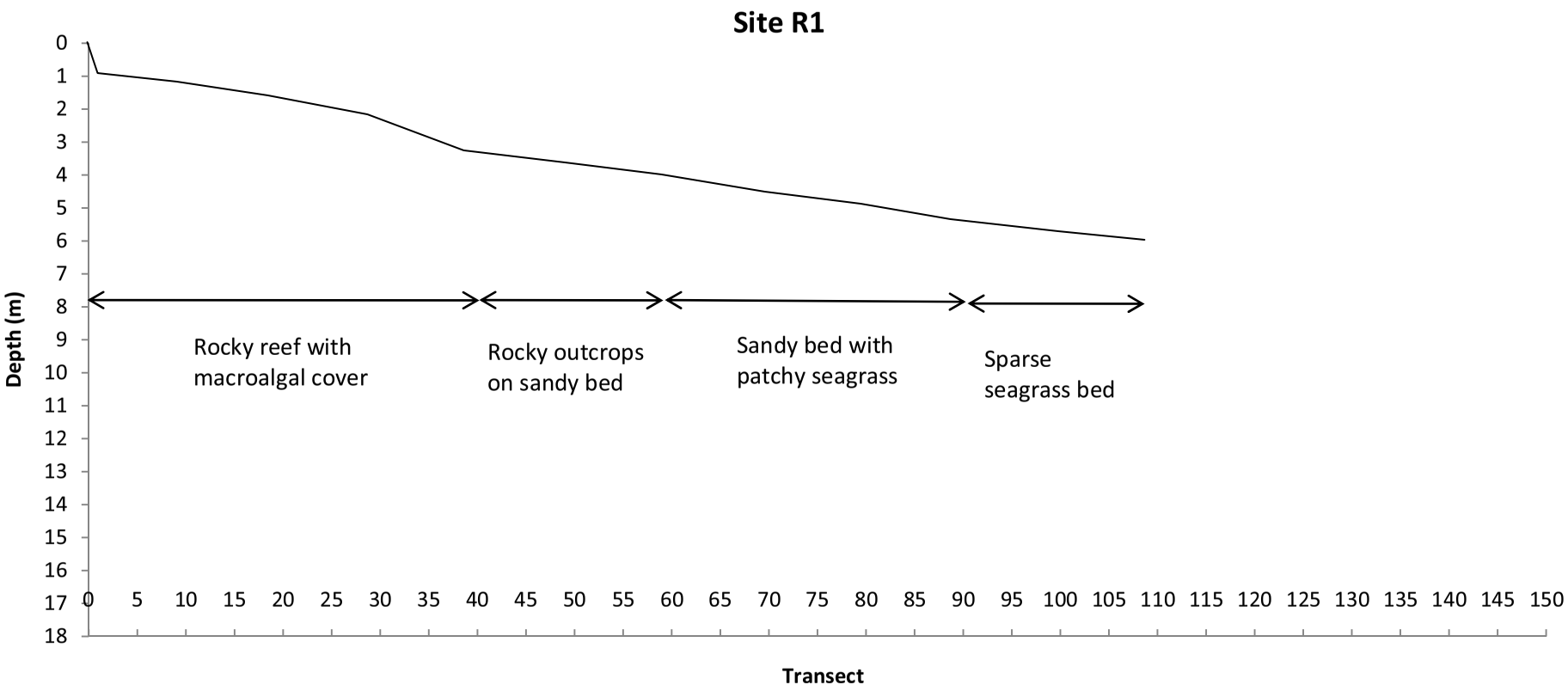

Figure C-4. Subtidal habitat surveys. Site R1.

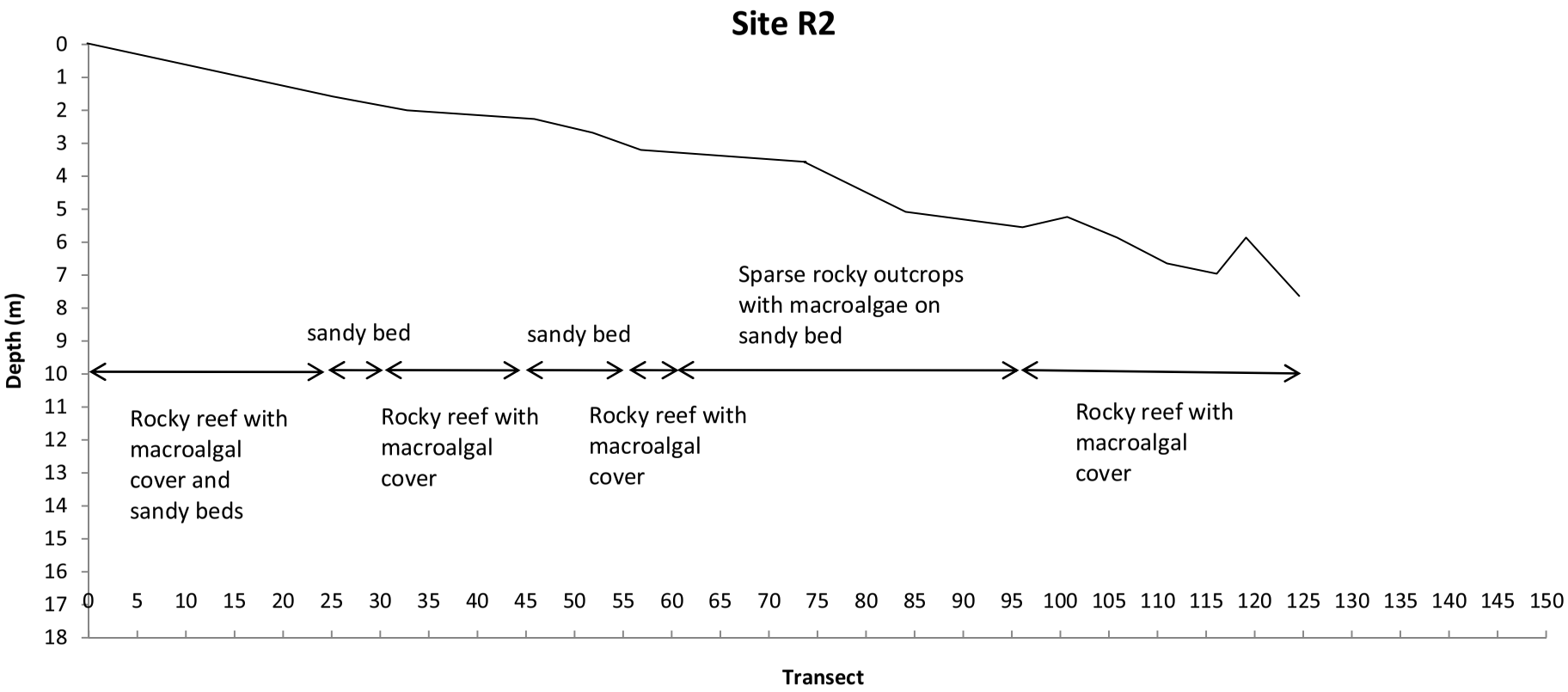

Figure C-5. Subtidal habitat surveys. Site R2.

Table C-1. Seagrass survey results (*Zostera* sp.). SD: Standard Deviation

Site	Cover (%)	Shoot length (mm)											
		1	2	3	4	5	6	7	8	9	10	Average	SD
R1	10	80	100	75	40	50	100	75	60	110	110	80	25
	1	40	60	50	50	80	40	100	30	30	50	53	22
	10	100	120	80	60	75	90	100	50	110	150	93	29
											Total	75	30

Table C-2. Results of fish and invertebrate transect surveys. Number of individuals recorded on rocky reefs or within 5 metres of a rocky reef and within 2 metres of transects. Where two numbers are given the first relates to numbers recorded on rocky reefs and the second to numbers recorded sand beds.

