Appendix G Technical Paper: Aquatic Ecology Assessment

PROPOSED BARANGAROO FERRY HUB

ENVIRONMENTAL IMPACT STATEMENT

- AQUATIC ECOLOGY ASSESSMENT

Diver's view of Barangaroo – looking east.

Report Prepared for RPS Australia East Pty Ltd

Marine Pollution Research Pty Ltd

November 2014

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REPORT TITLE:	PROPOSED BARANGAROO FERRY HUB REVIEW OF ENVIRONMENTAL FACTORS: AQUATIC ECOLOGY ASSESSMENT
CLIENT & CONTACT:	Mr Peter Mangels, Senior Planner RPS Australia East Pty Ltd on behalf of Transport for NSW (TfNSW)
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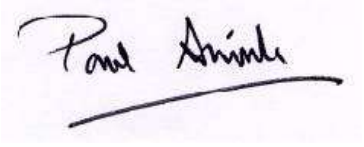
MPR APPROVAL: PAUL ANINK	 26 Nov 2014

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TABLE OF CONTENTS

FIGURES

TABLES

ANNEXURE

1 INTRODUCTION

Transport for NSW (TfNSW) is proposing the construction and operation of the Barangaroo Ferry Hub (refer to Figure 1) that would include:

- Establishment of a construction work area and temporary construction compound
- Construction of three new ferry wharves and ancillary landside ferry facilities
- Potential demolition of King Street Wharf wave baffle
- Site clean-up and opening of the new wharf
- Operation of wharves including ferry layover, pump out facilities

Initially, only two wharves would be constructed. The third wharf would be constructed in the future when the demand for ferry services necessitates.

Marine Pollution Research Pty Ltd (MPR) has been commissioned to undertake an aquatic ecology assessment for the Barangaroo Ferry Hub proposal (the proposal). The removal of King Street Wharf wave baffle is a potential part of the proposal and a previous assessment for the its removal (also known as King Street Wharf 10 jetty) has been previously prepared by MPR (MPR 2013). A copy of the report is attached at Annexure A.

This report assesses the aquatic ecology of the study area (as outlined in Figure 2) against the Fisheries NSW Policy and Guidelines (Fisheries NSW 2013), considers the likely impact on aquatic ecology of the construction and operation of the Barangaroo Ferry Hub, and provides impact mitigation measures where necessary.

An aerial view of the proposal in Darling Harbour is provided at Figure 2. The site is relatively well sheltered from wind waves from most directions other than north, with a fetch of about 1.3 kilometres to Goat Island. The proposal area is exposed to regular wash from local passing vessels. The Barangaroo reclaimed shoreline is encased behind concrete cassion units set onto basement rock on the seabed with concrete over-decking.

1.1 The Proposal

The proposal comprises the construction and operation of a ferry hub and would include:

- Establishment of a construction work area and temporary construction compound
- Construction of three new ferry wharves and ancillary landside facilities
- Potential demolition of the King Street Wharf wave baffle
- Site clean-up and opening of the new wharf
- Operation of wharves including ferry layover, pump-out facilities
- Eventual decommissioning and removal of the public transport elements of King Street Ferry Wharf such as ticket vending machines and signage.

Ancillary landside facilities included as part of the proposal would include wayfinding signage and ticketing (including Opal card facilities).

Barangaroo development approval Concept Design Modification 4 (MP06_162 (MOD 4)) has made provision for about 300 square metres of transport related office space. This space is to be delivered by BDA and/or Lend Lease, and therefore does not form part of the proposal.

Telecommunications, electricity, water and sewerage would be available at the foreshore edge. This would also be constructed by Lend Lease as part of the Barangaroo South development. The proposal includes connection into the landside service infrastructure.

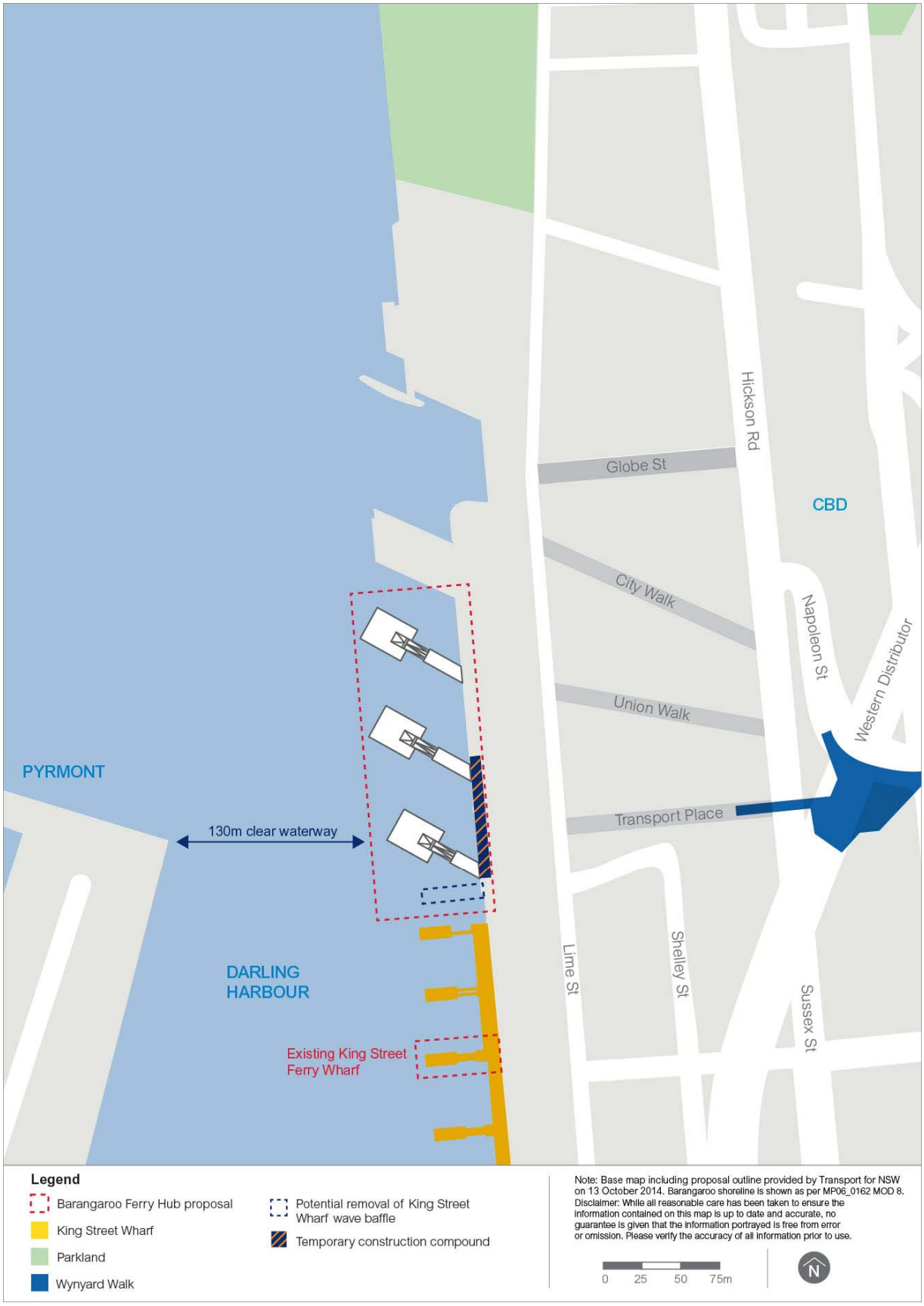

Figure 1 Location for Proposed Barangaroo Ferry Hub in Darling Harbour

Figure 2 Aerial view of Darling Harbour showing Aquatic Ecology Study Area

It is anticipated that each wharf would be self-supporting and would comprise:

- A prefabricated steel covered pontoon about 38 metres long and 22 metres wide, which includes:
    - two berthing faces on each pontoon
    - ancillary facilities on each wharf to provide for passenger safety, comfort and security and to display ferry service information
    - a roof structure which incorporates a glazed roof light, with a ceiling height of about 3.5 metres above the pontoon surface and 4.5 metres above sea level and an overall roof height of up to about 6.5 metres above sea level
- A fixed covered link structure to connect the gangway to the land (comprising two ramps and a landing) up to about 30 metres long, between about 13 metres to 37 metres wide. The link structure would be level with the built quay line (+RL 2.9 metres at northern wharf and +RL 2.5 metres at southern wharf) and ramps down to around +RL 1.9 metres for each wharf
- A prefabricated aluminium gangway about 15 metres long and 10 metres wide between the link structure and the pontoon
- Crew access to vessels in layover on both sides of each wharf
- Ticket barriers, wayfinding signage, public announcement system (PA system) and Opal ticketing infrastructure
- About 30 piles per wharf (including steel pontoon restraint piles, steel support piles, crash barrier piles and fender piles)
- Ferry crash barrier comprising cross beam attached to the crash barrier piles. On the southern side this would be installed adjacent to the sea wall, on the northern side this would be in front of the link structure
- Connection of power, telecommunication and data communications and potable water services (including fire hydrant services)
- A sewage pump-out facility comprising pump, filters, reels, valves, electrical and control facilities. It is anticipated that the pump-out facilities would be located in an enclosed space on the link structure and be about 3 metres by 2 metres by 1.5 metres in size
- A small gateline ‘kiosk’ (office) would also be located on the link structure for staff activities (no ticket sales), as well as a bin storage space.

Design elements including surface treatments and transition features would be designed to be compatible with Barangaroo South and the design of the ferry wharves.

1.2 Available Information on Aquatic Habitats

The aquatic ecological community around the proposal is described as "Waterway" on the *Sydney Harbour Catchment - Foreshores and Waterways Area Development Control Plan*: Ecological Communities and Landscape Characters Map 8 (DCP Map 8). This map indicates no foreshore or sub-tidal marine habitats at Barangaroo, with the closest designated habitats being ‘rocky platform’ at last 1km north-west of the proposal at White Bay and Balmain East (refer to Figure 3). Sheet 10 for the *Sydney Regional Environmental Plan (Sydney Harbour Catchment* (refer to Figure 4) indicates 'wetlands' at the rocky platform site at Balmain East and around the Balmain East foreshore. Previous MPR surveys undertaken at White Bay and around the Balmain East foreshore to Camerons Cove show these areas comprise of rock revetments that support kelp beds. The SREP ‘wetland’ designation therefore indicates marine algae for those sites.

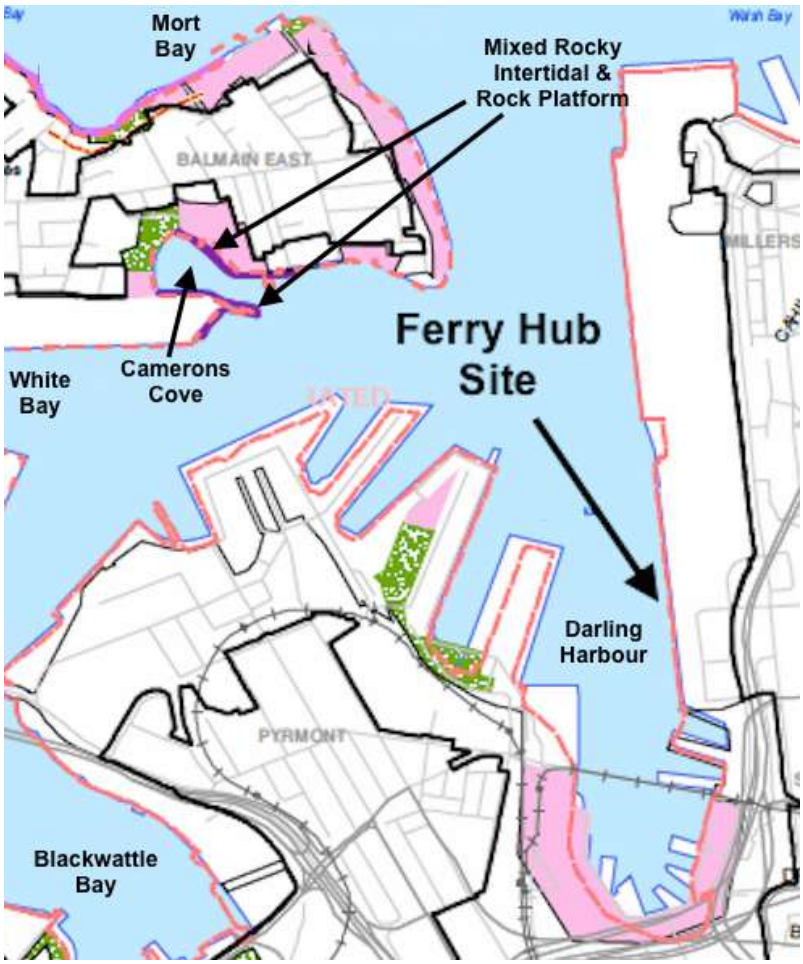

Figure 3 Portion of DCP Map 8 showing no foreshore or sub-tidal marine habitats at Barangaroo, and rocky reef habitat at Camerons Cove and White Bay, Balmain East.

Mapping by NSW Department of Primary Industries Fisheries Branch (DPI Fisheries) indicates no marine vegetation along the East Balmain peninsula or the Barangaroo foreshores, however the mapping does show *Kelp habitat* in the near-shore shallows of Camerons Cove north of White Bay. With regard to intertidal marine vegetation, there are no mangroves or saltmarsh indicated on the vegetation surveys prepared by Allen et al (2007) and Kelleway et al (2007).

Environmental Resources Management (ERM) assessed marine sediments offshore from Barangaroo along seven shore normal transects (about 350 metres in total length), from Barangaroo south to north, and collecting core samples to a maximum depth of about 1.2 metres for a total of 85 sediment samples (ERM, 2008).

Results (summarised by Worley Parsons (Barangaroo Stage 1: Barangaroo Concept Plan Amendment (MP06_0162 MOD4) – Marine Ecology, Water Quality and Contaminated Sediment Impact Assessment. Report prepared for Lend Lease 28 July 2010) concluded that sediments in the proposal area contain heavy metals and polycyclic aromatic hydrocarbons (PAH) components at elevated concentrations. These results are consistent with previous harbour-wide surveys. ERM concluded that a former gas works located adjacent to the proposal in Hickson Road could have contributed to elevated contaminants of potential concern in marine sediments.

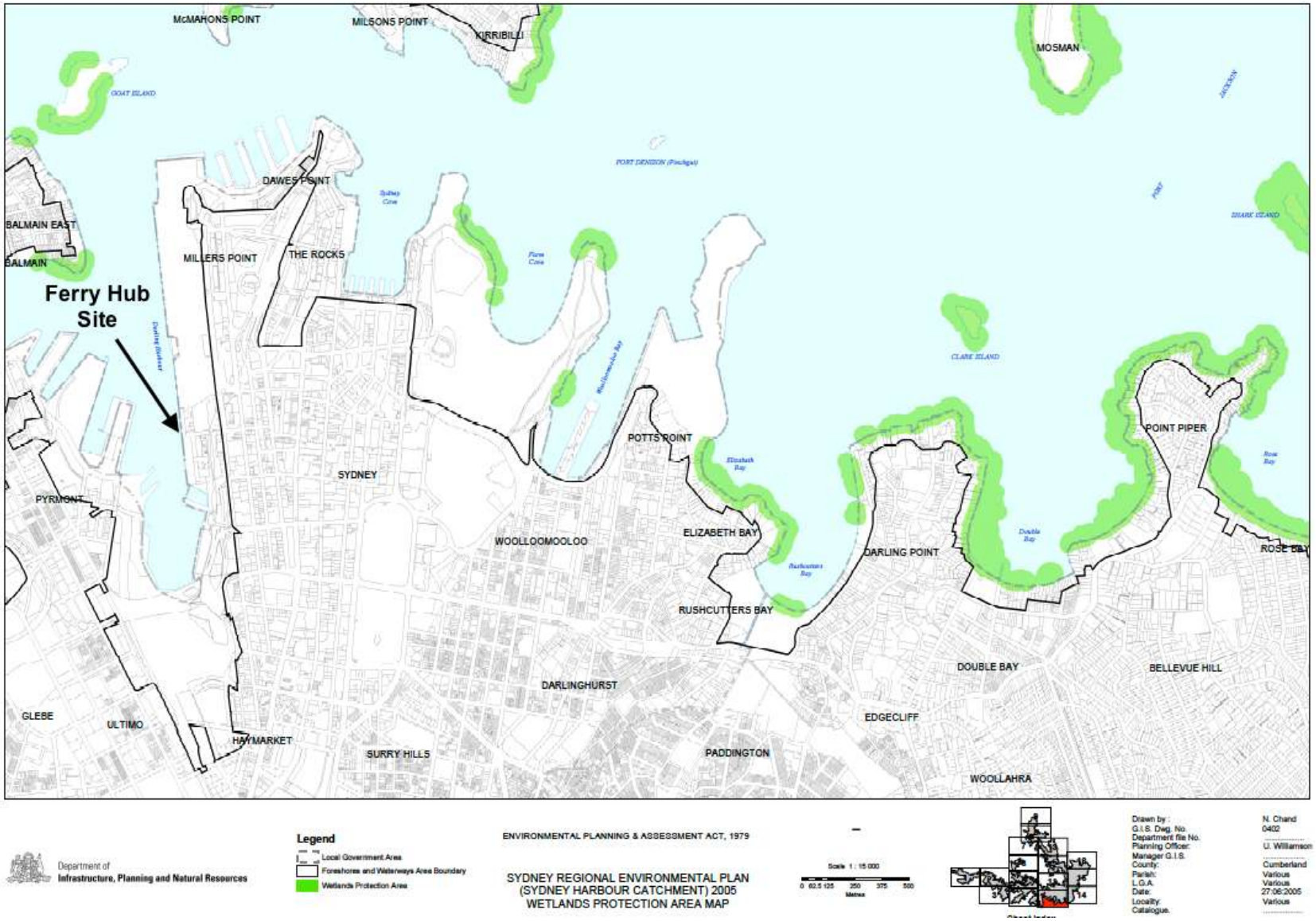

Figure 4 SREP (Sydney Harbour Catchment) Wetlands Protection Area Sheet 10 showing designated '*wetland'* at the Balmain Peninsula.

