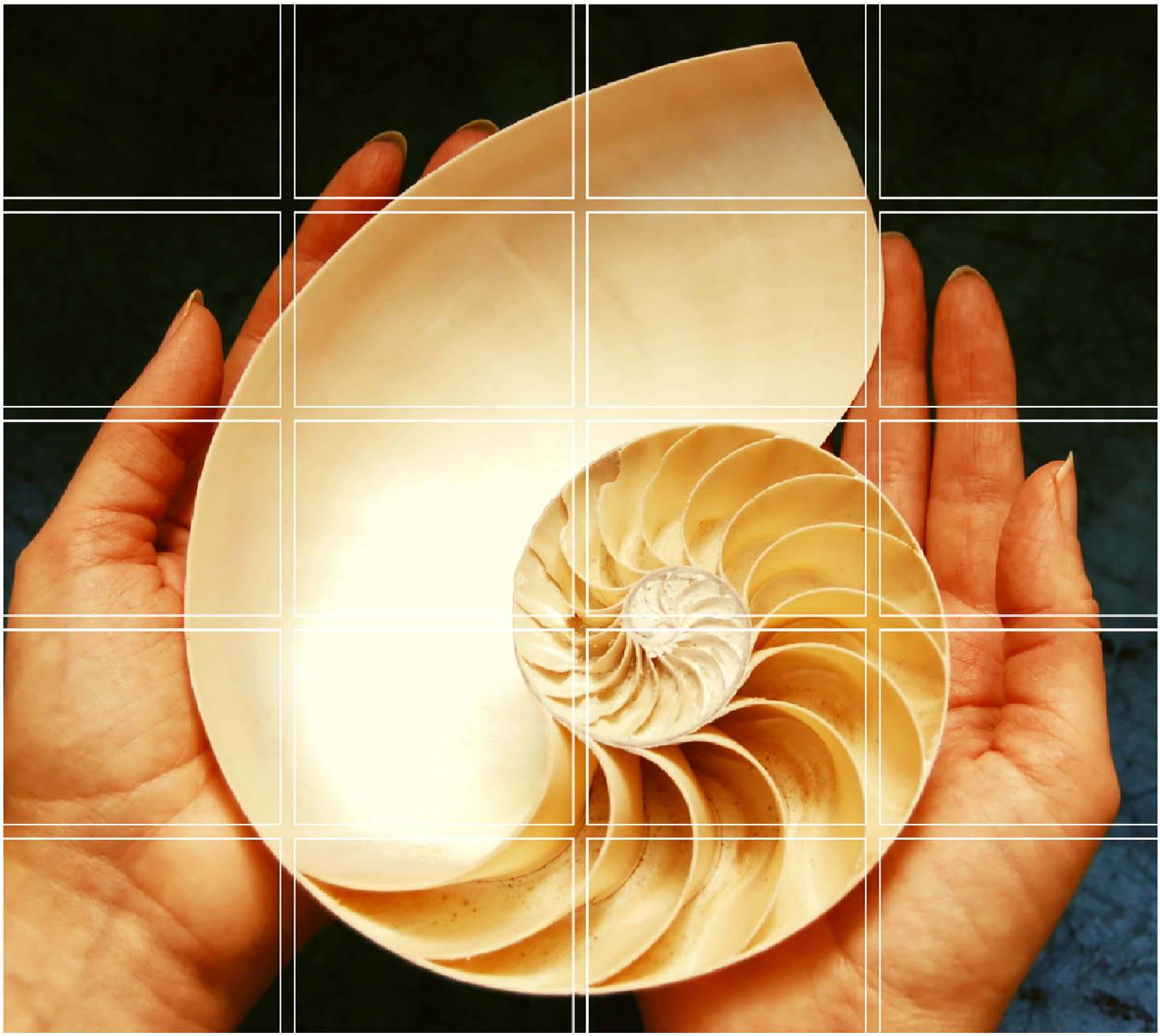

# Flora and Fauna Impact Assessment Cockle Bay Marine Structures Renewal

Sydney Harbour Foreshore Authority

April 2015

Final Report
0278780

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# Flora & Fauna Impact Assessment

# Cockle Bay Marine Structures Renewal

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| Approved by: | Alison Lane |
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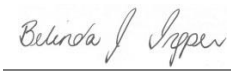
| Signed: |  |
| Date: | *22 April, 2015* |

*Environmental Resources Management Australia*

**FINAL REPORT**

Sydney Harbour Foreshore Authority

# Cockle Bay Marine Structures Renewal

April 2015

Reference: 0278780/Flora and Fauna Assessment

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## *EXECUTIVE SUMMARY*

Sydney Harbour Foreshore Authority ('the Authority') intends to renew the marine structures in Cockle Bay, those of which are at or near end of life and present a compliance risk to the Authority.

The proposed Cockle Bay Marine Structures Renewal Project ('the Project') involves the removal of the existing marine structure and 185 piles, and installation of a newly configured marine structure and approximately 80 piles. The replacement of the above water structure will reduce the area of seabed that is shaded by approximately 973 $m^2$. All works will be conducted from the water using barges over a total period of 29 weeks during two separate construction windows in 2016. Silt curtains will be used to reduce the influence of sediment disturbance resulting from the works.

This Flora and Fauna Assessment (herein referred to as the Study) considers the potential for impacts on existing marine ecological values from the planned works including the removal and installation of structures in the marine environment, long-term presence of new structures and construction logistics and assessing all sources of environmental disturbance resulting from these. Specifically the Study considers the effects of changes in the light regime, generation of underwater noise and vibration, removal of marine growth attached to piles, removal of vertical habitat as well as turbidity and the suspension and deposition of sediments.

In assessing the potential for environmental effects, the Study considers both the sensitivity of the environmental receptors identified in the Project Area and the potential magnitude of the effect from each activity. Following the initial assessment, any mitigation measures that will be applied to reduce environmental effects are considered in determining the residual potential effect.

The results show that, with the implementation of management and mitigation measures, all identified potential effect from the activities were found to be ***negligible*** or ***minor.*** Of these, the only effects greater than ***negligible*** were related to the potential for ***minor*** behavioural disturbance of species housed within the Sydney Aquarium as a result of underwater noise and vibration, and sediment disturbance. For unplanned events, the effects were found to be as low as reasonably practicable (**ALARP**) and no further mitigation measures were considered necessary.

# 1 INTRODUCTION

## 1.1 PURPOSE OF THIS REPORT

This Flora and Fauna Assessment (herein referred to as the Study) has been prepared to inform the applicant, decision makers and affected parties about the potential effects on marine ecological values resulting from activities associated with the proposed Cockle Bay Marine Structures Renewal Project ('the Project').

This report assesses the marine ecological values of the Site against the relevant legislation, determines the potential impacts of construction and long-term presence of marine structures occupying the area, and where necessary provides mitigation measures to avoid, remedy or mitigate those potential effects.

## 1.2 OVERVIEW OF THE PROJECT

Sydney Harbour Foreshore Authority ('the Authority') intends to renew the marine structures in Cockle Bay as part of the redevelopment of Darling Harbour. These assets are at or near the end of life and present a compliance risk to the Authority. The Project will resolve the current compliance risk and maximise Cockle Bay as a dynamic events and entertainment space, while continuing to provide water-based transport and tourism opportunities to Sydney's patrons and other visitors. In addition, the Project will also reduce existing conflicts of use between maritime operations; provide new events infrastructure; improve safety and access; and provide more opportunities for people to enjoy being on and around the water.

The Project scope will include the removal of all structures south of Pyrmont Bridge with the exception of the recently constructed timber boardwalk, and installation of new facilities including:

- A new public wharf;
- A new floating boardwalk;
- A dedicated multi-function events pontoon;
- Multi-use detachable aquatic events pods;
- Dedicated water taxi ranks;
- 30 overnight public vessel berths; and
- 8 permanent commercial berths.

The primary objective for this Study is to present a review of all available information regarding the baseline marine ecological conditions within the vicinity of Cockle Bay, along with the potential effects to marine ecological values during and after the proposed works.

### *1.2.1 Project Applicant*

The Authority owns and manages some of the most significant assets in NSW, including Sydney's heritage and cultural precincts at The Rocks and Darling Harbour. The Authority manages significant commercial and retail leases, provides security, cleaning, maintenance and cares for the public domain and over 100 heritage sites (Sydney Harbour Foreshore Authority, 2014a). The Authority was formed in 1999 under the *Sydney Harbour Foreshore Authority Act, 1998* to consolidate the work and function of the City West Development Corporation, Darling Harbour Authority and Sydney Cove Authority (Sydney Harbour Foreshore Authority, 2014a).

### *1.2.2 Project Location*

Cockle Bay and Darling Harbour are among the most popular areas for tourism within the Sydney region (*see Figure 1.1)* attracting more than 27 million visitors each year. This area features an array of restaurants, sightseeing, shopping and activities for locals and tourists and is a key Sydney celebration space. Darling Harbour was originally developed for maritime and industrial use in the early 1800s and these uses continued through much of the 20th Century (Sydney Harbour Foreshore Authority, 2014b). The current arrangement of the structures in Cockle Bay is outlined in *Figure 1.2*.


***Figure 1.1 Aerial view of the Project Location***


***Figure 1.2*** ***Existing Marine Structures in Cockle Bay*** ***Source: Sydney Harbour Foreshore Authority, 2014b***

Cockle Bay is bound by the Pyrmont Bridge to the north and the shorelines of Darling Harbour to the east, south and west (see *Figure 1.2*). The main existing structural features in Cockle Bay are outlined below.

*Harbourside Jetty*

The existing Harbourside Jetty (*see Figure 1.2*) is leased by the South Steyne ferry restaurant and is therefore generally only used by diners of the South Steyne and pedestrian visitors (Sydney Harbour Foreshore Authority, 2014b). The South Steyne ferry is an item of NSW state heritage.

*Harbourside Promenade*

The Harbourside Promenade is a large timber deck which resides at the front of the Harbourside retail centre. This deck is a step below the boardwalk area.

*Harbourside Steps*

These steps have become degraded overtime and their use is now restricted.

*Convention Wharf*

The Convention Wharf is made up of two fixed deck piers with a central floating pontoon and pylons and occupies a large on-water footprint for its berthing capacity. This wharf is currently used for the Sydney Exhibition Centre ferry service and private charter boats (Sydney Harbour Foreshore Authority, 2014b).

*Cockle Bay Marina*

This structure is made up of two components, one being the public wharf utilised for watching boats, jet boats, sailing charters, and water taxis and the other being the private short stay berths, includes a ticketing office on the wharf (Sydney Harbour Foreshore Authority, 2014b). The short stay berths also provide mooring for private boats visiting Darling Harbour.

*Heritage Seawall*

This structure is the only remaining area of the original 1850-1870 sandstone seawall and is located between the Harbourside promenade and the Pyrmont Bridge (Sydney Harbour Foreshore Authority, 2014b).

# 2 PROJECT DESCRIPTION

## 2.1 STRUCTURES RENEWAL

The design for the planned renewal activity involves optimising the use of the Cockle Bay facilities, while reducing the area of seabed occupied by marine structures as shown on *Figure 2.1*.

The planned works comprises:

- demolition and removal of 4,365 metres square ($m^2$) of the existing marine structures;
- removal of 185 timber (300 mm in diameter) and steel piles (400 to 600 mm in diameter);
- installation of approximately 80 timber and steel piles 300-600 mm in diameter, to a depth of up to 15 metres (m) below the seabed; and
- installation of the newly configured marine structures covering an area of approximately 3,392 $m^2$.

The final works will result in a reduction in area occupied by marine structures, including surface waters and seabed, by approximately 973 $m^2$.

All site works will be conducted from two vessels; an 18 m long barge mounted with a FVCO STD500SP Crane and a 21 m x 7 m service barge, or vessels of similar specifications. No works will be conducted from the shoreline. Piles that cannot be completely removed will be cut below the seabed, using a cutting sleeve to reduce seabed disturbance.

Site works are anticipated to be completed over two working windows including February to May 2016 (15 weeks) and August to November 2016 (14 weeks).

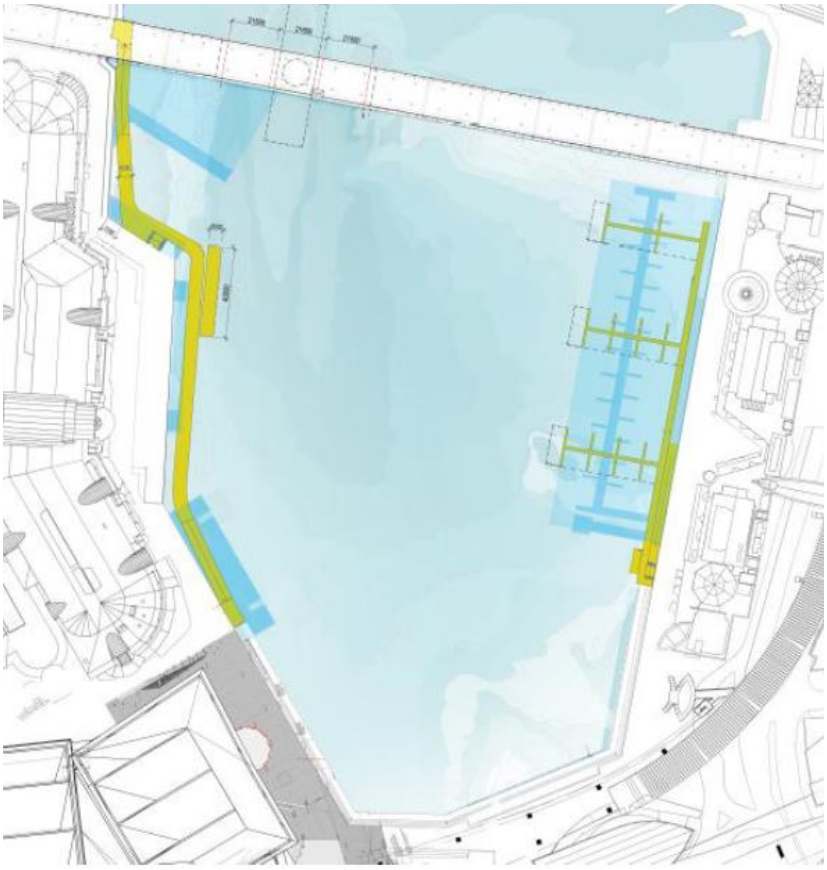

*Figure 2.1* ***Existing and Proposed Water Footprint (existing structures shown in light blue, new shown in yellow)*** *Source: Mott MacDonald, 2015*

# 3 ADMINISTRATIVE FRAMEWORK

The administrative framework under which the proposed works will be regulated includes Commonwealth, State and Local legislation. The following section details legislation specific to the protection of marine ecological values within the Project Area. These legislative instruments and the environmental features they are designed to protect have been taken into account in developing this document.

