&RDVWDO HQJLQHHULQJ WULDO R\VWHU VKHOO IL 3RUW 5LYHU $GHOD

By I R Coghlan and * /XPLDWWL

WRL TR 201 /2 , 2FWREHU 201

UNSW
SYDN

Contents

1

1 Introduction

The Water Research Laboratory (WRL) of the School of Civil and Environmental Engineering at UNSW Sydney was engaged by the Estuary Care Foundation to prepare a desktop coastal engineering assessment for trial oyster shell filled bag structures in Port River, Adelaide.

The Estuary Care Foundation proposes to plant seagrass (relocated from elsewhere in the estuary) just north of Snowdens Beach on the left bank (looking downstream) of Port River (Figure 1.1). Oyster bags are proposed to be installed seaward of transplanted seagrass primarily to attenuate incident wave energy. A secondary objective is to encourage local shellfish to colonise the oyster bags.

A series of 5-10 separate oyster bag structures (alongshore extent 3-5 m) are proposed to be constructed along a 120 m length of shoreline (Figure 1.2). The oyster bags will have the same J H R P H W U \ D V W K R V H G H S O R \ H G E \ 2 F H D Q : D W F K $ X V W U D O L D / W G K NSW.

This desktop coastal engineering assessment was undertaken prior to deployment to assess the stability of the oyster bags for the expected water levels and wave climate (wind and boat waves) at the proposed site. This report summarises the methodologies and outcomes of the desktop assessment.

The assessment is limited to the coastal engineering aspects of the oyster bags, and does not assess other professional engineering aspects, planning and policy issues, liability issues, expected shellfish growth and en71 0 595.32 842.04 n245<</MCID 12>>4842.04The astN >5.32 842m04 re W* n BT /F2 9.

