The general location and length of each of the towed video transects was as follows:

Transect 1: 112.8 m, located at the southern end of the development footprint;

Transect 2: 77.05 m, located at the southern end of the development footprint;

Transect 3: 56.96 m, located at the northern end of the development footprint in the approximate location of the Landmark Building; and

Transect 4: 102.7 m, located in the central section of the development footprint.

Figure 5.2 Locations of underwater video transects.

5.7 Benthic Infauna Sampling

Benthic infauna samples were collected at each site from the impact location and the two reference locations (refer **Figure 1.2**). At each site divers collected three replicate benthic samples, at a distance of approximately 1 m apart, using a 100 mm diameter polycarbonate core to a depth of 25 cm. The core was inserted into the seabed to its maximum depth, capped and then removed. Once removed, a bottom cap was inserted and the cores were returned to the surface. At the surface, samples were sieved through a 1 mm mesh sieve and the retained material was placed in a plastic sample bag and preserved using formalin (4% formalin in final solution). In the laboratory, samples were stained with Rose Bengal and sorted into taxonomic groups (to the lowest taxonomic level practicable). Data was analysed using Statistica Version 5. Test for homogeneity of variance was undertaken using a means versus standard deviation test. Data was found to be normally distributed. Two-way ANOVA was used to examine differences in species diversity and abundance, between locations and between sites within locations. Regression analysis was undertaken to investigate correlations between grain size and species diversity and abundance.

6 EXISTING CONDITIONS

6.1 Water Quality

Water quality parameters were measured at the surface (~ 0.3 m below surface) and mid-water at each site. The mean (+/- standard error) water quality values for each location are given in **Table 6.1.** Water quality values at all locations were generally within the expected values for estuaries in south eastern Australia, with slightly lower than expected conductivity values being the only exception.

Barangaroo

Water quality measurements indicated that physico-chemical conditions in Darling Harbour, within the vicinity of Barangaroo, were typical of a sub-tropical estuary in south eastern Australia. The average surface and mid-water pH of 8.21 measured is within the general acceptable pH range (7 - 8.5) for subtropical eastern Australian estuaries (ANZECC / ARMCANZ 2000). Average conductivity vales of 53, 475 µS/cm (surface) and 53, 125 µS/cm (mid-water) were slightly below the ANZECC / ARMCANZ (2000) value of 54, 000 µS/cm. Turbidity in surface waters (average of 1.55 NTU) was slightly higher than in mid-waters (average of 1.2 NTU) however, both values were within the general acceptable range (0.5 - 10 NTU) for subtropical eastern Australian estuaries (ANZECC/ARMCANZ 2000). Dissolved oxygen concentrations of 8.17 mg/L (surface) and 8.09 mg/L (mid water), equating to percentage (%) saturation values of approximately 88% and 86% respectively, were also within the acceptable range of 80 to 100% saturation. Mean surface water temperature at Barangaroo was 19°C and mid-water temperature was reported at 19.2°C. This was somewhat higher than the Sydney Harbour average for May (winter) of 15.9°C +/- 0.2°C (Hatje *et al.* 2001), likely attributed to uncharacteristically warmer air temperatures.

Berrys Bay

Water quality measurements indicate that physico-chemical conditions in the reference location Berrys Bay were also typical of a sub-tropical south eastern Australian estuary. Average surface and mid-water pH of 8.15 and 8.16 respectively is within the general acceptable pH range (ANZECC / ARMCANZ 2000). As was the case at Barangaroo, average conductivity vales of 53, 350 µS/cm (surface) and 53, 200 µS/cm (mid-water) were slightly below the ANZECC / ARMCANZ (2000) value. Turbidity in surface waters (average of 1.13 NTU) was slightly higher than in mid-waters (average of 1.05 NTU) however, both values were within the general acceptable range for subtropical eastern Australian estuaries (ANZECC / ARMCANZ 2000). Dissolved oxygen concentrations of 7.89 mg/L (surface) and 7.92 mg/L (mid water), equating to % saturation values of approximately 85% and 87% respectively, were slightly below the Barangaroo values, but also within the acceptable range. Mean surface water temperature at Berrys Bay was 20.83°C and mid-water temperature was reported at 20.73°C. These values are higher than the Harbour winter average (Hatje *et al.* 2001).

Snails Bay

Water quality measurements indicate that physico-chemical conditions in Snails Bay were typical of a sub-tropical estuary in south eastern Australia. An average surface and mid-water pH of 8.10 is within the general acceptable pH range for subtropical eastern Australian estuaries (ANZECC / ARMCANZ 2000). Average conductivity values of 53, 125 µS/cm (surface) and 52, 975 µS/cm (mid-water) were slightly below the ANZECC / ARMCANZ (2000) value and lower than at the other two locations. Turbidity in surface waters at Snails Bay (average of 1.60 NTU) was slightly lower than turbidity in mid-waters (average of 2.13 NTU) and turbidity values were higher than at the other two locations. However, both values were within the general acceptable range for subtropical eastern Australian estuaries (ANZECC / ARMCANZ 2000). Dissolved oxygen concentrations of 8.22 mg/L (surface) and 7.84 mg/L (mid water), equating to % saturation values of approximately 88% and 84% respectively were also within the acceptable range. Mean surface water temperature was 19.40°C and mid-water temperature was reported at 19.28°C, higher than the Harbour winter average (Hatje *et al.* 2001).

Table 6.1 Average water quality values for surface and mid-water at each survey location.

Location	Depth	pH	Conductivity (µS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/l) / % saturation	Temperature (°C)
Barangaroo	**Surface**	8.21 (0.026)	53, 475 (0.335)	1.55 (0.284)	8.17 (0.038) / ~ 88%	19.0 (0.135)
	Mid-water	8.21 (0.016)	53, 125 (0.103)	1.20 (0.041)	8.09 (0.063) / ~ 86%	19.2 (0.041)
Berrys Bay	**Surface**	8.15 (0.010)	53, 350 (0.096)	1.13 (0.180)	7.89 (0.101) / ~ 85%	20.83 (0.144)
	Mid-water	8.16 (0.008)	53, 200 (0.092)	1.05 (0.104)	7.92 (0.096) / ~ 87%	20.73 (0.111)
Snails Bay	**Surface**	8.10 (0.014)	53, 125 (0.165)	1.60 (0.122)	8.22 (0.075) / ~ 88%	19.40 (0.248)
	Mid-water	8.10 (0.015)	52, 975 (0.075)	2.13 (0.333)	7.84 (0.019) / ~ 84%	19.28 (0.250)
ANZECC/ARMCANZ (2000), NSW Government (1992)		7 – 8.5	54, 000 µS/cm	0.5 – 10 NTU	80 – 100% saturation	-
Hajte *et al.* (2001)		Increases in summer	-	Decreases seaward	More saturated at the water surface	15.9°C +/- 0.2°C (winter) – 26.5°C +/- 1.4°C (summer)

IMPACTS: Localised short term water quality impacts from the proposed development are expected, however these can be mitigated effectively with the use of appropriate measures as described in ***Section 7.2.1***

6.2 Sediment Particle Size Analysis

Sediment samples collected at each site for each location were analysed for particle size distribution by ALS Environmental using hydrometer to a minimum size of +75 µm. No testing of heavy metals or other contaminants was undertaken on the sediments collected as this has previously been investigated by ERM (2008b) as discussed in **Section 4.2.3**.

Overall, sediments at all three locations sampled, comprised of high proportions of clay, silt and sand, with little or no gravel or cobble recorded (most sites had readings of < 1%) (**Figure 6.1, Appendix 3**). Silt was the most common constituent of the sediments at all locations. While silt was most abundant in Berrys Bay, the values for silt did not differ considerably between the three locations. Barangaroo had significantly more clay than the two reference locations and Snails Bay had the highest percentage of sands. Sediments at Berrys Bay also had a low percentage of gravel, unlike the other two locations. Sediment classification results for each site at each location based on particle size are shown in **Tables 6.2** to **6.4**. Sediment from individual sites showed considerable variation in their composition. Most notable at Barangaroo was the high proportion of clay in the sediment collected from Site 1 (southern end of the sampling area). The findings of the sediment particle size analysis (PSA) are consistent with the locations sampled being in the Central Mud Basin Geomorphic Zone of the Port Jackson estuary (Roy 1984, Mesely 2003).

