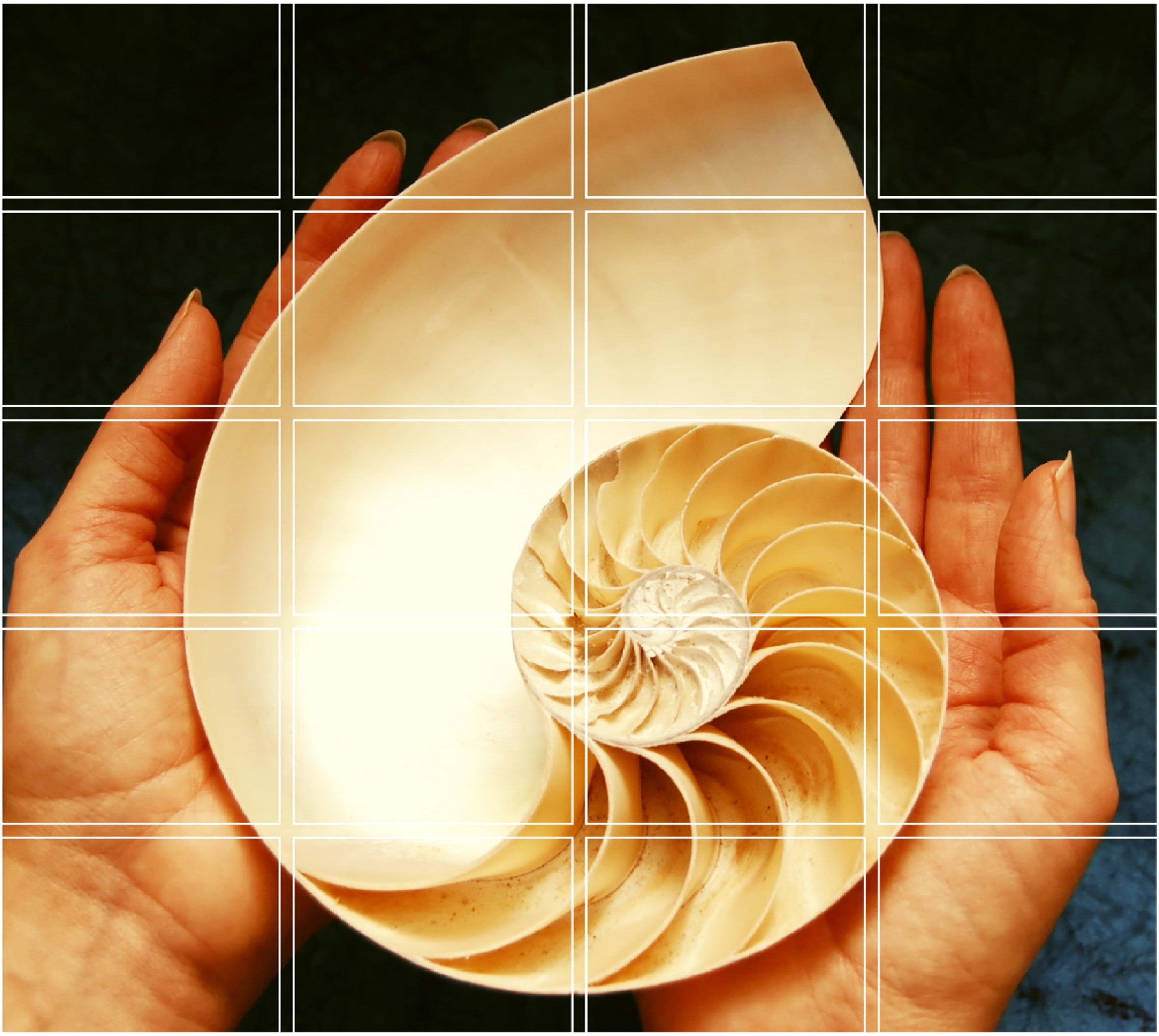

Water and Sediment Impact Assessment
Cockle Bay Marine Structures Renewal

Sydney Harbour Foreshore Authority

April 2015

Final Report
0278780

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Water & Sediment Impact Assessment

Cockle Bay Marine Structures Renewal

-

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Final Report

0278780

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FINAL REPORT

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Cockle Bay Marine Structures Renewal

April 2015

Reference: 0278780/Water and Sediment Quality 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 Water and Sediment Quality Assessment (herein referred to as the Study) considers the potential for impacts on seawater and sediment quality 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 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 effects greater than ***negligible*** relate to the potential for ***minor*** increases in sedimentation and turbidity as a result of removing and installing structures; and construction logistics. 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 Water and Sediment Quality Assessment (herein referred to as the Study) has been prepared to inform the applicant, decision makers and affected parties about the potential effects on seawater and sediment quality resulting from activities associated with the proposed Cockle Bay Marine Structures Renewal Project ('the Project').

