Appendix F

Aquatic Ecology Assessment

GHD Pty Ltd

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Sydney Opera House Trust

Bennelong Drain Diversion Project

Aquatic Ecology Assessment

January 2010

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

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1. Introduction

1.1 Purpose of this report

The Sydney Opera House Trust is proposing to divert the Bennelong Drain from its existing route to a new route discharging at Farm Cove (referred to as 'the project' for the purposes of this document).

This report has been prepared by GHD Pty Ltd (GHD) as part of the environmental assessment of the project. The Sydney Opera House Trust is the proponent of the project, and the environmental assessment is being prepared by GHD in accordance with the requirements of Part 3A of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

This report assesses the potential impacts of the project on the aquatic ecology of the receiving environment.

1.2 Project outline

The project involves the construction of a new section of drain from the point where the Bennelong Drain enters the Sydney Opera House site, adjacent to the air intake structure for the Sydney Opera House car park. The Sydney Opera House car park is a separate commercial entity that is not owned by Sydney Opera House.

The new section of drain would run in an easterly direction close to the Tarpeian Wall, around the southern side of the exhaust air shaft for the Sydney Opera House car park, extending to the proposed discharge point at Farm Cove.

The new section of drain would take the form of a box culvert measuring approximately 1.5 m wide by 1.5 high (internal dimensions) or 1.8 m wide by 1.9 m high (external dimensions) at the junction point, increasing to approximately 2.4 m wide by 1.8 m high (internal dimensions) or 2.7 m wide by 2.2 m high (external dimensions) along the majority of the diversion route. A 4.39 m deep junction pit would be constructed as the junction between the existing drain and the new section of drain. The junction pit would include an access cover for maintenance access. The access cover would be located within a narrow strip of feature garden located at the southern extreme of the Sydney Opera House site against the base of the Tarpeian Wall.

An area of approximately 8 m by 8 m and 4.4m deep would need to be excavated around the area of the proposed new junction to construct and install the required infrastructure. Excavation would also be required along the route of the proposed diversion, an excavation width approximately 2 m to 3.2 m wide (dependant on the size of the drain) would be required to allow sufficient space for the drain to be laid.

An approximately 8 m long section of the original Bennelong Drain would need to be removed to allow construction of the junction between the Bennelong Drain and the new section.

The outlet for the new section of box culvert drain would be located within the seawall at Farm Cove, immediately above the sea bed between the Royal Botanic Gardens Queen Elizabeth II gate and the Man O' War jetty.

The existing section of drain between the diversion point and the existing discharge would be blocked off at the diversion point and obsolete outlet.

1.3 Location of project

The site for the project is located within the forecourt area of Sydney Opera House, at the northern end of the Sydney CBD, on Bennelong Point. Bennelong Point is located between Sydney Cove and Farm Cove, both of which form part of Sydney Harbour. The project is located within the City of Sydney local government area (LGA).

The forecourt area is situated to the south of Sydney Opera House, between the Monumental Steps and the Tarpeian Wall.

The proposed outlet for the new section of drain would be located within the seawall at Farm Cove, immediately above the sea bed between the Royal Botanic Gardens Queen Elizabeth II gate and the Man O' War jetty.

The site location is shown in **Figure 1-1**.

1.4 Aim of study

The aim of this study is to provide a description of the marine environment existing or likely to exist within the vicinity of the new drain outlet and to assess the significance of any predicted impacts resulting from the project. Particular consideration has been given to the potential presence of threatened species and habitats of high conservation value such as seagrass beds.

Legend

Study Area — Upstream Drain Alignment

Proposed Drain Realignment

0 10 20 40 60

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Location of Key Site Features and Surrounds

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Figure 1.1

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10 Bond Street Sydney NSW 2000 **T** 61 2 9239 7100 **F** 61 2 9239 7199 **E** sydmail@ghd.com.au **W** www.ghd.com.au

Data source: Aerial Imagery from Google Earth Pro 2009; Locality Map Data, Navigate and Navteq, 2008.

2. Methodology

2.1 Desktop assessment

A review of available literature, including research papers, government and consultant reports for Sydney Harbour was undertaken to provide an indication of the existing environment within the general vicinity of the study area. A number of studies undertaken in Sydney Harbour, while not directly targeting the waters in the immediate vicinity of the Opera House, assisted in determining likely community structures associated with the intertidal rockwalls, seagrasses, macroalgae, benthic substrate, pelagic communities and water quality parameters.

Additionally, searches of databases maintained by the Department of Environment, Climate Change and Water (DECCW), BioNet, and the *Environment Protection and Biodiversity Conservation Act* 1999 (EPBC Act) Protected Matters Search Tool wildlife databases were undertaken to provide records of listed species with potential to occur within the study area or immediate locality.

2.2 Field investigation

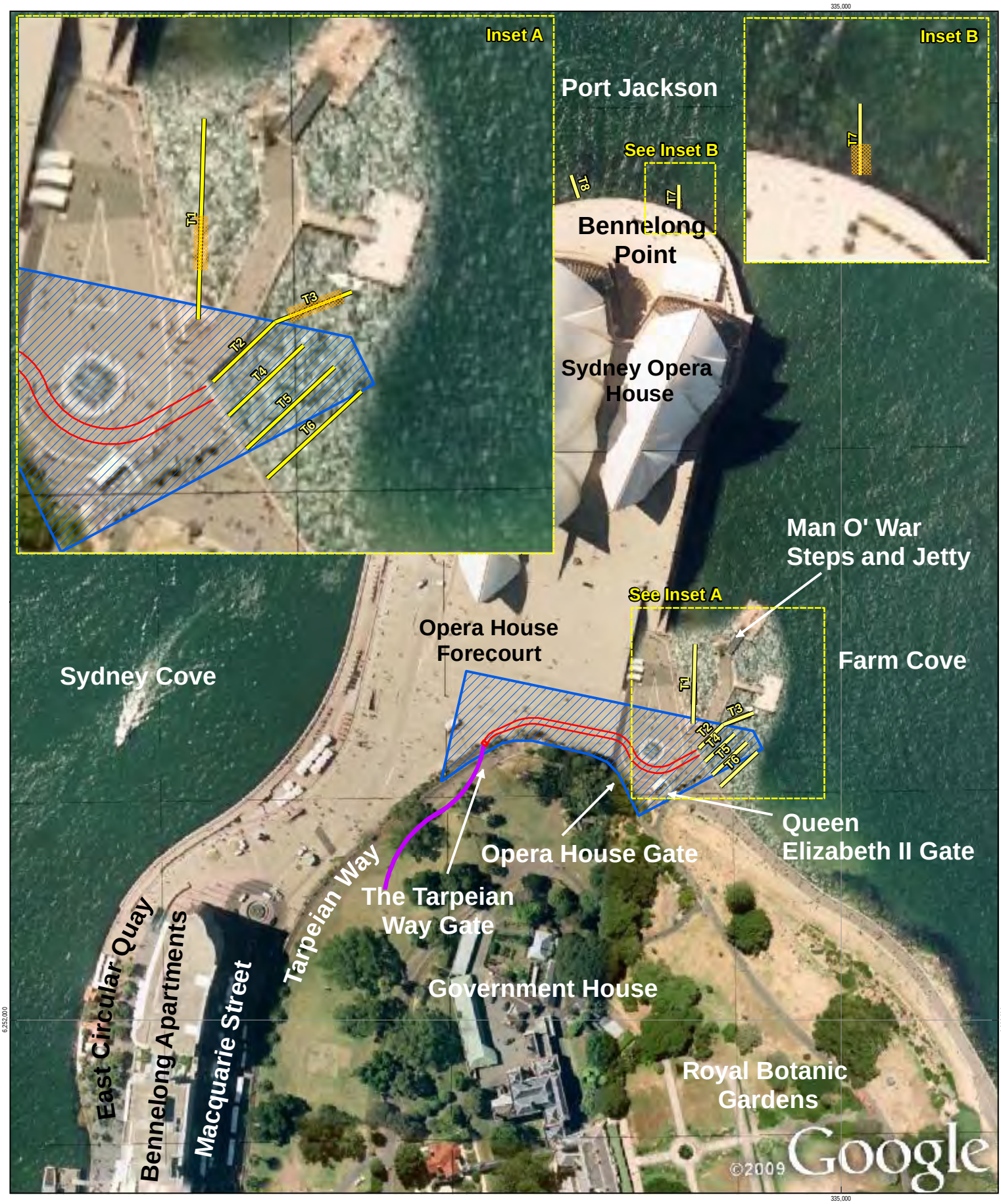
An assessment was undertaken to gain an understanding of the existing habitat type and integrity, the marine ecological communities, and potential to support listed species present within the study area.

