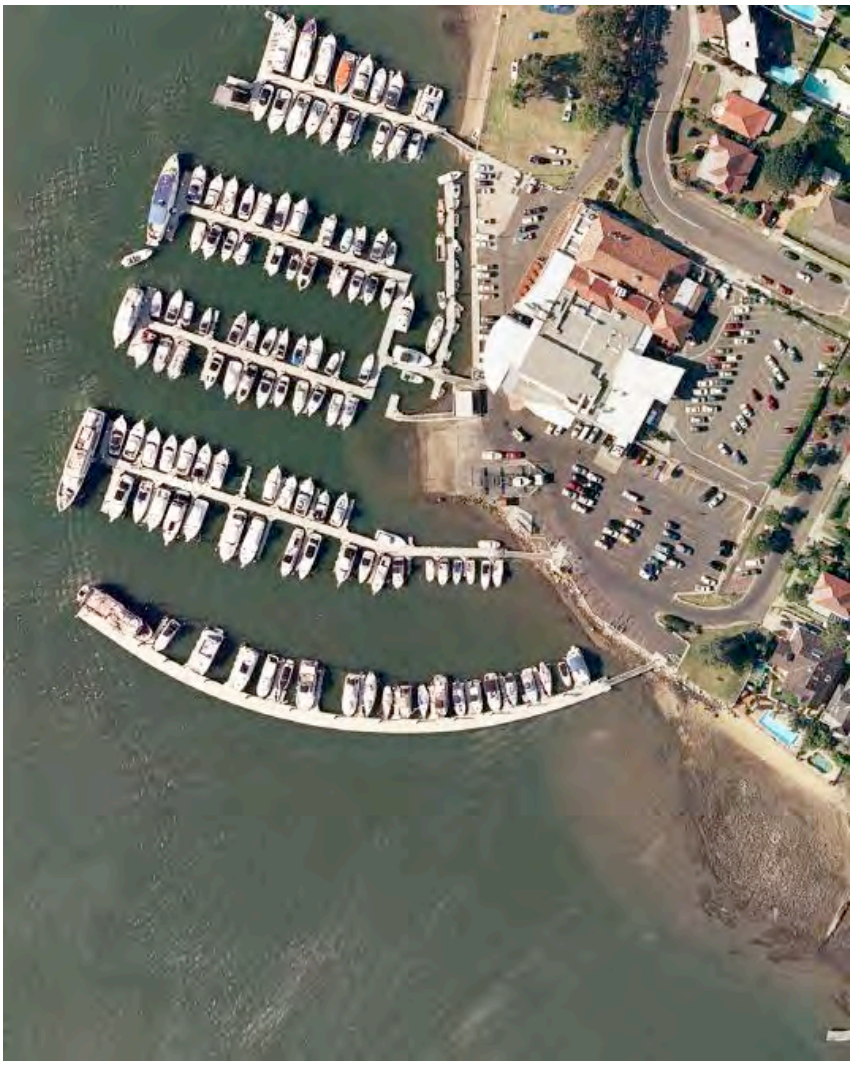
St GEORGE MOTOR BOAT CLUB
MARINA REDEVELOPMENT

AQUATIC ECOLOGY IMPACT ASSESSMENT



Report Prepared for Planning Ingenuity Pty Ltd

Marine Pollution Research Pty Ltd
February 2010

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1 INTRODUCTION

As outlined in a Preliminary Environmental Assessment prepared by Design Collaborative Pty Ltd in 2009, St George Motor Boat Club (SGMBC) have lodged an application to expand the Club's existing marina to provide an additional arm to the south of the existing marina (proposed Arm F). Approval is also sought for the continued use of 23 currently unauthorised berths in the existing marina. The proposed development will increase the number of berths at the marina to a total of 229 berths.

The site of the proposal is the St George Motor Boat Club at Wellington Street, Sans Souci. The Club is an existing development located at St Kilda Point, the eastern entry to Kogarah Bay on the Georges River, which supports a range of land and water-based facilities (both private and public). The Club has an existing lease from the Department of Lands for that part of the Club's site on Crown land. That lease relates to the water-based part of the land occupied by the Club together with part of the foreshore.

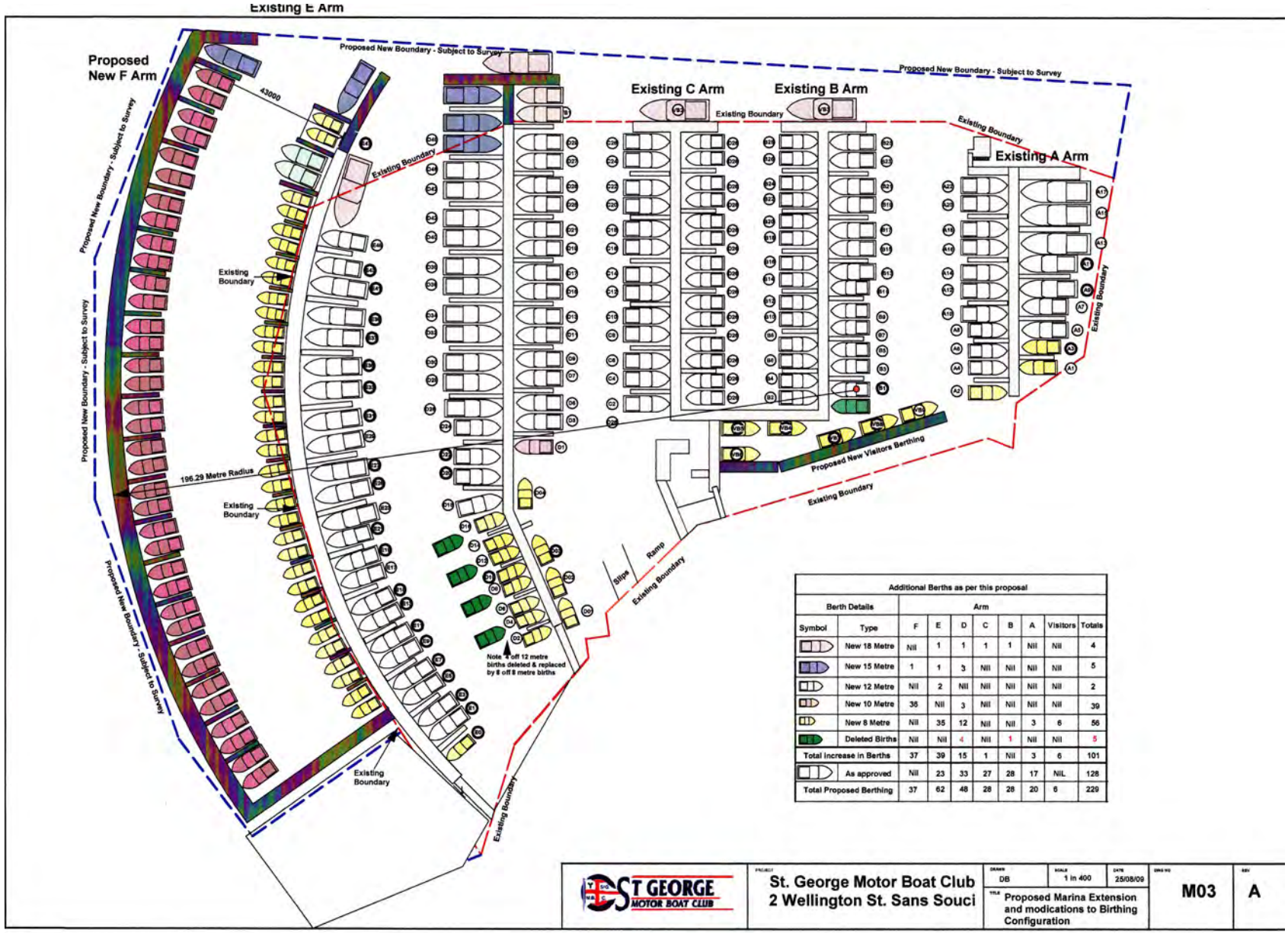
Marine Pollution Research Pty Ltd (MPR) has been requested by Planning Ingenuity Pty Ltd to provide an assessment of the potential aquatic ecological impacts arising from the proposed St. George Motor Boat Club Marina upgrade. The assessment is to address the requirements for development assessment contained in the Dept of Planning (DoP) Director General's Requirements for the "St George Motor Boat Club Marina Upgrade 2 Wellington Street Sans Souci" (dated 8 May 2009).

