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Kamay Ferry Wharves Seagrass Monitoring Report - Winter 2021

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Document control

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Glossary and list of abbreviations

Term or abbreviation	Definition
CHIRP	Compressed High-Intensity Radiated Pulse
CPCe	Coral Point Count with Excel extensions
DoD	Depth of Disturbance
DPI	The NSW Department of Primary Industries
EIS	Environmental Impact Statement
FM Act	*Fisheries Management Act 1994* (NSW)
TfNSW	Transport for New South Wales

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1. Introduction

1.1 Project Background

Transport for New South Wales (TfNSW) is proposing to reinstate the ferry wharves at La Perouse and Kurnell in Botany Bay (Figure 1 and Figure 2 respectively). The Project was classified State Significant Infrastructure (SSI) under the NSW Planning Framework and is currently at the EIS Review stage.

The Project would allow for an alternative to the road connection between La Perouse and Kurnell. Its main purpose would be to operate a public ferry service for visitors and the community. In addition, the Project would provide supplementary temporary moorings for tourism-related commercial vessels and recreational boating (ARUP In Preparation).

A Marine Biodiversity Assessment Report was prepared as part of the Environmental Impact Statement (EIS) (TfNSW 2021a). This report identified that the project would result in impact to seagrasses, including the endangered *Posidonia australis* ecological community and population in Botany Bay. Impacts on seagrasses will include some losses of seagrass within the Construction Footprint and associated 15 m buffer from shading, disturbances during construction works and ongoing operation of the wharves and ferries (TfNSW 2021a). In addition, a large and significant bed of the endangered *P. australis* seagrass occurring adjacent to and beyond the Project Boundary at Kurnell is considered of ecological significance and an important conservation requirement.

Investigations of seagrass in or nearby the Project Boundaries at La Perouse and Kurnell have found seagrass bed distribution and morphology (i.e. shoot density, leaf length) to be highly temporally and spatially variable, especially off Silver Beach at Kurnell. In some places, distribution was wider than previously mapped (Larkum and West 1990, Otway and Macbeth 1999, NSW DPI 2021). At both La Perouse and Kurnell, several vessel moorings within or adjacent to the Project Boundaries are likely to be having, and may have ongoing, impacts on seagrass distribution in these areas. At Kurnell in particular, exposure to large easterly swells is considered a major driver of temporal changes in seagrasses within the Project Boundary and expansion of the adjacent large *P. australis* bed to the east.

1.2 Project Description

The Project includes the construction of two new wharves, one at La Perouse and one at Kurnell. The wharves would be designed to accommodate ferries up to 40 m length, along with recreational and commercial vessels up to 20 m in length.

The total construction period is anticipated to take up to 13 months, starting in early 2022. Construction will require the following:

- Use of a temporary crane and rig platform (onshore) to install nearshore piles and piers at La Perouse.
- Construction of a causeway to provide piling plant access to install nearshore piles and piers at Kurnell.

- Repositioning and anchoring of a jack-up barge to provide a platform for construction works for the wharves.

1.3 Monitoring Purpose

The EIS has identified the need for a pre- to post-construction seagrass monitoring program designed to measure construction and operation impact as a mitigation measure for the Project. Furthermore, pre-construction monitoring will be required to determine baseline distribution and condition of seagrasses both within and adjacent to the Project Boundary to determine offset requirements and provide adequate long-term protection of the adjacent large *P. australis* bed.

The purpose of the monitoring program is to identify any large-scale changes in seagrass composition and distribution within the Project Boundary and monitor for any changes in the large adjacent bed of *P. australis* at Kurnell during construction and operation that may be attributable to the Project.

336250
336500
336750
6238250
6238000
6237750
6237500
OORANA AVENUE
TASMAN STREET
ELAROO AVENUE
MURRONG PLACE
GOOLAGONG PLACE
ADINA AVENUE
ADINA WAY
PB-LP12
HZ-LP03
HZ-LP04
HZ-LP01
HZ-LP02
PP-LP01
PB-LP11
PP-LP02
ENDEAVOUR AVENUE
GOORAWAHL AVENUE
ANZAC PARADE
ANZAC PARADE
ROAD

Baseline monitoring site
Project Boundary
Survey area
Permanent construction footprint
Temporary construction footprint 15m buffer

Seagrass Density
High
Medium
Low

Seagrass Types and Habitats
Halophila
Posidonia
Posidonia / Halophila
Posidonia / Zostera
Rock / Rubble / Reef
Zostera / Halophila

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0 75
m

GDA 1994 MGA Zone 56

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Survey Sites and Habitat Mapping: La Perouse Winter 2021

Kamay Ferry Project

Figure 1

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335250
335500
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6236500
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6236000
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6235500

HZ-K07
PB-K10
HZ-K06
HZ-K08
HZ-K05
PP-K03
PP-K04
HZ-K10
PB-K01
PB-K09
PB-K03
PB-K02
PP-K07
PP-K11
HZ-K09
PP-K08
PB-K04
PB-K05
PB-K06
PB-K07
PB-K08
MONUMENT TRACK

PP-K09
PP-K07
PP-K08
PP-K11

HZ-K06
PB-K10
HZ-K05
PP-K03
PP-K04
HZ-K10
PB-K01
PB-K09
PP-K07
PP-K09
PP-K08
PP-K11
HZ-K09
PB-K05
PB-K06
MONUMENT TRACK

PRINCE CHARLES PARADE
CAPTAIN COOK LANE
CAPTAIN COOK DRIVE
GANNON STREET
POLO STREET

Project Boundary
Survey area
Baseline monitoring site

Seagrass Types and Habitats
Halophila
Posidonia
Posidonia / Halophila
Posidonia / Zostera
Posidonia Mixed
Rock / Rubble / Reef
Zostera
Zostera / Halophila

Seagrass Density
High
Medium
Low

Permanent construction footprint
Permanent construction footprint
Temporary construction footprint 15m buffer

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0 100
m

GDA 1994 MGA Zone 56

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Niche Proj. #: 5811
Client: Arup Pty Ltd

Survey Sites and Habitat Mapping: Kurnell Winter 2021:
Kamay Ferry Project

Figure 2

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2. Methods

2.1 Overview

The seagrass monitoring program has been developed to align with the requirements identified within the Marine Biodiversity Offset Strategy (TfNSW 2021b). The program includes four survey approaches:

- Seagrass Mapping: Seagrass distribution mapping of the Project Boundaryies;
- Drop Camera Surveys: Drop-camera-based surveys of *Halophila* and *Zostera* seagrass beds;
- *Posidonia* Bed Monitoring: Seagrass morphology surveys of *P. australis* beds (>100 m^2); and
- *Posidonia* Patch Monitoring: Seagrass morphology surveys of smaller *P. australis* patches (<100 m^2).

Specific monitoring sites are shown for La Perouse in Figure 1, and for Kurnell in Figure 2. A full list of site codes and GPS coordinates can be found in Appendix 1.

2.2 Seagrass Mapping

2.2.1 Objective

To determine a baseline measure of seagrass composition and distribution within the Survey Area.

2.2.2 Survey Areas

La Perouse

Subtidal areas of seagrass habitat within 50-100m of the Project Boundary (Figure 1).

Kurnell

Subtidal areas of seagrass habitat within 50-100m of the Project Boundary (Figure 2).

2.2.3 Survey Frequency

Surveys will be undertaken twice per year – once during winter and once during summer, with approximately 6 months between surveys. Should there be a major storm event during construction that has potential to impact on seagrasses in the Survey Area, a supplementary survey would be undertaken within eight weeks, unless the winter or summer survey is scheduled to occur during this period.

The survey results presented in this report represent the first pre-construction and winter survey.

2.2.4 Methodology

Preliminary desktop works included review of the latest Nearmap imagery (Captured: 16 May 2021) and previously prepared polygons of seagrass distribution developed as part of the EIS investigations (ARUP 2021).

Previously developed layers and associated Nearmap imagery were loaded onto a field collection device with GPS accuracy of approx. +/-3m. Verification of habitat was recorded on the device as point data using Field Maps Software.

Visual observations to verify the seabed habitat were made using a combination of towed camera (Plate 1) transects through the Survey Area and spot observations using a bathoscope, drop camera or, in the cases of shallow areas and during periods of clear water, observation from the side of the boat. The towed camera was towed within 1 m of the seabed and positioned so

imagery was being provided from directly under the survey vessel or within 2 m of the stern of the survey vessel. The towed and drop cameras allowed for *in situ* field verification of mapping by providing video imagery live to the topside monitor on the survey vessel. The vessel sonar, which included CHIRP ClearVu and SideVu sonar that incorporates a thin, wide beam to provide clear images of structure and fish below the vessel, was also used to aid mapping and target seabed areas with structure.

Field verification survey effort within seagrass habitat inside the Survey Area consisted of collection of 1,864 points at La Perouse and Kurnell, with no greater than 30 m between two verification points.

Post-collection analysis of field verification points was undertaken using GIS software to construct an updated set of habitat polygons. Other data sources including previous mapping, site observations during other surveys and aerial imagery sourced through Nearmap were also used to update seagrass habitat polygons.

2.2.5 Data Analysis

The following calculations were made using GIS Software for La Perouse and Kurnell:

- Seagrass area within the Project Boundary
- Seagrass area within the Construction Footprint
- Seagrass area within the 15 m buffer zone around the construction footprint.