Figure 5 Locations for Barangaroo four towed Video Transect Sites (left) and four Surface Sediment Sample Sites (right) as provided in the Worley Parsons 2010 Report -Barangaroo Stage 1: Barangaroo Concept Plan Amendment (MP06_0162 MOD4) – Marine Ecology, Water Quality and Contaminated Sediment Impact Assessment. Report prepared for Lend Lease 28 July 2010

1.3 Existing environment

The existing environment within the study area (Figure 2) comprises:

The proposal area

Video transect routes (refer to Figure 5) within the proposal area (ERM, 2008) confirm no marine vegetation, however considerable bioturbation from burrowing organisms was noted.

Worley Parsons (2010) noted that their sediment particle size analysis results were similar to the previous ERM (2008) results, and that surface sediments comprised on average 38 per cent fines (<2µm), 40 per cent silts (2 to 60µm) and 22 per cent sand.

Benthic sampling and analysis showed that the sediments at Barangaroo supported a simple benthic assemblage comprising mainly polychaete worms (12 taxa) and crustaceans (4 taxa).

King Street Wharf wave baffle

A previous aquatic survey (MPR, 2013) carried out at the King Street Wharf wave baffle noted piles and baffles supported a diverse assemblage of biota including marine algae, and that there was a distinct zonation of encrusting and sessile biota on wetted surface areas of the wharf support piles and baffles. The attached and encrusting biota in turn provided feeding and shelter habitat for small and juvenile reef fish.

No additional survey for the Barangaroo Ferry Hub proposal was undertaken at the King Street Wharf wave baffle and the previous survey by MPR is described at Annexure A.

2 AQUATIC HABITATS AND ECOLOGY

2.1 Threatened and Protected Species and Endangered Ecological Communities

Aquatic habitats, flora and fauna of conservation significance are protected under both State and Federal legislation. In NSW, threatened species, populations and ecological communities of animals and plants are protected under the *Threatened Species Conservation Act 1995* (*TSC Act*). Threatened species, populations and ecological communities of fish and marine vegetation are protected under the *Fisheries Management Act 1994* (FM Act). The *TSC Act* and *FM Act* also list a number of key threatening processes that may threaten the survival of species, populations and ecological communities. The *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC Act)* protects wetlands of international importance, Commonwealth Marine Areas, nationally threatened species and ecological communities and migratory species, nuclear actions and world and national heritage places.

The FM Act, TSC Act and EPBC Act require that any proposed activity be assessed with respect to its potential impact on species or ecological communities listed as threatened under the Threatened Species Schedules of the Acts or listed as migratory species under the EPBC Act. Annexure B provides a table of threatened marine species, endangered marine populations and protected marine fish species known, presumed extinct or that could occur in Sydney Harbour. The list is derived from searches of the relevant agency data-bases of listed species including Fisheries NSW *Fish Records Viewer*, Office of Environment and Heritage (OEH) *Bionet Atlas of NSW Wildlife* and the Commonwealth Department of the Environment *Protected Matters Search Tool*.

2.1.1 Fish and Sharks

The FM Act and EPBC Act list a number of marine and estuarine shark and teleost fish species as Vulnerable Species under Schedule 5 of the Act..These listed species are considered as follows:

- Of the listed sharks, the Green Sawfish is presumed extinct, the two hammerhead sharks are oceanic species and are unlikely to enter Sydney Harbour. The Grey Nurse and Great White sharks are near-shore coastal species and could enter Sydney Harbour from time to time. However such visits would be infrequent and they would generally be only found in the outer harbour when in pursuit of mobile prey species. They would not make use of any of the habitats available at Barangaroo and the likelihood of these species occurring is low
- Of the listed teleost fish species known from Sydney Harbour only one, the Black Rock Cod *Epinephelus daemelli* could potentially occur in outer Darling Harbour Bay as its habitat is coastal and estuarine rocky reefs and there are rocky reef areas identified around the Balmain Peninsula. Notwithstanding, it is unlikely to occur on the rock rubble reef at Barangaroo by virtue of the lack of suitable cave and crevice habitat
- Syngnathiformes (seahorses, sea-dragons, pipefish, pipe-horses and sea-moths) are protected under the EPBC Act and the FM Act. Of the 31 species of syngnathiformes known from NSW waters, three, (White's seahorse *Hippocampus whitei*, Coleman's Seahorse *Hippocampus colemani* and the pygmy pipehorse *Idiotropiscis sp.)*, are endemic to NSW. White’s seahorse is common in Sydney Harbour and is known to inhabit jetty and wharf structures in Sydney Harbour upstream to at least Mort Bay, Balmain.

2.1.2 Other Listed or Protected Species

With regard to other aquatic species or ecological communities and migratory species listed under the FM Act, TSC Act and EPBC Act, listed species are considered as follows:

- Seagrass beds in Sydney Harbour that include *Posidonia australis* are listed as an Endangered Ecological Community under the FM Act. No *Posidonia* plants or beds are found in the inner harbour west of Bradleys Head, Mosman

- Little Penguins are observed fishing and feeding throughout the harbour and could be expected to visit the site from time to time, albeit rarely. These are likely to be members of the Little Penguin colony at North Head, which is listed as an Endangered Ecological Community under the TSC Act

- Various listed cetaceans (whales and dolphins), marine mammals (seals and sea lions), marine reptiles (turtles and sea-snakes) and sea-birds (migratory ocean birds and waders) are reported to occur in the outer Sydney Harbour estuary. The Bionet search for Sydney Harbour indicated nine marine species listed under the TSC Act; two *Endangered* species (the Little Tern and the Southern Right Whale), and seven *Vulnerable* species (Green Turtle, New Zealand and Australian Fur Seals, Humpback Whale, Goulds Petrel, Sooty Tern and Sooty Oystercatcher). The majority of these species are open water or open coastal species that are generally found on the coastline rocky shores around the harbour entrance or outer harbour waters. Both the whale species are known to penetrate well into the harbour, including the open waters of the harbour west of the Harbour Bridge, albeit rarely

  Of the species that may occur in the vicinity of the site, none would be utilising the resources of the site to any great extent and would generally be in the locality as transients or opportunistic feeders. The site does not provide any undisturbed intertidal rock reef habitat for seabird roosting or shore bird feeding and there are no undisturbed sites for seal haul-outs.

It is concluded that the study area and locality do not constitute specific habitat for threatened aquatic species as listed under the FM Act, TSC Act and EPBC Act, and therefore it is highly unlikely that there would be any threatened species residing within the study area. The threatened species discussed above are unlikely to penetrate this far into Darling Harbour. In regard to protected species, White's seahorse could reside in Darling Harbour where there is suitable feeding and shelter habitat.

2.2 Aquatic Habitats and General Ecology

A diver based aquatic ecology survey within the proposal area was carried out on 14 August 2014 by a suitably qualified aquatic ecologist. The survey area was nominally 130 metres by 60 metres and bounded by King Street Wharf wave baffle to the south and the Barangaroo foreshore to the east (refer to Figure 6). The dive survey comprised of:

- Three spot dives in deeper waters over a 10 metre diameter search area
- Three shore-normal transect swims from mid water depths to the shore (about 40 metres long)
- Three shore parallel swims (nominally 20 metres long)

Table 1 provides the GPS coordinates for the survey sites.

The survey included inspections of areas not investigated for the 2010 Worley Parson's survey, namely the deeper offshore seabed and the immediate inshore areas including the caisson footings and the caisson vertical wetted surfaces.

The survey was also required to confirm the absence of seagrass and of the listed pest algae species *Caulerpa taxifolia*. Dive surveys of vegetated aquatic habitats (both rock-based and on structures) were also done to ascertain the suitability of these habitats to support threatened or protected species identified from the database searches.

2.2.1 Survey conditions

The survey day was sunny and the site was sheltered from the light southerly winds on the day. Water clarity was poor to fair for most of the water column, with overall visibility about 1 to 2 metres in surface and mid depth waters increasing to 4 metre visibility in bottom waters

(for seabed depths greater than -12 metres ISLW). These bottom waters were also cooler than mid and surface waters.

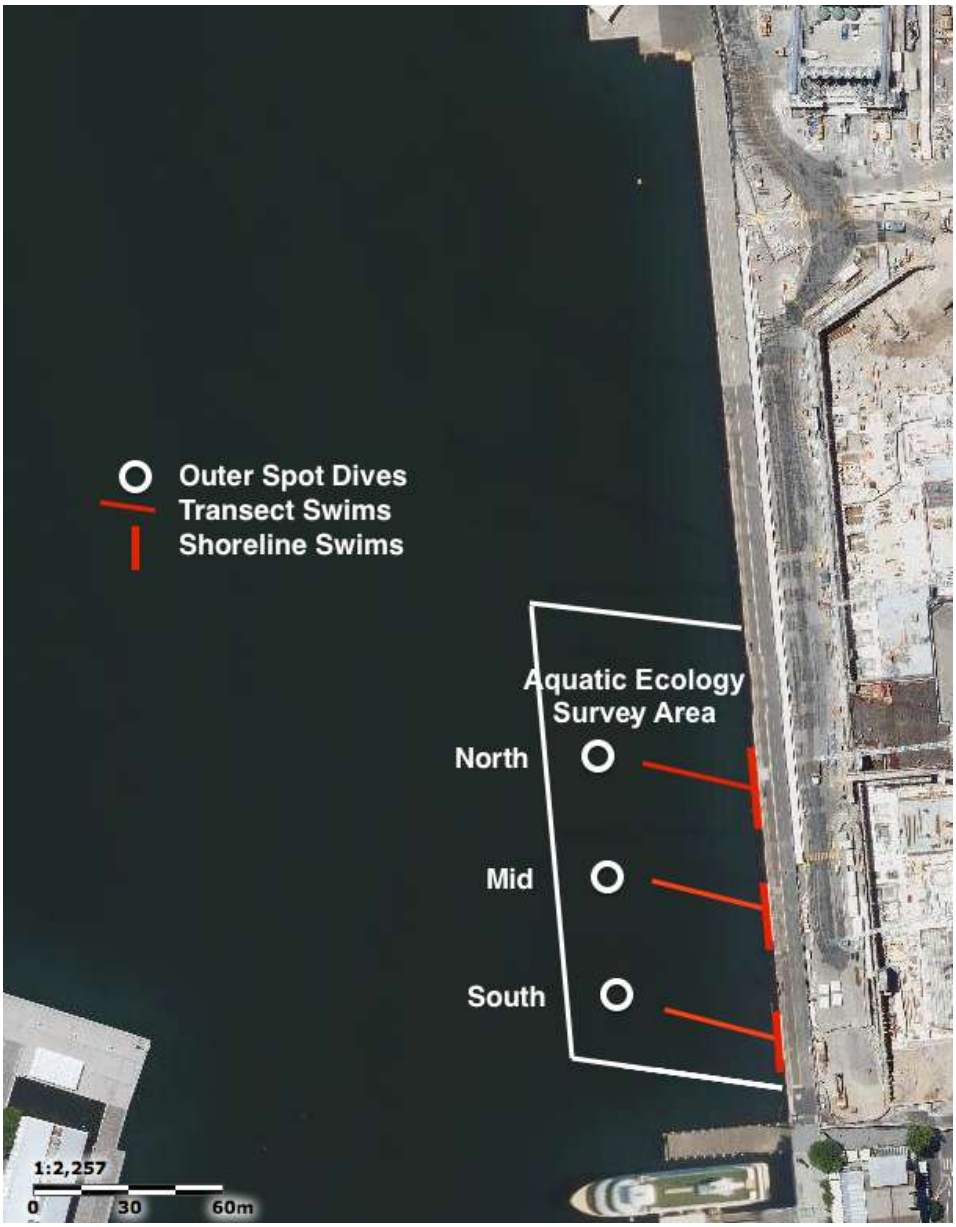

Figure 6 Schematic diagram of aquatic ecology dive survey sites on 14 August 2014.

Table 1 Aquatic Ecology Survey Site GPS Coordinates 14 Aug 2014

Dive Locations	Easting	Northing
Outer Spot Dives		
South	3335538	62512954
Mid	3335350	6251340
North	3335537	6251376
Shore Normal Transect Start Points		
South out	333557	6251297
Mid Out	333554	6251329
North Out	333549	6251367
Mid Point Shore Transects		
South	333607	6251289
Mid	333605	6251335
North	333598	6251368

The main aquatic habitats of the study area are described as follows:

- The original shoreline at Barangaroo has been reclaimed and covered with tarmac. The area is retained by concrete caissons (refer to Figures 7 and 8), set onto basement sandstone rock. The caissons have broad concrete bases that protrude 1.5m out from the main seawall face (refer to Figure 9). The bases are about 0.8 metres high and are set onto exposed basement sandstone rock. The depth at the top of the caisson base is about -10.5 metres ISLW.
- Basement sandstone rock may extend out from the caisson base for a metre or so and there is rock rubble offshore from the basement rock overlaying the silty-sand slope (refer to Figure 10)
- The rock rubble can extend up to about 15 metres offshore from the caisson face but generally extends about 5 metres into Darling Harbour
- There is a generally featureless silty-sand seabed (refer to Figure 11) from the rock rubble out to the -11.5 metre ISLW depth contour (about 35 metres offshore), that matches the seabed description provided from previous surveys (Worley Parsons, 2010) performed in the proposal area
- From the -11.5 metre contour to about the -12.5 metre ISLW contour (about 70 metres offshore) the seabed supports white sea-pens - Order Pennatulacea (refer to Figure 12).

Figure 7 Foreshore at Barangaroo showing concrete caissons with wooden barge boards and chain plus rubber fenders. The metal frames seen in the distance hold the silt curtain off the wharf front. The silt curtain extends to about the 6 metre depth.

Figure 8 Close up of caissons showing unit details.

Figure 9 Each caisson has a broad concrete base and there are gaps of about 5 centimetres wide between each caisson unit with rubber gaskets between the units. The exposed portions of these gaps provide shelter habitat for fish, in this case cardinal fish.

Figure 10 There is a variable width band of rock rubble from the caisson base that extends offshore some 5 metres and up to about 15 metres.

Figure 11 The seabed beyond the inshore rock rubble out to around the -12.5 metre depth contour is flat and generally featureless with burrows of ghost and snapping shrimp prominent.

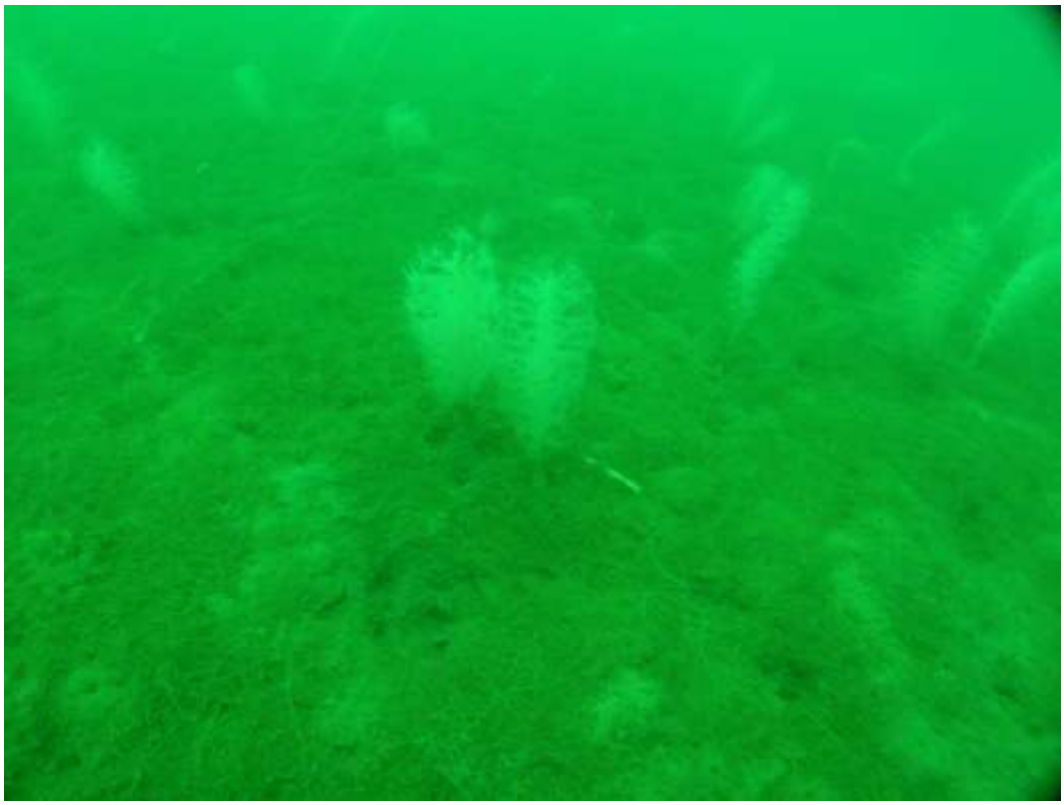

Figure 12 Sea-pens (Order Pennatulacea) on seabed beyond -11.5 metre ISLW depth.