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 conditions of water and sediment quality within the vicinity of Cockle Bay, along with the potential effects to these both 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 one of 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 continue 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*.

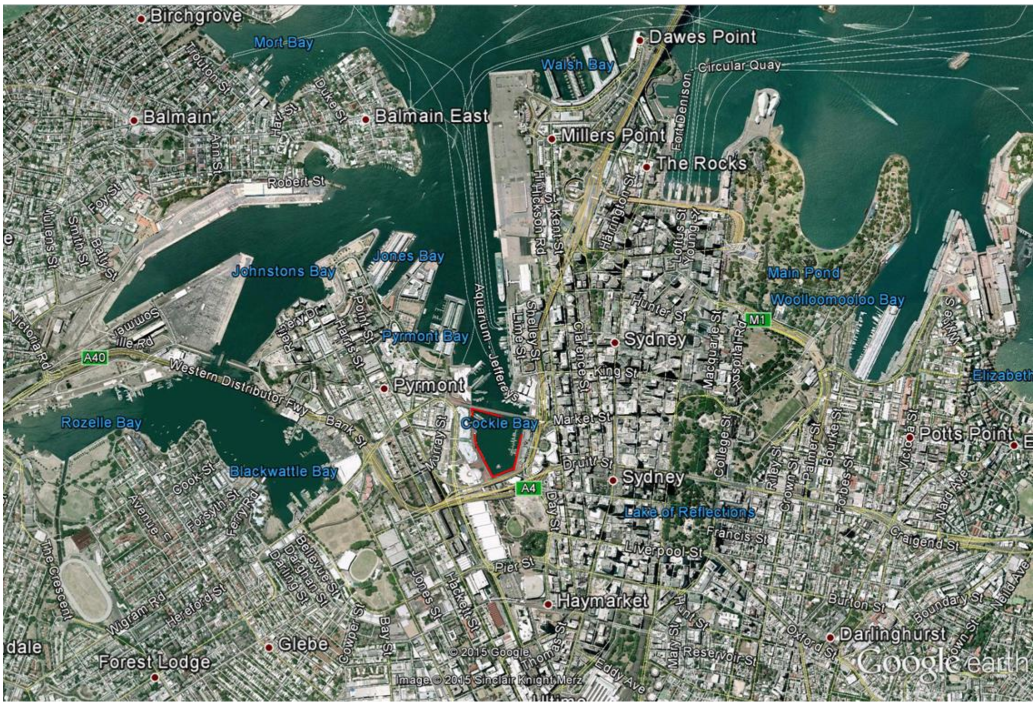

Figure 1.1 *Project Location*

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 located 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.*

As such, 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 to 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 the area occupied by 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. 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).

