The offshore disposal locations is located in 67m to 68 m of water, approximately 3.8 nautical miles from the entrance to Two Fold Bay. A towed video survey was also performed at the same time as that undertaken during the June 2015 survey in Snug Cove. The results of this survey work indicate that the seabed consists primarily of bare sand, with lots of bioturbation (see **Plate 1**). The infauna community present within the disposal footprint will be smothered from disposal activities, but given that the sediments to be disposed of consist of course sand material, the infauna community will likely recolonise these areas following disposal activities (AMA, 2015c).

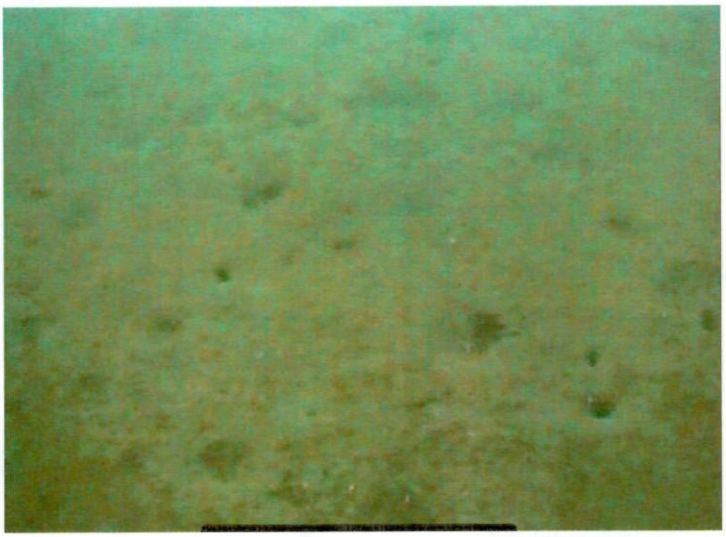


Plate 1 Eden offshore disposal site. Bare sandy seabed with bioturbation.

5.12 Marine Fauna

Twofold Bay provides coastal and near oceanic habitat for some 63 listed fauna species, including 26 threatened species under either or both the Commonwealth and State legislation; NSW Threatened Species Conservation Act 1995 (TSC Act), NSW Fisheries Management Act 1994 (FM Act) and the Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act) (Marine Pollution Research, 2013) (see **Appendix 1** for EPBC search outputs)

Twofold Bay and the immediate coastal offshore waters provide migration corridors and staging plus feeding resources for whales and dolphins, particularly Humpback and Southern Right whales. There is unlikely to be any interaction between whales and the cruise ships entering Snug Cove from Two Fold Bay. These vessels move into the area at slow speeds (8-12 knots), enabling the cetaceans sufficient time to move out of the way. Common and bottlenose dolphins are regularly reported in Twofold Bay and there may be a resident population of indo-pacific bottlenose dolphins in Twofold Bay (Marine Pollution Research, 2013).

The Australian fur seal, *Arctocephalus pusillus doriferus* is listed as Vulnerable under the TSC Act. Marine Pollution Research (2013) reported fur seals basking on the Eden Breakwater, but concluded that there are no permanent local populations and breeding occurs on exposed oceanic sites in Bass Strait from October to January. Fur seals were reported at the end of the Breakwater Wharf during a 2014 visit (see **Plate 2**) (AMA, 2015b).

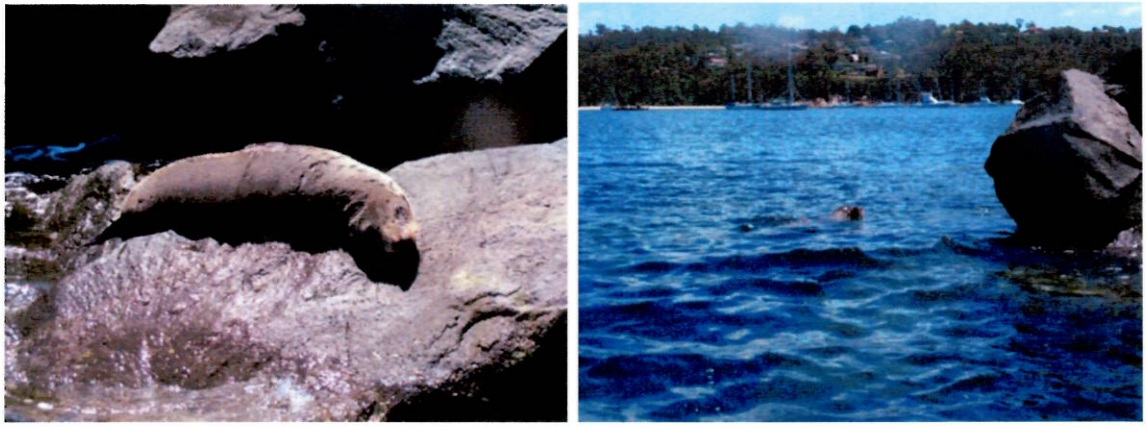


Plate 2 Fur seals swimming and basking on the rocks at the end of the Breakwater Wharf.