Fish		Sites				
Latin name	**Common Name**	**P1**	**P2**	**P3**	**R1**	**R2**
Sharks, rays						
Urolophidae						
Urolophus paucimaculatus	Sparsley spotted stingaree		0/3			0/1
Urolophus cruciatus	Banded stingaree		0/2			
Rhinobatidae						
Trygonorrhina sp	Eastern fiddler ray.				1	
Scyliorhinidae						
Cephaloscyllium laticeps	Draughtboard shark	1		1		
Heterodontidae						
Heterdontus portusjacksoni	Port jackson shark			1		
Bony fish						
Labridae						
Ophthalmolepis lineolata	Maori wrasse	25	1	45	4	
Notolabrus gymnogenis	Crimson banded wrasse	13	2	9		2
Pictilabrus laticlavius	Senator wrasse	1		4		
Notolabrus tetricus	Blue-throat wrasse	2		1		

Achoerodus vivides	Eastern blue groper	8	3	1		3
Kyphosidae						
Atypichthys strigatus	Mado	11	5	60	21	18
Scorpis georgiana	Silver Sweep	40/13	20			13
Dinolestidae						
Dinolestes lewini	Longfin Pike		100	150/50		
Carangidae						
Trachurus novaezelandidae	Yellow tail scad	150/50	180/20	35		30
Pseudocaranx dentex	Silver Trevally		100			
Pomacentridae						
Parma microlepis	White ear	24	3	11		
Parma mccullochi	McCulloch's scalyfin		1			
Chromis hypsilepis	One-spot puller	10		8		
Plesiopidae						
Trachinops taeniatus	Eastern hulafish	20	3	15		
Monacanthidae						
Eubalichthys bucephalus	Black reef leather jacket	5	1			
Eubalichthys mosaicus	Mosaic Leatherjacket	1				
Meuschenia freycineti	Six spine leather jacket	1	1			
Cheilodactylidae						
Cheilodactylus fuscus	Red morwong	7	1	1		
Aplodactylidae						
Crinodus lophodon	Rock Cale	7	1		1	
Chironemidae						
Chironemus marmoratus	Kelpfish		1			
Enoplosidae						
Enoplosus armatus	Old wife	2				
Tetraodontidae						
Tetractenos glaber	Smooth toadfish	1				
Diodontidae						

Dicotylichthys punculatus	Three bar porcupine fish	1		1	3	
Ostraciidae						
Anoplocapros inermis	Eastern smooth boxfish	5				
Muraenidae						
Gymothorax prasinus	Green moray			1		
Mullidae						
Parupeneus signatus	Black spot goat fish			3		
Plotosidae						
Cnidoglanis macrocephalus	Estuary catfish				1	
Platycephalidae						
Platycephalus fuscus	Dusky flathead					1
Pempheridídae						
Pempheris affinis	Black-tipped bullseye					15
Syngnathidae						
Dicotylichthys punculatus	Weedy seadragon	8			4	
	Total number of species	**22**	**18**	**17**	**7**	**8**
	Total number of individuals	**406**	**448**	**397**	**35**	**83**

Table C-3. Conspicuous invertebrates recorded along transects

Invertebrates		**Sites**				
Latin name	**Common Name**	**P1**	**P2**	**P3**	**R1**	**R2**
Echinoderms						
Centrostephanus rodgersii	Sea urchin	✓	✓	✓	✓	✓
Heliocidaris erythrogramma	Sea urchin				✓	
Phyllacanthus parvispinus	Pencil urchin			✓	✓	
Unidentified species	Starfish	✓				
Molluscs						

Unidentified species	Mussel		✓			
Unidentified species	Clam	✓				
Unidentified species	Limpets			✓		
Haliotis rubra	Abalone					✓
Unidentified species	Nudibranch			✓		
Octopus tetricus	Gloomy octopus			✓	✓	
Ascidians						
Botrylloides sp.	Ascidian		✓			
Pyura sp.	Cunjevoi			✓		✓
Unidentified species	Tunicate	✓	✓	✓	✓	
Polychaete						
Serpula sp	Worm			✓		
Unidentified species	Polychaete			✓	✓	
Protula sp	Feather duster worm			✓		
Sponges						
Unidentified species	Sponge			✓		

Table C-4. Conspicuous algal species recorded along transects

Macroalgae		Sites				
Group	**Species**	**P1**	**P2**	**P3**	**R1**	**R2**
Brown algae	*Ecklonia radiata*	✓	✓	✓	✓	✓
	Phyllaspora comosa	✓		✓	✓	✓
	Dictyota sp.		✓			
Red algae	Coralline algae				✓	✓
	Euptilota articulata		✓			

Table C-5. Benthic core surveys

Order/Family	P1			R1			R2		
	R1	R2	R3	R1	R2	R3	R1	R2	R3
Polychaetes									

Sabellidae	1	0	0	0	0	0	0	0	0
Spionidae	0	0	0	0	0	0	0	2	1
Magenolidae	0	0	0	0	0	0	1	1	0
Crustaceans									
Cumacea	1	0	0	0	0	0	0	2	1
Amphipoda/Corophiidae	0	0	0	0	0	0	1	0	1
Amphipoda/Ampeliscidae	1	0	0	0	0	0	0	0	0
Isopoda/Anthuridae	0	0	0	0	0	0	0	0	2
Molluscs									
Mytilidae	0	0	2	0	0	0	0	0	0
Tellinidae	1	0	0	0	0	0	1	0	0
Total number of taxa	**4**	**0**	**1**	**0**	**0**	**0**	**3**	**3**	**4**
Total number of individuals	**4**	**0**	**2**	**0**	**0**	**0**	**3**	**5**	**5**

Appendix D OCCURRENCE AND IMPACT ON THREATENED AND MIGRATORY SPECIES

Table D-1. An evaluation of the likelihood and extent of impact to threatened aquatic flora/fauna recorded within the Bega Valley Shire LGA (TSC Act and FM Act listed species) or with the potential to occur within a 10km radius around the proposal site (EPBC Act listed species). Records are from a search of the DECC, Wildlife Atlas, BioNet and the (EPBC) Environmental Reporting Tool for the Department of Environment & Water Resources. Ecology information has been obtained from the Threatened Species Profiles on the NSW DECC website and NSW DPI (fisheries) website.

Fauna Codes:

Presence of Habitat:

Present: Potential or known foraging, roosting, nesting, refuge, movement corridor (including movement of genetic material) or other habitat is present within the Proposal Site.

Absent: No potential foraging, roosting, nesting or other habitat is present within the Proposal Site.

Likelihood of Occurrence

None: Species does not occur at the Proposal Site.

Unlikely Species is unlikely to occur at the Proposal Site.

Vagrant: Species could occur on occasion as a vagrant or passing over/across the Proposal Site (usually applies to more mobile species)

Possible: Species could occur and utilise resources in the Proposal Site.

Present: Species was recorded during the field investigations

Possible Impact

No: The proposal would not impact this species or its habitats. No 7-Part Test is necessary for this species.

Yes: The proposal could impact this species or its habitats. A 7-Part Test has been completed for this species.