2.3 Drop Camera Surveys

2.3.1 Objective

To determine the baseline community composition and density of *Zostera*- and *Halophila*-dominated seagrass beds in the Project Boundary.

2.3.2 Survey Area

Each baseline monitoring site was a circular area with a radius of 10 m from a central point, amounting to a total area of 314 m^2.

La Perouse

Four drop camera monitoring sites were established at La Perouse (Figure 1):

- Two (2) potential 'impact' sites (HZ-LP-01 & HZ-LP-02) within the Project Boundary, positioned within seagrass beds dominated by *Halophila* between approximately 30 and 50 m from the proposed wharf.
- Two (2) 'control' sites (HZ-LP-03 & HZ-LP-04) outside the Project Boundary, positioned within the seagrass beds that occurred in similar water depths approximately 150 m to the north of the proposed wharves.

Kurnell

Six drop camera monitoring sites were established at Kurnell (Figure 2):

- Four (4) potential impact sites, two in deeper areas near the seaward end of the wharf (HZ-K-05 & HZ-K-06) near the seaward end of wharf and two nearer to the shore in shallower water (HZ-K-09 & HZ-K-10). These were positioned within seagrass beds dominated by *Zostera* and *Halophila* between approximately 30 and 50 m from the proposed wharf.
- Two (2) control sites (HZ-K-07 & HZ-K-08) outside the Project Boundary, positioned within the seagrass beds that occurred in similar water depths approximately 150 m from the proposed wharves.

2.3.3 Survey Frequency

Surveys will be undertaken twice per year – once during winter and once during summer, with approximately 6 months between surveys. Should there be a major storm event during construction that has potential to impact on seagrasses in the Survey Area, a supplementary survey would be undertaken within eight weeks, unless the winter or summer survey is scheduled to occur during this period.

The survey results presented in this report represent the first pre-construction and winter survey.

2.3.4 Methodology

The centre point of each monitoring site was located using handheld GPS. Once located a temporary float was positioned at the centre of the site. Each photo quadrat was haphazardly collected within 10 m of the centre of the site to ensure that the quadrat contained at least some seagrass.

Photoquadrats were collected with a drop camera custom designed for seagrass surveys (Plate 1), which can obtain a high-resolution image of a known area of the seabed while providing real time imagery. Care was taken to avoid collecting photographs of the seabed that overlapped during the field survey.

Photos that were of poor quality, taken when the frame was not stationary on the seabed or duplicates were removed from the dataset. A total of 30 photos were then randomly selected from the dataset and uploaded into CPCe Software for analysis. Within the CPCe software a digital photoquadrat was created to form an area of 0.25 m^2 (0.5 x 0.5 m) and 30 points were randomly assigned to the image. Under each point a habitat category was assigned (Table 1).

Table 1: Major and sub-categories used with the CPCe Software.

Major category	Sub-categories
SEAGRASS (S)	Halophila, Zostera, Posidonia
ALGAE (A)	Macroalgae, Turfing Algae, Epiphytic Algae (when identified to be attached to the seagrass)
CORAL (C)	Hard Coral, Soft Coral
SUBSTRATE (SU)	Gravel & Shell, Rock & Rubble, Sand & Silt
OTHER BIOTA (OB)	Sessile Invertebrate
TAPE WAND SHADOW (TWS)	Tape, Wand (frame), Shadow (insufficient resolution), Macroalgae Wrack, Seagrass Wrack, Other Debris.

2.3.5 Data Analysis

Within the CPCe software percent cover for each of the categories (except Tape, Wand and Shadow) and sub-categories were calculated for each photoquadrat (Plate 1), while Tape, Wand and Shadow were excluded from the percent cover calculations. Summaries for each site including means and standard errors were then calculated for:

- Seagrass cover by type
- Sediment/silt cover
- Turfing algae cover
- Epiphytic algae cover.

2.4 Posidonia Bed Monitoring

2.4.1 Objective

To determine the baseline community composition and biomass (density and leaf lengths) of *P. australis* seagrass beds (>100 m^2) with potential to be impacted during construction and operation.

2.4.2 Survey Area

Each monitoring site was a circular area with a radius of 5 m from a central point, amounting to a total area of 79 m^2.

La Perouse

Two *P. australis* bed monitoring sites were established at La Perouse (Figure 1):

- One (1) potential impact site (PB-LP11) within the Project Boundary, positioned within the largest and only stand greater them 100m^2 of *P. australis*.
- One (1) control site (PB-LP12) outside the Project Boundary, positioned in the largest and only potentially suitable area of *P. australis* inside Frenchman's Bay at La Perouse, approximately 200 m to the north of the proposed wharves. It is noted that this small bed is in very shallow water, very close to Frenchman's Beach and may potentially be impacted by public beach use.

Kurnell

Ten *P. australis* bed monitoring sites were established at Kurnell (Figure 2):

- Eight (8) potential impact sites within the large extensive bed of *P. australis* to the west of the Project Boundary (PB-K01 to PB-K08). These sites were located along two longshore transects (one near shore and one offshore) at a range of distances from the Construction Footprint (Approx. 75 m, 100 m, 150 m and 230 m). These sites were positioned within the main western bed to allow for a gradient-based approach to monitoring for impacts to the large bed of *P. australis* to the west of the Project Boundary, both close to shore and in deeper areas nearer to the seaward edge of the bed. It must be noted that the sites furthest from the Construction Footprint may more appropriately provide potential control sites rather than be categorised as impact sites.

- Two (2) additional potential impact sites within much smaller beds of *P. australis* inside the Project Boundary (PB-K09 and PB-K10). Site PB-K09 is in close proximity to the proposed wharf, while PB-K10 is in the outer areas of the Project Boundary.
- Control sites will need to be determined at the completion of baseline monitoring. It is envisaged they will be selected from monitoring sites in the main western bed outside the Project Boundary (e.g. PB-K03, -K04, -K07 and -K08). There is also potential to include the most easterly site in the Project Boundary as a control site, where impact from the proposal is considered unlikely.

2.4.3 Survey Frequency

Surveys will be undertaken twice per year – once during winter and once during summer, with approximately 6 months between surveys. Should there be a major storm event during construction that has potential to impact on seagrasses in the Survey Area, a supplementary survey would be undertaken within eight weeks, unless the winter or summer survey is scheduled to occur during this period.

The survey results presented in this report represent the first pre-construction and winter survey.

2.4.4 Methodology

The centre point of each monitoring site was located using handheld GPS. Once located a temporary float was positioned at the centre of the site. Seagrass was haphazardly surveyed via five 0.25 m^2 (0.5 x 0.5 m) quadrats within 5 m of the centre of the site to ensure that the quadrat contained at least some seagrass.

Within each quadrat the following data were recorded by ADAS scientific divers:

- Plant density (counted from the sheaf) for each seagrass species present (Note *Halophila* counted as shoots).
- Leaf Length of 10 randomly selected leaves for both *Zostera* and *P. australis*.
- Visible Sheaf Length for 10 randomly selected *P. australis* shoots.
- Epiphyte Load (scored 1-5, see Appendix 2) for 10 randomly selected leaves for each seagrass species present.

In addition to the above measurements a photograph was taken above each quadrat for archiving purposes.

At the Kurnell monitoring sites only, three Depth of Disturbance (DoD) rods were installed in a straight line through the mid-point at each site. The middle DoD rod was installed at the centre point of the site and the remaining two DoD rods were installed 3m either side (in directions towards the shoreline and seaward into Botany Bay). The DoD rods were installed at 40 cm above the sediment (measured between the seabed and the bottom of the cork).

2.4.5 Data Analysis

Data calculations and summaries included means and standard errors for the following:

- Plant (Shoot *Halophila*) count per 0.25 m^2
- Leaf length (cm)
- Sheaf length (presented as binary data)

- Epiphyte load score

2.5 Posidonia Patch Monitoring

2.5.1 Objective

To determine the baseline community composition and biomass (plant density and leaf lengths) of *P. australis* seagrass patches (<100 m^2) in close proximity to the Construction Footprint.

2.5.2 Survey Area

Patches (<100 m^2) of *P. australis* seagrass that met the following criteria were surveyed:

- inside or within 15 m of the construction footprint
- plant density of at least 5 plants per 1 m^2
- has a size of at least 10 m^2 and minimum average width/radius of 2 m.

La Perouse

Two *P. australis* patches satisfying the criteria were identified at La Perouse (Figure 1):

- PP-LP-01: Approximately 10 m east of the 15 m buffer, 12 m^2, with an average width of 3 m.
- PP-LP-02: Approximately 15 m east of the 15 m buffer, 16 m^2, with an average width of 4 m.

Kurnell

Ten *P. australis* patches satisfying the criteria were established at Kurnell (Figure 2):

- PP-K-03: Approximately 15 m east of the 15 m buffer, 55 m^2, with an average width of 6 m.
- PP-K-04: Inside the Construction Footprint and 15 m buffer, and approximately 35 m^2, with an average width of 4 m.
- PP-K-07: Approximately 3 m west of the 15 m buffer, 60 m^2, with an average width of 3 m.
- PP-K-08: On the western edge of the 15 m buffer, approximately 12 m^2, with an average width of 2 m.
- PP-K-09: On the eastern edge of the 15 m buffer, approximately 25 m^2, with an average width of 3 m.
- PP-K-11: On the eastern edge of the 15 m buffer, approximately 60 m^2, with an average width of 3 m. Note that this site has a *Zostera* patch in the middle that was not sampled.
- PP-K-12: On the eastern edge of the 15 m buffer, approximately 10 m^2, with an average width of 2 m.

