8.1 Introduction

This Chapter addresses the potential impacts of the Power Plant on marine ecology in the 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).

The full report is included in **Appendix C**.

8.2 Methodology

8.2.1 Background research

Database searches

Database searches for threatened, protected or other listed aquatic species 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 10 km 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.

Literature Review

A literature review of previous studies relating to the following 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 focus on noise impacts on cetaceans.

8.2.2 Field surveys

8.2.2.1 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 100 m of the proposal site (i.e. Chip mill jetty; P1-P3) and two within Twofold Bay but at least 500 m from the proposal sites (reference sites R1-R2) were surveyed (**Figure 8-1**).

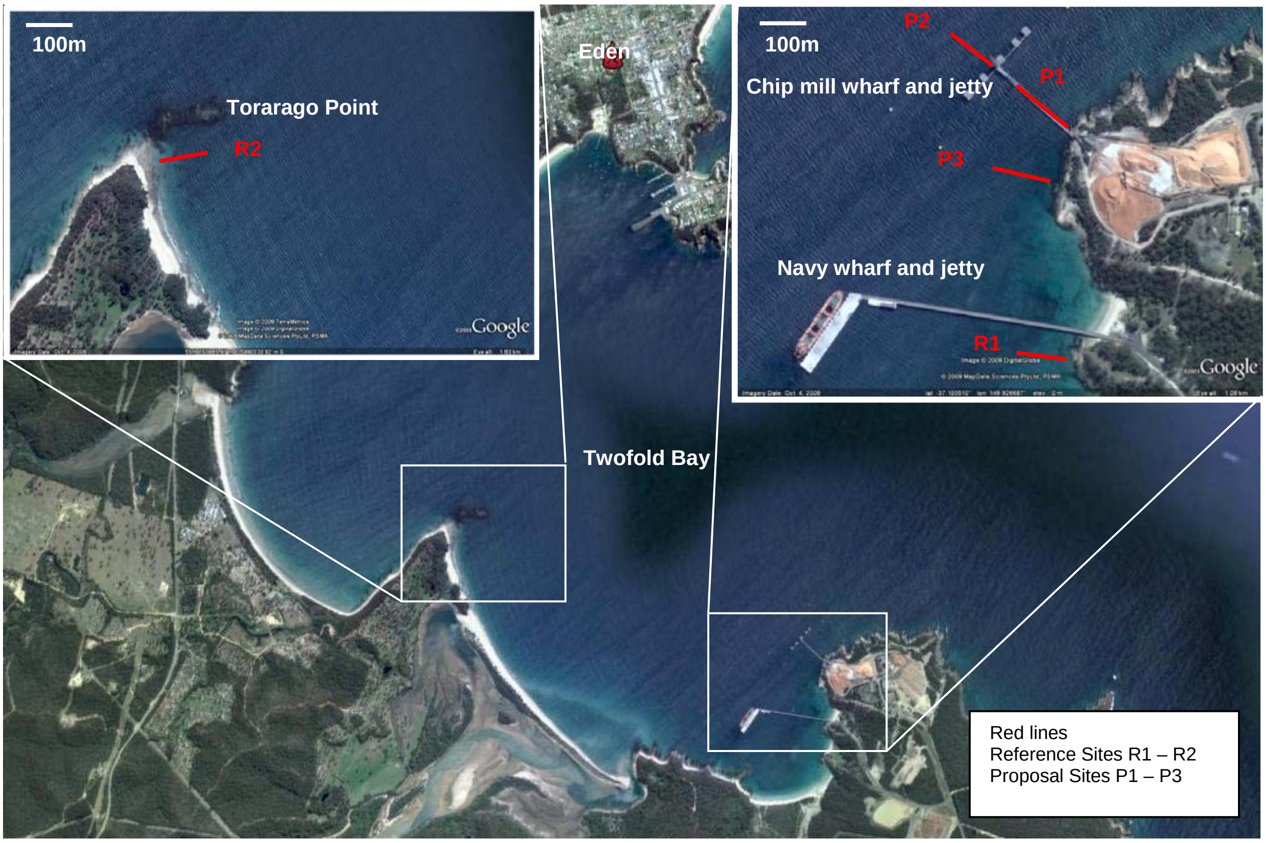


Figure 8-1 Locations of survey sites within Twofold Bay

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, choppy sea conditions and visibility around 5 m. Weather conditions on the 20th July were good, with calm sea conditions and 10 m visibility.