Species	Listing	Ecology	Presence of Habitat	Likelihood of Occurrence	Likelihood of Impact
Amphibians					
Heleioporus australiacus Giant Burrowing Frog	V-TSC V-EPBC	The Giant Burrowing Frog occurs from the NSW Central Coast to eastern Victoria, but is most common on the Sydney sandstone. It has been found from the coast to the Great Dividing Range. Found in heath, woodland and open forest with sandy soils. Generally lives in the heath or forest and will travel several hundred metres to creeks to breed. Burrows into deep litter or loose soil, emerging to feed or breed after rain. Diet includes ground-dwelling	Yes	Possible	No. No construction or operational impact envisaged at freshwater sites

Species	Listing	Ecology	Presence of Habitat	Likelihood of Occurrence	Likelihood of Impact
		invertebrates such as ants, beetles and spiders. Breeds from August to March and the eggs are laid in a white foam-mass under vegetation in creeks or in yabby holes.			
Litoria aurea Green and Golden Bell Frog	E-TSC V-EPBC	Formerly distributed from the NSW north coast near Brunswick Heads, southwards along the NSW coast to Victoria where it extends into east Gippsland. Records from west to Bathurst, Tumut and the ACT region. Since 1990 there have been approximately 50 recorded locations in NSW, most of which are small, coastal, or near coastal populations. These locations occur over the species' former range, however they are widely separated and isolated. Large populations in NSW are located around the metropolitan areas of Sydney, Shoalhaven and mid north coast (one an island population). There is only one known population on the NSW Southern Tablelands. Inhabits marshes, dams and stream-sides, particularly those containing bullrushes (*Typha* spp.) or spikerushes (*Eleocharis* spp.). Optimum habitat includes water-bodies that are unshaded, free of predatory fish such as Plague Minnow (*Gambusia holbrooki*), have a grassy area nearby and diurnal sheltering sites available. Some sites, particularly in the Greater Sydney region occur in highly disturbed areas. The species is active by day and usually breeds in summer when conditions are warm and wet. Males call while floating in water and females produce a raft of eggs that initially float before settling to the bottom, often amongst vegetation. Tadpoles feed on algae and other plant-matter; adults eat mainly insects, but also other frogs. Preyed upon by various wading birds and snakes.	Yes	Possible	No. No construction or operational impact envisaged at freshwater sites
Litoria littlejohni Littlejohn's Tree Frog, Heath Frog	V-TSC V-EPBC	Littlejohn's Tree Frog has a distribution that includes the plateaus and eastern slopes of the Great Dividing Range from Watagan State Forest (90 km north of Sydney) south to Buchan in Victoria. It occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops. It hunts either in shrubs or on the ground. Breeding is triggered by heavy rain and can occur from late winter	Yes	Possible	No. No construction or operational impact envisaged at freshwater sites

Species	Listing	Ecology	Presence of Habitat	Likelihood of Occurrence	Likelihood of Impact
		to autumn, but is most likely to occur in spring when conditions are favourable. Males call from low vegetation close to slow flowing pools. Eggs are laid in loose gelatinous masses attached to small submerged twigs. Eggs and tadpoles are mostly found in slow flowing pools that receive extended exposure to sunlight, but will also use temporary isolated pools.			
Fish					
Epinephelus daemelii Black Cod	V-FM	Adult Black Cods are usually found in caves, gutters, and beneath bommies in rocky reefs. They are territorial and often occupy a particular cave for life. Small juveniles are often found in coastal rock pools and larger juveniles around rocky shores in estuaries. Black Cod are opportunistic carnivores, eating mainly other fish and crustaceans. They can change from one colour pattern to another in a few seconds. They are usually black in estuaries and banded around clear water reefs. Black Cod are usually slow growing. Smaller fish are mostly females, but they generally change sex to become males at around 100-110 cm in length.	Yes. Rocky reefs located in vicinity of proposal site	Possible	**Yes TSC 7-Part Test has been completed for this species.**
Prototroctes maraena Australian Grayling	P-FM V-EPBC	Australian grayling occur in freshwater streams and rivers, especially clear gravelly streams with a moderate flow, as well as estuarine areas. They occur in fast-moving shoals and are a shy fish, fleeing when disturbed. They reach sexual maturity at 1–2 years of age when approximately 150 mm in length. Spawning takes place during late summer or autumn. Females can lay up to 82 000 small (approx. 1 mm) eggs, probably in the middle reaches of rivers, where they presumably settle among the gravel of the streambed. Once hatched, the larvae swim towards the water surface where they are swept downstream to the sea. The larvae and young juveniles have a marine stage before returning to freshwater rivers during spring when they are about 6 months old. The rest of their life cycle is spent in freshwater. Australian grayling are opportunistic omnivores, with a mixed diet of aquatic algae and insects.	Yes. Estuaries are located to the south of the proposal site. Marine environment provides habitat for juveniles.	Possible for juveniles to occur. Juveniles have been recorded in estuaries of Twofold Bay.	**Yes EPBC Act assessment of significance undertaken for species**
Carcharias taurus	CE-FM,	The Grey Nurse Shark is a coastal species found on the continental shelf	Yes	Vagrant	No

Species	Listing	Ecology	Presence of Habitat	Likelihood of Occurrence	Likelihood of Impact
(east coast population) Grey Nurse Shark (east coast population)	CE-EPBC	from the surf zone down to at least 190 m. The shark is a slow, strong-swimming species that is often seen hovering motionless near the bottom in or near deep sandy bottomed gutters or in rocky caves around inshore rocky reefs and islands at depths between 15 and 25 meters. These sites may play an important role in pupping and/or mating activities as grey nurse sharks often form aggregations at these sites. Occasionally, they are also found throughout the water column. The shark is thought to be more active at night, but this needs to verified using acoustic telemetry.			
Carcharodon carcharias Great White Shark	V-FM, V-EPBC, Migratory	The White Shark is widely distributed, and located throughout temperate and sub-tropical regions in the northern and southern hemispheres. In Australia, its range extends primarily from Moreton Bay in southern Queensland, with at least one record as far north as Mackay, around the southern coastline and to North West Cape in Western Australia. Great White Sharks are large, rare, warm-blooded apex marine predators. It is estimated that they mature at 12-18 years for females and 8-10 years for males. Maximum length is 6.4 metres, though specimens of up to 7 metres may exist. Great White Sharks reproduce only one every two to three years and produce between two and ten pups per litter.	Yes	Possible. Species is known to occur in Twofold Bay.	**Yes EPBC Act assessment of significance undertaken for species**
Rhincodon typus Whale Shark	V-EPBC, Migratory	One of only three filter-feeding sharks (the other two being the basking and megamouth sharks), the whale shark feeds on minute organisms including krill, crab larvae, jellyfish etc. Although they have approximately 3000 tiny teeth (each less than 6mm in length), these teeth are not used while feeding. Instead, the whale shark can sieve prey items as small as 1mm through the fine mesh of the gill-rakers. They are able to open their mouth to a great width (greater than 1m) to optimise feeding. Whale sharks can also feed via 'suction' while vertical in the water. Whale sharks have internal fertilisation and produce live young. It is, at present, not known where whale sharks breed. Whale sharks have a broad distribution in tropical and warm temperate seas, usually between latitudes 30°N and 35°S. They are known to inhabit both deep and shallow coastal waters and the lagoons of coral atolls and reefs. This species is widely distributed in Australian waters. Although most common at NMP (and to a lesser extent at Christmas Island and in the Coral Sea), sightings have been confirmed further south than Kalbarri (on the mid-west coast of WA) and Eden (on the NSW south coast). Whale sharks have also been recorded from Commonwealth waters between Australia and Indonesia. This species is thought to prefer surface sea-water temperatures between 21 -	Yes, though prefers tropical waters	Unlikely. While sightings have been confirmed in Eden, these are extremely rare.	No

