



ASSESSMENT REPORT 17

**CULLEN BAY WATERFRONT
ESTATE AND MARINA PROJECT**

**PROPOSED ADDITIONAL DREDGING FROM
THE EMERY POINT SANDBAR**

ENVIRONMENTAL ASSESSMENT REPORT

AND

RECOMMENDATIONS

by the

**ENVIRONMENT PROTECTION UNIT
CONSERVATION COMMISSION OF THE NT**

JANUARY 1993

Figures

1. Emery Point Sandbar
2. Proposed Dredging Plan

Appendix

- A. List of Respondents to the Draft EIS and Summary of comments on the Proposal.
- B. EIS Assessment Report by Port and Harbour Consultants Pty Ltd, Perth. W.A.
- C. Emery Point Sandbar Volumes
- D. Copy of Miscellaneous Licence number 1820.
- E. Thiess Pty. Ltd. Work Procedure for Recording of Dredging Profiles and Verification of Quantities Dredged

TABLE OF CONTENTS

Summary and Recommendations

	<i>page no.</i>
1. Introduction and Background	1
1.1 Environmental Assessment History	1
2. The Proposal	4
2.1 Dredging	4
2.2 Major Issues	6
3. Local Setting	7
3.1 The Emery Point Sandbar	7
3.2 Coastal Processes	8
3.3 Conservation and Recreation Significance	9
4. Environmental Assessment	10
4.1 Project Fill Requirements	10
4.2 Fill Replenishment Needs for the New Beach	11
4.3 Evaluation of Alternative Fill Sources	12
4.4 Adequacy of Existing Knowledge of Coastal Processes	14
4.5 Sand Volume Available for Extraction from the Emery Point Sandbar	17
4.6 Potential Impact of Dredging on the Form and Functions of the Sandbar	17
4.7 Adequacy of the Proposed Monitoring Programs	21
4.8. Other Issues	26
5. Conclusion	27
6. References	29

EXECUTIVE SUMMARY

Introduction

This report assesses the environmental impact of a proposal by Thiess Contractors Pty Ltd to dredge additional sand from the Emery Point Sandbar.

The report reviews the Draft EIS, public comments on the Draft, and the proponent's response to these comments in the Supplement to the Draft EIS. The conclusions and recommendations are based on information and advice provided by Northern Territory Government agencies, an independent assessment of the EIS by Port and Harbour Consultants Pty. Ltd. (Perth, W.A.), and the references cited in Section 6 of the assessment report.

Included in the report is a discussion of the main issues associated with the proposal, in particular the adequacy of the information about the existing environment and coastal processes, and the potential impacts on the physical and biological environment. Recommendations on how adverse effects may be minimised or avoided are also included.

The contents of the report form the basis of advice to the Northern Territory Minister for Conservation on the environmental issues associated with the proposed additional dredging from the Emery Point Sandbar.

Major Issues

The major issues associated with the additional dredging of sand from the Emery Point Sandbar raised during the review of the draft EIS and Supplement are listed below and form the basis of the contents of the assessment report.

- . *Project fill requirements and apparent short fall;*
- . *Fill replenishment needs for the new beach;*
- . *Evaluation of alternative fill sources;*
- . *Adequacy of existing knowledge of coastal processes, particularly:*
 - sedimentation processes*
 - sand budget*
 - source of sand and accretion*
 - wave climate;*
- . *Discrepancy concerning the sand volume available for extraction;*
- . *Potential impact of dredging on the form and functions of the sandbar;*
- . *Potential impact of the proposal on Mindil and Vestey's beaches; and*
- . *Adequacy of the proposed monitoring programs*

Conclusion

The quantity of material proposed to be dredged from the Emery Point Sandbar is relatively small in relation to the overall quantity of sand in the sandbar. It is also clear from further investigations conducted on the sandbar that it is a significantly larger feature than that identified in the 1987 EIS and early modelling tests. It is considered that the current EIS and supporting documentation provides adequate information on the existing coastal environment and functions of the Emery Point Sandbar to allow confident predictions to be made on the potential impacts of additional dredging of the sandbar. This conclusion is supported by Government advisory bodies and the independent assessment.

From the studies undertaken by the proponent, being the best available information on the sandbar and local coastal processes, it is concluded that the form and function of the sandbar would not be altered as a result of additional dredging as described in the EIS. Dredging would not result in any measurable change to waves and currents, and would not alter the supply of sediment or the processes which form and shape the sandbar and adjacent beaches. The proposed dredging should not significantly alter the profile or wave attenuation characteristics of the Emery Point Sandbar.

Natural accretion of the sandbar will continue, however, this rate is not critical to the protective function of the sandbar.

The recommendations in this report concerning the monitoring program and the commitments made by the proponent will ensure that the dredging volumes can be accurately determined and that the form and function of the sandbar will be properly monitored.

The independent assessment by Port and Harbour Consultants Pty. Ltd. concurs with the above conclusion, and considers that the additional dredging "in the form proposed should result in minimum impacts to the sandbar and beach coastal processes and also should maintain cyclone protection currently afforded to the Cullen Bay area".

Port and Harbour Consultants Pty. Ltd. also concluded that the "dredging of the Emery Point Sandbar should be restricted to a maximum quantity of 850,000 m³ within the specified design lines and grades until further monitoring allows better quantitative estimates of the dynamics of the sandbar". The assessment has shown this maximum quantity to be conservative.

Finally, it is concluded that, in general, the proponent has adequately addressed all relevant issues and those comments raised by Government and the public on the Draft EIS.

The Conservation Commission considers that the requirements and objective of the *Environmental Assessment Act 1982* and the Administrative Procedures have been met by the proponent.

Subject to decisions which permit the additional dredging of the Emery Point Sandbar to proceed, the primary recommendation resulting from the Environmental Impact Assessment process is as follows:

- **The proponent is to ensure that the proposal is implemented in accordance with the environmental commitments and safeguards identified in the Proposed Additional Dredging from the Emery Point Sandbar Draft Environmental Impact Statement 1992, or as modified in the Supplement to the Draft EIS.**

It is acknowledged that during detailed implementation of proposals, some flexibility is necessary and desirable to allow for minor and non-substantial changes to the specifications which have been examined as part of this assessment. It is considered that subsequent statutory approvals for this proposal could make provision for such changes, where it can be shown that the changes are not likely to have a significant effect on the environment.

The environmental impact assessment has identified that the following supplementary recommendations concerning the proposal to dredge additional material from the Emery Point Sandbar should also be considered by the approving authority.

1. Cullen Bay Public Beach

- **The proponent should specify the time frame for the annual surveys of the Cullen Bay Public Beach and monitor sand movements for at least one major storm event.**
- **Following the establishment of the Cullen Bay Public Beach, the proponent should assess the likely Beach replenishment costs which would be incurred if the aesthetics of a sandy beach are to be maintained in the long-term.**
- **Prior to dredging the sandbar for the Cullen Bay Public Beach replenishment, specific surveys of the sandbar should be carried out and assessed, to the satisfaction of the Department of Transport and Works, to ensure that the form and function of the sandbar will not be significantly affected.**

2. Monitoring Program

- **Monthly survey reports showing the progressive volumes of material dredged should be made available to the public on request.**

- The proponent should:
 - a) undertake a full clearance survey of the area dredged for the existing dredging operation (approved extraction volume of 300,000 m³ - Miscellaneous Licence 1820) to the satisfaction of the Department of Transport and Works prior to the commencement of any additional dredging; and
 - b) rectify and restore any area where dredging tolerance levels had been exceeded, to the satisfaction of the Department of Transport and Works, prior to the commencement of any additional dredging.

- The proponent should:
 - a) undertake a full clearance survey of the area dredged for the additional dredging operation (volume of 550,000 m³) to the satisfaction of the Department of Transport and Works prior to the decommissioning of the dredge plant; and
 - b) rectify and restore any area where dredging tolerance levels had been exceeded, to the satisfaction of the Department of Transport and Works, prior to the decommissioning of the dredge plant.

- Further dredging of the Emery Point Sandbar should be suspended for 12 months following the extraction of the additional 550,000 m³ of material to allow for investigations to confirm the integrity of the sandbar.

- The proponent should:
 - a) survey the sandbar 12 months after the additional material has been extracted and thereafter re-survey the sandbar each May and October for a period of four years;
 - b) submit the survey results to the Minister for Lands, Housing and Local Government together with an annual explanatory statement by a qualified coastal engineer;
 - c) 12 months after the additional material has been extracted, audit the effects of dredging the sandbar (which would include physical and mathematical modelling to determine the accuracy of predictions concerning the protective function of the sandbar), in accordance with Clause 15 (i) of the Administrative Procedures of the *Environmental Assessment Act*; and prepare and submit an audit report to the Minister for Conservation.

- Turbidity testing should not be made a condition of consent should the dredging be approved.

- **The proponent should prepare and implement an Aerial Surveillance Monitoring Program of the Emery Point Sandbar and Adjacent Beaches in consultation with the Conservation Commission and the Department of Lands and Housing and Local Government, to be implemented prior to the commencement of additional dredging.**

3. Social Issues

- **The proponent should continue to actively consult with the Darwin Sailing Club in relation to dredging activities to ensure that the club is fully informed of the location of dredge and proposed operations.**

1. INTRODUCTION AND BACKGROUND

This report assesses the environmental impact of a proposal by Thiess contractors Pty. Ltd. (the proponent) to dredge additional sand from the Emery Point Sandbar of Fannie Bay, Darwin. **Figure 1** shows the location of the proposal.

The report reviews the Draft EIS, public comments on the Draft, and the proponent's response to these comments in the Supplement to the Draft EIS. The conclusions and recommendations are based on information and advice provided by Northern Territory Government agencies and an independent assessment of the EIS by Port and Harbour Consultants Pty. Ltd. (Perth, W.A.)

Environmental Impact Assessment is predicated on defining those elements of the environment which may be affected by a proposed development, and where possible quantifying the significance, risks and consequences of the potential impacts of the development at a local and regional level.

This report assesses the adequacy of the EIS in achieving the above objectives, and evaluates the undertakings and environmental safeguards proposed by the proponent to mitigate against the potential impacts.