5.13 Invasive Species

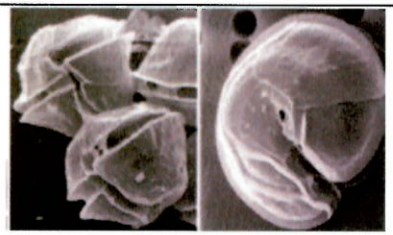
During the CSIRO (1996) marine pest survey three Australian Ballast Water Management Advisory Council (ABWMAC) listed marine pest were detected in the Port of Eden. They included the European shore crab Carcinus maenas, Mediterranean fanworm Sabella spallanzanii and the toxic dinoflagellate Alexandrium "catenella type". The NSW DPI completed follow up marine pest surveys in the Port of Eden between July 1999 and June 2002 (Pollard and Rankin, 2003).

The ABWMAC listed pest species detected in 1996 were targeted throughout the three year duration of this project, with changes in their abundances and distributions being monitored. A fourth introduced species, the New Zealand rosy screw shell *Maoricolpus roseus*, previously detected during the 1996 survey, was found to be extremely abundant in seagrass beds in East Boyd Bay, and was also monitored throughout the study. No additional ABWMAC listed target pest species were detected in the port during the survey period.

The Eden Breakwater Wharf Extension Project will require the removal of sea bed in close proximity to the existing wharf facilities in Snug Cove in the Port of Eden. The dredge material from this work will be disposed within an existing (approved) offshore dredge material disposal area. This area has received dredge material from previous dredging works in Twofold Bay (Royal Australian Navy of a Multi- Purpose Naval Ammunitioning Wharf at Edrom Bay). **Table 3** provides further assessment on the potential for marine pest translocations and appropriate monitoring requirements.

Table 3 ABWMAC listed marine pests found in the Port of Eden, and their potential to be transported to the offshore disposal area and establish via populations.

Pest Species	Image	Ecology (Habitat Frequented)	Potential for these organisms to be transported in the dredged material	Potential for these organisms to become established at the disposal site
European shore crab *Carcinus maenas*	 Juvenile European green crab. Photograph: Matt Tyler (NSW DPI)	The European shore crab is a littoral species that frequents the inter-tidal habitats.	It's unlikely that this species would transported in the dredge material. The sea bed subject to dredging is at a minimum of 4m below LAT. Well outside of the littoral zone.	Not possible because the disposal area is located 5 nautical miles offshore in 67-68m of water
Mediterranean fanworm *Sabella spallanzanii*	 The European fan worm, Sabella spallanzanii. Photo by Tim Glasby (NSW DPI)	The European fan worm (*Sabella spallanzanii)* demonstrates a clear preference for growth in sheltered, nutrient-enriched waters (Currie McArthur and Cohen 2000). It is generally found in shallow subtidal areas in depths from 1 to 30m (CSIRO 2001).	An eradication program for the fan worm has been active in the Port of Eden since its discovery in 1996. However, it is possible that individuals of this species could be transported in the dredge material and ultimately delivered to the offshore disposal area. The	The presence of this species has been confirmed at the proposed dredge material disposal location. However, the density and distribution of the species was low, suggesting that the offshore habitat is not ideally suited to this