Species	Listing	Ecology	Presence of Habitat	Likelihood of Occurrence	Likelihood of Impact
		25°C. Sightings at NMP, however, are most common in water temperatures around 27°C. The sharks (regularly) appear at locations where seasonal food 'pulses' are known to occur. The predictable annual whale shark aggregation at NMP is closely linked with an increase in productivity of the region. This is associated with a mass coral spawn which occurs around March/April each year. Whale sharks are regarded as highly migratory - although these 'migration patterns' are poorly understood. Satellite tracking of whale sharks in US waters and also in the South China Sea reveal that whale sharks can travel great distances (1000's of kilometres). These migrations may take years to complete.			
Mammals					
Eubalaena australis Southern right whale	V-TSC, E-EPBC, Migratory	Temperate and subpolar waters of the Southern Hemisphere, with a circumpolar distribution between about 200 S and 550 S with some records further south to 630 S. Migrate between summer feeding grounds in Antarctica and winter breeding grounds around the coasts of southern Australia, New Zealand, South Africa and South America. They feed in the open ocean in summer. They move inshore in winter for calving and mating. Calving females and females with young usually remain very close to the coast, particularly in the 5-10 m watermark. They feed on krill and copepods by filtering water through their baleen (plates of keratin that hang inside their upper-jaw). It appears Southern Right Whales may not feed at all in Australian waters.	Yes	Possible, especially during the southern migration period	**Yes TSC 7-Part Test and EPBC assessment of significance have been completed for this species.**
Megaptera novaeangliae Humpback whale	V-TSC, V-EPBC, Migratory	Species occurs in oceanic and coastal waters worldwide. The population of Australia's east coast migrates from summer cold-water feeding grounds in Subantarctic waters to warm-water winter breeding grounds in the central Great Barrier Reef. They are regularly observed in NSW waters in June and July, on northward migration and October and November, on southward migration.	Yes	Possible, especially during the southern migration period.	**Yes TSC 7-Part Test and EPBC assessment of significance have been completed for this species.**
Balaenoptera musculus Blue Whale	E-EPBC, Migratory	Oceanic within Southern Hemisphere between 20 degrees to 70 degrees South including NSW waters. Breeds in warm water at low latitudes, preferring open seas rather than coastal waters. Often feeds during spring and summer on krill close to the ice edge.	No, prefers open seas	Unlikely as would be found in open seas	No
Arctocephalus pusillus doriferus	V-TSC	The Australian Fur seal has a relatively restricted distribution around the islands of Bass Strait, parts of Tasmania and southern Victoria. They can	Yes, rocky shores present	Possible	**Yes TSC 7-Part Test has been**

Species	Listing	Ecology	Presence of Habitat	Likelihood of Occurrence	Likelihood of Impact
Australian Fur Seal		be seen hauling out (coming ashore) on islands off South Australia and areas of southern New South Wales such as Montague Island with the occasional animal appearing as far north as the mid north coast of New South Wales. Their preferred habitat especially for breeding is rocky islands, which include boulder or pebble beaches and gradually sloping rocky ledges. These seals feed on a variety of bony fish species plus squid and octopus. Australian Fur Seals come ashore each year and form breeding colonies. Females spend most of the gestation period at sea, coming ashore just before the birth of a single pup between October and December.			**completed for this species.**
Arctocephalus forsteri New Zealand fur-seal	V-TSC	Occurs in Australia and New Zealand. Reports of non-breeding animals along southern NSW coast particularly on Montague Island, but also at other isolated locations to north of Sydney. Prefers rocky parts of islands with jumbled terrain and boulders. Feeds principally on cephalopods, fish also seabirds and occasionally penguins.	Absent	Vagrant	No
Dugong dugong Dugong	E-TSC	Extends south from warmer coastal and island waters of the Indo-West Pacific to northern NSW, where its known from incidental records only. Major concentrations of Dugongs occur in wide shallow protected bays, wide shallow mangrove channels and in the lee of large inshore islands. Will also occupy deeper waters if their sea grass food is available. Shallow waters such as tidal sandbanks and estuaries have been reported as sites for calving.	Yes	Unlikely, while sightings have been confirmed in Eden, these are extremely rare as species prefers tropical habitats. No seagrass occurs at the proposal site.	No
Reptiles					
Chelonia mydas Green turtle	V-TSC, V-EPBC, Migratory	Widely distributed in tropical and sub-tropical seas.Usually found in tropical waters around Australia but also occurs in coastal waters of NSW, where it is generally seen on the north or central coast, with occasional records from the south coast. Ocean-dwelling species spending most of its life at sea. Carnivorous when young but as adults they feed only on marine plant material. Eggs laid in holes dug in beaches throughout their range. Scattered nesting records along the NSW coast.	Yes	Vagrant	**Yes TSC 7-Part Test and EPBC assessment of significance have been completed for this species.**
Migratory Species					

Species	Listing	Ecology	Presence of Habitat	Likelihood of Occurrence	Likelihood of Impact
Mammals					
Balaenoptera edeni Bryde's Whale	Migratory	There may be 2 distinct groups in some areas one occurring offshore and partially migratory and the other living inshore and resident all year-round. The two forms differ slightly in their reproductive behaviour and the offshore animals are usually larger, have more scaring and have longer and broader baleen than the inshore variety. There may also be a 'dwarf' form around the Solomon Islands. The Bryde's whale prefers water temperatures above 20°C (68°F) so it is most common in coastal areas of tropical and subtropical waters of all seas. Some tropical populations are possibly sedentary with most migrating short distances with no known long-distance migrations to higher latitudes. They often feed on schooling fish, and unlike the surface swimming sei whales, they are deep divers. They often approach ships, seemingly out of curiosity.	No, prefers deep tropical/subtropical waterswaters	Unlikely	No
Caperea marginata Pygmy Right Whale	Migratory	Pygmy Right Whales have primarily been recorded in areas associated with upwellings and with high zooplankton abundance, particularly copepods and small euphausiids which constitute their main prey. It is inconspicuous at sea and only surfaces for a few seconds at a time. It has not been observed breaching or lobtailing but it will throw its snout out of the water. Distribution appears limited by the surface water temperature as they are almost always found in 5° to 20°C temperature water. This excludes the whales presence south of the Antarctic Convergence and the cold waters of the Antarctic. Population numbers are unknown as it is easily confused with the Minke whale but Pygmy Right whales may be more common than the limited sightings suggest. Pygmy Right Whales have been seen in sheltered shallow bays, but it appears that these are predominantly juveniles and sub-adults.	Yes, juveniles and sub-adults	Unlikely	No
Lagenorhynchus obscurus Dusky Dolphin	Migratory	Dusky dolphin tend to like deep offshore water, hunting in pods which can sometimes number less than 20, but often more than 100. They can be found in the southern hemisphere in temperate and sub-Antarctic waters. Kiakoura in New Zealand is the place best known for these marine mammals, as they are there in numbers all year. In Australia these dolphin have been seen in places such as southern NSW, the eastern edge of Bass Strait, Wilson's Promontory and Cape Shank, Kangaroo Island, and Tasmania, but nowhere with any consistency.	No prefers deep offshore	Unlikely	No
Orcinus orca	Migratory	The pelagic killer whale is found in oceanic and shelf waters. While the species is found in both warm and cold waters, it may be more common	Yes	Possible	**Yes EPBC Act assessment of**

Species	Listing	Ecology	Presence of Habitat	Likelihood of Occurrence	Likelihood of Impact
Killer Whale, Orca		in cold, deep water. Off Australia, they are often seen along the continental slope and on the shelf, and near seal colonies. Macquarie Island is a key locality for the species in the Australian region as it is regularly sighted there. Killer whales are a top-level carnivore and often hunt in packs. Their diet differs seasonally and regionally. The specific diet of Australian killer whales is not known but there are reports of attacks on dolphins, young humpbacks, blue whales, sperm whales, dugongs and Australian sea lions. They are also known to herd bottlenose dolphins and common dolphins.			**significance undertaken for species**
Reptiles					
Dermochelys coriacea Leathery Turtle, Leatherback Turtle, Luth	Migratory	Throughout the world's tropical and temperate seas and in all coastal waters of Australia. Most sightings are in temperate waters. Large numbers of Leathery Turtles feed in coastal waters from southern Queensland to the central coast of NSW. Occurs in inshore and offshore marine waters. Rarely breeds in Australia, with the nearest regular nesting sites being the Solomon Islands and Malayan Archipelago. Occasional breeding records from NSW coast, including between Ballina and Lennox Head in northern NSW. A number of sightings in southern waters suggest species actively seeks temperate feeding grounds, rather than occurring only as stray vagrants. Feed on jellyfish.	Yes	Unlikely, while has the potential to occur in the southern waters of NSW this is rare	No

Appendix E 7-PART TESTS AND EPBC ACT ASSESSMENTS OF SIGNIFICANCE

7 Part test assessment of significance

Section 5A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) specifies seven factors to be taken into account in deciding whether a development is likely to have a significant impact on threatened species, populations or ecological communities, or their habitats listed on the TSC Act and FM Act.