The field investigation, undertaken on 12 May 2009, involved the deployment and survey of five line intercept transects (shown in Figure 2-1) that were randomly laid within the immediate vicinity of the proposed outlet in Farm Cove and three line intercept transects that were positioned within the surrounding area (including one at the current outlet location). Each transect ran from a position on the rock wall perpendicular out into the harbour, with total length limited by depth and visibility (i.e. survey on snorkel was only possible to depths of around 2.5 m).

The length of each transect was surveyed recording the type of habitat and the coverage distance (expressed as centimeter coverage) of each habitat type, such as seagrass, macro-algae and sand/rubble. Incidental sightings of fish and other fauna were recorded and photographs taken for identification where possible.

2.3 Impact Assessment

An assessment of the potential impacts of the project on species, populations and ecological communities and their habitats listed under the EPBC Act, *Fisheries Management Act 1994* (FM Act) and *Threatened Species Conservation Act 1995* (TSC Act) was undertaken with consideration of the guidelines for assessment for these Acts.



Legend

Study Area
Upstream Drain Alignment
Aquatic Ecological Transects
Proposed Drain Realignment
Extent of Seagrass

0 10 20 40 60
Metres
Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia (GDA)
Grid: Map Grid of Australia 1994, Zone 56

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Bennelong Drain Diversion Project
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Date	Jan 2010

Transcect Locations

Figure 2.1

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10 Bond Street Sydney NSW 2000 T 61 2 9239 7100 F 61 2 9239 7199 E sydmail@ghd.com.au W www.ghd.com.au

Data source: Aerial Imagery from Google Earth Pro, 2009.

3. Legislative requirements

3.1 Fisheries Management Act 1994

Part 7 of the *Fisheries Management Act 1994* (FM Act) relates to the protection of aquatic habitats. Section 205 of the FM Act relates to regulation of harm to marine vegetation and applies to:

(a) mangroves, or

(b) seagrasses, or

(c) any other marine vegetation declared by the regulations to be marine vegetation to which this section applies,

but does not apply to protected marine vegetation under section 204A.

(2) A person must not harm any such marine vegetation in a protected area, except under the authority of a permit issued by the Minister under this Part.

Section 75U(1) of the EP&A Act specifies certain authorisations which are not required for an 'approved project' under Part 3A, including:

'(b) a permit under section 201, 205 or 219 of the Fisheries Management Act 1994'

As such, a permit under Section 205 of the FM Act is not required due to application of Section 75U(1) of the EP&A Act.

Section 22ZA of the FM Act states that a person must not harm any fish or marine vegetation of a threatened species, population or ecological community. Section 220ZF outline defences against prosecution relating to offences under Division 4 of Part 7 that include if the offence was essential for the carrying out of a project approved under Part 3A of the *Environmental Planning and Assessment Act 1979*. As the project would be approved under Part 3A of the EP&A Act, this would be a defence against prosecution under Division 4 of Part 7 of the FM Act.

4. Description of existing environment

This section describes the marine habitat and ecological communities observed within the study area. Subsequently, the likelihood of occurrence of threatened species, based on habitat conditions or species observation, is determined. An assessment of possible impacts to threatened marine species and communities or those of high conservation value that occur, or are deemed likely to occur within the study area is the subject of the following section.

4.1 Desktop assessment

4.1.1 General habitat description

Sydney Harbour supports a diversity of marine habitats including a variety of ecological assemblages. The outer harbour, which includes Farm Cove is characterised by rocky shorelines, rock walls, rock platforms and kelp covered rocky reefs extending from the intertidal zone. Many of the fish species present rely on these rocky reef habitats and their associated kelp beds for food, shelter, and spawning sites at some stage of their lifecycles. The outer harbour is largely disturbed and general conditions are described in Table 1.

Farm Cove, into which the drain would discharge, is a small area of Sydney Harbour separated from Sydney Cove by Bennelong Point. Like a majority of the harbour bays, it is sheltered from natural wave action but experiences wash from high levels of boat activity and associated pollution. The geology of Farm Cove is sandstone with fine sediments dominating the substrate (AMBS, 2002) with a maximum depth of approximately nine meters.

Table 1 Existing conditions within the outer harbour

Descriptor	Status
Land use	Intensively developed
Ecological status	Considerably affected
Water quality	Affected by pollution from a range of sources, including stormwater discharges following rainfall events
Fisheries value	Moderate
Fisheries threat	Closed to commercial fishing due to revealed elevated levels of dioxins in fish and crustaceans across the Harbour, including Parramatta River and other connected tidal waterways (DPI, 2007)

4.1.2 Fish

There are over 580 fish species recorded in Sydney Harbour, including numerous threatened or endangered species (see Table 2). Families of fish typically associated with environments within Sydney Harbour similar to that of the study area (i.e. inshore waters, inter-tidal platforms, rockwalls and macro-algal and sandy habitats) include the Scorpidae, Sparidae, Carangidae, Labridae, Monacanthidae, Scorpaenidae, Serranidae and Syngnathids.

Sydney Harbour historically supported both professional and recreational fisheries, however in the last decade levels of dioxins measured within fish and crustaceans has risen to such levels as to force a ban upon commercial fisheries within the harbour until 9 February, 2011 (DPI, 2005).

Impacts upon water quality are of major concern to fisheries values and the health of aquatic biota. In relation to this project, the most notable potential impacts are habitat loss as a result of sedimentation (i.e. smothering habitat, increasing nutrient loads and increasing turbidity), which are known to have negative impacts upon fish communities, particularly when they affect valuable nursery habitats such as seagrass beds.

Threatened fish species are further discussed in Table 2. Impacts to these species and communities are discussed in Section 5.

4.1.3 Marine mammals

Despite heavy boating traffic and the highly altered marine conditions within Sydney Harbour, marine mammals such as whales, dolphins and seals are observed in and around the bays and coves on occasion.

The following marine mammals have been identified as occurring in the Harbour: Common Dolphin, Risso's Dolphin, Pygmy Sperm Whale, Sperm Whale, Killer Whale, Spotted Dolphin, Australian Fur-Seal, Leopard Seal, Crab-eater Seal, Southern Elephant Seal Dugong. (Australian Museum, 2009), Bottlenose Dolphin, the Long-beaked Bottlenose Dolphin, Indian Ocean Bottlenonse Dolphin, Southern Right Whale and Humpback Whale.

All cetaceans are protected under the EPBC Act which comprises a prohibition on the killing, injuring, taking, capturing or interfering with cetaceans in Australian waters.

These species likelihood of occurrence within the study area is summarised in Table 2.

4.1.4 Seagrasses

Seagrass communities are of considerable importance in the processes of coastal ecosystems because of their high rates of primary production and their ability to trap sediments and organic nutrients. Their special importance to commercial and recreational fisheries is well documented. Additionally, seagrasses are critical in substrate stabilisation, supply and fixation of biogenic calcium carbonate, detrital food chains, nutrient cycling and as substrate for epibiota and as critical habitats for many species (Larkum, *et al* 1989).

Seagrasses are included within the definition of marine vegetation under the *Fisheries Management Act 1994* and are therefore included within fish habitat protection plans (Division 4 FM Act) designed to minimise impacts to fisheries.