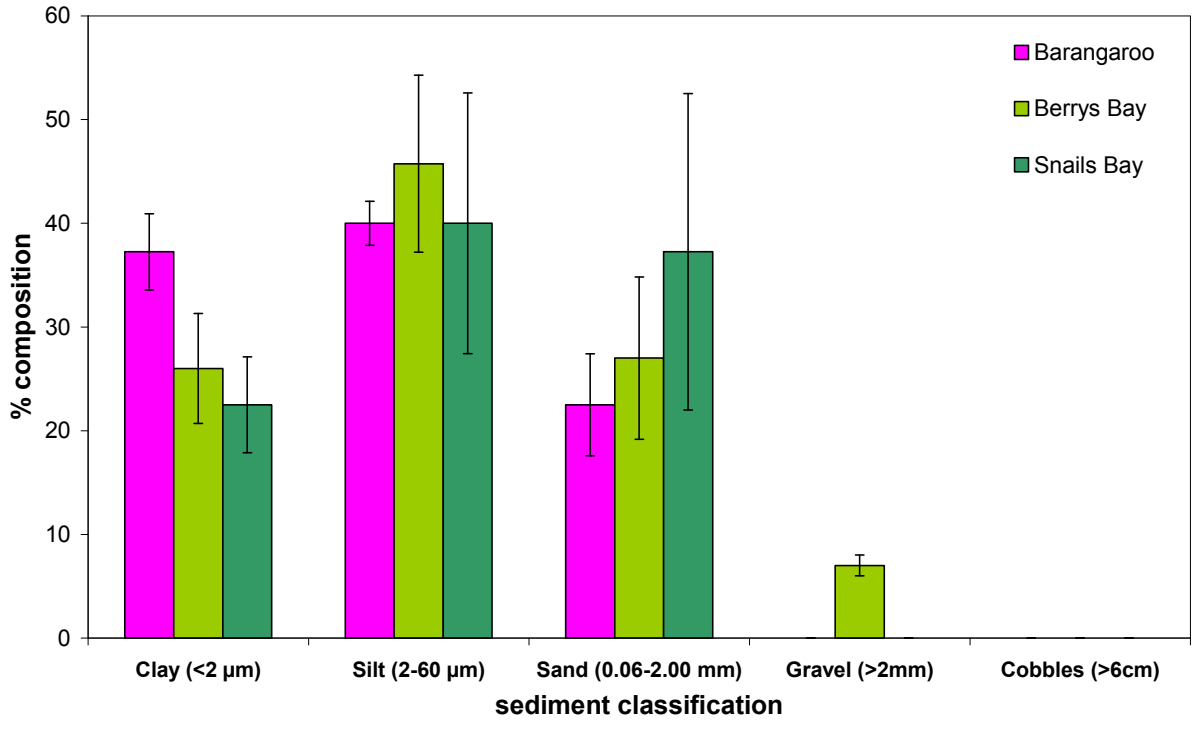


Figure 6.1 Classification of sediments at each location.

Table 6.2 Classification of sediments at Barangaroo based on Particle Size Analysis.

Sediment Classification	Site				Mean (+/- SE)
	BG1	BG2	BG3	BG4	
Clay (< 2 µm)	48	36	32	33	**37.25** (3.68)
Silt (2 - 60 µm)	41	41	34	44	**40** (2.12)
Sand (0.06 - 2.00 mm)	10	23	34	23	**22.50** (4.91)
Gravel (> 2 mm)	1	< 1	< 1	< 1	**< 1**
Cobbles (> 6 cm)	< 1	< 1	< 1	< 1	**< 1**

Table 6.3 Classification of sediments at Berrys Bay based on Particle Size Analysis.

Sediment Classification	Site				Mean (+/- SE)
	BB1	BB2	BB3	BB4	
Clay (< 2 µm)	29	22	39	14	**26** (5.31)
Silt (2 - 60 µm)	28	69	42	44	**45.75** (8.53)
Sand (0.06 - 2.00 mm)	38	9	19	42	**27** (7.82)
Gravel (> 2 mm)	5	< 1	< 1	< 1	**1.75** (1)
Cobbles (> 6 cm)	< 1	< 1	< 1	< 1	**< 1**

Table 6.4 Classification of sediments at Snails Bay based on Particle Size Analysis.

Sediment Classification	Site				Mean (+/- SE)
	SB1	SB2	SB3	SB4	
Clay (< 2 µm)	21	30	10	29	**22.5** (4.63)
Silt (2 - 60 µm)	63	60	14	23	**40.00** (12.56)
Sand (0.06 - 2.00 mm)	16	10	76	47	**37.25** (15.25)
Gravel (> 2 mm)	< 1	< 1	< 1	1	**< 1**
Cobbles (> 6 cm)	< 1	< 1	< 1	< 1	**< 1**

6.3 Aquatic Ecology

6.3.1 Benthic Habitat / Marine Flora

IMPACT LOCATION - BARANGAROO

The benthic habitat in Darling Harbour, adjacent to Barangaroo, consisted of clayey, silty, sandy sediments. Considerable bioturbation was evident across the entire site, presumably from burrowing organisms, such as polychaete works and invertebrate crustaceans (see **Figures 6.2** and **6.3**). The substrate towards the southern end of the development contained a high proportion of clay and was relatively undisturbed. Much of the substrate here has a 'honeycomb' type appearance. The middle and northern sections of the site contained a higher percentage of silt than the southern area. The underwater terrain was relatively flat across the site, with little evidence of movement in the way of sand ripples. Video transects provided evidence of areas of dense shell rubble, possible organic materials (e.g. dark woody looking objects), occasional sponges and discarded anthropogenic objects on the seabed (**Figure 6.3**). No aquatic vegetation was observed by divers, or was reported on the underwater video transects.

Seagrass / Mangroves / Saltmarsh

No seagrass was observed during spot dives, or on the video transects undertaken at the study site. The water depth (~ 13 m) and associated low light penetration would presumably restrict the growth of seagrasses in the footprint of the proposed Lend Lease development. No mangroves or areas of saltmarsh were observed at, or near, the proposed development during the site visit. The site currently lacks appropriate substrate and habitat for such vegetation to occur.

Wetland Areas

During our site visit a sandstone seawall was found to extend for several hundred metres along the foreshore, where the Wetlands Protection Area is currently mapped at Balmain East. A number of private jetties also extend into the harbour here. However, macroalgae was evident growing on subtidal rock below the footing of the seawall. In 2000, McLoughlin undertook a study examining the current extent of wetland vegetation along the Parramatta River, and suggested that some of the assumptions regarding the former extent of mangroves (which are based upon a variety of historical data sources), on which recent studies and foreshore plans are based, are inappropriate.

Introduced Marine Flora

No introduced marine algae *C. taxifolia* was observed during the spot dives or on video transects undertaken at the study site. It is possible that the oysters observed growing on the pylons at the north of the site were the Pacific Oyster *C. gigas.*

IMPACTS: Due to the lack of aquatic vegetation in the vicinity of the proposed Lend Lease development, no impacts on these sensitive habitats are expected.