8.2.2.2 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 of 100 m to 150 m in length perpendicular to the shore line was surveyed. SCUBA divers noted the habitat type and depth every 5 m or when habitat changed.

Where seagrass was encountered the species, percent cover and blade length of 10 random shoots within three replicate quadrats (0.25 m^2) were recorded.

Fish surveys

During the habitat surveys, SCUBA divers recorded the fish species and numbers within 2 m of the transect line. The habitat of observed fish was also recorded. Opportunistic sightings of fish outside the corridor were recorded. At sites P1 and P2, five random pylons were surveyed and fish species within 1 m recorded.

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

Invertebrate and macroalgal species surveys

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

8.3 Existing Environment

8.3.1 Background research

8.3.1.1 Databases searches

The Bionet and Wildlife Atlas database searches revealed a total of 10 threatened aquatic species including two amphibians, one fish, six mammals and one reptile previously recorded within 10 km of the proposal site. 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 10 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 10 km radius of the proposal site.

8.3.1.2 Literature review

Aquatic habitat, fauna and flora of the Twofold Bay region

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. 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. This number is highly dependent on the intensity of the search in a particular area (i.e. 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. 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*). Benthic cores revealed 80 different families of infaunal invertebrates.

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 bryozoans *Bugula neritina*, *Cryptosula pallasiana*, *Membranipora membranacea* and *Watersipora subtorquata*, the crab *Cancer noveazelandiae*, the Pacific oyster *Crassostrea gigas* and three other molluscs *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 m^2).

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 8-2**).

Recreational diving

Various sites within Twofold Bay are popular with recreational divers. The area around Fisheries Beach is popular as the weedy seadragon 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.