Seagrasses that commonly occur in the outer Sydney Harbour include the Eel-grass *Zostera capricorni,* Strap-weed *Posidonia* and Paddle-grass *Halophila.* Seagrass distribution maps prepared by West and Williams (2008) summarise the results of seagrass mapping from 1978-2003 (undertaken by West *et al* 1985 and 2004 and Williams *et al* 2003). These maps identify significant seagrass beds within Double Bay and Rose Bay, to the west of Farm Cove, but do not identify seagrass communities within Farm Cove itself. A subsequent model developed by West and Williams (2008) predicts areas suitable for seagrass colonisation based on variables such as depth, slope, substrata, fetch and distance from the Harbour entrance. This model predicts two small areas on the south west and south east inshore portion of Farm Cove as suitable for seagrass. However this study notes that factors not taken into consideration, including proximity to disturbances, pollutants and sediment movement, may limit actual seagrass potential. No ground truthing is known to have been undertaken within Farm Cove and seagrass may be present in other areas.

The likelihood of occurrence of seagrass within the study area is summarised in Table 2.

4.1.5 Intertidal zones

Built seawalls are one of the most extensive intertidal habitats in Sydney Harbour. They can be made of cement or sandstone, be sloping or vertical and have rough surfaces or be very smooth. Even sandstone walls, which are made of the same material as rocky shores around the harbour, differ from nearby natural shores in fundamentally important ways. They tend to have steeper slopes (often vertical), which reduces the amount of intertidal area from high - to lowshore, from tens of metres, to around two metres. In addition, they do not have particular microhabitats, such as rock-pools. Nevertheless, many intertidal animals and plants can be found living on seawalls. The intertidal zone in Farm Cove is dominated by constructed vertical sandstone rock walls, which provide habitat to numerous organisms which are typically dominated by grazing limpets (such as *Cellana tramoserica* and *Patelloida latistrigata*).

Seawalls around Sydney Harbour are largely constructed from local sandstone. This means that they can potentially be similar habitats to natural rocky shores. Previous studies (Blockley, 1999) have found intertidal species abundance and diversity vary between seawalls that were exposed and those that were sheltered. In general, organisms were more numerous on seawalls with greater exposure to waves than those that were sheltered. The diversity (number and variety of species) was also greater on these seawalls with the abundance of organisms being greater in holes than on exposed surfaces.

There is no specific historical data relating to the intertidal communities present at Farm Cove.

4.1.6 Macroalgae

Numerous species of macroalgae are present within Sydney Harbour. High densities occur at Manly Cove, Rose Bay and Double Bay. Macroalgae species are also common along constructed seawalls, which now skirt approximately 50 % of the outer harbour foreshore, in the more urbanised areas, particularly Farm Cove.

Common species within the area include the green algal species *Caulerpa filiformis* and the common kelp *Ecklonia radiata*. Both of these species are prevalent within the coastal waters of NSW and Sydney Harbour and demonstrate heightened tolerance to polluted conditions (in the case of *C. filiformis*) and low light conditions (*E. radiata*) (Edgar, 2000). These species may further be impacted by the removal of habitat.

4.1.7 Birds

Over 150 species of birds are known to occur within the Sydney Harbour region. Protected waters within the many bays provide suitable habitat for a range of aquatic birds such as Crested and Common Terns (*Sterna bergii* and *Sterna hirundo*) and Little Pied and Great Cormorants (*Phalacrocorax melanoleucos* and *Phalacrocorax carbo).* These birds utilise the protected waters in areas such as Farm Cove as hunting grounds to feed on small fish. Impacts upon food sources have the potential to flow-on to these species.

4.1.8 Reptiles

Turtle species known to occur within Sydney Harbour include the Green Turtle (*Chelonia mydas*), Loggerhead Turtle (*Caretta caretta*) and Leatherback or Luth Turtle (*Dermochelys coriacea*).

Green and Loggerhead Turtles are both predominantly tropical species, preferring the warmer waters around northern Australia. There is no evidence to suggest that breeding occurs within NSW and sightings of these species within the Sydney Harbour are considered to be associated with stray individuals (Australian Museum, 2002).

Leatherback Turtles are known to feed along the coast of NSW and are sighted within the Harbour from time to time. Nesting is not known to occur within the Harbour area, with only occasional records of nesting from beaches in northern NSW (Australian Museum, 2002). No suitable nesting habitat exists within the study area.

4.1.9 Threatened and Protected Species

Searches of the DECC, BioNet, NSW Fisheries and the EPBC Act Protected Matters Search Tool wildlife databases indicated that eight fish and 14 listed marine mammals have the potential to occur at Farm Cove (Table 2). Relevant information relating to preferred habitat and the likelihood of the species occurrence within the study area are described in Table 2. Potential impacts to species deemed likely to occur within the study area are discussed in Section 5.

Table 2 Likelihood of occurrence of threatened and protected species within the study area

Order	TSC Act	FM Act Status	EPBC Act Status	Habitat Association	Likelihood of Occurring in Study Area
FISH					
Weedy Sea Dragon *Phyllopteryx taeniolatus*		P		Weedy seadragons can be found in a variety of habitats including shallow estuaries and deep offshore reefs. They can occur to depths of 50 metres and are generally found in waters deeper than 10 metres. Juveniles of the species are often associated with kelp and seagrass habitats (NSW DPI, 2007). This species is known to occur in to Sydney Harbour.	**Likely**: Suitable habitat present.
Grey Nurse Shark *Carcharias taurus*		CE	CE	Key habitats for grey nurse sharks generally have sandy-bottomed gutters or rocky caves and are in the vicinity of inshore rocky reefs or islands. This species usually occurs in groups (NSW DPI, 2007). There are no known records of this species occurring within the study area.	**Unlikely**: Suitable habitat not present.
Elegans Wrasse, Elegant Wrasse *Anampses elegans*		P		The Elegant Wrasse is a widespread but uncommon species found on coral reef and rocky reef habitats at depths from 2 to 35 m, particularly around inshore islands. They can be found in different habitats depending on life cycle stage. Juveniles are found among seaweed in coastal bays and harbours. Large juveniles are found in small aggregations on coastal rocky reefs. It is recognised that protecting habitats is an important measure for recovery of this species population (NSW DPI, 2007). There are no known records of this species occurring within the study area.	**Possible**: Suitable habitat is present (i.e. seaweed beds preferred by juveniles), however this species naturally occurs in low abundance and the study area is already highly modified.
Macquarie Perch *Macquaria australasica*		E	E	The Macquarie Perch is a riverine, schooling species. It prefers deep, rocky holes with lots of cover (NSW DPI, 2007). As this species prefers freshwater environments it is highly unlikely to exist within the study area.	**Highly Unlikely**: Suitable habitat not present.
Bleekers Blue Devil Fish *Paraplesiops bleekeri*		P		Eastern blue devil fish are found in caves, crevices and under ledges on inshore reefs and estuaries in water as shallow as 3 m. It is more commonly seen in coastal waters down to about 30 m depth. Free-swimming larvae settle around reef areas when they have grown to about 10 mm (NSW DPI, 2007). There are no known records of this species occuring within the study area.	**Unlikely**: Suitable habitat not present.