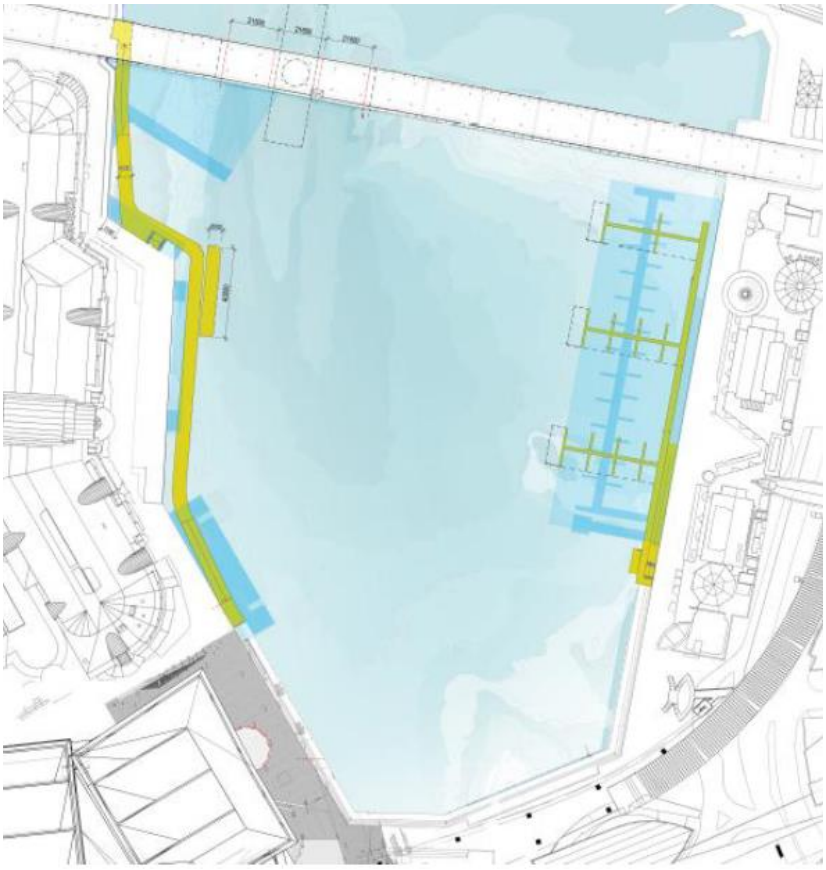

Figure 2.1 *Existing and Proposed Water Footprint (existing structures shown in light blue, new shown in yellow)* ***Source: Mott MacDonald, 2015***

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 water and sediment quality 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 both nationally and internationally important flora and fauna, ecological communities and heritage.

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) regulates the use of waterways within NSW in order to preserve aquatic habitats.

3.2.3 *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.

3.2.4 *Contaminated Land Management Act 1997*

The *Contaminated Land Management Act 1997* (CLM Act) serves to regulate significantly contaminated land in order to protect human health or the environment.

3.2.5 *Water Management Act 2000*

The *Water Management Act 2000* (WM Act) provides sustainable and integrated management of water resources in NSW. This Act is based on the concept of ecologically sustainable development in order to protect water resources for future generations.

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) (refer to *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 which could more readily be assessed for impact against 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 current regulatory requirements and industry best practices 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 interaction 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 (and Project alternative) 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 environmental studies of the AOI and surrounding areas;

- Internet websites; and
- A review of diver survey footage of the Project site collected in February 2015.

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

Assessing Condition and Sensitivity

For the purposes of this Study, the existing ecosystem condition was also taken into account. ANZECC (2000) defines three categories of ecosystem condition and the required levels of protection. These include;

1. *High conservation/ecological value systems — effectively unmodified or other highly-valued ecosystems, typically (but not always) occurring in national parks, conservation reserves or in remote and/or inaccessible locations. While there are no aquatic ecosystems in Australia and New Zealand that are entirely without some human influence, the ecological integrity of high conservation/ecological value systems is regarded as intact.*

2. *Slightly to moderately disturbed systems — ecosystems in which aquatic biological diversity may have been adversely affected to a relatively small but measurable degree by human activity. The biological communities remain in a healthy condition and ecosystem integrity is largely retained. Typically, freshwater systems would have slightly to moderately cleared catchments and/or reasonably intact riparian vegetation; marine systems would have largely intact habitats and associated biological communities. Slightly– moderately disturbed systems could include rural streams receiving runoff from land disturbed to varying degrees by grazing or pastoralism, or marine ecosystems lying immediately adjacent to metropolitan areas.*

3. *Highly disturbed systems - These are measurably degraded ecosystems of lower ecological value. Examples of highly disturbed systems would be some shipping ports and sections of harbours serving coastal cities, urban streams receiving road and stormwater runoff, or rural streams receiving runoff from intensive horticulture.*

Due to the current quality of both water and sediment within Darling Harbour, Cockle Bay and the greater Port Jackson estuary (refer to *Section 5.1*), the Project Area has been defined as a 'Highly Disturbed System'.

4.2 *EFFECTS ASSESSMENT*

This section describes the Study methodology adopted for identifying and assessing impacts from the Project on the environment. This methodology includes consideration of the activities, the physical and social 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 *Table 4.1*.

Certain effects may be scoped out due to their minor or 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 impact 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 4.7*.