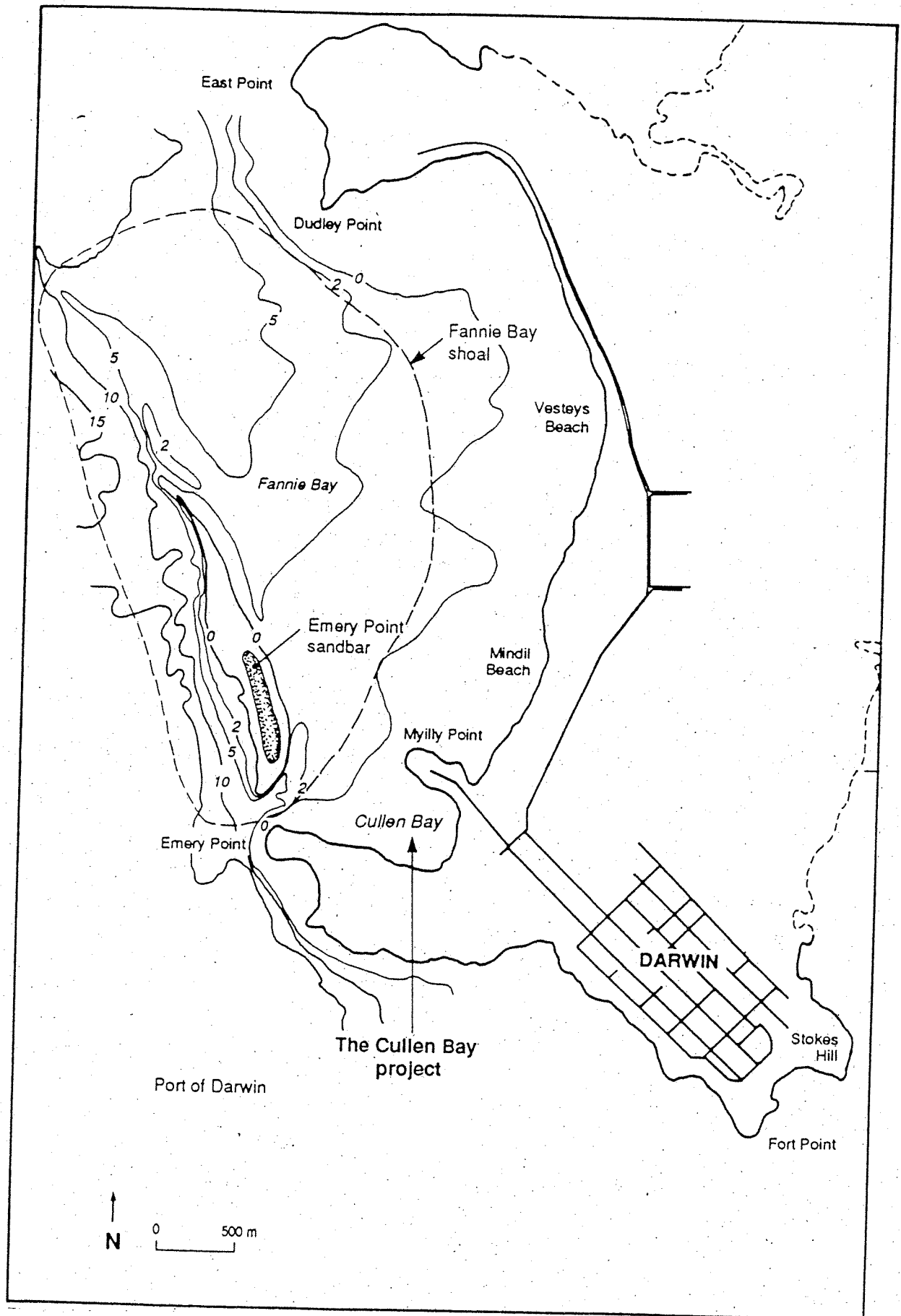
The contents of this report form the basis of advice to the Northern Territory Minister for Conservation on the environmental issues associated with the proposal for additional dredging from the Emery Point Sandbar.

1.1 Environmental Assessment History

In 1987 an EIS for the Cullen Bay Marina Estate was assessed in accordance with the *Environmental Assessment Act* and Administrative Procedures. The Assessment concluded that subject to the adherence of the commitments in the EIS that there was no outstanding environmental issue that would prevent the project from proceeding.

As part of the original proposal a new public beach was proposed to be established to form a barrier to protect the marina from waves and provide residents and the public with an additional recreational amenity. For the surface layer component of the artificial beach, it was proposed to dredge 200,000 m³ of sand in a 450 m long slice from the south west seaward edge of the Emery Point Sandbar. The bulk of the beach section however, was to be created from rock and general fill. The EIS concluded that dredging of up to 400,000 m³ of sand from the sandbar could be extracted from the proposed dredging site with negligible effect on the Mindil Beach wave climate and minimal effects on coastal processes. The EIS also claimed that there was evidence that sand was accreting on the bar at a rate of 50,000 m³ per year.

FIGURE 1: EMERY POINT SANDBAR



Extract from the Draft Environmental Impact Statement
Cullen Bay Waterfront Estate and Marina Project

7. The Licensee shall arrange for a licensed surveyor to survey both the extraction area and the location where the fill is to be deposited to determine the quantity of sand dredged. The survey is also to be carried out half way through the dredging as well as on completion.

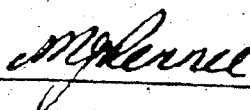
The Licensee will also carry out surveys of both areas at any other times as directed by the Minister administering the *Crown Lands Act*, provided that the interval between surveys is not less than 30 days.

The Licensee shall provide copies of all surveys and reports on quantities of sand dredged, certified by the surveyor, to the Director, Property Client Services within seven days of the completion of the survey.

The Licensee shall maintain continuous records of the quantity of material dredged and shall provide estimates of the quantity sand dredged based upon this information, at least weekly, to the Director, Property Client Services, together with details of profile monitoring and conformity with approved profiles.

8. The Licensee shall comply with all conditions of subdivision consent contained in Instrument of Determination S2131 dated 8 March 1991, as applicable to the land held under this Miscellaneous Licence No 1820.
9. The Licensee shall comply with any direction of the Minister administering the Crown Lands Act or his delegate duly delivered to the Licensee.
10. Notwithstanding any of the above the Licensee shall ensure that the requirements of all relevant authorities are met.

DATED this NINTH day of OCTOBER 1992


MICHAEL JOHN RENNIE
Delegate of the Minister

In relation to the effects of cyclones on the sandbar, the Conservation Commission Assessment Report for Cullen Bay Marina 1988 noted that some concern had been expressed that the dynamic nature of the sandbar had not been sufficiently examined, and indicated that the precise behaviour of the sandbar could not be determined without monitoring a variety of climatic events.

Following a review of certain amendments and additional information on the dredging proposal in January 1991, which included additional extraction of material from the sandbar (net extraction of 300,000 m³), the Conservation Commission was satisfied that 300,000 m³ of sand could be dredged from the sandbar, and concluded that the proposed changes did not constitute a material change in the environmental significance of the proposal.

The Minister for Conservation agreed to allow the extraction of 300,000 m³ following receipt of a Design Report 102 on coastal processes prepared by the proponent in July 1992. The application to dredge up to 300,000 m³ of sand from the Emery Point Sandbar was finally approved by the Department of Lands and Housing on 9 October 1992 under the *Crown Lands Act* - Miscellaneous Licence No. 1820, which licenses the developer to dredge a volume of 300,000 m³ of sand from the Emery Point Sandbar subject to 10 conditions. These conditions incorporate requirements to:

- Carry out dredging in accordance with the approved dredging profile and program.
- Meet the obligations of the Power and Water Authority and the Darwin Port Authority; and
- Monitor the extraction, dredging profiles, and quantity of sand extraction.

The proponent subsequently approached the N.T. Government, with revised estimates on fill requirements for the reclamation works and applied to dredge an additional 550,000 m³ of sand from the Emery Point Sandbar.

Under Clause 9 of the Administrative Procedures of the *Environmental Assessment Act* the Minister of Conservation was notified of this application and determined that the proposed additional dredging constituted a potential material change in the environmental significance of the 1987 EIS, and that the project could have considerable local community concern. Accordingly, the Minister directed the proponent to prepare an EIS for the additional dredging of sand from the Emery Point Sandbar.

Guidelines for the preparation of the EIS were prepared by the Conservation Commission and were published as Appendix A of the Draft EIS. On 13 November 1992 the proponent submitted the Draft EIS to the Minister for Conservation, and placed the document on public exhibition until 11 December 1992.

A total of 21 written submissions were received by the Conservation Commission which included 8 Government and 13 public responses. These were subsequently forwarded to the proponent to be taken into account in the revision of the Draft EIS and preparation of the Supplement. A list of the respondents and their comments on the Draft EIS is summarised at **Appendix A** of this report.

In addition to the above written comments on the Draft EIS, the proposal attracted considerable media and political attention. A petition to the Legislative Assembly, organised by the Cullen Bay Concerned Citizens, gathered 700 signatures against the proposal, and responses to an advertisement in the NT News on 7 December 1992 attracted approximately 40 requests to the Minister for Conservation to refuse further dredging.

The Supplement to the Draft EIS was received on 6 January 1992 and distributed to Northern Territory Government advisory bodies for comment and assessment. These comments are incorporated where relevant in the body of this report.

The Draft EIS and the Supplement were also examined by Port and Harbour Consultants Pty. Ltd. (Perth W.A.), which was contracted by the N.T. Government to provide independent expert comment and technical assessment. A copy of this report is attached at **Appendix B**.

2. THE PROPOSAL

2.1 Dredging

The proposed additional dredging of 550,000 m³ of sand would be taken on the western flank of the Emery Point Sandbar, over a length of approximately 1,100 m (see **Figure 2**). The area to be dredged would be north of the exposed area of the sandbar that is exposed at normal low tides and up to 500 m from the exposed outer edge of the sandbar. The dredge cut would range from 2 m to 6 m into the side of the sandbar.

Sand would be dredged from sea depths down to -23 AHD (the sea depths which are encountered 500 m from the exposed outer edge of the sandbar). The proponent has estimated from surveying the area and modelling wave conditions that approximately 1,700,000 m³ of sand could be obtained from a thin strip on the western flank of the sandbar within the defined dredge area without affecting the sandbar's form and function. The proponent, however, has applied to dredge half that which is available in this area, representing a total of 850,000 m³ (this includes the 300,000 m³ of sand already approved).

Dredging would be undertaken by a suction dredge, with pipe work submerged for the majority of the distance between the sandbar and reclamation areas inside the Cullen Bay Marina development site. Dredged sand would be contained behind established bunds in the reclamation areas.

The limits of dredging on the sandbar would be defined by dredging lines. These lines represent the form and shape of the sandbar which would and must remain after completion of dredging. Dredging would be confined within the dredging lines, with an allowable tolerance of 5m horizontally and 2m vertically. If dredging was carried out beyond the dredging lines in excess of the tolerable limits, the proponent has made a commitment to make good the dredging by filling to restore the sandbar to the dredging lines.



PROJECT
Cullen Bay Waterfront Estate and Marina
Darwin

DATE
22.6.92

SCALE
1:5000

DRG. NO.
CB-CM-13

REVISION

THIESS

Thiess Contractors Pty Limited
ACK 09/20/2018

POSTAL ADDRESS
PO BOX 10123
WARRILLIE NT 0820

TELEPHONE 089 443 241
FACSIMILE 089 443 444

CONSULTANTS
KENHILL RIEDEL & BYRNE
KENHILL ENGINEERS PTY LTD
ADELAIDE BRIDGE AND MARINE CONSULTANTS PTY LTD

APPROVALS
DATE: 12/12/92
REV: 15/92
APPR: [Signature]
DATE: 12/12/92

DESIGNED [Signature]
PROJECT [Signature]
TECHNICAL [Signature]
APPROVED [Signature]

REVISION

NO.	DATE	INITIAL
1	12/12/92	[Signature]
2	15/92	[Signature]

1. CHART DATUM - 1.35m AHD
2. THIS PLAN DEFINES THE EXTENT OF DREDGING ALLOWABLE ON THE SANDBAR AND DREDGING SHALL BE CARRIED OUT BEYOND THE DEFINED LIMITS
3. DREDGING WITHIN THE DEFINED SCALE CORRIDOR IS SUBJECT TO THE PRIOR APPROVAL OF THE POWER AND WATER AUTHORITY, AND THE MAIN CONTRACTOR

COORDINATES ALONG SET OUT LINE		
CHAINAGE	EASTING	NORTHING
00	7185.369	3173.895
100	7150.531	3267.631
200	7115.692	3361.366
300	7080.854	3455.101
400	7046.016	3548.836
500	7011.178	3642.572
600	6976.339	3736.307
700	6941.501	3830.042
800	6906.663	3923.777
900	6871.824	4017.513
1000	6836.986	4111.248
1100	6802.148	4204.983
1200	6767.310	4298.718
1300	6732.471	4392.454
1400	6697.633	4486.189
1500	6662.795	4579.924
1600	6627.957	4673.659

TIDE LEVELS (m AHD)	
HAT	+3.9
MHW	+2.8
MWN	+0.9
NGL	0.0
MLWN	-0.9
MLWS	-2.8
LAT	-4.1

FIGURE 2:
PROPOSED DREDGING PLAN

Extract from the
Supplement to the Draft
Environmental Impact
Statement

Dredging operations would be conducted in such way that the amount of turbidity generated will be minimal.

