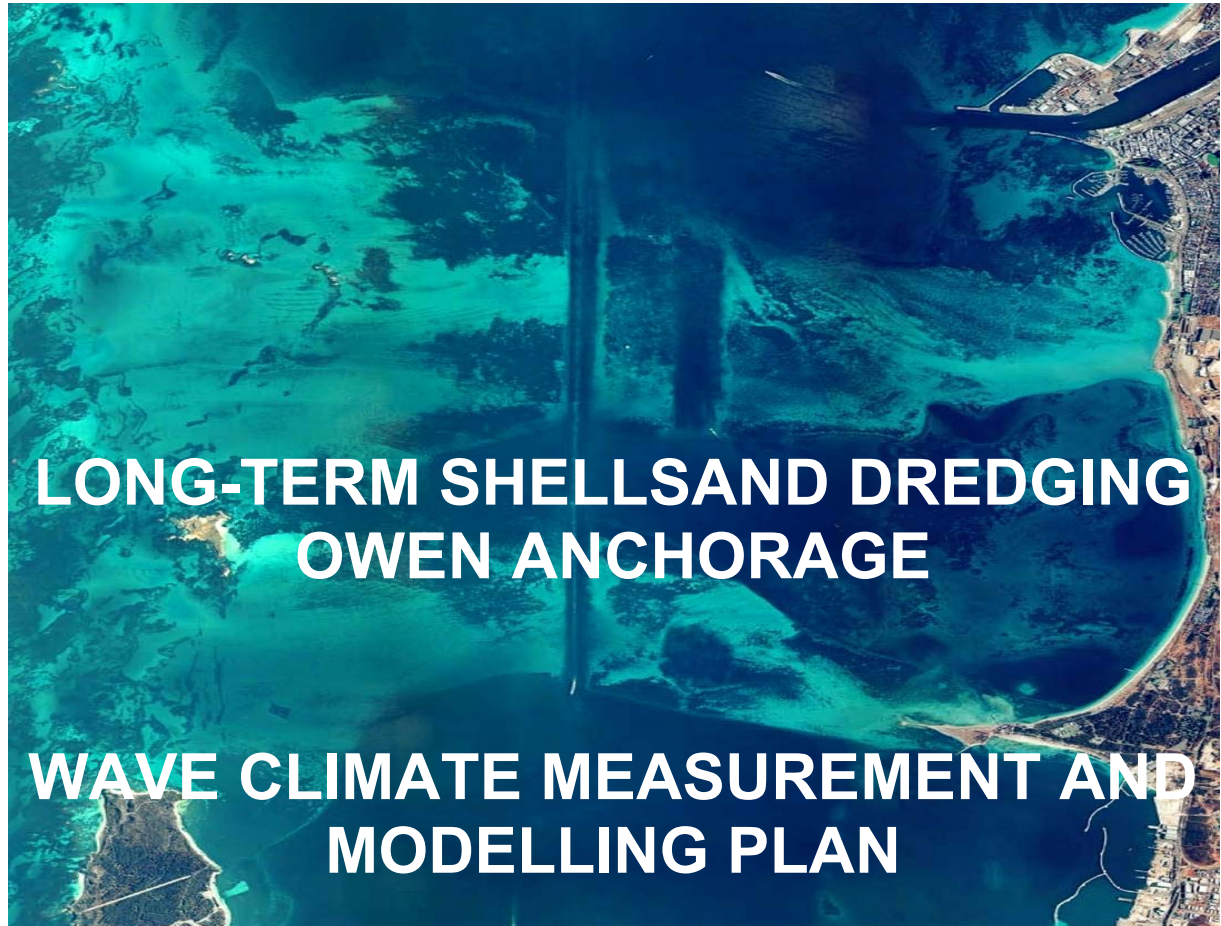




COCKBURN CEMENT



**LONG-TERM SHELLSAND DREDGING
OWEN ANCHORAGE**

**WAVE CLIMATE MEASUREMENT AND
MODELLING PLAN**

**CHAPTER SEVEN OF DOCUMENT:
LONG-TERM SHELLSAND DREDGING, OWEN ANCHORAGE
ENVIRONMENTAL MANAGEMENT PROGRAMME**



JUNE 2003

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**WAVE CLIMATE MEASUREMENT AND
MODELLING PLAN**

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1. INTRODUCTION

1.1 THIS DOCUMENT: WAVE CLIMATE MEASUREMENT AND MODELLING PLAN (WCMMP) FOR OWEN ANCHORAGE AND COCKBURN SOUND

Cockburn Cement Limited (Cockburn) submits this Wave Climate Measurement and Modelling Plan (WCMMP) for Owen Anchorage and Cockburn Sound in accordance with the Statement from the Minister for the Environment and Heritage (Statement 000599) that was issued on 8 July 2002, and which provided approval for the Long-Term Shellsand Dredging, Owen Anchorage.

1.2 LONG-TERM SHELLSAND DREDGING, OWEN ANCHORAGE

Cockburn Cement Limited (Cockburn) dredges shellsand from Success Bank and Parmelia Banks, Owen Anchorage, Australia. Shellsand is primarily calcium carbonate used in the production of lime and cement.

Cockburn's Long-Term Shellsand Proposal, which was approved on 8 July 2002, (Ministerial Statement 599) consists of two stages shown in Figure 1.1. Stage One involves the completion of two 350 m wide shipping channels through Success and Parmelia Banks, as well as the removal of some high grade shellsand from between the channels both on Success Bank and Parmelia Bank. Stage One dredging will involve the loss of 53 ha of seagrass, of which 40 ha is in the alignment of the two shipping channels, and 13ha is from areas to be dredged from between the two shipping channels. Stage One will be completed in eight years (i.e. by mid 2010) after which dredging will be relocated to the Stage Two area which is free of seagrass.

1.3 MINISTERIAL CONDITIONS: LONG-TERM SHELLSAND DREDGING, OWEN ANCHORAGE

A series of Ministerial Conditions have been imposed on Cockburn as part of the approval for its Long-Term dredging proposals. Included in these is Condition 2.1 that states that, "The proponent shall implement the environmental management commitments documented in schedules 2 and 3 of this statement". Schedule 2 contains a commitment by Cockburn, to prepare and then implement a Wave Climate Measurement and Monitoring Plan for Cockburn Sound and Owen Anchorage. The details of these commitments are shown in Table 1.1 below.

To meet this commitment, Cockburn has prepared this WCMMP for Owen Anchorage and Cockburn Sound.