## 3.1 COMMONWEALTH LEGISLATION

### 3.1.1 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides legislative framework to protect and manage wetlands of international importance, Commonwealth Marine Areas, nationally threatened species and ecological communities and migratory species, and world and heritage sites. All cetaceans are protected under this legislation regardless of their conservation status.

The EPBC Act requires that any development that may or will have a significant effect on a 'Matter of National Environmental Significance' (MNES) cannot be undertaken without prior approval from the Department of the Environment.

## 3.2 STATE LEGISLATION

### 3.2.1 Environmental Planning and Assessment Act 1979

The *Environmental Planning and Assessment Act 1979* (EP&A Act) serves to regulate planning and development actions with consideration to the environment (both natural and built).

### 3.2.2 Fisheries Management Act 1994

The *Fisheries Management Act 1994* (FM Act) is a key piece of NSW state legislation, its purpose to protect threatened species, populations and ecological communities of fish and marine vegetation.

### 3.2.3 Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act 1995* (TSC Act) serves to protect threatened species, populations and ecological communities of animals and plants.

### *3.2.4 Protection of the Environment Operations Act 1997*

The *Protection of the Environment Operations Act 1997* (POEO Act) is a key piece of environmental legislation under the administration of the Environmental Protection Authority (EPA). This Act enables Government to set out protection of the environmental policies (PEPs) and adopt more innovative approaches to reducing pollution.

# 4 METHODOLOGY

## 4.1 IMPACT ASSESSMENT SCOPING

Scoping was undertaken by ERM in accordance with ERM's standard methodology. This scoping exercise documented the resources and receptors potentially present within the Area of Interest (AOI) (see *Section 4.1.2*), and assessed which of these the Project activities may interact with and potentially effect.

### 4.1.1 *Identifying the Project Activities*

To initiate the scoping process, the activities were described based on information provided by SHFA. This stage of the Study entailed gathering information to define the Project design as far as possible. This Project design was then broken down into a series of discrete activities that could more readily be assessed for effects on the receiving environment.

### 4.1.2 *Establishing the Area of Interest*

Throughout the assessment process, the extent of the AOI took into account the specific aspect and the types of effects considered.

The AOI for the Project has been defined to include all that area within which it is likely that significant impacts could result. This takes into account:

- Primary Project site: the site of the Project, being the physical extent of the Project activities (in this case Cockle Bay);
- Potential areas affected by impacts from unplanned events resulting from the Project; and
- The nature of the affected resource or receptor, the source of impact and the manner in which the resultant effect is likely to be propagated beyond the Project footprint.

### 4.1.3 *Assessing Project: Resource/Receptor Interactions*

The nature and availability of baseline environmental and Project information is such that the identification of the potential interactions between the Project and resources/receptors within the AOI could be undertaken to a high level of confidence. Professional judgement was used to assess whether interactions have the potential to result in impacts that could lead to negative or positive effects greater than negligible. In addition the relevant regulatory requirements were considered.

Once potential interactions were identified, they were charted using a colour-coded matrix (see *Table 4.1* below as an example and *Table 6.1* the potential interactions matrix). The different colours within the matrix indicate the level of potential impact based on the following criteria:

Potential interactions between the activities and existing environment and uses were each classified into one of the following three categories:

- **No interaction**: where the Project is unlikely to interact with the existing environment or interests (coded white);
- **Interaction possible, but not likely to be significant**: where there is likely to be an interaction, but the resultant effect is unlikely to change baseline conditions in an appreciable or detectable way (coded light grey); and
- **Significant interaction**: where there is likely to be an interaction, and the resultant effect has a reasonable potential to cause a significant effect on the existing environment or interests (coded dark grey).
- **Positive interaction:** where there is likely to be an interaction that results in a beneficial effect on the existing environment or interests (coded with diagonal hatching).

*Table 4.1* *Example of a Scoping Matrix*

| | **Receptor # 1** | **Receptor # 2** | **Receptor # 3** | **Receptor # 4** | **Receptor # 5** | **Receptor # 6** |
|---|---|---|---|---|---|---|
| Project Activity | | | | | | |

### *4.1.4 Environmental Baseline Definition*

To assess and define the Project components and the environmental baseline, two steps were undertaken:

- Collection of relevant Project information; and
- Collection of baseline data for the AOI or considered to be adequately representative of the area.

A range of information was reviewed by ERM and incorporated into the Study including data from the following sources:

- Project technical specifications and project details provided by SHFA;
- Primary literature;
- Published ecological assessments of the AOI and surrounding areas;
- A review of diver survey footage of the Project Area collected in February 2015; and
- Internet websites including the following database searches:
    - The EPBC Act Protected Matters Search Tool returned a total of 29 species listed as Vulnerable and Endangered under the EPBC Act and FM act that are known to occur or may potentially occur within a 1 km buffer around the coordinates 33.87179 151.20075 or otherwise defined as the Project Area (Data retrieved 28th January 2015) (see *Table 5.2*). Of these species, 21 were marine, freshwater and/or terrestrial birds, 1 fish, 5 turtle and 2 species of shark. These species are described further in *Section 5*.
    - The NSW Wildlife Atlas database search returned a total of 210 species that are known to occur or may potentially occur within a 10 km buffer of the Project Site (Data retrieved 28th January 2015) (see *Table 5.3*). Of these, 19 species were considered Vulnerable, Endangered or as an Endangered Populations under the TSC Act and they included 16 marine, freshwater and/or terrestrial birds and 3 marine mammals as described in *Section 5*.

Each data set was assessed for completeness, sufficiency and applicability for use in the Study.

## *4.2 EFFECTS ASSESSMENT*

This section describes the Study methodology adopted for identifying and assessing effects from the Project on the environment. This methodology includes consideration of the activities, the conservation values affected by the activities, potential effects, and measures to avoid, remedy or mitigate adverse effects.

There are four phases to the assessment process, which are outlined below.

### *4.2.1 Phase One - Identification of Effects*

Environmental effects arise as a result of project activities interacting either directly or indirectly with the local environment. Specific interactions can affect a number of environmental aspects or contribute to a wider cumulative effect. The types of effect that may arise from the proposed works are outlined in *(see Table 4.2).*

Certain effects may be scoped out due to their negligible effect on the surrounding environment. Any issue with the potential to have a significant effect is assessed in greater detail during the following phases.

***Table 4.2 Types of Effects as Categorised within this Study***

| Type of Effect | Definition |
|---|---|
| **Nature of Effect** | |
| Negative | An effect that is considered to represent an adverse change from the baseline, or to introduce a new undesirable factor. |
| Positive | An effect that is considered to represent an improvement to the baseline or to introduce a new desirable factor. |
| **Type of Effect** | |
| Direct (or Primary) | Effects that result from a direct interaction between a planned Project activity and the receiving environment. |
| Secondary | Effects that follow on from the primary interactions between the Project and its environment as a result of subsequent interactions within the environment |
| Indirect | Effects that result from other activities that are encouraged to happen as a consequence of the Project. |
| Cumulative | Effects that act together with other effects (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the Project. |
| **Duration of Effect** | |
| Temporary | Effects are predicted to be of short duration and intermittent/occasional in nature. |
| Short-term | Effects that are predicted to last only for a limited period but will cease on completion of the activity, or as a result of mitigation/reinstatement measures and natural recovery. |
| Long-term | Effects that will continue over an extended period, but cease when the Project stops operating. These will include effects that may be intermittent or repeated rather than continuous if they occur over an extended time period. |
| Permanent | Effects that occur during the development of the Project and cause a permanent change in the affected receptor or resource that endures substantially beyond the Project lifetime. |

| Type of Effect | Definition |
|---|---|
| **Scale of Effect** | |
| Local | Effects on locally important environmental resources or restricted to a single habitat or biotope, a single (local) administrative area, a single community. |
| Regional | Effects on regionally important environmental resources or that are experienced at a regional scale as determined by administrative boundaries, habitat type or ecosystem. |
| National | Effects on nationally important environmental resources, affect an area that is nationally important, protected or have macro-economic consequences. |
| International | Effects on internationally important resources such as areas protected by International Conventions. |
| Trans-boundary | Effects that are experienced in one country as a result of activities in another. |

### *4.2.2 Phase Two – Evaluating Impacts*

Following the identification of potential environmental effects (Phase One), the significance of these effects was assessed, taking into account mitigation measures fundamental to the design of the Project.

For the purposes of this Study, the following definition of significance has been adopted:

> *An impact is significant if in isolation or in combination with other impacts it should, in the judgment of the Study team, be taken into account in the decision-making process, including the identification of mitigation measures and consenting conditions.*

Assessing the level of significance requires consideration of the likelihood and magnitude of the environmental effect, taking account of the geographical scale and duration of the impact in relation to the sensitivity of the key receptors and resources. Criteria for assessing the significance of impacts stem from the following key elements:

- The magnitude (including nature, scale and duration), as defined in Table 4.3 of the change to the natural environment (for example, loss or damage to habitats or an increase in noise), which is expressed in quantitative terms wherever practicable.

- The nature of the affected receptor, which may be physical, biological, or human, and its sensitivity as defined in Table 4.4. Where the receptor is physical (e.g. a water body) its quality, sensitivity to change and importance are considered.

- The likelihood (probability) that the identified impact will occur is estimated based upon experience and/or evidence that such an outcome has previously occurred. Categories of likelihood are defined in Table 4.6.

Effects predictions have been made using available data, but where significant uncertainty remains, this is acknowledged and an indication of its scale was provided.

*Table 4.3 The Criteria for Assessing the Magnitude of Effects for Ecological Values*

| | **Ecological Values** |
|---|---|
| **Negligible** | Immeasurable, undetectable or within the range of normal variation |
| **Small** | Affects a specific group of localised individuals within a population over a short period (one generation or less), but does not affect other trophic levels or the population itself. |
| **Medium** | Affects a portion of a population and may bring about a change in abundance and/or distribution over one or more generations, but does not threaten the integrity of that population or any population dependent on it. |
| **Large** | Affects an entire population or species in sufficient magnitude to cause a decline in abundance and / or change in distribution beyond which natural recruitment (reproduction, immigration from unaffected areas) would not return that population or species, or any population or species dependent upon it, to its former level within several generations. |
| **Positive** | In the case of positive impacts, it is generally recommended that no magnitude be assigned, unless there is ample data to support a more robust characterization. It is usually sufficient to indicate that the Project will result in a positive impact, without characterising the exact degree of positive change likely to occur. |

*Table 4.4 The Criteria for Assessing the Sensitivity of Receptors*

| | **Ecological Values** |
|---|---|
| **Low** | Ecological receptors are abundant, common or widely distributed and are generally adaptable to changing environments. Species are not endangered or protected. |
| **Medium** | Some ecological receptors have low abundance, restricted ranges, are currently under pressure or are slow to adapt to changing environments. Species are valued locally / regionally and may be endemic, endangered or protected. |
| **High** | Some ecological receptors in the area are rare or endemic, under significant pressure and/ or highly sensitive to changing environments. Species are valued nationally / globally and are listed as endangered or protected. |

The significance of impacts is then defined, based on the sensitivity of the receptor as shown in *Table 4.4* and the magnitude of impact as shown in *Table 4.3*. The significance of these interactions is shown in *Table 4.5*.

For this assessment, four effects significance categories have been applied being: *Negligible*, *Minor*, *Moderate, Major* and *Positive*. These categories of significance for environmental receptors are defined in *Table 4.6*.

*Table 4.5 Effect Assessment Matrix used for the Project*

| | | Sensitivity of Receptor | | |
|---|---|---|---|---|
| | | **Low** | **Medium** | **High** |
| **Magnitude of Effect** | **Negligible** | **Negligible** | **Negligible** | **Negligible** |
| | **Small** | **Negligible** | **Minor** | **Moderate** |
| | **Medium** | **Minor** | **Moderate** | **Major** |
| | **Large** | **Moderate** | **Major** | **Major** |
| | **Positive** | **Minor** | **Moderate** | **Major** |

*Table 4. Effect Significance Definitions*

| Impact Significance | Definition |
|---|---|
| Negligible | A resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations. |
| Minor | A resource/receptor will experience a noticeable effect, but the effect magnitude is sufficiently small (with or without mitigation) and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be well within applicable standards. |
| Moderate | Within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. The emphasis for moderate impacts is on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently. |
| Major | An accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of this IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long-term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e. ALARP has been applied). In such circumstances it is the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project. |

*Effects from Unplanned Events*

For impacts from unplanned events, the approach adopted in this assessment considered the likelihood of an unplanned event occurring and if it does, the likely consequence on the environment and public health and safety. A qualitative approach to impact prediction was adopted. Criteria to assess the likelihood and severity of impacts from unplanned events are presented in *Table 4.6* and *Table 4.7* respectively.