2.5.3 Survey Frequency

Surveys will be undertaken twice per year – once during winter and once during summer, with approximately 6 months between surveys. Should there be a major storm event during construction that has potential to impact on seagrasses in the Survey Area, a supplementary survey would be undertaken within eight weeks, unless the winter or summer survey is scheduled to occur during this period.

The survey results presented in this report represent the first pre-construction and winter survey.

2.5.4 Methodology

The centre point of each monitoring site was located using handheld GPS. Once located a temporary float was positioned at the centre of the site. Seagrass was haphazardly surveyed via up to five 0.25 m^2 (0.5 x 0.5 m) quadrats within 5 m of the centre of the site to ensure that the quadrat contained at least some seagrass.

Within each quadrat the following data were recorded by ADAS scientific divers:

- Plant density (counted from the sheaf) for each seagrass species present (Note *Halophila* counted as shoots).
- Leaf Length of 10 randomly selected leaves for both *Zostera* and *P. australis*.
- Visible Sheaf Length for 10 randomly selected *P. australis* plants.
- Epiphyte Load (scored 1-5, see Appendix 2) for 10 randomly selected leaves for each seagrass species present.

In addition to the above measurements a photograph was taken above each quadrat for archiving purposes.

2.5.5 Data Analysis

Data calculations and summaries included means and standard errors for the following:

- Plant (Shoot *Halophila*) count per 0.25 m^2
- Leaf length (cm)
- Sheaf length (presented as binary data)
- Epiphyte load score.

3. Results

3.1 General

The first pre-construction monitoring survey was completed between July 1 and September 1, 2021 (winter).

This first survey included establishment of the monitoring sites. As part of this process, as noted in Section 2.3.2, two additional sites (HZ-K-09 & HZ-K-10) were established at Kurnell to account for areas of higher density *Zostera*-dominated seagrass beds that had established near the shore and in close proximity to the Construction Footprint. During establishment of each *Posidonia* bed monitoring site at Kurnell three Depth of Disturbance (DoD) rods were installed with height above the seabed of 400 mm (Plate 1).

Mapping was based on 1,864 recorded observations of the seabed. These recorded observations were supported by various other continuous observations such as those made: from the boat; using a bathoscope; during dive surveys; during continuous observations of sides can sonar returns; and during video transects.

Some general photos of seagrasses at both La Perouse and Kurnell are provided in Plates 2 and 3.

3.2 Seagrass Distribution

As part of Winter 2021 monitoring, 65,721 m^2 (6.57 ha) of seagrasses were mapped within the Project Boundary at La Perouse and Kurnell. This included 1,987 m^2 (0.20 ha) of seagrasses within the Construction Footprint and an additional 7,738 m^2 (0.77 ha) within the 15m buffer areas. The majority of this seagrass comprised mixed *Zostera / Halophila* and *Halophila* beds (Table 2).

Table 2: Seagrass area mapped during Winter 2021 within the Project Boundary, Construction Footprint and associated buffer zone.

Seagrass/s	Project Boundary (m)	Direct Impact (m) *(Inside construction footprint)*	Indirect Impact (m) (Inside 15m buffer)
Posidonia	2,864	4	70
Posidonia / Halophila	1,013	16	22
Posidonia / Zostera	0	0	0
Posidonia Mixed	772	0	136
Zostera	199	52	146
Zostera / Halophila	33,660	867	3,797
Halophila	27,214	1,048	3,558
Total	**65,721**	**1,987**	**7,730**

Posidonia australis seagrass that was found to occur within or partially within the buffer and/or Construction Footprint at Kurnell consisted of part (30 m^2) of a small *P. australis* and *Halophila* bed on the western side of the construction footprint, along with 10 smaller patches. The P. *australis*

bed was surveyed in more detail as part of the monitoring that included the establishment of the *Posidonia* Bed Monitoring site PB-K09. These various areas consisted of *P. australis* and/or *P. australis* mixed with other seagrasses and amounted to 248 m^2 within the buffer and/or Construction Footprint (Table 2). Five of these patches found to be larger than 10 m^2 and include approximate plant densities greater than 5 plants per m^2 were surveyed in more detail (Section 3.4). Of these, PP-K07 was only partially within the buffer and/or construction footprint, with 34 m^2 within the buffer area. The remining five patches not surveyed in detail area described below from field observations:

- A small patch of *P. australis* and *Halophila* located on the western side of the construction footprint, inside the eastern part of the buffer area and between Site PB-K09 and PP-K04. This patch was mapped to have an area within the buffer of approximately 3 m^2 and consist of 10 plants or less in total.
- A very small patch of *P. australis* located within the construction footprint, east of site PP-K07. This patch was mapped to have an area within the buffer of approximately 1 m^2 and consist of less than 10 plants in total.
- A narrow, approximately 30 x 2 m ribbon of *P. australis* and *Halophila* located along the western edge of the buffer area (Figure 2). This patch was mapped to have an area within the buffer of approximately 24 m^2 and described to consist of approximately 2 plants per m^2.
- A small patch of *P. australis* and *Halophila* located in shallow nearshore areas inside the western edge of the buffer area (Figure 2). This patch was mapped to have an area within the buffer of approximately 10 m^2 and described to consist of approximately 2 plants per m^2.
- A small patch of *P. australis* located on the eastern edge of the Construction Footprint in shallow areas south of site PP-K11 (Figure 2). This patch was mapped to have an area within the buffer and/or Construction Footprint of approximately 6 m^2 and consist of 10 or less plants per m^2.

Further breakdowns of seagrass distribution data between La Perouse and Kurnell project locations is provided in Appendix 3.

3.3 *Zostera* and *Halophila* Seagrasses

Results for cover of *Zostera*- and *Halophila*-dominated beds were:

- At La Perouse seagrass cover ranged between 14-24% cover, with *Halophila* sp. the dominant seagrass (Figure 3).
- At La Perouse the sites inside the Project Boundary (HZ-LP-01 and HZ-LP-02) showed a trend of lower total seagrass cover but typically a higher proportion of that cover accounted for by *Zostera* seagrass than was the case at the control sites outside the Project Boundary (HZ-LP-03 and HZ-LP-04) (Figure 3).
- At Kurnell seagrass cover and composition at the four beds further from shore (HZ-K-05 to HZ-K-08) were noticeably different from those for the two sites closer to shore and adjacent to the Construction Footprint (HZ-K-09 and HZ-K-10) (Figure 3).
- At Kurnell the seagrass beds further from shore (HZ-K-05 to HZ-K-08) had very low seagrass cover (<3%) and a mixture of both *Zostera* and *Halophila* seagrasses (Figure 3).

- The Kurnell control sites (HZ-K-07 and HZ-K-08) had seagrass cover that was slightly higher than HZ-K-05 and HZ-K-06, possibly due to the presence of some *Zostera* seagrass (Figure 3).
- At Kurnell seagrass beds at the sites close to shore and adjacent to the Construction Footprint (HZ-K-09 and HZ-K-10) had much higher cover of seagrass than at other sites (23-43%), with *Zostera* sp. the dominant seagrass (Figure 3).

Further data are provided in Appendix 2.

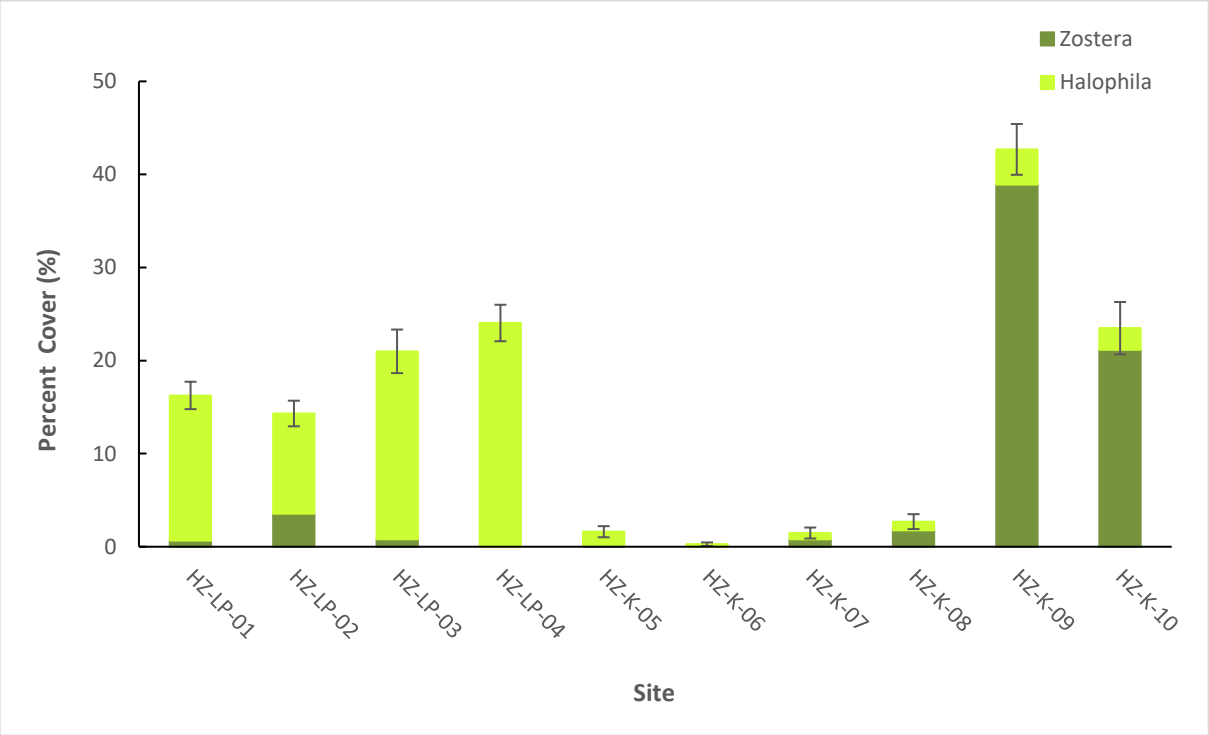

Figure 3: Mean *Halophila* and *Zostera* seagrasses cover (+/- SE Total seagrass cover).