The aquatic ecology of the identified habitats is summarised as follows:

- Barge Boards, Caisson Seawall and Rock Rubble Reef:
  - The intertidal wetted portions of the seawall and barge boards support barnacles, Sydney rock oysters, limpets and green microalgae that is grazed by littorinid snails and periwinkles (refer to Figures 13 and 15).
  - There is a mix of fringing plus frondose algae and tunicates growing on the lower shallow sub-tidal portions of the barge boards (refer to Figure 13). This assemblage would be expected on the caisson shallow sub-tidal fringe but is scattered and less diverse (refer to Figures 16 to 19 as the caisson is partially shaded by the floating silt curtain immediately offshore (refer to Figure 8).
  - The deeper vertical surfaces of the caissons from -4 metre to the base at -10.5 metre ISLW supports a matrix of bryozoa and accumulated silt with various sheet forming sponges, some branching sponges and colonial ascidians (refer to Figures 2o to 22). The assemblages are less complex than the assemblages observed on the King Street Wharf wave baffles. This is likely due to a combination of the greater accumulation of construction related silt trapped on the caisson surfaces, and the lack of wave and wash scouring of accumulate silts, both due to the presence of the floating silt curtain.
  - The caisson base and the rock rubble toe are covered in a thick veneer of fine silt that excludes most biota (refer to Figures 19, 10 and 23) although there were a few isolated encrusting orange and yellow sponges observed. Shell beds near the rock rubble (were also smothered in silt (refer to Figure 24).
  - Small reef fish observed during the survey included cardinal fish and eastern hula fish, always clustered around the crevices between caisson units (refer to Figure 9). Pygmy leatherjackets were observed in the kelp stands and fan bellied leatherjackets were observed feeding along the vertical walls. Predatory fish observed on the caisson walls included luderick and bream.

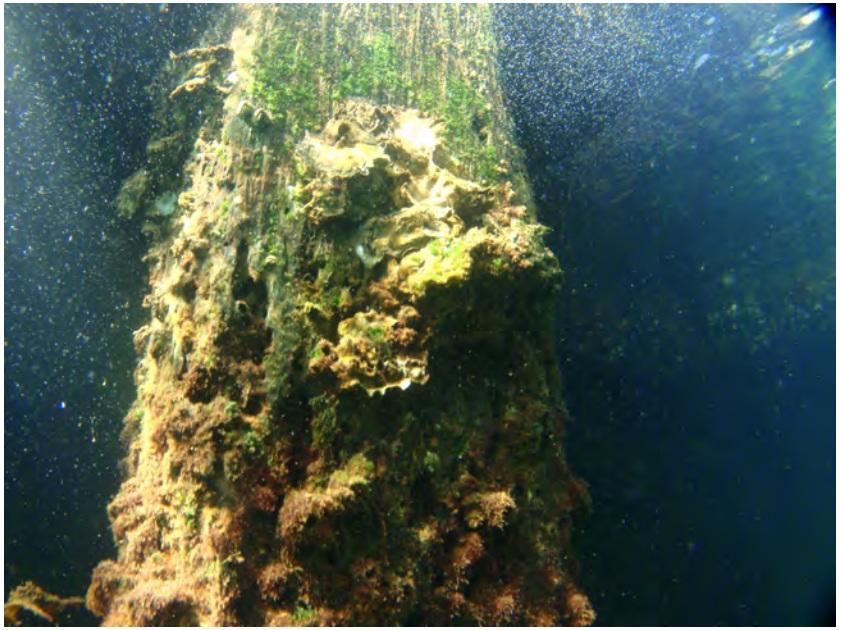

Figure 13 Barge Board Intertidal oyster band.

Figure 14 Barge Board Sub-tidal algae and tunicates.

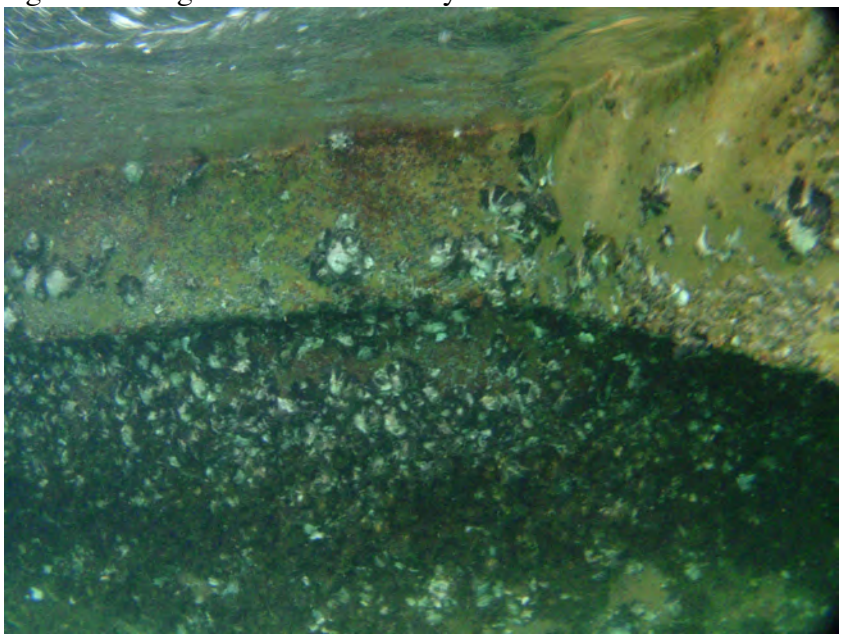

Figure 15 Caisson upper intertidal oysters, limpets and periwinkles.

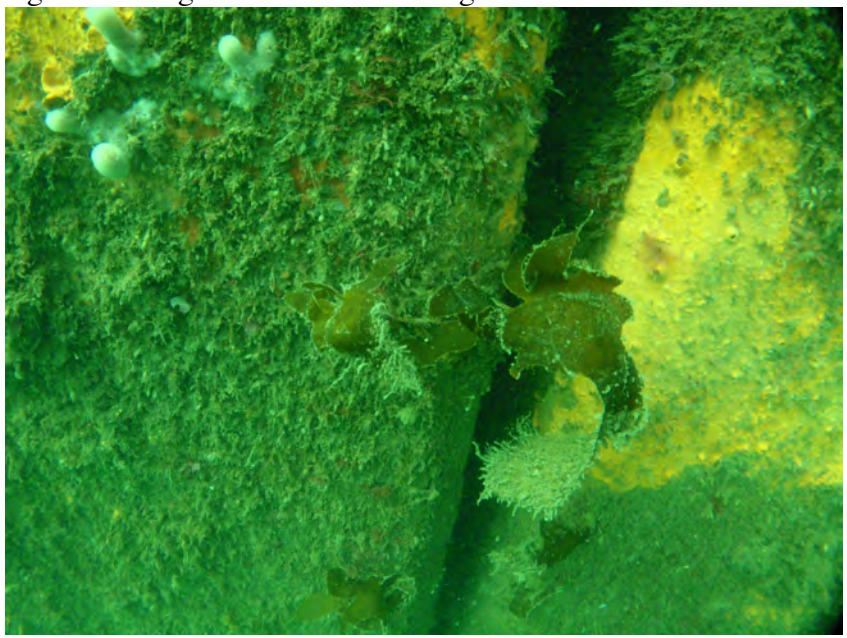

Figure 16 Shallow sub-tidal kelp, *Padina*, sponges and bryozoa.

Figure 17 Kelp and sponge habitat to –4m depth.

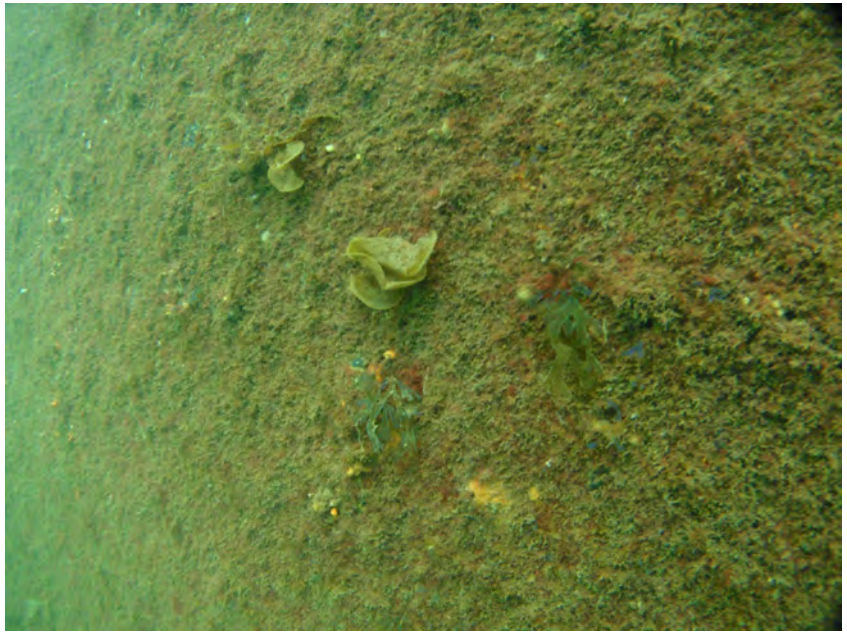

Figure 18 *Padina* and *Dictyota* under kelp canopy.

Figure 19 *Padina* and red bryozoa below kelp canopy.

Figure 20 Mid depth bryozoa and sponge habitat.

Figure 21 Mid depth bryozoa and sponge habitat.

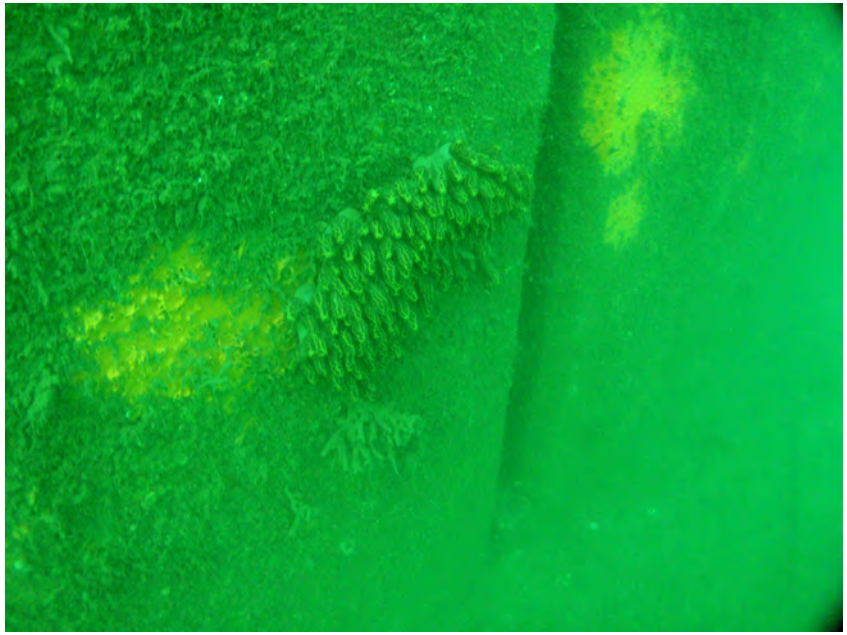

Figure 22 Colonial ascidian near the caisson base.

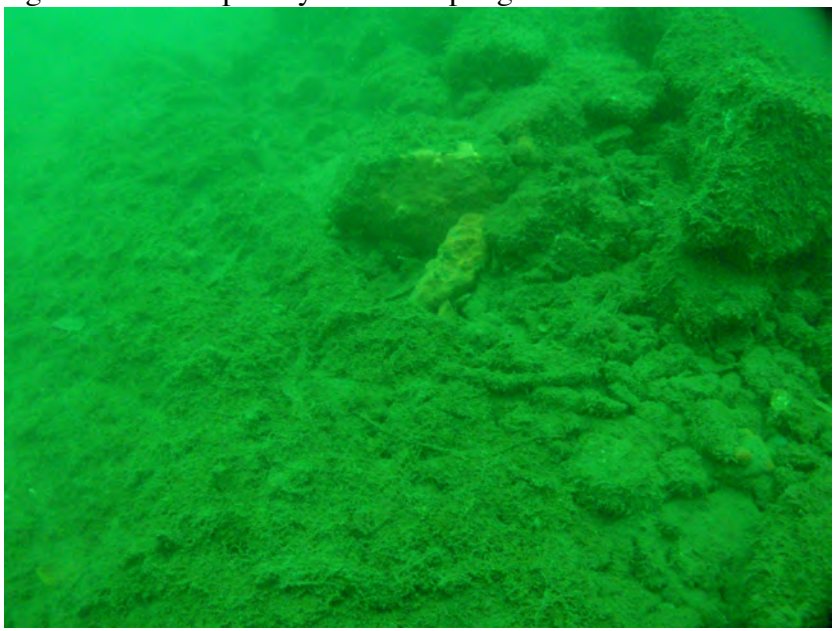

Figure 23 Heavily smothered rock rubble reef habitat

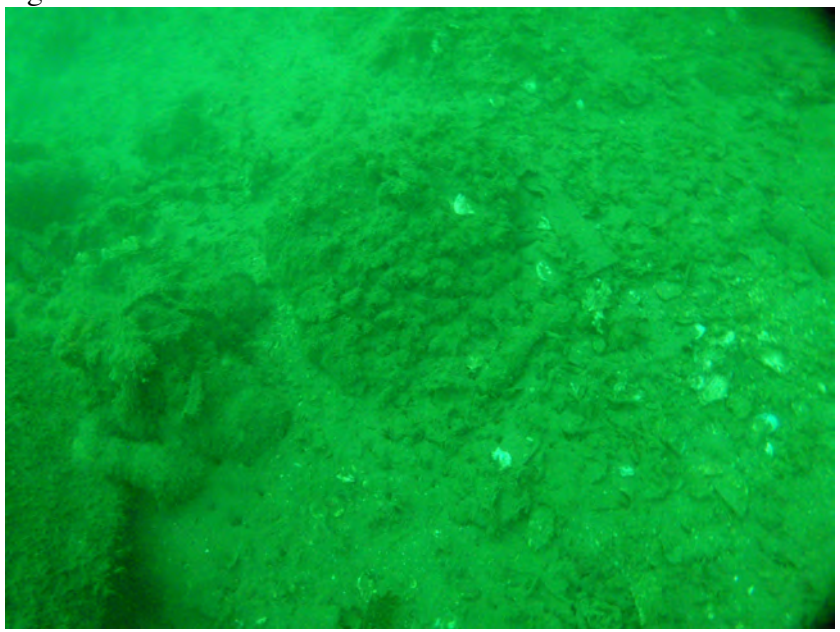

Figure 24 Smothered shell bed.

- There was also a build up of rubbish observed inshore, comprising wood off cuts, various metal objects, bottles and sections of geotextile cloth off cuts. These were also smothered in silt.

- Offshore soft sediment habitat:
  - Immediately beyond the built structures and rock rubble reef the sediment seabed supports benthic biota as indicated by the presence of burrows (mainly ghost and snapping shrimp), with sea-pens occurring further off-shore (refer to Figures 11 and 12). Other fauna observed were several sand anemones (in inshore sediments), a sea-star (in the rock rubble) and several flounder.
  - Worley Parsons (2010) collected sediment samples from the inshore sediments between the rock rubble and the sea-pen beds for benthic fauna analysis including, 120 individuals from 23 taxa of benthic fauna comprising 15 polychaete worm taxa (for 72 per cent abundance), four decapod crustaceans (22 per cent abundance) and 12 other taxa (10 per cent abundance). Molluscs were conspicuously absent with the only mollusc found being a sea-slug that is known to predate on sea-pens. Results are provided in Table 2.
  - Capitellid polychaete worms and Callianassid yabbies were the most common and most abundant, with the Capitellid worms accounting for 35 per cent of total abundance and the yabbies accounting for16 per cent abundance.