***Table 4.6 Likelihood Categories***

| Likelihood | Definition |
|---|---|
| Extremely Unlikely | The unplanned event is extremely unlikely to occur under normal operating conditions but may occur in exceptional circumstances. |
| Unlikely | The unplanned event is unlikely but may occur at some time during normal operating conditions. |
| Possible | The unplanned event is likely to occur at some time during normal operating conditions. |
| Likely | There is a high probability that the unplanned event could occur during normal operating conditions. |

***Table 4.7 Severity Criteria for Unplanned Events***

| Severity | Definition |
|---|---|
| Low | • Some damage to the environment/very localised<br>• No sensitive resources impacted<br>• Rapid degradation of spilled materials and rapid recovery of affected resources |
| Medium | • Localised environmental damage<br>• No sensitive resources impacted<br>• Degradation of spilled materials and full recovery of affected resources |
| High | • Severe environmental damage<br>• Sensitive resources impacted<br>• Recovery of affected resources is very slow |

The overall significance was then determined through a matrix of severity vs. likelihood as shown in *Table 4.8*.

***Table 4.8 Unplanned Event Impact Significance Matrix***

| | | **Severity of Impact** | | |
|---|---|---|---|---|
| | | **Low** | **Medium** | **High** |
| **Likelihood** | **Extremely Unlikely** | ALARP | ALARP | ALARP |
| | **Unlikely** | ALARP | Minor | Moderate |
| | **Possible** | Minor | Moderate | Major |
| | **Likely** | Moderate | Major | Major |

### *4.2.3 Phase Three – Mitigation Measures*

A key component of the process is to explore practical ways of avoiding or reducing potentially significant effects of the proposed project activity. These practical actions are termed mitigation measures and are aimed at preventing, minimising or managing significant negative effects to as low as reasonable practical (ALARP) as well as optimising and maximising any potential benefits of the Project.

ALARP is defined as the point where the cost (in time, money and effort) of further risk reduction is grossly disproportionate to the risk reduction achieved. For example, where an event is already extremely unlikely to occur, the implementation of any control measures other than not undertaking the activity would not further reduce the risk associated with the event.

In addition, risks must be tolerable in that they are within the bounds that society as a whole is willing to live with, based on confidence that the risk is worth taking and is properly controlled, in order to secure the benefits associated with the activity.

This does not necessarily mean that everyone will find the risk acceptable. The concept of ALARP is illustrated in *Figure 4.1*.

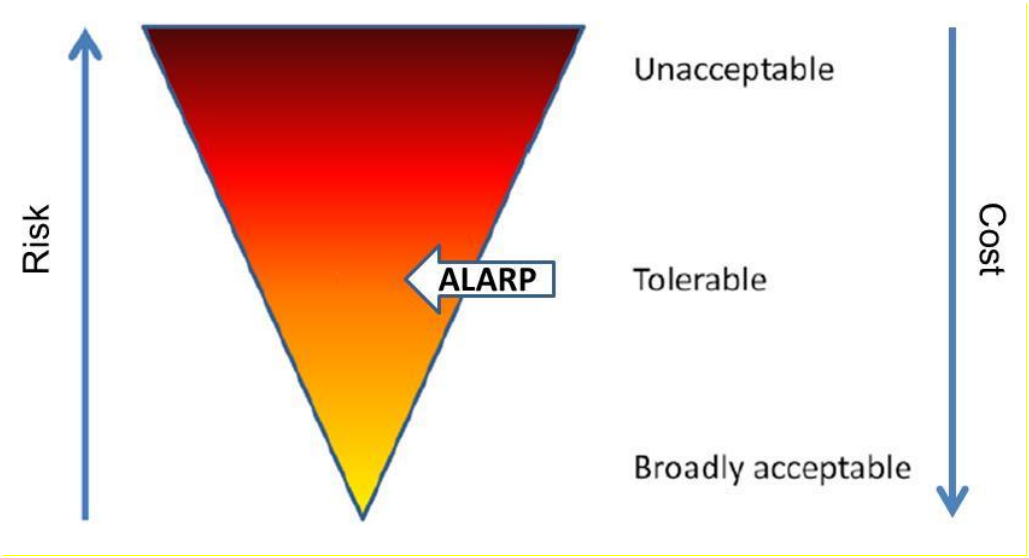


*Figure 4.1* *ALARP Concept Illustration*

The approach taken to identifying and incorporating mitigation measures into the Project is based on a hierarchy of decisions and measures as described in *Figure 4.2* below. This is aimed at ensuring that wherever possible potential effects are mitigated at source rather than mitigated through restoration after the effect has occurred.

| |
|---|
| *Avoid at Source; Reduce at Source*<br>**Avoiding or reducing at source is essentially 'designing' the Project so that a feature causing an effect is designed out (e.g. a waste stream is eliminated) or altered– often called minimisation**<br><br>*Abate on Site*<br>**This involves adding something to the basic design or procedures to abate the effect – often called 'end-of-pipe'. Pollution control (e.g. on board waste water treatment) falls within this category.** |
| *Abate Offsite/at Receptor*<br>**If an effect cannot be abated on-site then measures can be implemented off-site. Measures may also be taken to protect a receptor.** |
| *Repair or Remedy*<br>**Some effects involve unavoidable damage to a resource e.g. pollution from a spill. Repair essentially involves restoration and reinstatement type measures, such as the clean-up of a coast line where an oil spill has beached.** |
| *Compensate in Kind*<br>**Where other mitigation approaches are not possible or fully effective, then compensation, in some measure, for loss, damage and general intrusion might be appropriate.** |

*Figure 4.2* *The Mitigation Hierarchy for Planned Project Activities*

### *4.2.4 Phase Four – Evaluating Residual Effects*

Following the assessment of effects and their significance and the application of mitigation measures, effects may not be eliminated entirely. These remaining effects are termed residual effects and their significance is further defined.

### *4.2.5 Limitations in Assessing Effects*

Any Impact Assessment involves a process that interprets activities that are yet to unfold. Thus there is an inevitable uncertainty that arises between the predictions made and what will actually happen during the course of the Project. However, the proposed activity categories are not uncommon even within the local area, therefore the sources of effects are generally well-understood. Effect predictions have been made using available data, however, where the sensitivity of a resource to any particular activity is unknown and the magnitude of effects cannot be predicted, the Study team has used its professional experience to judge whether a significant effect is likely to occur or not.

# 5 BASELINE CONDITIONS

Sydney Harbour is a drowned river valley, formed many years ago during a rise in sea level (Hutchings et al., 2013). It is approximately 30 km long, 3 km wide and spans an area of 50 km$^2$ (Birch & Taylor, 1999). The Harbour, also referred to as Port Jackson, has experienced relentless stress due to a rapidly increasing population density and extensive residential, commercial and industrial expansion (Birch, 2007).

Port Jackson has been extensively modified by reclamation over the last 200 years, especially in the upper and central estuary (including Darling Harbour and Cockle Bay). Approximately 50% of natural foreshores have been modified by artificial structures such as seawalls, breakwaters, pier pilings and floating pontoons (Chapman & Bulleri, 2003). Reclamation of this land has resulted in a loss of almost 9 million cubic metres of water on each tidal cycle, causing large changes in water movements, water quality, sedimentation and ecology of the upper estuary (Liu, 1989).

Darling Harbour and Cockle Bay are shallow (< 7 m), contain fine sediments known to trap contaminants (Birch & Taylor, 1999) and have naturally low flushing rates (OEH, 2011). As a result pollution that enters these embayments is not readily diluted or dissipated as in other areas of the estuary (OEH, 2011). Therefore, it is not surprising that Port Jackson estuary has been identified as containing the most contaminated sediments on the eastern seaboard of Australia (Birch & Taylor, 2001).

Inherently, development and reclamation within Port Jackson and Cockle Bay has significantly affected the distribution and abundance of marine organisms and resulted in major alteration to ecological function, biological productivity, hydrology and physico-chemical attributes of the area (URS, 2011).

## 5.1 MARINE ECOLOGY

This assessment comprises of a desktop review of available primary literature, published ecological assessments of the AOI and surrounding areas, internet database searches and diver survey footage within the AOI to determine the baseline conditions of marine ecological values within Cockle Bay, Darling Harbour and the greater Port Jackson estuary. It is noted that limited information is available that directly refers to Darling Harbour itself, and the information presented in this assessment refers to more general assessments of the wider area that have been the subject of historic studies and are considered applicable.

### *1.2.1 Benthic Communities*

Benthic communities are strong indicators of ecosystem heath as they are linked to the physical and chemical properties of sediments (Stewart *et al.*, 2000).

Information relating to the taxonomy, distribution and abundance of benthic assemblages within Sydney Harbour is limited due to the lack of comprehensive surveys conducted in the area; however some indication of the diversity is given by Australian Museum collection records (Hutchings *et al.* 2013).

To date the total number of polychaete, crustacean and molluscan species recorded from Sydney Harbour stands at 2,355. Interestingly, neighboring estuaries have recorded significantly less, with 1,636, 1,335 and 981 species recorded in Botany Bay, Port Hacking (Fraser et al. 2006) and Hawkesbury River (Hutchings & Murray, 1984) respectively. This high species richness within Sydney Harbour is attributable to many factors including significant tidal flushing and high diversity of habitat types (Australian Museum, 2015a) (for records of benthic invertebrate species refer to http://australianmuseum.net.au/blogpost/science/sydney-harbour-species).

A more recent study carried out by Worley Parsons (2010) at Barangaroo Ferry hub (located approximately 1,000 m from the Project Area) indicated that sediments contained elevated levels of heavy metals and polycyclic aromatic hydrocarbons (PAHs) and supported a simple benthic assemblage including 120 individuals from 23 taxa comprising 15 polychaete worm taxa (72% of total abundance), 4 decapod crustaceans taxa (18% of total abundance) and 4 other taxa (10% of total abundance) (see *Table 5.1*). Molluscs and echinoderms, which are commonly abundant species in marine and estuarine sediments, were noticeably absent from the area (as cited in Marine Pollution Research Pty Ltd (MPR Pty Ltd), 2014).

***Table 5.1*** ***Benthic Assemblages in Seabed Sediments at Barangaroo*** (as cited in MPR Pty Ltd, 2014).

| | | **Occurrence and Abundance of Biota in Replicate Sediment Samples** | |
|---|---|---|---|
| **Class or Order** | **Family or Species** | **Occur** | **Abundance** |
| Polychaeta | Cirratulidae | 2 | 2 |
| Polychaeta | Lumbrineridae | 2 | 3 |
| Polychaeta | Nephtyidae | 1 | 1 |
| Polychaeta | Pilargidae | 2 | 2 |
| Polychaeta | Syllidae | 1 | 1 |
| Polychaeta | Oweniidae | 2 | 2 |
| Polychaeta | Sigalionidae | 1 | 1 |
| Polychaeta | Spionidae | 5 | 5 |
| Polychaeta | Terebellidae | 5 | 11 |
| Polychaeta | Hesionidae | 1 | 1 |
| Polychaeta | Chaetopteridae | 5 | 8 |
| Polychaeta | Capitellidae | 8 | 42 |

| | | | |
|---|---|---|---|
| Polychaeta | Maldanidae | 3 | 4 |
| Polychaeta | Opheliidae | 1 | 1 |
| Polychaeta | Orbiniidae | 2 | 2 |
| Decapoda | Callianassidae | 8 | 19 |
| Decapoda | Alpheidae | 1 | 1 |
| Decapoda | Xanthidae | 1 | 1 |
| Decapoda | *Brachyura sp.a* | 1 | 1 |
| Bryozoa | *Cheilostomata spp.* | 1 | 1 |
| Gastropoda | Philinidae | 1 | 1 |
| Nemertia | *Hoplonemertea spp.* | 5 | 8 |
| Platyhelminthes | *Digenia sp* | 1 | 2 |
| | No Taxa | | 23 |
| | Abundance | 120 | |

While it is well known that Port Jackson estuary, including Darling Harbour and Cockle Bay are heavily impacted upon after years of contamination it is not understood what benthic assemblages are present within the Project Area.

A recent archaeological dive survey carried out in the Project Area showed there to be some evidence of burrowing from crustaceans (see *Figure 5.1*), however baseline conditions have been inferred largely from more comprehensive assessments undertaken in the wider area. On this basis the Project Area, like that of Barangaroo, is expected to support a restricted assemblage of benthic invertebrate fauna due to the presence of heavily contaminated sediments.

***Figure 5.1*** ***Dive Survey Image Showing Benthic Habitat and Evidence of Burrowing within the Project Area*** ***Source: Cosmos Archaeology Pty Ltd, 2015.***

### *1.2.2 Sub-tidal and Intertidal Invertebrate Communities*

More than 50% of intertidal habitats within Sydney Harbour have been replaced with artificial structures (Chapman & Bulleri, 2003).

The physical characteristics of these structures differ significantly compared to that of natural rocky reefs; however both have been found to support a similar suite of species differing only in relative abundances and frequencies of occurrence (Chapman & Bulleri, 2003).

Although there is little information available in relation to sub-tidal and intertidal invertebrate communities in the Project Area, inference can be drawn from ecological surveys carried out nearby at Barangaroo Ferry Hub and King Street Wharf 10 Jetty (located approximately 400 m from the Project Area).

