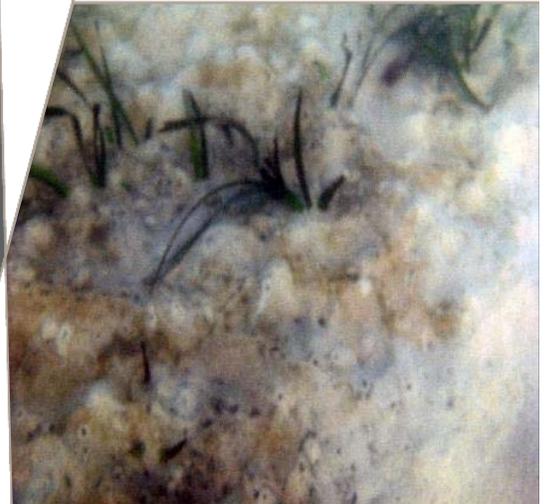


Port Botany Foreshore Beach Groynes

Seagrass Survey After Construction

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Prepared for
Ward Civil

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Executive Summary

Ward Civil Pty Ltd (Ward Civil), on behalf of the Port Authority of New South Wales, has recently installed three groyne structures along Foreshore Beach to protect against beach erosion. These are low crested, primarily submerged, groynes that will significantly decrease the erosive forces that have been removing sediment from the beach and depositing it to the north and offshore of the beach. The two outside groynes have incorporated an extended seaward from two existing stormwater outlets. The design should provide a hydrological environment that allows recovery of the last remaining beds of seagrass along the northern shoreline of Botany Bay.

Surveys of seagrass were undertaken in June 2016 (pre-construction), September 2016 (during construction) and December 2016 (after construction). After the June 2016 survey, Cardno recommended working zones, no go zones and no anchoring zones for barge operations during construction, to protect seagrass from construction impacts. Cardno's divers undertook the final seagrass survey at Foreshore Beach and surrounds on 16 and 20 December 2016.

Surveys involved comparing the extent, shoot density, leaf length and epiphyte growth on seagrass among surveys. Seagrass was also monitored in Yarra Bay in September and December 2016 to contextualise any potential changes at Foreshore Beach with broader patterns within Botany Bay.

The results of the December 2016 survey indicated that mitigation during construction of the groynes has protected *Halophila* species of seagrass. Patches did not change in size compared to surveys done prior to construction (June 2016) and densities increased typically as expected into the warmer season and as evidenced in the controls. The loss of one small patch of *Z. capricorni* (Patch 5) after June, noted in the seagrass survey during construction in September 2016, is not considered to be attributed to construction of the groynes given there has been a widespread decline of this species previously at Foreshore Beach.

The disappearance during construction of one small patch of *P. australis* and a 56% decline in area of the other patch are also not considered to be solely attributed to construction of the groynes. Although lower water quality and potential sedimentation from construction may have partly contributed to the decline of *P. australis*, it is more likely to have been mostly a consequence of long-term deterioration in the condition of *P. australis* at Foreshore Beach. The heavy covering of epiphytes in the remnant patches of *P. australis* and *Halophila* spp. in all surveys (i.e. including the survey done prior to construction) is indicative of the generally poor condition of seagrass at Foreshore Beach prior to construction.

No evidence of the introduced pest alga *Caulerpa taxifolia* at Foreshore Beach was found.

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1 Introduction

1.1 Background

Foreshore Beach, located along the northern shoreline between Sydney Airport and Port Botany, has been reduced significantly in length since its creation as a part of the original construction of Port Botany in the late 1970s. This has followed foreshore developments including the third runway for Kingsford Smith (Sydney) Airport and associated realignment of the Mill Stream, and construction of the parallel airport runway in the early 1990s. A recent expansion of Port Botany and development of a public boat ramp and creation of a flushing channel for the rehabilitated Penrhyn Estuary (The Port Botany Expansion Project, see below) further reduced beach habitat to the southeast of Foreshore Beach. At just over 500 m long, Foreshore Beach is now approximately one-third as long as it was in 2007, and approximately one-tenth of its length prior to the development of the airport runways. It represents some of the only beach habitat remaining in the northern shoreline of Botany Bay.