The following Assessments of Significance assess the level of likely impact associated with the proposed power plant on the threatened species identified below.

Common Name	Scientific Name	Status
Fish		
Black cod	*Epinephelus daemelii*	V-FM
Great White Shark	*Carcharodon carcharias*	V-FM
Cetaceans		
Southern right whale	*Eubalaena australis*	V-TSC
Humpback whale	*Megaptera novaeangliae*	V-TSC
Other Marine Mammals		
Australian fur seal	*Arctocephalus pusillus doriferus*	V-TSC
Reptiles		
Green turtle	*Chelonia mydas*	V-TSC

FAUNA – FISH

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Black Cod

Black cod are known to occur in caves, gutters and on rocky reefs from near shore to depths of at least 50 metres. Recently settled small juveniles are commonly found in intertidal rock pools along the NSW coastline and larger juveniles are generally found and captured by anglers on rocky reefs in estuary systems. Estuaries are reported to be important juvenile development grounds for other serranids. Black cod are territorial and individuals are frequently encountered in the same location or cave over long periods of time. Although there is a general lack of detailed information on the diet of black cod in NSW, it is likely that its diet would be similar to that of other *Epinephelus* species, which are epibenthic predators feeding on macroinvertebrates (mainly crustaceans) and fishes on or near the bottom. Adult black cod are believed to prey on fishes and larger crustaceans, while juveniles feed on smaller crabs and fish species. Black cod are considered to be most active at dusk and during the night and are thought to feed during these times.

Black cod populations have been reduced by over-harvesting by line, net and spear fishers. Black cod are now totally protected in NSW, but accidental capture (and hooking injuries in accidentally caught fish) still poses a threat. Accidental capture of black cod can cause mortality from barotrauma; injury caused by depressurization and swim-bladder decompression when fish are taken out of deep water. Impacts on juvenile black cod may occur due to the loss or degradation of estuarine nursery habitats.

The black cod has been previously recorded in Twofold Bay. The proposal site contains rocky reef and potential habitat for adult individuals. However, individuals were not observed during the surveys. Therefore, due to its high territoriality, it is highly unlikely that individuals would occur in the immediate vicinity of the proposal site. The proposal would not be part of one of the main actions listed as reasons for its decline (ie. fishing). Construction impacts would be highly localised and temporary. Potential construction impacts to rocky reef habitat could occur as a result of erosion and sedimentation and disturbance from construction noise and divers. During operation the thermal plume is unlikely to come into contact with the rocky reef. Furthermore, the location of the inlet and outlet pipes away from the rocky reef would remove any potential impacts from these structures. However, there is the potential for some minor changes in fish assemblages at the proposal site. This is unlikely to have implications for the diet of the black cod.

In the unlikely event that the species would occur at the proposal site, the impacts of the proposal would not affect the lifecycle of this species such that it would place the local population at risk of extinction.

Great White Shark

The White Shark is widely distributed, and located throughout temperate and sub-tropical regions in the northern and southern hemispheres. In Australia, its range extends primarily from Moreton Bay in southern Queensland, with at least one record as far north as Mackay, around the southern coastline and to North West Cape in Western Australia. Great White Sharks are large, rare, warm-blooded apex marine predators. They are normally found in inshore waters around rocky reefs and islands, and often near seal colonies. They have been recorded at varying depths down to 1,200 m. They may travel large distances in a relatively short time but can remain in the same area for weeks or even months. Juveniles feed mainly

on fish and adults mainly on other sharks, rays and marine mammals. It is estimated that they mature at 12-18 years for females and 8-10 years for males. Maximum length is 6.4 metres, though specimens of up to 7 metres may exist. Great White Sharks reproduce once every two to three years and produce between two and ten pups per litter.

The causes of decline in great white sharks in Australian waters include by-catch in a range of commercial fisheries. Another cause of mortality has been beach safety (shark) meshing. Great white sharks have a very low potential for population recovery.

This species has been observed around Twofold Bay in the past. The great white shark has high thermal tolerance as it can be found in various temperate and sub-tropical waters and can undertake migrations between the two. As such, the thermal effluent produced during operation of the power plant is unlikely to have any impact on this highly mobile species. Should fish community structure be impacted this would only occur in vicinity of the chip mill and it is unlikely that this would impact on the species diet.

Due to their high mobility it is unlikely the proposal would have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

Black cod

(i) Installation of the outlet and inlet pipe of the proposed sea water cooling system would be undertaken on the chip mill jetty. Rocky reef habitat would not be removed or modified as a result of the proposed works.

(ii) The thermal effluent plume would not contact the rocky reef and therefore it is unlikely that a thermal barrier would be created isolating or fragmenting habitat. No rocky habitat would be removed and as such no habitat would be physically fragmented as a result of the proposal.

(iii) The proposed works would not impact the long term survival of the species at the locality as no habitat for this species would be removed or fragmented.

Great white shark

(i) The proposed works would not remove any habitat of this pelagic species. The thermal effluent would change sea water temperature in the vicinity of the chip mill.

(ii) The great white shark has high thermal tolerance as it can be found in various temperate and sub-tropical waters and can undertake migrations between the two. The thermal effluent plume would not create any barriers.

(iii) The proposed works would not impact the long term survival of the species at the locality.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat has been declared for this species.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

A draft recovery plan has been prepared for the black cod (DPI 2009).

The specific objectives of the recovery plan are to:

- Mitigate medium and high risk threats to black cod.
- Initiate and support scientific research to increase knowledge of the distribution, abundance, reproductive biology, life history, ecology, migratory patterns and genetics of black cod.
- Monitor fishery management strategies where necessary to reduce potential for interaction with black cod (either directly or indirectly).
- Establish an on-going monitoring program to document the status of black cod populations and their habitats and to evaluate the effectiveness of recovery actions.
- Provide enhanced compliance and protection for important black cod habitats.
- Educate the community about the identification of and 'best practice' catch and release methods for black cod, increase awareness of the status of and threats to black cod populations, and enhance community support for recovery actions.
- Improve understanding of the threats to the survival of black cod and contribute to management actions to ameliorate identified threats.

The proposed power plant and inlet and outlet structures would not compromise any of the objectives of the draft recovery plan. Any impacts are likely to be to diet species and would be minor and would not have an effect on the recovery of the species.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Two key threatening processes (KTP) of relevance to black cod have been listed under the *Fisheries Management Act 1994* including:

- Hook and line fishing in areas important for the survival of threatened species; and
- The introduction of non-indigenous fish and marine vegetation to the coastal waters of NSW.

Of the two KTPs, the second has the potential to occur. Currently the introduction of non-indigenous fish and marine vegetation to the coastal waters of NSW is unlikely to directly affect black cod as none of the known introduced species are reported to interact with black cod. Introduction of marine pest species may alter the community structure at the proposal which may have a minor impact on food resources for the species. Management measures have been put in place so that construction barges and boats are checked for any marine pest species prior to their arrival at the proposal site.

One KTP of relevance to the great white shark have been listed under the *Fisheries Management Act 1994* including:

- The current shark meshing program in New South Wales waters

It would not be triggered by the proposal.

FAUNA – CETACEANS

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Southern right whale

The southern right whale occurs in temperate and subpolar waters of the Southern Hemisphere, with a circumpolar distribution between about 200 S and 550 S with some records further south to 630 S. They migrate between summer feeding grounds in Antarctica and winter breeding grounds around the coasts of southern Australia, New Zealand, South Africa and South America. They feed in the open ocean in summer. Individuals move inshore in winter for calving and mating. Calving females and females with young usually remain very close to the coast, particularly in the 5-10 m watermark. They feed on krill and copepods by filtering water through their baleen (plates of keratin that hang inside their upper-jaw). They have been observed within Twofold Bay.

Highest potential construction impacts to these marine mammals would occur as a result of accidental collisions with boats and/or underwater construction noise. Mitigation measures have been put in place so that works are undertaken outside their migratory period. Operational impacts would be highly localised around the inlet pipe and the outlet pipe and it is not anticipated that the impacts of entrainment and thermal effluent would adversely affect the species food source.