Table 2 Benthic Assemblages in Seabed Sediments at Barangaroo (from Worley Parsons 2010)

		Occurrence and Abundance of Biota in Replicate Sediment Samples													
Class or Order	Family or Species	BG1-1	BG1-2	BG1-3	BG2-1	BG2-2	BG2-3	BG3-1	BG3-2	BG3-3	BG4-1	BG4-2	BG4-3	Occur	Abund
Polychaeta	Cirratulidae		1						1					2	2
Polychaeta	Lumbrineridae						2				1			2	3
Polychaeta	Nephtyidae						1							1	1
Polychaeta	Pilargidae						1				1			2	2
Polychaeta	Syllidae			1										1	1
Polychaeta	Oweniidae				1							1		2	2
Polychaeta	Sigalionidae												1	1	1
Polychaeta	Spionidae					1		1	1	1		1		5	5
Polychaeta	Terebellidae		1		5	1	2		2					5	11
Polychaeta	Hesionidae										1			1	1
Polychaeta	Chaetopteridae						1	2		2	2	1		5	8
Polychaeta	Capitellidae				6	10	7	3	6	6	1	3		8	42
Polychaeta	Maldanidae			1	2						1			3	4
Polychaeta	Opheliidae	1												1	1
Polychaeta	Orbiniidae	1						1						2	2
Decapoda	Callianassidae	1		3		1	1	5	4	3			1	8	19
Decapoda	Alpheidae		1											1	1
Decapoda	Xanthidae								1					1	1
Decapoda	Brachyura sp.a								1					1	1
Bryozoa	Cheilostomata spp.	1												1	1
Gastropoda	Philinidae										1			1	1
Nemertia	Hoplonemertea spp.					1	3	1	2	1				5	8
Platyhelminthes	Digenia sp		2											1	2
	No Taxa	4	4	3	4	5	8	6	8	5	7	4	2		23
	Abundance	4	5	5	14	14	18	13	18	13	8	6	2	120	

Specific searches were also made for syngnathids (seahorses and the like), with particular reference to White's seahorse, which is known from the Balmain foreshore, particularly amongst kelp forest, however no syngnathids were found or observed. It is concluded that there was insufficient suitable shelter and feeding habitat on the caisson vertical surfaces and no suitable habitat on the rock rubble.

With regard to the Fisheries NSW waterway classification scheme in the Policy and Guidelines document (NSW Fisheries 2013), Darling Harbour is a Class 1 "Major key fish habitat" (KFH) by virtue of it being an estuarine waterway. In regard to the sensitivity classification of the specific habitats within the study area (as defined in Table 1 of Fisheries NSW 2013):

- There are no Type 1 "highly sensitive KFH" at or in the study area or in the immediate vicinity.
- Whilst not natural habitats, the proliferation of kelp and other shallow sub-tidal algae on wetted surfaces of caissons and associated barge boards could be considered Type 2 "moderately sensitive KFH" by virtue of the presence of the macroalgae species *Ecklonia* (kelp) and *Sargassum spp*.
- The un-vegetated rubble toe and silty-sand and shell habitats are Type 3 "minimally sensitive" KFH.

In summary, the existing aquatic habitats at Barangaroo (including the King Street Wharf wave baffle) currently support (or are capable of supporting) a diverse encrusting and attached biota on the vertical hard substratum habitats (caisson walls, wave baffles and piles) including marine algae, a limited diversity of biota on rock rubble habitats (by virtue of smothering silt), and a reasonably diverse benthic biota in the seabed sediments (possibly limited by accumulated sediment contaminants).

No threatened or protected aquatic species as listed under the FM Act, TSC Act or EPBC Act were found at the site and none are expected (refer to Section 2.1 for additional consideration of possible threatened and protected species). There is no marine vegetation (seagrass or marine algae) on the rock rubble reef of the sediment seabed and none is expected by virtue of the low light penetration to these habitats. The pest algae species *Caulerpa taxifolia* was also not present. It was not found during the Worley Parsons (2010) survey or the MPR (2013) survey and it is also not expected at the site due to low light penetration to the seabed.

Prior to the closure of Sydney Harbour to commercial fishing, prawn trawling occurred in the main river channel well away from the existing facilities. There are now no commercial fishing operations and there are no aquaculture activities in Darling Harbour. Consequently the proposal would not have any impact on commercial fishing operations or aquaculture activities.

3 IMPACT ASSESSMENT AND MITIGATION

With regard to the assessment of possible direct construction related aquatic ecological impact, the proposal would involve installation of support piles for the link structure and gangways, for the ferry arrester structures, and locator piles for each of the pontoon wharves. The proposal potentially requires the removal of the King Street Wharf wave baffle piles and structure.

Potential construction related impacts include a reduction in water quality caused by piling operations (installation and removal) and from sediments disturbed by vessel wash, and potential impact from spillages or disposal of construction related materials (fuel and oil spills, wood and plastic off-cuts, plastic wrapping materials).

The main potential impacts on aquatic ecosystems from operation of the Barangaroo Ferry Hub are:

- The possibility of shading existing marine algae habitats.
- The possibility of disturbance of inshore habitats or seabed sediments from ferry wash
- The risk of spillages from fuelling, pump-out operations or minor maintenance work

These potential impacts and mitigation measures are considered further below.

3.1 King Street Wharf Wave Baffle Demolition

The previous impact assessment for the removal of the King Street Wharf wave baffle (MPR 2013) provides impact assessment and mitigation measures for the removal of the decking and wave baffle structures (refer to Annexure A), but did not consider the impacts of removal of remaining wharf support and fender piles. This aspect of the King Street Wharf wave baffle demolition is addressed here below.

Removal of piles for the King Street Wharf wave baffle would be facilitated using a vibratory hammer operated from a barge-mounted crane to extract the piles. If a pile is unable to be pulled out, divers would cut the pile off at seabed level with the pile removed for appropriate land disposal.

The piles that are to be removed are located in deep unvegetated sediment habitat, and whilst there would be pulse turbidity events associated with the piling works there would be no significant impact on sediment benthic communities arising from these works. It is known from observations that disturbed sediments would be highly localised in the bottom waters around the pile removal or placement site and that sediments would rapidly re-settle (Knot and Johnston 2010).

Given the short pulse nature of bottom sediment disturbance during pile removal operations and the equally rapid settlement of the sediments, it is also concluded that there are no significant impacts of pile removal in respect to there being a low risk of sediment contaminants being mobilised into the water column. Rather, sediment contaminants are more likely to stay firmly bonded to the fine particulate and organic materials making up the sediments and rapidly re-settle.

3.1.1 Pile Removal Mitigation Measures

The residual risk of turbidity plumes associated with removal of piles at the King Street Wharf wave baffle can be mitigated by placement of silt curtains between the inner piles and the shore to protect remaining seawall and rock toe hard substratum habitats from potential smothering or excessive turbidity.

3.2 Barangaroo Ferry Hub Construction and Operation

A summary of the construction activities associated with the Barangaroo Ferry Hub proposal is detailed in Section 1.1 and Figure 25 provides a schematic diagram of ferry operations at the proposed Barangaroo Ferry Hub.

3.2.1 Construction Impacts

The main construction activity that has a direct impact on aquatic habitats is the placement of piles for the ferry link structures and ferry arrestor systems. The piles would be placed into bare sediment seabed with the inner piles placed into shallow sediments that may support some rock rubble at depths between -11m and -12 metre ISLW. The pontoons would be located over sediment seabeds at -12 to -12.5 metre ISLW water depths and the outer pontoon locator piles would be in water depths around -12.5 metre ISLW.

3.2.2 Construction Mitigation

Management of impacts associated with piling activities are considered as follows:

- With regard to the piles being placed into bare seabed sediments, given the large expanses of these sediment habitats throughout the area, the loss of benthic habitat is considered negligible. Further, there would be a net gain in overall aquatic habitat in the study area by virtue of the wetted surfaces on the piles that are available for colonisation by attached and encrusting biota including marine algae. These assemblages are likely to be similar to the assemblages on piles at King Street Wharf wave baffle and at West Pyrmont Ferry Wharf, and would provide a net beneficial increase in feeding and shelter habitat for small reef and juvenile fish (MPR 2013, 2014).
- The piles that are to be placed are all located in deep unvegetated sediment, and whilst there may be pulse turbidity events associated with the piling work there would be no significant impact on sediment benthic communities arising from this work, as it is known from observations that disturbed sediments would be highly localised in the bottom waters around the pile removal or placement site and that sediments would rapidly re-settle (see also Knot and Johnston 2010).
- Given the short pulse nature of bottom sediment disturbance during piling operations and the equally rapid settlement of the sediments, it is also concluded that there is a low risk of sediment contaminants being mobilised into the water column. Rather, sediment contaminants are more likely to stay firmly bonded to the fine particulate and organic materials making up the sediments and rapidly re-settle.
- As there are no marine vegetated habitats and the only rock habitat is smothered by silt, there would be no risk to these habitats from the use of anchors, mooring blocks and other apparatus for undertaking the construction work. Given the water depths at the site there is a low risk of seabed sediment mobilisation from construction related vessel wash and propeller thrust that can be mitigated by ensuring that contractors are instructed to not use excessive thrust when manoeuvring vessels in shallower waters near shore.
- The risks of spillages of liquids and solids from the construction work can be managed by a combination of normal best-practice to be specified in the Construction Environmental Management Plan (CEMP) for the proposal and would include information about the threat posed to marine biota (fishing birds, marine mammals and fish) of ingestion and throttling from discarded garbage and in particular from plastic wrapping materials and plastic off-cuts (such as hosing, jetty fenders, electrical wiring).

3.2.3 Operational Impacts

With respect to the possible operational impact from use of the Barangaroo Ferry Hub on the aquatic ecology of the locality, there is a net beneficial impact expected from the provision of the facility at this location in regard to losses and gains of aquatic habitat to shading.

The removal of the King Street Wharf wave baffle would eliminate shading impact on the adjacent seawall, which would be recolonised by algae in the shallow sub-tidal zone. The three proposed fixed gangways would shade portions of the caisson seawall which could limit or prevent growth of macroalgae on these portions of wall. However, as the offshore floating silt curtain currently shades most of the seawall there is a low risk of **actual** loss of *existing* macroalgae habitat.

Removal of the King Street wharf wave baffle support piles and fender piles (should it occur) would also remove hard substratum habitat. This would be balanced by the new piles required for the ferry hub wharves and ferry arrestor structures, with a net increase in hard substratum habitat. Further, there would be a large net increase in the available wetted surface areas suitable for colonisation by macroalgae and other encrusting and attached biota arising from the increase in floating pontoon wetted surfaces:

- On the basis that macroalgae can grow to -4 metre depth (this study and the MPR (2014) West Pyrmont Wharf study), each pile used for the proposal could provide up to 6.3 square metres shallow sub-tidal habitat, each pontoon would provide up to 106 square metres vertical shallow sub-tidal habitat along the pontoon sides, all potentially available for macro-algae colonisation.
- The undersides of the pontoons and a further 4 metre pile length below the shallow sub-tidal zone could provide an additional 6.3 square metres encrusting fauna habitat per pile and 690 square metres encrusting fauna habitat per pontoon.
- The net increase in available hard substratum algae and attached biota habitat would provide increased shelter and feeding habitat for small reef fish and for the larger pelagic fish that prey on these reef fish.

In regard to the potential aquatic ecology impacts from ferry wash:

- The overall depths at the site (all > 10.5 metre ISLW) means that there is only low risk of bottom sediment disturbance from ferry manoeuvring in and out of the berths or transiting the site.
- With regard to wash directed towards the caisson walls, ferries would create wash when manoeuvring to the wharves, which may contact the piles, arrestor systems, pontoon and seawall. For less direct was there would be a low risk of dislodging attached biota from the walls or dislodging cryptic fauna. In fact, the residual wash currents would more likely provide a beneficial impact in dislodging loose silts that can accumulate on these habitats in still waters.
- For vessels using the layover berths, the wash is directed at the arrester systems which would reduce wash reaching the seawalls. Biota colonisation of surfaces would be adapted to the conditions. For example, biota on the arrester baffles would be exposed to higher wash action and this may result in an overall more wash resilient biota colonising these surfaces which is also known to occur at Pyrmont Bay Wharf (MPR 2014)).

The risks of spillages of liquids and solids from fuelling, pump-out and maintenance work can be managed by a combination of normal best-practice, to be detailed in policies and procedures for the operation of the Barangaroo Ferry Hub , and that would also include information about the threat posed to marine biota (fishing birds, marine mammals and fish) of ingestion and throttling from discarded garbage and in particular from plastic wrapping materials and plastic offcuts (such as hosing, jetty fenders, electrical wiring).

Figure 25 Schematic showing indicative vessel movements for operation of the Barangaroo Ferry Hub

3.3 Fisheries Management Act Permit and Habitat Protection Requirements

Section 7.1 of the Fisheries NSW Policy and Guidelines (Fisheries NSW 2013) states that there must be *no net loss of fish habitat* and Section 3.3.3 of the Policy and Guidelines notes that under the Fisheries Management Act 1999 (FM Act) Section 220, there are a number of activities available that can be used to mitigate damage to fish habitat:

- *Habitat rehabilitation* is defined as repairing damage caused by past activities, and *environmental compensation* is defined as the creation or enhancement of fish habitats or fisheries resources in order to compensate for anticipated adverse or actual environmental effects of proposed developments. Habitat rehabilitation can be either passive or active. After the removal of the damaging or inhibiting factor or structure some habitats can be left to passive natural processes to rehabilitate the area.
- *Environmental compensation* (where required) must consider the representativeness and value of different types of habitats and compensation for Type 1 to 3 key fish habitat must be calculated on a minimum 2:1 basis (Policy and Guidelines Section 3.3.3.2).

For the Barangaroo Ferry Hub proposal, the aim of *no net loss of fish habitat* would be achieved by the addition of hard substratum habitat in the form of the wetted surface areas of piles and floating pontoon wharves that increase the overall habitat complexity in the locality, increase the available habitat for marine algae and results in an increase in fish feeding and shelter habitat.

Part 7 of the FM Act sets out the conditions under which permits are required for various construction activities, and the conditions under which a permit may be granted are specified in the Fisheries NSW Policy and Guidelines (Fisheries NSW 2013). As this is a State Significant Infrastructure project under s115ZG of the Environmental Planning and Assessment Act 1979, the operation of s201 of the FM Act which normally requires permit approval for these activities does not apply. With respect to estuarine activities, the Minister's concurrence is required for reclamation or dredging work, for the taking or harming of marine vegetation or for relocating fish:

- The present proposal (including the potential removal of the King Street Wharf 10 wave baffle) does not include dredging or reclamation.
- There is no direct or indirect impact on marine vegetation arising from the proposed work and, the proposal would result in a net gain of macroalgae hard substratum habitat.

3.4 Sydney Region Environmental Plan (Sydney Harbour Catchment) 2005

Clause 21 of the SREP (Sydney Harbour Catchment) outlines nine criteria for biodiversity, ecology and environmental protection:

17(a) Need for development to have a neutral or beneficial effect on water quality entering the waterway.

Provided construction work utilises best management practice for the King Street Wharf wave baffle demolition and for the ferry hub construction in regards to containing liquid and materials runoff from the construction activities, water quality impact would be minimal and temporary and there is a low risk of water quality impacts rising from the operation of the Barangaroo Ferry Hub.

17(b) Need for development to protect and enhance terrestrial and aquatic species, populations and ecological communities and, in particular, should avoid physical damage and shading of aquatic vegetation (such as seagrass, saltmarsh and algal and mangrove communities).

The only marine vegetation at the site is located on the seawall and the proposal would result in an increase in hard substratum habitat suitable for colonisation by marine algae.

Marine mammals, reptiles and aquatic or migratory birds are unlikely to utilise the aquatic resources of the site either on a transient or opportunistic basis and would not be impacted, as there is abundant alternate or equivalent habitat throughout the harbour.

There is no terrestrial habitat that would be impacted by the proposal.

17(c) Need for development to avoid indirect impacts on aquatic vegetation as a result of increased access.

There would be no increased access to aquatic habitats at the site arising from the development as vessels already use all parts of Darling Harbour.

17(d) Need for development to avoid indirect impacts on aquatic vegetation (such as changes to flow, current and wave action and changes to water quality) as a result of increased access.

Given the water depths and scale of the proposal there would be no changes in tidal flow or currents. Wave action from passing vessels would be dampened along the shore. There would be no changes to water quality arising from the proposal.

17(e) Need for development to protect and reinstate natural intertidal foreshore areas, natural landforms and native vegetation.

There are no natural inter-tidal foreshore areas, natural landforms or native vegetation), as this is a reclaimed and paved site.

17f) Need for development to retain, rehabilitate and restore riparian land.

The total riparian shore at this location comprises reclaimed land behind revetment walls. The proposal does not include any work on natural riparian lands and thus does affect existing riparian land.

17(g) Need for development on land adjoining wetlands to maintain and enhance the ecological integrity of the wetlands and where possible to provide a vegetative buffer to protect wetlands.

The DCP for the Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005 indicates that there are no designated wetlands at or in the near vicinity of the study area.

17(h) Need to assess the cumulative environmental impact of the development.