At La Perouse sediment contributed to 46-83% cover amongst *Zostera* and *Halophila* seagrasses, while both turfing and epiphytic algae was less than 0.5%. At Kurnell, the four sites further from shore (HZ-K-05 to HZ-K-08) were predominately sediment (92-97%), while the two sites closer to shore (HZ-K-09 and HZ-K-10) consisted of a much lower cover of sediment (57-72%). The cover of turfing and epiphytic algae at Kurnell was similar to those for La Perouse, at ~0.5% or less (Table 3).

Table 3: Mean covers of sediment, turfing and epiphytic algae at each site.

Site	Sediment	Turfing Algae	Epiphytic Algae
HZ-LP-01	67.77	0.00	0.00
HZ-LP-02	83.16	0.00	0.48
HZ-LP-03	75.45	0.03	0.00
HZ-LP-04	46.92	0.07	0.03
HZ-K-05	94.90	0.33	0.50
HZ-K-06	95.06	0.07	0.90
HZ-K-07	96.64	0.00	0.43

HZ-K-08	92.35	0.57	0.57
HZ-K-09	57.00	0.00	0.03
HZ-K-10	76.22	0.00	0.07

3.4 *Posidonia* Seagrasses

3.4.1 Plant Density

Results for plant density at *Posidonia* monitoring sites and patches were:

- All *Posidonia* monitoring sites and patches were found to include all three seagrass species, with *Zostera* amongst *P. australis* at Kurnell sites at much higher densities in comparison to at the La Perouse sites (Table 4, Figure 4).
- Mean *P. australis* plant density at *Posidonia* bed monitoring sites was up to 40 plants per 0.25m^2, with the highest *P. australis* densities recorded at sites within the main bed (west of the project site) at Kurnell (PB-K03, PB-K05 and PB-K06). The lowest densities were recorded at monitoring sites within the smaller beds at Kurnell (Figure 4).
- Mean *P. australis* plant density in *Posidonia* patches at La Perouse and Kurnell ranged between 7 and 17 plants per 0.25m^2(Table 44).
- The La Perouse impact site (PB-LP-11) and control site (PB-LP-12) were similar in regard to both *P. australis and Zostera* seagrass plant densities.
- Within the large *P. australis* bed west of the Project Boundary at Kurnell the lowest *P. australis* plant density was measured at the two sites located farthest away, 230m west of the Construction Footprint (both deep and shallow transects) (Figure 5).

Further data are provided in Appendix 3.

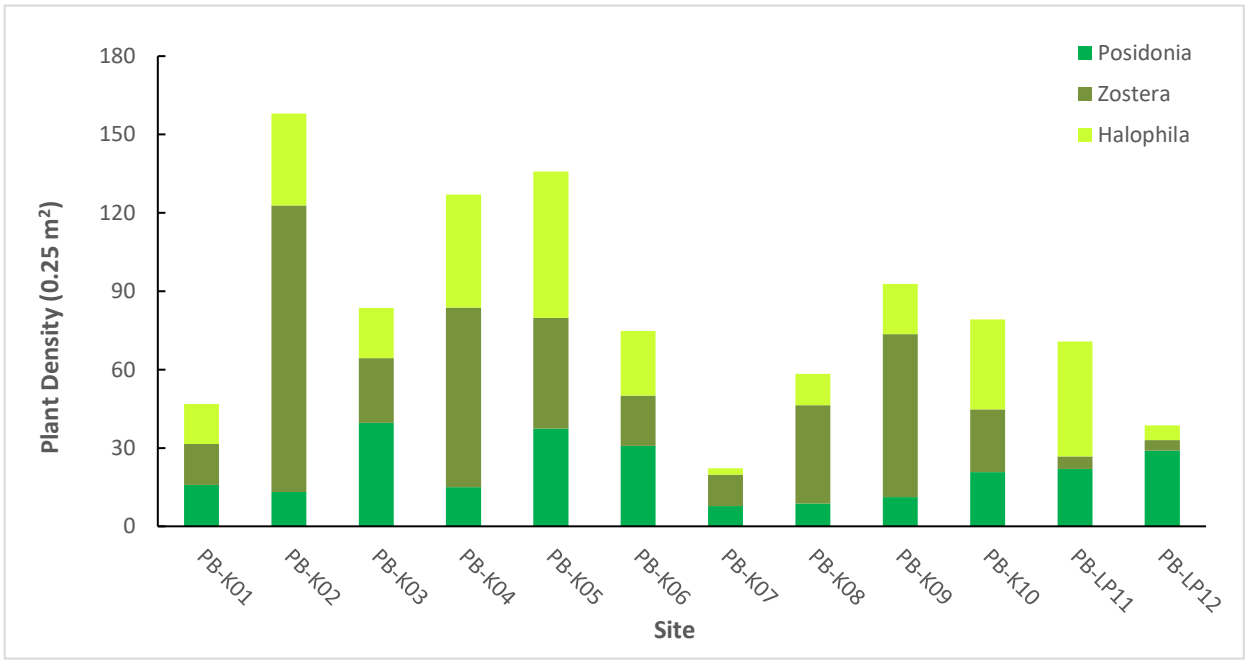

Figure 4: Mean plant density of each seagrass species within the *Posidonia* bed monitoring sites.

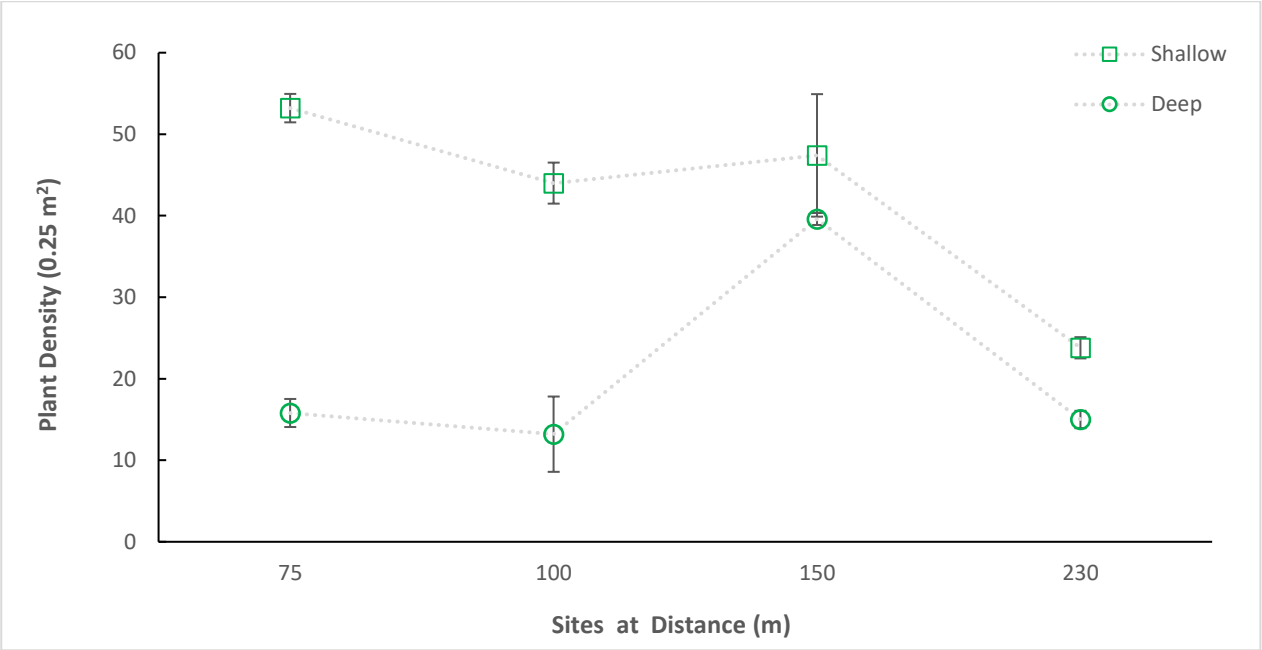

Figure 5: Mean *Posidonia* plant density at *Posidonia* bed monitoring sites positioned at different distances from the Construction Footprint along deep and shallow transects in the main Posidonia bed (+/-SE).

Table 4: Mean plant densities and lengths within *Posidonia* patches.