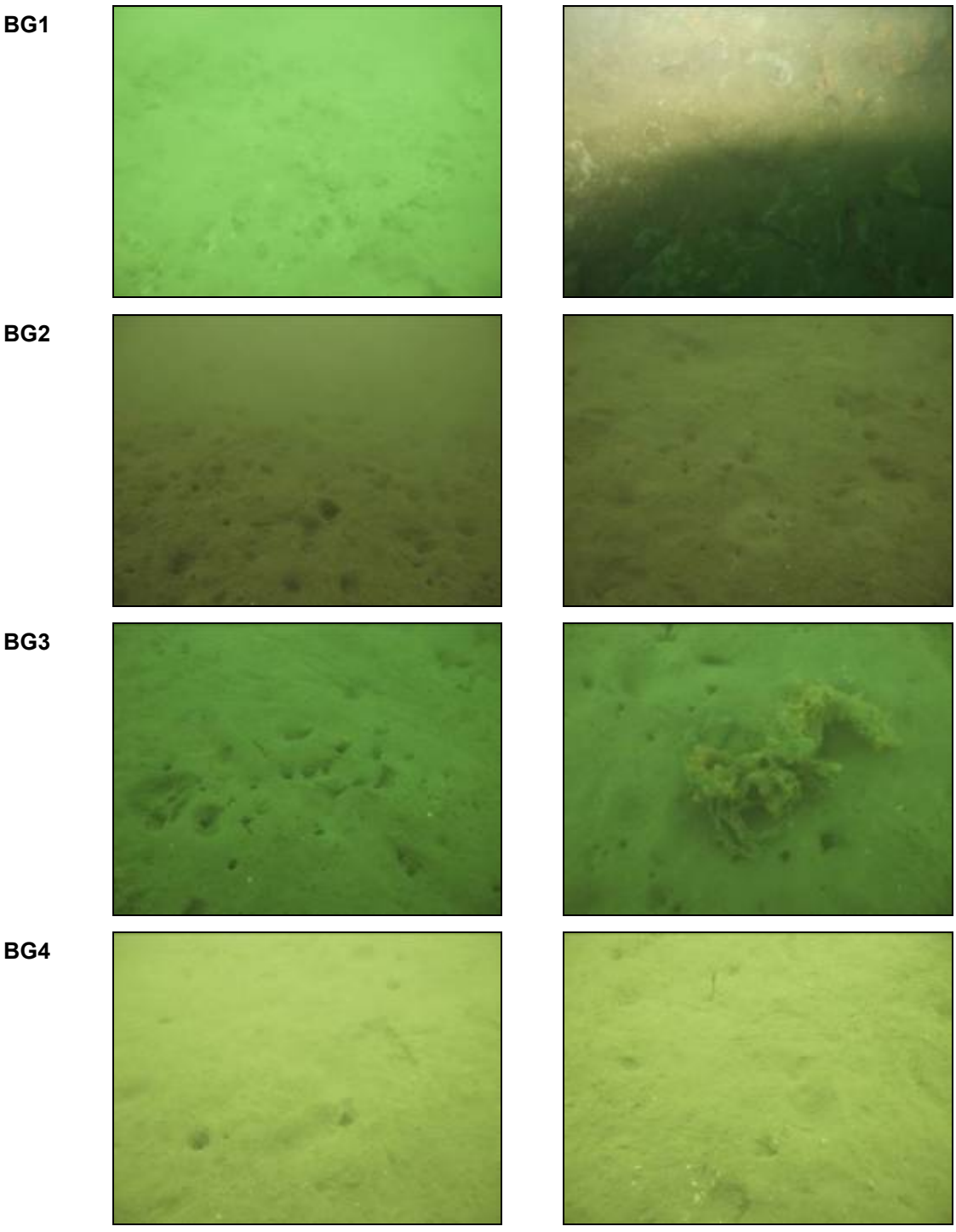
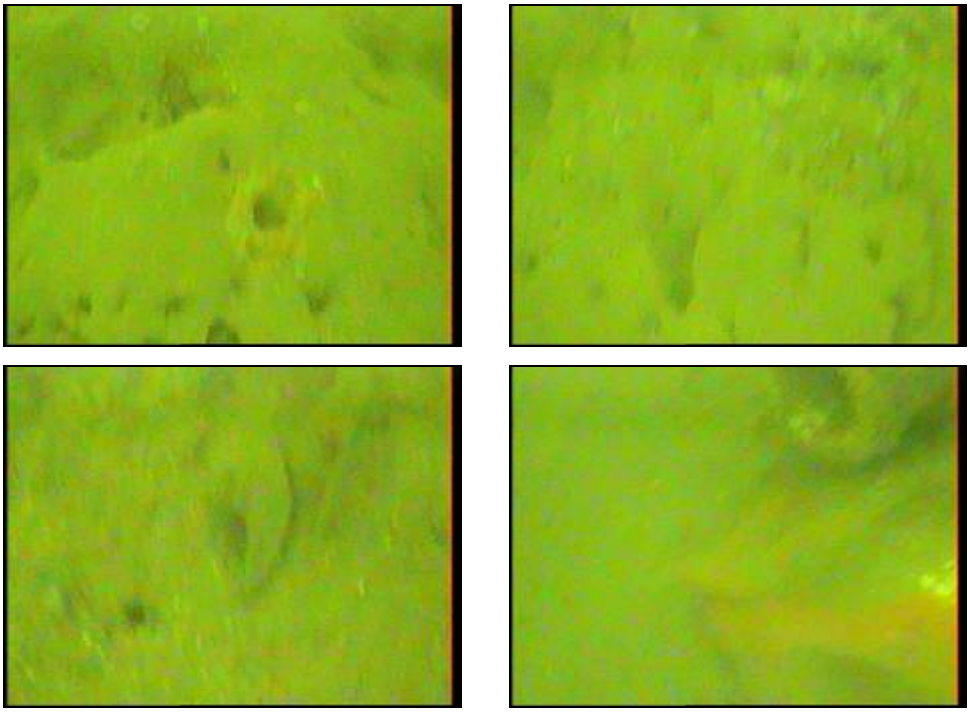
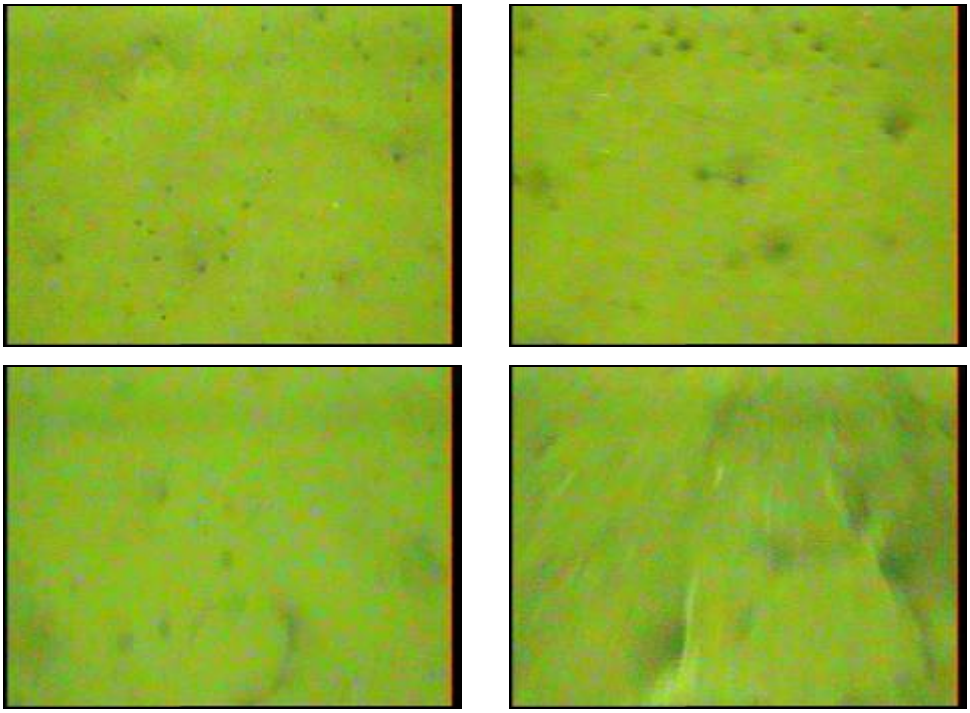


Figure 6.2 Benthic habitat at Barangaroo captured by diver photography.