Order	TSC Act	FM Act Status	EPBC Act Status	Habitat Association	Likelihood of Occurring in Study Area
Black Cod *Epinephelus daemelii*		P		Adult black cod are usually found in caves, gutters and beneath bomboras on rocky reefs. In Australia it is known from coastal and offshore reefs and islands. Small juveniles are often found in coastal rock pools, and larger juveniles around rocky shores in estuaries (NSW DPI, 2007). There are no known records of this species occuring within the study area.	**Possible**: Suitable habitat present.
Green Saw-fish, Green Sawfish, Longcomb Sawfish, *Pristis zijsron*		PE	V	Green Sawfish is listed under the NSW *Fisheries Management Act 1994* as endangered with a proposal currently under consideration to upgrade the species to presumed extinct. They are now only found north of Cairns. They are bottom dwelling rays, commonly found in near-shore coastal environments including estuaries, river mouths, embankments and along sandy and muddy beaches (NSW DPI, 2007).	**Highly Unlikely**: Presumed extinct within waters of NSW (*NSW FM Act 1994*).
Estuary cod *Epinephelus coioides*		P		Estuary cod inhabit turbid coastal reefs and are often found in brackish water over mud and rubble. Juvenile estuary cod are common in protected silty reef habitats and shallow waters of estuaries over sand, seagrass, mud and gravel and among mangroves. They are known to occur as far southwards as the Sydney area, however there are no known occurrences of this species within the study area (NSW DPI, 2007).	**Possible**: Suitable habitat present.
MAMMALS					
Southern Right Whale *Eubalaena australis*	V		E	In Australia, Southern Right Whales have been recorded in the coastal waters of all states between about May and November. Southern Right Whales use inshore areas for calving, some of which are close to populated centres (DEWHA, 2009). This species is known to occur periodically within Sydney Harbour.	**Likely**: Suitable habitat present.
Dwarf Minke Whale *Balaenoptera acutorostrata*			P	Dwarf Minke Whales appear to occupy primarily coastal habitats within tropical and warm temperate waters between 7° S and 41° S throughout the Southern Hemisphere. Insufficient information exists as to how Australian Dwarf Minke Whales use their habitat as no specific feeding or breeding grounds have been discovered off Australia (DEWHA, 2009). There are no known records of this species occuring within the study area.	**Unlikely**: Suitable habitat not present.

Order	TSC Act	FM Act Status	EPBC Act Status	Habitat Association	Likelihood of Occurring in Study Area
Unidentified Rorqual *Balaenoptera sp.*			E/V/P	Cetaceans that are included within the Balaenoptera genus and are known to inhabit Australian waters include the Fin Whale, *Balaenoptera physalus,* the Sei Whale, *Balaenoptera, borealis,* Bryde's Whale, *Balaenoptera brydei,* Eden's Whale, *Balaenoptera edeni, the* Blue Whale, *Balaenoptera musculus* and the Common Minke Whale, *Balaenoptera acutorostrata*. Rorqual whales are commonly found in open offshore waters; however they are sometimes associated with bays and inlets (DEWHA, 2009).	**Possible**: Suitable habitat present.
Humpback Whale *Megaptera novaeangliae*	V		V	The majority of Humpbacks can typically be found along various parts of the Australian coastline for up to nine months of the year (April to December) and migrate north to tropical calving grounds from June to August, and south to Southern Ocean feeding areas from September to November. Cow-calf pairs and attendant males appear to use sheltered bays to opportunistically rest during migration to the feeding grounds, including Twofold Bay, NSW (DEWHA, 2009). This species is known to occur periodically within Sydney Harbour.	**Likely**: Suitable habitat present.
Common Dolphin *Delphinus delphis*			P	Common Dolphins are found in offshore waters. Information on the species habitats is only available from outside of Australia. In most areas where they have been studied, Common Dolphins appear to occur mainly in medium water depths over the continental shelf however, this species has been sighted in inshore coastal areas (DEWHA, 2009). This species is known to occur within Sydney Harbour	**Likely**: Suitable habitat present.
Risso's Dolphin *Grampus griseus*			P	Risso's Dolphin occur mainly on steep sections of the upper continental slope (Baumgartner 1997), usually in waters deeper than 1000 m (Ross 1984), in tropical and warm temperate latitudes (DEWHA, 2009). There are no known records of this species occurring within the study area.	**Unlikely**: Suitable habitat not present.
Killer Whale *Orcinus orca*			P	The Killer Whale is found in all oceans and seas of the world usually in family groups. They occur in most habitat types from coastal areas to the deep ocean waters, from the tropics to polar regions and have been sighted throughout Australian waters. The habitat of Killer Whales is difficult to categorise due to the cosmopolitan nature of the species (DEWHA, 2009). This species is known to occur occasionally within Sydney Harbour.	**Possible**: Suitable habitat present.

Order	TSC Act	FM Act Status	EPBC Act Status	Habitat Association	Likelihood of Occurring in Study Area
False Killer Whale *Pseudorca crassidens*			P	False Killer Whales have an extensive and wide distribution within tropical and warm temperate waters. They seem to prefer areas of deep water in the open ocean away from land (DEWHA, 2009). There are no known records of this species occuring within the study area.	**Unlikely**: Suitable habitat not present.
Spotted Dolphin *Stenella attenuata*			P	Pantropical Spotted Dolphins inhabit both near-shore and oceanic habitats in tropical and warm temperate seas. They have also been found on the shelf and along the continental slope (DEWHA, 2009). There are no known records of this species occuring within the study area.	**Unlikely**: Suitable habitat not present.
Striped Dolphin *Stenella coeruleoalba*			P	The Striped Dolphin is a temperate to tropical species which inhabits pelagic and oceanic waters. All sightings have been made in waters where the sea surface temperature exceeds 25 °C (DEWHA, 2009). There are no known records of this species occuring within the study area.	**Unlikely**: Suitable habitat not present.
Bottlenose Dolphin *Tursiops truncatus*			P	Bottlenose Dolphin are usually found offshore in tropical and temperate waters deeper than 30 m (Hale et al. 2000; Ross 2006) but also inhabit inshore areas such as bays, lagoons and estuaries, and nearshore (open coast) and offshore environments, including the coast of oceanic islands. They are associated with many types of substrate and habitats, including mud, sand, seagrasses, mangroves and reefs (DEWHA, 2009). This species is known to occur within Sydney Harbour.	**Likely**: Suitable habitat present.
Pygmy Sperm Whale *Kogia breviceps*			P	The Pygmy Sperm Whale is considered to have a cosmopolitan, oceanic distribution. They occur in tropical and temperate oceans around the world, living mostly beyond the edge of the continental shelf (DEWHA, 2009), however, this species has previously been recorded within Sydney Harbour.	**Unlikely**: Suitable habitat not present.
Sperm Whale *Physeter macrocephalus*	V		P	Sperm Whales tend to inhabit offshore areas with a water depth of 600 m or more, and are uncommon in waters less than 300 m deep (NOAA Fisheries Fact Sheet 2006). There are no known records of this species occurring within the study area.	**Unlikely**: Suitable habitat not present.
Strap-toothed Beaked Whale *Mesoplodon layardii*			P	The Strap-toothed Beaked Whale apparently prefers deep oceanic waters of temperate (10–20 °C) to subantarctic (1–8 °C) regions (Pittman 2002; Ross 2006). Beaked whales may be found from the continental slope to the abyssal plain Breeding areas and habitat are unknown, but are presumed to be oceanic (DEWHA, 2009). There are no known records of this species occurring within the study area.	**Unlikely**: Suitable habitat not present.

Order	TSC Act	FM Act Status	EPBC Act Status	Habitat Association	Likelihood of Occurring in Study Area
SEAGRASS					
Eel-grass *Zostera capricorni*		P		*Z. capricorni* is the most common seagrass within NSW waters. This species is found on tidal flats in most rivers and lagoons and is generally associated with sheltered mud and sand substrates in depths of 0–7 m. This species has been identified within the study area.	**Likely**: Suitable habitat present.
Strap-weed (*Posidonia australis*)		P		Strap-weed occupies purely marine environments where sediments are stable and thus occupies fewer habitats throughout the NSW coast than Eel and Paddle-grass (NSW DPI, 2007). It occurs in dense meadows or along channels in sandy substrates and is found at depths from 1 to 15 metres. Eel-grass is particularly susceptible to impacts. This species is known to occur within Sydney Harbour.	**Unlikely**: Suitable habitat present however this species is highly susceptible to disturbance and thus is not expected within the study area.
Paddle-grass (*Halophila sp.*)		P		The range of *Halophila ovalis* and *H. decipiens* extends the length of New South Wales, while *H. australis* is present between central New South Wales and all of Victoria. *H. decipiens* also occurs along the NSW coast but is chiefly found growing near Sydney, in the Hawkesbury Shelf Bioregion. *Halophila* has a wide habitat range but its growth appears to be very seasonal. This species has been identified within the study area.	**Likely**: Suitable habitat present.

Note: PE = Presumed Extinct, CE = Critically Endangered, E = Endangered, V = Vulnerable, P = Protected.