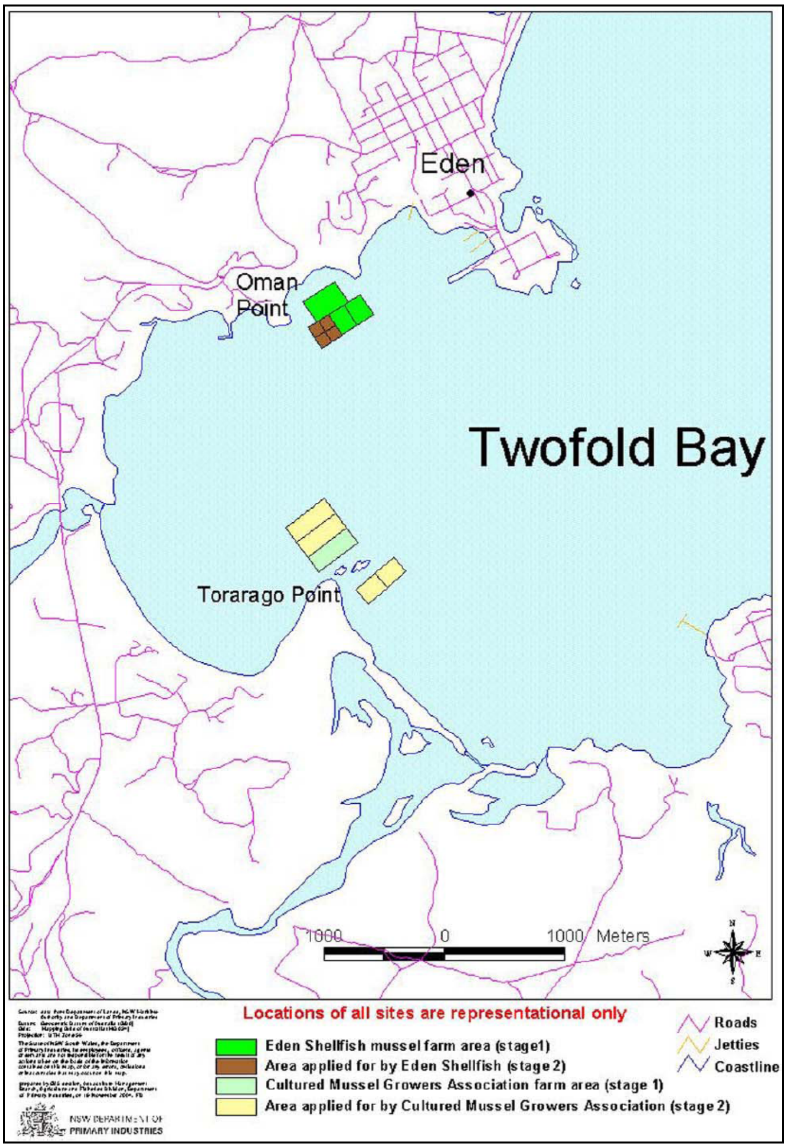


Figure 8-2 Locations of Mussel Aquaculture Farms in Twofold Bay (DPI 2005)

8.3.2 Field surveys

Intertidal habitats

Aerial photographs were analysed and habitats confirmed during field surveys. Intertidal habitats within 1 km of the chip mill jetty include rocky shorelines and sandy beaches (**Figure 8-3**).

Intertidal habitats in the 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 (e.g. chip mill jetty, navy jetty).

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

Figure 8-3 Intertidal Habitats in near to the Chip Mill Jetty

Subtidal habitats

SCUBA surveys identified a number of subtidal habitats including:

- rocky reefs with macroalgal coverage;
- rocky barrens;
- seagrass beds; and
- sandy beds.

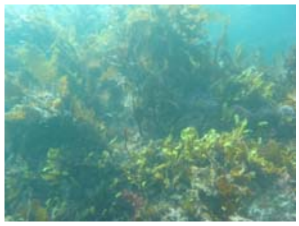
Appendix C contains the detailed results of the transect surveys undertaken at the five sites. These are summarised in **Table 8-1**.

Table 8-1 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 m and 70 m out to sea. Site P2 started at the chip mill jetty and thus did not include nearshore habitat. However, large boulders were located below the jetty 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. At some sites, the macroalgal cover disappeared to 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 (P2, P3) sparse rocky outcrops 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 53 mm and 93 mm in the three replicate quadrats. No seagrass beds were observed below or within 150 m of the chip mill jetty. 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 8-2**.

Table 8-2 Fish survey results

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 were:

- Yellow tailed scad (34%);
- Long finned pike (23%); and
- 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 sparsely spotted stingaree and the banded stingaree.

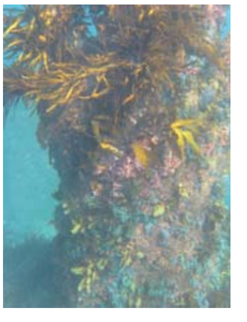
The most common species at the reference sites (i.e. R1-R2) for all habitats combined were:

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

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

No threatened species were observed.

Invertebrate surveys



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

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

8.4 Assessment of Potential Impacts

8.4.1 Construction impacts

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 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 close 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:

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

External factors include:

- non-acoustic 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; and
- 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 8-4** illustrates the general hearing frequencies of some of the major groups. Some minor deviations from these ranges could occur for certain species or individuals.