Transect 1



Transect 2



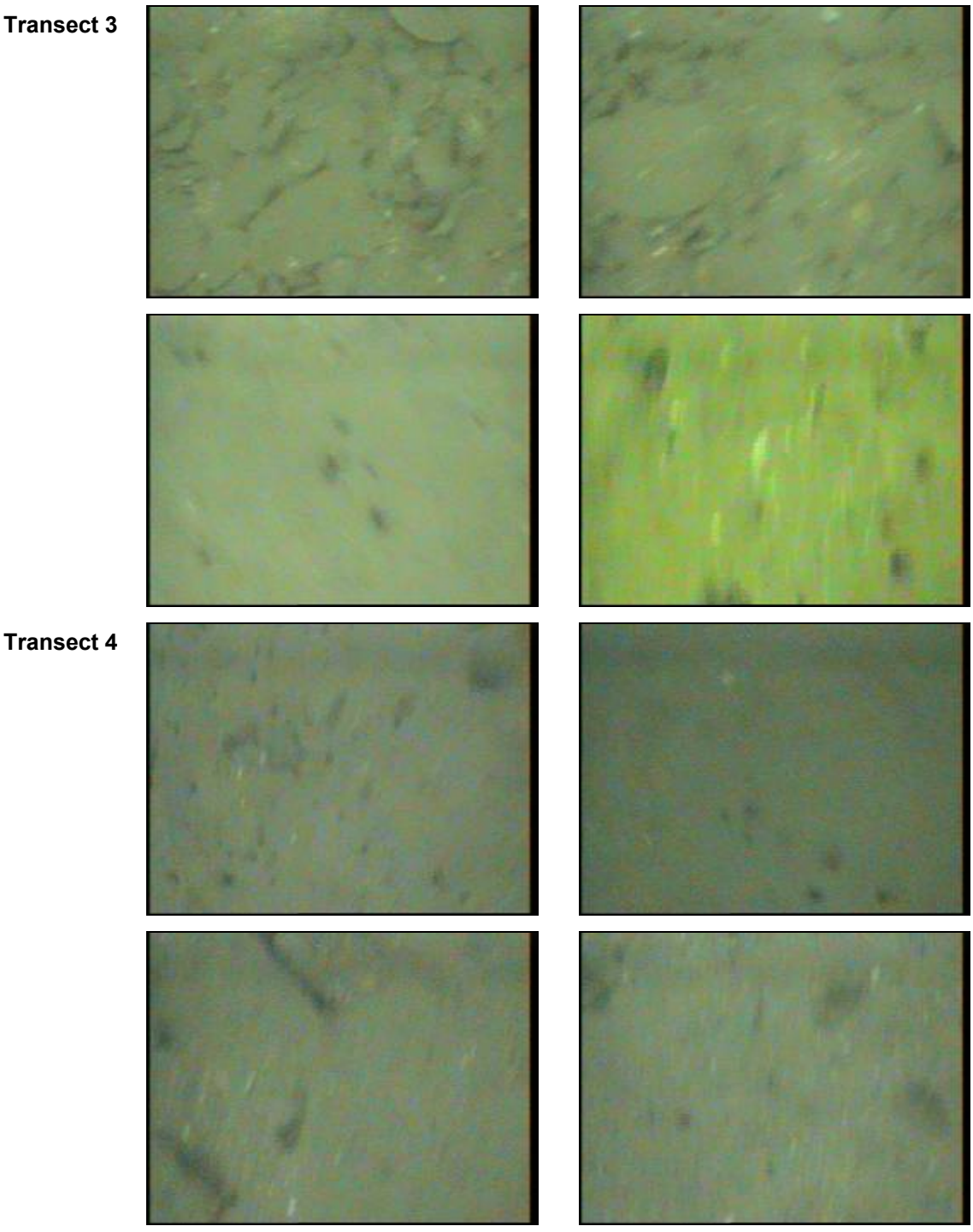


Figure 6.3 Benthic habitat at Barangaroo captured on video transects.

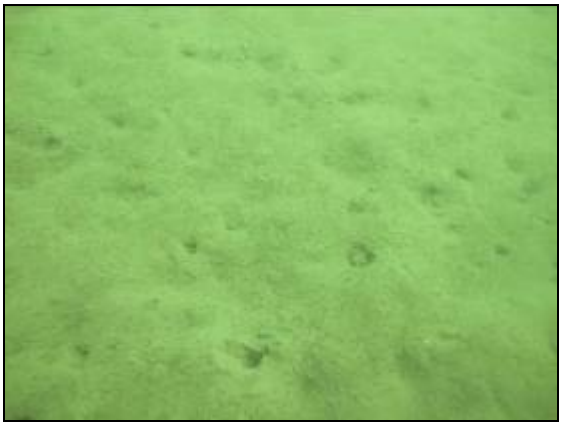
REFERENCE LOCATION 1 - BERRYS BAY

The benthic habitat at Berrys Bay consisted of silty sediments, with coral rubble and patchy subtidal reef evident at Sites 1, 2 and 4. At these sites, sponges and colonial ascidians were present. Bioturbation of the sediments was observed at all sites within Berrys Bay, but no aquatic vegetation was observed during any of the spot dives that were undertaken.

BB1

BB2

BB3



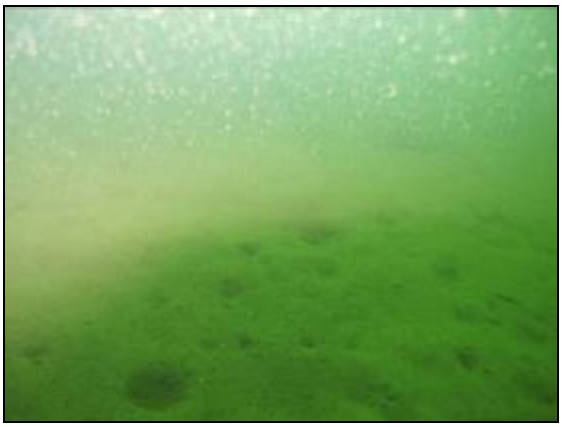
BB4

Figure 6.4 Benthic habitat at Berrys Bay captured by diver photography.

REFERENCE LOCATION 2 - SNAILS BAY

The benthic habitat at Snails Bay was comprised of soft silty sand. Bioturbation was apparent at all sites, with evidence of burrowing invertebrate crustaceans and polychaete worms. A small clump of the large brown macroalgae, *Ecklonia radiata*, was observed at Site 4, close to the shoreline. Aquatic fauna including a Numb Ray (*Hypnos monopterygium*) and a number of unidentified fish species were also observed in Snails Bay.

SB1



SB2

SB3

SB4

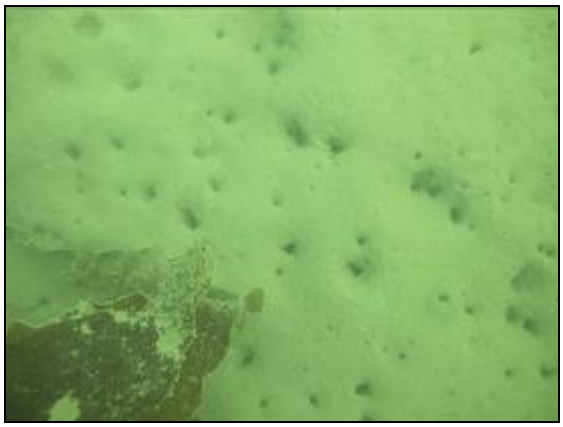


Figure 6.5 Benthic habitat at Snails Bay captured by diver photography.

6.3.2 Marine Fauna (Benthic Infauna)

A diverse range of benthic marine organisms were identified in sediments from Barangaroo, Berrys Bay and Snails Bay including polychaete worms, amphipods (e.g. yabbies and shrimps), crustaceans (e.g. crabs, shrimps, isopods), ascidians (sea squirts), cnidarians (polyps found), brittle stars, bivalves (e.g. clams) and gastropods (marine slugs) (see **Appendix 4** for raw data).

Species Diversity

There were no significant differences in species diversity between locations ($p > 0.05$), or between sites (Two-way ANOVA, df = 2, F = 1.4, $p > 0.05$). There was a difference in species diversity between sites within locations (df = 6, F = 7.9, p = 0.00). Infauna diversity was not homogeneous across the locations, likely attributed to differences in substrate type, whereby, the southern end of Barangaroo was dominated by clayey silts and the centre and southern ends by silt. The regression analysis indicated that as sediment size increased, species diversity decreased (Multiple R = - 0.67).

Table 6.5 ANOVA - Species Diversity - Summary of all Effects

	df effect	MS effect	df error	MS error	F	p-value
Location	2	3.08333	24	2.194444	1.405063	0.264819
Site	3	5.03704	24	2.194444	2.295359	0.103383
Sites within locations	6	17.34259	24	2.194444	7.902954	0.000090

Table 6.6 Regression Analysis - Species Diversity

	BETA	SE of BETA	B	SE of B	T(10)	p-value
Intercpt			9.245494	1.683759	5.49099	0.000265
PSA	-0.665240	0.236105	- 0.064948	0.023051	- 2.81756	0.018237

Regression Summary for Dependent Variable: SPECDIV

R= 0.66523978 R^2 = 0.44254397 Adjusted R^2 = 0.38679837

F(1,10) = 7.9386 p < 0.01824 Std. Error of estimate: 1.5261

Species Abundance

There was no significant differences in abundance between locations (df = 2, F = 1.3, p > 0.05). There was a difference in abundance between sites (df = 3, F = 4.1, p = 0.018) and between sites within locations (df = 6, F = 8.5, p = 0.00). Like species diversity, abundance was also variable across locations, also likely attributable to substrate types. The regression analysis indicated that as sediment size increased, species abundance decreased (Multiple R = - 0.82).