4.1.10 Water quality

Water quality in Sydney Harbour is typical of an urbanised catchment. It is likely that a number of port and non-port related activities including accidental spills and polluted stormwater run off from land combine to affect water quality. This includes sediment in runoff from construction and maintenance activities and litter and other contaminants such as oil from the catchment.

Water quality within Sydney Harbour is heavily influenced by runoff following large rain events. Runoff from urban areas is generally contaminated with sediment, nutrients, hydrocarbons, heavy metals, pathogens, and other toxic, and occasionally persistent chemicals (DEC, 2006). This contamination originates from roads, sewer overflows, spills, industrial activities, building sites and other sources. Water quality is comparatively better during drier periods with reduced volumes of runoff.

The impacts of such contamination include a reduction in species diversity, loss of pollution-sensitive species and high levels of persistent toxicants in sediments and marine species (DEC, 2006). The main threats to water quality, and therefore aquatic biota, as a result of stormwater input are:

- Sedimentation, as suspended sediment reduces light penetration and affects photosynthesis and can smother habitat;
- Deoxygenation as a result of organic loading; and
- Pollutants.

4.2 Field investigations

Field notes, including individual transect line intercept notes are presented in Appendix A.

4.2.1 Proposed outlet location habitat description – transects 2 - 6

Intertidal

The intertidal zone comprised of a vertical sandstone seawall that continues around Bennelong Point and Farm Cove. The habitats observed during these surveys were typical of many intertidal habitats within Sydney Harbour and are described in section 4.1.5.

Dominant species observed on the seawall included the Sydney Rock Oyster (*Saccostrea glomerata*), limpets (*Cellana tramoserica* and *Patella* sp.), Murex shell (*Morula marginalba*) and an unidentified species of Chiton (see Figure 4-1). Sydney Rock Oysters are common throughout sheltered, rocky, intertidal environments in NSW and beyond due to their natural abundance, as are the other invertebrate species recorded during this survey (Edgar, 2000). *M. marginalba* plays an important role in structuring intertidal communities as a dominant predator upon other intertidal invertebrates.

These species were observed as common throughout all seawall areas surveyed and are typical of the many rocky, intertidal habitats within NSW coastal waters. Due to the relative abundance of these species and the relatively limited extent of intertidal habitat included within the study area there is little risk of this environment being adversely impacted by the project.

No threatened species were observed within this area.

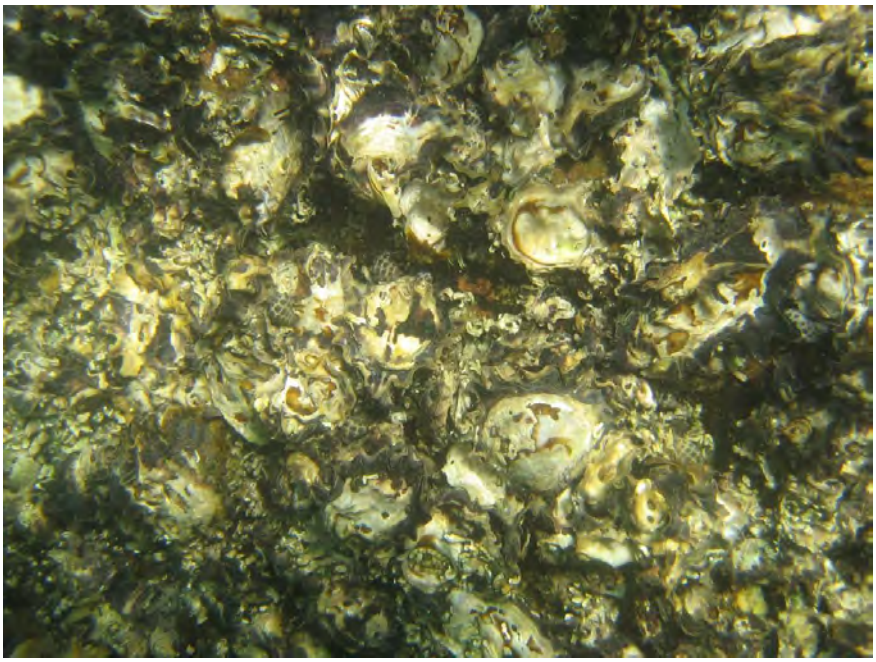

Figure 4-1 *Saccostrea glomerate* with *Morula marginalba*

Subtidal

The majority of the subtidal environment within the immediate vicinity of the proposed outlet location was characterised by macroalgal growth, areas of bare substrate and some rocky reef. Overall, this area was reasonably modified, however, despite large quantities of foreign man-made items littering the ocean floor; the study area retained a diversity of habitat suitable for a variety of aquatic biota.

Transects 2 – 6 were located within the immediate vicinity of the proposed outlet. The benthos within the area surveyed was generally medium grained sands with areas of shell grit and rocky rubble. Rubbish such as tyres, bottles, bricks, scrap metal and other construction material was prevalent throughout.

The habitat within the location of the proposed outlet was generally dependent on the presence of structure to provide an anchor point for green and brown algae. The green algae *Caulerpa filiformis* (Figure 4-1) and the common kelp *Ecklonia radiata* (Figure 4-3) were the dominant species occupying the hard substrate within the immediate vicinity of the seawall where they provide up to 100 % cover in localised areas. They were particularly prevalent along the Man O' War jetty structure. However, the majority of the area surveyed within the vicinity of the proposed outlet was the sandy rubble described above, with a very sparse and patchy coverage of *Ecklonia*, *Sargassum*, *Padina* and *Caulerpa* within around 10 m offshore from the seawall. Further offshore no hard benthic organisms were observed and the substrate was predominantly sand and shell grit that continued to at least 15 m from the seawall. Around 15 m was the limit that could be surveyed on snorkel in this area as depth limited visibility.

The only fish species observed during the survey were two Smooth Toadfish (*Tetractenos glaber*) and one Fan-bellied Leatherjacket.

Of noticed was a small localised area of *Zostera* seagrass that was identified along Transect 3 (Figure 4-4). The seagrass was observed from 3.9 m to 7.8 m, providing approximately 20 % cover with moderate epiphytic growth. The area occupied by the seagrass lay within close proximity to an area that experiences a high level of disturbance, being the Man-O'-War Jetty. The extent of this seagrass bed was minimal and estimated to be approximately 20 m^2. *Zostera* is however included as a key habitat within the *Fisheries Management Act 1994* and therefore requires consideration. This was the only protected species identified within the survey area considered to have the potential to be affected by the project.

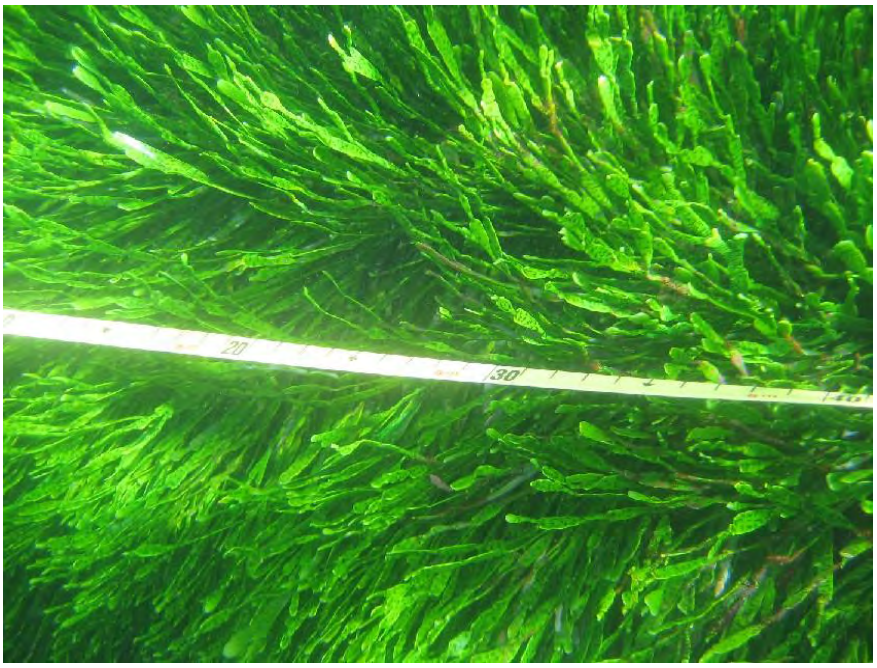

Figure 4-2 *Caulerpa filiformis* observed on hard substrate in the vicinity of the proposed discharge