Sydney Ports Corporation (now Port Authority of New South Wales) completed construction of the Port Botany Expansion Project in 2013. This included rehabilitation of the nearby Penrhyn Estuary to enhance the existing intertidal habitat and to expand the estuary as a long-term habitat for migratory shorebirds. Extensive dredging and modifications were required in Penrhyn Estuary and along nearby Foreshore Beach in Botany Bay. Prior to construction, monitoring works carried out in 2008 indicated that approximately 317 sq. m of seagrass (including *Zostera capricorni*, *Halophila* spp. and *Posidonia australis*) would be lost due to land reclamation, boat ramp construction and dredging works associated with the project. Changes in seagrass habitat were monitored during the construction phase and are now being monitored post-construction by Cardno (NSW/ACT) Pty Ltd (Cardno) in accordance with the Penrhyn Estuary Habitat Enhancement Plan (PEHEP) (Sydney Ports Corporation 2007). Monitoring records changes in seagrass distribution and condition. Cardno has completed several seagrass surveys and reports as part of the PEHEP (Cardno 2014, 2015a), identifying several patches of *Z. capricorni*, *Halophila* spp. and *P. australis* present along Foreshore Beach. All seagrass is protected under New South Wales State legislation and, in addition, *P. australis* in six locations within New South Wales (Port Hacking, Botany Bay, Sydney Harbour, Pittwater, Brisbane Waters and Lake Macquarie) have been listed as endangered populations under the Threatened Species Schedules of the *Fisheries Management Act 1994* (FM Act). 'Posidonia australis seagrass meadows of the Manning-Hawkesbury ecoregion', which includes Botany Bay, is also listed as an endangered ecological community under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). However, this listing does not apply to *P. australis* at Foreshore Beach given the consultation guide (DOE 2014). According to the Approved Conservation Advice for the listing (DOE 2014), an ecological community of *P. australis* is defined as a meadow, dominated by *Posidonia*, which is greater than 1 ha in size. The *P. australis* off Foreshore Beach does not meet the key diagnostic characteristics of the Commonwealth listing (Cardno 2014, 2015a).

Ward Civil Pty Ltd (Ward Civil), on behalf of the Port Authority of New South Wales, installed three groyne structures between end of June and mid-December 2016 along Foreshore Beach to protect against beach erosion. These are low crested, primarily submerged, groynes are expected to significantly decrease the erosive forces that have been removing sediment from the beach and depositing it to the north and offshore of the beach. The two outside groynes will incorporate and extend seaward from two existing stormwater outlets. The design should provide a hydrological environment that allows recovery of the last remaining beds of seagrass along the northern shoreline of Botany Bay. Previously, Cardno prepared the Marine Assessment Report for the installation of the groynes along Foreshore Beach which included a review of relevant legislation, assessment of impacts and recommended impact mitigation measures (Cardno 2015b). A key component of the assessment was the mapping of seagrass in the vicinity of the proposed groynes prior to construction.

Cardno also undertook a pre-construction seagrass survey at Foreshore Beach on behalf of Ward Civil to record the location, extent, condition and type of all seagrass existing on the site in the form of a GIS map. The map was used to recommended 'Barge Working Zones' during construction of the groynes, including no go zones around remnant patches of the seagrass *P. australis*, and no anchoring zones which gave an approximate 15 metre buffer around all seagrass patches. A second survey in September 2016, during construction, investigated the state of seagrass following severe weather conditions experienced on Friday 23 September, 2016, which included south-west winds of up to 43 km/hr and unexpected wave conditions within

the construction area. At that time, the sand bund around the perimeter of the construction area failed and sections of silt curtains, put in place to protect seagrass beds near to the groyne construction areas, were compromised. The results of the survey, however, indicated that the severe weather conditions had little, if any, effect on seagrass at Foreshore Beach (refer to September Report for more detail, Cardno 2016b). Following this event, there was a small change made to the no anchoring zones (refer to **Figure 3-1**).