Table 6.7 ANOVA - Species Abundance - Summary of all Effects

	df effect	MS effect	df error	MS error	F	p-value
Location	2	24.1944	24	18.58333	1.301943	0.290532
Site	3	76.1481	24	18.58333	4.097658	0.017558
Sites within locations	6	157.1204	24	18.58333	8.454907	0.000054

Table 6.8 Regression Analysis – Species Abundance

	BETA	SE of BETA	B	SE of B	T(10)	p-value
Intercpt			27.49646	4.025570	6.83045	0.000046
PSA	- 0.820080	0.180961	- 0.24975	0.055111	- 4.53180	0.001088

Regression Summary for Dependent Variable: ABUND

R = 0.82007957 R^2 = 0.67253050 Adjusted R^2 = 0.63978355

F(1,10) = 20.537 p < 0.00109 Std. Error of estimate: 3.6486

IMPACTS: Any localised impacts on benthic infauna from activities such as piling would be considered to be negligible considering the widespread availability of similar benthic habitat in Sydney Harbour.

7 BARANGAROO DEVELOPMENT RISK (IMPACT) ASSESSMENT

7.1 Description of Proposed Works

The methods which are most likely to be used in the construction of the Landmark Building, ferry terminals (by NSW Government in the future) and Southern Cove have been outlined in **Section 3**. The following impact assessment is based on the general impacts of the proposed construction methods.

7.2 Potential Impacts of Construction

The proposed construction methods for the Landmark Building, ferry terminal and Southern Cove could potentially generate a number of short term environmental impacts, which could affect the marine environment. Where appropriate, mitigation measures are discussed in **Section 7.2.1**. Potential impacts include:

Waste: Removal of the existing caisson walls and wharf / jetty structure may generate waste which has the potential to impact on the health of the marine environment in Darling Harbour if appropriate mitigation and waste disposal measures are not undertaken. Any wastewater discharges from the site have the potential to affect water quality in Darling Harbour.

Noise: Noise impacts on marine and terrestrial biota are expected over the duration of the works (e.g. from engines, generators, and construction equipment). However, mobile marine and terrestrial fauna have the ability to relocate to other areas during construction and no significant impacts are expected.

Marine Construction Equipment: The use of boats and barges during piling works for the Landmark Building could result in disturbance to benthic habitat through activities such as anchoring. Minimisation of anchoring impacts can be achieved by undertaking as much of the construction work as possible on land, as to reduce the time required by barges to be anchored. Anchoring would not occur in any sensitive environments such as seagrass beds as these do not occur in the vicinity of the proposed development. These vessels also have the potential to cause pollution through fuel and oil leaks. Potential impacts of fuel and oil leaks can be mitigated by making available spillage equipment so that any accidental spills or leaks can be absorbed immediately. Booms of silt curtains will also mitigate against spread of any accidental leakages.

Water Quality: Proposed construction works have the potential to impact on water quality in Darling Harbour.

- Piling associated with construction of the Landmark Building and ferry terminals has the capacity to generate localised short term increases in turbidity through resuspension of sediments.

- Resuspension of bottom sediments causes the remobilisation of any associated heavy metals and other contaminants into the water column. If appropriate mitigation measures are not taken these contaminants have the potential to disperse into less polluted areas of the Harbour, potentially affecting fish, algae and invertebrates.
- Excavation of the Southern Cove may release contaminated land-based sediments and groundwater into the marine environment, impacting on water quality and aquatic ecology, if not appropriately controlled.

Stormwater: Increases in stormwater discharged from the site would increase freshwater input into Darling Harbour, causing decreases in salinity levels. However, since estuarine environments such as Sydney Harbour are naturally variable in salinity due to freshwater inputs (mean salinity in the estuary ranges from around 18 ppt in the upper reaches to 35 ppt at the estuary mouth) this would unlikely have a significant effect on the aquatic fauna or flora in the area.

Benthic Infauna: Placement of piles and other structures into the seabed would displace soft sediment benthic habitat, directly impacting any associated benthic fauna. However, the high availability of similar benthic habitat in Sydney Harbour suggests that benthic communities such as those recorded at Barangaroo would be widespread and thus, any localised impacts from activities such as piling would be considered to be negligible at a broader scale. If released into the Harbour, the settlement of contaminated land-based sediments on the seafloor, excavated during construction of the Southern Cove, could also impact on benthic marine fauna. Contaminated sediments can have a significant impact on the diversity and abundance of marine organisms, reducing richness and evenness of communities (Clements 2004, Millward *et al.* 2004, Johnston and Roberts 2009). However, considering the history of contamination of sediments in the harbour it may be expected that these benthic organisms have adapted to cope with such inputs.

Mobile fauna: Mobile fauna, such as fish and sharks, may be impacted by the presence of barges and by noise generated during construction works. However, due to the current high levels of boating activity in Darling Harbour these effects are likely to be negligible. Mobile phytoplankton and bacteria can be affected by small-scale resuspension of contaminated sediments (Nayar *et al.* 2004). Velocities under and near the proposed Landmark Building (and associated submerged basement structure) are unlikely to be significantly increased and are not likely to have any negative effect on fish species inhabiting Darling Harbour or mobilisation of existing bed sediments (refer to **Hydrodynamic Assessment**).

Sessile Organisms: Although removal of the existing caisson wall and wharf / jetty structure will eliminate the artificial habitat for sessile invertebrates which currently exists at the site, the Landmark Building and associated structures will increase the surface area of habitat available for sessile marine fauna. It is expected that both intertidal and subtidal habitats would be increased, given materials used for construction are not deleterious to marine life (e.g. no anti-fouled surfaces, treated wood).

Although sessile organisms do not have the ability to move away from undesirable conditions, recent research in Sydney Harbour has found that small in-frequent disturbance of contaminated sediments does not significantly impact on sessile marine organisms such as ascidians and bryozoans, presumably as they have evolved to deal with frequent natural changes in water conditions within estuaries (e.g. salinity and turbidity) (Knott and Johnston 2010). Since any disturbance of sediments will be mitigated, short-term and highly localised, the potential disturbance of sediments at the site is unlikely to have any significant impacts on sessile marine organisms in the vicinity.

Aquatic Vegetation: Physical disturbance and increased sedimentation can seriously degrade seagrass beds through direct removal, smothering and / or reduced light intensity (Poiner and Peterken 1995; Smith and Pollard 1999). Suspension of sediments can also smother the photosynthetic surfaces of algae (Knott and Johnston 2010). In addition, new structures such as the Landmark Building and ferry terminals have the potential to impact on light availability to the seabed. However, no seagrass or other aquatic vegetation was observed in the footprint of the proposed development during the site inspections, by divers or on the underwater video. In addition, no aquatic vegetation has been mapped in the area by NSW DPI (2005). Further, the wetland area mapped at Balmain East was found to be dominated by seawalls and pontoons, rather than wetland vegetation. Due to the lack of aquatic vegetation in the vicinity of the proposed Lend Lease development, no impact on these sensitive habitats is expected.

Threatened and Protected Species: The proposed Lend Lease development is not expected to have any impact on any threatened or protected species of flora or fauna. No aquatic vegetation protected under the *FM Act* 1994 is present in the vicinity of the proposed development. The only species of aquatic fauna which have the potential to occur in the area are the Little Penguin, Loggerhead Turtle and Green Turtle. However, appropriate habitat for these species does not exist at the site, and due to high level of maritime development and boating activity in this area their presence is unlikely. In addition, each of these species has the ability to remove themselves from the area if conditions are unfavorable.

Introduced Species: The dominant fauna observed on the pylon structures, at the northern end of the site were oysters. These may have been the introduced pest species Pacific Oyster (*C. gigas*). Removal of these structures will reduce the available habitat for this species.

Key Threatening Processes: Construction of the Landmark Building and Southern Cove could be classified as a key threatening processes listed under Schedule 6 of the *FM Act* 1994 - *Installation and operation of instream structures and other mechanisms that alter natural flow regimes of rivers and streams.* Hydrodynamic modelling undertaken by WorleyParsons (June 2010) has determined that the proposed Landmark Building (and associated submerged basement structure) are unlikely to significantly increase water velocities in the area and thus will have no negative effect on fish species inhabiting Darling Harbour.

7.2.1 Mitigation Measures

To minimise the impacts associated with construction of the Landmark Building, ferry terminal and Southern Cove it is recommended that the following mitigation measures be implemented:

Waste: To mitigate against waste, the following is advised:

- Remove all construction waste from the site;
- Prevent any waste from entering the Harbour;
- Manage all waste in accordance with the *EPA's Environmental Guidelines – Assessment, Classification and Management of Liquid and Non-Liquid Wastes*;
- Prepare and implement a detailed *Construction Environment Management Plan* (CEMP) for the proposed development in which waste is addressed; and
- Ensure that all waste associated with barges and boats is contained and disposed of appropriately.