1.1 The Proposal

With regard to aquatic ecological assessment of the proposal, the existing marina facility (see aerial view on Cover Page) consists of the following:

- A floating pontoon marina structure utilising five floating pontoon walkways (Marina Arms A to E) oriented more or less east to west. The floating pontoon pen structures are connected together and to shore via floating pontoon walkways, ramps and fixed gangways,
- There are two fuel berths plus sewage pump out facilities,
- There is a dual rail slipway and there are three concrete boat launching ramps.

Details of the proposed Marina redevelopment project are contained in a General Arrangement Drawing prepared by SGMBC (drawing MO3 Revision A dated 25 Aug 2009) – see Figure 1 below.


Existing E Arm
Proposed New F Arm
Proposed New Boundary - Subject to Survey
43000
Existing Boundary
Existing C Arm
Existing B Arm
Existing A Arm
196.29 Metre Radius
Proposed New Visitors Berthing
Slips
Ramp
Note 1 off 12 metre births deleted & replaced by 8 off 8 metre births
Additional Berths as per this proposal
Berth Details
Arm
Symbol
Type
F
E
D
C
B
A
Visitors
Totals
New 18 Metre
Nil 1 1 1 1 Nil Nil 4
New 15 Metre
1 1 3 Nil Nil Nil Nil 5
New 12 Metre
Nil 2 Nil Nil Nil Nil Nil 2
New 10 Metre
36 Nil 3 Nil Nil Nil Nil 39
New 8 Metre
Nil 35 12 Nil Nil 3 6 56
Deleted Births
Nil Nil 4 Nil 1 Nil Nil 5
Total Increase in Berths
37 39 15 1 Nil 3 6 101
As approved
Nil 23 33 27 28 17 NIL 128
Total Proposed Berthing
37 62 48 28 28 20 6 229
ST GEORGE MOTOR BOAT CLUB
St. George Motor Boat Club
2 Wellington St. Sans Souci
DB
1 in 400
25/08/09
Proposed Marina Extension and modications to Birthing Configuration
M03
A

The main construction related items of the proposed redevelopment are:

- Installation of 39 new berthing pens on the southern side of existing arm E (35 new 8m berths, 2 new 12m berths, one 15m berth, and one new 18m berth).
- A seaward extension of the walkway of existing arm D approximately 10m to accommodate 3 new 15m berths, 2 new 10m berths, and one new 18m berth at the outermost berth.
- Construction of a new floating pontoon arm (arm F) attached to, and running parallel with existing marina arm E on the southern side. Arm F will accommodate 36 new 10m berths plus one 15m berth at the outermost berth. Access to Arm F will be via a 25 m floating pontoon walkway from Arm E and orientated parallel to the shoreline.
- Arm F is some 196 m long and is separated from Arm E by 43m, providing a fairway between proposed berths of 21m.
- Relocation of the existing fuel berth to the outer part of Arm A.

In addition to the marine construction elements described above, the aquatic ecology assessment is to include consideration of the continued use of 23 berths plus associated floating infrastructure that do not conform to the previously approved consent. The locations of the 23 berths plus associated floating walkways that are to be assessed are also shown on Figure 1. The proposed marina expansion and continued use of the additional berths requires the existing lease area to be expanded by 1.33 ha to 3.76ha (see Figure 1).

MPR (2001) provided a previous aquatic ecology impact assessment for the conversion of the then fixed timber jetty-based marina to the present floating pontoon and walkway based marina. In regards to the comparisons of the previous assessment (MPR 2001) to the present assessment, the following points are pertinent:

- Unlike the previous development, the present proposal does not require any seabed dredging.
- The new Arm F plus associated boat pens and walkway infrastructure will be identical to the existing marina infrastructure and the construction methodology (pier placement and floating pontoon placement plus connection will be identical to the previous construction.
- There are no shore-based or intertidal works proposed, as the new marine arm will be accessed by a floating pontoon walkway attached to the adjacent arm E.

1.2 Scope of Work

This report provides an assessment of the aquatic ecological impacts of the Marina upgrade proposal. The assessment has been conducted with respect to the Department of Planning (DoP) Director General's Requirements (MP09-0035 dated 8 May 2009) plus attachments. With respect to aquatic ecology assessment, the following specific issues were identified by the various agencies:

- Assessment of any impacts on critical habitats, threatened species, protected species populations or ecological communities and their habitats in the region (Key Issue DoP Aquatic Flora and fauna).
- Assessment to include consideration of benthic communities (Kogarah Council).
- Detailed assessment of any impact of construction and operation on aquatic vegetation (DECC).
- Detailed description of piling techniques and the impact on the sea floor (DECC).
- Potential impacts to aquatic habitats (including seagrasses and threatened species under the Fisheries Management Act 1994 (FMA), from structures, their construction and subsequent use (DPI).
- Description of the aquatic habitats, identification of any impacts, discussion of mitigation and compensation measures and any alternatives (DPI).

As required by the DoP DGRs and other agencies, the aquatic ecology assessment has been undertaken with regard to the following Policies, Plans and Guidelines:

- NSW Fisheries (1999) Policy and Guidelines – Aquatic Habitat Management and Fish Conservation.
- Draft Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act 1979 (DEC/DPI 2005)
- Kogarah Bay Estuary Management Plan.

In order to meet these objectives the report is structured as follows:

- Provide a description of the existing environment, using existing and field baseline data.
- Provide an assessment of the potential impacts of all stages of the project, including cumulative impacts.
- Describe measures to avoid, minimise, and if necessary, offset the potential impacts of the project.

2 KOGARAH BAY ESTUARY

Kogarah Bay is located on the northern side of the Georges River just upstream from the confluence with Botany Bay (Figure 2). Kogarah Bay catchment is small (around 8 km^2) and is approximately 0.9% of the total Georges River catchment area. The bay is about 2.3 km in length and varies in width from about 500m to 700m, with water depths generally less than 3m (JWP 2005). There are no extensive natural rocky shores or reefs in Kogarah Bay although there is a small intertidal to shallow sub-tidal rock shelf immediately east of the St George Motor Boat Club Marina (Figure 2). There are, however, extensive man-made rocky features (or other hard substrata) that support rocky shore or reef biota.