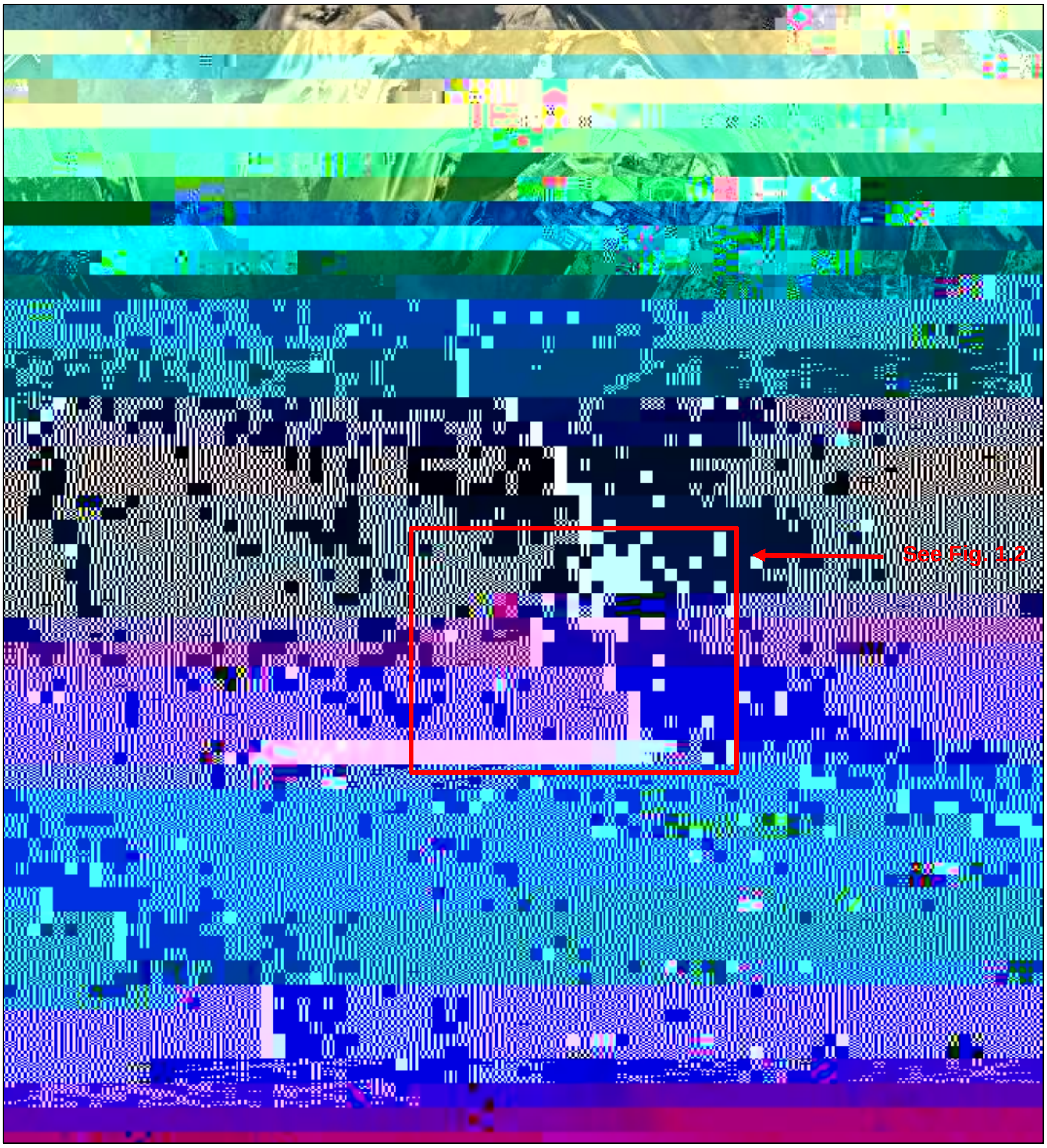


Figure 1.1 Overview of Port River

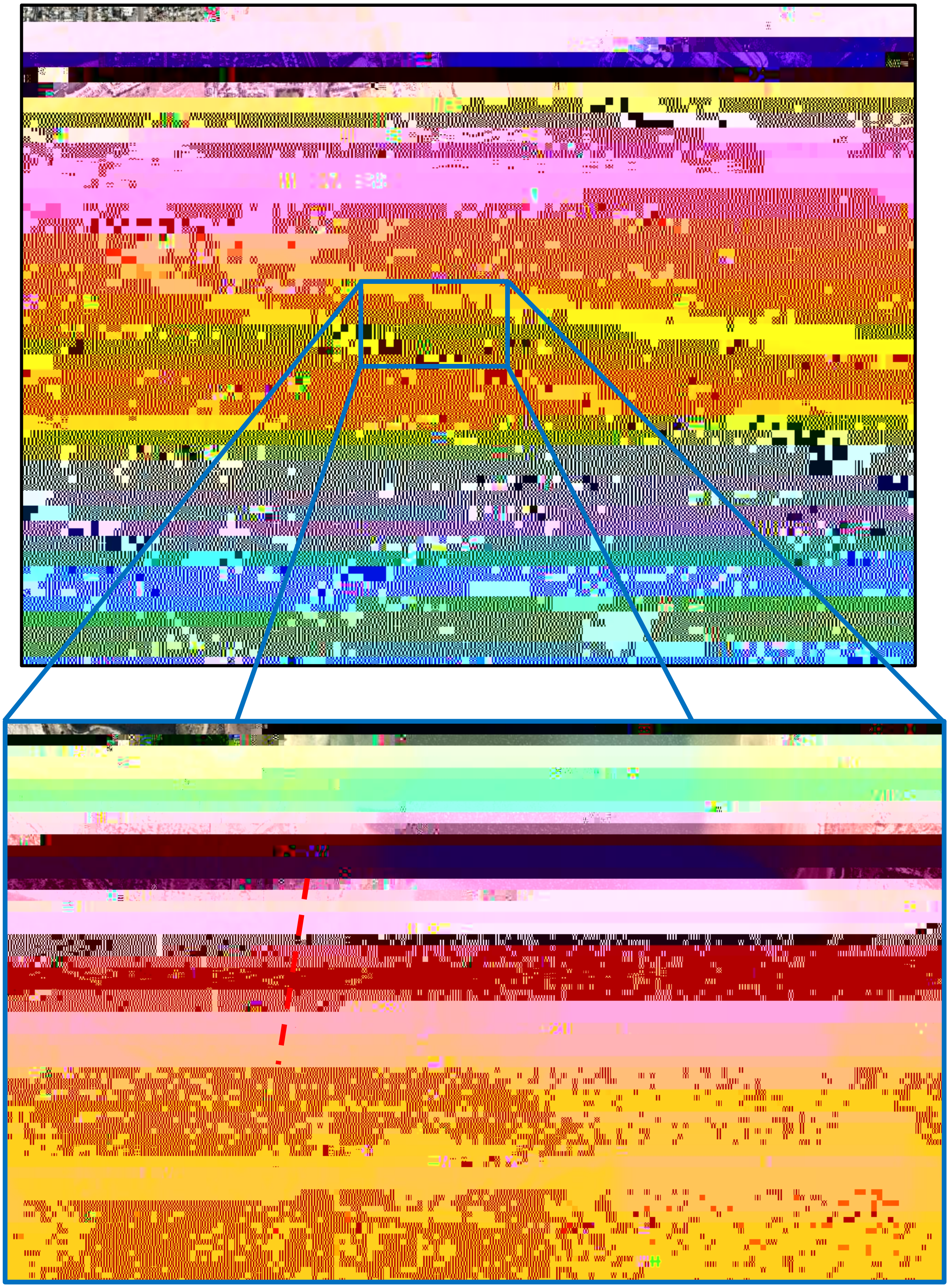


Figure 1.2: Zoomed in views of proposed site for trial oyster bag structures

2 Background information

The oyster shells used to fill the bags were a mix of Sydney rock oyster (Saccostrea glomerata) and Pacific oyster (Crassostrea gigas) shells. The bag material used was coconut coir netting with 12 mm × 12 mm aperture with seams sewn with Manila rope. Two single bags, one double bag and one triple bag (Figure 2.2) were assembled. Each bag was measured and weighed (dry) prior to testing. Key measurements are summarised in Table 2.2.

Figure 2.2 Example of triple oyster shell filled bag tested in the physical model

Bag #	Bag Type	Mass (kg)	Length (m)	Height (m)	Width (m)	Bulk Volume (m^3)	Dry Bulk Density (kg/m^3)	Porosity (%)
1	Single	12.84	0.92	0.17	0.32	0.039	327	0.82
2	Single	14.91	0.94	0.18	0.32	0.041	361	0.80
3	Double	30.25	0.91	0.20	0.27	0.070	430	0.76