Stormwater / Wastewater: Any water generated from dewatering activities shall be monitored to ensure that water quality conditions (i.e. site specific trigger limits) are suitable for returning wastewaters back into the Harbour (where applicable). Should water quality not be suitable (exceeds water quality trigger limits), then these waters should be treated, or disposed of offsite e.g. to trade waste discharges or liquid waste facilities, in accordance with DECCW requirements. Wastewater and additional stormwater discharges to the Sydney harbour should be avoided where possible. All wastewater on site should be contained during construction and treated appropriately. Wastewater or stormwater should be assessed by comparison to the relevant water quality objectives and environmental values for Sydney Harbour estuarine waters – DECCW.

Noise: Noise should be managed in accordance with the *NSW DECCW Noise Control Guidelines – Construction Site Noise* (DECCW 2008). Silencers should be used on engines and machinery where possible to minimise noise impacts on marine and terrestrial biota.

Water Quality: To minimise water quality impacts the following should be undertaken:

- Carry out all excavation and construction activities associated with the Southern Cove in a manner which reduces the potential for materials to enter the Harbour (Refer to **Section 2)**;
- Any construction activities associated with the basement perimeter retention systems, seawalls, caissons, and existing embankment should limit the creation of turbid plumes into the marine environment, adjacent to the Barangaroo foreshore by utilising appropriately designed and positioned silt curtains, installed prior to the commencement of operations;
- Prepare and implement a Construction Management Plan in which erosion and sediment management are addressed;

- Water quality monitoring should be undertaken (in accordance with protocols set out in the water Quality Report) surrounding the development, to ensure that water quality conditions are maintained beyond the silt curtains and in the broader area;
- Make available at the site spillage equipment to absorb any spills that may enter the water;
- Materials such as sand may be used to limit the potential resuspension of silts from within the cove area following inundation;
- Following construction of the Southern Cove, during inundation with seawater, the silt curtain should remain in place until the turbidity within the cove returns to background conditions, reflective of levels outside of the silt curtain and at the nominated reference locations (see prescriptive monitoring in the Water Quality Report; and
- Should barging of spoil / excavated material from the site be proposed, consultation with the Harbour Master will be required including an assessment of potential impacts and proposed mitigation measures.

Habitat Loss:

It is noted that the Southern Cove is proposed as a civic / urbane place for the gathering of people and a focal point of the public domain associated with the high density mixed use precinct of Barangaroo Stage 1. Structures that facilitate and encourage people to interact and engage with the water in the Southern Cove in an intimate manner may not be conducive to diverse habitat creation. However, it is noted that the proposed Northern Cove and the adjacent Headland Park at the north of the site pose a much greater opportunity for marine habitat creation at Barangaroo. The Northern Cove has a greater depth, width, area and planned variety of foreshore types, and the Headland Park has a greater foreshore area and length together with shoreline construction diversity.

- To increase habitat complexity and species diversity, and to reduce the likelihood of colonisation of novel habitats created by introduced marine species (Glasby *et al.* 2007), where possible the construction of seawalls (e.g. Northern Cove) should be undertaken according to *Environmentally Friendly Seawalls* (DECC 2009) as follows:
  - Incorporation of estuarine and riparian vegetation (this can only be undertaken where a seawall does not directly front deep waters) where appropriate (i.e. Headland Park and Northern Cove):
    - Step seawalls with mangrove / saltmarsh benches; and
    - Native riparian buffer landward of seawall.
  - Maximise habitat diversity and complexity where appropriate, (i.e. Headland Park and North Cove):
    - Use various sized / shaped boulders;

- Add cavities and pools that retain water at low tide;
- Do not cement between block to create crevices;
- Incorporate rubble toes for vertical seawalls;
- Utilise natural building materials;
- Utilise irregularly shaped and / or weathered blocks;
- Incorporate protruding / indented blocks; and
- Concrete panels with indentations and exposed aggregate.

- Use Low-sloping seawalls where appropriate, (i.e. Headland Park and North Cove):
  - Gentle slopes, and
  - Changes of slope e.g. benches and steps.

8 CONCLUSIONS

WorleyParsons was engaged by Lend Lease to undertake a Marine Ecology, Water Quality and Contaminated Sediment Impact Assessment to accompany a Concept Plan Amendment (MP06_0162 MOD4) Application for proposed works at Barangaroo. This report was prepared in support of the Concept Plan Amendment (Modification 4). Marine field surveys were undertaken adjacent to Barangaroo and at two reference sites within Sydney Harbour (Berrys Bay and Snails Bay) in May 2010 to provide a description of the existing environment and allow assessment of the potential impacts of the proposed development. The Director General Requirements (DGRs) addressed in this report and a brief summary of the relevant findings are provided below. It is considered that the information contained within this report including background information, description of existing conditions, description of proposed works and mitigative measures satisfies all the DGRs.

1. ***Assess the potential impacts due to construction and operations on water quality, marine vegetation and aquatic ecology.***

Water Quality: Piling associated with construction of the Landmark Building has the potential to generate localised short term increases in turbidity through resuspension of sediments. Resuspension of bottom sediments has the potential to cause remobilisation of associated heavy metals and other contaminants into the water column. Once resuspended, these contaminants have the potential to affect fish, algae and invertebrates. Additionally, excavation of the Southern Cove has the potential to cause the release of contaminated land-based sediments and groundwater into the marine environment, impacting on water quality and aquatic ecology. WorleyParsons have considered appropriate design and construction methodologies associated with the Landmark Building and Southern Cove and have concluded that by employing appropriate industry standards and mitigation measures, any impacts of the proposed development on water quality within Darling Harbour are expected to be negligible, localised and short-term in nature.

Marine Vegetation: No marine vegetation was recorded in the vicinity of the proposed development during field surveys, nor is any marine vegetation mapped by NSW DPI (2005) in the immediate area. Due to the lack of aquatic vegetation at or in the vicinity of Stage 1, no impacts on these habitats are expected.

Aquatic Ecology: The placement of piles and other structures into the seabed would displace soft sediment benthic habitat and any associated benthic infauna. If accidentally released, the settlement of contaminated land-based sediments on the seafloor, excavated during construction of the Southern Cove, could also impact on nearby benthic marine fauna. However, the abundance of similar benthic habitat in Sydney Harbour suggests that benthic communities such as those recorded at Barangaroo

would be widespread and thus, any localised impacts from the potential development on benthic invertebrate communities of Sydney Harbour would be considered to be negligible.

Mobile fauna such as fish and sharks may be impacted in the short term by the presence of barges and by noise generated during construction works. However, due to the current high levels of boating activity in Darling Harbour these effects are likely to be negligible.

Removal of the existing structures at Barangaroo will eliminate existing artificial habitat for sessile invertebrates which currently exists; however, new intertidal and subtidal habitats would be created at Barangaroo South. In addition, small in-frequent disturbance of contaminated sediments do not significantly impact on sessile marine organisms such as ascidians and bryozoans, presumably as they have evolved to deal with frequent natural changes in water conditions within estuaries (Knott and Johnston 2010). Therefore, it is unlikely that there will be any significant impact of the proposed development on sessile communities residing in the vicinity of the proposed works.

The proposed Stage 1 development would not have any impact on any threatened or protected species of flora or fauna. Due to the high level of boating activity and lack of suitable feeding and nesting habitats at Barangaroo, it is highly unlikely that any species of threatened fauna listed under the *TSC Act* 1995 or *EPBC Act* 1999, which have the potential to occur in Sydney Harbour, would utilise this area. Further, no aquatic vegetation protected under the *FM Act* 1994 is present in the vicinity of the proposed development.

In summary, if effectively mitigated using the industry standard methods and techniques described in the previous sections, any potential impacts on water quality and aquatic ecology arising from the Landmark Building or Southern Cove, would be negligible, temporary and localised.

2. Assess potential impacts on aquatic habitats from changes to the quantity, quality and discharge of stormwater from the site.

It is expected that during development excavation and construction works, all stormwater and wastewater onsite will be contained, collected, decontaminated / treated and discharged to either the sewage network (under trade waste agreement) or stormwater system. Water generated from dewatering activities during bulk excavation would be monitored and treated to ensure that water quality conditions (i.e. site specific trigger limits) were satisfactory prior to discharge to sewer or into the Harbour via stormwater. In the case that treated water is discharged to the harbour, the increased freshwater input would cause localised decreases in salinity levels. However, due to the naturally high variability in salinity levels in estuarine environments such as Sydney Harbour, this is unlikely to have a significant effect on the aquatic fauna or flora in the area. In the case where untreated water was to enter the Harbour, the mitigation measures put in place for water quality management as described in the previous section would mean that any impacts would be localised and negligible. In the longer term, upon completion of construction, Principles of Water Sensitive Urban Design (WSUD) are proposed within Stage 1 to improve quality of any storm water discharge to Darling Harbour. Stormwater is proposed to be collected for reuse within the development (as a source of irrigation etc)

and therefore quantity of stormwater discharge to Darling harbour is expected to reduce form current levels.