			presence of this species at the offshore disposal area has been confirmed by AMA (2015c)	species.
Dinoflagellate *Alexandrium catenella*	 Electron microscope image of A. catenella (Cawthron NZ)	*A. catenella* is an armoured, marine, planktonic dinoflagellate. It is associated with toxic PSP blooms in cold water coastal regions. Cysts fall to the sea bed and can lay dormant for some time. Cysts have been detected in sediments from the Port of Eden (Pollard and Rankin, 2003)	It is possible that dormant A. catenella cysts could be transported in the dredge material and ultimately delivered to the offshore disposal area (67-68 m deep). However, the CSIRO (1996) and Pollard and Rankin (2003) found this species in low densities in Snug Cove.	It is possible that cysts may be translocated to the offshore disposal area. However, this species of Dinoflagellate is common along the NSW coastline and any translocation would not increase the chances of establishment (Hallegraeff *et al*. 1998).
New Zealand Rosy Screw Shell *Maoricolpus roseus*	 NZ Rosy Screw Shell (CSIRO)	It forms a dense covering on the sea floor with live and dead shells at depths up to 100m, and competes with native shellfish for food. lives on, or partially buried in sand, mud or gravel. Intertidal to subtidal. From 1-130m depth (NSW DPI)	It is possible that live specimens of the NZ Rosy Screw Shell could be transported in the dredge material and ultimately delivered to the offshore disposal area.	It is possible that a live specimen could survive the transportation to the dredge spoil to the offshore area. See Part H Monitoring for further information

5.14 Terrestrial Fauna and Migratory Waders and Shorebirds

The NPWS Wildlife Atlas reported 12 vulnerable and three endangered species within 5 km of the proposed project area. The Pied Oystercatcher, *Haematopus longirostris*, Hooded Plover, *Thinornis rubricollis* and Swift Parrot, *Lathamus discolour* are all listed as Endangered (E) or Critically Endangered (Hooded Plover) under the under the NSW Threatened Species Conservation Act 1995 (AMA, 2015b).

The Pied Oystercatcher is an unmistakable, large, black and white wader, reaching 50 cm in length, which favours intertidal flats of inlets and bays, open beaches and sandbanks. They forage on exposed sand, mud and rock at low tide (Environment & Heritage, 2014). The DECC Atlas of NSW Wildlife has recorded a sighting of the Sooty Oystercatcher (*H. fuliginosus*) and 10 sightings of the Pied Oystercatcher, *H. longirostris* in the intertidal and coastal areas of Twofold Bay (AMA, 2015b).

The Swift Parrot is a small parrot about 25 cm long. It is bright green with red around the bill, throat and forehead. On the Australian mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations (Environment & Heritage, 2014).

Hooded Plovers are small to medium-sized, stocky shorebirds with short bills, large eyes and rounded heads. In southeastern Australia, Hooded Plovers prefer sandy ocean beaches, especially those that are broad and flat, with a wide wave-wash zone for feeding, much beachcast seaweed, and backed by sparsely vegetated sand dunes for shelter and nesting (Environment & Heritage, 2014).

The Breakwater Wharf does not contain any suitable foraging or nesting habitat for these three species. These species are unlikely to be adversely impacted from the proposed construction or operational activities, given that the works are along the Breakwater and there is no interaction with intertidal or inshore areas. Two species of shorebirds were reported during the site visit, namely the Egret, *Ardea* spp. and Cormorant, *Phalacrocorax* (see **Plate 3**) (AMA, 2015b).

Three species of Albatros have been recorded in the NPWS Wildlife Atlas, including the Shy Albatros, *Thalassarche cauta*, Yellow-nosed Albatros, *Thalassarche chlororhynchos* and the Black-browed Albatros, *Thalassarche melanophris* (AMA, 2015b).

A number of the species listed as occurring within the vicinity of the project area are also migratory species, listed under the Commonwealth's Environment Protection and Biodiversity Conservation Act 1999, the Japan – Australia Migratory Bird Agreement (JAMBA) and the China - Australia Migratory Bird Agreement (CAMBA).

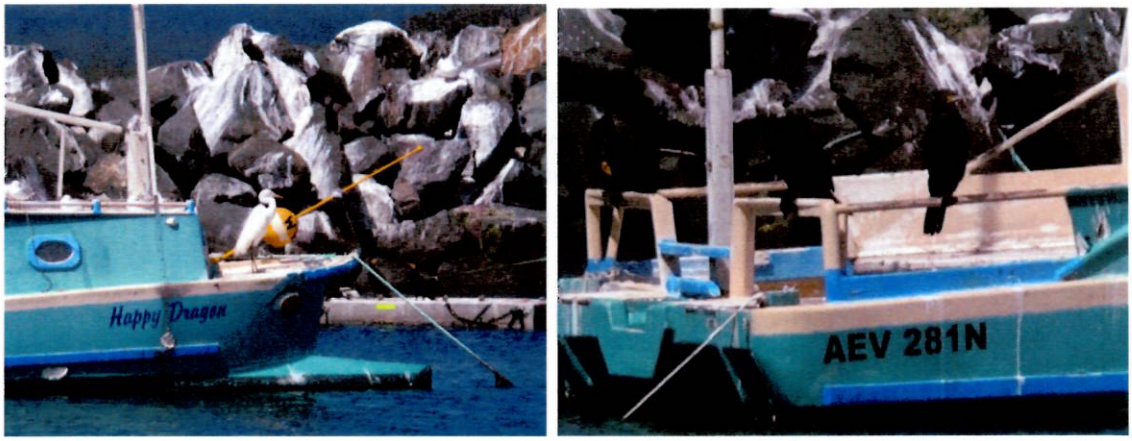


Plate 3 Egret, *Ardea* spp. and Cormorant, *Phalacrocorax spp.*, in Quarantine Bay Marina.