The proponent has applied to commence the additional dredging immediately after the approved initial dredging operation had been completed, and has estimated that the operation would be completed by the end of July 1992.

2.2 Major Issues

The major issues associated with the additional dredging of sand from the Emery Point Sandbar raised during the review of the draft EIS and Supplement are listed below and form the basis of the contents of the assessment report.

- *Project fill requirements and apparent short fall;*
- *Fill replenishment needs for the new beach;*
- *Evaluation of alternative fill sources;*
- *Adequacy of existing knowledge of coastal processes, particularly:*
 - sedimentation processes*
 - sand budget*
 - source of sand and accretion*
 - wave climate;*
- *Discrepancy concerning the sand volume available for extraction;*
- *Potential impact of dredging on the form and functions of the sandbar;*
- *Potential impact of the proposal on Mindil and Vesteys beaches; and*
- *Adequacy of the proposed monitoring programs*

3. LOCAL SETTING

This section of the report describes the local setting (existing environment) of the area proposed to be dredged and places the project in context with the local and regional environment. For further information on the existing environment the reader is referred to the EIS.

3.1 The Emery Point Sandbar

The volume of the sandbar depends on how the sandbar is defined. **Appendix C** addresses this issue. For the purpose of this proposal and assessment, the sandbar can be defined to extend down to -5 m AHD on the eastern side and down to -30 m AHD on the western side, representing a total volume of 48,780,000 m³.

Analysis of the historical hydrographic surveys by Kinhill Engineers Pty Ltd of the sandbar in the 1992 coastal report indicated the sandbar to have a volume of approximately 3,000,000 m³ above the bed level of Fannie Bay, however, this figure was based on the volume of sand above the line drawn through the sandbar between the RL -5 contour and the RL -14 contour, for the length of the bar from the southern tip to the northern extent of the proposed dredging area. Most of the coastal studies and impact predictions concerning the effects of additional dredging the sandbar have been based on this later figure.

All the evidence available indicates that the sandbar is accreting with time. Sand accretion rates, however, are not precisely known. A comparison of 1936 and 1986 surveys together with information from 1986 and 1991 surveys, which surveyed the southern end of the sandbar, indicate accretion rates of approximately 50,000 m³ per year on the whole of the sandbar.

The movement and accretion of sediment on the sandbar are largely a result of tidal currents, which cause the clockwise circulation of sand around the sandbar. The ebb tides carry sediments from the Darwin Harbour and deposit them along the western side. Subsequent movement of the sediment takes it to the northern end of the sandbar. Flood tides flowing past the western side of the bar cause some movement back into the harbour, but the net movement is believed to be out of the harbour. The flood tides through Fannie Bay move material back along the eastern face. The currents flowing out of Fannie Bay prevent the sandbar from fusing with the headland.

Historical records show the sandbar to be a stable feature governed by the ebb and flooding tidal streams associated with the harbour, and oscillating as a result of weather climatic events. This oscillation is in response to the ambient wave climate and the large tidal currents, producing a net inshore shift during ambient conditions. Whilst under cyclonic conditions there is a significant movement offshore, together with a drop in height and widening of the sandbar.

The Sandbar can be described as a sediment "sink" rather than a "source". The material deposited on the sandbar is primarily composed of broken shell fragments and bryozoans, micro-molluscs, foraminifera, and broken echinoderm tests and spines. This portion represents around 80 to 90% of the sandbar, the remaining portion contains quartz and accessory mica.

The sediments originate from various sources, rather than any single source. Inside Darwin Harbour is believed to be an important source. Areas of shell grit and sand are known elsewhere in the harbour. Movement of sediment out of the harbour is promoted by the tidal stream which scours the main channels in the harbour of all sediment except gravel. As the harbour widens, the effect of the tidal stream diminishes and there is deposition of transported material. Most of the sediment is fine to coarse grained sand and is transported either as a saltation or traction load. The presence of sand waves along the western side of the sandbar indicates this to be the case. Areas of high productivity of shell in the harbour are in the tidal flats, mangroves and rocky shoreline. Further up the harbour the sedimentary rocks erode to produce medium to coarse sand.

According to the proponent, the bulk of the sediment is contributed by the flood tide flowing from north west to south east over the shoals to the west of East Point and into Fannie Bay. Quartz and mica sediments are sourced from the gradual erosion of rocky headlands within the Darwin area.

The Emery Point Sandbar plays an important role in the sand protection of Cullen Bay, Mindil and, to a lesser extent, Vestey's Beaches. The sandbar significantly reduces wave energy as a result of seabed friction and wave breaking. During cyclones the larger waves of the spectrum are broken as they pass over the sandbar, thus reducing their erosive impact on the beaches.

3.2 Coastal Processes

The coastal environment is influenced by the surrounding waters and adjacent land masses, which limit the extent of waves and the propagation of waves approaching Cullen Bay. The wave climate is dominated by locally generated waves in Port Darwin and more distant sea areas in the Beagle Gulf. Waves reaching the Cullen Bay area are attenuated by passage through the Port Darwin inlet and by the narrow channel between Darwin and Cox Peninsula.

The wave climate of the region has been assessed through detailed hindcasting and mathematical modelling. The height of waves generated from distant sources is attenuated to a large extent by the Emery Point Sandbar. At high water levels, the sandbar effectively reduces the height of waves from distant sources by 25%. At low water levels the attenuation is in excess of 75%. Local sea waves generated within Darwin Harbour can still penetrate Cullen Bay from the south of the sandbar and the beaches of Fannie Bay from the north of the sandbar.

Results of studies into the maximum significant wave heights along the coastline indicate that a maximum significant wave height of 6 m can occur in Beagle Gulf at the entrance to Port Darwin. Locally generated waves with shorter period waves can also peak up to 2.9 m during cyclonic conditions. Following the attenuating effects of refraction, shoaling, friction and breaking, these waves are reduced to 2.23 m and 1.27 m respectively. Waves tend to move over the sandbar from west to east, with a southerly bias. Ambient waves move sand over the sandbar, increasing the level at the eastern side.

Sediment transport within the Darwin Harbour environs has been investigated and hypothesised by several researchers. From analysis of historical records, sediment sampling studies, and mathematical modelling of the wave climate, it can be concluded that the beaches are very stable around the harbour. All results indicate very low sediment transport rates along beaches and, although the tidal currents are strong off Fannie Bay and in Port Darwin, the currents in the near-shore area have little influence on sediment transport along the beaches.

Sedimentation processes influencing the Emery Point Sandbar have been discussed above. The main processes that affect sedimentation in the Mindil and Vestey's beaches are storms and creek flow rates. Storms result in the offshore movement of sediment by storm waves, where it can be influenced by strong flood tides. Strong creek flow rates across the beaches can result in the movement of sediment offshore and also result in localised beach erosion. When sand movement occurs offshore from Fannie Bay beaches, the sand can be transported from north to south by the flood tidal stream and moved out into Port Darwin through the gap between the sandbar and Emery Point. The proponent considers this action has contributed to the formation of the Emery Point Sandbar at the southern end of Fannie Bay.

Both the beaches and the sandbar are sediment sinks and are supplied with sediment from similar sources. The sediment interaction is limited due to the tidal stream barrier and the nature of sediment transportation in the area. There is some sediment interaction between the beaches and the sandbar but it is considered limited. Work on foraminiferal fauna indicates that there is some sediment movement and interaction with the sandbar in Fannie Bay. Elements of foraminiferal reef fauna are found in low numbers in the sandbar. Analysis and examination of sediment from the beaches and the sandbar shows the grain size on the sandbar to be considerably larger than found on the beaches. This supports the conclusion that sediment interaction between the sandbar and the beaches is limited.

Absolute values of sand input and loss are not available. The evidence available shows that the sandbar is accreting and that there is a net input of material on the sandbar.

3.3 Conservation and Recreation Significance

The sandbar is not a significant marine habitat. Subject to harsh tidal influences, sediment transport, there are few types of marine organisms found in the sand. In essence, the sandbar is an assemblage of animal remains. Examination of sand dredged from the sandbar shows very little sign of marine life.

The Fannie Bay region includes a number of important marine areas. East Point Reef and Doctors Gully Aquatic Life Reserves are protected by legislation and have significant scientific and social values. East Point Reserve has been described as a fragile community, vulnerable to changes in tides, currents, and nutrient and sedimentation loads.

The foreshore between Bullocky Point northward to Buffalo Creek is on the National Estates Register. The Estate incorporates Vesteys Beach, East Point Reef Aquatic Life Reserve, and Lee Point.

Fannie Bay is probably the main focus of coastal recreation in the Darwin region. Significant recreational use is made of the area in the general vicinity of the Emery Point Sandbar and adjacent beaches. Recreational activities involve boating, skiing, sailing, and swimming. At low tide the Emery Point Sandbar is visited regularly.

4. ENVIRONMENTAL ASSESSMENT

4.1 Project Fill Requirements

The issue of fill requirements for the Cullen Bay Project has concerned both the government and the public. The need for additional dredging, above that identified in the 1987 EIS, resulted in a direction by the Minister for Conservation to require an EIS.

In the 1987 EIS, fill volume available on-site at Cullen Bay was estimated to be 750,000 m³. The construction plan submitted and approved in 1991 revised this estimated down to 514,000 m³. With further survey confirmation and geo-technical studies of the suitability of the fill on-site, the actual fill available on site was re-assessed and reduced by a further 211,000 m³. Therefore, the 1987 preliminary assessment of fill sources and quantities available over-estimated the on-site fill volume by approximately 60%. This significant discrepancy with the initial estimates is of concern and emphasises the necessity for more accurate estimation of fill required and assessment of fill sources by proponents when planning and assessing future coastal developments.

The additional material necessary to displace marine mud is also significant. The science of estimating mud displacement is complex and is not well understood. The additional material required to cater for mud displacement can be significant in relation to total fill requirements.

Shortfalls in the amount of fill available at the identified sources outlined in the 1991 construction plan have occurred in the following areas:

- 198,000 m³ from Lot 4646 due to Government restrictions.

- 81,000 m³ at the site due to confirmation of available material.

- 130,000 m³ at the site due to consolidation.

- 137,000 m³ lost due to construction methodology.

The sum of the total short falls, reductions, and additional material is 546,000 m³.

4.2 Fill Replenishment Needs for the New Beach

Under extreme climatic events the new Cullen Bay Public Beach may lose material offshore. Modelling has indicated that sand taken from the top of the beach would be shifted approximately 125 m offshore of the beach crest, and that some of this material would be transported away from the beach compartment by the strong flood tide currents in the Harbour. It is arguable that in extreme events that most of the sand would be transported into the Harbour. Some of the sand would be resuspended and deposited on the Emery Point Sandbar.

Therefore, it is likely that the Cullen Bay Public Beach will require infrequent replenishment to maintain its amenity. According to the proponent, a cutter suction dredge is often based in Darwin and is readily available. The proponent has stated that beach replenishment would be carried out by retrieving material from the Emery Point sandbar.

In the event that replenishment of the Cullen Bay Public Beach is necessary, under the Development Agreement between the proponent and the Northern Territory, the proponent is required to repair any damage to the beach for a period of 7 years from the date of the agreement. Prior to undertaking any works, the proponent has committed to outline details on the methodology and duration of activities to the Northern Territory Government.