Figure 4-3 *Ecklonia* observed on hard substrate in the vicinity of the proposed discharge

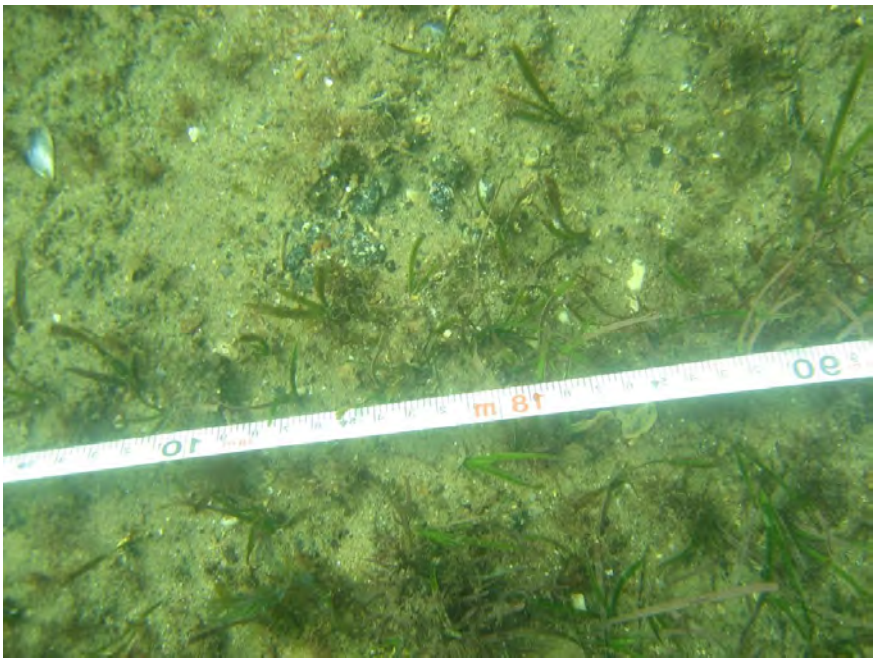

Figure 4-4 *Zostera capricorni* identified on Transect 3

4.2.2 External sites – transect 1, 7 and 8

Transect 1

Transect 1 was located on the western side of the Man O' War Jetty. Although spatially very close to the proposed outlet, for this survey it was considered an external site as direct water movement between the eastern and western sides of the jetty is prevented by the structure of the jetty. The site was less exposed than sites on the eastern side of the jetty and had a gentle slope allowing a 40 m transect to be surveyed before depth limited visibility. These physical characteristics of the benthic environment were associated with a habitat that varied markedly from that surrounding the site at the proposed outlet. Most notable was the higher abundance and diversity of seagrass within this region.

The inshore section (0 – 19 m) of this site comprised of unconsolidated sands with no epi-benthic organisms observed. At 19 m a narrow (1.4 m) strip of *Caulerpa filiformis* was observed. From 20.4 m out to the limit of survey at 40 m the benthos was dominated by seagrass beds. The seagrass beds comprised a combination of *Z. capricorni* and *Halophila australis* (Figure 4-5 and Figure 4-6) with approximately 90 % coverage. *Z. capricorni* became the dominant species with increasing depth. Small areas of *Caulerpa* were randomly distributed throughout. This area appeared to be in relatively good condition considering its urban locality and epiphytic growth was minimal. The extent of this seagrass bed is not known as depth limited visibility at 40 m from the shore.

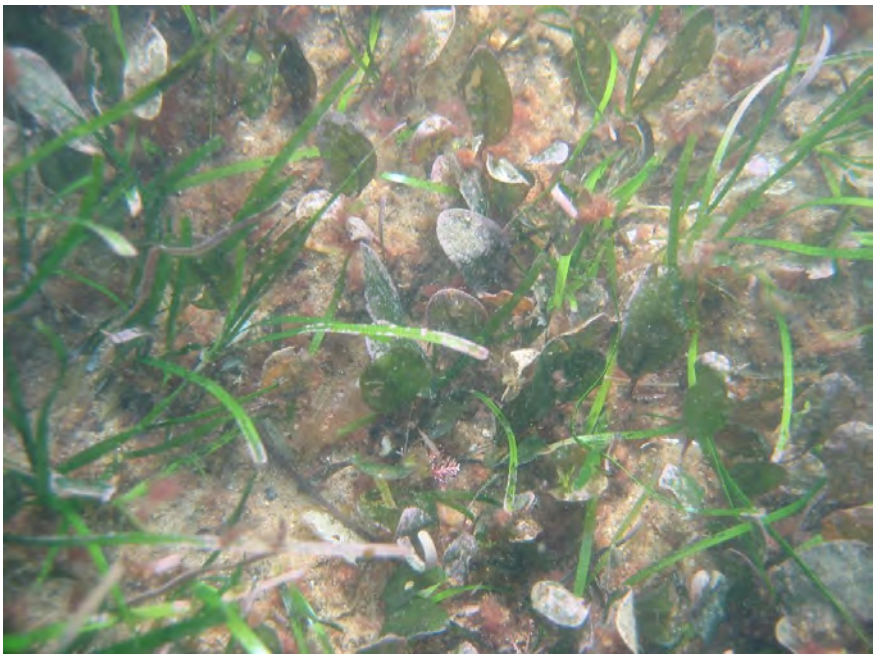

Figure 4-5 *Zostera* and *Halophila* seagrass along Transect 1

Figure 4-6 *Zostera* seagrass and tape measure at the end of Transect 1

Transect 7 and 8

Transects 7 and 8 were positioned off the northern end of Bennelong Point. The water depth at this location was greater than in the proposed discharge location (approximately 2 m at the seawall), which meant that the length of transect was much

shorter; however valuable observations could be made, particularly at the location of the existing outlet (Transect 7). The species that were observed along this area of seawall were the same as observed in the shallower proposed outlet location and dominated by *Caulerpa filiformis* and *Ecklonia radiata*. The main difference was that these species were found to be in much greater density in this area with around 80 % cover of the entire visible area.

A small area of seagrass was identified at the base of the existing outlet. Transect 7 ran from the outlet directly out towards the shipping channel. The seagrass *Halophila australis* (Figure 4-7) was recorded from 0 – 3.0 m and *Z. capricorni* from 3.0 – 6.2 m where depth limited further survey. Both seagrass species provided approximately 80 % cover. These results indicate that either these two species are largely tolerant of stormwater discharge at this location or that mixing within this region is sufficient to adequately disperse stormwater inputs.

Figure 4-7 *Halophila australis* at the base of the existing discharge

5. Impact assessment

5.1 Noise and vibration

Potential noise and vibration impacts relate to the concern that the sounds introduced into the sea by humans could have detrimental effects on marine fauna, by interfering with their ability to detect calls from individuals of the same species, echolocation pulses or other important natural sounds (Richardson *et al* 1995). Construction of the project has the potential to temporarily impact upon the marine biota via the generation of noise and vibrations associated with machinery working in and around the water during construction. This impact is unlikely to be significant as the noise and vibration generated during construction would be intermittent, short term and limited to the area immediately adjacent the proposed outlet. In an urbanised location such as this, and with the large volume of boat traffic regularly using the area, it is unlikely that construction noise would pose a significant impact to the marine environment.

Cetaceans are sensitive to acoustic pollution and have been shown to actively avoid such environments. It is possible that acoustic pollution may deter migratory cetaceans from temporally occupying Farm Cove.

5.2 Sedimentation

Sediment mobilisation has the potential to decrease water quality and smother seagrass and algae in the immediate vicinity of the study area during both construction and operation. It is possible sediment mobilisation could occur directly from construction of the outlet and indirectly from runoff associated with other construction. With the adoption of an appropriate construction environmental management plan (CEMP) that provides measures for sediment mobilisation and containment, it is expected that the potential for adverse impacts would be negligible.