Figure 2 Oblique aerial view of Kogarah Bay looking north from Georges River.

The bay is flushed by tides with a tidal exchange efficiency of around 2.2 days and generally the water quality within Kogarah Bay is a product of that found in the broader Georges River and Botany Bay system as a whole. The tidal range of the bay is from 0.8 to 1.2m with an average of 1m, and at low tide 80% of the bay has a depth of less than 2m (JWP 2005).

Notwithstanding the flushing characteristics of Kogarah Bay itself, the location of the marina, on St Kilda's Point at the mouth of the bay, places the marina more under the influence of Georges River and the marina waters would be expected to display similar tidal and storm flushing characteristics to the Georges River (MPR 2001).

Kogarah Bay is used for recreational activities such as fishing, swimming, sailing and tourism. SPCC (1989) noted the principal areas for recreational fishing in the vicinity of Kogarah Bay are in the Georges River just above the Taren Point Bridge. Within Kogarah Bay there are a number of boating storage facilities and sailing clubs including Botany Bay Yacht Club, Kogarah Bay and Connells Point Sailing Clubs, St George and Sutherlands Anglers Club, and there are two known tourist cruising operators who visit Kogarah Bay as part of their Botany Bay/Georges River cruises (JWP 2005).

Since 2002 there has been a commercial fishing closure placed on the entire Georges River – Botany Bay estuary. Prior to 2002 a single commercial fisher meshed the bay occasionally for blackfish and bream (NSW Fisheries Inspectors pers. comm. cited by MPR 2001). Whilst Georges River once supported a thriving oyster farming industry there is now no aquaculture activities in Georges River and the closest aquaculture operations are located in Botany Bay; native Sydney Rock and triploid Pacific oyster farming in Woolooware Bay and Mulloway farming off Silver Beach, Botany Bay.

Most of the original rocky shoreline has been modified around the perimeter of the bay to form artificial seawalls fronting the intertidal mud and sand-flats. The western shore is predominantly foreshore public reserves and residential properties with around 10 private jetties and 20 private slipways, and there is a four-ramp public boat launching facility at Dover Park. The eastern shore is predominantly single-dwelling residential with around 40 private jetties and 35 private slipways, two public marina facilities and one government marina. There is also a boat-launching ramp at the northern end of the Bay (at Torwood Street). The majority of swing moorings are located within the eastern half of the bay, north of the SGMBC lease area to Rawson St.

MPR (2001) noted that there was no available water or sediment quality data for Kogarah Bay other than Beach Watch data for the public swimming enclosures plus the sediment quality data collected for the proposed marina dredging. Subsequently, JWP (2005) has provided summaries of water and sediment quality data collected from Kogarah Bay since that time:

- JWP (2005) found that water quality in Kogarah Bay is similar to that of Georges River, with suspended solids and nutrients generally meeting ANZECC (2000) guidelines for the protection of aquatic life during dry weather although nutrient and suspended solids levels could be elevated at times, generally during storm events. Total phosphorus was often greater than the criteria and chlorophyll-a concentrations were more often greater than criteria. Bacterial levels met the criteria for recreational use during dry weather but were elevated during wet weather. Sources for water

pollution included urban runoff, sewer overflows, leachate from old landfill sites. Boating was implicated for litter plus possible sewage discharges and some petrochemical pollution from motor boats and accidental spills.

- Kogarah Bay is a silt trap for sediments entering the bay via catchment runoff and siltation rates in Kogarah Bay are said to be in the order of 45 mm per year. Sediments grade from sand in some of the intertidal shallows to silty clays in patches with silty sand predominant. Oil, grease, copper, lead and zinc concentrations tended to increase towards the centre of the bay and then with depth towards the Georges River mouth. JWP (2005) attribute the relatively high levels of trace metals to leachate from previous landfill and the effects of urban runoff.

With regard to the impacts of stormwater discharges on the aquatic ecology of Kogarah Bay, Kogarah Council commissioned a study on the benthic macrofauna colonising artificial units of habitat (AUH's) conducted by Sydney University in 2004-2005 (Chapman *et al* 2005). The study established AUH's within areas subjected to stormwater flows and at control locations. The study found that AUH's were colonised by a diversity of invertebrates, that abundances were patchy and sparse and that species diversity varied between locations and seasons. The study results were inconclusive regarding whether there was an impact attributable to proximity to stormwater outfalls.

With regard to the available water and sediment quality of the SGMBC study area, the Coastal Processes report prepared by Cardno Lawson Treloar (2010) for this project has summarised the results of original sediment data collected for the previous SGMBC dredging program undertake in 2002 and results of water quality sampling from the SGMBC lease area obtained in 2001 and 2009.

2.1 Existing Aquatic Habitat Information

MPR (2001) provided a comprehensive review of the aquatic habitats of Kogarah Bay as they related to the proposal to remove the timber jetty structures at St George Motor Boat Club, dredge the lease area and provide a floating marina (i.e., the present marina). Since that report there has been a catchment-wide study of the aquatic ecological resources of the Georges River that included Kogarah Bay (Williams et al 2004).

2.1.1 Marine Vegetation in Kogarah Bay

Marine vegetation (mangroves, saltmarsh and seagrass) are all recognised as significant nursery habitats for estuarine fish (NSW Fisheries 1999) and there have been a number of studies to map the distribution of these fisheries resources in the Georges River catchment.

Figure 3 Mapping of Zostera beds in Kogarah Bay (West et al 1985)

Figure 4 Mapping of *Zostera* beds in Kogarah Bay (Williams et al 2004).

The most recent mapping by Williams et al (2004) confirms the conclusion of earlier reports (West et al 1985 and MPR 2001) that there are no mangroves or saltmarsh resources in Kogarah Bay. Kogarah Bay does support seagrass beds. Figure 3 shows the West et al (1985) mapping of *Zostera* (eelgrass) beds in Kogarah Bay and Figure 4 shows the Williams et al (2004) mapping (based on 1998 photos).

Williams et al (2004) noted that whilst seagrass beds in Kogarah Bay had increased in size at some sites (most notably the bed off Tom Ugly's Point), others had decreased and/or become fragmented. In particular, the continuous narrow bed of *Zostera* that was mapped by West et al (1985) along the eastern shore had become fragmented at the southern end (as originally reported in MPR 2001) and less fragmented at the northern limits. Contrary to earlier studies, Williams et al (2004) also found small patches of strap weed (*Posidonia australis*) and mixed strap weed and eelgrass in the south eastern corner of the bay. This is currently the most upstream location of strap weed in the Georges River - Botany Bay estuarine system.

2.1.2 Aquatic fauna of Kogarah Bay

As described in MPR (2001) there was little available quantitative data on the true aquatic fauna (fish, invertebrates) of Kogarah Bay. Since that time NSWII Fisheries' Division has undertaken a survey of fish populations in the Georges River estuary based on sampling in April 2000 (Williams et al 2004). Whilst there were at least seven sites sampled in Kogarah Bay (see Figure 5 below), the available electronic report does not provide the results on a site-by-site basis. Comparison of Figures 4 and 5 indicate that at least one mud site is located at or near the SGMBC.