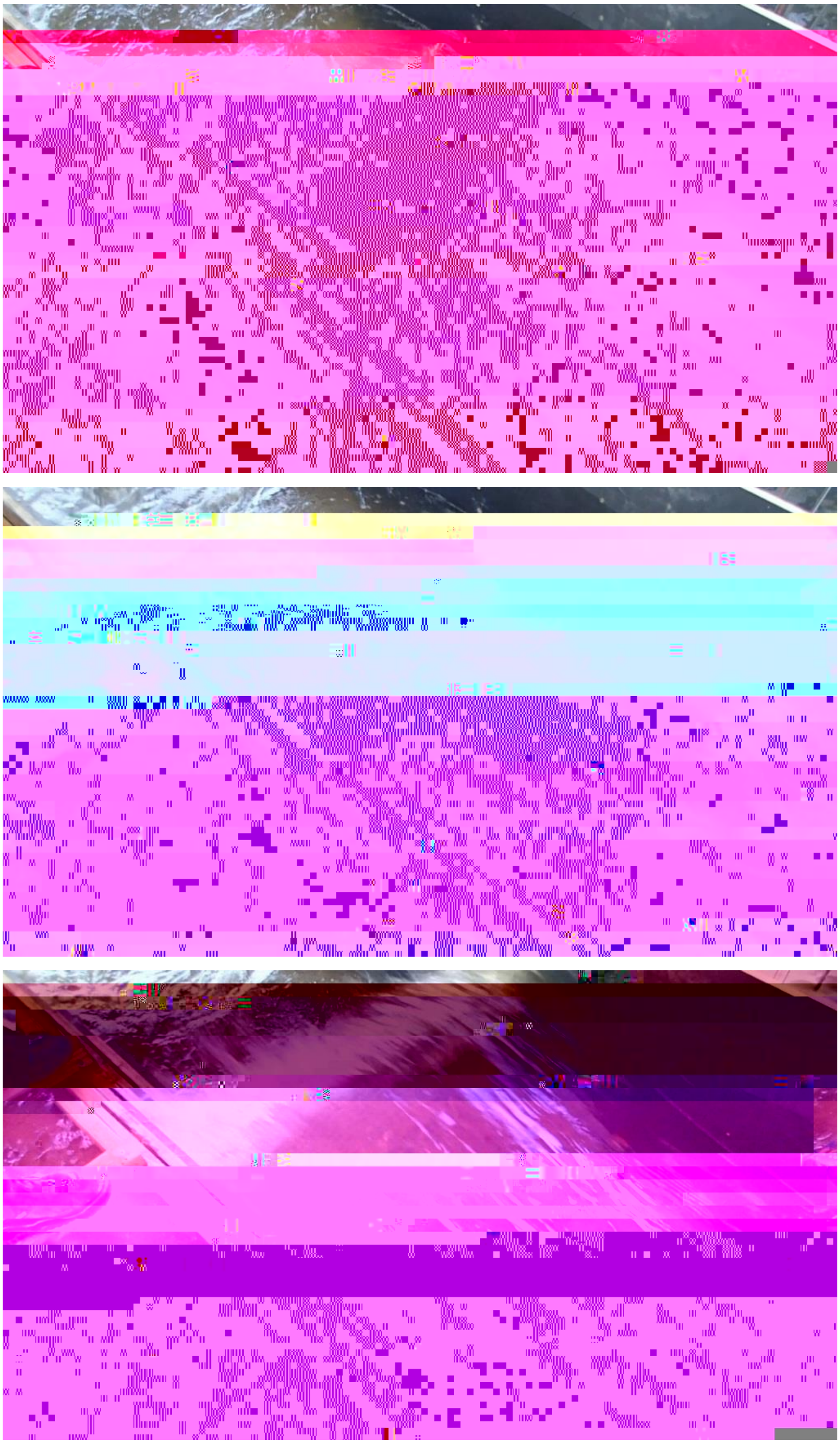


Figure 2.3 Example photographs of wave attack on oyster shell filled bags during Phase 2

Note ±Waves are travelling from right to left

Pilot field t ˙ ˙ ´oyster bag longevity)

ThH ORQJHYLW\ DQG GXUDELOLW\ RI WKH EDJ PDWHULDO LV RXWVL understands that fields trials in NSW undertaken by OceanWatch found an average oyster shell filled bag life of 12-16 months prior to degradation of the bag material itself depending on the substrate (e.g. mud, sand, rock) and material composure (e.g. shellfish species, sharpness of shell edges, dry bulk density) inside the bags (Rowe, S., 2018, personal communication, 3 August).

As such, the nominal design life for th

3 Preliminary wave and water level design conditions

3.1 Long period ocean swell waves

Large ocean swells do not penetrate into the Port River upstream to the proposed site, therefore, they were not considered in this assessment.

3.2 Short period wind generated waves

3.2.1 Preamble

Wind wave heights were estimated using the principles of USACE Coastal Engineering Manual (2006), Part II Coastal Hydrodynamics as described below.