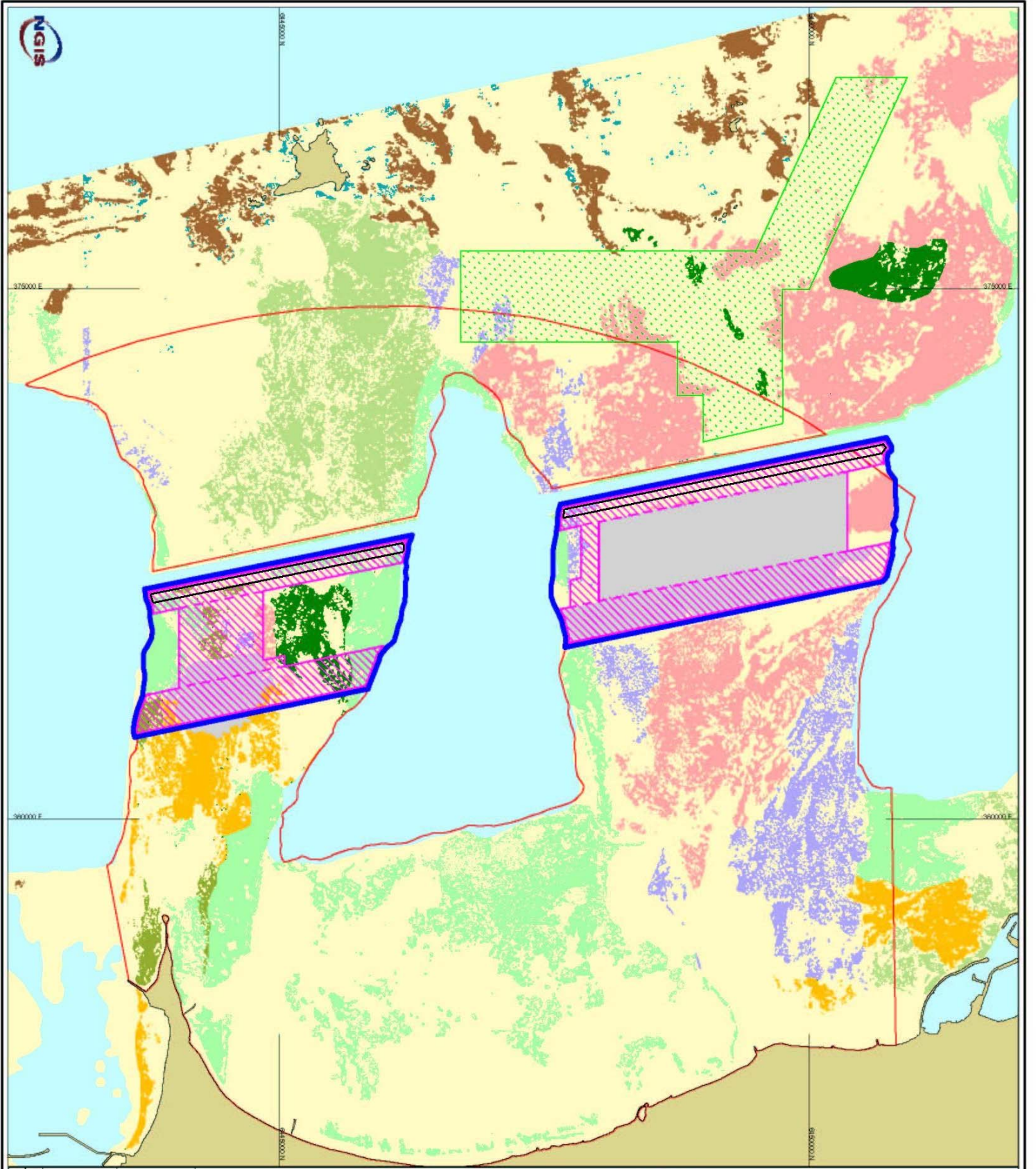
Table 1.1 Commitment by proponent to implement a Wave Climate Measurement and Modelling Plan for Cockburn Sound and Owen Anchorage

<p>599:P1 Wave Climate Measurement and Modelling Plan - Preparation</p>	<p><u>Action</u> Prepare a Wave Climate Measurement and Modelling Plan for Owen Anchorage and Cockburn Sound. <u>How</u> Address: 1) Measurement of wave climate 2) Validation/modification of model used to forecast changes in wave climate due to dredging. <u>Objective</u> to: •Determine changes in wave climate due to previous dredging (validate model); Forecast changes in wave climate due to proposed dredging, using validated model; and •Determine effects of changes in wave climate on shipping, coastal structures, and shoreline stability. <u>Evidence</u> Wave Climate Measurement and Modelling Plan.</p>	<p>Operations Complete by 1/3/03</p>	<p>FPA DPI</p>
<p>599:P2 Wave Climate Measurement and Modelling Plan - Implementation</p>	<p><u>Action</u> Implement the Wave Climate Measurement and Modelling Plan referred to in P1 <u>Evidence</u> As required by M5.1.</p>	<p>Operations Complete first measurement and modelling program within 24 months of commencement of long term dredging; and •repeat each five years, or more frequently if required</p>	<p>EPA FPA DPI</p>

1.4 IMPLEMENTATION OF WCMMP

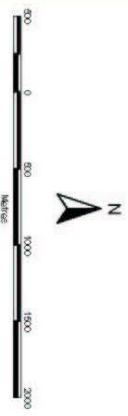
The WCMMP that is presented is scheduled for implementation over the three years, 2003, 2004 and 2005. Wave climate measurements are proposed to be undertaken in the winter of 2003 (period of greatest storms) and in summer in early 2004 (period of strongest sea breeze). The detailed numerical modelling will occur in the latter part of the year 2004, and an interpretive report prepared by early 2005.