The proposal would not place the local population at risk of extinction.

Humpback whale

This species occurs in oceanic and coastal waters worldwide. The population off Australia's east coast migrates from summer cold-water feeding grounds in Subantarctic waters to warm-water winter breeding grounds in the central Great Barrier Reef. They are regularly observed in NSW waters in June and July, on northward migration and October and November, on southward migration including in the Twofold Bay area.

Highest potential construction impacts to these marine mammals would occur as a result of accidental collisions with boats and/or underwater construction noise. Mitigation measures have been put in place so that works are undertaken outside their migratory period. Operational impacts would be highly localised around the inlet pipe and the outlet pipe and it is not anticipated that the impacts of entrainment and thermal effluent would adversely affect the species food source.

The proposal would not place the local population at risk of extinction.

(b) n the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

(i) The proposed works would not remove any habitat of this species. The thermal effluent would change sea water temperature in the vicinity of the chip mill.

(ii) The southern right what and hump back whale have a high thermal tolerance as they migrate from the cool waters Antarctic/subantarctic water in the southe to warmer waters in the north. . The thermal effluent plume would not create any barriers.

(iii) Both these species only migrate through this location and as such the proposed works would not impact the long term survival of these species at the locality.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat has been declared for either of these species.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

No recovery plans have been prepared for these species.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

One KTPs of relevance to the species has been listed under the *Fisheries Management Act 1994* and *Threatened Species Conservation Act 1995*:

- The current shark meshing program in New South Wales waters

It would not be triggered by the proposal.

FAUNA – OTHER MARINE MAMMALS

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Australian fur seal

The Australian fur-seal has a relatively restricted distribution around the islands of Bass Strait, parts of Tasmania and southern Victoria. They can be seen hauling out (coming ashore) on islands off South Australia and areas of southern New South Wales such as Montague Island with the occasional animal appearing as far north as the mid north coast of New South Wales. Their preferred habitat, especially for breeding is rocky islands, which include boulder or pebble beaches and gradually sloping rocky ledges. These seals feed on a variety of bony fish species plus squid and octopus. Australian Fur Seals come ashore each year and form breeding colonies. Females spend most of the gestation period at sea, coming ashore just before the birth of a single pup between October and December.

The Australian fur-seal is threatened by commercial and recreational fishing operations, particularly through by-catch mortality around Montague Island. In addition, fishing operations may limit the availability of prey items for visiting seals. The species also is threatened by entanglement or ingestion of plastic debris that is increasingly discarded from boats or washed out to sea. The depleted population of Australian fur-seals, resulting from commercial sealing, has increased the species' vulnerability to other threats. The small, temporal aggregations at Montague Island, Steamer's Beach and Greencape are susceptible to stochastic events such as oil spills.

Individuals have the potential to occasionally occur in Twofold Bay and at the chip mill site. Potential construction impacts may occur as a result of minor chemical spills, temporary underwater construction noise and collisions from boats. Management measures have been put in place to mitigate against such impacts. Fish and invertebrate assemblage changes may occur in the vicinity of the proposal site as a result of thermal effluent though this is unlikely to impact the species food source.

The proposal would not place a local population at risk of extinction.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

Australian fur seal

(i) The proposed works would not remove any habitat of this species. Proposed works along the rocky shoreline would be undertaken in vicinity of an already disturbed site at the location of the chip mill jetty and would be limited in scope.

(ii) Rocky habitat would not be fragmented or isolated from other areas of habitat. The thermal plume would not create any thermal barriers for this species.

(iii) The proposed works would not impact the long term survival of the species at the locality.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat has been declared for this species.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

No recovery plans have been prepared for any of these species.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

One KTPs of relevance to the Australian fur seal has been listed under the *Fisheries Management Act 1994* and *Threatened Species Conservation Act 1995*:

- The current shark meshing program in New South Wales waters
- Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments

Shark netting would not be triggered by the proposal. The proposal has the potential to generate debris, however stringent management measures would be put in place to manage and monitor waste.

FAUNA – REPTILES

(a) in the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction,

Green turtle

This species is widely distributed in tropical and sub-tropical seas. It is usually found in tropical waters around Australia but also occurs in coastal waters of NSW, where it is generally seen on the north or central coast, with occasional records from the south coast. It is an ocean-dwelling species spending most of its life at sea. Carnivorous when young but as adults they feed only on marine plant material. Eggs are laid in holes dug in beaches throughout their range.

Threats to this species includes collision with boats and other marine traffic, accidental entanglement in shark nets, traps, longlines and other fishing gear, marine debris, particularly plastic, which is mistaken for jellyfish and can cause asphyxiation, abrasion, infection and blockages in the turtle's system when swallowed. Predation at nest site by feral pigs and foxes, disturbance to nest sites is a threat to hatching individuals

Due to its more tropical distribution it is very unlikely to occur at the proposal site on the NSW southern coast, though individuals have been sighted in Twofold Bay in the past. Highest potential construction impacts to these marine mammals would occur as a result of accidental collisions and ingestion of any debris left at the site. Operational impacts would be highly localised around the inlet pipe and the outlet pipe and it is not anticipated that the impacts of entrainment/impingement and thermal effluent would adversely affect the species. Impingement is unlikely to occur due to the low inflow velocity. The thermal plume may attract some individuals should they occur.

As no breeding would occur at the site and individuals encountered would most likely only be passing through, the proposal would not place a local population at risk of extinction.

(b) in the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction,

Not applicable.

(c) in the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:

(i) is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or

(ii) is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,

Not applicable.

(d) in relation to the habitat of a threatened species, population or ecological community:

(i) the extent to which habitat is likely to be removed or modified as a result of the action proposed, and

(ii) whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and

(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,

(i) The proposed works would not remove any habitat of this species. The thermal effluent would change sea water temperature in the vicinity of the chip mill which has the potential to attract any vagrant individual occurring in the area.

(ii) No habitat would become fragmented or isolated as a result of the proposal.

(iii) The proposed works would not impact the long term survival of the species at the locality.

(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),

No critical habitat has been declared for this species.

(f) whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,

No recovery plans have been prepared for any of these species.

(g) whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.

Two KTPs of relevance to the species has been listed under the *Fisheries Management Act 1994* and *Threatened Species Conservation Act 1995*:

- The current shark meshing program in New South Wales waters
- Entanglement in or ingestion of anthropogenic debris in marine and estuarine environments

Of the two only the second has the potential to be triggered by the proposal. Management measures have been put in place so that no debris would be left on site during and after construction. Monitoring would occur to ensure this measure is maintained.

Conclusion

The activity is not likely to result in a significant adverse impact to the aforementioned species or their habitats. A Species Impact Statement would not be required. The activity does not therefore need to be referred to the NSW Department of Environment, Climate Change and Water for further consideration.

EPBC ACT – ASSESSMENT OF SIGNIFICANCE

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) protects the environment, particularly Matters of National Environmental Significance (Protected matters). It streamlines the national environmental assessment and approvals process, protects Australian biodiversity and integrates management of important natural and cultural places. The Matters of National Environmental Significance are:

- Listed threatened species and ecological communities;
- Migratory species protected under international agreements;
- Ramsar wetlands of international importance;
- The Commonwealth marine environment;
- World Heritage properties;
- National Heritage places; and
- Nuclear actions.

An action will require approval if the action has, will have, or is likely to have a significant impact on a species listed in any of the following categories:

- Extinct in the wild;
- Critically endangered;
- Endangered; or
- Vulnerable.

An action will also require approval if the action has, will have, or is likely to have a significant impact on an ecological community listed in any of the following categories:

1. Critically endangered; or
2. Endangered.

The following species require an assessment of significance.