Based on the available data, the Bennelong Diversion Drain Hydrology and Drainage Report (GHD, 2009) concludes that the suggested location of the new outlet is within an area that is buffered and therefore poorly mixed. This is due both to the shallow, gently sloping bathymetry at the new site and the lack of adequate hydrodynamic properties at this site that promote rapid sediment dispersal. The project has the potential to increase the deposition of sediment in the immediate vicinity of the outlet depending on the quantity of sediment flushed from the drainage catchment. The hydrology report notes that Sydney Water has advised there is a sediment trap in the Sydney Opera House Car Park, immediately upstream of the subject section of the Bennelong Drain. Sydney Water advised that the sediment trap is considered to be operating effectively and that it is required to be emptied relatively infrequently. Due to there being limited circulation in an area to the north of the outlet, it is possible that sediment may be deposited at the junction of the corner of the groyne and the existing eastern seawall.

The small community of *Z. capricorni* which lies adjacent Man O' War jetty is sparsely distributed and limited in extent. Investigations undertaken as part of the environmental

assessment suggest that sedimentation may not extend to this region. However, due to the range of data on sediment loads in stormwater (GHD, 2009), it is conceivable that sedimentation impacts may extend beyond the junction between the wharf and seawall to this small bed of *Z. capricorni* (located during Transect 3). *Z. capricorni* is a hardy, tolerant species which can recolonise by vegetative growth and can therefore survive small-scale disturbances (i.e. recolonisation of cleared areas can occur from surrounding rhizomes). As this patch is relatively limited in size (approximately 20m^2) and the impacts of sedimentation are not expected to extend to this area, the potential impacts to this patch of seagrass are considered to be largely negligible.

Sedimentation also has the potential to smother, and therefore, adversely impact the dense communities of *C. filiformis* and *E. radiata* which were identified. The impacts of the project upon macroalgal communities within the wharf/seawall junction are unlikely to be significant at a species level as both *C. filiformis* and *E. radiata* are common throughout Sydney harbour.

As Farm Cove is sheltered and has a shallow sloping seabed there is the potential for sedimentation in the vicinity of the outlet. This would be monitored via inspections undertaken as part of ongoing operation and maintenance of the overall system, including the upstream sediment trap and performance of the outlet.

5.3 Habitat removal

Whilst there would be some small-scale habitat loss, it would be primarily due to the removal of a small section of seawall. This section is occupied by intertidal habitat which is prevalent within the outer harbour. As such this impact is considered negligible.

As noted in Section 5.2, there is a possibility that a small area of *Z. capricorni* on the eastern side of the Man O' War Jetty may be impacted by the project. The seagrass in this area composes a disconnected remnant area of approximately 20 m^2 and is considered in much poorer condition than the more extensive seagrass bed to the west. The *Ecklonia* and seagrass beds in the vicinity of the outlet have the potential to provide habitat for the weedy sea dragon, however the larger seagrass bed to the western side of the jetty is more likely to provide substantial, stable habitat. The habitat on the eastern side of the jetty is in poor condition and exhibits signs of scouring due to boat traffic which would make the site unlikely to support fragile seahorse colonies. The western side which is outside the area of impact is much more sheltered and supports denser seagrass and macroalgae providing better habitat for marine communities particularly Syngnathids.

5.4 Water quality

Following completion of the project the primary cause of potential impacts would be the introduction of a periodic discharge of stormwater coinciding with rain events. As the project is not introducing a 'new' discharge into Sydney Harbour, but rather diverting an existing discharge to a new location, far field impacts are considered unlikely. Potential

impacts are likely to be limited to the marine communities within the immediate vicinity of the new discharge location.

The introduction of a stormwater discharge at the site has the potential to result in short term periodic changes in water quality. Discharges from the Bennelong Drain would occur concurrently with other stormwater discharges to Sydney Harbour and would be diluted in the receiving water body. This is considered a secondary impact, as sedimentation impacts likely to result in the most visible changes to the marine communities.

The species identified at the proposed outlet location were the same as those identified at the site of the existing outlet, indicating that these species are tolerant of water quality fluctuations associated with the stormwater outlet. It is noted that the potential for dilution and mixing within the receiving waters appears to be lower at the proposed site than the existing site, as the proposed site is shallower, more protected (within a bay compared to on a point) and bounded on one site by a jetty structure. Sydney Water periodically undertakes monitoring of discharges from its overall stormwater network to identify impacts on water quality. The results of monitoring relevant to the Bennelong Drain were not available at the time this report was prepared.

5.5 Threatened and protected species

Many of the threatened and protected species identified (Section 4.1.9) are either unlikely to occur within the study area or are threatened by processes exclusive of activities relevant to the project. Threatened and protected species that have some potential of being impacted by the project and a summary of potential issues have been included within Table 3.

The conclusion of our assessment is there is not likely to be any significant impacts on threatened or protected species or their habitats as listed under the TSC Act, FM Act and EPBC Act as result of the project.

Table 3 Possible impacts to threatened and protected species

Name	Threat	Risk	Reason
Weedy Sea Dragon *Phyllopteryx taeniolatus*	Habitat loss Water quality	Low	The proposed site contains various species of seagrass and macroalgae, which provide habitat for this species. Some marginal habitat has the potential to be removed and by sedimentation, however, the impact of the project is relatively restricted in area. Provided that discharge waters are intermittent, threats to this species should be minimal. There is however, a risk of adverse affects to individuals if discharge water is highly polluted.
Elegant Wrasse *Anampses elegans*	Habitat loss	Low	Risk to this species should be low as it is relatively uncommon; however, inshore seaweed beds have been identified as important habitat for juveniles.
Black Cod *Epinephelus daemelii*	Habitat loss	Low	Juveniles are known to inhabit rocky shorelines; however, they prefer sheltered areas such as rock pools and estuaries. As the area to be impacted is relatively small any impacts of habitat loss should be minimal at a species level.
Southern Right Whale *Eubalaena australis*	Acoustic pollution Habitat loss Water quality	Low	As noise produced as a result of construction will be intermittent and the project site is already heavily industrialised, acoustic impacts upon this species are presumed to be negligible. As this site receives a high quantity of boat traffic it is unlikely to be a significant site for feeding, calving or resting. Therefore habitat loss and water quality within the study area are unlikely to impact this species.
Unidentified Rorqual *Balaenoptera sp.*	Acoustic pollution Habitat loss Water quality	Low	Rorqual whales are more likely to occur in offshore habitats and therefore the project is not likely to impact this species.
Humpback Whale *Megaptera novaeangliae*	Acoustic pollution Habitat loss Water quality	Low	As noise produced as a result of construction will be intermittent and the project site is already heavily industrialised, acoustic impacts upon this species are presumed to be negligible. As this site receives a high quantity of boat traffic it is unlikely to be a significant site for feeding, calving or resting. Therefore habitat loss and water quality within the study area are unlikely to impact this species.

Name	Threat	Risk	Reason
Bottlenose Dolphin *Tursiops truncatus*	Habitat loss Water quality	Low	This species is known to generally inhabit offshore marine waters, however, they are also known to frequent inshore mud, sand and seagrass habitats. As this site receives a high quantity of boat traffic it is unlikely to be a significant site for feeding, calving or resting. Therefore habitat loss and water quality within the study area are unlikely to impact this species.
Common Dolphin *Delphinus delphis*	Habitat loss Water quality	Low	This species is known to generally inhabit offshore marine waters, however, they are also known to frequent inshore mud, sand and seagrass habitats. As this site receives a high quantity of boat traffic it is unlikely to be a significant site for feeding, calving or resting. Therefore habitat loss and water quality within the study area are unlikely to impact this species.
Eel-grass *Z. capricorni*	Sedimentation Water quality	Moderate Low	There is the potential for indirect impacts to the immediate bed of *Zostera* during construction and operation if construction activities are inadequately managed and sedimentation results during operation. The area to be disturbed is limited in size and is highly disturbed. Furthermore, *Zostera* is relatively hardy and has the ability to recolonise from surrounding rhizomes. As a result, impacts to the community within Farm Cove as a whole are thought to be negligible. As the community identified lies just beyond the area of potential impact, the risk of sedimentation upon the immediate area is moderate. *Zostera* is a tolerant species which already exists within close proximity to the existing outlet. Further more, the community identified during Transect 3 is further removed from the outlet. Impacts upon this species as a result of variable water quality are therefore considered negligible.