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 Sediment Disturbance and Water Quality*

	Sediment Disturbance/Quality	Water Quality
Negligible	Immeasurable, undetectable or within the range of normal natural variation	Immeasurable, undetectable or within the range of normal natural variation
Small	Minimal seabed disturbance/ change in sediment quality	Slight change in water quality expected over a limited area with water quality returning to background levels within a few metres
Medium	Localised and/or short term disturbance of seabed/ change in sediment quality	Temporary or localized change in water quality with water quality returning to background levels thereafter
Large	Widespread and/or long term disturbance or permanent change to the seabed/ sediment quality	Change in water quality over a large area that lasts over the course of several months with quality likely to cause secondary effects on marine ecology
Positive	In the case of positive effects, 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 effect, without characterizing the exact degree of positive change likely to occur.	

Table 4.4 *The Criteria for Assessing Sensitivity*

	Seawater and Air Quality
Low	Existing quality is good and the ecological resources and human receptors that it supports are not sensitive to a change in quality.
Medium	Existing quality already shows some signs of stress and/ or supports ecological resources and human receptors that could be sensitive to change in quality.
High	Existing quality is already under stress and/ or the ecological resources and human receptors it supports are very sensitive to change (secondary ecological or health impacts are likely).

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*.

For this assessment, four effects significance categories have been applied being: *Negligible*, *Small*, *Medium*, *Large* and *Positive*. These categories of significance for environmental receptors are defined in *Table 4.6 Impact Significance Definitions*.

Table 4.5 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 4.6 Impact 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 Study 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.

Likelihood has been considered for the assessment of all unplanned events (e.g. spill), but only after the impact of the event is determined.

Impacts from Unplanned Activities

For impacts from unplanned activities, 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 4.7* and *Table 4.8*.

Table 4.7 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 4.8 Severity Criteria for Unplanned Events

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

The overall significance was then determined through a matrix of severity vs. likelihood as shown in *Table 4.9*.

Table 4.9 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*.

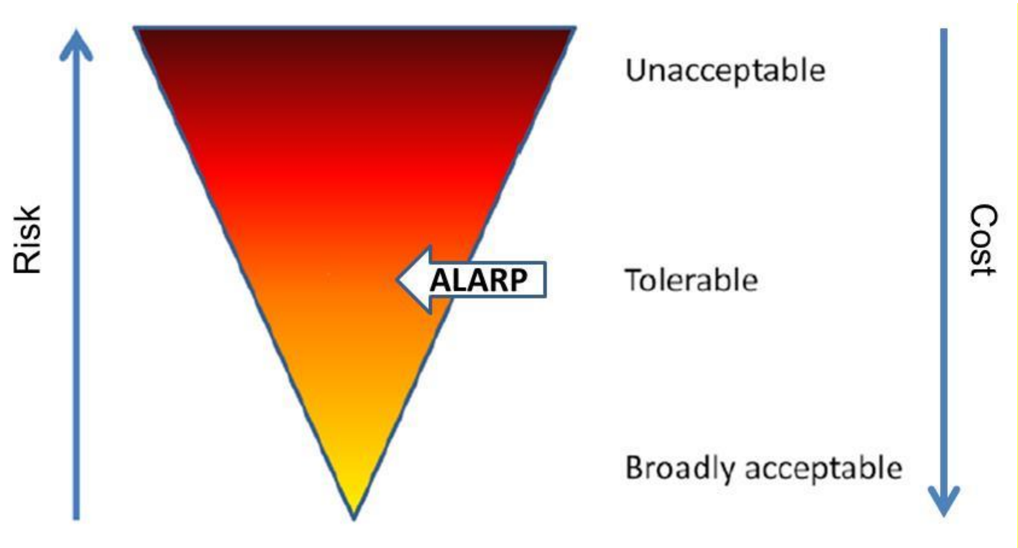

Figure 4.1 ***ALARP Concept Illustration***

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
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

Abate on Site
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
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
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
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 estuary with narrow winding channels and irregular bathymetry (Birch & Taylor, 1999). Estuaries generally act as a transition zone, in which mainland material is trapped and through which some of this material is then transported to the open sea. The chemical composition of estuarine sediments and the variability of suspended particulate matter is controlled by complex physical and biogeochemical processes (Hatje *et al*. 2001), including the mixing of terrigenous and marine sediments.

Embayments on the southern shores of the upper and central harbour (such as Darling Harbour and Cockle Bay) are shallow (<8 m in depth) and contain fine sediments with a high potential for trapping contaminants (Birch & Taylor, 1999). Waterways of the Port Jackson estuary have been identified as the most contaminated on the eastern seaboard of Australia (Birch & Taylor, 2001) after more than two hundred years of industrial activities in the area. In more recent times, with the implementation of improved pollution controls on industry, urban stormwater is thought to be the major source of contaminants in the estuary (Rochford 2008).