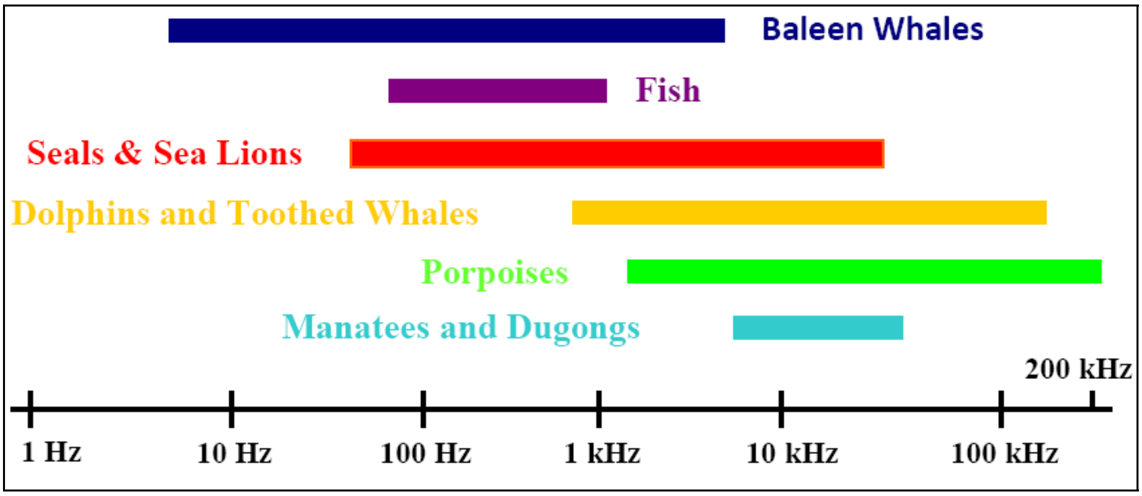


Figure 8-4 Hearing Frequency of Marine Fauna (Okeanos 2008)

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 100 – 1000 Hz low frequency range (**Table 8-3**). As such, these are unlikely to affect odontocetes (i.e. toothed whales such as dolphins and killer whales). However, construction noise frequencies would overlap with the hearing frequencies of seals, fish and mysticetes (i.e. baleen whales such as the southern right whale and humpback whale).

Table 8-3 Underwater Noise Levels from Potential Construction Activities

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

*1 Carlton and Dabbs (2009)
*2 Nedwell J, Martin A, Mansfield N (1993)

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 short 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 (e.g. seals); and
- 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 8-3**) 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 propagation of low frequency noise in water is such that the noise levels 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 assessments of construction noise impacts 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 3 - 4 km 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 3 km from the construction site and for fish up to 800 m. Some physiological responses were possible during the use of explosive charges and rock fracturing cartridges for marine fauna located in close range (within 20 m).

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 jetty and near 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. Any effects would be short term and would not have any long term effect on marine biodiversity.

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 low as vessels used for the construction works would essentially be used around the chip mill jetty which would restrict the speed at which boats can operate. The chip mill jetty would also create a barrier which would restrict the larger whales from accessing the area thus reducing the chance of collisions.

Marine pests

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 outlet pipes. Intertidal habitats are unlikely to be disturbed as all works would be undertaken from construction vessels and / or the jetty. The majority of the pipeline would be installed along the jetty platform. 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 floor. 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 400 mm 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.

8.4.2 Operational impacts

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 to moderately 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 area.

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 change in the zone of influence.

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 6-7**, Case 1). The behaviour of the thermal plume has been determined assuming different environmental and discharge characteristics (**Table 6-10**). For the purpose of this assessment, calm, typical and worst case conditions in terms of wind and current have been considered.

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^{o}C above the ambient temperature (**Section 6.2.5**). The mixing zone for the proposed thermal discharge would be within 1 m of the outlet under all scenarios in summer and within 3.5 m under all scenarios in winter (**Figure 6-6**).

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 is the case inside 3.5 m of the discharge point.

Far field modelling has also determined that the plume is unlikely to reach the shore and that the plume could touch the seabed at a distance greater than 200 m from the outlet (URS 2009). At this distance the temperature rise would be 0.3^{o}C or less.