Design Report 102 on Coastal Processes prepared by the proponent commits the proponent to annual surveys of the Beach and analysis of those surveys to establish a management plan for the Beach, which would include beach replenishment procedures (p-27. Design Report 102).

The seawall at the rear of the Beach has been designed to withstand wave action should the Beach be completely eroded by a succession of extreme storms. According to the proponent, the decision to replenish the Beach with sand would be driven by aesthetic reasons rather than stability or safety of the reclaimed area.

Approximately 200,000 m³ of sand is required for the establishment of the Cullen Bay Public Beach. This amount has been incorporated in the total budget of sand required for the completion of the project, and is included in the additional dredging figures.

The proponent has argued that most sand lost from the Cullen Bay Public Beach would be re-deposited on the sandbar. As a result, dredging to replenish the Beach would pick up this sand with no net loss of sand from the system as a result of these activities. This prediction is not considered entirely realistic and there maybe some net loss from the local system, with no net loss of sand from a regional perspective.

It is understood that annual beach surveys are proposed to establish the extent of onshore/offshore sand movements and to provide data for preparation of a beach management plan. The time frame for these surveys, however, has not been specified by the proponent.

Recommendation 1

The proponent should specify the time frame for the annual surveys of the Cullen Bay Public Beach and monitor sand movements for at least one major storm event.

Having established that replenishment of the Cullen Bay Public Beach will be required over time (the frequency and amount of which can not be accurately predicted), the issue is that further dredging of the sandbar will be required in the future. The amount of dredged material is likely to be small, however, the costs could be relatively high. The cost of dredging is related to the proximity of the dredging area to the Cullen Bay Public Beach.

Recommendation 2

Following the establishment of the Cullen Bay Public Beach, the proponent should assess the likely Beach replenishment costs which would be incurred if the aesthetics and recreational purposes of a sandy beach are to be maintained in the long-term.

Allowing for future accretion and that the dredging area in the Draft EIS indicates that there is 1.7 M m³ of sand available for dredging, there appears to be a good supply of sand for beach replenishment purposes. Prior to dredging for replenishment purposes, however, specific surveys of the sandbar would need to be undertaken to ensure that potential accumulative impacts were prevented. Potential accumulative impacts associated with future dredging of the sandbar for the purpose of Beach replenishment is an important issue and is addressed in Section 4.6 of this report.

Recommendation 3

Prior to dredging the sandbar for the Cullen Bay Public Beach replenishment, specific surveys of the sandbar should be carried out and assessed, to the satisfaction of the Department of Transport and Works, to ensure that the form and function of the sandbar will not be significantly affected.

4.3 Evaluation of Alternative Fill Sources

There were many comments relating to the adequacy of the evaluation of the alternative sources available provided in the Draft EIS. In particular, the lack of detail provided by the proponent regarding the economic and environmental costs associated with the alternatives. The proponent has acknowledged this concern and has provided more specific information in the Final EIS.

In summary, the proponent has acknowledged that there are other sources of fill available for the Cullen Bay Project. The sand lease at the Arnhem Highway, approximately 52 km from the GPO, was dismissed by the proponent as a unrealistic option on economic grounds. Likewise, the option of dredging sand from Bynoe Harbour, an alternative option raised by a member of the public, was rejected due to the extremely high costs associated with transportation and dredging of sand.

The Hook Road option has not been approved by Government and, accordingly, is not a realistic option. Nevertheless, the proponent considers that the economics of this option are similar to the proposal to dredge sand from the Emery Point Sandbar.

Lot 4646 , Jolly St location, has already been approved by Government following assessment under the *Environmental Assessment Act*. The approval, however, limited the extraction to 310,000 m³, approximately 200,000 m³ less than the 1991 construction plan allowed for.

The Thirteen Mile Quarry option is considered too costly by the proponent, with an additional cost exceeding \$2M on the sandbar option. According to the EIS, the short-term environmental impacts associated with carting fill from the Thirteen Mile Quarry would be significant in relation to other options. The impact on the road system, dust problems, noise pollution, and the risk of road accident were quoted in the EIS as real issues that had to be taken into account in the evaluation of the alternative fill sources. The proponent has also rejected this option due to the suitability of the material available at the Thirteen Mile Quarry, concluding that it is only marginally suitable.

Alternative marine sources of fill for the marina were also considered in the evaluation of other options. The current dredging program utilises two kilometres of pipeline, requiring one booster pump for this purpose. The proponent has advised that any increase over the limit of two kilometres piping distance would require an additional booster pump station, increasing the cost of dredging by \$4/m³, and would extend the dredging operation duration by approximately 10 weeks. As for the Bynoe Harbour option, the proponent considers that other marine sources would be too costly.

Taking into account the economics, the potential environmental impacts, and the suitability of the fill at the various fill sources, the proponent concluded that the Emery Point dredging option was the preferred alternative and, accordingly, instigated detailed environmental investigations on the potential impacts of dredging the Emery Point Sandbar.

It is concluded that the comparison of the available sources for fill for the Cullen Bay Project has been satisfactorily undertaken by the proponent.

Apart from concerns expressed about the potential impacts on the function of the sandbar, the adequacy of existing knowledge of coastal processes was the main issue raised by respondents to the Draft EIS. A reasonable knowledge of the existing coastal processes is a critical pre-requisite to predict with any accuracy, the potential impacts of dredging 850,000 m³ of sand, with scope to dredge up to 1.7 M m³.

The principal components of the coastal environment that influence the Emery Point Sandbar and adjacent beaches are:

- the local and regional wave climate; and
- sediment transport processes.

Sediment transport processes are subject to the wave climate, tidal influences, and sources and sinks of sediment. A summary of the coastal environment associated with the Emery Point Sandbar has been given in Section 3 of this report.

Matters that were raised by respondents concerning the existing coastal environment included:

- the source of material supplying the sandbar
- the sandbar - beach interaction
- the sand budget for the sandbar
- the basis for the conceptual model
- sand accretion of the sandbar with time
- the protective role of the sandbar
- the stability of the sandbar verses cyclic movement

It is reasonable to assume that the sources of the sandbar originate from various sources both within Darwin Harbour and from the shoals to the west of East Point. Given that between 80 and 90% of the sandbar is carbonate of marine origin, it is also reasonable to conclude that the source is not finite and is constantly being renewed. The rate of renewal is not known.

The nature of the material on the beaches and the sandbar is similar, although it is significantly smaller in size on the beaches. It is reasonable to assume with confidence that the sandbar and the beaches are supplied with material from the same sources, and that sandbar and the beaches are sediment sinks and do not source other areas.

It is concluded that there is some interaction between the beaches and the sandbar, however, this interaction is limited. The sandbar is not a significant source of material for the beaches. If there was significant interaction between the two features it is considered that the grain size would be more similar. The influence of the flood tidal stream between the beaches and the sandbar also represents a significant barrier for sediment interaction.

The proponent has acknowledged that absolute values of sand input and loss are not able to be derived from the available information. However, all evidence indicates that the sandbar has a net input of material, and that the sandbar is accreting with time. The proponent has estimated that the approximately 50,000 m³ of material is accreted each year on the whole of the sandbar. This was determined through the comparison of 1938 and 1986 surveys and by subtracting two large numbers. Although recent surveys have provided consistent estimates, the proponent concludes that the "estimates of accretion rates of the sandbar cannot be confidently predicted" (Issue 46, p-26 - Supplement to the Draft EIS). The proponent believes that the lack of confidence in accretion rates would not in any way affect the potential impact of dredging. From studies undertaken on the function of the sandbar and modelling dredging effects, it was concluded in the Final EIS that "even without any additional replenishment of the sandbar, the removal of the proposed volumes of material by dredging would not affect the overall stability or nature of the sandbar or have any measurable impact on neighbouring beaches" (Issue 46, p-26 - Supplement to the EIS).

The conceptual model of the supply of sediment and its transport has been summarised in the Final EIS (page 11). An extract of this summary is provided below:

- The flood tidal current enters Darwin Harbour on the rising tide, with a flow from north-west to south-east over the shoals to the west of East Point and into Fannie Bay.
- This current is forced over the shoals by the strong momentum of the continuing ebbing tide in the middle of the main channel, even when the waters outside of Darwin Harbour have started to rise.
- Wave and current action moves sand from the comparatively shallow waters to the west of East Point and transfers this sand into Fannie Bay (these sands probably originally came from further to the north-east).
- The sands in Fannie Bay are moved in a clockwise direction to the south, some onto the beach and some onto the sandbar.
- On the western side of the sandbar, the very strong currents from the Harbour ebb tide are responsible for the alignment of the sandbar and the long tail to the north.
- The ebb tide contributes some material eroded from the seabed of the harbour. Other materials originate from the erosion of Emery Point and the movement of that material northward by the ebb currents. However, the bulk of the material probably comes from the north.
- Wave action, particularly during cyclones, is responsible for the east-west movement of the sandbar and for the changes in its height. The normal tidal currents act as a restoring force to return the sandbar to its normal condition.

Port and Harbour Consultants Pty. Ltd. consider that the coastal processes described, particularly in relation to the formation and migration of the Emery Point Sandbar, appear to be logical and correct.

Wave and tidal climate was not raised as an important issue during the review of the Draft EIS as this aspect of coastal processes had been extensively researched by the proponent and, as a result, was well documented in the Draft EIS and supporting documentation. The methods used for wave hindcast and wave transformation are standard techniques and are considered acceptable.

Sediment transport along the Fannie Bay and Darwin coastline has been investigated in a number of studies (ACER - Vaughan consulting Engineers, 1991; Riedel and Bryne Consulting Engineers, 1988; Mitchie, 1988; and Dwyer and Assoc, 1980). The conclusion reached by all studies is that there is only small net littoral drift throughout the year, and that sediment transport rates along the coastline can be considered very small in relation to other coastlines in Australia. Due to a low energy coastline and shallow protected waters, the beach areas around Darwin are very stable.

The main mechanism that can cause loss of beach sediment is storm waves. Storm wave influence results in beach sediment being deposited offshore where it can be influenced by strong flood tides. Under ambient climatic conditions the offshore sand is gradually re-deposited on the beaches.

As discussed earlier, cyclones can also affect the location and form of the sandbar. Examination of historical information shows that cyclonic activity reduces the height of the sandbar but greatly increases its width. The sandbar also shifts to the west and to a lesser extent to the south. Port and Harbour Consultants Pty. Ltd. have commented that the effect of cyclonic conditions on the sandbar has been adequately addressed.

The protective role of the Emery Point Sandbar has been discussed in the previous section. Wave transformation over the sandbar was tested by mathematical and flume (physical) modelling. Wave transformation over the sandbar occurs due to wave breaking and frictional attenuation. The results of the mathematical modelling of waves ranging from 3 to 6 m in height, considered for a 1 in 100 year water level showed that waves were limited to a height of $H = 2.9$ m. The largest significant wave height generated in the physical study was $H_s = 2.4$ m, with the highest single wave equal to $H_{max} = 3.6$ m.

Port and Harbour Consultants Pty Ltd. concluded that, in comparison, the mathematical modelling of the actual situation produced results which were no greater than the design waves estimated by the flume testing, and considered that the waves used in the flume modelling study to design the breakwaters and revetments for the Cullen Bay Marina were valid. Wave attenuation across the Emery Point Sandbar is critical to the whole coastal engineering design of the Cullen Bay Marina. Therefore, it is in the developers interests to ensure that this information is validated. The conclusion by Port and Harbour Consultants Pty. Ltd. supports the wave climate studies undertaken by the proponent and the assessment of the wave attenuating function of the sandbar.