The results of the WCMMP will be combined with additional information being collected by Cockburn (such as from its Shoreline Monitoring Plan) as well as from other available sources to prepare a regional Banks and Shoreline Protection Management Plan (BSPMP) by 1 March 2005.



Legend

- Amphibolis griffithii* and *Posidonia coriacea*
- Amphibolis griffithii*
- Amphibolis griffithii*, *Amphibolis antarctica*, *Posidonia coriacea*, *Posidonia sinuosa*, and *Posidonia australis*
- Posidonia australis*
- Posidonia coriacea*
- Posidonia sinuosa* and *Posidonia australis*
- Posidonia sinuosa*
- Reef
- Sand
- Unclassified seagrass
- Dredged
- Unmapped
- State Agreement Ad boundary
- Seaway Boundary
- FREMANTLE PORT AUTHORITY BUFFER ZONE
- STAGE 1: DUAL CHANNEL PROPOSAL (Yr 0-8)
- STAGE 2: WEST SUCCESS BANK



Scale 1 : 35 000
WGS84/UTM Z50 Coordinates



Long-Term Shellsand Dredging
Stage One: Dual Channel
Stage Two: West Success Bank

DRAWING NO: Date: 14/5/2002 FIGURE 1.1
per: [Signature]

2. WAVE CLIMATE MEASUREMENT AND MODELLING PLAN

2.1 BACKGROUND

2.1.1 *Initial wave climate measurement and modelling*

In 1994 Cockburn submitted a proposal for the dredging of shellsand on Success Bank, Owen Anchorage, Western Australia in an area east of the existing FPA shipping channel. The areas proposed for dredging were known as the Short-Term and Medium-Term areas (see Figure 2.1). Approval for the Short-Term dredging was provided but access to the Medium-Term area was contingent on a number of factors, including the requirement for Cockburn to demonstrate that the dredging of the Medium-Term area would have no adverse effects on the wave climate of the region, assessed by sediment transport, beach stability, integrity of coastal structures, and coastal navigation (EPA, 1996).