Patch	Approximate Area (m^2)	Plant Density (O.25 m^2)			Leaf Lengths (cm)	
		Posidonia	*Zostera*	*Halophila*	*Posidonia*	*Zostera*
PP-K03	57	17	33	33	37	6
PP-K04	39	13	62	83	28	9
PP-K07	61	7	146	155	35	10
PP-K08	12	13	104	51	37	12
PP-K09	25	13	71	24	37	12
PP-K11	67	17	76	42	58	10
PP-LP01	11	12	4	140	33	14
PP-LP02	17	15	13	97	27	2

3.4.2 Leaf Length

Results for leaf lengths at *Posidonia* monitoring sites and patches were:

- Mean leaf length for *P. australis* typically ranged between 25 and 39 cm across all monitoring sites within *Posidonia* beds. The exception was some shorter mean leaf lengths at monitoring sites within the main bed to the west of the Kurnell Project Boundary (PB-K03 = 12 cm and PB-K04 = 17cm) (Table 5, Figure 6).
- Mean leaf length for *P. australis* within the smaller *Posidonia* patches was typically longer and much more variable, ranging between 27 and 58 cm (Table 45).

- Mean leaf length for *Zostera* was highly variable across *P. australis* monitoring sites and patches (Table 5).

Further data are provided in Appendix 3.

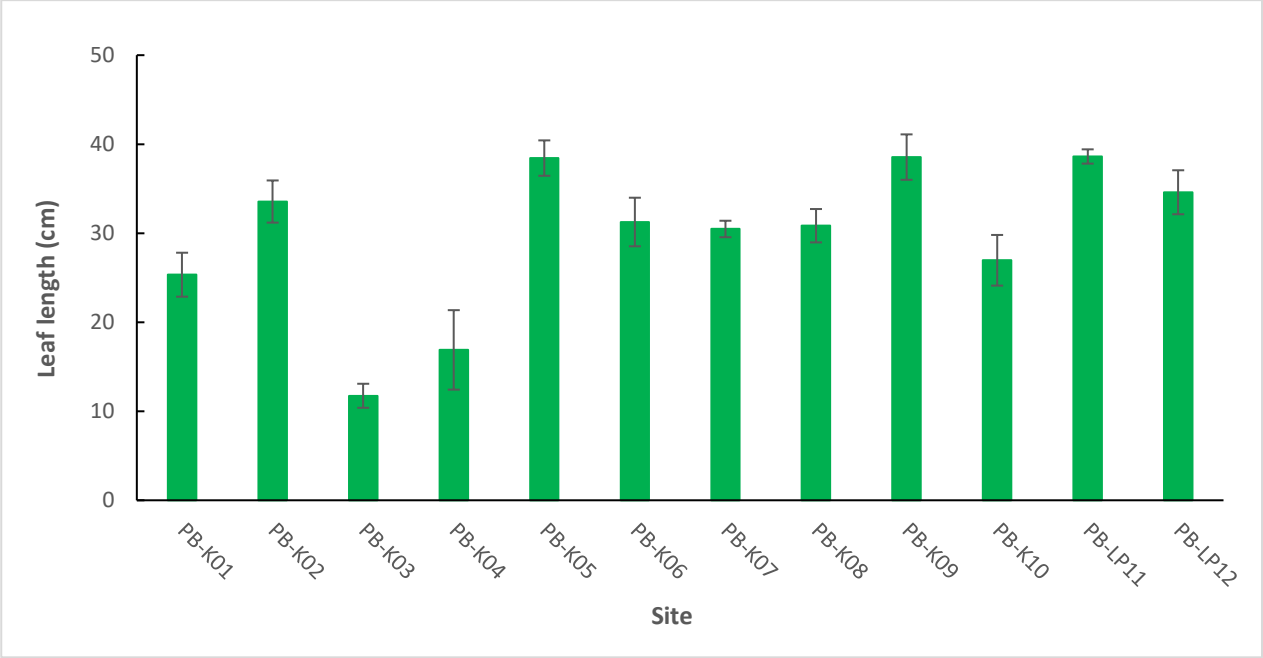

Figure 6: Mean *Posidonia* leaf length at the *Posidonia* bed monitoring sites (+/-SE).

Table 5: Mean values for visible seagrass sheafs (*Posidonia* only) and epiphyte cover score.

Site/Patch	Leaf Length (cm)		Sheaf Visible (%)	Epiphytic Cover Score		
Seagrass	*Posidonia*	*Zostera*	*Posidonia*	*Posidonia*	*Zostera*	*Halophila*
PB-K01	25	5	46	2.0	2.7	2.2
PB-K02	34	9	43	3.0	1.7	2.6
PB-K03	12	31	42	2.0	3.3	2.5
PB-K04	17	29	0	3.3	3.0	3.0
PB-K05	38	5	68	3.0	1.3	2.6
PB-K06	31	9	44	3.7	1.5	3.1
PB-K07	30	11	41	3.6	1.7	4.0
PB-K08	31	10	47	3.8	1.9	3.6
PB-K09	39	15	4	3.8	2.1	2.5
PB-K10	27	4	55	3.8	2.9	3.9
PB-LP11	39	4	6	2.2	1.7	2.3
PB-LP12	35	5	50	3.9	2.8	2.9
PP-K03	25	5	46	4.2	ND	4.1
PP-K04	34	9	ND	4.1	ND	3.4
PP-K07	12	31	15	2.2	ND	2.1
PP-K08	17	29	0	4.1	ND	3.0
PP-K09	38	5	68	4.0	ND	3.7

Site/Patch	Leaf Length (cm)		Sheaf Visible (%)	Epiphytic Cover Score		
Seagrass	*Posidonia*	*Zostera*	*Posidonia*	*Posidonia*	*Zostera*	*Halophila*
PP-K11	31	9	25	3.0	ND	2.6
PP-LP01	30	11	31	2.3	2.0	1.7
PP-LP02	31	10	3	1.9	ND	1.8

ND = No data/ Missing data

3.4.3 Other Measurements

Seagrass Sheafs

Seagrass sheafs were measured to the nearest cm (Appendix 3) for *P. australis* plants, however, many were found to be covered by sediment and measurements could not be obtained (this was recorded as 0 cm). For this report it was deemed more appropriate to present these data as percent of plants with visible sheafs. Visible sheafs was found to be highly variable, ranging from 0 to 68% across *Posidonia* monitoring sites and patches (Table 55).

Further data are provided in Appendix 3.

Epiphyte Cover

Epiphytic growth was found to typically be higher on *P. australis* plants. The epiphyte scores across *P. australis* monitoring sites and patches ranged between 2.0 and 4.2 for *P. australis,* 1.3 and 3.3 for *Zostera* and 1.7 and 4.1 for *Halophila* seagrasses (Table 5).

Further data are provided in Appendix 3.

4. Discussion

4.1 Suitability of Control Sites

A continuing limitation of the program will be obtaining suitable control sites at both La Perouse and Kurnell that have the following characteristics:

- Similar seagrass community compositions.
- Exposure to similar levels of other anthropogenic disturbances such as mooring and vessel disturbance.
- Exposure to similar levels of natural disturbances such as swell, and sediment secretion and deposition.

Current potential limitations for control sites include the following:

- The original *Zostera/Halophila* seagrass bed impact and control sites at Kurnell (HZ-K05 to HZ-K08) are very different in composition to the additional sites added (HZ-K09 and HZ-K10) in shallow areas that are characterised by dense, *Zostera*-dominated beds.
- The La Perouse *P. australis* bed control site (PB-LP12) is located very close to the beach and vulnerable to additional levels of anthropogenic disturbances from vessel operation and beaching. Alternative options for control locations at La Perouse are limited due to the lack of *P. australis* outside the Project Boundary.
- Control sites for *P. australis* bed at Kurnell will likely be adopted from monitoring sites within the very large bed to the west. This bed is much larger and more protected from swell, however, other anthropogenic disturbances such as commercial vessel moorings, as well as natural movement of a large sand patch, continue to pose the potential threat to impact on areas of this bed. Selection of monitoring sites along the two transects in this bed for future use as control sites will need to consider these disturbances.

Given the above, the collection of a full set of baseline data will be essential in monitoring for impacts at some sites during construction and operation phases.

4.2 Success Criteria

Comparison with success criteria will be an essential component of monitoring during the construction and operation phases. As part of baseline monitoring the following outcomes will be required:

- Seagrass distribution changes will need to be reviewed at the completion of baseline monitoring to determine acceptable decreases or rates off change in seagrass distribution.
- Data from the *Zostera/ Halophila* and *Posidonia australis* seagrass bed control sites will need to be reviewed to determine if they are suitable for comparison with monitoring sites within the Project Boundary. Should some control sites not be suitable for comparison against the potential impact sites, alternate success criteria will need to be developed for those potential impact sites.

4.3 Conclusions

Mapping of seagrass distribution and detailed survey of both *Zostera/ Halophila* and *Posidonia australis* seagrass beds and patches was completed during Winter 2021 as the first baseline Survey. Seagrass mapping during Winter 2021 identified an area of 9,717 m^2 of seagrasses within the buffer and/or Construction Footprint of the project. This area was dominated by very variable

Zostera and *Halophila* beds ranging from <1 to 43% cover, while *P. australis* seagrass accounted for only 248 m^2 of the seagrass. Based on distribution mapping, measures of densities within beds and patches, and field observations of smaller patches collected during the winter 2021 survey, it is estimated that there are approximately 10,000 *P. australis* plants inside the buffer area (including construction footprint) with potential to be impacted, however, there are only approximately 850 *P. australis* plants within the construction footprint. The second baseline survey is due to be undertaken in late January / February 2022.

5. References

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Transport for NSW (2021b). Kamay Ferry wharves EIS - Marine Biodiversity Offset Strategy. Prepared by Andrea McPherson (Arup Australia Pty Ltd), David Cummings (Niche, H2O Consulting Group) and Adriana Verges (University of New South Wales), October 2021.