3.2.2 Design wind speed

Annual wind roses for Adelaide Airport (approximately 15 km south of the proposed site) from the Bureau of Meteorology are shown in Appendix A. While it is outside the scope of works, data from this site could be used to derive seasonal design wind speeds or regional wind velocities for average recurrence intervals (ARI) less than 1 year (e.g. 1 month or 6 month ARI).

Rather than using the data from Adelaide Airport, it was preferable to estimate the wind conditions which generate wind waves using the design wind velocities for Australia excluding tornadoes set out in Australian Standard 1170.2 (2011). Design wind velocities (0.2 second gust, 10 m elevation) applicable to the present coastal engineering assessment (Port River falls within Region A1) are given for average recurrence intervals of 1 to 100 years in Table 3.1. Site wind speeds $(V_{sit,\beta})$ are calculated according to Equation 3.1 using multipliers for direc480.94og(

Direction (approximate)	Fetch Bearing (degree TN)	Fetch Length (m)
NNE	26	951
S	174	808

Table 3.4 Wind wave fetch characteristics

Figure 3.1 Location of adopted wind wave fetches

Wind waves generated by winds blowing along the Port River are the result of sustained winds rather than extreme gusts. Therefore, the equivalent sustained 20 minute wind speeds were calculated using the approach set out in Figure II-2-1 of Part II of the USACE Coastal EnET Q.32 n /F2 9.96 Tf 1

3.3 Boat waves

As a boat travels through the water, it generates a series of waves. The height and period of these waves vary depending on boat type and its speed. Table 3.7 summarises the primary parameters used to calculate the maximum height of waves generated by boats and large ships navigating through the Port River channel adjacent to the proposed location of the trial oyster bag structures. Boat/ship waves were calculated based on five main equations provided by Kriebel and Seelig (2005) and reproduced in Appendix C.

Primary Input Parameters	Abbreviations	Units
Boat Length	L	m
Boat Draft	D	m
Boat Speed	V	m/s
Water Depth	d	m
Sailing Line Distance	y	m
Beam (width of the hull)	B	m
Displacement		

The Estuary Care Foundation and Flinders Ports indicated that the following boats/ships pass the proposed location of the trial oyster bag structures:

- MV Accolade II (regular operator in Port River);
- Stadacona (occasional operator in Port River);
- California Highway (occasional operator in Port River);
- Commercial tugs (4 tugs owned by Svitzer regularly operating in Port River); and
- Pleasure craft (various public vessels regularly operating in Port River).

Information on the geometry and displacement of each boat/ship was gathered from a range of sources including the Estuary Care Foundation, Flinders Ports, direct communication with vessel owners and reference websites. The values for the boat parameters used to calculate the height of boat generated waves, including boat speed, water depth and distance between the sailing line and the proposed trial oyster bag structures, are summarised in Table 3.8 (see footnotes for information sources).

Description	Water Level (m relative to datum)	
	LAT	AHD
Highest Astronomical Tide (HAT)	2.8	1.348
Mean High Water Springs (MHWS)		

(runoff in Adelaide is largely directed W R W K H 5 L Y H U 7 R U U H Q V W R W K H V R X W K ³ V source of flooding.

While land subsidence is prevalent in Adelaide (City of Port Adelaide Enfield, 2005), it is considered appropriate to exclude land subsidence and sea level rise from the preliminary water level assessment due to the modest desired working life of the trial oyster shell bag structures.