As noted previously, the design significant wave height generated in Beagle Gulf is 6 m from a wave direction of 300 degrees. A 6 m wave is reduced in height significantly as it progresses towards Myilly Point. By the time it reaches the seaward side of the Emery Point Sandbar the wave height is limited to approximately 3.5 m. At high tide, the sandbar effectively reduces this wave height by around 25%, providing important protection to Cullen Bay and Mindil and Vestey's beaches.

In conclusion, the EIS and supporting documentation provides adequate information on the existing coastal environment and functions of the sandbar to allow confident predictions to be made on the potential impacts of additional dredging of the Emery Point Sandbar. This conclusion is supported by all Government advisory bodies.

4.5 Sand Volume Available for Extraction from the Emery Point Sandbar

The proponent reported a number of submissions querying the amount of sand that could safely be removed from the sandbar without resulting in any significant change to the existing form or function of the sandbar.

Since the 1987 EIS the amount available for dredging has changed from 400,000 m³ to 1,000,000 m³ (indicated in the coastal engineering study report 102) to 1,700,000 m³ in the current Draft EIS. The proponent explains in the Supplement to the Draft EIS that the studies undertaken in the 1987 EIS were sufficient to show that up to 400,000 m³ could be taken. The area of dredging was to the south of the current proposed area and was much smaller in size than the area shown in the 1992 Draft EIS. More detailed studies were undertaken in 1992, involving mathematical wave modelling, sediment transport, and bar behaviour. This study and modelling showed that dredging to depth of AHD -14m in a thin slice along the out edge of the sandbar could yield up to 1,000,000 m³ of material without changing wave transformation over the sandbar. By changing the dredge capacity so that dredging could be undertaken at AHD -23m, it would enable up to 1,700,000 m³ to be removed. Modelling undertaken by the proponent for the maximum dredge capacity of 1,700,000 m³ in the manner proposed would not result in significant changes to the existing form or function of the sandbar.

The justification provided by the proponent for the above changes in sand available for dredging from the Emery Point Sandbar is considered entirely reasonable and acceptable. The impacts associated with the dredging described in the Draft EIS are examined in the following sections.

4.6 Potential Impact of Dredging on the Form and Functions of the Sandbar

The main issue of concern raised during the assessment of the additional dredging proposal was the potential impact on the form of the sandbar and whether a change in form would affect the protective function of the sandbar. Associated with this issue is the potential impact of dredging on coastal processes, in particular sediment transport.

In summary, the issues concerning the potential impacts of dredging on the sandbar and coastal processes are as follows:

- . potential impact on the form of the sandbar, and the possibility of collapse and crest height reduction;
- . potential impact on the wave attenuation capacity of the sandbar and the potential impact of storms on the sandbar following dredging;
- . potential impact on local coastal processes, including the dynamics of the sandbar, current patterns, and sediment transport; and
- . potential impact on Cullen Bay, Mindil and Vesteys beaches, in particular sand budget, sediment transport and beach erosion.

To minimise the above impacts, a number of dredging location options were assessed. The constraints of this assessment included:

- . the maintenance of the dynamics of the sandbar and inshore wave climate;
- . the likely interaction with interpreted sandbar behaviour;
- . to ensure that the removal of sand would not have any adverse impact at Cullen Bay or on Fannie Bay beaches;
- . location of the power cable crossing; and
- . feasible dredging depths and distance from the site. (As noted previously, to dredge further than 2 km from the site would carry an additional cost burden of \$4 m³).

These options included a channel on the south eastern side of the sandbar and dredging near the southern tip and a strip taken from the seaward side of the sandbar. Dredging of the southern tip and the inshore side of the sandbar were rejected because of concern regarding potential modifications to the wave, current and sediment transport regimes and potential impacts on the adjacent beaches, despite the fact that both options would have resulted in less expensive dredging rates.

The proponent has advised that "there would be no change to the form and function of the sandbar following the proposed dredging" (issue 38, p-24 of the Supplement). The coastal process studies and modelling undertaken for the Draft EIS indicates that if sand is removed as a relatively thin slice from the seaward edge, there would be no significant impact on the coastal processes. The Draft EIS states that "the coastal process studies considered in detail the most appropriate dredge location, operation, and profile which would ensure suitable material was obtained without adversely impacting on the form and function of the sandbar" (issue 35, p-23 of the Supplement).

It is likely, however, that the dredging of a total of 850,000 m³ of material will effect the form of the sandbar because, if nothing else, the dredging would result in a reduction in the size of the existing sandbar by approximately 2 %. The issue, therefore, is whether this change in form of the sandbar is significant, and whether it could result in the downstream impacts, such as sediment transport effects and wave transformation changes.

By dredging a relatively narrow parallel strip from the outside of the sandbar, and by maintaining the contour profile, the proponent has shown using mathematical and physical modelling that the resultant change in form is not significant. The Supplement states that the height of the sandbar would be maintained, and that the dredging area is located to ensure that there would be no significant impact on the crest height. Furthermore, the width of the sandbar, following dredging, would still be substantial in comparison with the wave length of approaching waves. The notion that dredging the sandbar in the manner described would lead to an early collapse of the sandbar is unfounded and can be dismissed as a potential outcome.

Port and Harbour Consultants Pty Ltd concur that the design dredge profile from the sandbar is optimal in terms of reducing the risk to the sandbar sediment transport processes and therefore its form and function as shelter to the beached and to the Cullen Bay Development.

Notwithstanding the fact the 1,700,000 m³ of material is an enormous volume, in relation to the entire sandbar it represents a small percentage. Examination of natural scale diagrams of the resultant face of the sandbar after dredging shows that the change in the overall sandbar form is minimal.

The main issue concerning any change in the form of the sandbar, as a result of dredging is the potential associated impacts. The proponent has undertaken extensive studies of the wave climate that have indicated that as long as the dredging was carried out in the manner described in the Draft EIS there would be no impact on waves or currents. "The studies have shown that there would be no measurable change to the waves and currents and therefore no change to the supply of sediment or the processes which form and shape of the sandbar and the neighbouring beaches" (Issue 38, p-24, Supplement).

Extensive measurements of tidal currents and patterns were undertaken as part of the 1987 EIS over a variety of tidal conditions. The proponent considers that actual measurements of tidal movements are more accurate than the results which could be achieved by modelling and that tidal modelling, therefore, was not warranted. This is supported.

The wave climate studies, as described previously, used a full year of wave hindcasting sampling wave height 4 times a day. The wave climate portrait was then modelled to depict the wave transformation over the sandbar. The model was run for the existing situation and then modified to show the wave transformation over the sandbar after dredging had taken place. The sandbar after dredging continued to act as an effective barrier to larger waves, the width of the sandbar being sufficient to effectively remove any further wave energy passing over the sandbar by frictional energy loss.

Appendix B of the Supplement provides wave height exceedance curves for the existing and dredged situations shows there is very little difference in wave conditions. It should

be noted, however, that the hindcasting sampling over the year did not encounter extreme climatic events, that would produce design significant wave heights. It is obvious that the protective function of the sandbar needs to be examined when subject to extreme wave conditions. After all, it is under these circumstances when the protective capacity of the sandbar is required.

This matter, however, was also considered in some detail by the proponent in the EIS, including the modelling of a post-cyclonic form of the sandbar. Although the post-cyclone shape of the sandbar was different (lower crest height but considerably wider), the effect on wave attenuation of the significantly wider bar section is substantially the same.

Mathematical modelling with dredging, coupled with a reduced bar height (post-cyclonic conditions), using the design significant wave height generated in Beagle Gulf of 6m showed that wave transformation over the sandbar was similar to that provided by the existing sandbar and that the dredged sandbar still performed its current function. Within the accuracy of the model the proponent concluded that the dredging would have no measurable impact on the extent of that protection.

It is important to add that in the modelling exercise, the sandbar which was modelled was considerably smaller in size to the 1991 section and that the proposed dredged profile of the sandbar still resulted in a significantly larger feature than that modelled in the flume stability and wave transformation tests. A narrower bar had to be modelled due the limited length of the flume. According to Kinhill Engineers Pty. Ltd., in Report number 102 on Coastal Processes, this limitation of the model "would therefore result in slightly conservative designs"(p-38). Kinhill Engineers Pty. Ltd. also concluded that it would be possible to remove the entire thin outer-section length, without modifying the inshore wave climate or bar stability.

Given that the modelling has been validated and that it appears to provide a good indication of wave transformation over the bar under varying sandbar formations, and that the form of the sandbar would not be significantly altered as a result of dredging the outside strip, it is reasonable to conclude that the sandbar would continue to provide effective protection of nearby beaches under post-dredging and post-cyclonic conditions.

By maintaining the approximate form of the sandbar, the dredging of this area is unlikely to result in any change to the hydrodynamics of the tidal current patterns around the sandbar. Also, the existing sediment transport patterns influencing sediment growth would continue unaffected. According to the EIS, sand would continue to move in the same cyclic pattern around the sandbar as in the past. The proponent considers that there is no conceivable event which might prevent the continued supply of sediment to the sandbar. The EIS concludes that, in relation to accretion of the sandbar, the rate of increase is not important as the studies and modelling show that even without any regeneration the sandbar is stable and the dredging would have no measurable impacts on the beaches, sand processes, wave climate and other coastal processes.

The potential impact on the adjacent Fannie Bay beaches as a result of dredging the sandbar is a concern to several respondents to the Draft EIS, including the Darwin City Council. The Supplement to the Draft EIS has adequately addressed this issue and states that the extensive modelling undertaken on the impact of dredging of the bar has taken into account the associated potential impacts on neighbouring beaches and that it has shown that there would be no measurable impact on the adjacent beaches.

Modelling of sediment transport at Mindil Beach showed that after dredging the long shore sediment transport would be the same. The beaches were also modelled for a cyclonic event, for both pre-dredging and post-dredging conditions which indicated that within the accuracy of the model there was no change as a result of dredging. That is, there was no measurable difference in either the longshore transport or inner wave climate as a result of dredging.

As discussed in Sections 3.2 and 4.4 the interaction between the sandbar and the beaches is limited in respect to sediment transfer. It follows that the removal of 850,000 m³ from the outer edge of the sandbar is highly unlikely to result in any accelerated beach erosion other than that naturally encountered.

Future dredging of the sandbar for the purpose of the Cullen Bay Public Beach replenishment could result in potential accumulative impacts if the dredging is not appropriately planned and managed. Accordingly, it is important that future dredging for this purpose be undertaken within the dredging area defined in the EIS. Given that there is 1,700,000 m³ available and that excess material will remain after additional dredging, it appears that there is ample material available within the dredging area for future replenishment. Should replenishment dredging be required within those areas that have already been dredged, a surveying would be necessary to ensure that sufficient accretion had occurred in these areas. Alternatively, future dredging would have to take place to the north of the proposed dredging program in accordance with the dredging profiles provided in the EIS. Provided that this safeguard is adopted, accumulated impacts of future dredging for replenishment purposes would be expected to be minimal.

From the studies undertaken by the proponent, it can be concluded that the form and function of the sandbar would not be altered as a result of additional dredging as described in the EIS. The proposal would not result any measurable change to waves and currents, and would not alter the supply of sediment or the processes which form and shape the sandbar and adjacent beaches. Natural accretion of the sandbar would continue, however, this rate is not critical to the protective function of the sandbar.

4.7 Adequacy of the Proposed Monitoring Programs

Several respondents to the Draft EIS commented on the adequacy of the monitoring program put forward by the proponent. Essentially, there are two main components of the program:

- . monitoring of the volumes of material dredged; and
- . monitoring the compliance with approved dredging profiles.