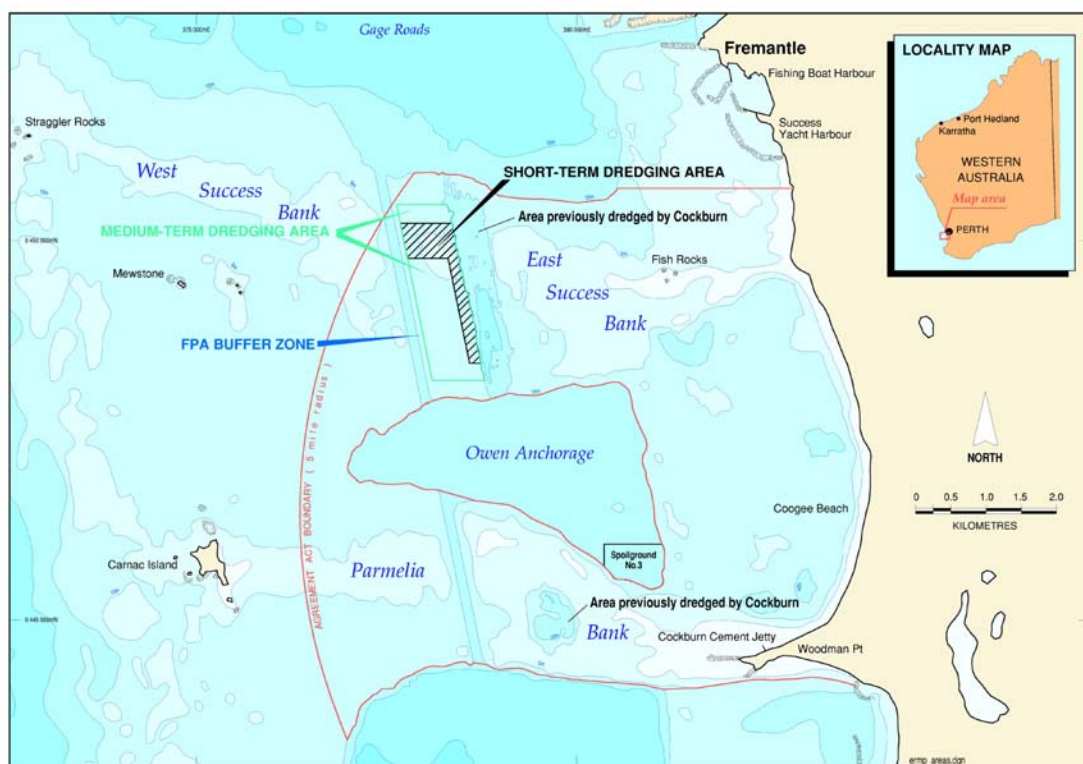


Figure 2.1 Success and Parmelia Banks, Owen Anchorage – boundaries of Cement Works Agreement Act, and areas dredged

Cockburn undertook this work through a programme of measurement of wave characteristics undertaken in 1994 and 1995 followed by the development of appropriate numerical models to represent propagation of waves and wave energy in the region.

Wave measurements were taken in deep water offshore and south west of Rottnest Island, and on the eastern side of Success Bank (MRA, 1995b) during both winter and summer. A sophisticated spectral wave prediction model (2GWave) was validated using this field information, and used to predict the effects of the proposed Medium-Term dredging. The effects were shown to be very minor; and principally occurring at the site of dredging. Based on wave climate considerations, dredging of the Medium-Term area was considered acceptable, and ultimately, approval for the Medium-Term dredging was provided (EPA, 1998).

2.1.2 Use of 2GWave Model to assess effects of proposed seaway

The next main use of this model occurred to support Cockburn's proposal for the Long-Term dredging of shellsand from Owen Anchorage, where Stage One of this proposal consisted of the dredging of a 1.5km wide Seaway through these Banks. This proposal was submitted to government in as an Environmental Review and Management Programme (ERMP) in November 2000 (Cockburn, 2000).

The 2GWave Model was used to assess the influence of this dredge configuration on Owen Anchorage and Cockburn Sound. It was recognised that the proposed Seaway configuration will alter wave climate over an area larger than that dredged, and that under certain conditions, a greater amount of wave energy will penetrate into Cockburn Sound.

The full conclusions from this modelling and interpretation are reproduced below (Table 2.1).

Table 2.1 *Effects on Wave Climate of Dredging 1500m wide Seaway through Success and Parmelia Banks (Cockburn, 2000)*

1.	For swell and sea breeze the proposed dredging programmes are predicted to have a small effect on the wave conditions within Owen Anchorage and Cockburn Sound. Most changes are localised to the dredge areas and along the banks of the surrounding dredge areas. The exception is the swell direction which is predicted to change by 5 to 20° in Owen Anchorage and through to the southern extent of Cockburn Sound.
2.	For moderate winter storm and severe storm events it is predicted that a small change in the wave conditions from the proposed Seaway will be experienced to the southern extent of Cockburn Sound after the completion of the dredging schemes.
3.	The change in wave conditions indicate that the WAPET Groyne and the Jervoise Bay Northern Harbour Northern Breakwater will experience increased wave heights during a design storm of a 30 to 100 year ARI as a result of dredging.
4.	The bank stability of Success and Parmelia Banks will be unaffected by dredging except in localised areas during severe storm events.
5.	The shorelines of Owen Anchorage and Cockburn Sound will undergo gradual reorientation and changes in degree of erosion or accretion. Localised erosion will occur at the Explosives Jetty in Owen Anchorage.
6.	The present programme of shoreline monitoring in Owen Anchorage needs to be expanded to include selected locations in Cockburn Sound.
7.	A programme of wave climate measurement and continuing modelling is also needed to ratify or modify conclusions about changes in wave conditions, and allow mitigative measures to be implemented if required.
8.	A series of management options will be further developed, to allow for mitigation should these forecasts change, or should effects be observed. These options include: modifying the dredge plan to reduce effects; shoreline protection and/or nourishment; and the strengthening of structures. The first of these options is strongly preferred.