1.2 Aims

Ward Civil have requested that Cardno undertake a final seagrass survey at Foreshore Beach to investigate the state of seagrass following the completion of construction of the groynes at Foreshore Beach.

The main aim of the seagrass survey was to assess whether seagrass at Foreshore Beach has been affected by construction work. This was done from assessment of change, if any, to the location, extent, condition and type of all seagrasses among surveys in June (pre-construction), September (during construction) and December 2016 (post-construction).

This document provides the results of the final seagrass survey and how these data have been used to address the aim given above.

2 Methodology

2.1 Field Survey of Seagrass

Maps created from the pre-construction (June 2016) and during construction (September 2016) seagrass surveys of Foreshore Beach (Cardno 2016a and 2016b) were used to plan the December 2016 survey, which included:

1. Visiting previously identified patches of *P. australis*, *Z. capricorni* and *Halophila* spp. at Foreshore Beach to determine their presence and, if present, to measure their extents and percentage cover. Divers were directed to these locations using a hand-held GPS. Once located, previous coordinates of these small patches were confirmed, the area of each patch was measured using a tape measure and the percentage cover and evidence of sedimentation was estimated visually. Coordinates of the edges of the larger patches of *Halophila* spp. were collected. Searches of the area were also made for any new patches of *Halophila* spp.
2. Measuring the condition of the large areas of *Halophila* spp. at Foreshore Beach in five 0.25 sq. m quadrats at four locations monitored previously as part of the PEHEP (P1A, P2A, P1B and P2B) using the following indicators within each quadrat:
 - > Shoot Density - The total number of shoots within each of the five quadrats was recorded to provide a measure of seagrass density.
 - > Leaf Length - The length of 10 randomly selected leaves within each of the five quadrats was recorded to provide an indicator of growth which can vary widely depending on the habitat in which seagrass grows.
 - > Epiphyte Load - Epiphyte load was recorded by divers on 10 randomly selected leaves within each of the five quadrats using a four-point classification scale: L=Low; M=Medium; H=High; N=None.

NB: No seagrass was found at sites P1A and P1B in any of the three surveys.

The amount of epiphytic growth on the leaves is considered an indicator of seagrass health. Excessive epiphytic growth can reduce the amount of light available and high epiphytic load may be indicative of high nutrient levels within the water column.

3. Measuring the condition of the large area of *Halophila* spp. in Yarra Bay (a control area to the east of Foreshore Beach) in five 0.25 sq. m quadrats at two locations (to compare with seagrass at Foreshore Beach) using the same methods as (2) above.

Cardno's divers investigated seagrass at Yarra Bay on 16 December 2016 from a 5 m boat but were unable to investigate seagrass at Foreshore Beach on this date due to unsafe water quality following a heavy rainfall event. Seagrass at Foreshore Beach was investigated on 20 December 2016, where there were light winds and no cloud cover in the morning and strong onshore north-east winds in the afternoon. The underwater visibility was between 2-4 m. This was not unusual for Foreshore Beach and was adequate for divers to undertake investigations of seagrass beds.

2.2 Mapping

Cardno used GIS software (MapInfo Pro 15.2 and ArcGIS 10.4.1) to map the seagrass beds at Foreshore Beach using aerial imagery and the GPS coordinates of seagrass patches recorded by divers during the field survey. The footprint of the groyne structures (supplied by Ward Civil) was overlaid on this map to identify proximity of construction to any areas of seagrass, particularly *P. australis*.

The map of seagrass and locations for groynes was used to determine whether areas of seagrass had changed between June, September and December 2016.