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 (i.e. temperate open sea) and a review of the general impacts of thermal effluents, thermal impacts are likely to be highly restricted with the highest potential limited to a few metres from the outlet.

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 (e.g. 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 mixing zone. Invertebrates, in particular sessile organisms, in the vicinity of the outlet (e.g. 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 around 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 m of the chip mill jetty. The thermal plume would not reach the shoreline where the macroalgal covered reefs are located.

Biofouling

The intake and outlet pipes and screens are likely to become fouled 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 (i.e. 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.

Copper-based antifouling is also being considered. This 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.

In Australian, background levels of copper range from 0.025 to 0.38 µg/L in marine waters and 0.06 to 1.3 µg/L in estuarine waters (ANZECC 2000). In NSW coastal waters, average copper concentrations are 0.031 µg/L (Apte et al 1998). In Perth coastal waters, copper concentrations ranged from 0.046 µg/L to 0.145 µg/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 antifouling system would be relatively small within the pipelines (circa 10 µg/L) resulting in an annual release of around 10 kg of copper to the marine environment. Once released, copper, as copper (II) oxide, will precipitate out of the water column, generally within the mixing zone identified from the marine modelling exercise (up to 3.5 m) (**Section 6.5.4**).

Cupro ions are known to be toxic to marine life at high concentrations, generally above 10 µg/L (Neff 2002). Copper (II) oxides are much less bioavailable and therefore less toxic than cupro ions. In invertebrates, effects include 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 effects 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.

Benthic habitat located adjacent to the discharge point below the jetty was sandy sea bed with fauna represented by the sparse occurrence of sea urchins, starfish, clams and tunicates. No seagrass beds occur in this area. The majority of invertebrates found are restricted to the pylons of the jetty and include sea urchins, tunicates, limpets and mussels. Few species of fish were recorded from the sandy sea bed habitat.

Due to the low concentrations of copper being released and the absence of significant biota close to the discharge point it is unlikely that the release of copper would have a detrimental impact on local marine life or fisheries resources. ANZECC (2000) guidelines state that trigger values for copper in slightly to moderately modified marine systems should be below 1.3 µg/L. It is unlikely this value would be exceeded outside the pipeline.

Impingement and Entrainment

Seawater is proposed to be pumped via a 450 mm diameter pipeline which would be located 90 m from the shore along the chip mill jetty with the intake located at least 2 m above the sea floor. The intake pipe would be screened with a 2 mm wedge wire screen. The intake would be located within a sandy bed with rocky outcrops around 50 m from the rocky barrens and 80 m 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 (i.e. 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 (California Energy Commission 2005). The majority of these studies have been undertaken in the northern hemisphere. 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 for a particular site. (Low rates of impingement and / or entrainment may still have significant impacts on particularly sensitive environments.)

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 8-4** provides impingement rate estimates at various power plant sites in California.

While **Table 8-4** lists only impingement of fish, intake pipes are also known to trap large marine organisms such as seals and turtles (Foster and Steinbeck undated). 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.

Table 8-4 Impingement rates of fish at various power plants in California

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 Screens	814	26,666
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

Source: Foster and Steinbeck undated

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).

Reducing intake flow rate is one of the more widely recommended methods for reducing impingement impacts. A water quality control policy 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 0.15 m/s. Reducing inflow velocities has been shown to considerably reduce impingement rates by up to 99% in some cases (Thomas and Johnson 1980).

The velocity of water at the intake screen of the cooling system would be 0.1 m/s. The intake pipe would also be located near 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 vary 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 higher inflows (**Table 8-4**), it is highly unlikely that the Power Plant would result in a major impact to local fisheries from impingement.

Entrainment

Entrainment impacts 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. The early life histories of most marine organisms are also poorly known, limiting the usefulness of demographic models for assessing effects. **Table 8-5** provides entrainment rate estimates at power plant sites in the US.