6. ENVIRONMENTAL MANAGEMENT FRAMEWORK

6.1 Environmental Factors Requiring Management

The environmental factors that have been assessed for the Project were identified through existing studies, other published information and consultation with the NSW Environmental Protection Authority, NSW Department of Primary Industries (Aquatic Ecosystems), Department of Environment (DOE) and other stakeholders.

The following environmental factors require management and/or monitoring

- Water quality;
- Marine fauna;
- Marine flora
- Introduced marine pests;
- Hydrocarbon management; and
- Waste management
- Mussel Lease Productivity

Table 4 summarises the identified impacts, management and risk associated with the Project.

Table 4 Summary of identified impacts, management and risk.

Factor	Potential Impact	Proposed Management Measures
Water Quality	Dredging related turbidity exceeds the predicted intensity and extent modelled and total suspended solids concentrations from dredging impact on local water quality. Changes to physiochemical water quality parameters as a resulting of dredging and disposal activities.	Section 6.2
Marine Fauna	Direct impacts to marine fauna as a result of accidental hydrocarbon spills. Vessel collision with marine fauna.	Section 6.3
Marine Flora	Dredging related turbidity exceeds the predicted intensity and extent modelled and total suspended solids concentrations from dredging impact on nearby seagrass beds (Cattle Bay).	Section 6.4
Introduced Marine Pests	Introduction of invasive marine species to the waters of Snug Cove as a result of entrainment in internal vessel systems or hull fouling, originating from interstate or international waters, and associated environmental impacts.	Section 6.5
Hydrocarbon Management	Impacts to marine fauna and habitat following an hydrocarbon spill during dredging and disposal	Section 6.6

Waste Management	Impacts to marine water quality, macro algal beds, fauna, recreation and aesthetic values as a result of spills and leaks of hazardous chemicals. Impacts to the surrounding environment, marine flora and fauna from toxicity and ingestion as a result of incorrect management or disposal of solid and liquid wastes.	Section 6.7
Mussel Lease Productivity	Dredging related turbidity exceeds the predicted intensity and extent modelled and total suspended solids concentrations from dredging impact on mussel growth rates and quality.	Section 6.8

6.2 Water Quality

6.2.1 Potential Impacts

The potential effects from dredging and dredge material disposal for the project on water quality are:

- During dredging, turbidity is generated when the Backhoe Dredge cuts into the seafloor. With a grab or bucket, further sediment plume is generated as overflows from the bucket escapes as it is lifted through the water column. Overflow of some sediments also occur as the bucket breaks free of the water surface and drains freely.
- During disposal, plumes of turbid water are generated as the material from the hopper barge or dredge is released and settles to the seafloor, interacting with the bed sediments. Finer sediments can be entrained in the water column by prevailing surface currents while heavier material will settle directly to the seafloor.

The increase in turbidity caused by the project is expected to be limited temporally and spatially as:

- The duration of the dredging campaign is short (approximately 12 weeks);
- Plume demonstrates that the plumes are not likely to have a large intensity and extent; and
- The 50th %ile of the 5 mg/L area is limited to within ~50 m of the dredging activity.

6.2.2 Objectives

The environmental objective for marine water quality is to maintain the quality of water so that existing and potential environmental values are protected.

The water quality objectives for the Project are to:

- maintain the structure and function of marine ecosystems, including seagrass;
- cause no increase in turbidity that impacts key sensitive receptor monitoring sites; and
- cause no long-term deterioration in water quality after dredging and spoil disposal is completed.

6.2.3 Management measures

The following management measures will be put in place:

- dredging and disposal to be undertaken within proposed and approved areas;
- use of a vessel monitoring system on the dredge, allowing a track plot analysis to ensure maximum efficiency of dredging and that no dredging occurs outside the required area occurs;

- split hopper barges will be equipped with DGPS to enable precise positioning of the barge for discharge and accurate recording of discharge locations; and
- use of suitable and well maintained dredging plant and equipment to minimise turbidity.