Prior to the development of Barangaroo Ferry Hub, existing structures consisted of a vertical concrete seawall, set onto basement sandstone rock which transitioned into rock rumble overlying a silty sand slope (MPR Pty Ltd, 2014). These concrete structures supported a restricted assemblage of intertidal invertebrates, including barnacles, Sydney rock oysters, limpets, littorinid snails and periwinkles in the intertidal zone; and bryozoan, sponges and colonial ascidians in sub-tidal areas (from 4 m to depths of 10.5 m). The adjacent seabed was devoid of most biota except for some encrusting sponges occurring within a thick layer of fine silt (MPR Pty Ltd, 2014).

In contrast, King Street Wharf 10 Jetty prior to its refurbishment, consisted of various structures including a fixed timber and steel wharf, built out from a concrete retaining wall and supported by steel and timber piles. In addition, steel wave baffles had fallen away from their wharf fixtures and settled on the seabed. Typical of a natural shallow marine community, distinct depth zonation of all biota on all vertical surfaces was evident, including barnacles in high intertidal surge zones; various gastropod molluscs in lower intertidal areas; oysters, black mussels, sponge, bryozoa and tunicate species occupying sub-tidal habitats. The discarded wave baffles and areas shaded by the wharf also supported encrusting species (MPR Pty Ltd, 2013).

The Project Area is similar to King Street Wharf 10 Jetty in that it consists of various marine structures including natural and artificial seawalls; and timber and steel wharf structures that shade the seabed (refer to *Section 1.2.2* for structures within Project Area). Therefore it is likely that the Project Area and its array of structures support a variety of invertebrate species at each tidal zone.

### *1.2.3 Marine Plants*

Intertidal and sub-tidal plant communities play an important role in contributing to estuarine food chains and offering shelter for juvenile and adult species of fishes, crustaceans and molluscs (West *et al.,* 2004).

The NSW DPI has mapped the distribution aquatic vegetation within Sydney Harbour, focusing on seagrasses, mangroves and saltmarsh, all of which provide productive and sheltered habitats for other organisms. Results showed that species of seagrass are distributed in soft sediment habitats downstream of the Harbour Bridge, areas of mangrove reside in the upper reaches of the Parramatta River and saltmarsh reside on the foreshore of Sydney Olympic Park (West *et al.,* 2004). Seagrasses are of particular conservation significance, they provide shelter for pipefish (*Solenostomidae)* and seamoths *(Pegasidae)* which are listed as protected under the FM Act and in addition, seagrass *Posidonia australis* is listed as an Endangered Ecological Community also under the FM Act.

While these plant species have a higher conservation profile than kelp, it is important to note that much of the rocky foreshore of Sydney Harbour is covered in kelp habitat mainly *Ecklonia* and small amounts of *Sargassum spp* (West *et al.,* 2004). Seahorses (*Syngnathids*) which are protected under the EPBC Act and the FM Act are commonly observed in kelp forests.

No mapping has been undertaken in the Project Area. A recent archaeological dive survey undertaken in the Area showed piles supported some microalgae species (see *Figure 5.2*), however baseline conditions of aquatic vegetation is largely inferred from more comprehensive surveys carried out in surrounding localities. Barangaroo Ferry Hub supported few species of microalgae in the intertidal and sub-tidal portions of the seawall (MPR Pty Ltd, 2014). In contrast, the sub-tidal areas of King Street Wharf 10 Jetty supported a variety of algae including three large kelp species (*Ecklonia radiate, Padina sp.,* and *Sargassum spp*.) which were confined to piles and parts of wave baffles exposed to light (MPR Pty Ltd, 2013). No species of seagrass, mangroves or saltmarsh were observed at either location. It is therefore considered that the Project Area, which is structurally very similar to King Street Wharf 10 Jetty, is likely to support a similar suite of algae species attached to support piles.

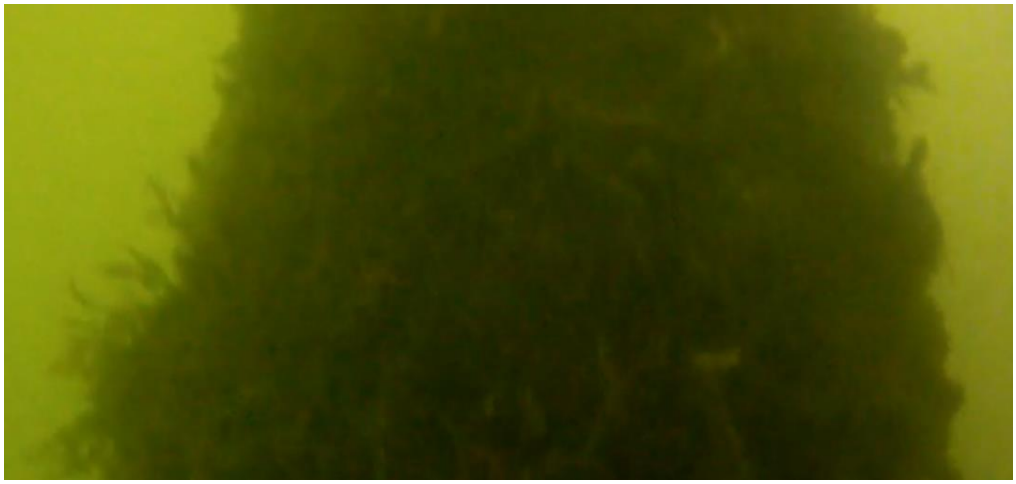

*Figure 5.2* ***Dive survey footage of aquatic vegetation on piles within the Project Area***
***Source: Cosmos Archaeology Pty Ltd, 2015.***

### *1.2.4 Fish*

Sydney Harbour has a diverse fish fauna with over 588 species, 20 of those species belong to the Families of seahorses, ghost pipefish and seamoths (*Syngnathidae, Solenostomidae* and *Pegasidae)* which are listed as protected under the FM Act (Australian Museum, 2015b) (for a list of species refer to http://australianmuseum.net.au/Fishes-of-Sydney-Harbour).

Past commercial and recent recreational fishing efforts also provide an indication of fish species in the Harbour. Commercial fisheries, banned in 2006 due to unacceptably high levels of dioxins in the tissue of fin fish (Birch, 2007), traditionally targeted dusky flathead (*Platycephalus fuscus*), blue swimmer crab (*Portunus pelagicus*), sand whiting (*Sillago ciliata*), silver biddy (*Gerres subfasciatus*), river (*longfinned*) eels (*Anguilla reinhardti,* pipis (*Plebidonax deltoids*), mullet (*Mugil cephalus*), luderick (*Girella tricuspidata*) and yellowfin bream (*Acanthopagrus australis*) (NSW DPI, 2015a). Commercial prawn trawlers, also forbidden, targeted eastern king prawn (*Penaeus plebejus*) (URS, 2011). Recreational fishing efforts remain high in the area, despite known accumulations of toxins in fish. Results show recreational fishers were estimated to have caught approximately 74 tonnes of fin fish, crabs and cephalopods over a 3 month period in 2008 (NSW DPI, 2015a).

No direct studies of fish species have been conducted within the Project Area and therefore baseline conditions of fish fauna have been inferred from surveys carried out in surrounding localities. The vertical concrete seawalls of nearby Barangaroo Ferry Hub provided suitable shelter and feeding habitat for small reef fish, including cardinal fish, eastern hulafish, pygmy leather jackets, fan bellied leatherjackets; and predatory fish which included luderick and bream (MPR Pty Ltd, 2014). In contrast, timber and steel wharf structures of King Street Wharf 10 Jetty provided significant areas of shading and kelp-covered support piles suitable for larger fish species including senator wrasse, bat fish, bream and luderick. Smaller substratum fish such as eastern hula fish were not observed (MPR Pty Ltd, 2013). Specific searches were carried out at

both localities and also in the recent dive survey to investigate the presence of seahorses, however no individuals were observed. No other threatened or protected species as listed under the FM Act or EPBC Act were observed at either site (MPR Pty Ltd, 2014; MPR Pty Ltd, 2013).

A database search carried out using the EPBC Act Protected Matters Search Tool, as discussed in *Section 4.1.4,* recorded three protected fish species listed as vulnerable under the FM Act and EPBC Act, including black rock cod, grey nurse shark and great white shark (see *Table 5.2*). Black rock cod inhabit coastal and estuarine rocky reefs and could potentially occur in Darling Harbour, however the lack of suitable cave and crevice habitats within the Project Area conclude that it is unlikely to occur. Both species of shark are near-shore coastal species that could enter Sydney Harbour, however such visits would be infrequent and generally only in the outer harbour and therefore they are unlikely to occur in the Project Area. No seahorses were recorded in the database search.

Based on the above information, it is considered that the Project Area, like that of King Street Wharf 10 Jetty, is likely to support an assemblage of large fish species occupying shaded habitats beneath wharf structures and is unlikely to support seahorse or any other protected fish species will be present within the Project Area. This is consistent with a recent dive survey carried out within the Project Area which showed the presence of large fish (species unknown) occupying habitat around the piles (see *Figure 5.3*) and no observations of seahorse.

***Figure 5.3*** ***Dive survey footage of fish occupying habitat around piles within the Project Area*** ***Source: Cosmos Archaeology Pty Ltd, 2015.***

### *1.2.5 Seabirds*

Seabirds that may occur in the area, such as gulls and cormorants are common and widely distributed however marine structures, such as the conical shaped piles, are designed specifically to minimise birds resting and therefore the Project Area is not important habitat even for these species.

The EPBC Act Protected Matters Search Tool, as discussed in *Section 4.1.4*, recorded 21 species of bird that are known to occur or may potentially occur within the Project Area (see *Table 5.2*). Of these, a total of 12 seabird species were listed as Vulnerable including 10 species of albatross, northern giant-petrel and Australian fairy tern; and 9 bird species considered as Endangered including 7 marine and freshwater species (3 albatross species, Australian bittern, eastern bristle bird, southern giant-petrel, Australian painted snipe) and 2 terrestrial species (regent honeyeater and swift parrot).

The NSW Wildlife Atlas tool, also discussed in *Section 4.1.4*, recorded 19 bird species listed as Vulnerable, Endangered or as an Endangered Population under the TSC Act that are known to occur or may potentially occur within the Project Area (see *Table 5.3*). Of these, 9 species are considered as Vulnerable, including 4 terrestrial species (little eagle, glossy black cockatoo, sooty owl, diamond firetail) and 5 species transient across all habitats (black bittern, little lorikeet, barking owl, powerful owl, white-fronted chat); 6 species considered as Endangered including 2 species of seabird (wandering albatross, pied oystercatcher), 2 terrestrial species (bush stone-curlew, swift parrot) and 2 species transient across all habitats (curlew sandpiper, little tern); and white-fronted chat also considered as an Endangered Population.

The recorded bird species are either open water or open coastal in the distribution or inhabit freshwater and terrestrial habitat that are not represented within the Project Area and therefore these species are unlikely to occur. In addition, there is no literature supporting the presence of these protected bird species.

It should be noted that little penguin, which are listed as an Endangered Population under the TSC Act, reside in a colony located at Manly (approximately 7 km from the Project Area). Little penguin are known to swim a considerable distance from nesting sites during foraging trips, however there are no records of them utilising the Project Area and although it may be possible that they enter the area during the planned works (see *Section 2.1*) it is considered unlikely.

### *1.2.6 Invasive Marine Pests*

Port Jackson's trading ports, Botany Bay, Port Kembla and Eden are known to contain at least 30 introduced marine taxa, including aquarium caulerpa (*Caulerpa taxifolia*), and the dinoflagellates (*Alexandrium catenella, Alexandrium tamarense* and *Gymnodinium catenatum*) found as inactive cysts (URS, 2011). NSW DPI continually monitors *Caulerpa taxifolia*, the European fanworm and the green crab and is involved in the development of the National System for the Prevention and Management of Marine Pest Incursions, which is aimed at preventing the introduction and translocation of exotic marine species (NSW DPI, 2011b).

It is not known whether the Project Area contains any invasive marine pests. Surveys carried out at nearby Barangaroo Ferry Hub and King Street Wharf 10 Jetty, did not observe listed pest algae *Caulerpa taxifolia* nor are the habitats suitable due to the depth of the seabed at these sites and the degree of sediment disturbance and turbidity (MPR Pty Ltd, 2014; MPR Pty Ltd, 2013). Based on this, the Project Area is unlikely to support the invasive algae *Caulerpa taxifolia.*

### *1.2.7 Other Marine Protected Species (Reptiles, Marine Mammals)*

The EPBC Act Protected Matters Search Tool, as discussed in *Section 4.1.4,* recorded 5 species of turtle that are known to occur or may potentially occur within the Project Area (see *Table 5.2*) including 3 species listed as Vulnerable (green turtle, hawksbill turtle, flatback turtle) and 2 species considered as Endangered (loggerhead turtle, leatherback turtle).

The NSW Wildlife Atlas database search, also discussed in *Section 4.1.4,* returned a total of 3 protected species of marine mammal that are known to occur or may potentially occur within the Project Area. Of these, the southern right whale is considered as Endangered and Australian fur seal and New Zealand fur seal are considered as Vulnerable under the Threatened Species Conservation Act 1995 (see *Table 5.3*).

The recorded species are open water or open coastal in their distribution and therefore are unlikely to occur within the Project Area.