Assessment of the proposal on the aquatic environment provided above indicates that as colonisation of new wetted surfaces of the piles and pontoons occurs there would be a substantial increase in hard substratum habitat, which is considered a beneficial impact. The proposal is some distance from other projects being undertaken as part of the Roads and Maritime Services Sydney Harbour Commuter Wharf Upgrade Program, and no other relevant maritime projects are known of, therefore no additional cumulative impact is anticipated.

17(i) State whether sediments in the waterway adjacent to the development are contaminated, and what means will minimise their disturbance.

The available studies of inshore sediments along the foreshore of Barangaroo indicate that there are elevated levels of hydrocarbons, heavy metals and PAH that are similar to sediments throughout the harbour. As there would only be piling impact disturbance of sediments arising from construction work with rapid settling after disturbance, there are not

expected to be any measurable release of contaminants from sediments to the water column but rather a resettling of sediments, with chemical contaminants generally remaining bound within sediment mineral and organic complexes. Given that the depths in the study area are greater than 10.5 metres there is a negligible risk of seabed sediment disturbance from vessel use of the proposed Barangaroo Ferry Hub.

3.5 Recommended Mitigation Measures

The Barangaroo Ferry Hub proposal would achieve the aim of *no net loss of fish habitat* by the implementation of appropriate construction mitigation measures. Potential impact can be mitigated to insignificance by the use of best practice construction management procedures incorporated into a CEMP for the proposal that includes the following precautions:

- Potential removal of piles at the King Street Wharf wave baffle would require placement of silt curtains between the inner piles and the shore to protect remaining seawall and rock toe hard substratum habitats from potential smothering or excessive turbidity.
- For piling activities floating silt curtains should be used to limit the potential spread of visible turbidity plumes. Placement of piles for the ferry hub are likely sufficiently remote from the rock rubble toe habitat under the boardwalk to not require full-length silt curtain containment.
- There should be no stockpiling of demolition or construction materials on the seabed.
- The potential for materials and liquids to be accidentally spilt into the waters would be minimised by the use of best practice construction management procedures as specified in a CEMP. These should include (but not be limited to):
    - Emergency spill kits will be kept on-site (on each barge and at the temporary construction compound site) and would be maintained throughout the construction work. The spill kits must be appropriately sized for the volume of substances at the work site and specific to the marine environment.
    - All staff will be made aware of the location of the spill kits and trained in their use.
    - If a spill occurs, the TfNSW Contract Manager and TfNSW environment staff will be notified as soon as practicable
    - Equipment barges (carrying plant, machinery, fuels or chemicals) will be bunded to contain any accidental chemical spills or leaks.
    - Any chemicals or fuels stored at the temporary construction compound will be within double bunded areas.
    - All equipment, materials and wastes transported between an off-site facility, and the construction work site will be secured to avoid spills during transportation.
    - Vehicles, vessels and plant will be properly maintained and regularly inspected for fluid leaks. Regular visual checks for signs of spills (e.g. oily slicks) will be undertaken, at least daily, during the works.
    - No vehicle or vessel wash down will occur on-site during construction.
- A CEMP for the proposal is to include information about the threat posed to marine biota (fishing birds, marine mammals and fish) of ingestion and throttling from discarded garbage and in particular from plastic wrapping materials and plastic off cuts (such as hosing, jetty fenders, electrical wiring).
- All demolition materials and collected construction garbage are to be removed off-site for appropriate disposal.

As the Barangaroo Ferry Hub is to be used for vessel layovers, pump-out and minor maintenance, the proposal would require policies and procedures for the operation of the

Barangaroo Ferry Hub. These policies and procedures should include the following precautions:

- Operational procedures and policies will include measures to avoid the risk of spillages of liquids and solids from pump-out and maintenance work can be managed by a combination of normal best-practice, to be detailed in the project operational environmental management plan (OEMP), and that would also include information about the threat posed to marine biota (fishing birds, marine mammals and fish) of ingestion and throttling from discarded garbage and in particular from plastic wrapping materials and plastic offcuts (such as hosing, jetty fenders, electrical wiring)..

4 CONCLUSIONS

It is concluded that the demolition and complete removal of the King Street Wharf wave baffle and the construction and operation of the proposed Barangaroo Ferry Hub would result in negligible losses of sediment benthic aquatic habitat and organisms to construction and a long-term gain in available hard-substratum marine vegetation (algae) habitat post-construction:

- Benthic organisms would be disturbed or lost to piling operations and new encrusting assemblages would colonise wetted surfaces of piles and pontoons for the new facility.
- Disruption to fish assemblages of the seawall and at adjacent wharves would be negligible.
- The shading impact associated with the proposal is low and there would be a substantial increase in habitat available to support marine algae growth.
- Possible impact arising from the proposed construction work and from operation of the new facilities can be satisfactorily mitigated by appropriate best-practice construction, demolition and operational safeguards as outlined in the report.

On balance, there would be a net beneficial impact from the Barangaroo Ferry Hub proposal as there would be no net loss of aquatic habitat to construction and in the medium to long term, there would be a beneficial impact for reef fish assemblages utilising the additional marine assemblages attached to the wetted surfaces of the new piles and pontoons.

The construction of the Barangaroo Ferry Hub proposal can be managed to satisfy the aquatic ecology conservation requirements of the SREP (Sydney Harbour Catchment) 2005 and the aquatic ecology and fish habitat conservation requirements of the Fisheries Management Act 1994 as set out in the Fisheries NSW Policy and Guidelines (NSW Fisheries 2013) to ensure that there would be *no net loss of fish habitat.* The proposed work will not require any permits under the Fisheries Management Act 1994.

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ANNEXURE A

PROPOSED REFURBISHMENT OF KING ST WHARF 10

JETTY

REVIEW OF ENVIRONMENTAL FACTORS:

PROPOSED REFURBISHMENT OF KING STREET WHARF 10 JETTY

- AQUATIC ECOLOGY ASSESSMENT

Figure 1 View of Wharf 10 Jetty, King Street Wharf looking south.

Report Prepared for Brookfield Multiplex

Marine Pollution Research Pty Ltd

July 2013

MARINE POLLUTION RESEARCH PTY LTD

Marine, Estuarine and Freshwater Ecology, Sediment and Water Quality Dynamics

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REPORT TITLE:	Review Of Environmental Factors: Proposed Refurbishment, King Street Wharf 10 Jetty - Aquatic Ecology Assessment
CLIENT & CONTACT:	Mr Michael Hamilton, Design Manager Brookfield Multiplex
MPR REPORT No:	MPR 979
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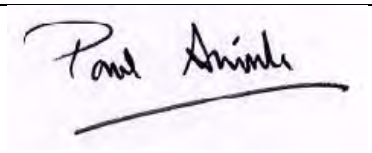
MPR APPROVAL: PAUL ANINK	 **25 January 2014**

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TABLE OF CONTENTS

REPORT FIGURES

ANNEXURE A FIGURES

ANNEXURE B

1 INTRODUCTION

Roads and Maritime Services NSW (RMS) proposes to refurbish the fixed timber jetty at Wharf 10, King Street Wharf, Darling Harbour (the proposal). Brookfield Multiplex is managing the refurbishment and Marine Pollution Research Pty Ltd (MPR) has been requested to provide an Aquatic Ecology Impact Assessment Report.

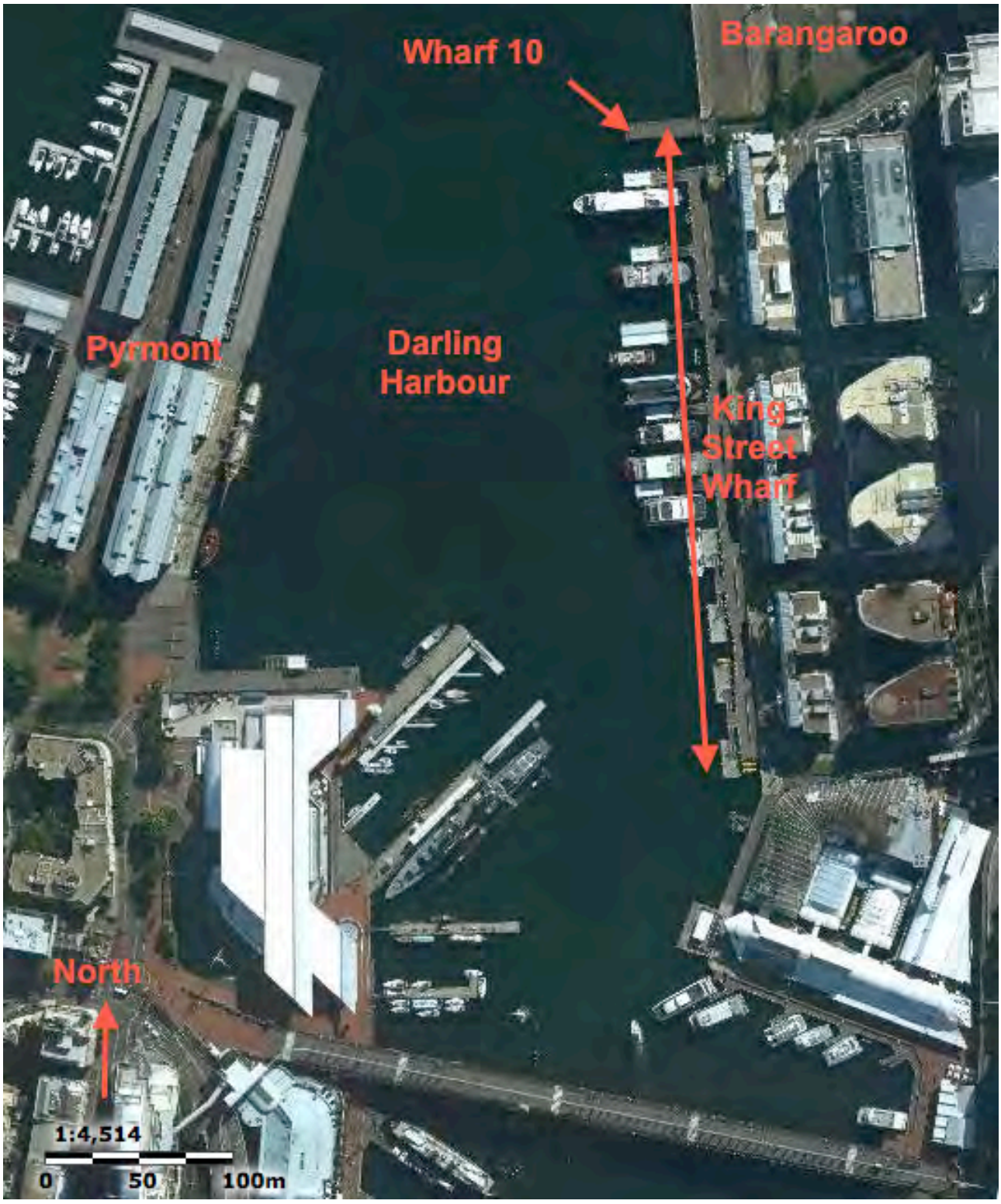

Figure 2 Aerial view of Darling Harbour showing the location of Wharf 10

This report assesses the aquatic ecology of the wharf site, considers the likely impacts on the aquatic ecology of wharf refurbishment operations, and provides possible impact mitigation measures where necessary.

1.1 Site Details

The Wharf 10 jetty is at the northern-most end of King Street and abuts the southern end of the Barangaroo (see Figures 1 and 2). The jetty is a fixed wood and steel structure supported on steel piles with wooden fender piles along the wharf edges. The present wharf structure includes concrete wave baffle panels running east to west under the wharf centreline held in place by vertical steel "H" beams set in rock at the seabed and supported by the wharf deck structure above. Two of the outer panels and the three H beams can be seen in Figure 3.

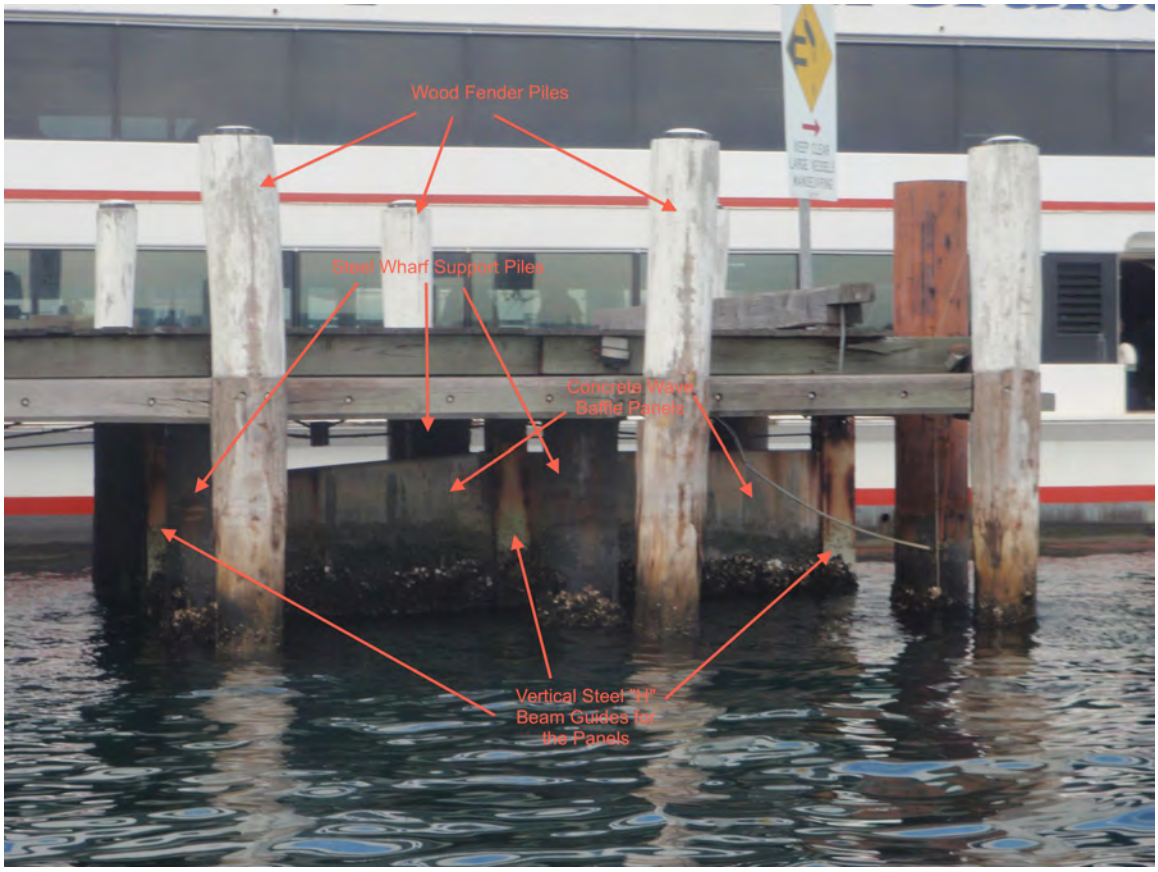

Figure 3 Outer section of Wharf 10 Jetty showing two suspended wave baffles

The concrete wave baffles shown in Figure 3 are supported off the seabed by steel rods under the wharf decking, but for most of the other baffles the steel rods have given way and the concrete baffles have settled onto the seabed, held in place vertically by the "H" beam piles. Figure 4 shows another section of the wharf with a partially supported wave baffle panel and a number of support rods hanging from the wharf deck underside.

Figure 4 Middle Section of Wharf 10 Jetty showing a partially supported concrete wave baffle and a number of broken tie rods.

King Street Wharf Jetty 10 is built out from a reclamation that is held in place by a sandstone rock and concrete retaining wall (Figure 5) and the soft sediment seabed beyond the retaining wall is more or less level, having been dredged in the past. Dredged depths are around 10.2 to 10.3m below chart datum (Indian Spring Low Water ISLW).

As Wharf 10 Jetty is the northern (outermost) jetty for the King Street wharves it bears the brunt of wind waves from the north (2.8km fetch to Berrys Bay, North Sydney) and north-west (1.1km fetch to the water police base at Balmain) plus wash and wakes from vessels transiting the harbour north of the Harbour Bridge or transiting Darling Harbour. Given the large number of commercial and recreational boating facilities catering for cruise liners, local tour operators, fishing vessels, service vessels, private vessels and ferries in Johnsons Bay, White Bay, Rozelle Bay, Blackwattle Bay and Darling Harbour, the waters around the wharf are generally in constant motion, at least during daylight and evening hours.

There is a stormwater outlet just to the north of the wharf that is currently being upgraded as part of the Barangaroo construction project. There are no commercial fishing operations or aquaculture activities in the vicinity of the proposal.

Figure 5 View of sandstone and concrete retaining wall at the shore-end of Wharf 10 Jetty. The floating boom and construction fencing to the left side of the wharf are part of the Barangaroo construction works, and there is a stormwater outfall to the left of the jetty.

1.2 The Proposal

For the purposes of aquatic ecology impact assessment the project includes the following:

- Removal and storage of timber decking and girders.
- Removal of all components of the existing wave barrier (rod bracing, concrete barrier units, H beam locator piles) for re-use or disposal elsewhere, as appropriate.
- Installation of two raker-pile sets (four piles in total).
- Installation of pre-fabricated steel cross bracing.
- Reinstatement of a section of steel headstock to pile at the north-western corner.
- Installation of temporary scaffolding to enable painting of steelwork (headstocks).
- Reinstatement of the timber girders and decking.
- Divers to clean off steel pile heads, apply a primer and protective petrolatum wraps to the piles followed by protective jackets secured with straps.