3. ***Assess the geotechnical and contamination issues associated with the construction of the Landmark Building and associated pier.***

The proposed submerged basement structure below the Landmark Building and associated pier is proposed to be suspended above the current harbour bed level. Hydrodynamic numerical modelling undertaken by WorleyParsons (June 2010) has found that velocities under and near the proposed Landmark Building are unlikely to be significantly increased such that existing bed sediments would be mobilised. To mitigate against possible mobilisation of existing contaminated sediments, any activities not conducted in the dry, associated with construction of the Landmark Building and submerged basement carpark (such as pile driving) should employ industry standard and appropriate techniques as described in the previous section. Prior to such activities, silt curtains should be installed around the work area. Water quality monitoring should be undertaken (in accordance with protocols set out in the **Water Quality Report** prepared by WorleyParsons (June 2010) for the Bulk Excavation and Basement Carparking Application) surrounding the development, to ensure that water quality conditions are maintained beyond the silt curtains and in the broader area. Piled foundations to the proposed Landmark Building would be founded in suitable strength sandstone bedrock at appropriate depths below the existing harbour bed. On this basis, contamination issues associated with laying of the foundations are expected to be readily managed within acceptable levels.

In summary, it is concluded that through thoughtful design, detailing and construction methodology, and by employing the appropriate industry standard mitigative measures described throughout this report, the proposed Lend Lease Barangaroo South development would be unlikely to have any significant or lasting impacts on the marine environment (including water quality impacts and impacts on flora and fauna), and any impacts would be short-term in nature and highly localised. It is considered that all DGRs above have been satisfied in this report.

9 REFERENCES

Adam, P., Urwin, N., Weiner, P., and Sim, I. (1985). *Coastal wetlands of New South Wales*: A survey and report prepared for the Coastal Council of New South Wales. Coastal Council of NSW, Sydney.

ANZECC / ARMCANZ (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000. Australian and New Zealand Environment and Conservation Council / Agriculture and Resource Management Council of Australia and New Zealand.

Barangaroo Delivery Authority (2010). Barangaroo Sydney Australia. http://www.barangaroo.com/.

Barry, S. C., Taylor, S. E. and Birch, G. F. (2001). Heavy metal supply to the Port Jackson Estuary, Australia by stormwater. *Australian Journal of Water Resources* **4**, 147-154.

Bell, J. D., and Pollard, D. A. (1989). Ecology of fish assemblages and fisheries associated with seagrasses. *In: Seagrass Ecosystems – An Australian Perspective* (eds. Larkum, A. W. D., McComb, A. J., Shepherd, S. A.), Elsevier, Amsterdam.

Birch, G. F. (1996). Sediment-bound metallic contaminants in Sydney's estuaries and adjacent offshore, Australia. *Estuarine, Coastal and Shelf Science* **42**, 31-44.

Birch, G., and Taylor, S. (1999). Source of heavy metal in sediments of the Port Jackson estuary, Australia. *The Science of the Total Environment* 227, 123-138.

Birch, G. F., and Taylor, S. E. (2000). The distribution and possible sources of organochlorine residues in sediments of a large urban estuary, Port Jackson, Sydney. *Australian Journal of Earth Sciences* **47**, 749-756.

Birch, G., and Taylor, S. (2002). Possible biological significance of contaminated sediments in Port Jackson, Sydney, Australia. *Environmental Monitoring and Assessment* **77**, 179-190.

Bulleri, F., Chapman, M. G., and Underwood, A. J. (2005). Intertidal assemblages on seawalls and vertical rocky shores in Sydney Harbour, Australia. *Austral Ecology* **30**, 655-667.

Cardno Ecology Lab (2009). Aquatic Ecological Assessment Rushcutters Bay. June 2009.

Clements W. H. (2004). Small-scale experiment support causal relationship between metal contamination and macroinvertebrate community response. *Ecological Applications 14*, 954-967.

DEWHA (2005). Waterwatch Australia National Technical Manual: Module 4 - physical and chemical parameters. http://www.waterwatch.org.au/publications/module4/temperature.html.

DIPNIR (2005). Wetlands Protection Area Maps. http://www.planning.nsw.gov.au/PlansforAction/CatchmentsandWaterways/SharingSydneyHarbour/SydneyHarbourCatchmentREP/tabid/222/language/en-AU/Default.aspx

DECC (2009). *Environmentally Friendly Seawalls – A Guide to Improving the environmental value of Seawalls and Seawall-lined Foreshores in Estuaries*. NSW Department of the Environment and Climate Change.

ERM (2007). Environmental Site Assessment, East Darling Harbour, Sydney, NSW. Environmental Resources Management, Australia. June 2007.

ERM (2008a). Additional Investigation Works at Barangaroo, Hickson Road, Millers Point, NSW. July 2008.

ERM (2008b). Preliminary Screening Works at East Darling Harbour, Adjacent to Barangaroo, NSW. Environmental Resources Management, Australia. August 2008.

Hatje, V., Birch, G. F., and Hill, D. M. (2001). Spatial and temporal variability of particulate trace metals in Port Jackson Estuary, Australia. *Estuarine, Coastal and Shelf Science* **53**, 63-77.

Hewitt, C. L., and Martin, R. B. (1996). Port Surveys for Introduced Marine Species – Background Considerations and Sampling Protocols, Technical Report no. 4. Prepared for CSIRO Centre for Research on Introduced Marine Research (CRIMP) / Australian Association of Ports and Marine Authorities. CSIRO Centre for Research on Introduced Marine Species. Hobart, Tasmania.

Hewitt, C. L., and Martin, R. B. (2001). Revised protocols for baseline port surveys for introduced marine species: survey design, sampling protocols and specimen handling, CRIMP Technical Report no. 22. Prepared for CSIRO Centre for Research on Introduced Marine Research (CRIMP) / Australian Association of Ports and Marine Authorities. CSIRO Centre for Research on Introduced Marine Species. Hobart, Tasmania.

Hunt, J., Birch, G. F., and Warne, M. St. J, (2008). Deriving trigger values for, and assessing hazard posed by, volatile chlorinated hydrocarbons in a Sydney estuary. *Australian Journal of Ecotoxicology* **12**, 33-42.

Johnston, E. L., and Roberts, D. A. (2009). Contaminants reduce the richness and evenness of marine communities: A review and meta-analysis. *Environmental Pollution* **157**, 1745-1752.

Knott, N., and Johnston, E. (2010). Is the ecology of Sydney harbour threatened by the disturbance of contaminated sediments? An experimental assessment of the effects of resuspension of contaminated sediment on sessile animals of Sydney Harbour. University of New South Wales (UNSW).

Knott, N. A., Aulbury, J. P., Brown, T. H., and Johnston, E. L. (2009). Contemporary ecological threats from historical pollution sources: impacts of large scale resuspension of sediments on sessile invertebrates. *Journal of Applied Ecology* **46**, 770-781.

Larkum, A. W. D., McComb, A. J., Shepherd, S. A. (1989). Seagrass Ecosystems – An Australian Perspective. Elsevier, Amsterdam.

Lopez-Galindo, C., Garrido, M.C., Casanueva, J.F., Nebot, E. (2010). Degradation models and ecotoxicity in marine waters of two antifouling compounds: Sodium hypochlorite and an alkylamine surfactant. *Science of the Total Environment* **408**, 1779-1785.

Matthai, C. and Birch, G. F. (2000). Trace metals and organochlorines in sediments near a major ocean outfall on a high energy continental margin (Sydney, Australia). *Environmental Pollution* **110**, 411-423.

McCready, S., Slee, D., Birch, G. F., and Taylor, S. E. (2000). The distribution of polycyclic aromatic hydrocarbons in surficial sediments of Sydney Harbour, Australia. *Marine Pollution Bulletin* **40**, 999-1006.

McLoughlin, L. C. (2000). Changes in estuarine wetlands distribution along the Parramatta River, Sydney, 1788–1940: implications for conservation and planning. *Cunninghamia* **6**, 579–610.