3 Results

3.1 Distribution and Cover of Seagrass in December 2016

3.1.1 *Posidonia australis*

P. australis Patch 1, observed in the previous surveys was not present in December 2016 indicating the small (0.7 m²) patch had died since the previous (September) survey (**Figure 3-1**).

P. australis Patch 3 near the middle groyne, was present in December 2016 but it has steadily reduced in size from 31.3 m² (June) to 24.5 m² (September) to 13.9 m² (December) (**Table 3-1**). The condition of *P. australis* was similar (i.e. poor) in June, September and December 2016 with a thick cover of epiphytes (**Plate 1**).

Table 3-1 Areas and percent cover of patches of *P. australis* at Foreshore Beach

Patch no.	June 2016		September 2016		December 2016	
	Area (m ²)	Percent Cover (%)	Area (m ²)	Percent Cover (%)	Area (m ²)	Percent Cover (%)
1	0.5	10	0.7	10	Not present	
3	31.3	15-20	24.5	10-20	13.9	10-20



a)

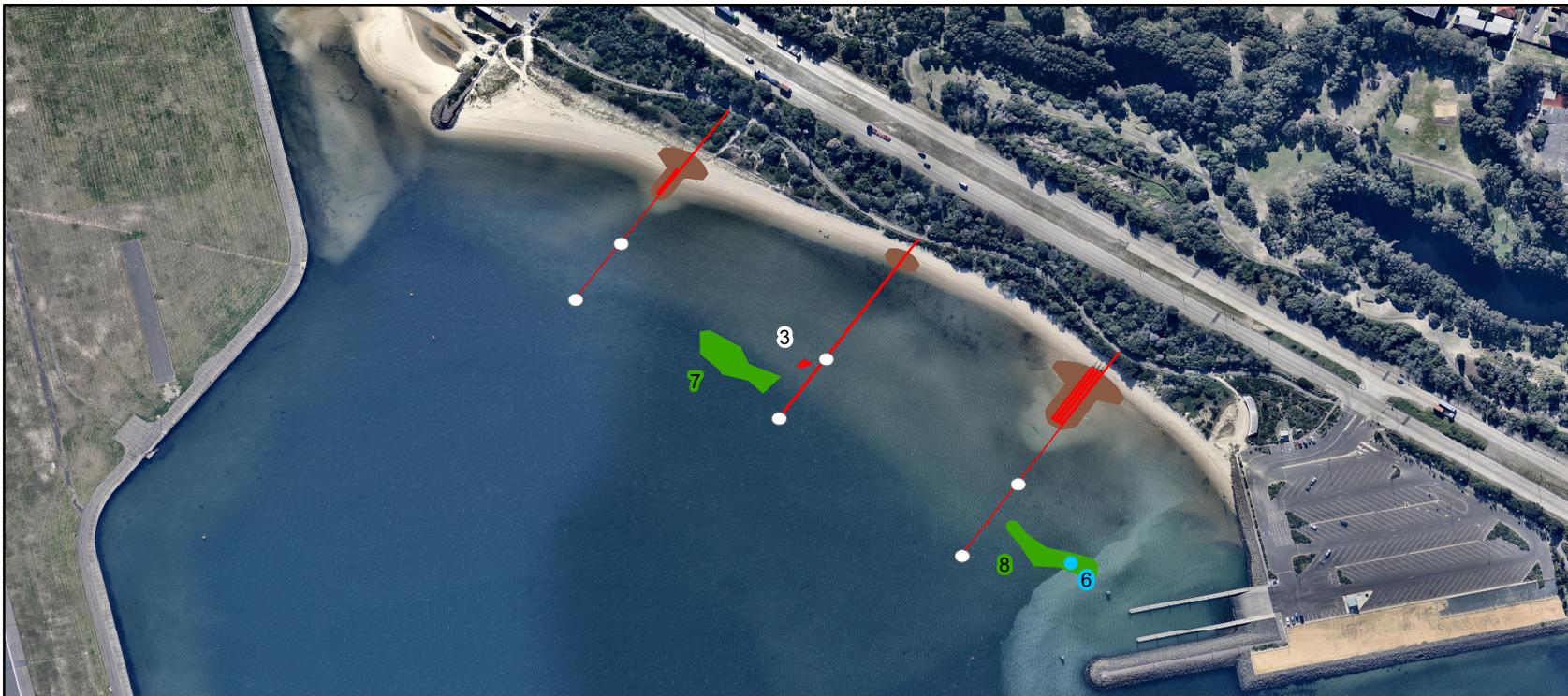
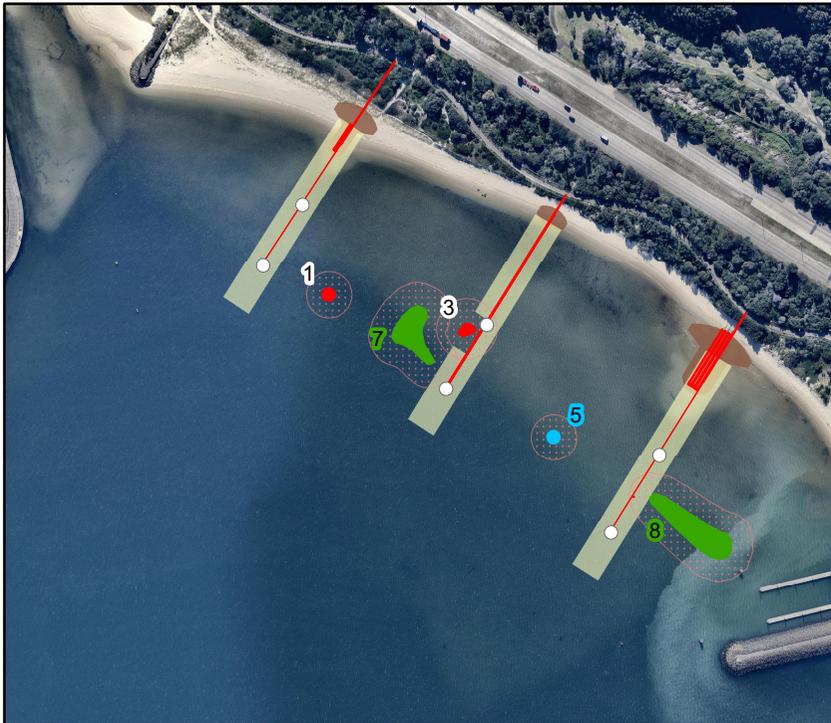