Condition number 7 of the Miscellaneous Licence (see **Appendix D - Miscellaneous Licence 1820**) for the approved dredging requires the licensee to do the following monitoring tasks:

- . arrange for a licensed surveyor to survey both the extraction area and the location where the fill is deposited to determine the quantity of sand dredged. This survey is required half way through the dredging as well as on completion to determine the quantity of fill dredged;
- . carry out surveys of both areas at any other times as directed by the Minister administering the *Crowns Land Act*, provided that the interval between surveys is not less than 30 days;
- . provide copies of all surveys and reports on quantities of sand dredged to the Department of Lands and Housing and Local Government; and
- . maintain continuous records of the quantity of material dredged, providing estimates on a weekly basis to the above Department together with details of profile monitoring and conformity with approved profiles.

The proponent has made a commitment in the EIS to undertake the additional dredging in accordance with the same or similar conditions as the above, and has made a commitment to carry out surveys to determine the progressive volumes of material dredged on a monthly basis. To date, sandbar clearance surveys are carried out with survey lines at 10 m centres. Port and Harbour Consultants Pty. Ltd. have supported the commitments by the proponent, concluding that the "monitoring programme for dredging operations from the Emery Point sandbar is extensive and appears to cover all aspects".

Recommendation 4

Monthly survey reports showing the progressive volumes of material dredged should be made available to the public on request.

An audit of the compliance with the Miscellaneous Licence conditions has been carried out by the Department of Transport and Works, with specific emphasis on condition number 1 of the Licence which requires the dredging of the sandbar to be carried out in accordance with dredging profiles and program approved by the Secretary of the Department of Transport and Works.

In summary, a before and after survey of a dredged area were over laid and compared to the predicted and approved post dredging profile. The quantity of sand dredged from the survey area was also compared with the pre-determined quantity for the given area to be dredged. Some allowance was given for the final profile as this could take several months before the final profile stabilised. The results of the audit indicates that the removal of sand, is overall, within the approved plan areas and allowable quantities.

According to Port and Harbour Consultants Pty. Ltd., all dredging is should be maintained within dredging tolerances as these were set with the dredging operation in mind, and that "these dredging tolerances should be monitored closely as dredging contractors will prefer to over-dredge in any one area to avoid plant movements". To ensure the these dredging tolerances have not been exceeded and that the resultant dredged profile compares with the design specifications, it is important that clearance surveys be undertaken regularly and that the work procedure for recording of dredging profiles and verification of quantities dredged as outlined in **Appendix E** be strictly adhered to by the proponent. Before any additional dredging proceeds, it is considered that a clearance survey of that area already dredged should be undertaken by the proponent and certified by Government, and that any non-conformance with dredging tolerance levels should be rectified.

Recommendation 5

The proponent should:

- a) **undertake a full clearance survey of the area dredged for the existing dredging operation (approved extraction volume of 300,000 m³ - Miscellaneous Licence 1820) to the satisfaction of the Department of Transport and Works prior to the commencement of any additional dredging; and**
- b) **rectify and restore any area where dredging tolerance levels had been exceeded, to the satisfaction of the Department of Transport and Works, prior to the commencement of any additional dredging.**

The independent assessment by Port and Harbour Consultant Pty Ltd, considered that in light of the current state of knowledge of the sandbar dynamics being mainly of a qualitative nature, the quantities of material to be dredged should not be excessive in relation to the magnitudes of the sediment transport processes. Accordingly, they recommended that the total quantity removed from the sandbar should be limited to 850,000 m³. This conclusion, however, is conservative and is based on the sandbar having a total volume of 3,000,000 m³ and dredging not extending beyond -14 AHD. Further explanation on this aspect is provided in Section 3.1 of this report and the Supplement to the Draft EIS.

Port and Harbour Consultants believe that prior to any further dredging, the continued effectiveness of the post-dredged sandbar for attenuation of the design wave conditions should be ascertained. Within the period of responsibility as determined under the development agreement, but not before at least 2 years which include some cyclonic activity, survey results should be renewed to re-affirm the sandbar dynamics. The need to ascertain the effects of dredging 850,000 m³ is supported and, accordingly, dredging operations should be suspended following the extraction of the additional material. At the completion of dredging, however, a clearance survey should be carried out, similar to that required for the initial dredging operations.

Recommendation 6

The proponent should:

- a) undertake a full clearance survey of the area dredged for the additional dredging operation (volume of 550,000 m³) to the satisfaction of the Department of Transport and Works prior to the decommissioning of the dredge plant; and
- b) rectify and restore any area where dredging tolerance levels had been exceeded, to the satisfaction of the Department of Transport and Works, prior to the decommissioning of the dredge plant.

Recommendation 7

Further dredging of the Emery Point Sandbar should be suspended for 12 months following the extraction of the additional 550,000 m³ of material to allow for investigations to confirm the integrity of the sandbar.

Recommendation 8

The proponent should:

- a) survey the sandbar 12 months after the additional material has been extracted and thereafter re-survey the sandbar each May and October for a period of four years;
- b) submit the survey results to the Minister for Lands, Housing and Local Government together with an annual explanatory statement by a qualified coastal engineer; and
- c) 12 months after the additional material has been extracted, audit the effects of dredging the sandbar (which would include physical and mathematical modelling to determine the accuracy of predictions concerning the protective function of the sandbar), in accordance with Clause 15 (i) of the Administrative Procedures of the *Environmental Assessment Act*; and prepare and submit an audit report to the Minister for Conservation.

The proposed monitoring program put forward by the proponent also includes:

- Turbidity testing, using a Secchi disc on a weekly basis (three replicate readings at 6 different locations near the dredge, listed in the Draft EIS); and

- Aerial surveillance every six weeks to verify the existence of any sediment plume and to monitor the visible sandbar, the results of which the proponent has stated would be made available to the Conservation Commission or the Darwin Port Authority.

Turbidity testing using a Secchi disc for the initial dredging operation has shown that the turbidity levels associated with the dredging activities of the sandbar are well within NH & MRC Australian Water Quality Guidelines. Turbidity levels around the operating dredge show similar levels to that which occur naturally in the vicinity of the sandbar.

Inspection by Conservation Commission Officers during the initial dredging operations visually confirmed that turbidity was not significant. This is due to the type of dredge being deployed, the nature of the material being dredged (coarse shell grit and quartz), and the absence of sensitive marine ecosystems in the immediate area. It is therefore concluded that further turbidity testing associated with the proposed dredging is not warranted.

Recommendation 9

Turbidity testing should not be made a condition of consent should the dredging be approved.

Aerial photography is considered important, particularly to examine and compare the visual sandbar and adjacent beaches at low tide. This information together with surveys will indicate whether the form of the sandbar has been significantly altered. If aerial photography indicated unexpected variation of the form of the sandbar, then this would trigger new surveys and physical modelling testing to indicate if the function of the sandbar had been significantly affected.

Aerial photographic interpretation proposed by the proponent will require further consideration by Government. Aspects that need to be resolved include frequency, period, and interpretation method.

Recommendation 10

The proponent should prepare and implement an Aerial Surveillance Monitoring Program of the Emery Point Sandbar and Adjacent Beaches in consultation with the Conservation Commission and the Department of Lands and Housing and Local Government, to be implemented prior to the commencement of additional dredging.

In conclusion, it is considered that, subject to the above recommendations concerning the dredging monitoring program, that the commitments made by the proponent and conditions already required under the development agreement and licensing provisions are adequate to ensure that the dredging volumes can be accurately determined and that the form and function of the sandbar will be properly monitored.

4.8 Other Issues

Impacts on Marine Fauna and Conservation Areas

Section 3.3 describes the sandbar as not a significant marine habitat, and that there are only few types of marine organisms found in the sand. Examination of sand from the sandbar shows very little sign of marine life. Turbidity and sedimentation associated with the dredging is very limited and would be of short-term consequences only. Relevant Government agencies consider that the dredging would not result any significant impact on marina fauna, commercial or recreational fisheries, or to marine conservation areas.

Greenhouse Effects

As a result of concerns expressed during the review of the Draft EIS additional studies were commissioned to model the effects of enhanced greenhouse impacts on existing sea levels, on wave climate and coastal processes around the sandbar.

Longshore sediment transport was also modelled assuming a 50 cm rise in sea level. The Supplement states that although the absolute value of sediment transport increased with higher water level, within the accuracy of the model, there were no differences between the pre-dredged and post-dredged condition.

Greenhouse issues were also raised in the 1987 EIS which resulted in the Cullen Bay Project being designed to allow for a potential sea level rise, having incorporated this allowance into the sea wall design to increase its height with sea level changes.

Social Issues

It is concluded that there will be no long-term social impacts associated with the proposal, and that short-term impacts will be minor. It should be noted that land based fill options would result in considerable short-term adverse impacts compared to the dredging proposal.

Social issues related to the additional dredging are not considered to be significant. Respondents to the Draft EIS did not comment on any social issue, except to clarify information on the existing social environment.

Noise levels are expected to be similar to those occurring during the initial dredging operation. The proponent has recognised that the additional dredging would cause a temporary deterioration in the existing aesthetic quality of the Emery Point area.

Recreational activities which are undertaken at Mindil and Vestey's beach areas would not be affected by the additional dredging, and the proponent anticipates that there would be no deleterious effects on the activities of the Darwin Sailing Club.

Recommendation 11

The proponent should continue to actively consult with the Darwin Sailing Club in relation to dredging activities to ensure that the club is fully informed of the location of dredge and proposed operations.

NT Legislation

The Aboriginal Areas Protection Authority has advised that the proposal does not pose a substantive risk to sacred sites in the vicinity.

The proponent has made fully aware of Thiess's responsibilities under the Heritage Conservation Act.

Navigational issues have been determined by the Darwin Port Authority, in accordance with the *Darwin Port Authority Act*. It is expected that should the proposal be approved by the Minister for Lands and Housing and Local Government, that the Darwin Port Authority will issue similar conditions to that required for the existing dredging program.

5.0 CONCLUSION

The quantity of material proposed to be dredged from the Emery Point Sandbar is relatively small in relation to the overall quantity of sand in the sandbar. It is also clear from further investigations conducted on the sandbar that it is a significantly larger feature than that identified in the 1987 EIS and early modelling tests. It is considered that the current EIS and supporting documentation provides adequate information on the existing coastal environment and functions of the Emery Point Sandbar to allow confident predictions to be made on the potential impacts of additional dredging of the sandbar. This conclusion is supported by Government advisory bodies and the independent assessment.

From the studies undertaken by the proponent, being the best available information on the sandbar and local coastal processes, it is concluded that the form and function of the sandbar would not be altered as a result of additional dredging as described in the EIS.

Dredging would not result in any measurable change to waves and currents, and would not alter the supply of sediment or the processes which form and shape the sandbar and adjacent beaches. The proposed dredging should not significantly alter the profile or wave attenuation characteristics of the Emery Point Sandbar.

Natural accretion of the sandbar will continue, however, this rate is not critical to the protective function of the sandbar.

The recommendations in this report concerning the monitoring program and the commitments made by the proponent will ensure that the dredging volumes can be accurately determined and that the form and function of the sandbar will be properly monitored.

The independent assessment by Port and Harbour Consultants Pty. Ltd. concurs with the above conclusion, and considers that the additional dredging "in the form proposed should result in minimum impacts to the sandbar and beach coastal processes and also should maintain cyclone protection currently afforded to the Cullen Bay area".

Port and Harbour Consultants Pty. Ltd. also concluded that the "dredging of the Emery Point Sandbar should be restricted to a maximum quantity of 850,000 m³ within the specified design lines and grades until further monitoring allows better quantitative estimates of the dynamics of the sandbar". The assessment has shown this maximum quantity to be conservative.

It is concluded that, in general, the proponent has adequately addressed all relevant issues and those comments raised by Government and the public on the Draft EIS.

The Conservation Commission considers that the requirements and objective of the *Environmental Assessment Act* 1982 and the Administrative Procedures have been met by the proponent.