5.6 Other species

Although many species are expected to use environments within Farm Cove, the potential for alterations to habitat as a result of the project are expected to be minimal. Considering the site is relatively contained, exists within a highly modified environment, and that the project involves replacing a nearby structure of similar design and function, risks to other marine species within Sydney Harbour is thought to be negligible.

6. Recommended mitigation measures

6.1 Construction

Mitigation measures during construction would be based on the management of the site outlined in the CEMP and the erosion and sediment control plan. Whilst impacts have not been identified as significant, particular emphasis would be required for the management of sedimentation. Construction has the potential to increase sedimentation impacts that would decrease water quality values in the direct vicinity of the works. The CEMP should address the maintenance of existing water quality and ensure suspended solids are not introduced to the receiving environment.

6.2 Operation

Operation of the drain would introduce storm water flows to a more sheltered area than the previous location. The hydrology and drainage report indicates that there is potential for the discharges to directly impact on the receiving environment. It is recommended that:

- The quantity of sediment discharged from the outlet to the receiving environment be further quantified post construction. This would be undertaken as part of Sydney Water's existing operational plan for the overall stormwater network and would involve inspections of the sediment trap immediately upstream of the project to ensure it is operating effectively; and
- Periodic water quality monitoring of discharges from the drain would be undertaken as part of Sydney Water's existing operational plan for the overall stormwater network.

7. Conclusion

This assessment concludes that the overall impacts of the project upon the marine community of Farm Cove should be largely negligible; however, some localised impacts may occur.

The potential for impacts may result from habitat loss due to construction activities, and the potential smothering of marine communities as a result of sedimentation if inadequately managed. Sydney Water has an existing sediment trap immediately upstream of the project which would minimise the volume of sediment discharged from the drain.

Habitat loss would occur due to the removal of a section seawall to facilitate the new outlet. However, the area designated for removal is restricted in regard to the overall seawall habitat available within this area. It is likely some macro-algal communities would be negatively impacted if discharged sediment and is deposited within the corner of the eastern seawall and the adjacent corner of the groyne. Impacts upon such habitats within this region are unlikely to significantly affect the status of communities of *C. filiformis* and *E. radiata* throughout Sydney Harbour.

It has been noted that the drain outlet is positioned in an area that is protected from tidal current and wave action induced mixing and is likely to result in sediment deposition in the vicinity of the discharge point. This increases the possibility that impacts upon marine communities may be different to the impacts of the outlet in its current position. This is due to the fact the existing outlet is both more exposed to tidal flows, vessel movements, wind and wave action, and empties upon a more rapidly sloping seabed. Despite this, the project is expected to have a negligible overall impact to protected species or their habitat within the region.

The potential impacts associated with the construction of the project are largely temporary and short term related with noise generated from construction. Managing these potential impacts can be achieved through the development and implementation of the CEMP. Potential impacts associated with the operational phase of the project would be mostly due to sediment deposition from the drain. Sediment deposition is likely to be insignificant given low sediment yields for this catchment and the operation and management of the sediment trap up stream of the outlet. Based on these considerations there is not likely to be any significant impacts on threatened or protected species or their habitats.

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Appendix A

Field notes

Transect 1	Western side of jetty - base of 400mm stormwater outlet
0 - 19m	Unconsolidated sand, rubbish, loose Caulerpa & Ecklonia
19 - 20.4m	Caulerpa filiformis ~ 90% cover
20.4 - 40m	Seagrass beds. Mix of paddle-grass (*Halophila)* australis and eel-grass (*Zostera)* ~ 70% cover
40m+	Too deep *Zostera* continued
Comments:	Established seagrass beds between jetty and opera house, gently grading shore profile

Transect 2	Eastern side of jetty along rockwall
0 - 2.3	Kelp (*Ecklonia*)
2.3 - 2.8	Green algae (*Caulerpa filiformis*)
2.8 - 4.3	Kelp (Ecklonia)
4.3 - 5.1	Green algae (Caulerpa filiformis)
5.1 - 6.4	Kelp (Ecklonia)
6.4 - 9.1	Green algae (Caulerpa filiformis)
Comments:	This transect ran along the edge of the small causeway area of the jetty, so was dominated by green and brown algae which are prevelant along rockwalls within the area.

Transect 3	Runing from the end of T2(from the coner of the jetty) out towards the ferry berths.
0 - 3.9	Kelp (Ecklonia) with rubble
3.9 - 7.8	Sand with rubble, sparse seagrass (Zostera) ~20% cover
7.8 - 15	Sand with rubble
15+	Too deep appeared as if sand and rubble continued.
Comments:	This transect eastern corner of the jetty and reached depth relatively quickly. Seagrass colinisation may be limited by scouring due to boat movements?

Transect 4	From proposed discharge point straight out.
0 - 4.1	Green algae (Caulerpa filiformis) 100% cover
4.1 - 8.1	Rocky rubble with sparse brown algae (Sargassum and Padina)
8.1 - 11	Rocky rubble with sparse kelp (Ecklonia)
11 - 12.2	Bombie with 100% Ecklonia coverage on sides and Caulerpa coverage on top
12.2 - 16.5	Sand with rubbish, bottles etc
16.5+	Too deep
Comments:	This transect appeared consistent with what you would expect in such an urban environment. Lots of brick and rock rubble and rubbish such as bottles and tyres. Depth started at around 1.2 m at the wall to ~2.5 at 15m. Incidental fish sighting included two Smooth toadfish (Tetractenos glaber) - one of the most abundant fish in muddy estuarys along the SE of Aust, and one Yellow-finned leatherjacket (Mauschenia trachylepis) - these are abundant near the entrances to NSW estuaries and also seen on coastal reefs.

Transect 5	From wall ~10m east of proposed discharge point (small oufall in wall)
0 - 9	Rocky rubble, Caulerpa, Ecklonia, Sargassum mix ~ 5% cover total
9.0 - 16	Sand with some small rubble and gravel, shell grit. Rubbish bricks, bottles, scrap metal etc
16 +	Too deep
Comments:	Similar to T4.

Transect 6	Further east of T5 at the next small outfall in rockwall
0 - 5.2	Sand with some gravel and rubble, sparse Sargassum ~5% cover
5.2 - 9.9	Sand with shell grit, Sargassum and Padina mix ~10% cover total
9.9 - 15	Sand and shell grit
15+	Too deep
Comments:	Similar to T4.

Transect 7	At site of existing Bennalong drain outfall, extending outwards
0 - 3.0	Seagrass bed (Halophlia) ~80% cover
3.0 - 6.2	Seagrass bed (Zostera) ~80% cover, flanked to the east by Ecklonia kelp and Caulerpa green algae ~ 90% cover
6.2+	Too deep
Comments:	Drain extended to near seabed. Thick epibenthic growth the entire way along the wall. Deeper site - around 3m and drops away quickly towards shipping channel marker.

Transect 8	From wall ~ 30 west of existing Bennalong drain outfall.
0 - 6.0	Ecklonia and Caulerpa mix ~ 80% cover. Sandy rubble substrate.
6.0+	Too deep
Comments	Thick Ecklonia and Caulerpa growth throughout visible areas along the wall. Deeper site - dropping away towards shipping channel.

Mrs Maquaries Point Opposite side of Farm Cove

Visual inspection only - Ecklonia and Caulerpa were common and abundant along the majority of rockwalls and rock platforms.

Rockwall general description

The rockwalls themselves were dominated by Sydney Rock Oysters (*Saccostera glomerata*), limpets and chitons. Occasional seastars were observed.

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