Detailed engineering plans and steel maintenance coating specifications for the Wharf 10 refurbishment proposal have been prepared by Robert Bird Group (2012a,b).

1.3 Available Information on Aquatic Habitats

The aquatic ecological communities known from the location are shown on Map 8 for the Harbour Foreshores and Waterways Area Development Control Plan 2005 (DCP), a portion of which is shown here as Figure 6. The closest identified habitats are rock rubble revetments to the north-west at White Bay Terminal and in Cameron Cove, being 'rock intertidal and rock platform habitat (shown as dark purple).

Figure 6

Portion of the DCP Map 8 for Johnsons Bay and Darling Harbour showing 'rock intertidal and rock platform' habitat (dark purple) in Camerons Cove and around the eastern end of the White Bay Terminal.

A portion of Sheet 10 for the Sydney Regional Environmental Plan (Sydney Harbour Catchment) 2005) is shown as Figure 7 and it indicates 'wetlands' in Camerons Cove and around White Bay Terminal that coincide with the dark purple "rocky intertidal and rock platform" habitat shown in Figure 6. There are additional designated wetlands indicated to the north at the end of Barangaroo.

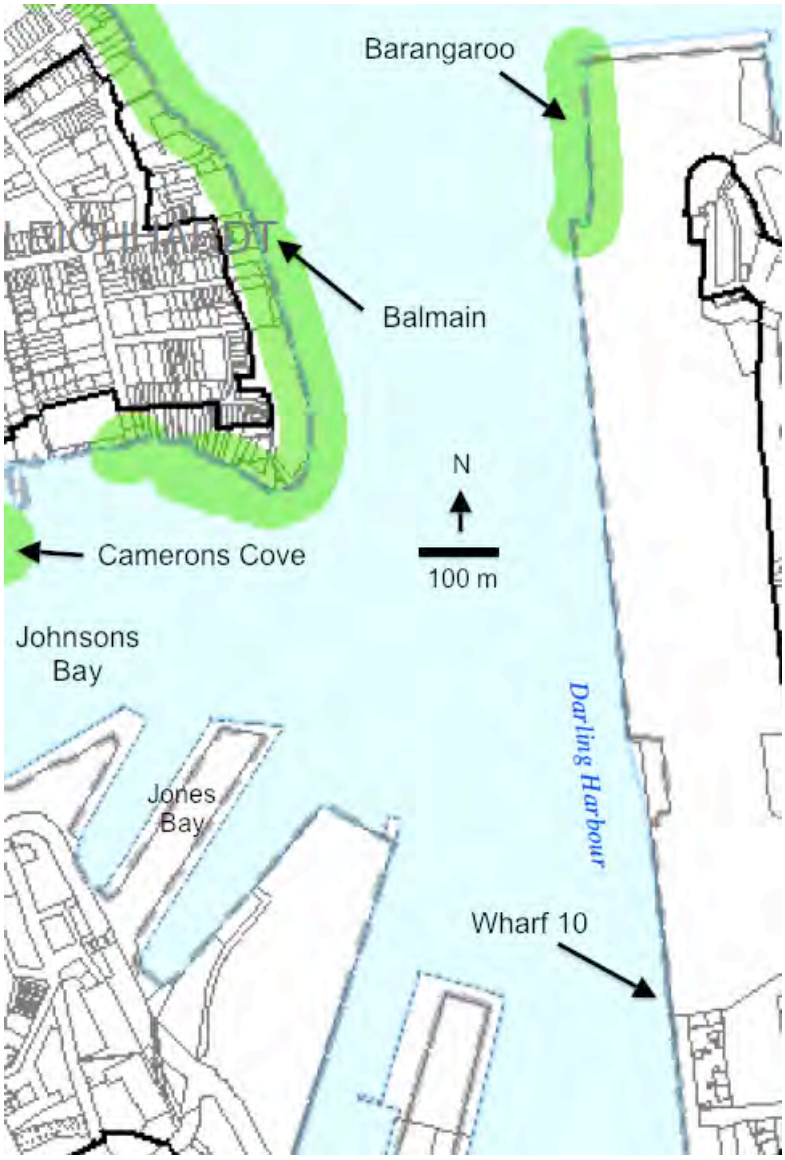

Figure 7 Portion of SREP (Sydney Harbour Catchment) Wetlands Protection Area Sheet 10 showing designated 'wetland' areas (green) around Johnsons Bay and Darling Harbour.

Recent mapping by NSW Department of Primary Industries Fisheries Branch (DPI Fisheries) indicates *Kelp habitat* in the near-shore shallows of Camerons Cove (Figure 8). This location also matches up with the SREP 'wetland' area shown in Figure 6, and it is concluded that the SREP wetland areas shown in Figure 7 indicate macroalgae (kelp) habitats on intertidal to subtidal rip rap rock revetments.

With regard to intertidal marine vegetation there are no mangroves or saltmarsh within Darling Harbour or Johnsons Bay (Allen et al (2007) and Kelleway et al (2007)).

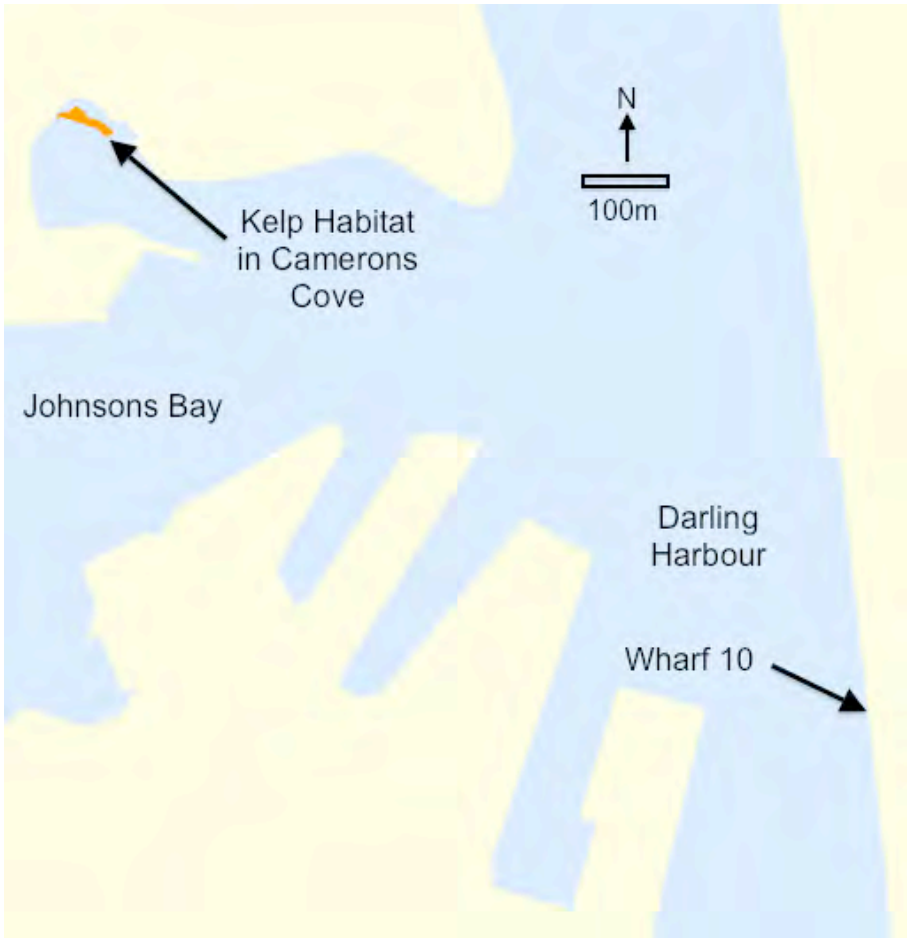

Figure 8

Portion of Fisheries NSW estuarine vegetation map 39a showing kelp habitat in Cameron Cove, that coincides with the SREP Sheet 4 'wetland' designation.

1.4 Protected and Threatened Species, and Endangered Ecological Communities

Aquatic habitats, flora and fauna of conservation significance are protected under both State and Federal legislation. In NSW, threatened species, populations and ecological communities of animals and plants are protected under the *Threatened Species Conservation Act 1995* (*TSC*). Threatened species, populations and ecological communities of fish and marine vegetation are protected under the *Fisheries Management Act 1994* (FMA). The *TSC and FMA* also list a number of key threatening processes that may threaten the survival of species, populations and ecological communities. The *Environment Protection and Biodiversity Conservation Act 1999* (*EPBC)* protects wetlands of international importance, Commonwealth Marine Areas, nationally threatened species and ecological communities and migratory species, nuclear actions and world and national heritage places.

A number of data-bases were searched for relevant records of aquatic biota in the locality. All the searches were conducted on 19 July 2013:

- The NSW Fisheries' *Threatened and Protected Species Record Viewer* search criteria were for *Sydney Metro* Catchment Management Area (CMA), *all species* and *all records*. The search returned no records.
- The NSW OEH *Bionet Atlas Tool* search criteria were of all valid records of *Endangered Populations* and of *Animals* in the *Selected Area* (*North: -33.8 West: 151.14 East: 151.24 South: -33.), Recorded since 01 Jan 2000*. The *Selected Area* was a 10km by 10km square, centered on the King Street Wharf Jetty 10. The search did not indicate any Endangered Populations of Aquatic Animals and there were 165 records of protected or listed animals from the search area that included two listed aquatic species, the Australian fur seal and the southern right whale (see Annexure B for full list).
- The EPBC Act Protected Matters Search Tool search criteria was a 4km radius circle centered on the Wharf 10 Jetty. The search revealed no listed threatened ecological communities. In terms of listed aquatic species there are two listed fish, two whales, four marine turtles and four sharks See Annexure B for the full EPBC Search report.

2 AQUATIC HABITATS AND ECOLOGY

A diver based aquatic ecology survey to identify and describe aquatic habitat types, to ascertain whether there were seagrasses or the pest algae species *Caulerpa taxifolia* on the seabed and to determine the presence of listed or protected aquatic species (or their habitat) – including targeted searches for syngnathiformes (seahorses and the like), was undertaken on 22 May 2013. Structures surveyed included the Wharf 10 Jetty steel support piles, the inshore concrete and sandstone retaining wall, the wharf wood fender piles, the concrete wave baffles, support steel H beams and tie rods plus the seabed below the wharf.

Due to the presence of the Captain Cook cruise vessel *Sydney 2000* in the berth immediately south of the wharf, and due to constant vessel movements past the wharf, the diving survey area was confined by NSW RMS and by Sydney Ports Corporation to a footprint immediately under the wharf on the southern and western sides of the wharf. The sea-bed survey was able to be extended some 10m north of the wharf on the Barangaroo side.

The survey day was clear and the site was protected from prevailing winds, water visibility was reasonably good for the shallow waters, fair for mid waters and poor for waters greater than about 8 m deep. Two divers undertook the survey for a survey period of two hours.

There are two main areas of aquatic habitat in the locality:

- The wetted surface areas of the wharf constructed surfaces.
- The soft sediment habitat under and around the wharf. The bare sediment seabed is uniformly silty-sand and does not support any marine vegetation.

There is a distinct depth zonation of aquatic biota on all vertical surfaces. This zonation and the biota of each of the zones are described as follows and photographs illustrating these zones and biota are shown in Figures 9 to 15 in Annexure A:

- Whilst there is constant wash activity at the site there is little breaking wave activity so there is no extended splash zone in the upper intertidal which comprises bare concrete or bare wood with a limited variety of intertidal animals. There is a sparse band of barnacles *(Elminius sp.)* in the high surge zone, a band of tufted green algae below that, and a broad oyster band in the low intertidal. The steel pile does not support the turfted algae band (Figure 9).
- The lower intertidal habitats support a variety of gastropod molluscs; *B. nanum, Austrocochlea obtusa,* the Oyster borer, *Morula*

marginalba plus limpets *(Cellana tramoserica)* and false limpets *(Montfortula sp.)*.

- The shallow sub-tidal fringes exposed to sunlight support a patchy cover of encrusting red coralline algae plus a variety of short frondose brown algae species including *Dictyota dichotoma* and *Sargassum sp*. Shaded shallow sub-tidal habitats support an extended oyster band with black mussels (Figure 10).
- Below the shallow sub-tidal algae fringe there is a patchy band of algae including three brown macroalgae species *(kelp, Ecklonia radiata, Padina sp., and Sargassum spp.)*, a number of frondose red and green algae, some mussels plus a variety of sponge, bryozoa and tunicate species. Shaded areas supported no algae but with a similar encrusting fauna assemblage (Figure 11). Whilst the subtidal algae zone is confined to the upper wash agitated waters, Kelp occurs from 0m to -6m depth (chart datum) with very scattered cover and is confined to the piles and part of one suspended wave baffle that are exposed to sunlight.
- Below the algae zone, and from about 4m depth to some 4m off the seabed the habitats become progressively covered with silt and supports a a diverse fauna of mainly encrusting species such as bryozoa, sponges, colonial ascidians and tufted bryozoans embedded in a silt matrix, with few aborescent or branching species (Figure 12).
- At around 3 m above the seabed, the bottom portions of the piles and the wave baffles that have fallen to the bottom are covered in silt with a much-reduced cover of encrusting fauna, generally small orange sponges (Figure 13).
- The seabed is soft silty-sand and the presence of burrows and bioturbation mounds indicate that the soft substratum supports benthic infauna (animals that live in the sediments). There were no marine plants or algae encountered on the seabed and none were expected at these depths.
- Fish were generally observed under the wharf (Figure 14) and species observed included senator wrasse, bat fish, bream, luderick, fan belly leatherjackets and sand gobies. Smaller hard substratum fish such as eastern hulas and juvenile fish were not observed.
- Tie rods suspended in the water supported biota similar to adjacent piles, including encrusting orange sponges, *Ciona sp*. ascidian colonies and small aborescent bryozoans (Figure 15).

In regard to other specific requirements of NSW Fisheries, the following results were obtained from the field survey:

- There were no seagrass plants, mangroves or saltmarsh plants at the site and none are expected owing to lack of suitable habitat.
- There are no aquaculture or commercial activities undertaken at the site or in the extended study area (Darling Harbour and Johnsons Bay).
- The introduced and listed pest algae species *Caulerpa taxifolia* was not found at the site and is not expected at the site owing to unsuitable habitat, i.e., by virtue of the depth of the seabed at this site, which limits light penetration to the seabed to the extent necessary to support plant life.
- No threatened or protected aquatic species as listed under the FMA, TSC Act or EPBC Act (see Annexure B for species lists) were found at the site and none are expected (see Section 2.1 for additional consideration of possible threatened and protected species).

2.1 Possible Threatened and Protected Species

2.1.1 Fish and Sharks

The FMA and EPBC Act list a number of marine and estuarine shark and teleost fish species as Vulnerable Species under Schedule 5 of the Act. Syngnathiformes (seahorses, sea-dragons, pipefish, pipe-horses and sea-moths) are protected under the EPBC and FMA (see Annexure B for species lists):

- The listed Grey Nurse and Great White sharks are near-shore coastal species and could enter Sydney Harbour from time to time. However such visits would be infrequent and would generally be confined to the outer harbour below the Harbour Bridge and then only when in pursuit of mobile prey species. They would not make use of any of the habitats available in the locality. Accordingly the likelihood of these species occurring is low.
- Of the listed teleost fish species known from Sydney Harbour only one, the Black Rock Cod *Epinephelus daemelli* could potentially occur in rocky reef habitat areas of Johnsons Bay, and then only as transiting juveniles due to lack of suitable cavern and cave habitat for adults. It would not occur on the retaining wall rock or on the wood, steel and concrete surfaces of the pile and wave baffle habitats at King Street Wharf 10 Jetty, by virtue of lack of suitable crevice habitat. Accordingly the likelihood of this species occurring, even as a transiting juvenile, is low.

- Of the 31 species of syngnathiformes known from NSW waters, three, (White's seahorse *Hippocampus whitei*, Coleman's seahorse *Hippocampus colemani* and the pygmy pipehorse *Idiotropiscis sp.*), are endemic to NSW and White's seahorse is common in Sydney Harbour, including Mort Bay at Balmain. However, there is not sufficient suitable seahorse habitat at the King Street Wharf 10 Jetty site. The shallow kelp and fringing algae habitat on the hard substratum surfaces of the piles and wave baffles is too sparse to provide sufficient feeding or shelter habitat, the lack of habitat topological complexity for the deeper encrusting assemblages does not afford any shelter from predatory fish, and the whole locality is isolated from suitable habitats (at Camerons Cove and Balmain). This conclusion was confirmed by extensive, targeted searches for seahorses, which found none at the site. The lack of topographical complexity in the biotic assemblages on the hard substrata at the site would also appear to limit colonisation by smaller reef fish that were also not found.