b)



c)

Plate 1: *P. australis* at Patch 3 in June (a), September (b) and December 2016 (c) showing a thick cover of epiphytes



Seagrass Survey - Comparison

PORT BOTANY FORESHORE BEACH

FIGURE 3-1

Comparison of beach seagrass:
 Top Left: June 2016
 Top Right: September 2016
 Bottom: December 2016

Legend

- Navigational Markers
- Groyne Structures
- Rock Armour
- Seagrass**
- Z. capricorni*
- P. australis*
- Halophila spp.*
- Buffers**
- No Anchoring Area (15m radius)
- Barge Operating Area (20 x 30 m)

Seagrass patch numbers are as indicated on map



1:5,000 Scale at A4



Map Produced by Cardno (NSW/ACT) Pty Ltd (2304)
 Date: 2016-12-23
 Coordinate System: GDA 1994 MGA Zone 56
 Project: 59916193
 Map: 59916193-GS-003-SiteLocation_3 months.mxd 02
 Imagery supplied by Nearmap (July 2016)

3.1.2 *Zostera capricorni*

The patch of *Z. capricorni* (Patch 5) observed in June 2016 was unable to be located in September or December 2016. However, a patch (Patch 6) that was found in September 2016 close to the ramp, and away from the area of construction was again observed during the December 2016 survey with an area of 4 m² (Figure 3-1).