3.5 Processes not considered

Consideration of the influence of the following processes on the stability of the oysters bags was outside the scope of works:

- Tidal currents;

4 Stability of trial oyster bag s proposed site

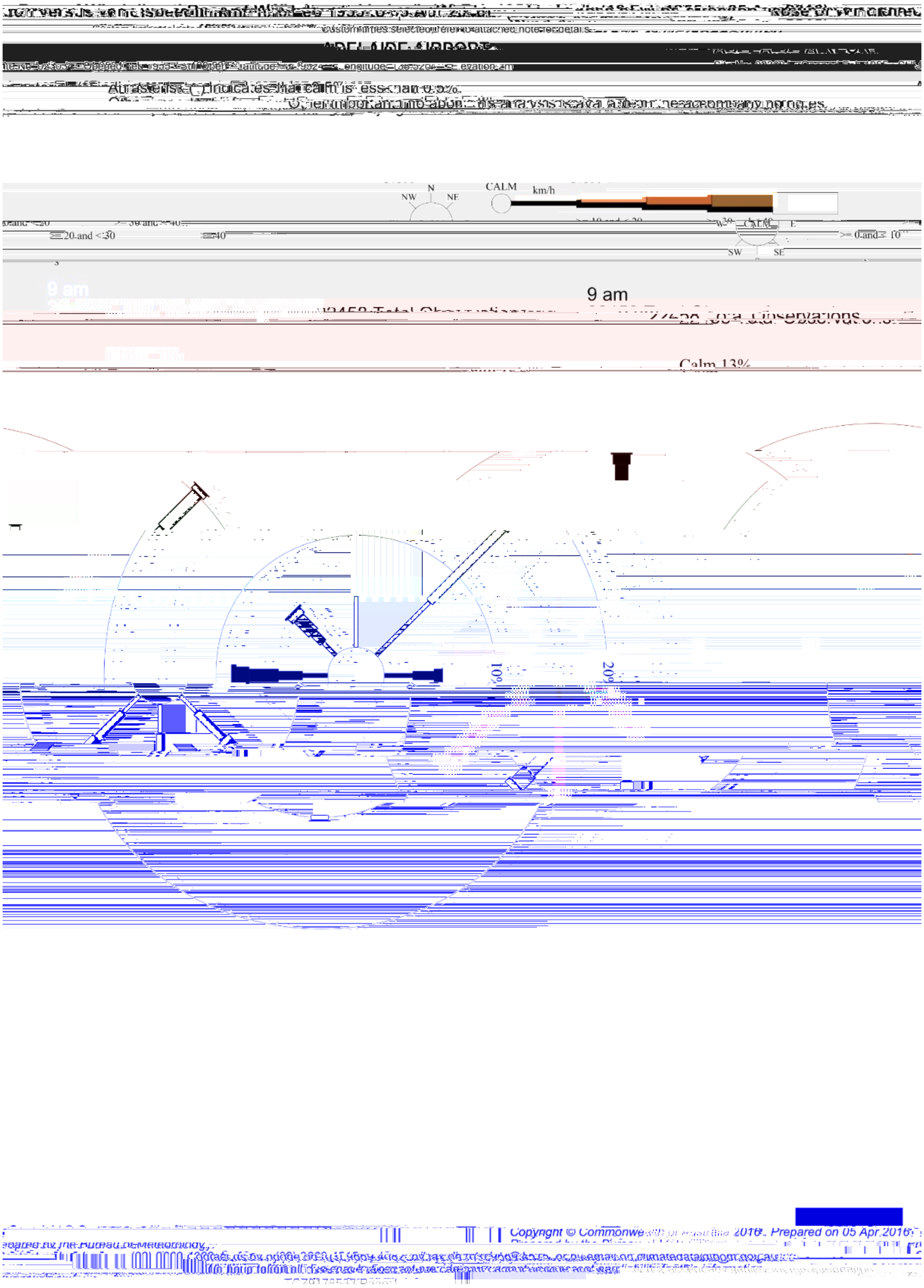
In terms of cross-shore position of the oyster shell bags on the inter-tidal profile, toe elevations to replicate conditions tested in the wave flume are set out in Table 4.1 for 1, 2 and 3 tier oyster bag structure arrangements. With this cross-shore position, depth limited waves exceeding that tested in the flume could only occur for water levels exceeding the Mean High Water Springs level (2.3 m LAT; 0.85 m AHD) coincident with wind or boat waves exceeding 0.3 m in height.