Appendix A provides the results of the study as reported in Table 22 of Williams et al (2004), and a summary in the Kogarah Bay EMP (JWP 2005) provides some additional information on fish diversity and abundance from the Kogarah Bay sites, but no breakdown for the individual sites:

- There were 87 species of fish and decapod fauna found in the total study, of which 46 were reported from the Central Mud Basin (the 20 sites shown on Figure 5).
- Seagrass sites in the Georges River had a distinctly different suite of species compared to bare substrata sites and there were seven species reported from the two unvegetated (mud) sites in Kogarah Bay and 20 species from the three seagrass sites (*Zostera*).

- Overall abundance at Kogarah Bay mud sites was 87 individuals compared to 275 from the *Zostera* sites, with mean abundance from sites being 43.5 on mud sites and 91.7 on *Zostera* sites (JWP 2005).
- Whilst no threatened species listed under the FMA were reported from the study, Williams et al (2004) caution that specific searches for threatened species would require more surveys (over years) using a variety of sampling equipment.

Figure 5 Fish Sample Sites for the Central Mud Basin (from Williams et al 2005)

Other aquatic fauna that utilise the resources of the Georges River estuary and could occur in Kogarah Bay include marine mammals (dolphins, seals and whales), seabirds and marine reptiles (turtles and sea-snakes). Of these, only seabirds are expected in Kogarah Bay. Neither the SPCC Water and Wading Bird Survey (SPCC 1979) nor the SPCC Coastal Resource Atlas for Botany Bay (SPCC 1989) indicated any significant usage of Kogarah Bay by fishing or wading birds. However, important wading bird areas are identified around the perimeter of Wollooware Bay and along the northern shore of the Georges' River mouth at Sans Souci, and it could be expected that some wading birds would utilise the Kogarah Bay mud flats during low tides. The seagrass beds provide nursery habitat for fish, and when fish are seasonally abundant, the bay waters are fished by a variety of sea-birds, mainly cormorant and tern species. Little Black Cormorants feed in large communal groups seasonally and are generally accompanied by sea gulls. Penguins are known from Botany Bay where they are generally reported from the outer bay waters, although they have been known to enter Georges River.

Figure 6 Location of Aquatic Ecological Habitats in October 2009.

Note that the seabed habitat seaward of the rock rubble habitats and seaward of the Marina seawalls and concrete ramps is all unvegetated soft sediment habitat.

3 AQUATIC ECOLOGY AT ST GEORGE MOTOR BOAT CLUB

MPR (2001) provided the results of a study of the aquatic ecology of the existing marina plus surrounds at that time, and the results of that study were used as base-line information for a further field study undertaken on 29 October 2009, to identify changes in the reported aquatic ecology of the locality since the 2001 study. Figure 6 (above) shows the current location of aquatic habitats at the site.

For both the 2001 and 2009 surveys, dive inspections were made of inshore, mid-depth and offshore sediment habitats in the existing marina lease area plus of the mixed sediment and rock rubble habitat located to the south of the present lease area (encompassing the habitats south of the marina for a distance of about 30 m south of the proposed Arm F – see Figure 6). Inspections were also made of the marina seawall and of the intertidal plus shallow subtidal mixed sediment and rocky rubble reef to the south of the marina. Dive inspections were also made of wetted surfaces of the marina infrastructure (piles and pontoons).

The main habitats (in area terms) are soft sediment habitat and hard substratum habitat (the wetted surfaces of marina infrastructure plus seawalls and rocky reef/rubble to the south of the marina). Seagrass (mainly *Zostera capricorni*) is found in the vicinity and there are algae on infrastructure and rock rubble. These habitats and the changes between surveys are described in more detail below.

In terms of changes from 2001 to 2009, the major alteration to aquatic habitats has been the dredging for the marina undertaken in 2002. As a result of the dredging, the shoreline now drops off fairly rapidly within the lease area to a depth of -2.5m to -3m (AHD), within 5 to 10m of the shoreline (see the post-dredging hydrographic survey - Figure D1 in the Cardno Lawson Treloar (2010) Coastal Processes report for the present EA).

To the south of arm E, the decline is more gradual, reaching the same depth at a distance of 30 to 40m from the shoreline. This can be seen in Figure 7 (below), which provides a magnified view of portion of Cardno Lawson Treloar Figure D1- with the inner portions of marina arms D and E plus the proposed Arm F superimposed over the hydrographic survey.

For both studies, the aquatic ecological habitats within and adjacent the marina (including the Arm F construction area) include mixed intertidal rocky reef with rubble interspersed by sandy shoals and some rock rubble extending into shallow subtidal waters (to the south of the marina), shallow muddy sand habitats inshore grading to muddy habitats with depth, a constructed rock retaining wall abutting the foreshore of the marina plus the constructed marine infrastructure (piles and floating pontoons) of the marina itself.