It should be noted that nearby, Sydney Sea Life Aquarium holds a number of marine species listed as protected under the FM Act and EPBC Act, including marine turtles, dugongs, grey nurse sharks (*Carcharias taurus*) and seabirds such as the little penguin (*Eudyptula minor*) (URS, 2011). Additionally, a large number of captive fish are held by the aquarium. The Aquarium, which is located north east of the Project Area and separated by approximately 120 m of water, houses two steel oceanariums that are in direct contact with harbour water. The Aquarium also accesses seawater from the harbour through an intake located under the adjacent wharf (approximately 80 m from the Project Area).

The facilities proximity to the Project Area means that it has been considered as a sensitive receptor to the planned works (see *Section 2*).

### *Table 5.2 Results of EPBC Act Protected Matter Search Tool*

| Class | *Scientific Name* | Common Name | Legal Status | Type of Presence | Likelyhood of Occurrencce within Project Area |
|---|---|---|---|---|---|
| Aves | *Anthochaera phrygia* | Regent Honeyeater | E | Species or species habitat known to occur in area | Unlikely to occur |
| Aves | *Botaurus poiciloptilus* | Australasian Bittern | E | Species or species habitat known to occur in area | Unlikely to occur |
| Aves | *Dasyornis brachypterus* | Eastern Bristlebird | E | Species or species habitat known to occur in area | Unlikely to occur |
| Aves | *Diomedea epomophora* | Southern Royal Albatross | V | Foraging feeding or related behaviour likely to occur within area | Unlikely to occur |
| Aves | *Diomedea epomophora sanfordi* | Northern Royal Albatross | E | Foraging feeding or related behaviour likely to occur within area | Unlikely to occur |
| Aves | *Diomedea exulans antipodensis* | Antipodean Albatross | V | Foraging feeding or related behaviour likely to occur within area | Unlikely to occur |
| Aves | *Diomedea exulans exulans* | Tristan Albatross | E | Species or species habitat known to occur in area | Unlikely to occur |
| Aves | *Diomedea exulans gibsoni* | Gibson's Albatross | V | Foraging feeding or related behaviour likely to occur within area | Unlikely to occur |
| Aves | *Diomedea exulans* | Wandering Albatross | V | Foraging feeding or related behaviour likely to occur within area | Unlikely to occur |
| Aves | *Lathamus discolor* | Swift Parrot | E | Species or species habitat known to occur in area | Unlikely to occur |
| Aves | *Macronectes giganteus* | Southern Giant-Petrel | E | Species or species habitat known to occur in area | Unlikely to occur |
| Aves | *Macronectes halli* | Northern Giant-Petrel | V | Species or species habitat known to occur in area | Unlikely to occur |
| Aves | *Rostratula australis* | Australian Painted Snipe | E | Species or species habitat known to occur in area | Unlikely to occur |
| Aves | *Sternula nereis nereis* | Australian Fairy Tern | V | Species or species habitat known to occur in area | Unlikely to occur |
| Aves | *Thalassarche bulleri* | Buller's Albatross, Pacific Albatross | V | Species or species habitat known to occur in area | Unlikely to occur |
| Aves | *Thalassarche cauta cauta* | Shy Albatross, Tasmanian Shy Albatross | V | Foraging feeding or related behaviour likely to occur within area | Unlikely to occur |
| Aves | *Thalassarche cauta salvini* | Salvin's Albatross | V | Foraging feeding or related behaviour likely to occur within area | Unlikely to occur |
| Aves | *Thalassarche cauta steadi* | White-capped Albatross | V | Foraging feeding or related behaviour likely to occur within area | Unlikely to occur |
| Aves | *Thalassarche eremita* | Chatham Albatross | E | Foraging feeding or related behaviour likely to occur within area | Unlikely to occur |
| Aves | *Thalassarche melanophris* | Black-browed Albatross | V | Species or species habitat known to occur in area | Unlikely to occur |
| Aves | *Thalassarche melanophris impavida* | Campbell Albatross | V | Species or species habitat known to occur in area | Unlikely to occur |
| Fish | *Epinephelus daemelii* | Black Rockcod, Black Cod, Saddled Rockcod | V | Species or species habitat known to occur in area | Unlikely to occur |
| Reptiles | *Caretta caretta* | Loggerhead Turtle | E | Species or species habitat known to occur in area | Unlikely to occur |
| Reptiles | *Chelonia mydas* | Green Turtle | V | Species or species habitat known to occur in area | Unlikely to occur |
| Reptiles | *Dermochelys coriacea* | Leatherback Turtle | E | Species or species habitat known to occur in area | Unlikely to occur |
| Reptiles | *Eretmochelys imbricata* | Hawksbill Turtle | V | Species or species habitat known to occur in area | Unlikely to occur |
| Reptiles | *Natator depressus* | Flatback Turtle | V | Species or species habitat known to occur in area | Unlikely to occur |
| Shark | *Carcharias taurus* | Grey Nurse Shark (east coast population) | V | Species or species habitat known to occur in area | Unlikely to occur |
| Shark | *Carcharodon carcharias* | Great White Shark | V | Species or species habitat known to occur in area | Unlikely to occur |

***Key: E, Endangered; V, Vulnerable***

## *Table 5.3 Result of NSW Wildlife Atlas database*

| Class | Family | *Scientific Name* | Common Name | Legal Status | Likelyhood of Occurrencce within Project Area |
|---|---|---|---|---|---|
| Aves | Diomedeidae | *Diomedea exulans* | Wandering Albatross | E1 | Unlikely to occur |
| Aves | Ardeidae | *Ixobrychus flavicollis* | Black Bittern | V | Unlikely to occur |
| Aves | Accipitridae | *Hieraaetus morphnoides* | Little Eagle | V | Unlikely to occur |
| Aves | Burhinidae | *Burhinus grallarius* | Bush Stone-curlew | E1 | Unlikely to occur |
| Aves | Haematopodidae | *Haematopus longirostris* | Pied Oystercatcher | E1 | Unlikely to occur |
| Aves | Scolopacidae | *Calidris ferruginea* | Curlew Sandpiper | E1 | Unlikely to occur |
| Aves | Laridae | *Sternula albifrons* | Little Tern | E1 | Unlikely to occur |
| Aves | Cacatuidae | *Calyptorhynchus lathami* | Glossy Black-Cockatoo | V | Unlikely to occur |
| Aves | Psittacidae | *Glossopsitta pusilla* | Little Lorikeet | V | Unlikely to occur |
| Aves | Psittacidae | *Lathamus discolor* | Swift Parrot | E1 | Unlikely to occur |
| Aves | Strigidae | *Ninox connivens* | Barking Owl | V | Unlikely to occur |
| Aves | Strigidae | *Ninox strenua* | Powerful Owl | V | Unlikely to occur |
| Aves | Tytonidae | *Tyto tenebricosa* | Sooty Owl | V | Unlikely to occur |
| Aves | Meliphagidae | *Epthianura albifrons* | White-fronted Chat | V | Unlikely to occur |
| Aves | Meliphagidae | *Epthianura albifrons* | White-fronted Chat population in the Sydney Metropolitan Catchment Management Area | E2 | Unlikely to occur |
| Aves | Estrildidae | *Stagonopleura guttata* | Diamond Firetail | V | Unlikely to occur |
| Mammalia | Otariidae | *Arctocephalus forsteri* | New Zealand Fur-seal | V | Unlikely to occur |
| Mammalia | Otariidae | *Arctocephalus pusillus doriferus* | Australian Fur-seal | V | Unlikely to occur |
| Mammalia | Balaenidae | *Eubalaena australis* | Southern Right Whale | E1 | Unlikely to occur |

***Key: E1, Endangered; E2, Endangered Populations; V, Vulnerable***

# 6 EFFECTS ASSESSMENT

## 6.1 INTRODUCTION

This chapter describes the assessment of potential environmental effects from both planned activities and unplanned events relating to the proposed works. The assessment considers the various components of the Project (see *Section* 2) and their potential effects on marine flora and fauna within Cockle Bay.

## 6.2 SCREENING AND SCOPING RESULTS

A scoping exercise was undertaken in January 2015 to characterise the discrete processes and activities involved with the works to inform the potential for effects and guide the further development and assessment of the potential effects (see *Section 4*). Each of the individual activities that would be undertaken as part of the Project were identified and were then further considered with respect to their potential environmental aspects (e.g. generation of underwater noise, disturbance of seabed sediments). A further distinction was made between planned activities and unplanned events (e.g. accidental spills).

The planned works considered in this assessment include:

- Removal of existing structures -
    - Removal of marine structures; and
    - Removal of piles.
- Installation of new structures -
    - Installation of piles;
    - Installation of marine structure;
- Construction logistics -
    - Project vessels anchoring;
    - Vessel and equipment noise; and
    - Operational discharges from vessels;
- Long –term presence of structures -
    - Presence of the wharf and piles.

Unplanned events considered in this Study include:

- Marine hydrocarbon spill;
- Marine vessel incident; and
- Dropped objects.

As discussed in *Section 4*, effects from planned activities have been determined by assessing the sensitivity of the resources and receptors being affected, coupled with the magnitude of the effects, to determine the overall effect significance. Effects from unplanned events (see *Section 4*) have been assessed by considering the severity of potential effects against the likelihood of the effects occurring to assess the overall effect significance. In all instances, mitigation and control measures are considered after the initial effect assessment, and residual effect significance is then determined.

The Project components which may result in significant effects include:

- the removal of structures;
- the installation of structures;
- construction logistics – including vessel movements and discharges from vessels; and
- any unplanned activities resulting from the operation of vessels and equipment.

## *Table 6.1: Potential Interactions Matrix*

| | Project Phases and Activities | | Environmental Aspects and Existing Uses | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Benthic Communities (Sediment Quality) | Invertebrates (Attached) | Fish | Marine Mammals | Seabirds | Sydney Aquarium |
| Planned Activities | **Removal of Existing Structures** | | | | | | | |
| | Removal of marine structure | Temporary increase in light | | | | | | |
| | | Generation of underwater noise and vibration | | | | | | |
| | Removal of piles | Marine growth removal | | | | | | |
| | | Removal of vertical habitat | | | | | | |
| | | Sediment plumes/smothering (TSS) | | | | | | |
| | | Mobilisation of contaminants | | | | | | |
| | | Generation of underwater noise and vibration | | | | | | |
| | **Installation of New Structures** | | | | | | | |
| | Installation of piles | Generation of underwater noise and vibration | | | | | | |
| | | Sediment plumes/smothering (TSS) | | | | | | |
| | | Mobilisation of contaminants | | | | | | |
| | | Increased benthic area unoccupied | | | | | | |
| | | Addition of vertical habitat | | | | | | |
| | Installation of marine structure | Permanent changes to light regime | | | | | | |
| | | Generation of underwater noise and vibration | | | | | | |
| | | Increased benthic area unoccupied | | | | | | |
| | **Construction Logistics** | | | | | | | |
| | Vessels anchoring | Destruction of habitat | | | | | | |
| | | Sediment plumes/smothering (TSS) | | | | | | |
| | | Mobilisation of contaminants | | | | | | |
| | Vessel and equipment noise | Generation of noise and vibration | | | | | | |
| | Discharge from vessels | Minor releases of contaminants | | | | | | |
| | **Long-Term Presence of Structures** | | | | | | | |
| | Presence of marine structure | Addition of new habitat | | | | | | |
| | Presence of piles | Addition of new habitat | | | | | | |
| Unplanned Events | Marine hydrocarbon spill | Habitat degradation/direct toxicity | | | | | | |
| | Marine vessel incident | Minor release of contaminants | | | | | | |
| | | Debris | | | | | | |
| | Dropped objects | Sediment plumes/smothering (TSS) | | | | | | |
| | | Debris | | | | | | |

LEGEND:

- **No interaction**: where the Project is unlikely to interact with the existing environment or interests (coded white);
- **Interaction possible, but not likely to be significant**: where there is likely to be an interaction, but the resultant effect is unlikely to change baseline conditions in an appreciable or detectable way (coded light grey); and
- **Significant interaction**: where there is likely to be an interaction, and the resultant effect has a reasonable potential to cause a significant effect on the existing environment or interests (coded dark grey).
- **Positive interaction (coded with diagonal hatching):** where there is likely to be an interaction that results in a beneficial effect on the existing environment or interests.

## *6.3 SENSITIVITY OF RECEPTORS*

### *6.3.1 Benthic Communities*

Studies indicated that sediments within the AOI contain elevated levels of heavy metals and PAHs and therefore the area is likely to support a simple benthic assemblage of polychaete and crustacea. No threatened or endangered benthic communities were recorded within the AOI.

In the absence of definitive information on the sensitivity of benthic communities in the area to further degradation for the purposes of this assessment ERM has determined the sensitivity of benthic communities in the AOI as ***low.***

| | |
|---|---|
| **Low** | Benthic communities are abundant, common or widely distributed and are generally adaptable to changing environments. Species are not endangered or protected. |

### *6.3.2 Attached Invertebrates*

Studies indicated that various artificial marine structures within the AOI, including natural and artificial seawalls, and timber and steel wharves which shade the seabed, provide habitats likely to support a variety of invertebrate species in each tidal zone. No threatened or endangered invertebrate species were recorded within the AOI.