In the ERMP, Cockburn recognised the need to continue to investigate the effects of dredging on wave climate and made a commitment to undertake this work.

2.1.3 Modified stage one dredge configuration

Subsequent negotiations with government resulted in a considerable reduction in the area to be dredged as part of Stage One (see Figure 1.1). This modification not only included far narrower shipping channels (two 350m wide channels rather than one 1500m channel), but most importantly, also resulted in a significant shallow buffer segment remaining at both the northern and southern ends of both Success and Parmelia Banks. These will act to provide major amelioration to the propagation of wave energy from the proposed Stage One dredge area.

No wave modelling has been undertaken to assess the effects of this reduced dredging configuration.

2.1.4 Elements of WCMMP to meet ministerial commitments

The WCMMP has been designed to meet the Ministerial Commitments required of Cockburn. The WCMMP contains the following elements:

- Confirm/modify the predictions made about the effects of the Short and Medium-Term dredging using an appropriate programme of field measurements;
- Modify the 2GWave model if required;
- Forecast the effects of the modified Stage One dredging proposal;
- Forecast the effects of the modified Stage One plus Stage Two dredging proposal; and
- Contribute to the development of a Banks and Shoreline Protection Management Plan (BSPMP) for Owen Anchorage and Cockburn Sound.

2.2 WAVE MEASUREMENTS

The proposed programme is scheduled for a wave measurement campaign in late winter 2003 (8 weeks deployment in July and August) and the summer of 2004 (4 weeks in January and February). The location of the wave measurement sites are shown on Figure 2.2 and are listed in the table below.