The Port Jackson estuary experiences a maximum 2.1 m tidal range (Lee *et al*. 2011) with Darling Harbour having a naturally low flushing rate. As a result contaminants that enter Darling Harbour are not diluted or dissipated as readily as other parts of the estuary (OEH 2011).

5.1 SEDIMENT AND WATER QUALITY

Areas within the Port Jackson estuary, including Cockle Bay and Darling Harbour are reported to be some of the most contaminated of any harbour in the world. The sources of this contamination are believed to be past and present industrial activities, and the ever-increasing use of harbour.

This assessment comprises a desktop review of available literature to determine the baseline conditions of both water and sediment quality within Cockle Bay, Darling Harbour and the greater Port Jackson estuary. It is noted that limited literature is available that directly refers to Darling Harbour, and the information presented in this assessment necessarily refers to more general assessments of the wider area that have been the subject of historic studies.

5.1.1 *Water Quality*

Water quality in Darling Harbour and Cockle Bay is known to have been significantly degraded by industrial and urban activities within the catchment area (ERM 2007). Urban stormwater has been identified as the largest contemporary source of heavy metals within the estuary (Birch *et. al*., 1996; Birch & Taylor, 1999; Barry *et. al*., 2000). Birch *et al.,* (2010) estimates that, on average, stormwater contributes to 475 tonnes of total nitrogen, 63 tonnes of total phosphorous and 343,000 tonnes of total suspended solids to Sydney Harbour each year.

Water samples collected from Pier 26 (less than 200 metres north of the Project Area) in April and May 2014 indicate exceedances of the ANZECC values for marine waters for copper and zinc (see *Table 5.1* below) (SMC Marine 2014). These metals are also known to be found in high concentrations in sediments within the wider area (see *5.1.2 Sediment Quality* below). Values that exceed the ANZECC 2000 trigger values for a moderately disturbed system are shown in bold.

Table 5.1 Water quality results at Pier 26 in Darling Harbour – April and May 2014

	Units	Trigger Value(1)				
Date			**22/04/2014**	**28/04/2014**	**13/05/2014**	**30/05/2014**
Total Suspended Solids	mg/L	-	<5	<5	13	<5
Turbidity	NTU	-	0.5	0.9	8	<0.1
Arsenic-Total	µg/L	-	2	2	2	2
Cadmium-Total	µg/L	0.7	<0.1	<0.1	<0.1	0.3
Chromium-Total	µg/L	4.4(2)	<1	<1	<1	<1
Copper-Total	µg/L	1.3	**8**	**7**	**10**	**23**
Lead-Total	µg/L	4.4	<1	1	4	1
Mercury-Total	µg/L	0.4	<0.05	<0.05	<0.05	<0.05
Nickel-Total	µg/L	7	<1	2	<1	3
Zinc-Total	µg/L	15	**22**	**46**	**63**	**47**

1. ANZECC (2000) 'slight-moderately disturbed systems' trigger values
2. Trigger values for Chromium VI adopted here

Harbour waters at Barangaroo (just over 1,000 metres north of the project area) are regularly monitored, revealing stable and consistent results for conductivity, turbidity, pH and temperature from a number of areas between Barangaroo and Johnston's Bay. *Table* 5.2 provides a summary of water quality data collected for Barangaroo.

Table 5.2 Water Quality Results in Barangaroo Headland Park – 2013 and 2014

	Parameter		Conductivity	pH	Turbidity	Temperature
	Units		mS/cm	pH	NTU	°C
Sampling date	December 2013 (1)	min	34.5	6.7	1.4	21.2
		max	53.7	7.41	6.4	24.5
		mean	52.85	7.06	1.96	23.32
	April 2014(2)	min	33	7.67	0	17.8
		max	53.7	8.06	14.3	23.46
		mean	52.27	7.94	1.2	21.66
	July 2014 (3)	min	49.7	7.78	1.2	12.3
		max	54.2	8.07	12.1	15.88
		mean	52.9	7.97	1.6	14.47
	September 2014 (4)	min	28.5	7.7	1.2	14.09
		max	52.7	8.25	15	19.65
		mean	50.2	7.98	1.7	17.24

1. Lend Lease (2013)
2. Baulderstone (2014)
3. Lend Lease (2014a)
4. Lend Lease (2014b)

5.1.2 *Sediment Quality*

The Port Jackson estuary is known to be heavily effected after years of contamination. Studies over the past 20 years have shown extensive contamination within the estuary by a range of toxicants (Rochford, 2008). Sediments are known to have elevated heavy metal concentrations and a recent study indicated very high concentrations of copper, lead and zinc within surficial sediments across the entire Port Jackson estuary, including Cockle Bay and Darling Harbour (Birch & Taylor, 1999).