For the purposes of this assessment ERM has determined the sensitivity of invertebrate species in the AOI as ***low*** based on the homogenous nature of the sedimentary habitats and the current high levels of contamination in the area.

| | |
|---|---|
| **Low** | Attached invertebrates are abundant, common or widely distributed and are generally adaptable to changing environments. Species are not endangered or protected. |

### *6.3.3 Fish*

Studies indicate that timber and steel wharf structures and associated shaded areas within the AOI are likely to support an assemblage of fish using these structures as shelter, and feeding and foraging habitat. No threatened or endangered fish species were recorded within the AOI.In the absence of definitive information on the sensitivity of fish species in the area to further degradation for the purposes of this assessment ERM has determined the sensitivity of fish species in the AOI as ***low.***

| | |
|---|---|
| **Low** | Fish species are abundant, common or widely distributed and are generally adaptable to changing environments. Species are not endangered or protected. |

### *6.3.4 Seabirds*

Records from database searches indicated the presence of protected seabird species within the AOI. However, the identified species are either open water or open coastal in their distribution or inhabit freshwater and terrestrial habitat that are not represented within the AOI and therefore these species are unlikely to occur. Marine structures specifically designed to limited resting habitat, restrict the occurrence of even those widely distributed species such as gulls and cormorants. No other threatened or endangered seabirds, including little penguin, were recorded within the AOI.

For the purposes of this assessment ERM has determined the sensitivity of seabird species that are likely to occur in the AOI as ***low.***

| | |
|---|---|
| **Low** | Seabirds are abundant, common or widely distributed and are generally adaptable to changing environments. Species are not endangered or protected. |

### *6.3.5 Sydney Aquarium*

This facility is located approximately 120 m north-east of the AOI and holds species protected under the FM Act and the EPDC Act, including marine turtles, dugongs, grey nurse sharks and little penguin. In addition, the facility accesses seawater from the harbour through an intake located under the adjacent wharf approximately 80 m from the AOI (see *Section 5.1.7*).

The sensitivity of Sydney Aquarium's species to impacts from the Project activities has been determined to be ***high.***

| | |
|---|---|
| **High** | Sydney Aquarium's protected species are rare or endemic, under significant pressure and/ or highly sensitive to changing environments. Species are valued nationally / globally and are listed as endangered or protected. |

## *6.4 PLANNED ACTIVITIES*

### *6.4.1 Removal of the Marine Structure*

*Sources of Effects*

The key source of disturbance during this activity is the demolition and removal of the existing 4,365 m$^2$ marine structure, which is expected to result in a temporary reduction in shaded areas of seabed and an associated increase in light and potential generation of underwater noise and vibration. These effects and their sensitive receptors are discussed below.

#### *6.4.1.1 Temporary Increases in Light on Fish*

Wharf structures provide shelter from light, temperature and wave action. Studies have shown that organisms favouring these habitats have experienced greater recruitment and survival where there is shade (Blockley, 2007). Therefore the removal of the marine structure and temporary increases in light have the potential to temporarily affect species of fish within the immediate area. Studies indicate that the wharf structure supports an assemblage of fish (see *Section 5.1.4*), their sensitivity has been assessed as ***low.*** Additionally, given their mobility most fish species are expected to avoid unfavourable lighting conditions and abundant alternative shaded habitats are present in nearby areas as well as shading provided by buildings surrounding the bay.

*Evaluation of Effects*

| | | | | |
|---|---|---|---|---|
| Magnitude of Effects – Temporary Increase in Light | Negligible | **Small** | Medium | Large |
| Applicable Criteria | Affects a specific group of localised individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself. | | | |

*Mitigation Measures*

No mitigation measures are required for this action although it is noted that some of the removed marine structures will be replaced, with a permanent reduction in shaded area of approximately 973 $m^2$. Fish temporarily displaced by the increase in light may return to the newly shaded areas as these are completed.

*Residual Impacts*

The sensitivity of fish is considered to be ***low***, the magnitude effect of increased light on these species was found to be ***small***. Accordingly, the overall significance of removal of the marine structure and subsequent temporary increases in light on fish is considered ***negligible.***

| Category | Effect before Mitigation | Residual Effect |
|---|---|---|
| Magnitude of Temporary Increase in Light | Small | Small |
| Sensitivity of Fish | Low | Low |
| Significance of Temporary Increase in Light on Fish | Negligible | Negligible |

### 6.4.1.2 *Generation of Underwater Noise and Vibration on Fish*

Most marine animals, particularly marine mammals and fish, are sensitive to underwater noise, using sound for all important aspects of their life including feeding, reproduction, navigation and avoiding hazards like predators (Tyack and Miller 2002; Popper 2003).

Studies have observed fish mortality at 229 dB to 231 dB, injury at 220 dB re 1 µPa and changes to behaviour at 171 dB re 1 µPa rms (SLR, 2014). In this instance, general construction noise has been identified as 10 to 100 Hz (NRC, 2003). Therefore short-term generation of low level noise is unlikely to alter the behaviour of fish species within the AOI (see *Section 5.1.4*). This noise will not contribute much in excess of the ambient noise levels generated from existing boat traffic and adjacent road traffic. Fish sensitivity has been assessed as ***low.***

*Evaluation of Effects*

| | | | | |
|---|---|---|---|---|
| Magnitude of Effects – Generation of Underwater Noise and Vibration | Negligible | **Small** | Medium | Large |
| Applicable Criteria | Affects a specific group of localised individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself. | | | |

*Mitigation Measures*

No mitigation measures are required for this action although it is noted that all works will be completed within a total of 29 weeks, and only some of the activities are expected to generate significant underwater noise levels.

Noise generating equipment used at the site will be maintained in accordance with manufacturer's recommendations, and any malfunction that results in elevated noise levels above those normally expected for the equipment will be immediately investigated and remedied.

*Residual Impacts*

While the sensitivity of fish is considered to be ***low***, the magnitude effect of underwater noise and vibration on these species was found to be ***small***. Accordingly, the overall significance of removal of the marine structure and subsequent generation of noise and vibration on fish is considered ***negligible.***

| **Category** | **Effect before Mitigation** | **Residual Effect** |
|---|---|---|
| Magnitude of Generation of Underwater Noise and Vibration | Small | Small |
| Sensitivity of Fish | Low | Low |
| Significance of Generation of Underwater Noise and Vibration on Fish | Negligible | Negligible |

### 6.4.1.3 *Generation of Underwater Noise and Vibration on Sydney Aquarium*

As discussed, most marine animals are sensitive to sound and this has been taken into consideration for species housed within Sydney Aquarium (see *Section 5.1.7*). Of these species, dugongs are considered the most sensitive to noise and have similar thresholds to that of cetaceans, which may experience injury at 226 dB re 1 µPa, injury at 225 to 218 dB re 1 µPa and changes in behaviour at 157 to 164 dB re 1 µPa if the underwater noise is within their sensitive hearing range (SLR, 2014). However, considering the distance to the facility from the Project Area (see *Section 5.1.7*) and the level of noise anticipated to be generated by the project activities it is understood that short-

term generation of construction and barge noise is unlikely to alter the behaviour of these species. In addition, this type of noise is unlikely to contribute notably in excess of the existing noise levels generated from vessel movements in waters surrounding the facility from adjacent road traffic. Sensitivity of species within the Aquarium has been assessed as ***high.***

*Evaluation of Effects*

| **Magnitude of Effects – Generation of Underwater Noise and Vibration** | **Negligible** | Small | Medium | Large |
|---|---|---|---|---|
| Applicable Criteria | Immeasurable, undetectable or within the range of normal natural variation. | | | |

*Mitigation Measures*

Noise generating equipment used at the site will be maintained in accordance with manufacturer's recommendations, and any malfunction that results in elevated noise levels above those normally expected for the equipment will be immediately investigated and remedied.

The presence of suitably experienced personnel at the aquarium facility means that behavioural changes of important marine fauna within Sydney Aquarium during noise-intensive activities would likely be observed rapidly. Any reports of adverse effects by the Aquarium would be investigated by SHFA.

*Residual Impacts*

While the sensitivity of species housed in Sydney Aquarium is considered to be ***high***, the magnitude of impact of underwater noise and vibration on these species was found to be ***negligible***. Accordingly, the overall significance of removal of the marine structure and subsequent generation of underwater noise and vibration on Sydney Aquarium's protected species is considered ***negligible.***

| **Category** | **Effect before Mitigation** | **Residual Effect** |
|---|---|---|
| Magnitude of Generation of Underwater Noise and Vibration | Negligible | Negligible |
| Sensitivity of Sydney Aquarium | High | High |
| Significance of Generation of Underwater Noise and Vibration on Sydney Aquarium | Negligible | Negligible |

### 6.4.2 *Removal of Piles*

*Sources of Effects*

The key sources of disturbance during this activity are the removal of 185 existing timber piles, which are expected to result in marine growth removal; removal of vertical habitat; sediment disturbance; and generation of underwater noise and vibration. These effects and their sensitive receptors are discussed below.

#### 6.4.2.1 *Marine Growth Removal of Attached Invertebrates*

Marine growth removal from piles will result in direct destruction of those invertebrates that have become attached to the structures. Piles within the AOI and more widely in the area are expected to support a diverse assemblage of encrusting biota at each tidal zone (see *Section 5.1.3*). Their sensitivity has been assessed as ***low.***

*Evaluation of Effects*

| | | | | |
|---|---|---|---|---|
| Magnitude of Effects – Marine Growth Removal | Negligible | **Small** | Medium | Large |
| Applicable Criteria | Affects a specific group of localised individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself. | | | |

*Mitigation Measures*

The loss of attached invertebrate species during pile removal is unavoidable and as such no mitigation measures are offered.

*Residual Effects*

While the sensitivity of attached invertebrates is considered to be ***low***, the magnitude of impact on these species was found to be ***small***. Accordingly, the overall significance of removal of the marine structure and subsequent removal of attached invertebrates is considered ***negligible.***

| **Category** | **Effect before Mitigation** | **Residual Effect** |
|---|---|---|
| Magnitude of Marine Growth Removal | Small | Small |
| Sensitivity of Attached Invertebrates | Low | Low |
| Significance of Marine Growth Removal on Attached Invertebrates | Negligible | Negligible |

### 6.4.2.2 *Removal of Vertical Habitat on Attached Invertebrates*

Temporary reduction of vertical habitat within the AOI will limit the area available for colonisation by encrusting invertebrates; their sensitivity has been assessed as ***low***. Accordingly the loss of these habitats is not considered significant due to the eventual installation of approximately 80 new vertical structures for recolonization in Cockle Bay and the large amount of alternative habitat in nearby areas that will support the local populations of these species.

*Evaluation of Effects*

| Magnitude of Effects – Removal of Vertical Habitat | Negligible | **Small** | Medium | Large |
|---|---|---|---|---|
| Applicable Criteria | Affects a specific group of localised individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself. | | | |

*Mitigation Measures*

No mitigation measures are required for this action.

*Residual Effects*

While the sensitivity of attached invertebrates is considered to be ***low***, the magnitude of impact on these species was found to be ***small***. Accordingly, the overall significance of removal of vertical habitat is considered ***Negligible.***

| **Category** | **Effect before Mitigation** | **Residual Effect** |
|---|---|---|
| Magnitude of Removal of Vertical Habitat | Small | Small |
| Sensitivity of Attached Invertebrates | Low | Low |
| Significance of Removal of Vertical Habitat on Attached Invertebrates | Negligible | Negligible |

### 6.4.2.3 *Removal of Vertical Habitat on Fish*

Temporary reduction of vertical habitat within Cockle Bay will limit the availability of foraging and feeding structures for fish species, their sensitivity has been assessed as ***low***. Accordingly the loss of these habitats is not considered significant due to the eventual installation of approximately 80 new structures and the presence of large areas of alternative foraging habitat within the wider AOI and harbour areas.

*Evaluation of Effects*

| | | | | |
|---|---|---|---|---|
| Magnitude of Effects – Removal of Vertical Habitat | Negligible | **Small** | Medium | Large |
| Applicable Criteria | Affects a specific group of localised individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself. | | | |

*Mitigation Measures*

No mitigation measures are required for this action.

*Residual Effects*

While the sensitivity of fish is considered to be ***low***, the magnitude of impact on these species was found to be ***small***. Accordingly, the overall significance of removal of vertical habitat on fish species is considered ***Negligible.***

| **Category** | **Effect before Mitigation** | **Residual Effect** |
|---|---|---|
| Magnitude of Removal of Vertical Habitat | Small | Small |
| Sensitivity of Fish | Low | Low |
| Significance of Removal of Vertical Habitat on Fish | Negligible | Negligible |

### 6.4.2.4 *Localised Sediment Disturbance on Benthic Communities, Invertebrates and Fish*

The sediment, as mentioned previously, is believed to be substantially contaminated and disturbance of sediments has the potential to result in localised increases in turbidity. Sediment disturbance may also elevate the concentration of contaminants in the water column and their bioavailability to benthic communities, invertebrates and fish species in the AOI. However, considering the current and ongoing extent of vessel movements and anchoring within the AOI, this activity is unlikely to contribute much in excess of the existing sediment disturbance levels. As can be seen from the images taken during the archaeological surveys (*Section 5.1*), the water clarity in Cockle Bay is low indicating the presence of suspended solids in the water column. Benthic communities, invertebrates and fish sensitivities have been assessed as ***low.***

*Evaluation of Effects*

| | | | | |
|---|---|---|---|---|
| Magnitude of Effects – Sediment Disturbance | Negligible | **Small** | Medium | Large |
| Applicable Criteria | Affects a specific group of localised individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself. | | | |

*Mitigation Measures*

Silt curtains will be installed prior to any construction works. Silt curtains are a floating barrier, designed to temporarily contain, deflect or slow down the movement of suspended particles. In addition, a cutting sleeve will be utilised to cut piles off below the surface of the seabed and minimise sediment disturbance. The use of these structures during this activity will help to contain any suspended sediment and therefore limit the spread of turbidity and contaminated sediments through the Bay.