Common Name	Scientific Name	Status
Fish		
Australian grayling	*Prototroctes maraena*	V-EPBC
Great White Shark	*Carcharodon carcharias*	V-EPBC, Migratory
Mammals		
Southern right whale	*Eubalaena australis*	E-EPBC, Migratory
Humpback whale	*Megaptera novaeangliae*	V-EPBC, Migratory

Common Name	Scientific Name	Status
Killer whale	*Orcinus orca*	Migratory
Reptile		
Green turtle	*Chelonia mydas*	V-EPBC, Migratory

An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

Australian grayling

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

Australian grayling occur in freshwater streams and rivers, especially clear gravelly streams with a moderate flow, as well as estuarine areas. They occur in fast-moving shoals and are a shy fish, fleeing when disturbed. They reach sexual maturity at 1–2 years of age when approximately 150 mm in length. Spawning takes place during late summer or autumn. Females can lay up to 82 000 small (approx. 1 mm) eggs, probably in the middle reaches of rivers, where they presumably settle among the gravel of the streambed. Once hatched, the larvae swim towards the water surface where they are swept downstream to the sea. The larvae and young juveniles have a marine stage before returning to freshwater rivers during spring when they are about 6 months old. The rest of their life cycle is spent in freshwater. Australian grayling are opportunistic omnivores, with a mixed diet of aquatic algae and insects.

There is some very limited potential for juveniles to be present in the area. The proposal site is, however, located away from estuaries with the closest approximately 1 km to the south. The proposal is unlikely to lead to a long-term decrease of an important population of the species should one occur.

b) reduce the area of occupancy of an important population;

The proposal would not remove any potential habitat for this species. The thermal effluent would not reach any estuaries.

c) fragment an existing important population into two or more populations;

No existing population of this species is known to occur at the proposal site. Juveniles of this species have the potential to occur in areas around estuaries located to the south. The thermal plume would not create any potential barriers due to its limited coverage area in an open sea environment. The proposal would not fragment any populations should these occur.

d) adversely affect habitat critical to the survival of a species;

The proposal would not adversely affect any habitat critical to the survival of the species due to the site's location away from any estuaries.

e) disrupt the breeding cycle of an important population;

Breeding occurs in freshwater environments and juveniles migrate downstream to the sea before migrating back upstream. The proposal is unlikely to impact the breeding cycle of the species.

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

The proposed activity would not result in modifying or destroying the quality of habitat for the Australian grayling. The thermal plume, due to its limited coverage area in an open sea environment, would not fragment or isolate any habitat.

g) result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;

The proposed activity has the potential to introduce invasive marine species though the use of potentially contaminated boats and barges. None of the current introduced species would compete with the Australian grayling's life cycle. Appropriate mitigation measures have been put in place to reduce the potential for the introduction of marine pests.

h) introduce disease that may cause the species to decline; or

The works should not introduce disease that may cause the species, if present, to decline.

i) interfere substantially with the recovery of the species.

Given the area of habitat that would be impacted by the proposed works it is unlikely to interfere with the recovery of the Australian grayling if present. There is no recovery plan in place this species.

Conclusion

It is unlikely that the works would result in a significant impact on the Australian grayling, or its habitat. Based on this assessment a referral under the *Environment Protection and Biodiversity Conservation Act 1999* is not required.

Great white shark

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

The White Shark is widely distributed, and located throughout temperate and sub-tropical regions in the northern and southern hemispheres. In Australia, its range extends primarily from Moreton Bay in southern Queensland, with at least one record as far north as Mackay, around the southern coastline and to North West Cape in Western Australia. Great White Sharks are large, rare, warm-blooded apex marine predators. They are normally found in inshore waters around rocky reefs and islands, and often near seal colonies. They have been recorded at varying depths down to 1,200 m. They may travel large distances in a relatively short time but can remain in the same area for weeks or even months. Juveniles feed mainly on fish and adults mainly on other sharks, rays and marine mammals. It is estimated that they mature at 12-18 years for females and 8-10 years for males. Maximum length is 6.4 metres, though specimens of up to 7 metres may exist. Great White Sharks reproduce only once every two to three years and produce between two and ten pups per litter.

The causes of decline in great white sharks in Australian waters include by-catch in a range of commercial fisheries. Another cause of mortality has been beach safety (shark) meshing. Great white sharks have a very low potential for population recovery.

It is not expected that the proposed activity would affect the life cycle of this species such that a viable local population would be placed at risk of extinction.

b) reduce the area of occupancy of an important population;

The proposal would not remove any potential habitat for this species. The thermal effluent would not create any barriers due to its limited size in an open sea coastal environment.

c) fragment an existing important population into two or more populations;

The species is highly mobile. Due to its limited size in an open sea coastal environment, the thermal effluent would not fragment any population of this species. No other construction or operational impacts have the potential to fragment a population.

d) adversely affect habitat critical to the survival of a species;

The species is highly mobile and pelagic. Potential water quality impacts may arise as a result of accidental spills and thermal effluent. Due to the location of the proposal site in an open coastal environment, impacts would be confined and not adversely affect habitat critical to the survival of the species.

e) disrupt the breeding cycle of an important population;

Little is known on the breeding of this species. Great white sharks reproduce only once every two to three years and produce between two and ten pups per litter. Due to the proposal site being located in an open coastal environment in vicinity of a disturbed site it is unlikely that the proposal would disrupt the breeding cycle of a population.

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

The proposed activity would not result in modifying or destroying the quality of habitat for the great white shark. The species is highly mobile. The proposal would not isolate or fragment any habitat.

g) result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;

The proposed activity has the potential to introduce invasive marine species though the use of potentially contaminated boats and barges. None of the current introduced species would compete with the great white shark's life cycle. Appropriate mitigation measures have been put in place to reduce the potential for the introduction of marine pests.

h) introduce disease that may cause the species to decline; or

The works should not introduce disease that may cause the species in the study area to decline.

i) interfere substantially with the recovery of the species.

A recovery plan for the great white shark has been prepared (Commonwealth of Australia 2002). The objectives of the plan are:

- monitor and reduce the impact of commercial fishing on White Sharks;
- investigate and evaluate the impact of recreational fishing on White Sharks;
- monitor and reduce the impact of shark control activities on White Sharks;
- identify and manage the impact of tourism on White Sharks;
- monitor and reduce the impact of trade in White Shark products;
- develop research programs toward the conservation of White Sharks;
- identify habitat critical to the survival of White Sharks and establish suitable protection of this habitat from threatening activities;
- promote community education and awareness in relation to White Sharks; and
- develop a quantitative framework to assess the recovery of the White Shark.

Given the limited area of Twofold Bay that would be impacted by the proposed works it is unlikely to interfere with the recovery of the great white shark if present. The objectives of the recovery plan would not be compromised as a result of the proposal.

Conclusion

It is unlikely that the works would result in a significant impact on the great white shark, or its habitat.

Based on this assessment a referral under the *Environment Protection and Biodiversity Conservation Act 1999* is not required.

Humpback whale

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

The species occurs in oceanic and coastal waters worldwide. The population of Australia's east coast migrates from summer cold-water feeding grounds in Subantarctic waters to warm-water winter breeding grounds in the central Great Barrier Reef. They are regularly observed in NSW waters in June and July, on northward migration and October and November, on southward migration including in the Twofold By area.

The highest potential construction impacts to these marine mammals would occur as a result of accidental collisions with boats and/or underwater construction noise. Mitigation measures have been put in place so that works are undertaken outside their migratory period. Operational impacts would be highly localised around the inlet pipe and the outlet pipe and it is not anticipated that the impacts of entrainment and thermal effluent would adversely affect the species food source.

b) reduce the area of occupancy of an important population;

The proposed works would only have a limited overall impact on Twofold Bay and impacts would mostly be confined to within 100 metres of the chip mill jetty. There would be no reduction in the area of occupancy of a population.

c) fragment an existing important population into two or more populations;

The proposed works would only have a limited overall impact on Twofold Bay and impacts would mostly be confined to within 100 metres of the chip mill jetty. No barriers would be created that would result in the fragmentation of a population of this highly mobile species.

d) adversely affect habitat critical to the survival of a species;

Resting areas are used by cow-calf pairs and attendant males during the southern migration. These whales appear to use sheltered bays to opportunistically rest during migration to the feeding grounds including resting grounds in Twofold Bay. The proposed works would only have a limited overall impact on Twofold Bay and impacts would mostly be confined to within 100 metres of the chip mill jetty.

e) disrupt the breeding cycle of an important population;

Cow-calf pairs and attendant males may enter Twofold Bay during their southern migration. The proposed works would only have a limited overall impact on Twofold Bay and impacts would mostly be confined to within 100 metres of the chip mill jetty. Entrainment of plankton and thermal effluent discharge is unlikely to affect the availability of the species food source.