6.2.4 Water Quality Reporting

If Tier 2 monitoring is initiated, the Principal's Project Manager will Notify NSW EPA and Commonwealth DoE regulators. A daily update on the Tier 2 monitoring outcomes will be provided to the regulators. The dredge contractor will maintain a daily log of visual observations of the plume.

If Tier 2 is not initiated, a final project environmental report will be provided to State and Commonwealth regulators. This report will present the water quality data generated during the baseline and project monitoring programs. A discussion of observed trends and drivers for the observed trends will be provided. Included in this report will be a summary of project dredging work and progressive volumes. This report will be delivered within 30 days of project completion.

6.3 Marine Fauna

6.3.1 Potential Impacts

NSW Fisheries is responsible for ensuring that fish stocks are conserved and that there is "no net loss" of key fish habitats upon which they depend. In addition, Fisheries NSW is responsible for ensuring the sustainable management of commercial, recreational and Aboriginal cultural fishing, aquaculture and marine protected areas within NSW (DPI, 2014).

The potential impact of the development upon the aquatic habitats, fish communities and the aquaculture industry in Eden Harbour is of particular interest to this Department in relation to this proposal (DPI, 2014). The Eden Mussels mussel lease area is located immediately offshore of Cattle Bay and is approximately 700 m from the Breakwater Wharf.

The proximity of the dredge footprint to this aquaculture area is a trigger for satisfying the provisions outlined in the NSW Oyster Industry Sustainable Aquaculture Strategy (OISAS). Whilst not an oyster aquaculture area, DPI has advised that the same mitigation measures be implemented, for managing potential impacts to the mussel leases.

SEPP 62 requires the consenting authority to consider whether the development may adversely impact on oyster aquaculture (DPI, 2014). To manage water quality and mitigate impacts to oyster aquaculture, NSW Fisheries has identified the water quality guidelines for oyster aquaculture areas, as detailed in OISAS.

The dredging and construction works have the potential to resuspend sediment into the water column and create turbid plumes. To manage potential water quality impacts, it is therefore recommended to adopt the water quality guideline values provided in ANZECC/ARMCANZ (2000) for aquaculture areas and also where possible, utilise background water quality data to inform future monitoring. These site-specific trigger values should be developed during baseline monitoring.

The scale and short temporal timeframe of dredging works are unlikely to impact upon marine fauna. They have the ability to move away from the area during these activities and there are

mitigation measures that can be employed to warn any nearby animals of increased noise, enabling them to swim away from the noise source (i.e. slow/ soft start warning noises). The Projects Construction EMP, includes a series of management mitigation measures for managing underwater noise risk to marine fauna.

6.3.2 Vessel Movements

The number and type of vessels operating in Snug Cove will increase during dredge activity, increasing the risk of vessel strike on marine turtles and cetaceans. Dredging however, by backhoe and barge may largely eliminate the risk of vessel strike, because of intermittent and/or slow movements. Ultimately, the slow movement of the offshore barge will allow the mammals adequate time to avoid the vessel.

6.3.3 Conclusion

A number of threatened or migratory species have been identified as being potentially present in the Project area. Environmental impacts associated with the project will be localised and transitory. There are no significant impacts predicted to occur to the marine habitats present in the Project area or to any critical resources for threatened and migratory species.

Current industry within Twofold Bay has associated commercial shipping activities related to Defence, Wood Chip Industry, and local fishing and whale watching operators. The Project is not likely to have a significant impact on "matters of national environmental significance", namely listed threatened species and listed migratory species.

The impacts associated with the project are non-significant based on the criteria as provided in the EPBC Act Policy Statement 1.1 Significant impact guidelines: Matters of national environmental significance. The mitigation and monitoring measures associated with management of vertebrate fauna are addressed in Section 6.3.5.

6.3.4 Objective

The environmental objective for marine fauna is to ensure that dredging and offshore disposal activities do not impact on the marine vertebrate fauna of Twofold Bay. The marine fauna objective for the Project is to:

- Cause zero injury/mortality of marine mammals related to the dredging activities.

6.3.5 Management measures

The following management measures will be undertaken:

- Maintain a 300 metre distance from all cetaceans for a minimum of twenty minutes prior to disposing of dredge spoil;
- A distance of at least 300 m will be maintained from any whale and a whale shall never be deliberately approached by construction personnel or vessels;
- A distance of at least 100 m will be maintained from any dolphin and a dolphin shall never be deliberately approached by construction personnel or vessels; and
- A distance of at least 20 m will be maintained from any seal or construction personnel or vessels shall never deliberately approach turtles or seals.