Subject to decisions which permit the additional dredging of the Emery Point Sandbar to proceed, the main recommendation resulting from the Environmental Impact Assessment process is as follows:

Recommendation 12

The proponent is to ensure that the proposal is implemented in accordance with the environmental commitments and safeguards identified in the Proposed Additional Dredging from the Emery Point Sandbar Draft Environmental Impact Statement 1992, or as modified in the Supplement to the Draft EIS.

It is acknowledged that during detailed implementation of proposals, some flexibility is necessary and desirable to allow for minor and non-substantial changes to the specifications which have been examined as part of this assessment. It is considered that subsequent statutory approvals for this proposal could make provision for such changes, where it can be shown that the changes are not likely to have a significant effect on the environment.

6.0 REFERENCES

ACER Vaughan Consulting Engineers, 1991. Gunn Point Cliff Study. A report prepared for the Northern Territory Department of Transport and Works. (unpublished)

Byrne, A. P. 1988. **Darwin Harbour - Hydrodynamics and Coastal Processes.** In Larson and Others (eds) Darwin Harbour: Proceedings of a workshop on Research and Management held in Darwin, 2-3 September, 1987, NARU Mangrove Monograph No. 4, 19-31.

Conservation Commission of the Northern Territory, 1988. **Cullen Bay Marina Environmental Assessment Report** - Assessment Report No. 10. CCNT. Darwin, N.T.

Darwin Marina Estates Pty. Ltd., 1987. **Darwin Marina Estate Cullen Cove Marina - Draft Environmental Impact Statement and Planning Study. Vol 1-3.** Prepared by Vos Woodhead Planning Group, Woodhead Australia, and Riedel and Byrne Consulting Engineers Pty. Ltd.

Dwyer and Associates Pty. Ltd., 1980. Draft Report - Marina Study Stage II - Vesteys Beach. A study commissioned for the Northern Territory Department of Transport and Works. (unpublished)

Kinhill Engineers Pty. Ltd., 1992. Cullen Bay Waterfront Estate and Marina - Design Report 102 - Coastal Processes. Prepared for Thiess Contractors Pty Ltd Darwin. (unpublished)

Kinhill Pty Ltd., 1992 Cullen Bay Waterfront Estate and Marina - Technical Specification 105 - Dredging. Prepared for Thiess Contractors Pty Ltd Darwin. (unpublished)

Kinhill Pty Ltd., 1992 Cullen Bay Waterfront Estate and Marina - Supplementary Study - Wave Transformation Over Bar, Report No. 108. Prepared for Thiess Contractors Pty Ltd Darwin. (unpublished)

Mitchie, M.G. 1988. **Sediments, Sedimentary Environments and Palaeoenvironments of Port Darwin, Northern Territory of Australia.** In Larson and Others (eds) Darwin Harbour: Proceedings of a workshop on Research and Management held in Darwin, 2-3 September, 1987, NARU Mangrove Monograph No. 4, 19-31.

Mitchie, M.G., 1992. Sediments on the Emery Point Sandbar. A paper provided to the Conservation Commission to assist in the assessment of the Additional Dredging of the Emery Point Sandbar EIS. (unpublished)

Acknowledgment

The Environment Protection Unit would like to acknowledge and thank Mr Michael Mitchie for his contribution to this Assessment Report.

Table 2.1 Details of submissions received

Submission number	Name/organization/ affiliation	Address	Pages of submission
<i>Public</i>			
1	S. Jackson, J. Pittock – Environment Centre	–	4
2	T. Fitzgerald	40 Playford Street, Fannie Bay	3
3	J. Haritos	7 Larrakeyah Terrace, Darwin	4
4	T. Haritos	137 Smith Street, West Darwin	6
5	W. Petrass	17 Waters Street, Rapid Creek	3
6	J. Fitzgibbon	56 Gregory Street, Parap	10
7	J. Hooper	10 Brogan Street, Fannie Bay	4
8	Cullen Bay Concerned Citizens	GPO Box 2120, Darwin	2
9	G. Parsons	14 Maude Street, Anula	1
10	M. Mulrennan, M. Sullivan – North Australia Research Unit (ANU)	PO Box 41321, Casuarina	2
11	W. Fisher	19 Kirkland Crescent, Darwin	3
12	R. Whiting	PO Box 42778, Casuarina	3
<i>Government</i>			
13	Darwin City Council	–	1
14	CCNT	PO Box 496, Palmerston	4
15	Department of Transport and Works	PO Box 61, Palmerston	6
16	Darwin Port Authority	GPO Box 390, Darwin	1
17	Department of Lands and Housing	PO Box 40246, Casuarina	1
18	Museums and Art Galleries of the N.T.	GPO Box 4848, Darwin	1
19	Aboriginal Areas Protection Authority	GPO Box 1890, Darwin	1
20	Department of Primary Industry and Fisheries	GPO Box 990, Darwin	3

Table 2.2 SUMMARY OF ISSUES

		Submission Number																			
Issue No.	Issue	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	EXISTING ENVIRONMENT																				
	Coastal Processes																				
1	Sources of material supplying the sandbar/sandbar-beaches interaction.		*				*	*					*	*	*	*			*		*
2	Sand budget for the sandbar.							*						*							
3	Sand accretion of sandbar with time.	*					*	*			*	*	*	*	*	*					
4	Homogeneity of sandfill.																	*			
5	Protective role of sandbar for beaches.				*	*		*		*	*	*	*		*	*					
6	Stability of sandbar versus cyclic movements.			*						*	*	*	*		*	*					
7	Basis of conceptual model of sand transport.										*										
8	Composition of sandbar.						*								*						
9	Tidal model.										*										
	Social Environment																				
10	Archaeology and Aboriginal sites.															*				*	
11	National estates register.															*					
	Biological Environment																				
12	Sampling of marine organisms on sandbar.								*			*									

[illegible]

[illegible]

[illegible]

Issue No.	Issue	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
	OTHER																				
	EIS Process																				
54	Total review of EIS versus only additional sand/assessment of 850,000m ³	*											*								
	EIS Documentation																				
55	Compliance with CCNT guidelines			*	*		*														
56	Scales and references on drawings.			*	*		*						*								
57	Sources of figures and references						*														
58	Queries on figure 4.4 - set out line.						*														
59	Maps for Appendix E						*														
60	Public consultation		*	*			*					*									
61	Use of 1991 contours for accretion calculations.																				
	Miscellaneous																				
62	Charges for additional material	*					*														
63	Funding for beach replenishment.												*								
64	Dredge size														*						

CULLEN BAY MARINA

REVIEW OF E.I.S. AND SUPPLEMENT FOR ADDITIONAL DREDGING OF EMERY POINT SANDBAR

Prepared by

PORT AND HARBOUR CONSULTANTS PTY LTD

38012/1

CONTENTS

	PAGE
1.0 INTRODUCTION	1
2.0 EIS AND EIS SUPPLEMENT REVIEW	1
2.1 Coastal Processes	1
2.2 Social and Biological Environments	4
2.3 Project Description, Fill Requirements and Dredging Operations	4
2.4 Impacts and Safeguards	7
2.4.1 Coastal Processes	7
2.4.2 Dredging	8
2.5 Monitoring	8
3.0 CONCLUSIONS	9

1.0 INTRODUCTION

In response to a request from the Northern Territory Department of Transport and Works (reference facsimile of 30th December, 1992), a review of the Cullen Bay Waterfront Estate and Marina Project, Draft Environmental Impact State (Draft EIS) and also of the "Supplement to the Draft EIS" have been carried out.

This document includes comments on the major issues relating to the additional dredging of the Emery Point sandbar as proposed by the proponent and as detailed in the Draft EIS and Supplement to the Draft EIS documents.

2.0 EIS REVIEW

2.1 Coastal Processes

On the basis of reporting provided in the supplement to the EIS it is clear that the sources of supply of the coarse and well sorted materials forming the sandbar are of marine origin carbonates (80%) and a smaller percentage (20%) of quartz origin.

Indications are that the sources of materials which will supply the sandbar are not finite. Marine organisms and the supply of quartz from breakdown of topographic features are not hindered by either the Cullen Bay development or other developments in the Darwin region to date.

The sediment budget (accretion/erosion) of the sandbar is difficult to assess with any reasonable degree of accuracy as stated by Kinhill Riedel and Byrne in their Coastal Processes Document No. PE1044.100.DO.102 and reiterated in the Draft EIS and Supplement.

Considering the geological age of this feature, and in particular the comparison of the 1938 and 1986 surveys of the Emery Port sandbar, an average annual accumulation rate of 50,000 m³/year appears to be on the upper limit of possible accumulation per year. For example, the 48 year period stipulated above would result in 2.4 million m³ accumulated over that period compared with a total volume of 3.0 million m³. However, it is not unlikely that any one year could achieve such accretion rates.

2.1 Coastal Processes (Cont'd)

Although it is felt that the average accumulation is less than 50,000 m³/year the accreting nature of the sandbar as stipulated in KRB reports is concurred with.

The sandbar's characteristics of reworking under current and wave action make it difficult without detailed regular surveys to be sure about the accretionary quantities (monitoring as discussed later in this report will need to be established both during dredging and post dredging to obtain a satisfactory understanding of the sandbar sediment dynamics to establish any further utilisation of the bar as a future source of materials).

With the above points in mind, it is clear that an assessment of the exact quantity of the sandbar to be dredged without major reshaping of the sandbar occurring is a difficult number to assess. However, the quantity to be dredged should be dredged with minimal disturbance to the mean configuration of the sandbar.

At this stage it is understood that the Developer intends borrowing up to 850,000 m³ in total from the sandbar for construction purposes (including beach construction).

The sediment transport along and around the sandbar in absolute terms is not as critical to the assessment of sandbar sediment dynamics as opposed to the gradients in transport which are set up along the sandbar due to interaction of waves and currents on the bathymetry of the sandbar.

Modification of the bathymetry due to dredging should therefore concentrate on producing minimal disturbance to the existing pre-dredge sandbar profiles. Kinhill Riedel and Byrne (KRB) are fully aware of these processes as evidenced in their reporting and have consequently opted to dredge the material from a thin slice along the seaward western face of the sandbar.

It should be noted that these gradients which can be in a longshore direction due to tidal currents plus waves and in an onshore/offshore direction due to waves will cause the flattening and redistribution of the sandbar reported in the Coastal Processes report (refer section 6.1 and 6.2 and figures 6.1 to 6.5 of Document Number PE 1044.100.DO.102).

2.1 Coastal Processes (Cont'd)

These processes will be expected to result in some redistribution of the sandbar sediments following dredging, albeit in reduced amounts due to the proposed dredging configuration, however it is not expected that material will be lost from the sandbar regime. The redistribution will occur in the same orders of magnitude for cyclonic and ambient conditions as observed by KRB in the coastal processes assessments.

With a nett accretionary trend on the sandbar, it is expected that the sandbar will tend back to its existing equilibrium with time.

With the current state of knowledge of the sandbar dynamics being mainly of a qualitative nature, the quantities of material to be dredged should not be excessive in relation to the magnitudes of the sediment transport processes.

The figure of 940,000 m³ allowable dredging referenced in our letter of 7th December, 1992 (includes an allowance for overdredging within the allowable dredging tolerances: 850,000 + 90,000 = 940,000) accounts for interpretation of the dredging specification. It is however recommended that dredging should be monitored closely to ensure that the total quantity removed from the sandbar does not exceed 850,000m³.

The draft Cullen Bay Agreement requires the Developer to re-survey the sandbar each May and October for a period of 5 years and to review the continual effectiveness of the sandbar as a cyclone protection structure.