*Residual Effects*

While the sensitivity of benthic communities, invertebrates and fish species is considered to be ***low***, the magnitude of impact on these species was found to be ***small.*** Accordingly, the overall significance of sediment disturbance on benthic communities, invertebrates and fish species is considered ***negligible.***

| Category | Effect before Mitigation | Residual Effect |
|---|---|---|
| Magnitude of Localised Sediment Disturbance | Small | Small |
| Sensitivity of Benthic Communities, Invertebrates and Fish | Low | Low |
| Significance of Localised Sediment Disturbance on Benthic Communities, Invertebrates and Fish | Negligible | Negligible |

### 6.4.2.5 *Localised Sediment Disturbance on Sydney Aquarium*

As discussed in *Section 6.4.2.4*, sediment is highly contaminated and its disturbance may affect species housed within Sydney Aquarium via a seawater intake located approximately 80 m from the AOI (see *Section 5.1.7)*. However, based on the current and ongoing extent of vessel movements and anchoring within the AOI, this activity is unlikely to contribute much in excess of the existing sediment disturbance levels. Species housed within Sydney Aquarium have been assessed as ***high.***

*Evaluation of Effects*

| **Magnitude of Effects – Sediment Disturbance** | **Negligible** | **Small** | Medium | Large |
|---|---|---|---|---|
| Applicable Criteria | Affects a specific group of localised individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself | | | |

*Mitigation Measures*

Silt curtains will be installed and a cutting sleeve utilised during this activity (see *Section 6.4.2.4*).

*Residual Effects*

While the sensitivity of species within Sydney Aquarium is considered to be ***high***, the magnitude of impact on these species was found to be ***small.*** Accordingly, the overall significance of sediment disturbance on species housed within Sydney Aquarium is considered ***minor.***

| Category | Effect before Mitigation | Residual Effect |
|---|---|---|
| Magnitude of Sediment Disturbance | Small | Small |
| Sensitivity of Sydney Aquarium | High | High |
| Significance of Sediment Disturbance on Sydney Aquarium | Moderate | Minor |

### 6.4.2.6 *Generation of Underwater Noise and Vibration on Fish*

As discussed, fish may be sensitive to underwater noise generated by the project resulting in temporary alterations of normal behavioural patterns (see *Section 6.4.1.2*). The extent of noise and vibration is expected to be less than that generated during screw piling and therefore is unlikely to result in behavioural responses in fish (SLR, 2014) (see *Section 6.4.3.1*). Their sensitivity has been assessed as ***low.***

*Evaluation of Effects*

| | | | | |
|---|---|---|---|---|
| Magnitude of Effects – Generation of Underwater Noise and Vibration | Negligible | **Small** | Medium | Large |
| Applicable Criteria | Affects a specific group of localised individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself. | | | |

*Mitigation Measures*

No mitigation measures are required for this action.

*Residual Impacts*

While the sensitivity of fish is considered to be ***low***, the magnitude of effect on these species was found to be ***small***. Accordingly, the overall significance of underwater noise and vibration on fish is considered ***negligible.***

| Category | Effect before Mitigation | Residual Effect |
|---|---|---|
| Magnitude of Underwater Noise and Vibration | Small | Small |
| Sensitivity of Fish | Low | Low |
| Significance of Underwater Noise and Vibration on Fish | Negligible | Negligible |

*6.4.2.7 Generation of Underwater Noise and Vibration on Sydney Aquarium*

As discussed, species within Sydney Aquarium are potentially sensitive to noise (see *Section 6.4.1.3*). The extent of noise and vibration is less than that generated during screw piling, which was found during a similar activity conducted at Pier 26 to have negligible impacts on species within Sydney Aquarium (SLR, 2014). Therefore noise and vibration is unlikely to alter behaviour of these species (see *Section 6.4.3.2*). Their sensitivity has been assessed as ***high.***

*Evaluation of Effects*

| **Magnitude of Effects – Generation of Underwater Noise and Vibration** | **Negligible** | **Small** | Medium | Large |
|---|---|---|---|---|
| Applicable Criteria | Affects a specific group of localised individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself | | | |

*Mitigation Measures*

Noise generating equipment used at the site will be maintained in accordance with manufacturer's recommendations, and any malfunction that results in elevated noise levels above those normally expected for the equipment will be immediately investigated and remedied.

The presence of suitably experienced personnel at the aquarium facility means that behavioural changes of important marine fauna within Sydney Aquarium during noise-intensive activities would likely be observed rapidly. Any reports of adverse effects by the Aquarium would be investigated by SHFA.

*Residual Impacts*

While the sensitivity of species housed in Sydney Aquarium is considered to be ***high***, the magnitude of impact of underwater noise and vibration on these species was found to be ***small***. Accordingly, the overall significance of underwater noise and vibration on Sydney Aquarium's protected species is considered ***Minor.***

| Category | Effect before Mitigation | Residual Effect |
|---|---|---|
| Magnitude of Underwater Noise and Vibration | Small | Small |
| Sensitivity of Sydney Aquarium | High | High |
| Significance of Underwater Noise and Vibration on Sydney Aquarium | Moderate | Minor |

### *6.4.3 Installation of Piles*

*Sources of Effects*

The key source of disturbance from the installation of structures is the installation of piles. Approximately 80 piles will be installed with the majority of these made of smooth steel, although some timber piles also to be used. Piles will be screwed into the seabed using a purpose built 18 m barge. The installation of piles is expected to result in generation of underwater noise and vibration; and sediment disturbance. These effects and their sensitive receptors are discussed below.

#### *6.4.3.1 Generation of Underwater Noise and Vibration on Fish*

As discussed previously in *Sections 6.4.1.2*, fish are sensitive to noise and vibration. The extent of noise and vibration is expected to be more than that generated during removal of the existing marine structure and support piles. Studies have indicated screw piling has an expected sound exposure level of 117 to 122 dB re 1 µPa at 100 m range, and 130 dB re 1 µPa at 10 m range and this is unlikely to result in behavioural responses in fish (SLR, 2014). Fish sensitivity has been assessed as ***low.***

*Evaluation of Effects*

| | | | | |
|---|---|---|---|---|
| Magnitude of Effects – Generation of Underwater Noise and Vibration | Negligible | **Small** | Medium | Large |
| Applicable Criteria | Affects a specific group of localised individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself. | | | |

*Mitigation Measures*

Noise generating equipment used at the site will be maintained in accordance with manufacturer's recommendations, and any malfunction that results in elevated noise levels above those normally expected for the equipment will be immediately investigated and remedied.

*Residual Effects*

While the sensitivity of fish is considered to be ***low***, the magnitude effect of underwater noise and vibration on these species was found to be ***small***. Accordingly, the overall significance of the installation of piles and subsequent generation of underwater noise and vibration on fish is considered ***negligible.***

| Category | Effect before Mitigation | Residual Effect |
|---|---|---|
| Magnitude of Underwater Noise and Vibration | Small | Small |
| Sensitivity of Fish | Low | Low |
| Significance of Underwater Noise and Vibration on Fish | Negligible | Negligible |

### 6.4.3.2 *Generation of Underwater Noise and Vibration on Sydney Aquarium*

The expected noise levels for this activity at 100 m range are below the noise threshold for dugong (see *Section 6.4.1.3*). In addition a similar activity undertaken at Pier 26 (located directly adjacent to the Aquarium) resulted in negligible impacts from screw piling (SLR, 2014) and therefore it is expected that there is unlikely to be any changes in the behaviour of Aquarium species from pile installation within the AOI. Sensitivity of Sydney Aquarium's species has been assessed as ***high.***

*Evaluation of Effects*

| | | | | |
|---|---|---|---|---|
| Magnitude of Effects – Underwater Noise and Vibration | Negligible | **Small** | Medium | Large |
| Applicable Criteria | Affects a specific group of localised individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself. | | | |

*Mitigation Measures*

In addition to the maintenance of equipment as described above, the presence of suitably experienced personnel should continuously monitor behaviour of important marine fauna within Sydney Aquarium during noise-intensive activities. Any reports of adverse effects by the Aquarium should be investigated by SHFA.

*Residual Effect*

While the sensitivity Sydney Aquarium is considered to be **high**, the magnitude of effect of underwater noise and vibration on these species was found to be ***small***. Accordingly, the overall significance of the installation of piles and subsequent generation of underwater noise and vibration on Sydney Aquarium's species is considered ***moderate.***

| Category | Effect before Mitigation | Residual Effect |
|---|---|---|
| Magnitude of Underwater Noise and Vibration | Small | Small |
| Sensitivity of Sydney Aquarium | High | High |
| Significance of Underwater Noise and Vibration on Sydney Aquarium | Moderate | Minor |

### 6.4.3.3 *Localised Sediment Disturbance on Benthic Communities, Invertebrates and Fish*

Screw piling is known to increase turbidity, and may also introduce toxicants into the water column and increase overall bioavailability of contaminants through disturbance of contaminated sediments. However, the extent of sediment disturbance is expected to be less than that generated during removal of the existing piles, and the increase in suspended sediment is expected to be localised. Sensitivities of benthic communities, invertebrates and fish have been assessed as ***low.***

*Evaluation of Effects*

| Magnitude of Effects – Sediment Disturbance | Negligible | **Small** | Medium | Large |
|---|---|---|---|---|
| Applicable Criteria | Affects a specific group of localised individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself. | | | |

*Mitigation Measures*

Silt curtains will be installed prior to any construction works.

*Residual Effects*

While the sensitivity of benthic communities, invertebrates and fish species is considered to be ***low***, the magnitude of impact on these species was found to be ***small.*** Accordingly, the overall significance of sediment disturbance on benthic communities, invertebrates and fish species is considered ***negligible.***

| Category | Effect before Mitigation | Residual Effect |
|---|---|---|
| Magnitude of Localised Sediment Disturbance | Small | Small |
| Sensitivity of Benthic Communities, Invertebrates and Fish | Low | Low |
| Significance of Localised Sediment Disturbance on Benthic Communities, Invertebrates and Fish | Negligible | Negligible |

*Positive Effects*

The replacement of 185 existing piles with approximately 80 new piles will result in an increased benthic area unoccupied by structures and therefore create additional habitat available for benthic communities to colonise.

### *6.4.4 Installation of Marine Structure*

*Sources of Effects*

The key source of disturbance during this activity is the installation of a newly configured marine structure covering an area of 3,392 $m^2$, which is expected to result in generation of underwater noise and vibration. These effects and their sensitive receptors are discussed below:

#### *6.4.4.1 Generation of Underwater Noise and Vibration on Fish*

As previously discussed, fish are very sensitive to sound (see *Sections 6.4.1.2*). For the purpose of this evaluation, the sensitivity of fish has been assessed as ***low.***

*Evaluation of Effects*

| | | | | |
|---|---|---|---|---|
| Magnitude of Effects – Generation of Underwater Noise and Vibration | Negligible | **Small** | Medium | Large |
| Applicable Criteria | Affects a specific group of localised individuals within a population over a short time period (one generation or less), but does not affect other trophic levels or the population itself | | | |

*Mitigation Measures*

No additional mitigation measures are required for this action.

*Residual Impacts*

While the sensitivity of fish is considered to be ***low***, the magnitude effect of underwater noise and vibration on these species was found to be ***small***. Accordingly, the overall significance of installation of the marine structure and subsequent noise generation on fish is considered ***negligible.***

| Category | Effect before Mitigation | Residual Effect |
|---|---|---|
| Magnitude of Generation of Underwater Noise and Vibration | Small | Small |
| Sensitivity of Fish | Low | Low |
| Significance of Generation of Underwater Noise and Vibration on Fish | Negligible | Negligible |

#### 6.4.4.2 *Generation of Underwater Noise and Vibration on Sydney Aquarium*

Marine species housed within Sydney Aquarium are sensitive to sound (see *Sections 6.4.1.3*). For the purpose of this evaluation, the sensitivity of Sydney Aquarium's protected species has been assessed as ***high.***

*Evaluation of Effects*

| **Magnitude of Effects – Generation of Underwater Noise and Vibration** | **Negligible** | Small | Medium | Large |
|---|---|---|---|---|
| Applicable Criteria | Immeasurable, undetectable or within the range of normal natural variation | | | |

*Mitigation Measures*

The presence of suitably experienced personnel at the aquarium facility means that behavioural changes of important marine fauna within Sydney Aquarium during noise-intensive activities would likely be observed rapidly. Any reports of adverse effects by the Aquarium would be investigated by SHFA.

*Residual Impacts*

While the sensitivity of species housed in Sydney Aquarium is considered to be ***high***, the magnitude of impact of underwater noise and vibration on these species was found to be ***negligible***. Accordingly, the overall significance of installation of the marine structure and subsequent generation of underwater noise and vibration on Sydney Aquarium's protected species is considered ***negligible.***

| Category | Effect before Mitigation | Residual Effect |
|---|---|---|
| Magnitude of Underwater Noise and Vibration | Negligible | Negligible |
| Sensitivity of Sydney Aquarium | High | High |
| Significance of Underwater Noise and Vibration on Sydney Aquarium | Negligible | Negligible |

*Positive Effects*

Removal of the existing marine structure (4,365 m²) and replacement by a newly configured marine structure (3,392 m²) will result in an increased benthic area unoccupied by structures and therefore create more available habitat for benthic communities colonisation.

### *6.4.5 Long-Term Presence of Marine Structures*

Long-term presence of installed structures includes approximately 80 piles and a newly configured marine structure. These structures will create habitats and a positive effect for invertebrate species that colonise these structures and species of fish seeking shelter.