In addition to these exclusion zones the following expectations will be met:

- All construction personnel shall comply with all relevant components of the Australian National Guidelines for Whale and Dolphin Watching 2005.
- Vessels will not stop suddenly or change direction suddenly if a whale, dolphin, turtle or sea lion is in close proximity to the vessel.
- Wherever possible, wide, deep channels will be used as transport routes for work vessels. The end of the Breakwater Wharf will be avoided.
- Wherever possible outboard motors on work vessels should be able to tilt up (rather than lock-down) in the event of a collision with marine fauna.
- Recreational fishing, diving, spearfishing, and fossicking (i.e. collecting shells and any other biological or natural material e.g. animal's bones) will be prohibited during construction.

During the dredging works a sufficiently trained fauna spotter will visually monitor for marine fauna during dredging and dredge spoil disposal activities.

6.3.6 Monitoring

The following monitoring will be undertaken during dredging and disposal of dredged material:

- A spotter aboard the dredging plant will be used to maintain a look out for whales or dolphins; and
- Dredging will commence only after no whales or dolphins have been sighted within 300 metres of the disposal vessel for a continuous period of 15 minutes.

6.3.7 Reporting

A log of visual observations will be maintained. If one or more marine mammals suffer injury or mortality as a result of the dredging and dredge disposal activities, the Department will notify the regulators as soon as practicable, but no more than within 24 hours from the incident occurring.

In addition to this, reporting of the details of any encounter with a cetacean will be recorded by the dredge contractor and provided to The Department on request.

6.4 Marine Flora

The proposed construction works will be primarily focussed on the northern side of the Breakwater Wharf. The barges and excavators used for the dredging works will likely be floated on the water surface and the barges will be filled with dredge spoil for transportation to the offshore disposal area.

The proximity of the known seagrass beds and rocky reef communities ensures that these habitats are unlikely to be impacted by the dredge plant. This assumption is based on the hydrodynamic plume modelling which demonstrates that the plumes will be confined to around the dredge and are unlikely to interact with these habitats.

6.4.1 Objective

The environmental objective for marine flora is to ensure that dredging and offshore disposal activities do not impact on the marine flora of the Snug Cove and Cattle Bay. The marine flora objective for the Project is to:

- Cause zero impacts on marine flora communities in Snug Cover and Cattle Bay related to the dredging activities.

6.4.2 Management Measures

The management measures provided in **Section 6.1.5** for water quality are of direct relevance for managing or mitigating any impacts on marine flora communities in Snug Cove and Cattle Bay. If Tier 2 monitoring is required, a field based examination of the seagrass and macroalgal beds will be initiated. The primary objective of this survey work will be to establish the health status of these habitats. The field-based survey will establish the extent and density of the habitats and also the presence of sediment deposition within these habitats.

6.4.3 Reporting

The Reporting commitments outlined in **Section 6.1.5** for water quality are of direct relevance for communicating the field observations and outcomes of management mitigation. If Tier 2 monitoring is required, a scientific report containing the outcomes of the marine habitat survey will be drafted and delivered to the Department.

6.5 Introduced Marine Pests

The introduction of vessels used during dredging has the potential to introduce marine pests from other locations. Marine pests can be introduced from ballast water discharges, biofouling species that become attached to the hulls of vessels, or released from niche spaces such as sea chests and intakes. Potential environmental impacts that may occur as a result of the introduction of marine pests include the following:

- competition for food and space with native species;
- out compete and/or removal of native species;
- introduction of associated pests and disease

6.5.1 Objectives

The environmental objective for introduced marine pests is to minimise the risk of marine pest species introduction, establishment and spread into and within Snug Cove and Twofold Bay waters as a result of the dredging and disposal activities.

The objective for the project in relation to introduced marine pests is to:

- prevent the introduction of introduced marine pests from dredging operations; and
- implement appropriate management measures where known or suspected introduced marine organisms are detected during vessel inspections or during dredging operations.

6.5.2 Management measures

The dredging contractor will be required to address all Commonwealth and State import controls for the entry of vessels. Prior to commencing dredging operations, the dredging contractor is to provide confirmation that the dredge vessel is free of introduced marine pests and that any ballast water is managed in accordance with the mandatory requirements by the Department of Agriculture (DoA), (previously Department of Agriculture, Fisheries and Forestry (DAFF)).