Table 2.2 Location of wave measurement sites

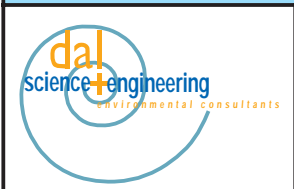
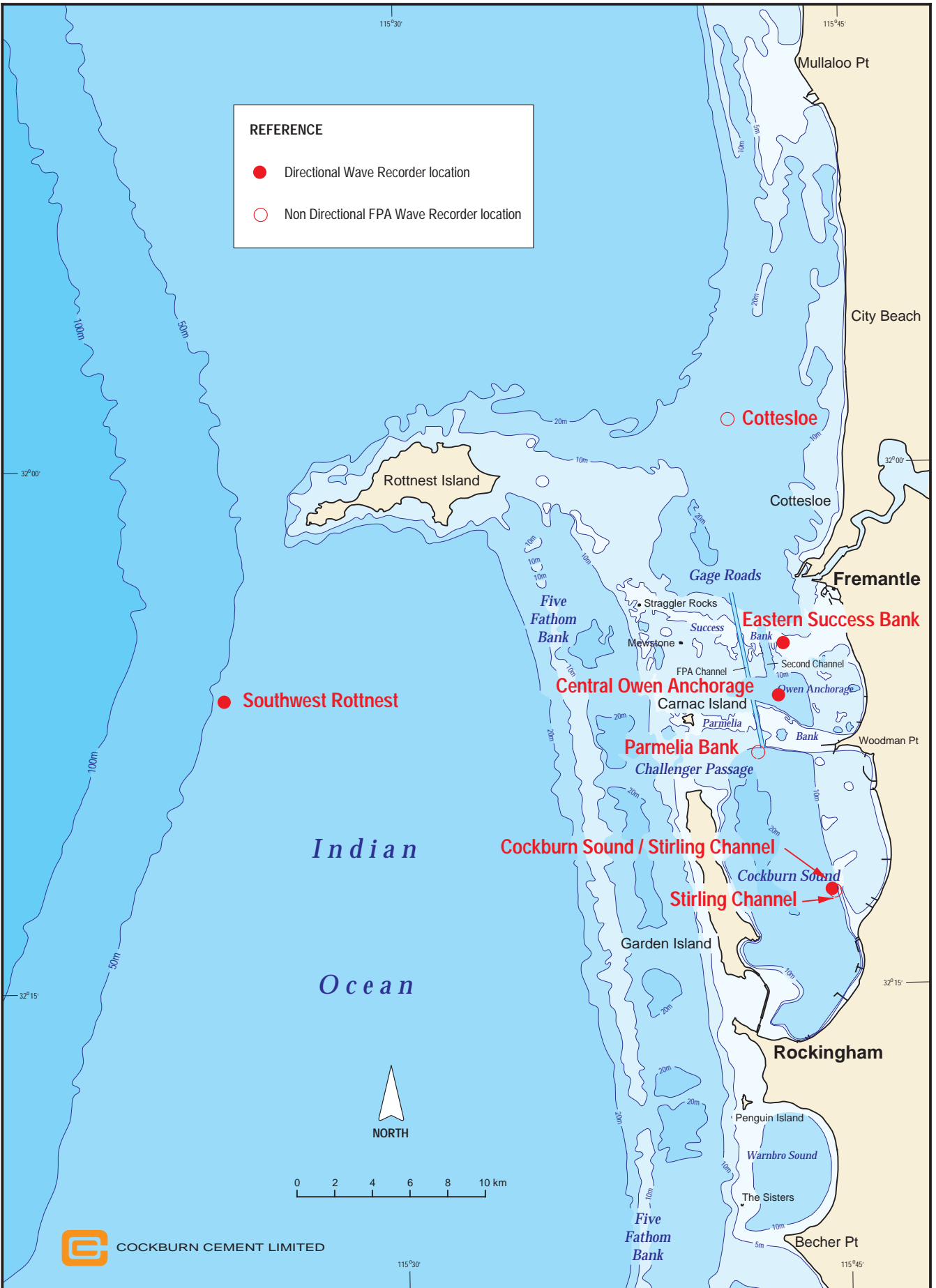
LOCATION & TYPE OF MEASUREMENT	APPROX WATER DEPTH	INSTRUMENT TYPE
Southwest Rottneest (measurements taken by Cockburn)	48 m	Directional wave rider buoy
Offshore of Cottesloe measurements taken by Fremantle Ports	17 m	Non directional wave rider buoy
Eastern part of Success Bank (measurements taken by Cockburn)	3.5 m	Directional wave recorder
Central Owen Anchorage in area of predicted wave direction change (measurements taken by Cockburn)	15 m	Directional wave recorder
Parmelia Bank measurements taken by Fremantle Ports	15m	Non directional wave pole
Stirling Channel/Cockburn Sound in area of possible future wave direction change** (measurements taken by Cockburn)	13 m	Directional wave recorder
Stirling Channel measurements taken by Fremantle Ports	12m	Non directional wave pole

* Original site moved several hundred metres east following discussions with the DEP and DPI

** Original site position in central Cockburn Sound moved to Stirling Channel following discussions with DEP and DPI.

The positions of the Directional wave recorders in Owen Anchorage and Cockburn Sound were decided following discussions with the DEP and DPI. The positions were chosen in order to meet several objectives:

- Establish wave measurement sites where changes in wave amplitude and/or direction due to medium-term and long-term dredging are anticipated, so that wave model predictions can be validated;
- Establish measurement sites in areas which better characterised the wave approach to shorelines where changes in littoral budget may be expected to result from the medium to long-term dredging;
- Establish a new baseline for wave climate at these sites, so that wave measurement at these sites may be repeated for future comparison; and
- To increase the overall utility of the wave climate modelling in relation to littoral drift and shoreline stability issues.



Cockburn Cement Limited
 WAVE CLIMATE MEASUREMENT AND MODELLING PLAN
LOCATION OF WAVE MONITORING SITES

Figure
2.2

2.3 VALIDATION OF THE WAVE MODEL

2.3.1 *Validation using wave measurements*

Based on the wave modelling completed, there is expected to be only minor and localised changes in the nearshore wave conditions as a result of the Short and Medium-Term Dredging. The model has predicted virtually no change at the location of the 1994/95 directional wave measurements on the eastern part of Success Bank and the non-directional measurements offshore of Cottesloe. Cross plots of the Southwest Rottnest and the Success Bank wave heights and directions will be completed for the 1994/95 measurements and the 2003/04 measurements. All of the data will be analysed in this way as well as the data filtered for event type, water level and offshore direction. The statistical parameters from the various plots will be used to confirm that there has been little change in the wave conditions on the eastern portion of Success Bank.