6. Plates

Plate 1: Survey equipment and methodologies a) Towed camera used to map seagrasses, b) Drop camera used to collect photoquadrats, c) CPCe digital photoquadrat analysis screen, and d) DoD rod installed within the main I *P. australis* seagrass bed at Kurnell.

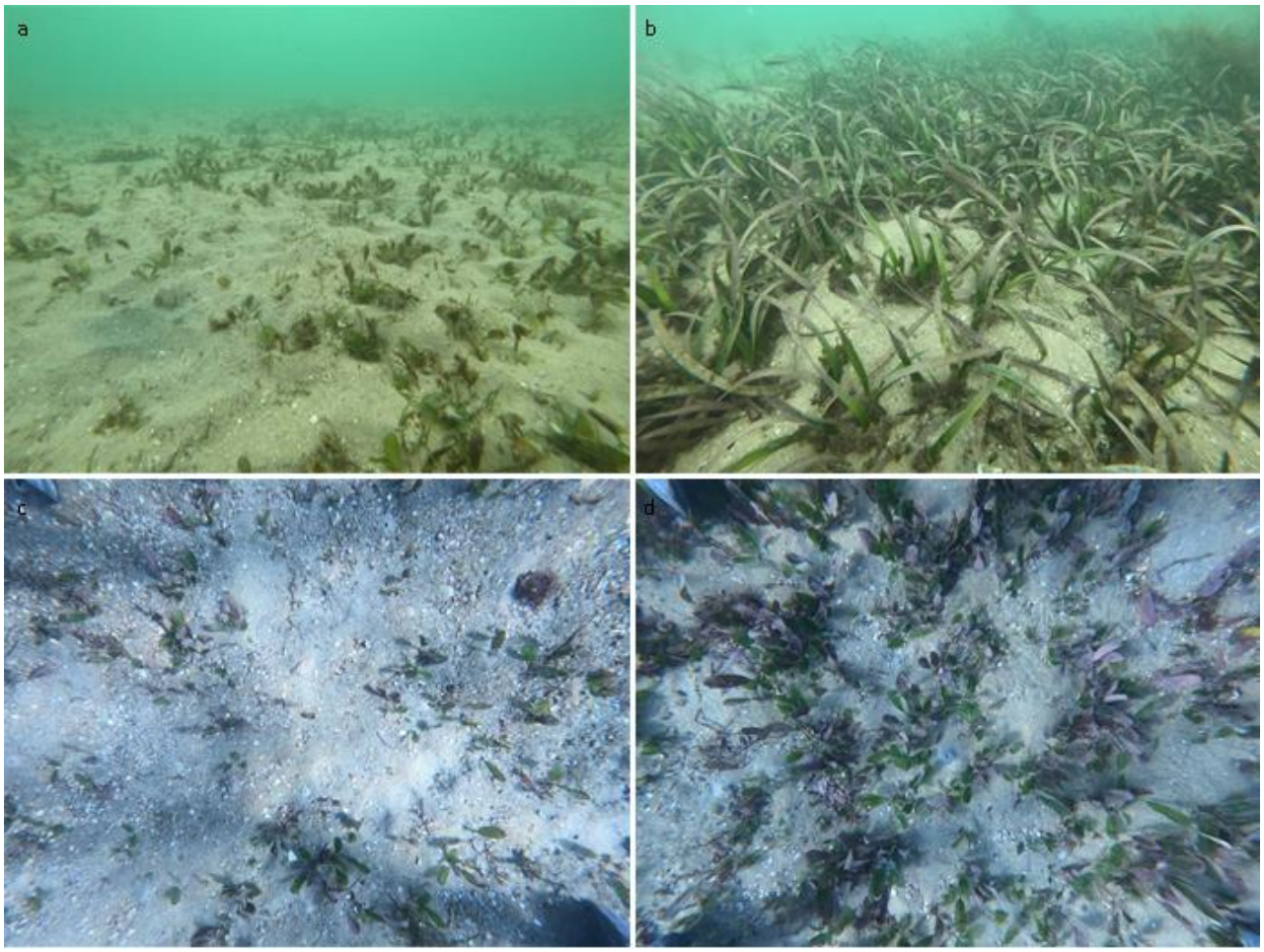


Plate 2: Seagrasses in the Project Area at La Perouse, a) Low density *Halophila* dominated seagrass within *Zostera / Halophila* beds, b) *Posidonia australis*, c) low density *Halophila*, and d) medium density *Halophila*.

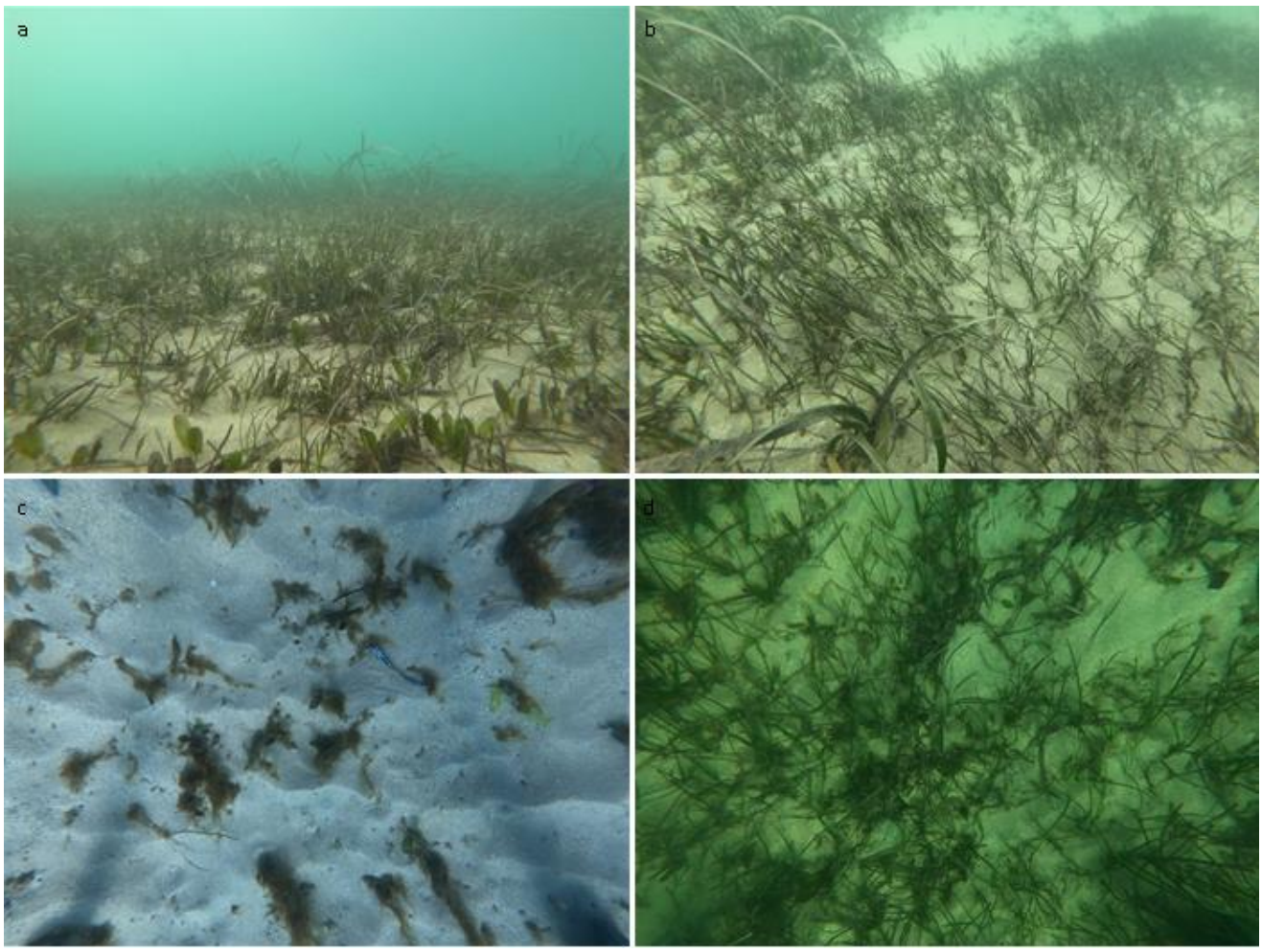
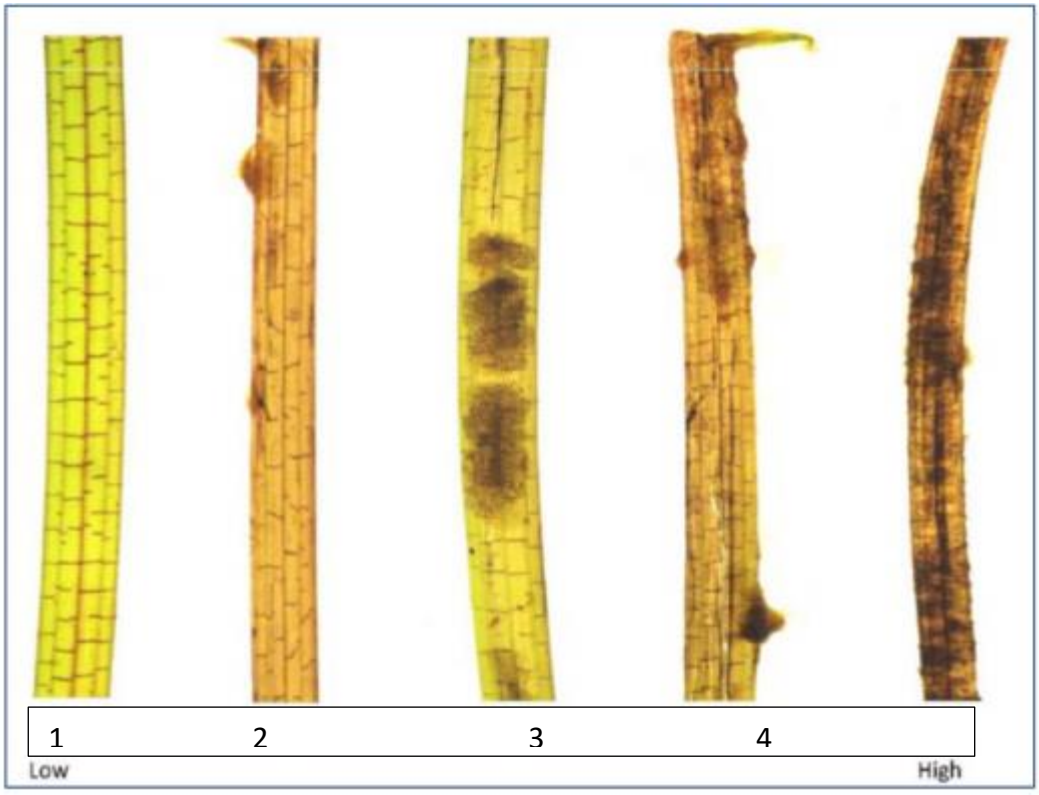