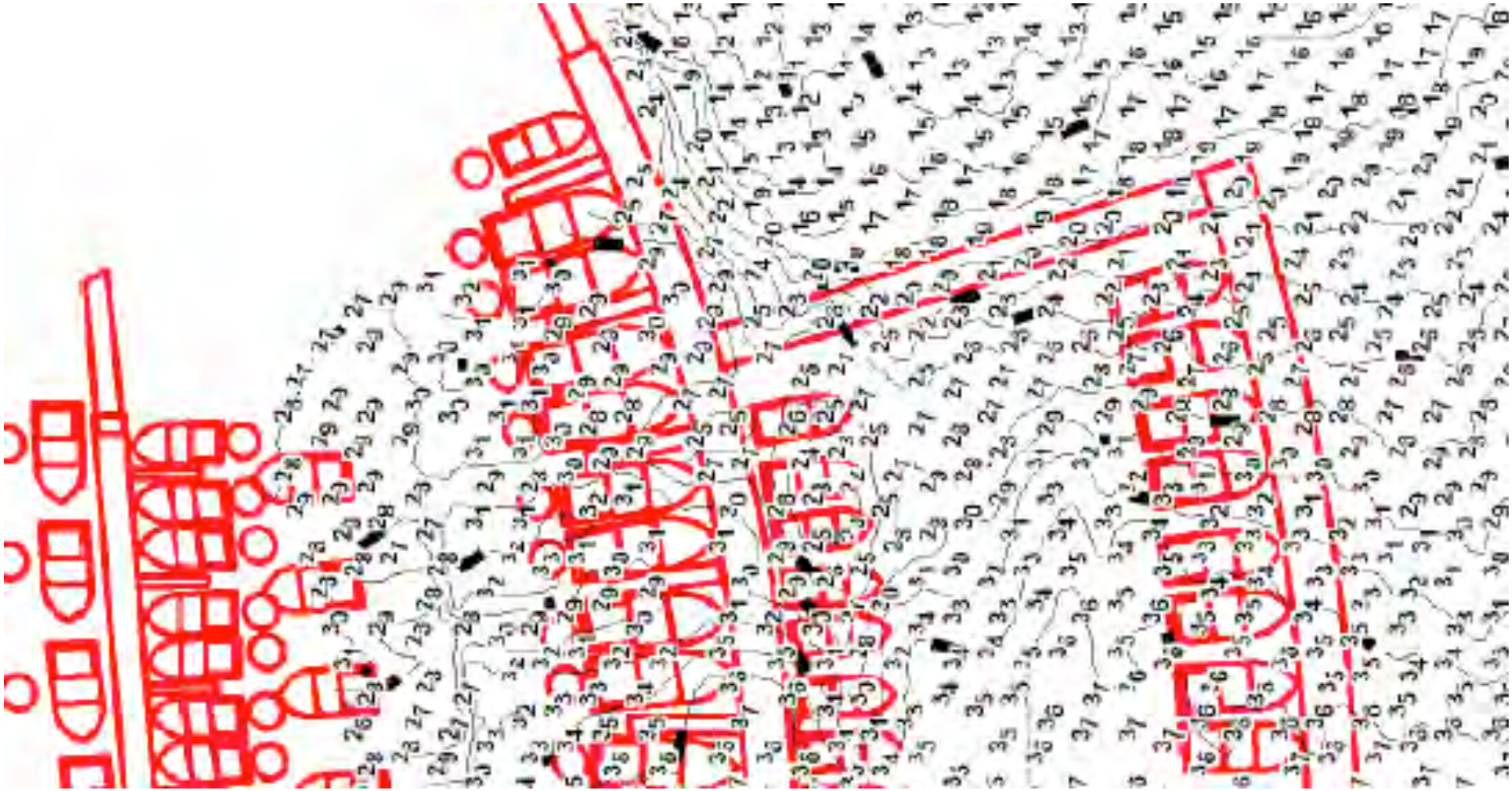


Figure 7 Portion of Figure D1 from Cardno Lawson Treloar (2010) showing inshore parts of existing and proposed marina arms D to F superimposed over post-dredging hydrosurvey. Note depths are –m AHD.

3.1 Sediment and Rocky Reef Benthic Habitats

The aquatic ecology of the soft sediment and rock habitats of the study area is summarised as follows:

- For all locations inspected, the sediment habitat generally supported a diverse benthic fauna as inferred by the abundance and variety of burrows and tubes of burrowing benthic fauna, tracks of surface gastropods and frequency of feeding depressions left by stingrays.
- For the 2009 survey, event though the density of invertebrate burrows and holes observed in sediments throughout the proposal area was sparse (2 to 5/m^2), there were stingray and flathead holes observed throughout the area indicating active predation on the benthic fauna by these fish species.
- The rocky shore along the waterfront of the marina carpark and reserve shoreline is made up of large boulder and rock fragments, which gives way to sparse rock/ rubble on sand around the lower intertidal limits. The intertidal rocky sea wall, rubble and reef habitats are affected by siltation and consequently supported a simplified benthic faunal assemblage comprising bands of oysters, dominated by Sydney rock oysters, with periwinkles (*Bembicium nanum*) and the black nerite *Nerita atramentosa* present. There were rock crabs and other crustaceans (e.g., sand fleas) located under and between rocks.
- The shallow sub-tidal shoreline to the east and south of arm E (including inshore from the proposed marina arm F walkway) comprises a sparse distribution of boulders and rock rubble. During both the 2001 and present surveys some boulders and larger rock fragments supported patchy growth of several brown algae (mainly *Sargassum spp*., with some kelp *Ecklonia radiata* and *Codium fragile*. Patches of Sargassum were also observed growing attached to rock fragments underneath the access gangways to marina arms D and E.

3.2 Marina Infrastructure Habitats

In 2001 the mooring pen and jetty support piles supported a simple assemblage of rocky shore and reef flora and fauna, some encrusting coralline and green algae on the intertidal parts of the piles interspersed with oysters and limpets. The sub-tidal portions of piles supported some *Sargassum* macroalgae, encrusting sea-squirts, bryozoa, colonial worms and oysters.

In 2009 the epifaunal assemblages of piles were similar to that recorded in 2001, comprising mainly Sargassum algae from the shallow sub-tidal down, with kelp occurring lower down

on the piles (to at least 2m). Both species of oyster (Sydney Rock and the introduced Pacific) were particularly abundant in the shallow sub-tidal, as were solitary ascidians and branching hydrozoans.

There were few reef fish associated with these structures, with the only fish observed on the deeper piles being yellowtail and sweep in mid depths and fan-bellied leather-jackets deeper.

There were no pontoons available for study in 2001, whilst for the 2009 survey pontoon wetted surface areas made up the greater part of the hard substratum habitat available for colonisation by attached benthic biota (epi-benthos). The 2009 survey compared the Arm E northern (protected) sides of pontoons to the southern (exposed) sides:

- The northern (protected) pontoon sides supported a variety of marine algae, including juvenile kelp (*Ecklonia* radiata), brown algae, *Dictyota dichotoma*, *Colpomenia sinuosa*, green algae *Codium fragile*, sea lettuce (*Ulva sp*), *Grateloupia filicina*, plus encrusting coralline and foliose brown algae.
- There were various mollusc and crustacean species; both of the oyster species, blue mussel *Mytilus edulus* and colonial serpulid polychaete worms were present. A number of large red bait crabs of the species *Plagusia chabrus* were observed feeding.
- Other encrusting or attached epifauna included encrusting sponges, solitary ascidians (*Herdmania* and *Pyura spp*.,), colonial ascidians (orange and white forms of *Botrylloides spp*), branching hydrozoans and encrusting bryozoans.
- The southern exposed faces of arm E pontoons supported similar epifaunal assemblages with overall higher percentage covers of the alga *Dictyota*, *Codium*, brown algae and sea lettuce. A number of herbivorous grazing Patellid limpets were present as were barnacles.
- The horned blenny *Parablennius intermedius* was the only fish species observed on or around the pontoon structures.

3.3 Seagrass Distribution

In 2001 the fringing sub-tidal sediment and rock boulder habitat to the south of the marina supported sparse and patchy algae attached to some rock fragments and the habitat was interspersed with *Zostera* seagrass patches which together provides some mixed marine vegetation fish nursery habitat area. Only one species, eel grass *(Zostera capricorni)* , was found. No strap weed *(Posidonia australis),* was located and it was noted that the habitat

was unsuitable for *Posidonia*. No paddle weed *(Halophila sp*.) was found although it was thought that it could occur seasonally.

Off-shore form the sub-tidal fringing rock habitat south of the marina and along the rock boulder foreshore at the toe of the seawall of the marina to the north, the MPR (20010 study mapped a discontinuous strip of shallow water *Zostera* from around Harris Street (adjacent to the Government Marina Facilities) past the SGMBC to at least Nelson Street (the northern extent of the survey at that time). There were several linear patches of *Zostera* noted in the shallows fronting SGMBC. The patches were not uniform and density varied throughout the distribution. There were a few individual isolated shoots of *Zostera* also found outside the defined patch limits. The distribution of the strip of *Zostera* was in accord with the mapping presented in West et al (1985) but the width of the strip was less (i.e., a decrease in depth distribution and the strip was more fragmented (i.e., a distribution between that shown in Figures 4 and 5 above).