In addition, episodes of swell, storm and sea breeze activity in 2003/04 will be compared to comparable conditions as measured in 1994/95. Time history plots of wave heights, periods and directions will be prepared for the Southwest Rottnest and eastern Success Bank measurements.

These comparisons will be used to verify that the wave conditions have not changed on Eastern Success Bank as a result of the Short and Medium-Term Dredging and that the wave model has accurately predicted the change in wave conditions.

2.3.2 *Validation using wave modelling*

The wave model will be run using the 2003 bathymetry (anticipated to be collected by Cockburn in April 2003) and 1999 seagrass distribution with offshore wave data, winds and water levels from the measurement program and routinely collected by the Fremantle Port Authority, the Department for Planning & Infrastructure and the Bureau of Meteorology. Model runs will be completed for typical swell, winter storm and sea breeze events. The results of the wave model runs will be compared to the nearshore wave measurements at:

- Offshore of Cottesloe (non directional);
- Eastern Success Bank;
- Central Owen Anchorage;
- Parmelia Bank (non directional);
- Central Cockburn Sound;
- Stirling Channel (non directional); and
- Fremantle Port Entrance.

The wave model output of wave height, wave period, wave direction and spectral shape will be compared to the measurements to validate that the wave model is accurately modelling the wave conditions associated with the completion of the Short and Medium-Term Dredging.

2.3.3 *Validation using monitoring of Owen Anchorage shoreline position*

Information collected regularly since 1974 (aerial photography) and some information dating back as far as 1942 on the progressive change in the position of the shoreline of Owen Anchorage indicates that this shoreline has been stable or

accreting. There are two sites along this shoreline which have shown erosion. These are: the southern portion of Quarantine Beach east of Woodman Point, and the beaches either side of Catherine Point. This historical record, coupled with the additional information of nearshore profiles to be collected along the Owen Anchorage shoreline as part of Cockburn's programme of environmental measurements, will be used to validate the models predictions and to identify the dominant causes of these changes in shoreline position, especially relative to the previous and proposed offshore dredging programmes.

2.3.4 *Modification of 2GWave model*

These activities will determine areas where modification and/or improvement is needed with the 2GWave model. Validation will be confirmed with the Environmental Protection Authority prior to the models further application.

3. WAVE MODELLING OF THE STAGE ONE AND STAGE TWO DREDGING

The validated 2GWave model will be used to examine the changes to the nearshore wave conditions that would result from:

- a) The modified Stage One dredging proposal; and
- b) The combined modified Stage One plus Stage Two dredging proposal.

The results of the modelling will be used to examine the effects of these dredging configurations on:

- Bank stability and shoreline stability;
- Shipping movement and navigation; and
- Coastal structures.

4. REPORTING

Comprehensive technical reports will be prepared for each component of the wave measurement and modelling plan. These will include the following items:

- Wave measurements;
- Wave model validation work;
- Wave model enhancement and subsequent validation; and
- Wave model predictions for Stage One and Stage Two Dredging.

Once this work is completed, the results of the WCMMP will be used in the preparation of the BSPMP for Owen Anchorage and Cockburn Sound. This BSPMP needs to be submitted to government by 1 March 2005.

5. REFERENCES

- Cockburn, 2000. *Long-Term Shellsand Dredging, Owen Anchorage. Environmental Review and Management Programme.* Cockburn Cement Limited
- EPA, 1996. *Short-Term Shell-Sand Dredging, Success Bank, Owen Anchorage.* Report and Recommendations of the Environmental Protection Authority, Perth, Western Australia. Bulletin 833
- EPA, 1998a. *Medium-Term Shellsand Dredging, Success Bank, Owen Anchorage.* Report and Recommendations of the Environmental Protection Authority, Perth, Western Australia. Bulletin 901
- MRA, 1995b. *Owen Anchorage Wave Study, Model Set-up, Calibration & Verification, R008 R1,* prepared for Cockburn Cement