Sediments within industrialised and urbanised harbours and lakes worldwide have been found to frequently contain high concentrations of organic pollutants (NRC, 1989; Bryan and Langston, 1992; Burton, 1992; Simpson *et al.*, 1996; Long, 2000 *cited in* McCready *et al.*, 2006). Typical contaminants include organochlorine pesticides (OCs), polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs), and the Port Jackson estuary is no exception. Studies within Cockle Bay indicated high concentrations of copper (200 to300 µg/g), zinc (500 to >800 µg/g) and lead (>400 µg/g) (Birch & Taylor, 1999). Nutrient analysis of sediment samples collected within the Port Jackson estuary were analysed by Birch *et al* (1999) and indicated high levels of organic phosphorous, total phosphorous and total Kjeldahl nitrogen in Darling Harbour, and the greater region. McCready *et al* (2000) collected 124 sediment samples from the Port Jackson estuary for analysis of Polycyclic Aromatic Hydrocarbons (PAHs). Levels within Cockle Bay were found to be approximately 20,000 µg/kg^{-1}. These levels were lower than a number of other sites, with PAH levels at Neutral Bay (approximately six kilometres northeast of the Project Area) reaching 380,000 µg/kg^{-1}.

The original source of these substances can be broadly grouped as being sourced from industrial activities, historic and current stormwater discharges, and leachates from reclaimed land (Birch 2007). Stormwater continues to deliver large quantities of contaminants (particularly heavy metals and PAHs) to the estuary (Birch 2007).

6 EFFECTS ASSESSMENT

6.1 INTRODUCTION

This chapter describes the assessment of potential environmental effects from both planned and unplanned activities relating to the proposed works. The assessment considers the various components of the Project and their potential effects on water and sediment quality 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 impacts (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 structures.
- Construction logistics:
  - Project vessels anchoring;
  - Vessel and equipment noise; and
  - Operational discharges from vessels.
- Long –term presence of structures:
- Presence of the marine structures 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 quantified 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 6.5*) 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 provided.

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.

Consideration was given also to the potential for interactions between the Project activities and groundwater or drainage patterns. In both cases it was determined that there was no potential for interactions, with all works being conducted at water depths well above that of any subsurface aquifers, and no land-based activities being conducted that would alter drainage patterns.

Table 6.1: Potential Interactions Matrix

	Project Phases and Activities		Water Quality	Sediment Quality
Planned Activities	**Removal of Existing Structures**			
	Removal of marine structures	Temporary increase in light		
		Generation of surface noise		
	Removal of piles	Marine growth removal		
		Removal of vertical habitat		
		Sediment plumes/smothering		
		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		
		Mobilisation of contaminants		
		Increased benthic area unoccupied		
		Addition of vertical habitat		
	Installation of marine structures	Permanent changes to light regime		
		Generation of surface noise		
		Increased benthic area unoccupied		
	Construction Logistics			
	Vessels anchoring	Destruction of habitat		
		Sediment plumes/smothering		
		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 structures	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		
		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 *Water Quality*

Water quality within Cockle Bay and Darling Harbour is known to be contaminated, with the source most commonly found to be effected stormwater run-off. These waters are therefore not considered pristine and background levels of heavy metals, PAHs etc. (see *Section 5.1*) are high and is therefore defined as a highly disturbed ecosystem in accordance with the ANZECC (2000) criteria.

In the absence of definitive information on the sensitivity of the water quality in the area to further degradation for the purposes of this assessment ERM has conservatively determined the sensitivity of the marine water quality in the AOI as ***Medium*** as follows:-

Medium	Existing water quality already shows some signs of stress and/or supports ecological resources and human receptors that could be sensitive to change in quality.