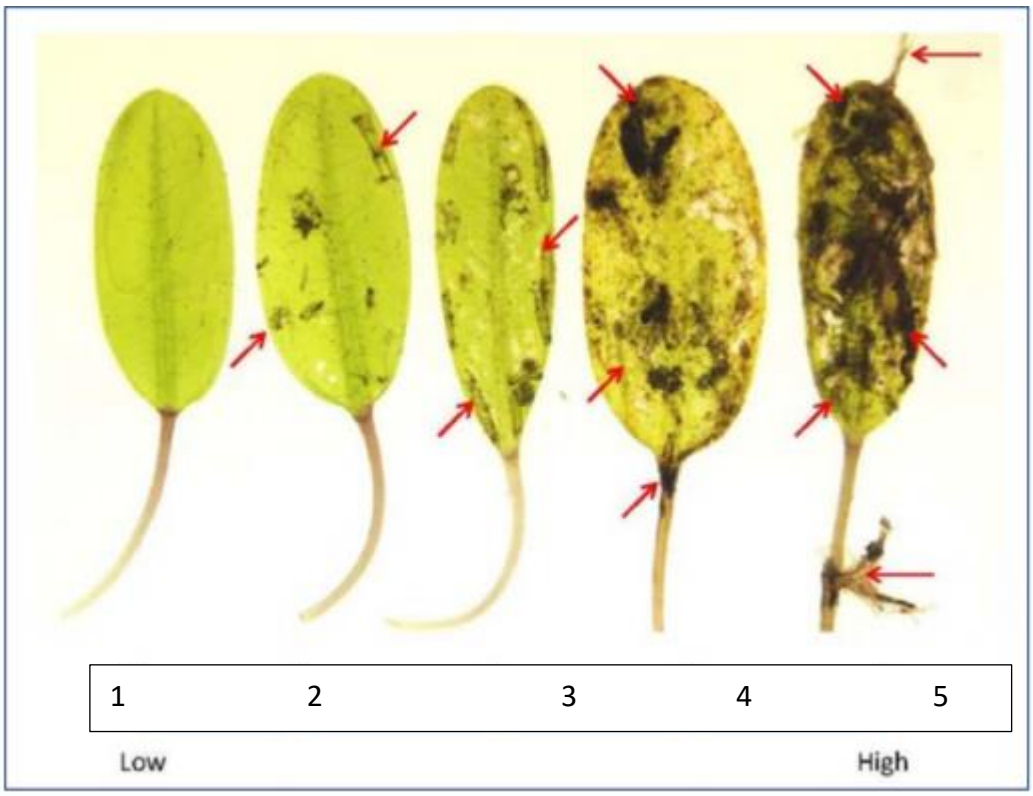
Plate 3: Seagrasses in the Project Area at Kurnell, a) Medium density *Zostera* dominated seagrass within *Zostera* / *Halophila* beds with *P. australis* in the background, b) Medium density *Zostera* dominated seagrass within *Zostera* / *Halophila* beds adjoining a low density patch of *P. australis*, c) low density *Halophila* with heavy epiphytic fouling and d) Medium density *Zostera* dominated seagrass within *Zostera / Halophila* bed in shallow areas close to the proposal footprint.

Appendix 1: Monitoring Site Locations

Type	Site Code	Easting (GDA94 MGA56)	Northing (GDA94 MGA56)
Halophila / Zostera Monitoring	HZ-LP01	336429.98	6237907.40
Halophila / Zostera Monitoring	HZ-LP02	336516.36	6237871.92
Halophila / Zostera Monitoring	HZ-LP03	336438.35	6238037.70
Halophila / Zostera Monitoring	HZ-LP04	336317.97	6238009.92
Halophila / Zostera Monitoring	HZ-K05	335274.25	6236137.09
Halophila / Zostera Monitoring	HZ-K06	335344.73	6236180.62
Halophila / Zostera Monitoring	HZ-K07	335437.75	6236230.96
Halophila / Zostera Monitoring	HZ-K08	335164.51	6236149.72
Halophila / Zostera Monitoring	HZ-K09	335310.06	6236050.64
Halophila / Zostera Monitoring	HZ-K10	335383.27	6236105.94
Posidonia Bed Monitoring	PB-K01	335263.13	6236095.86
Posidonia Bed Monitoring	PB-K02	335234.62	6236085.28
Posidonia Bed Monitoring	PB-K03	335189.91	6236071.11
Posidonia Bed Monitoring	PB-K04	335127.20	6236041.22
Posidonia Bed Monitoring	PB-K05	335315.43	6236006.55
Posidonia Bed Monitoring	PB-K06	335287.92	6235986.41
Posidonia Bed Monitoring	PB-K07	335250.49	6235967.27
Posidonia Bed Monitoring	PB-K08	335173.89	6235927.58
Posidonia Bed Monitoring	PB-K09	335326.24	6236087.61
Posidonia Bed Monitoring	PB-K10	335417.71	6236193.76
Posidonia Bed Monitoring	PB-LP11	336545.65	6237861.53
Posidonia Bed Monitoring	PB-LP12	336578.02	6238082.55
Posidonia Patch Monitoring	PP-LP01	336506.15	6237863.79
Posidonia Patch Monitoring	PP-LP02	336533.90	6237847.83
Posidonia Patch Monitoring	PP-K03	335367.57	6236122.05
Posidonia Patch Monitoring	PP-K04	335346.18	6236109.77
Posidonia Patch Monitoring	PP-K07	335340.22	6236069.58
Posidonia Patch Monitoring	PP-K08	335355.60	6236062.17
Posidonia Patch Monitoring	PP-K09	335366.10	6236071.99
Posidonia Patch Monitoring	PP-K11	335370.57	6236060.62

Appendix 2: Epiphyte Loading Scale





Appendix 3: Data

Seagrass Distribution Data

Project Boundary

	Kurnell m^2	La Perouse m^2	Total m^2
Posidonia	2864	0	2864
Posidonia / Halophila	843	170	1013
Posidonia / Zostera	0	0	0
Posidonia Mixed	772	0	772
Zostera	199	0	199
Zostera / Halophila	27243	6417	33660
Halophila	1874	25340	27214
	33794	**31928**	**65721**

Buffer Area

	Kurnell m^2	La Perouse m^2	Total m^2
Posidonia	70	0	70
Posidonia / Halophila	22	0	22
Posidonia / Zostera	0	0	0
Posidonia Mixed	136	0	136
Zostera	146	0	146
Zostera / Halophila	3745	52	3797
Halophila	84	3474	3558
	4204	**3526**	**7730**

Construction Footprint

	Kurnell m^2	La Perouse m^2	Total m^2
Posidonia	4	0	4
Posidonia / Halophila	16	0	16
Posidonia / Zostera	0	0	0
Posidonia Mixed	0	0	0
Zostera	52	0	52
Zostera / Halophila	867	0	867
Halophila	57	991	1048
	996	**991**	**1987**