Mesley, E. (2003). *Estuarine geomorphology as a surrogate for ecological habitat, Port Jackson estuary NSW.* BSc Marine Science (Honours Thesis), University of Sydney.

Millward, R. N., Carman, K. R., Fleeger, J. W., Gambrell, R. P., and Portier, R. (2004). Mixtures of metals and hydrocarbons elicit complex responses by a benthic invertebrate community. *Journal of Experimental Marine Biology and Ecology* **310**, 115-130.

Nayar, S., Goh, B. P. L., Chou, L. M. (2004). Environmental impact of heavy metals from dredged and resuspended sediments on phytoplankton and bacteria assessed in in situ mesocosms. *Ecotoxicology and Environmental Safety* **59**, 349-369.

NSW DPI (2005). Mapping the estuarine habitats of NSW – Sydney Harbour. http://www.dpi.nsw.gov.au/research/areas/aquatic-ecosystems/estuarine-habitats-maps

NSW DPI (2007). Seagrasses – Primefact 629. www.dpi.nsw.gov.au/__data/assets/pdf_file/0019/203149/seagrasses-primefact-629.pdf. NSW Department of Primary Industries.

NSW Maritime (2004). Information Sheet: Sydney Harbour and Tributaries.

Poiner, I. R., and Peterken, C. (1995). *Seagrasses.* In: *The Marine Environment, Technical Annex: 1* of *State of the Marine Environment Report for Australia* (Zann, L.P.). Department of the Environment, Sport and Territories, Canberra.

Roy, P. (1984). New South Wales estuaries – their origins and evolution. In: Developments in Coastal Geomorphology in Australia (Ed. Thom, B. G.). Academic Press New York, pp. 99-121.

Roy, P. S., Williams, R. J., Jones, A. R., Yassini, I., Gibbs, P. J., Coates, B., West, R. J., Scanes, P. R., Hudson, J. P., and Nichol, S. (2001). Structure and function of south-east Australian estuaries. Estuarine, Coastal and Shelf Science **53**, 351-384.

Smith, A. K., and Pollard, D. A. (1999). Policy and Guidelines Aquatic Habitat Management and Fish Conservation: 1999 Update. NSW Fisheries, Port Stephens Research Centre.

Snelgrove, P. V. R. (1998). The biodiversity of macrofaunal organisms in marine sediments. *Biodiversity Conservation* **7**, 1123-1132.

Sprecher, S. L., and Getsinger, K. D. (2000). Zebra mussel chemical control guide. Environmental Laboratory U.S Army Engineer Research and Development Centre, pp.87-92.

Stark, J. S. (1998). Heavy metal pollution and macrobenthic assemblages in soft sediments in two Sydney estuaries, Australia. *Marine and Freshwater Research* **49**, 553-540.

West, R. J., Thorogood, C. A., Walford, T. R., and Williams, R. J. (1985). An estuarine inventory for New South Wales, Australia. Division of Fisheries, NSW Department of Agriculture, Sydney, Australia.

Appendix 1 – NSW Maritime Habitat Assessment Guidelines

NSW MARITIME

Marine Habitat Survey

Why is it required?

- NSW Maritime owns the bed of Sydney Harbour and its tributaries, and is responsible for the conservation of and protection of the marine environment.
- There has been a significant loss of habitat, and NSW Maritime requires information to assess impacts in the marine environment.

When do applicants need to provide a marine habitat survey?

- When applying for Land Owner's Consent or development under Part 5 of the Environmental Planning and Assessment Act 1979.
- Where a structure or activity has the potential to impact on marine habitat.

What information is required?

- scaled plans showing the existence of any vegetation below mean high water mark (mangroves, seagrass varieties etc) within a minimum of 20m of the proposal
- details of the survey area and sampling method
- photographs of the sampling area
- description of dominant habitats and species, including their sensitivity to change and the incidence of threatened species
- the nature of the inter-tidal and sub-tidal zone (sand, rock etc)
- direct and indirect impacts on marine habitat of the proposal both during and after construction
- proposed mitigation measures both during and after construction
- proposed monitoring of impacts after construction

Who conducts the habitat surveys?

- Suitably qualified marine ecologists.
- You can refer to the Yellow Pages under Environmental Consultants or Natural Resource Consultants.

Appendix 2 – Threatened Species Searches

Australian Government
Department of the Environment, Water, Heritage and the Arts

Protected Matters Search Tool

You are here: Environment Home > EPBC Act > Search

28 April 2010 10:49

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

You may wish to print this report for reference before moving to other pages or websites.

The Australian Natural Resources Atlas at http://www.environment.gov.au/atlas may provide further environmental information relevant to your selected area. Information about the EPBC Act including significance guidelines, forms and application process details can be found at http://www.environment.gov.au/epbc/assessmentsapprovals/index.html

Search Type: Point
Buffer: 1 km
Coordinates: -33.859369,151.200215

Report Contents:

Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance - see http://www.environment.gov.au/epbc/assessmentsapprovals/guidelines/index.html.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Significance: (Ramsar Sites)	1
Commonwealth Marine Areas:	None
Threatened Ecological Communities:	None

Threatened Species:	15
Migratory Species:	33

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place and the heritage values of a place on the Register of the National Estate. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage/index.html.

Please note that the current dataset on Commonwealth land is not complete. Further information on Commonwealth land would need to be obtained from relevant sources including Commonwealth agencies, local agencies, and land tenure maps.

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species. Information on EPBC Act permit requirements and application forms can be found at http://www.environment.gov.au/epbc/permits/index.html.

Commonwealth Lands:	3
Commonwealth Heritage Places:	None
Places on the RNE:	182
Listed Marine Species:	36
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	1
Other Commonwealth Reserves:	None
Regional Forest Agreements:	None

Details

Matters of National Environmental Significance

National Heritage Places [Dataset Information]

Sydney Harbour Bridge NSW

Wetlands of International Significance [Dataset Information]
(Ramsar Sites)

TOWRA POINT NATURE RESERVE	Within same catchment as Ramsar site

Threatened Species [Dataset Information]	Status	Type of Presence
Birds		
Anthochaera phrygia Regent Honeyeater	Endangered	Species or species habitat likely to occur within area
Lathamus discolor Swift Parrot	Endangered	Species or species habitat may occur within area

Rostratula australis Australian Painted Snipe	Vulnerable	Species or species habitat may occur within area
Frogs		
Heleioporus australiacus Giant Burrowing Frog	Vulnerable	Species or species habitat likely to occur within area
Litoria aurea Green and Golden Bell Frog	Vulnerable	Species or species habitat may occur within area
Mammals		
Chalinolobus dwyeri Large-eared Pied Bat, Large Pied Bat	Vulnerable	Species or species habitat may occur within area
Dasyurus maculatus maculatus (SE mainland population) Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population)	Endangered	Species or species habitat may occur within area
Potorous tridactylus tridactylus Long-nosed Potoroo (SE mainland)	Vulnerable	Species or species habitat may occur within area
Pteropus poliocephalus Grey-headed Flying-fox	Vulnerable	Species or species habitat likely to occur within area
Reptiles		
Caretta caretta Loggerhead Turtle	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle	Vulnerable	Species or species habitat likely to occur within area
Hoplocephalus bungaroides Broad-headed Snake	Vulnerable	Species or species habitat likely to occur within area
Plants		
Caladenia tessellata Thick-lipped Spider-orchid, Daddy Long-legs	Vulnerable	Species or species habitat likely to occur within area
Cryptostylis hunteriana Leafless Tongue-orchid	Vulnerable	Species or species habitat may occur within area
Pimelea curviflora var. curviflora	Vulnerable	Species or species habitat may occur within area
Migratory Species [Dataset Information]	Status	Type of Presence
Migratory Terrestrial Species		
Birds		
Haliaeetus leucogaster White-bellied Sea-Eagle	Migratory	Species or species habitat likely to occur within area
Hirundapus caudacutus White-throated Needletail	Migratory	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater	Migratory	Species or species habitat may occur within area
Monarcha melanopsis Black-faced Monarch	Migratory	Breeding may occur within area
Myiagra cyanoleuca Satin Flycatcher	Migratory	Breeding likely to occur within area
Rhipidura rufifrons Rufous Fantail	Migratory	Breeding may occur within area
Xanthomyza phrygia Regent Honeyeater	Migratory	Species or species habitat likely to occur within area
Migratory Wetland Species		
Birds		
Ardea alba Great Egret, White Egret	Migratory	Species or species habitat may occur within area
Ardea ibis Cattle Egret	Migratory	Species or species habitat may occur within area