6.3.2 *Sediment Quality*

Sediments within the Port Jackson estuary, including Cockle Bay and Darling Harbour are the most contaminated along the eastern seaboard of Australia (Birch & Taylor 2001). Sediments within and surrounding the Project Area have high concentrations of a wide range of contaminants over extensive areas, including heavy metals, organochlorine pesticides, PAHs, polychlorinated biphenyls (PCBs), polychlorinated dibenzo-p-dioxins and dibenzofurans (Birch & Taylor, 1999, 2000; Birch *et al* 2006; Irvine & Birch, 1998; McCready *et al* 2000). Background levels therefore, (not unlike water quality) are not considered pristine and the ecosystem is defined as highly disturbed in accordance with ANZECC (2000) criteria.

In the absence of definitive information on the sensitivity of the marine sediments in the area to further degradation for the purposes of this assessment ERM has conservatively determined the sensitivity of the water quality in the AOI as ***Medium*** as follows:-

Medium	Existing sediment quality already shows some signs of stress and/or supports ecological resources and human receptors that could be sensitive to change in quality.

6.4 PLANNED ACTIVITIES

6.4.1 Removal of Structures

Sources of Effect and Sensitivity of Receptors

The key source of disturbance during this activity is the removal of 185 existing piles, which is expected to result in the disturbance of seabed sediments. The sediment, as mentioned previously, is heavily contaminated and disturbance of sediments has the potential to result in localised increases in turbidity, and may also elevate the concentration of contaminants in the water column. The bioavailability of these contaminants may also increase as a result of this disturbance.

The current status of the water and sediment quality within the Project Area is defined as highly disturbed and their sensitivity has been assessed as ***medium***. Additionally, sediments in Cockle Bay are routinely resuspended by propeller wash during vessel movements and the placement and removal of temporary moorings.

The activity of removing the existing piles is anticipated to be of a short duration. It is considered unlikely that the temporary increase in sedimentation and turbidity during this time will significantly alter the water or sediment quality of the surrounding area. Increases in total suspended solids (TSS) are expected to be localised due to the low flushing rate within Darling Harbour (see *Section 5.1.2*).

Magnitude of Effects – Removal of Piles	Negligible	Small	**Medium**	Large
Applicable Criteria	Temporary or localised change in water / sediment quality, with water / sediment quality returning to background levels thereafter.			

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. The use of these curtains during construction will help to contain any suspended sediment and therefore limit the spread of turbidity and contaminated sediments through the Bay.

Residual Effect

While the sensitivity of water and sediment quality was found to be ***medium***, the effect magnitude from the removal of structures was found to be ***small***. Accordingly, the effect significance from the removal of existing structures is considered to be ***minor***.

Category	Effect before Mitigation	Residual Effect
Magnitude of Removal of Structures	Medium	Small
Sensitivity of Water and Sediment Quality to Removal of Structures	Medium	Medium
Significance of Removal of Structures on Water and Sediment Quality	Moderate	Minor

6.4.2 *Installation of Structures*

Sources of Effect

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 of a smooth steel construction, with some timber piles also to be used. Piles will be screwed into the seabed utilising a purpose built 18 m crane mounted barge.

Effect Description

The installation of piles is expected to have a temporary effect on water quality. Screwing or boring of piles 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 old piles, and the increase in suspended sediment is expected to be localised due to the low flushing rate within Darling Harbour (see *Section 5.1.1*)

Magnitude of Effects – Installation of Piles	Negligible	Small	**Medium**	Large
Applicable Criteria	Temporary or localized change in water / sediment quality with water / sediment quality returning to background levels thereafter.			

Mitigation Measures

As discussed previously, silt curtains will be installed prior to any construction works. These curtains will help to contain any suspended sediment and therefore limit the spread of turbidity and contaminated sediments.

Residual Effect

While the sensitivity of water and sediment quality was found to be ***medium***, the effect magnitude from the removal of structures was found to be ***small***.

Accordingly, the effect significance of the installation of structures is considered to be ***minor***.

Category	Effect before Mitigation	Residual Effect
Magnitude of Installation of Structures	Medium	Small
Sensitivity of Water and Sediment Quality to Installation of Structures	Medium	Medium
Significance of Installation of Structures on Water and Sediment Quality	Moderate	Minor

6.4.3 *Long-Term Presence of Structures*

Sources of Effect

The key sources of disturbance from the long-term presence of installed structures include the presence of the new piles, and the potential for changes to the existing current regime within Cockle Bay. However, despite reduction in the number of piles within the water, it is expected that the installation of new piles would have an immeasurable effect on current regimes within Cockle Bay and Darling Harbour due to the limited water movement and current speeds experienced in the area and the semi-enclosed nature of the site.