### *6.4.6 Construction Logistics*

#### *6.4.6.1 Vessel Anchoring*

*Effects Description*

Vessel anchoring can cause increases in turbidity, and may also introduce toxicants into the water column and increase overall bioavailability of contaminants through disturbance of contaminated sediments. This activity can also result in habitat damage. However, existing vessel movements and anchoring within the AOI means that this effect will not be in excess of what already exists. Operational discharges from vessels would all be within applicable local and international standards with respect to type and treatment, and are unlikely to affect marine organisms. These effects and their sensitive receptors are discussed below:

##### *6.4.6.1.1 Sediment Disturbance on Benthic Communities and Fish*

The potential impacts from sediments disturbance include increased suspended solids, the potential for mobilisation of contaminants, and resettlement of suspended sediments onto the seabed. Sensitivities of benthic communities and fish have been assessed as ***low.***

*Evaluation of Effects*

| Magnitude of Effects – Sediment Disturbance | **Negligible** | Small | Medium | Large |
|---|---|---|---|---|
| Applicable Criteria | Immeasurable, undetectable or within the range of normal natural variation | | | |

*Mitigation Measures*

Silt curtains will be installed prior to any construction works.

*Residual Effects*

While the sensitivity of benthic communities and fish species is considered to be ***low***, the magnitude of impact on these species was found to be ***negligible.*** Accordingly, the overall significance of sediment disturbance on benthic communities and fish species is considered ***negligible.***

| Category | Effect before Mitigation | Residual Effect |
|---|---|---|
| Magnitude of Sediment Disturbance | Negligible | Negligible |
| Sensitivity of Benthic Communities and Fish | Low | Low |
| Significance of Sediment Disturbance on Benthic Communities and Fish | Negligible | Negligible |

### 6.4.6.2 *Vessel and Equipment Noise*

*Sources of Effects*

The key source of disturbance is noise generated by vessels and equipment used on these vessels. These effects and their sensitive receptors are discussed below.

#### 6.4.6.2.1 *Generation of Underwater Noise and Vibration on Fish*

Noise generated from project vessels and equipment will not be too dissimilar from the existing noise levels due to the amount of vessel movements and other activities occurring within the AOI. For the purpose of this evaluation, the sensitivity of fish has been assessed as ***low.***

*Evaluation of Effects*

| Magnitude of Effects – Generation of Underwater Noise and Vibration | **Negligible** | Small | Medium | Large |
|---|---|---|---|---|
| Applicable Criteria | Immeasurable, undetectable or within range of normal natural variation | | | |

*Mitigation Measures*

Noise generating equipment used at the site will be maintained in accordance with manufacturer's recommendations, and any malfunction that results in elevated noise levels above those normally expected for the equipment will be immediately investigated and remedied.

*Residual Impacts*

While the sensitivity of fish is considered to be ***low***, the magnitude effect of noise on these species was found to be ***negligible***. Accordingly, the overall significance of vessel and equipment operation and subsequent generation of underwater noise and vibration on fish is considered ***negligible.***

| Category | Effect before Mitigation | Residual Effect |
|---|---|---|
| Magnitude of Underwater Noise and Vibration | Negligible | Negligible |
| Sensitivity of Fish | Low | Low |
| Significance of Underwater Noise and Vibration on Fish | Negligible | Negligible |

6.4.6.2.2 *Generation of Underwater Noise and Vibration on Sydney Aquarium*

Underwater noise and vibration generated from project vessels and equipment will not be in excess of existing noise levels due to the amount of vessel movements and other activities occurring in the waters surrounding the Aquarium. For the purpose of this evaluation, the sensitivity of Sydney Aquarium's protected species has been assessed as ***high.***

*Evaluation of Effects*

| | | | | |
|---|---|---|---|---|
| Magnitude of Effects – Generation of Underwater Noise and Vibration | **Negligible** | Small | Medium | Large |
| Applicable Criteria | Immeasurable, undetectable or within range of normal natural variation | | | |

*Mitigation Measures*

No additional mitigation measures beyond those proposed above are required for this action.

*Residual Impacts*

While the sensitivity of species housed in Sydney Aquarium is considered to be ***high***, the magnitude of impact of underwater noise and vibration on these species was found to be ***negligible***. Accordingly, the overall significance of vessel and equipment operation and subsequent generation of underwater noise and vibration on Sydney Aquarium's protected species is considered ***negligible.***

| Category | Effect before Mitigation | Residual Effect |
|---|---|---|
| Magnitude of Underwater Noise and Vibration | Negligible | Negligible |
| Sensitivity of Sydney Aquarium | High | High |
| Significance of Underwater Noise and Vibration on Sydney Aquarium | Negligible | Negligible |

## 6.5 *UNPLANNED EVENTS*

### 6.5.1 *Marine Hydrocarbon Spill*

*Effects Description*

The most likely unplanned spill or release of fuels is the accidental spill during refuelling of equipment or due to a vessel collision. Fuels, hydraulic fluids and lubricating oils have the potential to impact on local water and sediment quality. The construction vessels are expected to use marine diesel, which is a middle petroleum distillate that typically undergoes rapid dispersion and evaporation in the marine environment when subjected to weathering. Refuelling of barges will not occur at the Project site, but will be undertaken at an approved refuelling facility. Due to the size of the vessels and the availability of resources (being within the confines of the harbour), spills are expected to be small in size and immediately responded to.

Given the localised nature of the accidental spills outlined above, due to the small quantities considered, the severity of effects from the accidental spill of hydrocarbons or chemicals is considered to be ***medium***.

| Severity of Effect | Low | **Medium** | High |
|---|---|---|---|
| Applicable Criteria | Localised environmental damage, no sensitive resources effected and degradation of spilled materials and full recovery of affected resources | | |

Due to the range of operations that could result in an accidental spill and the access to emergency responses, it is considered unlikely that a small accidental spill may occur at some stage during the Project.

| Likelihood of Occurrence | Extremely Unlikely | **Unlikely** | Possible | Likely |
|---|---|---|---|---|
| Applicable Criteria | The event is unlikely but may occur at some time during normal operating conditions | | | |

*Mitigation and Control Measures*

Vessels used during the Project are legally required to comply with Annex 1-Oil of the International Convention for the Prevention of Pollution (MARPOL), under the *Ports and Maritime Administration Act 1995*, the *Marine Safety Act 1998* and the *Marine Pollution Act 1987*. Vessels are required to store fuels, oils and chemicals in bunded areas on board. Emergency Response Plans are also required on board in addition to spill kits on each vessel for the immediate containment of any spill.

With the implementation of the above mitigation measures, including the immediate response to any discharge or oil from the Project vessels, the severity effects from the accidental spill of fuel, oil or chemicals, is considered to be ***Low***

| Severity of Effect | **Low** | Medium | High |
|---|---|---|---|
| Applicable Criteria | Some damage to the environment/ very localised, no sensitive resources effected and rapid degradation of spilled materials and rapid recovery of affected resources | | |

With these mitigation and control measures in place, the likelihood of an accidental spill of fuels, oils and chemicals, is considered to be ***unlikely***.

| Likelihood of Occurrence | Extremely Unlikely | **Unlikely** | Possible | Likely |
|---|---|---|---|---|
| Applicable Criteria | The event is unlikely but may occur at some time during normal operating conditions | | | |

*Residual Effect*

| **Category** | **Effect before Mitigation** | **Residual Effect** |
|---|---|---|
| Magnitude of Effects from a Marine Spill | Medium | Low |
| Likelihood | Unlikely | Unlikely |
| Significance of Effects | Minor | ALARP |

### *6.5.2 Marine Vessel Incident*

*Effects Description*

Vessel collisions could cause debris and chemicals to enter the harbour. Sunken debris or the sinking of a vessel would cause sediment disturbance, and therefore a potential effect on water quality. Additionally, a vessel collision would potentially result in the spill of fuels, oils or chemicals (see *Section 7.5.1* above). An incident due to a vessel collision is considered unlikely due to the low speed of vessel traffic and the sheltered conditions of the harbour. Additionally, the work barges will be stationary for the majority of the time they are working in the bay.

Given the already contaminated nature of the water and sediment within the Project Area, and the use of silt curtains during operation, the severity of effects from vessel collisions is considered to be ***medium***.

| Severity of Effect | Low | **Medium** | High |
|---|---|---|---|
| Applicable Criteria | Localised environmental damage, no sensitive resources effected and degradation of spilled materials and full recovery of affected resources | | |

Due to the low speed of vessel traffic and the sheltered conditions of the harbour range of operations, it is considered ***unlikely*** that vessel collisions will occur at some stage during the Project.

| Likelihood of Occurrence | Extremely Unlikely | **Unlikely** | Possible | Likely |
|---|---|---|---|---|
| Applicable Criteria | The event is unlikely but may occur at some time during normal operating conditions | | | |

*Mitigation and Control Measures*

Vessels used during the Project are legally required to comply with Annexes of the International Convention for the Prevention of Pollution (MARPOL), under the *Ports and Maritime Administration Act 1995*, the *Marine Safety Act 1998* and the *Marine Pollution Act 1987*. Vessels are required to store fuels, oils and chemicals in bunded areas on board and refuelling will only occur in calm conditions. Emergency Response Plans are also required on board in addition to spill kits on each vessel for the immediate containment of any spill. In addition to pollution controls, these regulations provide for standards of crew training, watchkeeping and navigational safety to minimise the risk of a collision occurring.

With these mitigation and control measures in place, the likelihood of an accidental spill of fuels, oils and chemicals, is considered to be ***unlikely***.

| Likelihood of Occurrence | Extremely Unlikely | **Unlikely** | Possible | Likely |
|---|---|---|---|---|
| Applicable Criteria | The unplanned event is extremely unlikely to occur under normal operating conditions but may occur in exceptional circumstances | | | |

With the implementation of the above mitigation measures, the severity of an effects from the accidental spill of fuel, oil or chemicals, is considered to be ***Low***.

| Severity of Effect | **Low** | Medium | High |
|---|---|---|---|
| Applicable Criteria | Some damage to the environment/ very localised, no sensitive resources effected and rapid degradation of spilled materials and rapid recovery of affected resources | | |

*Residual Effects*

| Category | Effect before Mitigation | Residual Effect |
|---|---|---|
| Magnitude of Effects from a Vessel Collision | Medium | Low |
| Likelihood | Unlikely | Extremely Unlikely |
| Significance of Effects | Minor | ALARP |

### 6.5.3 *Dropped Objects*

*Effects Description*

The Project Area is relatively shallow (<8 m in depth) and therefore any dropped objects should be easily retrieved. These objects though, depending on their size, may create localised sediment disturbance and plumes.

Given the already contaminated nature of the water and sediment within the Project Area, and the use of silt curtains during operation, the severity of effects from dropped objects is considered to be ***low***.

| Severity of Effect | **Low** | Medium | High |
|---|---|---|---|
| Applicable Criteria | Some damage to the environment/ very localised, no sensitive resources effected. | | |

*Mitigation and Control Measures*

Vessels used during the Project are legally required to comply with annexes of the International Convention for the Prevention of Pollution (MARPOL), under the *Ports and Maritime Administration Act 1995*, the *Marine Safety Act 1998* and the *Marine Pollution Act 1987*. Vessels are required to store drums, objects in bunded areas or secure areas on board.

Due to the range of operations that could result in an accidental spill and the access to emergency responses, it is considered ***unlikely*** that objects may be dropped overboard at some stage during the Project.

| Likelihood of Occurrence | Extremely Unlikely | **Unlikely** | Possible | Likely |
|---|---|---|---|---|
| Applicable Criteria | The event is unlikely but may occur at some time during normal operating conditions | | | |

With the implementation of the above mitigation measures, the severity of an effects from the accidental spill of fuel, oil or chemicals, is considered to be ***Low***.

| Severity of Effect | **Low** | Medium | High |
|---|---|---|---|
| Applicable Criteria | Some damage to the environment/ very localised, no sensitive resources effected and quick recovery of dropped objects. | | |

*Residual Effect*

| **Category** | **Effect before Mitigation** | **Residual Effect** |
|---|---|---|
| Magnitude of Effects from a Dropped Object | Low | Low |
| Likelihood | Unlikely | Unlikely |
| Significance of Effects | ALARP | ALARP |

# 7 *CONCLUSION*

The activities that will take place during the Cockle Bay Marine Structure Renewal Project have the potential for significant interactions with marine plants and animals within the Cockle Bay. The removal of the marine structure and piles has the potential to result in changes to the light regime, generation of underwater noise and vibration, removal of marine growth attached to piles, removal of vertical habitat as well as turbidity and the suspension and deposition of sediments. Similarly, installation of the marine structure and piles has the potential to result in changes to underwater noise and vibration; and turbidity and the suspension and deposition of sediments.

Each of these environmental aspects could potentially affect species defined as sensitive receptors, including benthic communities, attached invertebrates, fish and species housed within the Sydney Aquarium. The long-term presence of structures was found to positively influence species of invertebrate that attached to piles and fish species in Cockle Bay.

The Study took into account the existing modifications, contamination and disturbance status within Cockle Bay, the degree to which species expected to be found in the bay were representative of the wider area, and the lack of critical habitat for protected or vulnerable species. Given these factors, and the relatively minor nature of the disturbance posed by the Project activities, in each case the residual potential impacts after the application of mitigation measures were found to be negligible or minor.

Unplanned events that may occur during the works, including marine hydrocarbon spills, vessel incidents and dropped objects also have the potential to affect sensitive marine plants and animals. With the application of control measures, these events were considered to be either unlikely or extremely unlikely to occur, and the residual impact magnitude was low. The residual risk of impacts from an unplanned event was therefore found to be as low as reasonably practicable (ALARP), and no further mitigation measures were considered necessary.

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