Due to the low likelihood of occurrence of these species at the King Street Wharf 10 Jetty, no Assessments of Significance have been prepared for the relevant listed species.

2.1.2 Other Listed or Protected Species

With regard to other aquatic species or ecological communities and migratory species listed under the TSC and EPBC Acts, little penguins are observed fishing and feeding throughout the harbour and could be expected in Johnsons Bay/outer Darling Harbour from time to time. These are likely to be members of the little penguin colony at North Head, which is listed as an Endangered Population under the TSC Act.

Various listed cetaceans (whales and dolphins), marine mammals (seals and sea lions), marine reptiles (turtles and sea-snakes) and sea-birds (migratory ocean birds and waders) are known from the outer Sydney Harbour and are known to penetrate the harbour to and beyond the study area, albeit rarely. The majority of these species are open water or open coastal species that are generally found on the coastline rocky shores around the harbour entrance or in the outer harbour waters. Both the whale species are known to penetrate well into the harbour, including the open waters of Darling Harbour.

Of the species that may occur in the vicinity of the site, none would be utilising the resources of the site to any great extent and would generally be in the locality as transients or opportunistic feeders. The site does not provide any undisturbed intertidal rock reef habitat for seabird roosting or shore bird feeding and there are no undisturbed sites for seal or penguin haul-outs. The degree of disturbance by vessel traffic and the lack of suitable

shelter habitat for small fish also limit the likelihood of there being schools of bait fish that form the prey of many aquatic fishing birds including the little penguin. It is concluded that there would not be any threatened species residing within the locality of the King Street Wharf 10 jetty and that the wharf and the locality does not constitute specific habitat for other threatened aquatic species as listed under the FMA, TSC and EPBC Acts.

Due to the low likelihood of occurrence of these species at the King Street Wharf 10 Jetty, no Assessments of Significance have been prepared for the relevant listed species.

With regard to the Fisheries NSW waterway classification scheme as shown in Table 2 of the revised Policy and Guidelines document (NSW Fisheries 2013), the location is a Class 1 "Major key fish habitat" (KFH) by virtue of it being an estuarine waterway. In regard to the sensitivity classification of the specific hard-substratum habitats of the King Street Wharf 10 Jetty to be demolished, the habitats are Type 3 "minimally sensitive" KFH (as defined in Table 1 of Fisheries NSW 2013).

3 IMPACT ASSESSMENT

With regard to the assessment of possible aquatic impacts, the refurbishment project includes the works as described in Section 1.2 above. Following the completion of the works the King Street Wharf 10 Jetty will be re-opened to the public.

3.1 Construction Impacts

The majority of the construction works would be undertaken using barge mounted cranes and pile driving rigs, and construction materials would be taken away or brought to the site on barges. The steelwork headstock painting and touch-up painting for the steel cross bracing units would be undertaken directly over water by painters using scaffolding and the final protective measures for the steel pile heads would be undertaken by divers either working from small work barges or directly in-water (for applying the petrolatum wraps).

These works would (a) remove aquatic assemblages from the locality, (b) have the potential for accumulation of solid materials (off cuts etc.) on the seabed, (c) would cause localised turbidity with the potential for mobilisation of seabed contaminants and (d) could cause deterioration of water quality via spillages or leachate from materials used. These potential impacts are considered below.

Loss of existing encrusting and attached aquatic biota and associated disturbance to fish assemblages that utilise these assemblages.

The removal of wave baffles, wave baffle H beams and bracing rods would remove hard substratum aquatic habitat from the locality. Metal cleaning and protection works for the steel pile head-works will be undertaken by divers using hand tools to remove marine growth from the pile surfaces. These works are confined to the intertidal zone.

Only three of the wave baffles are still suspended in the water column with the remainder on the bottom. The wave baffles on the bottom are smothered in silt and support little if any attached biota. The suspended wave baffles and the H beams support an assemblage of encrusting biota that is similar to that found on adjacent piles and would be found on all the remaining King Street wharves and on the Barangaroo seawall.

The encrusting material to be removed from the steel pile headstocks comprises the oyster bands and algae zone assemblages in that zone. Some of the removal works would be undertaken during low tides by divers standing in work barges, which would allow for some of the material to be collected into the work barges for later land disposal. The remaining

material to be removed from the lower headstock areas would comprise kelp plants and encrusting organisms. Kelp can be removed and placed into the work barges but the residual encrusting material would likely fall to the seabed. Fish and scavenging organisms on the seabed will devour some of this material and the remainder will be assimilated into the seabed sediments where it will be eaten by benthic organisms. This is an accelerated natural process where attached organisms die or are displaced by wave action and fall to the bottom and the works are not expected to result in any water quality deterioration such that local adjacent aquatic ecosystems are put at risk.

The items to be removed or scraped do not support resident reef fish assemblages but do provide habitat for some larger reef and pelagic fish. The fish assemblages do not include smaller reef fish that depend on encrusting habitat for food and for shelter from predatory fish. The larger reef and pelagic fish are able to move away safely onto similar suitable habitat on adjacent piles, other wharf structures or inshore retaining wall habitats to the north and south of the Jetty.

Accordingly, the loss of these attached and encrusting habitats is not considered significant as the cleaned and protected headstock habitats will be recolonised by similar organisms, and the placement of the four raker piles would provide additional wetted surface areas for colonisation by aquatic encrusting biota.

Turbidity and possibility of mobilisation of seabed sediment contaminants arising from H beam removal and raker pile placement works:

Removal of the wave baffles from the bottom will create turbidity as the accumulated silt built up over the fallen wave baffles is displaced.

The biota within the project area are already subjected to occasional periods of high turbidity during flood events, and consequently the assemblage in the vicinity of the works would be expected to contain organisms that are generally tolerant of occasional turbidity (Knot and Johnston 2009). That is, the organisms most likely to be affected by localised turbidity from the remediation works would already be turbidity tolerant and would thus not be impacted.

Pile placement creates short impact pulses of turbidity, which are not considered a significant problem as turbidity would be localised to the immediate area around the piling work area, would be confined to bottom waters and would settle rapidly in the saline waters at the site.

Given the intermittent or pulse nature of the various proposed removal works and the fact that the waters around the work site are well mixed and therefore well oxygenated, there would be a low risk of mobilising contaminants from the disturbed bottom sediments of Darling Harbour such that local aquatic biota would be placed at risk (see also Knot and Johnston 2009).

Loss of benthic (sediment dwelling) biota to piling operations:

All proposed new piles would be driven into silty-sand substratum. As there are no seagrass beds, marine algae or rocky rubble reef habitat located in the construction area there will be no impacts on marine vegetation or attached biota. Some benthic organisms would be displaced sideways or lost by the action of pile driving. As the area of disturbance from the pile driving activity is very small compared to the total area of soft sediment habitat in the study area, this impact is considered insignificant. Bottom fish and other mobile benthic invertebrates would be able to move away from the piling works.

Water quality deterioration arising from paint and protective coating material spills into the water:

The majority of over-water metal cleaning and painting activities will be undertaken from scaffolding which will be constructed to include suitable spill containment measures and these will be set out in a Construction Environmental Management Plan (CEMP) for the project (RPS 2013). Similar safeguards would be provided to prevent solid materials falling onto the seabed from the remediation works.

The residual overwater works for the application of protective coatings on steel pile heads includes divers applying a primer coat to the cleaned pile heads prior to wrapping the heads with a petrolatum wrap. The primer will be an epoxy based paint and will need to be applied to the pile heads during low tides and in calm conditions. Under these conditions overspill to the waters will be minimised and there is a low risk of water quality deterioration such that local aquatic biota would be affected.

3.2 Operational Impacts

Once completed the jetty would be opened to public use. The main operational impact arising from that use would be the risk of litter falling into the harbour with a possible risk to marine animals from ingestion of litter (particularly plastics) or being trapped or strangled by litter. Given that the jetty will provide an incrementally small additional open public space area in this locality the incremental additional risk to marine biota arising from the use of the jetty is considered low.

3. 3 Mitigation Measures

3.3.1 Construction Impacts

As noted in Section 3.1 turbidity arising from the proposed construction works will be localised to the immediate area around the works, and would be expected to settle rapidly, given the saline nature of the waters. The residual risk of turbidity plumes will be managed by the use of silt curtains that limit the possibility of turbidity spread from the site.

As detailed in Section 2.1.1, the diversity and complexity of attached and encrusting species on the hard substratum surfaces of the piles and wave baffles is too sparse to provide sufficient feeding or shelter habitat for smaller reef fish including syngnathiformes (seahorses and the like). Nothwithstanding, if any syngnathids are identified at the site unexpectedly all work is to cease and advice sought from a relevant specialist.

Spill containment measures and safeguards to prevent solid materials falling onto the seabed from the remediation works will be set out in a Construction Environmental Management Plan (CEMP) for the project.

3.3.2 Operational impacts

Provision of appropriate signage regarding the threat to marine life from litter coupled with the provision of suitable litter bins will minimise litter entering the harbour.

3.4 Fisheries Management Act Permit and Habitat Protection Requirements

Part 7 of the Fisheries Management Act 1994 (FMA) sets out the conditions under which permits are required, and the conditions under which a permit may be granted are specified in the NSW DPI (Fisheries) Policy and Guidelines (NSW Fisheries 1999). With respect to estuarine activities, permits are required for reclamation or dredging works and for the taking or harming of marine vegetation:

- The present proposal does not include activities that fall under the definition of dredging or reclamation.
- Whilst the construction works would require the removal of intertidal macroalgae the proposal would not result in any significant net loss of macroalgae habitat, as there would be an additional area of hard substratum habitat suitable for macroalgae colonisation created by virtue of the extra wetted surface areas on the new raker piles.

- The provision of habitat protection precautions in the CEMP will manage the impacts so that there is negligible risk of damage to adjacent marine algae habitats and biota.

It is concluded that the proposal would not require a permit under the FMA to take or kill marine vegetation, as there would be no net loss of available marine algae habitat arising from the proposal.

3.5 Sydney Region Environmental Plan (Sydney Harbour Catchment) 2005

Clause 21 of the SREP (Sydney Harbour Catchment) outlines nine criteria for biodiversity, ecology and environmental protection:

21(a) Need for development to have a neutral or beneficial effect on water quality entering the waterway.

Provided construction works utilise best management practice for containing water and materials loss from the site, water quality impacts would be minimal and temporary.

21(b) Need for development to protect and enhance terrestrial and aquatic species, populations and ecological communities and, in particular, should avoid physical damage and shading of aquatic vegetation (such as seagrass, saltmarsh and algal and mangrove communities).

The proposal would result in the temporary loss of existing marine vegetation habitat by virtue of the removal of the wave baffles and cleaning of the intertidal pile heads for metal protection. Following completion of the works there would be regrowth on the wetted intertidal surface areas including on the new additional wetted surface areas on the raker piles.

Marine mammals, reptiles and aquatic or migratory birds may utilise the aquatic resources of the locality on a transient or opportunistic basis and would not be impacted in any meaningful way as there is abundant alternate or equivalent habitat in the locality and throughout the harbour.

Syngnathid fish were not found on the existing wetted surfaces and are not expected due to inadequate suitable habitat plus isolation from the nearest suitable habitat along the Balmain shore.

21(c) Need for development to avoid indirect impacts on aquatic vegetation as a result of increased access.

There would be no increased access to the aquatic vegetation at the site arising from the development.

21(d) Need for development to avoid indirect impacts on aquatic vegetation (such as changes to flow, current and wave action and changes to water quality) as a result of increased access.

By virtue of the openness of the site to the harbour, and with the removal of the remaining wave baffles there would be beneficial changes to tidal flow, currents, wave action and water quality arising from the proposal.

21(e) Need for development to protect and reinstate natural intertidal foreshore areas, natural landforms and native vegetation.

There are no natural inter-tidal foreshore areas, natural landforms or native vegetation at the King Street Wharf site, as this is a totally reclaimed and paved site.

21f) Need for development to retain, rehabilitate and restore riparian land.

The total riparian shore at this location comprises reclaimed land behind revetment walls (sandstone and concrete). The project does not include any works on riparian lands and thus does not affect existing riparian land.

21(g) Need for development on land adjoining wetlands to maintain and enhance the ecological integrity of the wetlands and where possible to provide a vegetative buffer to protect wetlands.

There are no wetlands at or in the immediate vicinity of the site.

21(h) Need to assess the cumulative environmental impact of the development.

Assessment of the cumulative impacts of the proposal on the aquatic environment provided above indicates that recolonisation of the new and remediated wetted surface areas of the wharf by marine algae will not result in any net change in available marine vegetation habitats at the location. There would be no long-term water quality or ecological impacts arising from the proposal. Accordingly, the net impact of the proposal will be neutral compared to the present situation.

21(i) State whether sediments in the waterway adjacent to the development are contaminated, and what means will minimise their disturbance.

Contamination investigations for the bays around the site and for the harbour sediments generally have found that there are elevated levels of hydrocarbons, heavy metals, PAH and TBT throughout the harbour. The sources of this contamination are varied and would include shipbuilding/maintenance and general runoff from the surrounding urban and former industrial catchments.

The disturbance of sediments arising from construction works would be episodic, localised and short term and there are no measurable disturbance impacts expected such that aquatic biota at the locality would be placed at risk. Notwithstanding, silts curtains will be deployed around the works to limit the potential spread of turbidity plumes from construction operations.

4 CONCLUSIONS

The marine habitats at King Street Wharf 10 Jetty support an assemblage of marine algae and attached fauna typical of hard substratum habitats throughout Sydney Harbour. There is limited kelp habitat and low habitat topographical complexity and this limits the fish assemblage by not providing suitable shelter habitat for small fish and juveniles.

There are no seagrass or *Caulerpa taxifolia* (a pest algae species) at the locality and there are no syngnathids (seahorses and the like) at the site. The site does not provide suitable shelter, breeding or feeding habitat for any listed or protected marine species or communities.

It is concluded that refurbishment works at King Street Wharf 10 Jetty would result in permanent loss of shallow sub-tidal marine algae habitat by virtue of the removal of the remaining suspended wave baffles, plus temporary loss of habitat to cleaning of the intertidal parts of steel piles for protective coating. These losses will be balanced by recolonisation onto the refurbished steel pile heads and by additional colonisation onto four new raker piles to be installed under the wharf.

Use of silt curtains will minimise disruption to adjacent inshore or other wharf biotic assemblages arising from construction related turbidity and scaffolding plus safe working provisions for minimising paint spillages to the waters of Darling Harbour will be included in the project CEMP. The disturbance of sediments arising from construction works would be episodic, localised and short term and there is no significant disturbance impact expected such that aquatic biota at the locality would be placed at risk. The safeguard provisions in the CEMP will minimise water quality deterioration arising from the refurbishment works, further reducing the possibility of risk for adjacent aquatic habitats and biota.

On balance, there will be a net neutral impact from the proposed wharf refurbishment works; there would be no net loss of aquatic habitat in the medium to long term, and there will be a beneficial impact for reef fish assemblages utilising the additional marine biotic assemblages on the wetted surfaces of the additional piles to be introduced to the locality.

Whilst the proposed construction works may require a permit to take or kill marine vegetation under the FMA, the project would meet the aquatic ecology conservation requirements of the SREP (Sydney Harbour Catchment) 2005 and would meet the aquatic ecology and fish habitat conservation requirements of the Fisheries Management Act 1994 (FMA) and the NSW Fisheries guidelines (NSW Fisheries 1999).

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ANNEXURE A

PHOTOGRAPHS OF AQUATIC HABITATS AND SPECIES

Figure 9 Intertidal zonation in surge zone. Top photograph shows a wave baffle and associated H beam and the bottom photograph is of a steel pile. There is a sparse band of barnacles in the high surge zone, a band of tufted green algae below that, and a broad oyster band in the low intertidal. The steel pile does not support the turfted algae band.

Figure 10

Low intertidal to subtidal fringe.

The upper photograph shows a steel pile under the wharf. There are no algae, the oyster band continues into the shallow sub-tidal. and there are mussels imbedded in the oyster band.

The middle photograph shows a portion of a suspended wave in sunlight baffle, with an assemblage of mixed algae, ascidians and bivalve molluscs.

The lower photograph shows a similar assemblage on a wooden fender pile.