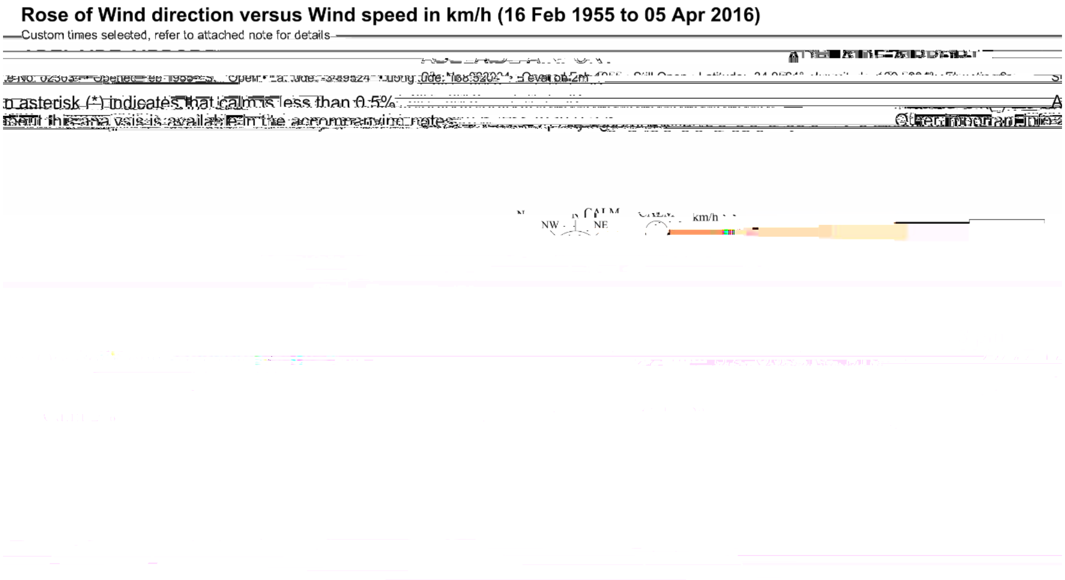
Oyster Bag Structure Type	Minimum Toe Elevation (m relative to datum)

5 Future research opportunities

If the Estuary Care Foundation intends to increase the present level of understanding of coastal engineering aspects of oyster shell filled bags, two opportunities for future research have been identified by WRL. Cross-sectional monitoring surveys could be undertaken seaward and landward of the trial oyster shell filled bag structures and at another control location nearby with similar wave exposure and sediment composition. The deployment of a wave gauge and/or an imaging system, which is able to accurately measure waves with relatively small heights and periods just offshore of the oyster shell filled bags, would also assist in performance monitoring and verification of the desktop wind wave and boat generated wave climate estimates.

Appendix A BoM wind rose plots for Adelaide Airport




Rose of Wind direction versus Wind speed in km/h (16 Feb 1955 to 05 Apr 2016)
Custom times selected, refer to attached note for details
asterisk (*) indicates that calm is less than 0.5%

Appendix B Equations for estimating wind wave heights

Wind waves were calculated based on four equations from the Coastal Engineering Manual (Equation II-2-36: USACE, 2006) and reproduced as Equations B.1 to B.4.

$$\frac{gH_{m0}}{u_*^2} = 4.13\times10^{-2}\left(\frac{gX}{u_*^2}\right)^{1/2}$$

Appendix C Equations for estimating boat wave heights

Boat/ship waves were calculated based on five main equations provided by Kriebel and Seelig (2005) and reproduced as Equations C.1 to C.5.

% Ö L Ï ——— (C.1)

= L t ä u w s F % Ö ; (C.2)

(Û L (Å ‡ š 1 = — † p L ——— ¥ C . ‡ š 1 = — † p (C.3)

Ú L s E z Û P = D 7 : r ä v w — · · Ø p F t ; ; (C.4)

C * / 8 6 L Ú : (Û F r ä s ; 6 @ U ? 5 7 · A (C.5)

Where:

C b = Block c