3.1.3 *Halophila* spp.

A check in the field of the locations of the edges of patches of *Halophila* spp. at Foreshore Beach indicated the extent of *Halophila* spp. (which co-existed with some *Z. capricorni*) at Foreshore Beach in December 2016 appears to be similar to June and September 2016 (Figure 3-1).

Table 3-2 Areas and percent cover of patches of *Halophila* spp. at Foreshore Beach

Patch no.	June 2016	September 2016	December 2016
	Area (m ²)	Area (m ²)	Area (m ²)
7	551.7	551.7	803.3
8	865.9	865.9	696.0

Compared to initial densities in June 2016, the mean density of *Halophila* spp. at Foreshore Beach increased up to five times in September 2016 and further increases were observed in December 2016. There proportional increases in density between September and December 2016 at Foreshore Beach were similar to what was observed at Yarra Bay (Table 3-3). Leaf length at all sites was similar but the cover of epiphytes on *Halophila* spp. at Foreshore Beach in December 2016 (Plate 2) appeared to be similar to that in June 2016 and slightly higher compared to Yarra Bay. Epiphyte cover at Foreshore Beach was generally greater than for Yarra Bay.

As for previous surveys, there was no evidence of the introduced pest alga *Caulerpa taxifolia* at Foreshore Beach.

Table 3-3 Mean shoot density (shoots per 0.25 sq. m quadrat, n=5) of seagrass in morphology monitoring sites at Foreshore Beach in 2015 and 2016 surveys

Shoot Density (per 0.25 m ²)	Jun-16			Sep-16			Dec-16		
P2A (Foreshore Beach)	2.2			10			14.4		
P2B (Foreshore Beach)	2.7			14.8			33.6		
YB1 (Yarra Bay)	ND			2.8			5.7		
YB2 (Yarra Bay)	ND			2.7			6		
Leaf Length (mm)									
P2A (Foreshore Beach)	2.2			2.5			2.1		
P2B (Foreshore Beach)	2.7			2.7			3.3		
YB1 (Yarra Bay)	ND			2.8			3.8		
YB2 (Yarra Bay)	ND			2.7			3.4		
Epiphyte Load (%)	Low	Med	High	Low	Med	High	Low	Med	High
P2A (Foreshore Beach)	22%	78%	0%	36%	2%	61%	26%	68%	6%
P2B (Foreshore Beach)	21%	44%	35%	35%	8%	56%	34%	40%	26%
YB1 (Yarra Bay)	ND	ND	ND	72%	18%	10%	34%	40%	0%
YB2 (Yarra Bay)	ND	ND	ND	66%	24%	10%	72%	28%	0%



a)



b)

Plate 2: Epiphytes on *Halophila* sp. at Foreshore Beach in September 2016 (a) and December 2016 (b)

4 Conclusions and Recommendations

The results of the December 2016 survey indicated that mitigation during construction of the groynes has protected *Halophila* species of seagrass. Patches did not change in size compared to surveys done prior to construction (June 2016) and densities increased typically as expected into the warmer season and as evidenced in the controls. The loss of one small patch of *Z. capricorni* (Patch 5) after June is not considered to be attributed to construction of the groynes given there has been a widespread decline of this species previously at Foreshore Beach.

The disappearance during construction of one small patch of *P. australis* and a 56% decline in area of the other patch are also not considered to be solely attributed to construction of the groynes. Although lower water quality and potential sedimentation from construction may have partly contributed to the decline of *P. australis*, it is more likely to have been mostly a consequence of long-term deterioration in the condition of *P. australis* at Foreshore Beach. The heavy covering of epiphytes in the remnant patches of *P. australis* and *Halophila* spp. in all surveys (i.e. including the survey done prior to construction) is indicative of the generally poor condition of seagrass at Foreshore Beach prior to construction.

No evidence of the introduced pest alga *Caulerpa taxifolia* at Foreshore Beach was found.

5 References

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