For the 2009 seagrass survey the distribution was similar to that shown in Figure 5 above, with the continuous bed south of the marina now located well south. However, whilst there was no seagrass bed located within the study area in 2009, eel grass was observed to be growing amongst the sediment and rock boulder habitat inshore (as noted in 2001). The eelgrass occurred as either as single shoots or clusters of a few individual plants, free of epiphytic growth with relatively long leaves (around 40cm in length) – also similar to that reported in 2001.

There was also a single patch of five shoots of eelgrass observed to be growing within or very close to the footprint of the inshore limits of the proposed arm F (see Figure 6 for location). Isolated sprigs of paddle weed were also observed growing in this location. There was no seagrass found within the marina lease area, underneath arm E or the access gangway or inshore along the carpark seawall.

3.4 Threatened and Protected Species

With regard to the possibility of threatened species listed under Part 7A of the Fisheries Management Act (1994) occurring in the vicinity of the marina, there is only one species that is known from the Botany Bay/Georges River region that could occur in the locality; juvenile Black Cod, *Epinephelus daemelli,* was recorded amongst the fish species caught in Botany Bay for the Botany Bay Study undertaken by NSW Fisheries in the 1980s. As post-larval juveniles this species moves into rocky reef habitat, eventually settling as an adult onto suitable coastal and estuarine rocky reef habitat. A specific search was made for Black Cod

during both the 2001 and 2009 surveys. No Black Cod were observed during the survey and no suitable Black Cod habitat was found- there were no ledges, gutters or caves, or large boulders big enough to support these large territorial fish.

A specific search was also made for *Caulerpa taxifolia*, a pest algae species declared under the FMA that is known to occur in Botany Bay. There was no *C. taxifolia* found in the study area. As noted previously, there are no mangroves reported from the locality and none have been observed for the present survey.

Consideration has also been given to the possibility of threatened aquatic species or communities listed under the NSW Threatened Species Conservation Act 1995 (TSC Act) and under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC) occurring in the locality and, as detailed in MPR (2001), whilst there are a number of marine mammals (dolphins, seals and whales), seabirds and marine reptiles (turtles and sea-snakes) reported from the region (Botany Bay), only seabirds are expected in Kogarah Bay:

- Whilst some use of Kogarah Bay mud flats by listed wading birds could be expected during low tides, the high degree of urbanisation of Kogarah Bay means that such usage would be opportunistic.
- The seagrass bed off Tom Ugly's Point provides good nursery habitat for fish, and when fish are seasonally abundant, the bay waters are fished by a variety of sea-birds, mainly cormorant and tern species, and the listed Little tern could utilise this resource from time to time. This usage would also be opportunistic.

Since the original 2001 study, Saltmarsh has been listed as a threatened community under the TSC Act. As noted previously there is no saltmarsh in Kogarah Bay and none is known from the SGMBC study area.

It is concluded that whilst a number of water related species listed under the TSC and EPBC Acts could utilise some of the resources of Kogarah Bay from time to time the use would be opportunistic and Kogarah bay is not considered as providing prime feeding, roosting or staging habitat for any of these species.

4 ASSESSMENT OF IMPACT & SUGGESTED MITIGATION

The following sections discuss the construction and operational aspects of the St George Motor Boat Club Marina Upgrade proposal, how they could potentially impact on the aquatic ecology of Kogarah Bay and the avoidance or mitigation measures taken to ensure no significant impact on the aquatic ecology of the bay.

Whilst all of the installed works will be located in or over soft substratum habitat, there are a few isolated plants of eelgrass and small amounts of sparse paddle weed in the immediate vicinity of the inshore extent of proposed marina arm F and there is shallow water rock rubble habitat supporting fragmented growth of algae plus isolated seagrass plants inshore of the proposed access walkway between arms E and F and to the south of the proposal (see Figure 6).

As an initial **avoidance measure**, the present proposed marina configuration was developed to avoid direct impacts on these inshore rock rubble habitats. Specifically, the connecting walkway was moved into deeper waters offshore and marina arm F was shortened so that there would be no vessel mooring or movement over the shallow habitats (compare the Appendix 4 and 6 plans in the Preliminary EA with the adopted proposal as shown in Figure 1 above).

4.1 Construction Impacts

The main construction aspects potentially impinging on the marine environment are:

- Floating-in and positioning of pontoon structures.
- Installation of locator piles to hold the proposed floating pontoon marina arm and walkway in place.

Construction will require work barges for transporting materials to the site, floating pile driving plant and powered work vessels for moving barges and pontoons into place and for manoeuvring the pile driving barge into position:

- Holding the pile-driving barge in place would require the use of mooring lines and possibly the use of anchors. These could be placed into the vegetated habitats, resulting in the disturbance and possible loss of marine vegetation (seagrass or algae).
- Vessels pushing or pulling pontoons into place or manoeuvring barges into position could require use of full propulsion power to undertake these activities, particularly

if there are adverse winds or strong tidal currents. Use of excessive propulsion power in shallow waters can mobilise bottom sediments resulting n turbidity plumes and possible mobilising pollutants to the water column.

With regard to direct loss to the marina proposal, there is not expected to be any significant loss of vegetated habitat arising from the proposal, by virtue of the avoidance measures taken to position the proposed walkway and marina arm off-shore away from the vegetated habitats (see Figure 6).

Whilst placement of locator piles will impact some unvegetated soft sediment habitat, the impact is not considered significant:

- The main methods used to place piles (pile driving a pointed pile or screwing in a screw shaped pile) have the effect of displacing sediments rather than burying sediment, thus mitigating impact. Consequently sediment benthic organisms are displaced laterally lessening overall loss of benthic fauna.
- The loss of some benthic organisms to piling operations is considered insignificant, given the availability and total area of soft sediment habitat in the locality, in Kogarah bay and throughout the Georges River catchment.
- The loss of benthic organisms to pile driving would e directly offset by the provision of a relatively large area of pile wetted surface area that will be available for colonisation by attached benthic biota. As noted in Section 3.2 above the existing marina piles support an epibenthic assemblage of algae and encrusting biota that provides valuable feeding and shelter habitat for fish.

Whilst the proposed pontoons for the walkway and marina arm plus the vessels that will be placed into the created marina pens and the currently unauthorised pontoons plus moored vessels (as show on Figure 1) do (or will) shade the seabed, the proposal has been located so as to avoid any shading impact on vegetated habitats. Accordingly there are no significant shading impacts arising from the proposal:

- The only vegetated areas are inshore of the walkway and to the south of the inner portion of Arm F. By virtue of the orientation of the marina arm to the sun, the marina arm will predominantly cast a shadow to the north thus the few isolated seagrass plants located to the south of the marina arm would not be impacted by shading.
- The walkway has been moved offshore and the vegetated inshore rock rubble will be minimally shaded by the walkway on a daily basis. As the algae growing on the inshore rock habitat is known to survive in locations of almost total direct shading

(i.e., under the connecting ramps to Arms D and E), it is concluded that the minimal shading from the arm E to F floating walkway would not have any shading impact on the shallow rock algae.