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

The proposed works would only have a limited overall impact on Twofold Bay and impacts would mostly be confined to within 100 metres of the chip mill jetty.

g) result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;

The proposed activity has the potential to introduce invasive marine species though the use of potentially contaminated boats and barges. None of the current introduced species would compete with the

humpback whale's life cycle or food source. Appropriate mitigation measures have been put in place to reduce the potential for the introduction of marine pests.

h) introduce disease that may cause the species to decline; or

The works should not introduce disease that may cause the humpback whale if present in the study area to decline.

i) interfere substantially with the recovery of the species.

A recovery plan has been prepared for this species (DEH 2005). The objectives of the plan are:

- the recovery of populations of humpback whales utilising Australian waters so that the species can be considered secure in the wild;
- a distribution of humpback whales utilising Australian waters that is similar to the pre-exploitation distribution of the species; and
- to maintain the protection of humpback whales from human threats.

Given the limited area of Twofold Bay that would be impacted by the proposed works it is unlikely to interfere with the recovery of the humpback whale if present. The objectives of the recovery plan would not be compromised as a result of the proposal.

Conclusion

It is unlikely that the works would result in a significant impact on the humpback whale, or its habitat.

Based on this assessment a referral under the *Environment Protection and Biodiversity Conservation Act 1999* is not required.

Green Turtle

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

This species is widely distributed in tropical and sub-tropical seas. Usually found in tropical waters around Australia but also occurs in coastal waters of NSW, where it is generally seen on the north or central coast, with occasional records from the south coast. The green turtle is an ocean-dwelling species spending most of its life at sea. Carnivorous when young but as adults they feed only on marine plant material. Eggs are laid in holes dug in beaches throughout their range.

The species if it occurs at the proposal site would likely be a vagrant and it is unlikely that a viable population would occur in the area. Collisions with boats during construction could occur though it is highly unlikely. Low inflow velocities at the intake pipe would not affect the species from impingement.

b) reduce the area of occupancy of an important population;

The proposed works would only have a limited overall impact on Twofold Bay and impacts would mostly be confined to within 100 metres of the chip mill jetty. There would be no reduction in the area of occupancy of a population.

c) fragment an existing important population into two or more populations;

No population of green turtles currently occur within Twofold Bay. The proposed works would only have a limited overall impact on Twofold Bay and impacts would mostly be confined to within 100 metres of the chip mill jetty.

d) adversely affect habitat critical to the survival of a species;

The proposed works would only have a limited overall impact on Twofold Bay and impacts would mostly be confined to within 100 metres of the chip mill jetty. The thermal plume is unlikely to reach the shoreline.

e) disrupt the breeding cycle of an important population;

The green turtle currently doesn't breed in southern NSW and therefore the breeding cycle would not be disrupted as a result of the proposal.

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

The proposed works would only have a limited overall impact on Twofold Bay and impacts would mostly be confined to within 100 metres of the chip mill jetty. The proposal would not modify, destroy, remove or isolate habitat.

g) result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat;

The proposed activity has the potential to introduce invasive marine species through the use of potentially contaminated boats and barges. None of the current introduced species would compete with the green turtle's life cycle. Appropriate mitigation measures have been put in place to reduce the potential for the introduction of marine pests.

h) introduce disease that may cause the species to decline; or

The works should not introduce disease that may cause the green turtle if present in the study area to decline.

i) interfere substantially with the recovery of the species.

A viable population of the species is unlikely to occur at the proposal site with any individuals occurring within Twofold Bay likely to be vagrants. Potential threats to the species include boat collisions. Management measures have been put in place to limit this potential construction impact.

Conclusion

It is unlikely that the works would result in a significant impact on the green turtle, or its habitat.

Based on this assessment a referral under the *Environment Protection and Biodiversity Conservation Act 1999* is not required.

An action is likely to have a significant impact on an endangered species if there is a real chance or possibility that it will:

Southern right whale

(a) lead to a long-term decrease in the size of a population;

The southern right whale occurs in temperate and subpolar waters of the Southern Hemisphere, with a circumpolar distribution between about 200 S and 550 S with some records further south to 630 S. They migrate between summer feeding grounds in Antarctica and winter breeding grounds around the coasts of southern Australia, New Zealand, South Africa and South America. They feed in the open ocean in summer. Individuals move inshore in winter for calving and mating. Calving females and females with young usually remain very close to the coast, particularly in the 5-10 m watermark. They feed on krill and copepods by filtering water through their baleen (plates of keratin that hang inside their upper-jaw). They have been observed within Twofold Bay.

Highest potential construction impacts to these marine mammals would occur as a result of accidental collisions with boats and/or underwater construction noise. Mitigation measures have been put in place so that works are undertaken outside their migratory period. Operational impacts would be highly localised around the inlet pipe and the outlet pipe and it is not anticipated that the impacts of entrainment and thermal effluent would adversely affect the species food source.

(b) reduce the area of occupancy of the species;

The proposed works would only have a limited overall impact on Twofold Bay and impacts would mostly be confined to within 100 metres of the chip mill jetty. There would be no reduction in the area of occupancy of a population.

(c) fragment an existing population into two or more populations;

The proposed works would only have a limited overall impact on Twofold Bay and impacts would mostly be confined to within 100 metres of the chip mill jetty. No barriers would be created that would result in the fragmentation of a population of this highly mobile species.

(d) adversely affect habitat critical to the survival of a species;

Areas that have been used intermittently as calving areas or by small numbers of mothers with very young calves include Eden. The proposed works would only have a limited overall impact on Twofold Bay and impacts would mostly be confined to within 100 metres of the chip mill jetty. Therefore no substantial impacts to habitat critical to this species is anticipated.

(e) disrupt the breeding cycle of a population;

Cow-calf pairs may enter Twofold Bay during their southern migration. The proposed works would only have a limited overall impact on Twofold Bay and impacts would mostly be confined to within 100 metres of the chip mill jetty. Entrainment of plankton and thermal effluent discharge is unlikely to affect the availability of the species food source.

(f) modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

The proposed works would only have a limited overall impact on Twofold Bay and impacts would mostly be confined to within 100 metres of the chip mill jetty.

(g) result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat;

The proposed activity has the potential to introduce invasive marine species though the use of potentially contaminated boats and barges. None of the current introduced species would compete with the southern right whale's life cycle. Appropriate mitigation measures have been put in place to reduce the potential for the introduction of marine pests.

(h) introduce disease that may cause the species to decline; or

The works should not introduce disease that may cause the southern right whale if present in the study area to decline.

(i) interfere with the recovery of the species.

A recovery plan has been prepared for this species (DEH 2005). The objectives of the plan are:

- the recovery of the southern right whale population utilising Australian waters so that the population can be considered secure in the wild;
- a distribution of southern right whales utilising Australian waters that is similar to the pre-exploitation distribution of the species; and
- to maintain the protection of southern right whales from human threats.

Given the limited area of Twofold Bay that would be impacted by the proposed works it is unlikely to interfere with the recovery of the southern right whale if present. The objectives of the recovery plan would not be compromised as a result of the proposal.

Conclusion

It is unlikely that the works would result in a significant impact on the southern right whale, or its habitat.

Based on this assessment a referral under the *Environment Protection and Biodiversity Conservation Act 1999* is not required.