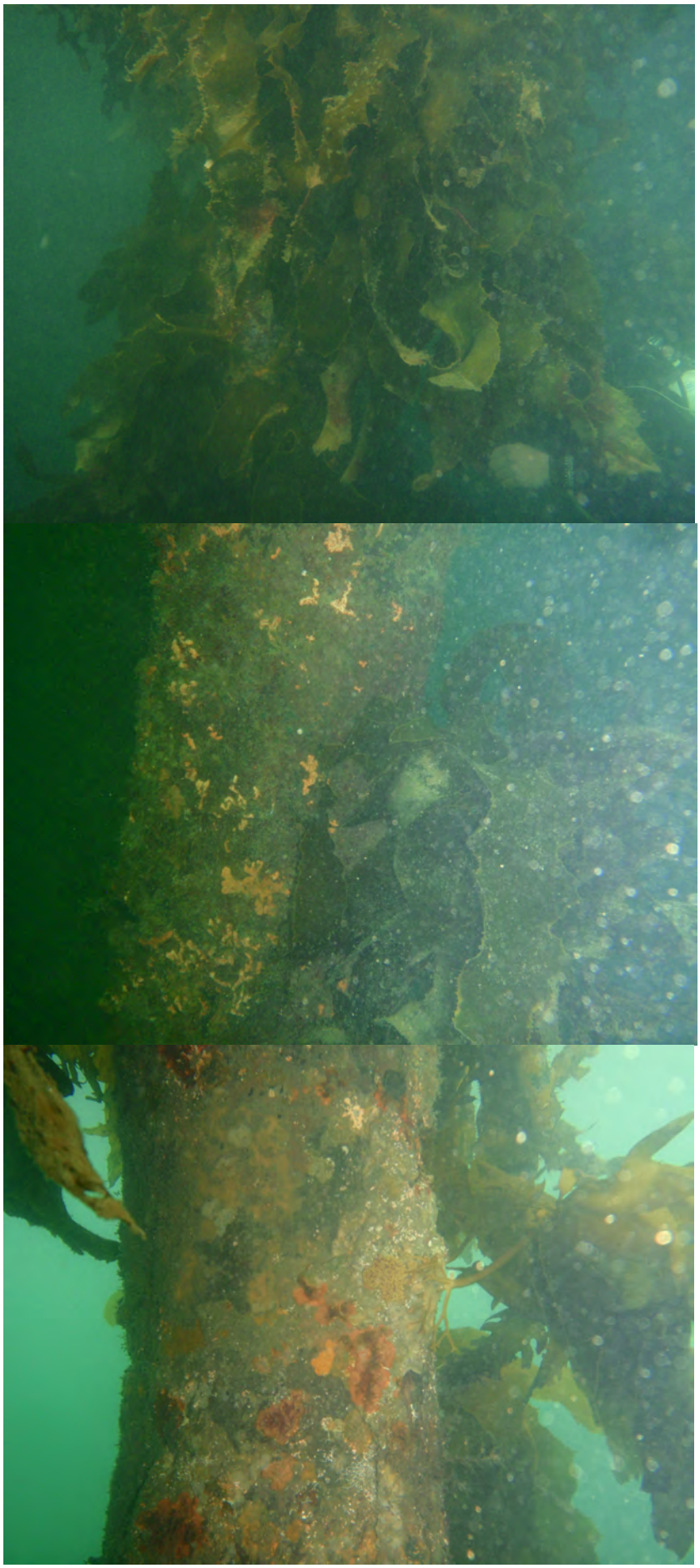


Figure 11

The Kelp zone is confined to the piles and part of one suspended wave baffle that are exposed to sunlight. Kelp occurs from 0m to -6m depth (chart datum) with very scattered cover.

The top photograph shows a wooden pile at the north-west corner that supports a total cover of kelp.

The middle photograph shows a steel support pile with less cover. This cover is more typical of the piles that support kelp.

The lower photograph shows the kelp cover and associated undercover attached fauna (mainly encrusting sponges, bryozoa and colonial ascidians with some frondose bryozoa).

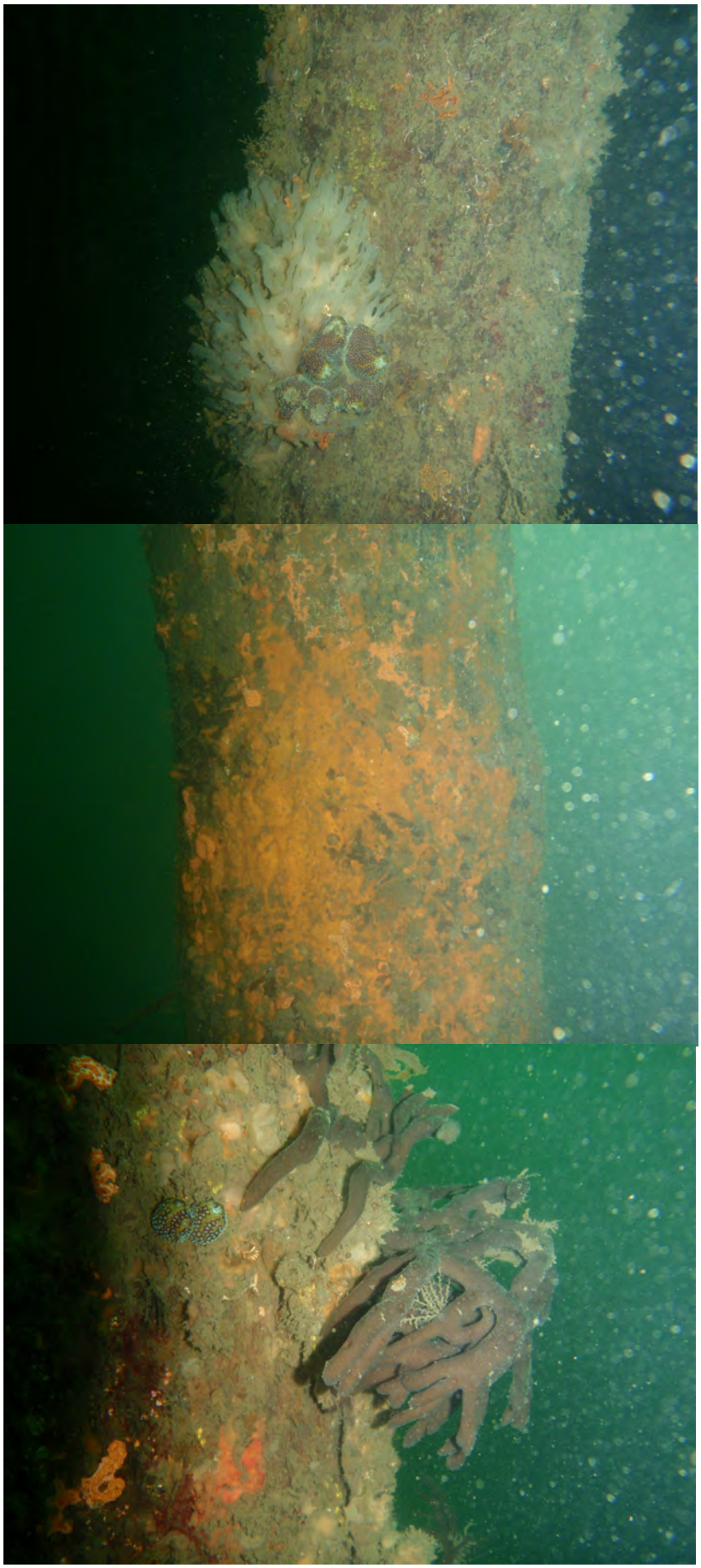


Figure 12 Mid water fauna

From about 4m depth to some 4m off the seabed the hard substratum surfaces support a diverse fauna of mainly encrusting species such as bryozoa, sponges, colonial ascidians and tufted bryozoans embedded in a silt matrix.

The middle photograph provides a view of the typical cover in this zone and is distinguished by not supporting many aborescent or branching species.

The top and bottom photographs show several branching species that do occur as isolated individuals, a colonial ascidian in the top photograph and a branching sponge in the bottom photograph.

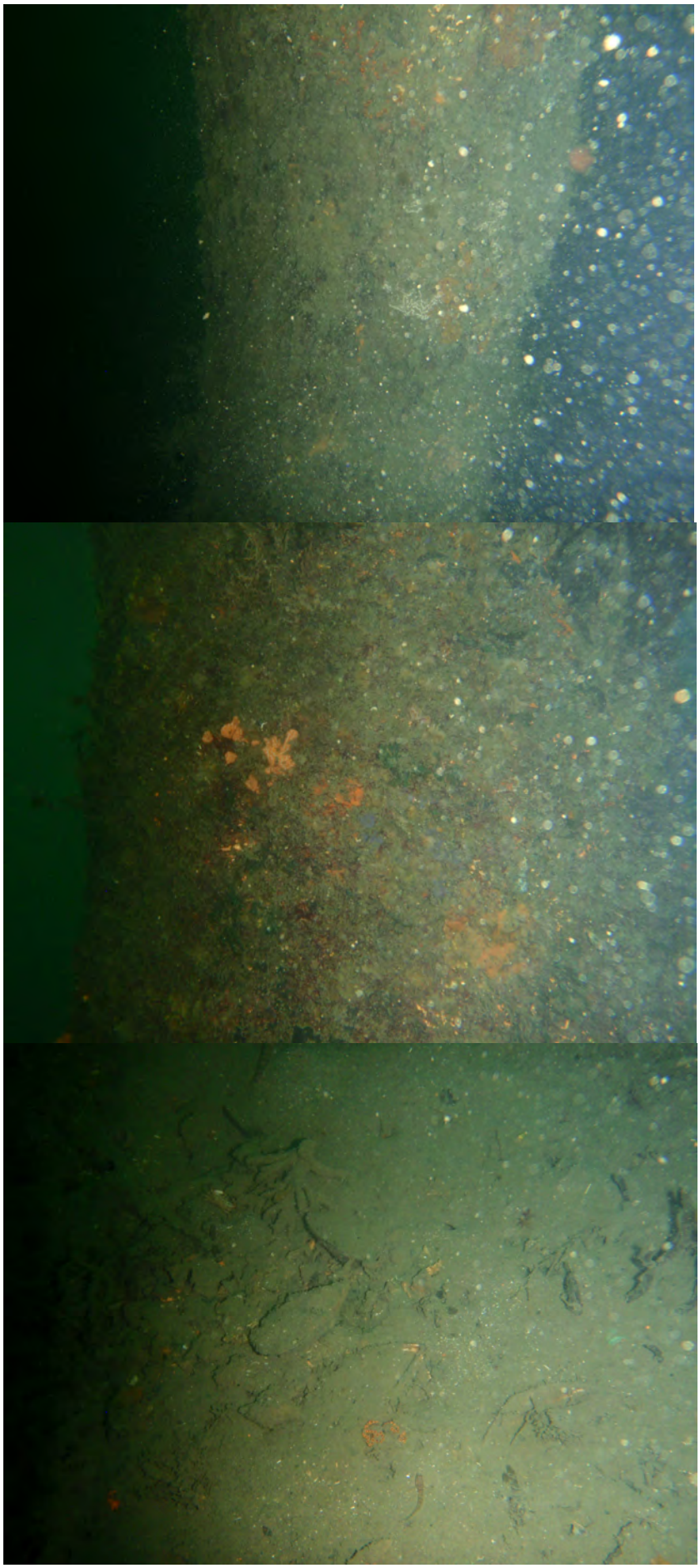


Figure 13 Pile and Wave Baffle fauna near the seabed.

The bottom portions of the piles and the wave baffles that have fallen to the bottom are covered in silt with a much-reduced cover of encrusting fauna. The top and middle photographs are piles and the bottom photograph is a portion of a wave baffle. The wave baffle still has mussel and oyster shells attached (now dead and smothered in silt) that would have colonized the baffle when it was suspended in the shallows.

Figure 14 Fish observed under the wharf.

Most of the fish observed around the structures were larger predatory fish such as luderick and bream. A school of batfish was observed under the wharf and there were at least two fan-bellied leatherjackets seen, both on the shallower portions of the two remaining suspended wave baffles. Sand gobies were observed on the seabed.

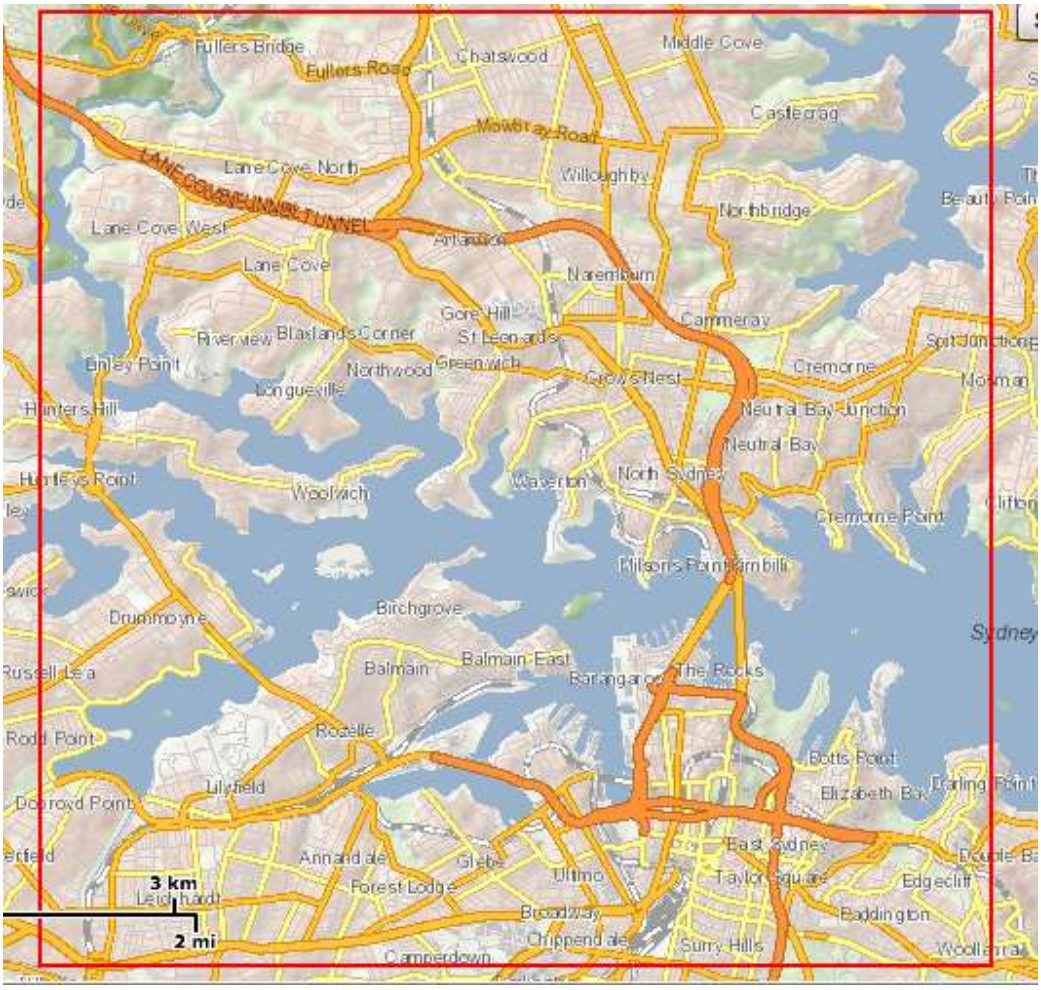
Specific and targeted searches were made for.

There were also no smaller reef fish (such as eastern hulas) or any schools of juvenile fish observed and Syngnathiformes (seahorses and the like) were not found.

Figure 15 A broken tie rod suspended below the water surface supporting an encrusting orange sponge, a colony of *Ciona sp*. ascidians and small aborescent bryozoans.

ANNEXURE B

THREATENED AND PROTECTED SPECIES AND COMMUNITIES IN SYDNEY HARBOUR. NSW



Annexure Figure B1 Bionet and EPBC (Protected Matters) Search Areas

Table B1 Listed marine species that have been recorded in the 10km square Bionet Search Area

Class	Family	Scientific Name	Common Name	NSW status	Comm. status	Records
Reptilia	Cheloniidae	*Chelonia mydas*	Green Turtle	V,P	V	1
Aves	Procellariidae	*Ardenna pacificus*	Wedge-tailed Shearwater	P	J	3
Aves	Procellariidae	*Ardenna tenuirostris*	Short-tailed Shearwater	P	J,K	1
Aves	Procellariidae	*Pterodroma leucoptera leucoptera*	Gould's Petrel	V,P	E	1
Aves	Spheniscidae	*Eudyptula minor*	Little Penguin	P		51
Aves	Ardeidae	*Egretta sacra*	Eastern Reef Egret	P	C	1
Aves	Ardeidae	*Ixobrychus flavicollis*	Black Bittern	V,P		2
Aves	Accipitridae	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	P	C	14
Aves	Accipitridae	*^^Pandion cristatus*	Eastern Osprey	V,P,3		1
Aves	Haematopodidae	*Haematopus fuliginosus*	Sooty Oystercatcher	V,P		3
Aves	Scolopacidae	*Actitis hypoleucos*	Common Sandpiper	P	C,J,K	1
Aves	Stercorcariidae	*Stercorarius longicaudus*	Long-tailed Jaeger	P	J	1
Aves	Laridae	*Onychoprion fuscata*	Sooty Tern	V,P		1
Aves	Laridae	*Sterna hirundo*	Common Tern	P	C,J,K	2
Aves	Laridae	*Sternula albifrons*	Little Tern	E1,P	C,J,K	1
Mammalia	Otariidae	*Arctocephalus forsteri*	New Zealand Fur-seal	V,P		2
Mammalia	Otariidae	*Arctocephalus pusillus doriferus*	Australian Fur-seal	V,P		6
Mammalia	Balaenidae	*Eubalaena australis*	Southern Right Whale	E1,P	E	3
Mammalia	Balaenopteridae	*Megaptera novaeangliae*	Humpback Whale	V,P	V	1