- The currently unauthorised pontoon plus the associated unauthorised moored vessels are all located over the in-shore areas dredged in 2002, and there is no marine vegetation, and the adjacent seawall does not support any marine vegetation. Thus there are no shading impacts arising from these facilities.
- The remaining unauthorised moored vessels and marina extensions are all located over deep water where there is no marine vegetation.
- Any potential loss of algae to shading would also be directly offset by the provision of a relatively large area of pontoon wetted surface area that will be available for colonisation by attached benthic biota. As noted in Section 3.2 above, the existing marina pontoons support an epibenthic assemblage of algae and encrusting biota that provides valuable feeding and shelter habitat for fish.

The potential indirect impacts on the aquatic ecology of the locality arising from the construction works are outlined above. The potential impacts of mobilising contaminants from the sediments to the water column have been considered in the Coastal Processes report (Cardno Lawson Treloar 2010) and as the potential for mobilising contaminants is judged to be insignificant, the possible impacts on aquatic habitats is not considered further here.

Whilst several of the potential indirect impacts on aquatic habitats are considered insignificant, the remainder can be mitigated to insignificance by the application of suitable mitigation measures as outlined below:

- Potential impacts from anchoring of barges and vessels associated with the construction can be mitigated to insignificance by avoiding/prohibiting anchoring or mooring in the vegetated areas.
- Turbidity generated by the actual piling operation is not expected to be significant. As noted above, impact piling displaces sediments laterally resulting in a small transient plume that is rapidly dispersed or resettled prior to the next pile impact. Screw piling creates almost no turbidity. Accordingly there are no turbidity plumes generated by piling operations and consequently the risk of smothering or shading impacts on adjacent habitats is minimal and is considered insignificant.
- Whilst turbidity and bottom scouring arising from excessive propeller thrust by construction vessels can be potentially significant, this can be mitigated to insignificance by putting into place procedures to limit these sorts of activity. Suggested procedures can be depth related (e.g., only working inshore areas during

high tides and/or setting clearance depth limits between vessel propulsion gear and the seabed for particular vessels), location based (e.g., prohibiting or limiting certain vessels to certain areas/tasks) or weather based (e.g., limiting particular work tasks to certain low wind/current conditions).

- Consideration could also be given to placing floating silt curtains that are weighted at the bottom between the construction zone and the inshore vegetated habitats. However, whilst this may have the effect of minimising indirect impacts from propeller wash or scour related turbidity, measures should still be put into place to minimise the generation of turbidity at source. Note also that the deployment of silt curtains in the marine environment can have its own problems, as the curtains can be mobilised to destruction by inclement weather/adverse currents or wind wave action. For this reason the turbidity avoidance measures suggested above are preferred.

It is concluded that direct and indirect impacts arising from the proposed construction are either individually insignificant or can be mitigated into insignificance by the use of mitigation procedures as outlined above. This outcome can be achieved by the proponent, or the contractor who will be undertaking the construction works, addressing these issues directly in the Construction Environmental Management Plan CEMP.

4.2 Operational Impacts

In relation to the operational aspects of the marina upgrade, the potential impacts that need to be considered are water quality (turbidity) impacts arising from possible propeller wash by vessels using the new facilities (and from vessels using the currently unauthorised facilities), and the potential for water quality degradation from the increased number of vessels in the bay arising from the construction. The latter question has been addressed in the Coastal Processes report (Cardno Lawson Treloar 2010) that concluded local waters and Kogarah Bay water quality would not be significantly impacted by the proposal.

With regard to the unauthorised vessel locations as indicated on Figure 1, the vessels are located over dredged inshore seabed or in naturally deep waters. Consequently the potential for propeller wash is minimal and continued use of these berths by the appropriately sized vessels is not considered to pose any significant risk of turbidity generation.

With regard to the use of the new facilities, being the south side of arm E and the north side of arm F), the schedule of vessels has been complied to match the size of the proposed vessel to the available water depth in the pens. Note also that the initial avoidance action taken for the present proposal was to amend the inshore layout of the proposed new arm and walkway to place the moorings in deeper water:

- Analysis of available depths for the inshore pens can be made against the hydrographic plan provided in the Cardno Lawson Treloar (2010) report Figure D1; a portion of which is provided in this report as Figure 7 above. This plan indicates that the minimum depth at the inshore berth for Arms F is -2.0 m AHD indicating a minimum tidal depth of -1.1m ISLW.
- The minimum depth in the fairway between Arms E and F is slightly higher -2.2 m AHD (-1.3 m ISLW). The remaining berths have rapidly increasing depths (around -3.5 m AHD depth for berths seven vessels to the west).

Given that these inner berths will be well protected from wind by virtue of the floating pontoons either side and the curved shape of the marina, that vessels speeds will be necessarily slow to leave or reach these locations and that the overall size of the proposed vessels is limited which will limit propulsion needs and weight based inertia, it is concluded that the operational use of these inner berths by the appropriately sized vessels would not generate any significant propeller wash such that there would be any significant mobilisation of seabed sediments.

5 SUMMARY AND CONCLUSIONS

This report provides a detailed account of the aquatic ecology of the St George Motor Boat Club locality and outlines how the aquatic ecology of the locality integrates with the wider aquatic ecology of Kogarah Bay and the Georges River estuary. A combination of field survey (comparing studies undertaken in 2001 and for the present proposal in 2009) plus literature review, was used to describe the aquatic habitats of the proposed marina.

The benthic habitats of the study area include the intertidal to shallow sub-tidal rocky rubble shoreline and the sub tidal muddy and sandy habitats:

- The rocky shore along the waterfront of the marina carpark and reserve shoreline is made up of large boulder and rock fragments inshore, with sparse rock/ rubble on sand around the lower intertidal limits. The intertidal rocky sea wall, rubble and reef habitats did not support any significant fauna, and were dominated by estuarine molluscs. The lower intertidal to shallow subtidal rock rubble benthic habitats supports some patchy algae (mainly *Sargassum* spp., with some Kelp).
- There were a number of isolated patches of eelgrass (*Zostera capricornii*) south of the proposed arm F, mooring pens and fairway, growing amongst the kelp and *Sargassum* inshore. Extensive searching in the proposed Arm F footprint area only

yielded five single shoots of eelgrass and some small amounts of Paddle weed (*Halophila ovalis*), occurring within or very close to the footprint of the inshore limits of the proposed arm F. There were no observations of seagrass further north, underneath arm E or the access gangway or inshore along the carpark seawall north of arm E.

- Sandy to muddy unvegetated benthic habitat extends under the existing marina and throughout the footprint of the proposed Arm F and its mooring pens plus fairway. This habitat supports a mixed burrowing and epi-benthic assemblage including polychaete worms, crustaceans and molluscs, as evidenced by the uniform distribution of burrows throughout the habitat, and by the uniform distribution of stingray feeding burrows.
- There was no *Caulerpa taxifolia*, a declared pest algae species, found at the site. This species is known to occur in Botany Bay.

Considering that the main benthic habitat within the area for Arm F and its mooring pens and fairway is predominantly unvegetated silty sand to mud, and given the observed distribution of seagrass plants away from the existing and proposed works, it is concluded that the construction of Arm F would not have any direct impact on the existing marine vegetated habitats (seagrass beds and rocky rubble reefs) in Kogarah Bay.