Drop Camera Surveys

Mean							
Site	ALGAE (A)	SEAGRASS (S)	SUBSTRATE (SU)	Halophila (HS)	Zostera (ZC)	Posidonia (PA)	
HZ-LP-01	0.00	16.25	83.75	15.59	0.67	0.00	
HZ-LP-02	2.01	14.31	83.68	10.76	3.56	0.00	
HZ-LP-03	0.41	20.99	78.60	20.19	0.81	0.00	
HZ-LP-04	0.42	24.04	75.54	24.04	0.00	0.00	
HZ-K-05	3.36	1.61	95.03	1.48	0.13	0.00	
HZ-K-06	4.40	0.27	95.33	0.27	0.00	0.00	
HZ-K-07	1.76	1.47	96.77	0.67	0.80	0.00	
HZ-K-08	4.69	2.69	92.62	0.95	1.74	0.00	
HZ-K-09	0.30	42.69	57.00	3.78	38.91	0.00	
HZ-K-10	0.29	23.49	76.22	2.32	21.17	0.00	
SE							
Site	ALGAE (A)	SEAGRASS (S)	SUBSTRATE (SU)	Halophila (HS)	Zostera (ZC)	Posidonia (PA)	
HZ-LP-01	0.00	1.47	1.47	1.41	0.39	0.00	
HZ-LP-02	0.62	1.38	1.41	1.34	0.73	0.00	
HZ-LP-03	0.23	2.34	2.41	2.21	0.56	0.00	
HZ-LP-04	0.23	1.96	1.92	1.96	0.00	0.00	
HZ-K-05	0.96	0.60	1.42	0.49	0.13	0.00	
HZ-K-06	0.87	0.19	0.88	0.19	0.00	0.00	
HZ-K-07	0.46	0.59	0.78	0.28	0.49	0.00	
HZ-K-08	1.26	0.80	1.65	0.38	0.63	0.00	
HZ-K-09	0.21	2.73	2.70	1.06	2.77	0.00	
HZ-K-10	0.20	2.81	2.77	0.64	2.53	0.00	
Mean				SE			
Site	Sediment	Turfing Algae	Epiphytic Algae	Site	Sediment	Turfing Algae	Epiphytic Algae
HZ-LP-01	67.77	0.00	0.00	HZ-LP-01	2.24	0.00	0.00
HZ-LP-02	83.16	0.00	0.48	HZ-LP-02	1.44	0.00	0.15
HZ-LP-03	75.45	0.03	0.00	HZ-LP-03	2.74	0.03	0.00
HZ-LP-04	46.92	0.07	0.03	HZ-LP-04	3.05	0.05	0.03
HZ-K-05	94.90	0.33	0.50	HZ-K-05	1.41	0.15	0.14
HZ-K-06	95.06	0.07	0.90	HZ-K-06	0.91	0.05	0.21
HZ-K-07	96.64	0.00	0.43	HZ-K-07	0.82	0.00	0.11
HZ-K-08	92.35	0.57	0.57	HZ-K-08	1.65	0.28	0.19
HZ-K-09	57.00	0.00	0.03	HZ-K-09	2.70	0.00	0.03
HZ-K-10	76.22	0.00	0.07	HZ-K-10	2.77	0.00	0.05
SE				SE			
Site	Sediment	Turfing Algae	Epiphytic Algae	Site	Sediment	Turfing Algae	Epiphytic Algae
HZ-LP-01	2.24	0.00	0.00	HZ-LP-01	2.24	0.00	0.00
HZ-LP-02	1.44	0.00	0.15	HZ-LP-02	1.44	0.00	0.15
HZ-LP-03	2.74	0.03	0.00	HZ-LP-03	2.74	0.03	0.00

HZ-LP-04	3.05	0.05	0.03	HZ-LP-04	3.05	0.05	0.03
HZ-K-05	1.41	0.15	0.14	HZ-K-05	1.41	0.15	0.14
HZ-K-06	0.91	0.05	0.21	HZ-K-06	0.91	0.05	0.21
HZ-K-07	0.82	0.00	0.11	HZ-K-07	0.82	0.00	0.11
HZ-K-08	1.65	0.28	0.19	HZ-K-08	1.65	0.28	0.19
HZ-K-09	2.70	0.00	0.03	HZ-K-09	2.70	0.00	0.03
HZ-K-10	2.77	0.00	0.05	HZ-K-10	2.77	0.00	0.05

Posidonia monitoring sites and patches

Plant Density

Density (0.25m2)

Site / Patch	Posidonia		Zostera		Halophila	
	Mean	SE	Mean	SE	Mean	SE
PB-K01	15.80	1.74	15.80	3.69	15.20	2.94
PB-K02	13.20	2.52	109.60	8.45	35.20	5.43
PB-K03	39.60	7.51	24.80	1.96	19.20	2.94
PB-K04	15.00	1.30	68.80	13.76	43.20	13.23
PB-K05	37.40	1.72	42.40	11.43	56.00	15.70
PB-K06	30.80	4.62	19.20	4.27	24.80	11.20
PB-K07	7.80	0.73	12.00	3.79	2.40	1.60
PB-K08	8.80	1.07	37.60	10.40	12.00	4.00
PB-K09	11.20	0.37	62.40	8.45	19.20	7.09
PB-K10	20.80	2.58	24.00	4.38	34.40	3.71
PB-LP11	22.00	1.82	4.80	2.94	44.00	7.04
PB-LP12	29.00	1.92	4.00	4.00	5.60	5.60
PP-K03	17.40	1.60	32.80	8.98	32.80	2.65
PP-K04	13.00	1.76	62.40	7.00	83.20	9.67
PP-K07	6.50	1.32	146.00	29.64	155.00	35.34
PP-K08	13.00	0.58	104.00	18.90	50.67	21.95
PP-K09	13.00	1.87	71.00	9.98	24.00	10.33
PP-K11	17.25	2.66	76.00	12.54	42.00	13.11
PP-LP01	12.00	1.73	4.00	4.00	140.00	26.63
PP-LP02	15.33	1.45	13.33	13.33	97.33	15.38

Leaf and Sheaf Lengths

Site / Patch	Leaf Length				Sheafs Length		Sheaf Visible	
Seagrass	Posidonia		Zostera		Posidonia		Posidonia	
	Mean	SE	Mean	SE	Mean (cm)	SE (cm)	Mean (%)	SE (%)
PB-K01	25.3	2.5	5.3	0.8	0.5	0.0	46.0	2.4
PB-K02	33.6	2.4	8.7	1.2	0.6	0.1	42.7	5.5
PB-K03	11.7	1.3	30.6	1.4	0.4	0.1	42.0	5.8
PB-K04	16.9	4.5	29.1	5.9	0.0	0.0	0.0	0.0
PB-K05	38.4	2.0	5.5	0.4	1.1	0.2	68.0	3.7
PB-K06	31.3	2.7	9.2	2.4	0.5	0.1	44.0	5.1
PB-K07	30.5	0.9	10.5	0.7	0.4	0.0	40.7	2.0
PB-K08	30.8	1.9	10.4	0.6	0.5	0.0	47.0	4.0
PB-K09	38.6	2.6	15.2	1.8	0.0	0.0	4.0	4.0
PB-K10	27.0	2.8	4.2	0.8	0.6	0.1	55.0	7.4
PB-LP11	38.6	0.8	4.4	0.3	0.1	0.1	6.0	4.0
PB-LP12	34.6	2.5	4.6		0.6	0.1	50.0	10.0
PP-K03	36.9	3.0	6.2	1.1	0.5	0.1	46.0	6.0
PP-K04	27.7	1.6	8.7	1.0		!		#
PP-K07	34.8	2.8	9.9	0.8	0.3	0.1	14.6	6.2
PP-K08	37.0	1.8	11.9	1.9	0.0	0.0	0.0	0.0
PP-K09	37.1	1.5	11.7	0.3	0.8	0.1	67.5	4.8
PP-K11	58.5	2.7	10.1	0.9	0.7	0.7	25.0	25.0
PP-LP01	32.7	3.3	13.9		0.5	0.3	30.7	9.7
PP-LP02	27.2	2.2	2.1		0.1	0.1	3.3	3.3

Epiphyte Score

Site / Patch	Posidonia		Zostera		Halophila	
	Mean	SE	Mean	SE	Mean	SE
PB-K01	2.0	0.1	2.7	0.2	2.2	0.2
PB-K02	3.0	0.4	1.7	0.2	2.6	0.2
PB-K03	2.0	0.2	3.3	0.3	2.5	0.4
PB-K04	3.3	0.2	3.0	0.0	3.0	0.0
PB-K05	3.0	0.1	1.3	0.0	2.6	0.4
PB-K06	3.7	0.2	1.5	0.1	3.1	0.3
PB-K07	3.6	0.1	1.7	0.0	4.0	0.3
PB-K08	3.8	0.2	1.9	0.1	3.6	0.3
PB-K09	3.8	0.1	2.1	0.1	2.5	0.5
PB-K10	3.8	0.2	2.9	0.4	3.9	0.2
PB-LP11	2.2	0.2	1.7	0.3	2.3	0.1
PB-LP12	3.9	0.2	2.8		2.9	
PP-K03	4.2	0.3			4.1	0.3
PP-K04	4.1	0.2			3.4	0.2
PP-K07	2.2	0.0			2.1	0.2
PP-K08	4.1	0.1			3.0	0.5
PP-K09	4.0	0.2			3.7	0.2
PP-K11	3.0	0.2			2.6	0.3
PP-LP01	2.3	0.1	2.0		1.7	0.3
PP-LP02	1.9	0.2			1.8	0.3

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Sydney
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Our services

Ecology and biodiversity
Terrestrial
Freshwater
Marine and coastal
Research and monitoring
Wildlife Schools and training

Heritage management
Aboriginal heritage
Historical heritage
Conservation management
Community consultation
Archaeological, built and landscape values

Environmental management and approvals
Impact assessments
Development and activity approvals
Rehabilitation
Stakeholder consultation and facilitation
Project management

Environmental offsetting
Offset strategy and assessment (NSW, QLD, Commonwealth)
Accredited BAM assessors (NSW)
Biodiversity Stewardship Site Agreements (NSW)
Offset site establishment and management
Offset brokerage
Advanced Offset establishment (QLD)