As **Table 8-5** indicates, 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 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 (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 (i.e. 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%) of proportional mortality due to entrainment for wide ranging pelagic species such as northern anchovy to levels as high as 50% for fish with more limited habitat that were spawned near power plant intake structures. The results were generally consistent with the biology and habitat distributions of the fishes analysed.

Table 8-5 Entrainment Rates for Larval Fishes at various Power Plants in California

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 Power plant	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
South Bay Powerplant	Southern California	Bay/Harbour	1897	2,420,527,779*

*Based on design flows and not average flow from 2000-2005 data
Source: Foster and Steinbeck undated

Various methods have been applied to this project to reduce entrainment including:

- moving the intake to an area of lower productivity; and
- use of wedge wire screens

The proposed intake screen would have a 2 mm 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 m and a surface area of 35 km^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 0.1 m/s which would also limit entrainment potential. As per the results of recent studies undertaken in California, 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 seadragon and threatened organisms are discussed below.

8.4.3 Threatened protected and migratory species

Threatened and migratory species

An assessment of the potential for threatened and migratory species to be impacted by the proposed works has been undertaken (**Appendix C**). Seven threatened species and one migratory species have been assessed to have the potential to be impacted by the proposed works (**Table 8-6**).

Table 8-6 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 Act, TSC Act and EPBC Act. The details of the tests are provided in **Appendix C**.

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

Weedy seadragon

The weedy seadragon (*Phyllopteryx taeniolatus*) was observed amongst the boulders on the sandy bed at a depth of 10 m approximately 75 m from the shore below the chip mill jetty. Individuals were also observed within the seagrass bed and the rocky reefs near 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 (Sanchez-Camara and Booth 2004, Sanchez-Camara et al 2005, 2006). A study on weedy seadragon populations in the Sydney area shows the species to potentially have restricted home ranges varying from 50 m to 150 m in length and high site fidelity, though horizontal and vertical movement were observed in some individuals related to reproduction. 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.

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 seawater temperature and lengthening of day light hours and the moon cycle. 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 (i.e. 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 m and 1 m 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 outlet pipes, most likely staying closer to the rocky reef environment located along the shore.

8.4.4 Other impacts

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 2.5 km 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 10 µg/L and would be much less in the open environment (refer to **Section 8.4.2** for further details).

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 m which is unlikely to have a major impact on accessibility.

8.5 Conclusions

It was determined that the cooling system is unlikely to have a significant impact 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 be confined to within 3.5 m of the site and 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 site by marine mammals due to construction noise; and
- reduced access to the chip mill jetty for recreational divers.

8.6 Mitigation Measures

A summary of the mitigation measures applicable to the proposed works is provided in **Table 8-7**.

Table 8-7 Mitigation Measures

Mitigation Measure	Project Stage		
	Pre construction	Construction	Operations
During detailed design, the inlet and outlet design will be optimised taking into account mixing characteristics and ecological considerations.	✓		
A management plan would be prepared to mitigate any potential encounters with marine mammals and reptiles.	✓		
Works on the seawater cooling facility along the jetty would be avoided during periods of cetacean migration.		✓	
A fauna observer will be present during all phases of marine construction.		✓	
Work on the jetty will stop if marine mammals approach within 150 m (300 m if a calf is present).		✓	
A spill management plan would be prepared.	✓		
Divers would be inducted and made aware of the ecology of the site, the importance of limiting habitat disturbance and on avoiding contact with marine mammals.		✓	
Only the minimal amount of attached flora and fauna on the jetty will be removed during the installation of the inlet and outlet pipes.		✓	
Concrete footings for the inlet and outlet pipe would be placed in an area with limited habitat potential. Any visible benthic invertebrates would be relocated to nearby habitat prior to the placement of the footing.		✓	
Workers would be inducted on the importance of maintaining the area clean and devoid of marine debris.		✓	
Discussions will be held with DECCW and DPI (Fisheries) on the need for a marine monitoring program.	✓		✓
Discussions will be held with DECCW and DPI (Fisheries) on the need to monitor copper concentrations in the area surrounding the outlet.			✓