Construction has the potential to indirectly impact marine vegetated habitats via anchoring and propeller wash damage. These impacts can be mitigated to insignificance by the imposition of appropriate mitigation measures as outlined in this report and that can be detailed in the Construction Environmental Management Plan for the project.

With regard to the use of the new facilities, the potential for seabed disturbance from propeller wash would be restricted to use of the shallower innermost berthing areas as all other berths have sufficient water depth at all times to minimize risk of propeller wash to insignificance. For the inner berths, this impact has been avoided by relocating the walkway plus arm F further offshore so as to ensure adequate depths for the innermost berths.

With regard to the currently unauthorised berths located outside the present marina Permissive Occupancy, these berths are all located over deeper water areas with unvegetated sediment aquatic habitats and thus there are no anticipated disturbance impacts arising from the continued use of these berths.

There were no threatened or protected aquatic birds or marine mammal, or fish species found in the area of the development or in the immediate locality, nor does the development site or the immediate locality constitute a significant part of the habitat of any such species. It is concluded that the proposed marina upgrade and continued use of existing berths does not pose any significant impact to any threatened species, populations or ecological communities, or their habitats on which they interact with.

As there is no dredging or reclamation proposed and no significant harm to marine vegetation there is no need to obtain permits under Section 204 and 205 of the Fisheries Management Act 1994.

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APPENDIX A

FISH SPECIES IN THE GEORGES RIVER ESTUARY

TABLE 22 FROM WILLIAMS ET AL (2004)

Table 22 Taxonomic list and total number of fish, decapods and molluscs collected from the estuarine portion of the Georges River in April 2000

Class/Order/Infraorder/Family/Species		Common Name	Marine Tidal Delta	Central Mud Basin	Fluvial Delta	Riverine Channel	Total number caught
FISH							
CLASS CHONDRICHTHYES							
Order Rhinobatiformes							
Rhinobatidae	*Trygonorrhina fasciata**	Fiddler ray	1				1
CLASS ACTINOPTERYGII							
Order Myliobatiformes							
Dasyatididae	*Dasyatis fluviorum*	Stingray		1			1
Order Anguilliformes							
Anguillidae	*Anguilla australis**	Short-fin eel			2		2
Order Clupeiformes							
Clupeidae	*Hyperlophus vittatus**	Sandy sprat		25	103	256	384
Engraulidae	*Engraulis australis**	Australian anchovy		87			87
Order Lophiiformes							
Antennariidae	*Antennarius striatus*	Striped anglerfish	1				1
Order Atheriniformes							
Atherinidae	*Atherinomorus ogilbyi**	Ogilby's hardyhead	43	2			45
	Pseudomugil signifer	Southern blue-eye				8	8
Order Gasterosteiformes							
Syngnathidae	*Hippocampus whitei*	White's seahorse		1			1
	Stigmatopora nigra	Wide-body pipefish	7				7
	Urocampus carinirostrus	Hairy pipefish	3				3
Order Scorpaeniformes							
Scorpaenidae	*Centropogon australis*	Fortescue	220	48	18		286
Platycephalidae	*Platycephalus arenarius**	Flag-tail flathead	3				3
	*Platycephalus fuscus**	Dusky flathead		3	7		10
	*Platycephalus speculator**	Yank flathead	3				3
Order Gonorynchiformes							
Chandidae	*Ambassis jacksoniensis*	Port Jackson glassfish	119	280	5	41	445
	Ambassis marianus	Ramsey's glassfish		1	5	25	31
Order Perciformes							
Terapontidae	*Pelates sexlineatus**	Eastern striped trumpeter	627	131	70		828
Apogonidae	*Siphamia roseigaster*	Silver siphonfish	3				3
Sillaginidae	*Sillago ciliata**	Sand whiting	221	83	24	16	344
	*Sillago maculata**	Trumpeter whiting	3	35	21		59
Pomatomidae	*Pomatomus saltatrix**	Tailor	55	52	12		119
Carangidae	*Trachurus novaezelandiae**	Yellow-tail scad			1		1
Gerreidae	*Gerres subfasciatus**	Common silver belly	1	77	30	25	133
Sparidae	*Acanthopagrus australis**	Yellow-finned bream	2	40	50	11	103
	*Rhabdosargus sarba**	Tarwhine	12	42	8		62
Mullidae^	*Mullidae* unknown 1^	Goatfish	3				3
	Mullidae unknown 2^	Goatfish	9				9
	Upeneus tragula	Bar-tail goatfish	4				4
Monodactylidae	*Monodactylus argenteus*	Silver batfish				7	7
Girellidae	*Girella tricuspidata**	Blackfish	3	12	5	2	22
Enoplosidae	*Enoplosus armatus**	Old wife	2				2
Mugilidae	*Liza argentea**	Flat-tail mullet		13	25	88	126
	*Mugil cephalus**	Sea mullet			3	7	10
	*Myxus elongatus**	Sand mullet	10	31	5		46
Sphyraenidae	*Sphyraena obtusata**	Striped sea pike		3	2		5
Blenniidae	*Petroscirtes lupus*	Brown sabretooth blenny	29	4	1		34
Clinidae	*Heteroclinus* spp.	Weedfish	5				5
Gobiidae	*Acanthigobius flaviomonius*	Oriental goby			3	3	6
	Afurcagobius tamarensis	Tamar River goby		19	3	28	50
	Arenigobius bifrenatus	Bridled goby		3	3	1	7
	Arenigobius frenatus	Half bridled goby	4	163	48		215
	Bathygobius kreffti	Frayed-fin goby	20	1	1		22
	Cryptocentrus critatus	Oyster goby			1		1
	Favonigobius exquisites	Exquisite sand goby	3	18	47	4	72
	Favonigobius lateralis	Long finned goby	39	1	2		42
	Gobiopterus semivestitus	Glass goby				1	1
	Mugilogobius stigamaticus	Checkered mangrove goby	2				2
	Pseudogobius olorum	Blue-spot goby			1	5	6
	Redigobius macrostoma	Largemouth goby			2	1	3
Eleotridae	*Philypnodon grandiceps*	Flathead gudgeon				22	22
Siganidae	*Siganus nebulosus*	Happy moments	17				17
Order Pleuronectiformes							
Paralichthyidae	*Pseudorhombus arsius**	Large-tooth flounder	1	4	13		18
	*Pseudorhombus jenynsii**	Small-tooth flounder	1	15	9		25
Pleuronectidae	*Ammotretis rostratus**	Long-snout flounder	1	1			2
Cynoglossidae	*Paraplagusia unicolor**	Lemon tongue sole	3				3

Table 22 (cont.) Taxonomic list and total number of fish, decapods and molluscs collected from the estuarine portion of the Georges River in April 2000

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Gerreidae	*Gerres subfasciatus**	Common silver belly	1	77	30	25	133
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Pleuronectidae	*Ammotretis rostratus**	Long-snout flounder	1	1			2
Cynoglossidae	*Paraplagusia unicolor**	Lemon tongue sole	3				3