Magnitude of Effects – Long term Presence of Structures	**Negligible**	Small	Medium	Large
Applicable Criteria	Immeasurable, undetectable or within the range of normal natural variation.			

Mitigation Measures

No mitigation measures are required for this action.

Residual Effect

While the sensitivity of water and sediment quality was found to be ***medium***, the effect magnitude from the long term presence of structures was found to be ***negligible***. Accordingly, the effect significance of the long term presence of structures is considered to be ***negligible***.

Category	Effect before Mitigation	Residual Effect
Magnitude of Long-Term Presence of Structures	Negligible	Negligible
Sensitivity of Water and Sediment Quality to Long-Term Presence of Structures	Medium	Medium
Significance of Long-Term Presence of Structures on Water and Sediment Quality	Negligible	Negligible

6.4.4 Construction Logistics

Sources of Effect

The key sources of disturbance from the overall construction logistics include:

- project vessels anchoring; and
- operational discharges from vessels

Vessels and their movements can have an effect on the water quality of the within the vicinity of works. The Project Area is shallow (<8 m) and therefore, the use of propellers or dynamic positioning systems can cause sediment plumes and increase local turbidity, as well as introduce contaminated sediment to the water column. Anchoring can also cause sediment disturbance and also cause plumes. Discharges from vessels, including sewage, garbage and oils can impact on water quality and increase contamination of sediments.

Magnitude of Effects – Construction Logistics	Negligible	Small	**Medium**	Large
Applicable Criteria	Temporary or localized change in water / sediment quality with water / sediment quality returning to background levels thereafter.			

Mitigation Measures

As discussed previously, silt curtains will be used during the entirety of the Project. These curtains will help to contain any suspended sediment and therefore limit the spread of turbidity and contaminated sediments.

Vessels used during the Project are legally required to comply with Annexes of the International Convention for the Prevention of Pollution (MARPOL 93/98) including Annexes relating to the discharge of oil, noxious liquid substances, sewage, garbage and air, under the *Ports and Maritime Administration Act 1995*, the *Marine Safety Act 1998* and the *Marine Pollution Act 1987*.

Residual Effect

While the sensitivity of water and sediment quality was found to be ***medium***, the effect magnitude from use of anchoring and discharges was found to be ***small***. Accordingly, the effect significance of the construction logistics is considered to be ***minor***.

Category	Effect before Mitigation	Residual Effect
Magnitude of Effects from Construction Logistics	Medium	Small
Sensitivity of Water and Sediment Quality to Removal of Structures	Medium	Medium
Significance of Construction Logistics on Water Quality	Moderate	Minor
Significance of Construction Logistics on Sediment Quality	Moderate	Minor

6.5 UNPLANNED EVENTS

There is the potential for adverse consequences on both water and sediment quality in the event of an accidental event. The unplanned events that could potentially occur during the proposed works and are considered to have potential for significant environmental effects are discussed below.

6.5.1 *Marine Hydrocarbon Spill*

Effect Description

The most likely unplanned spill or release of fuels is the accidental spill during refuelling or due to a vessel collision. Fuels, hydraulic fluids and lubricating oils have the potential to cause further effects to the 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. 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 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.

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

With the implementation of mitigation measures the severity of a marine hydrocarbon spill is considered to be reduced due to the reduced volumes that may be spilled and the response to remove hydrocarbons quickly from the water surface. Accordingly, the effect significance is considered to be ***ALARP***.

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*

Effect 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 6.5.1* 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 Effect

With the implementation of mitigation measures both the likelihood and severity of a marine vessel incident are considered to be reduced. Accordingly, the effect significance is considered to be ***ALARP***.

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

Effect 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 and quick recovery of dropped objects.		

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 hazardous materials 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 dropped object 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

With the implementation of mitigation measures, the likelihood and effect of a dropped object remain unlikely and low respectively and the effect significance is considered to be ***ALARP***.

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

7 *CONCLUSIONS*

The potential activities identified that have the potential to significantly affect water or sediment quality included the removal and installation of piles and the construction logistics. Each of these activities has the potential to result in temporary increases in turbidity and the suspension and deposition of sediments. The long-term presence of structures was also found to potentially influence water movement in the Cockle Bay. In each case the residual potential impacts, after the application of mitigation measures, was 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 local water and sediment quality. 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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