Within that period, but not before at least 2 years which include some cyclone activity, the survey results should be reviewed to re-affirm the sandbar dynamics and provide more precise quantitative estimates of these. With this at hand, the continued effectiveness of the sandbar for attenuation of the design wave conditions and as a further source of material can be ascertained.

Should the sandbar lose its effectiveness in attenuating cyclone waves and/or as a source of additional material for beach replenishment (for material lost from the beach system), advice needs to be given as to remedial measures for alternative sources of sand and re-assessment of breakwater stability.

2.1 Coastal Processes (Cont'd)

Re-assessment of the sandbar dynamics needs to take place as early as possible in the 7 year defects liability period to ensure risk to the Northern Territory Government for additional costs are reduced.

With respect to wave transformation over the Emery Point Sandbar and in particular its protective role for the beaches and on the design of breakwaters and revetments, a review of KRB report (Document No. PE 1044-100.C.DO.108) "Supplementary Study, Wave Transformation Over Bar" has been carried out and reported in PHC letter of 29th October, 1992. PHC do concur with the Supplementary EIS explanation regarding this matter.

The quantities should however not increase beyond the 850,000 m³ required, and should be kept within the approved dredging area slice to avoid large re-shaping of the sandbar.

2.2 Social and Biological Environments

Findings discussed on the impact to the social environment as discussed in the Draft EIS and the Supplementary Draft EIS are concurred with. Likewise the impacts on the biological environment due to additional dredging are not expected to increase risk to any marine organisms.

2.3 Project Description, Fill Requirements and Dredging Regulations

The possible requirements for additional dredging from the Emery Port Sandbar are outlined in our report of 2nd August, 1991.

The Developer has now returned with a request for additional material which is the topic of this EIS. The changes result from major changes to the 1987 EIS proposed development, reduction in dredged quantities from entrance channel and inner and outer harbours, higher than expected consolidation of materials from on-site used as fill and the requirement for the beach to be constructed from sand alone.

The assessment of alternative sources of material for reclamation appear to be exhaustive and have resulted in some cases with non approval, excessive costs or negative environmental impacts.

2.3 Project Description, Fill Requirements and Dredging Regulations (Cont'd)

It is recommended that the beach construction be completed prior to excavation of the full 850,000 m³ of dredging from Emery Point Sandbar as any shortfalls in reclamation will need to be met from the alternative sources in light of the coastal processes review.

The future beach replenishment requests are said to be able to be met by sand deposited offshore from the beach due to offshore transport gradients established by cyclonic activity.

In this sheltered area it may be difficult for the ambient wave conditions to re-transport the sediment back onto the beach before some losses occur due to tidal currents. Some losses are expected to therefore occur onto the sand bar, into the deep gully adjacent to Emery Point and due to contamination of the material moved offshore from the beach. As stated by KRB these losses should be minimal, and beach replenishment will only be required after long periods.

Again the exact quantitative magnitude of these movements will be more well defined with the results of the re-survey of the beaches for the 5 year period following construction.

It should be stressed that the requirement for the proponent to outline details on the methodology and duration of activities to carry out beach renourishment should include a contingency plan for sourcing additional material to that recovered offshore from the beach in the event that monitoring of the Emery Point sandbar reveals that accumulation of sediment cannot accommodate additional dredging for replenishment to replace beach losses.

Dredging Operations

In the reviewed proposal for dredging it is proposed that dredging will take place down to a depth of -23m AHD. Dredging to a deeper depth if carried out on a thin sheet basis as proposed is in fact more beneficial than isolating dredging to the top shallower areas of the sandbar.

Dredging Operations (Cont'd)

The material at greater depth does have lesser bottom stirring applied as a result of the wave climate and tends to be a relatively less mobile region of the sandbar. Resulting storms should therefore reflect a lesser reshaping due to removal of sediment at deeper depths.

The dredging tolerances specified for the sandbar are plus or minus 5 metres horizontally and 2 metres vertically. The vertical tolerance should only reach this maximum overdredging if in the process of dredging, the dredge suction nozzle requires to be set at this depth to recover the design profile material. It should likewise be shown in the surveyed post dredge profile that the as dredged profile does fluctuate equally between the plus/minus 2 metre allowable vertical tolerance (refer PHC facsimile of 18th January, 1993).

These dredging tolerances should be monitored closely as dredging contractors will prefer to overdredge in any one area to avoid dredging plant movements.

With respect to the PAWA cables, the design dredge profiles do result in a significant gradient in bathymetry at the boundaries of the cable corridor. It is clear from measurements and observations to date on the sandbar mobility that such gradients will result in significant sediment transport gradients in the region and probably the exposure of the PAWA cables. This item has been addressed previously in some detail and the current understanding is that this cable was laid directly on the sandbar surface.

The flexible nature of the cable in conjunction with the mobile nature of the sediments have resulted in self burial of the cable as is typical of flexible lines placed on the seabed. On the basis of this process having been adopted in the past it is currently unforeseen that this process would not occur once again if the cable becomes exposed.

With respect to the proponents preference to dredge additional material from the sandbar, in other projects of this nature, the economics of dredged fill materials is significantly better than other sources particularly when haulage distances are large. The cost of mobilisation of the dredge is a significant cost of the dredging exercise, however once on site, it is understandable that the preference for additional dredge material is high.

Dredging Operations (Cont'd)

A seven year responsibility period has been placed on the proponent Thiess contractors under the Development Agreement, for assurance that coastal processes are monitored on the beaches and the sandbar. In the Supplement to the Draft EIS, KRB under issue 43 state that:

".... although the nature of the data precludes precise estimates of quantities or the application of confidence limits, the impacts of dredging on coastal processes and the marine environment can be confidently predicted."

It is clear however, and detailed in the KRB reports that the impact of a storm on the reclaimed beach will result in offshore sediment transport. This offshore movement will result in some losses of sediment as a result of further transport away from the region due to current and waves and a loss of sediment due to inability to recover some sediment due to its location and/or contamination. The need to borrow further material from the sandbar to replenish the beach may therefore occur again in the future.

Therefore it should be stressed that until the quantitative nature and associated confidence limits of sandbar coastal processes can be firmed up following a number of years of monitoring, an alternative source of additional materials for beach replenishment may need to be defined.

2.4 Impacts and Safeguards

2.4.1 Coastal Processes

It is agreed that the design dredge profile from the sandbar is optimal in terms of reducing the risk to the sandbar sediment transport processes and therefore its form and function as shelter to the beaches and to the Cullen Bay Development.

The modelling of longshore sediment transport on the Cullen Bay beaches has indicated approximately 1,000m³ per annum nett transport. This type of modelling does produce results with an order of accuracy of +/- 50% which in this case indicates a worst case nett transport of 1,500m³.

2.4.1 Coastal Processes (Cont'd)

As pointed out in the KRB report, this is not an excessive nett transport when compared to the open coast however, when the beach profile has stabilised in the first few months following reclamation, this nett loss from the beaches will commence and subsequently need to also be replenished to maintain the design beach alignment.

As discussed earlier the need to replenish the beaches following a cyclonic event may overshadow the relatively low quantities of longshore transports due to the high quantities of offshore transport achieved during these types of events (refer PHC letter 2/8/91, 40,000m³ lost in severe storm 1989 from Mindil and Vesteys beaches). In the event of low occurrences of cyclones with direct impact on the beaches, replenishment to the beaches due to longshore transport would need only take place on a five to 10 year cycle.

2.4.2 Dredging

With respect to the dredging, review of the geotechnical assessment of materials to be removed from the sandbar, indicates the sediment is a well sorted coarse sand material with negligible fines which by definition will settle out of the water column rapidly once out of the region of disturbance.

It is therefore understandable that as observed in the current dredging programme that no sediment plume is formed.

Likewise no tailwater discharge impacts are expected if good control is observed at the reclamation site, and impacts on marine fauna will be expected to be isolated to the immediate dredging area where in this case the risk was accepted as being negligible in the 1987 Cullen Bay EIS.

2.5 Monitoring

The monitoring programme for dredging operations from the Emery Point sandbar is extensive and appears to cover all aspects required.

It is important that all information be checked for compliance with agreed specifications and most importantly that quantities and profiles do not exceed those specified.

Ongoing monitoring of the sandbar and beaches by the developer for a period of five years as covered in the development agreement are essential components to the ongoing security of the development and public amenity of the sandbar and beaches. The information from these surveys will allow the sandbar to be assessed in more quantitative terms for its suitability as a further supply of sand and as to its form and future as a cyclone protection structure to the development.

3.0 CONCLUSIONS

Following review of the "Cullen Bay Waterfront Estate and Marina Project, Proposed Additional Dredging from the Emery Point Sandbar, Draft EIS" and "Supplement to the Draft EIS", the following points provide a summary of the main issues identified:

- Dredging of the Emery Point Sandbar should be restricted to a maximum quantity of 850,000m³ within the specified design lines and grades until further monitoring allows better quantitative estimates of sandbar dynamics.
- Dredging at the Emery Point Sandbar in the form proposed should result in minimum impacts to the sandbar and beach coastal processes and also should maintain cyclone protection currently afforded to the Cullen Bay area.
- Monitoring of the sandbar and beaches are critical aspects which will provide more understanding of the sandbar dynamics and allow its potential as a further source of material to be assessed. This monitoring is covered in the development agreement for the first five years following completion of the development.

3.0 CONCLUSIONS (Cont'd)

- All dredging is to be maintained within dredging tolerances as these have been set with the dredging operation in mind.
- This review assumes all aspects covered in PHC letter of 2/8/91 regarding development and management agreements have been addressed.

KINHILL RIEDEL & BYRNE

Kinhill Engineers Pty Ltd

ACN 007 660 317

47 Burswood Road

Victoria Park Perth

Western Australia 6100

Telephone (09) 362 5900

Facsimile (09) 362 5627

FACSIMILE TRANSMISSION

Attention Andrew Read

CC to _____

Company CCNTFax no. (089) 89 4403From Tony ByrneOur reference PE1044/200Number of pages including cover sheet 1Date 19 December 1993

MESSAGE

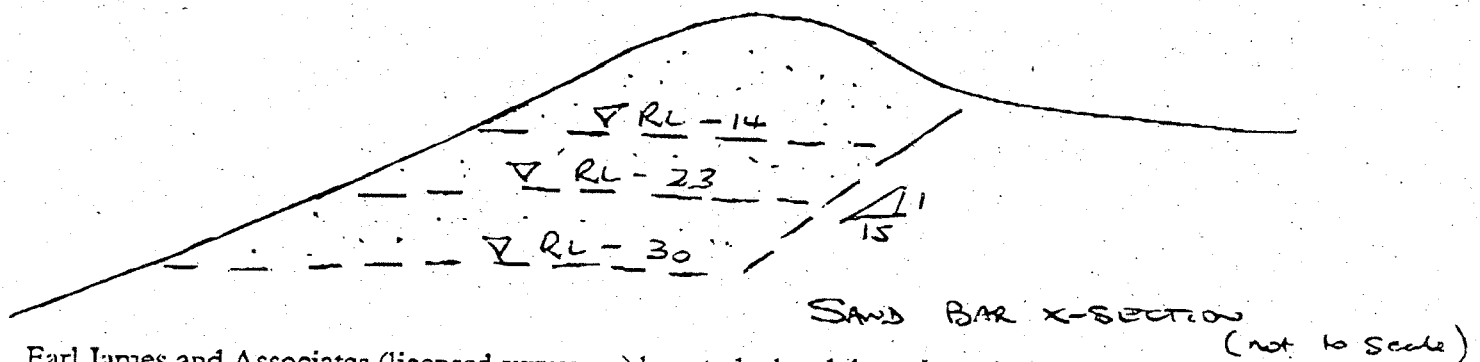
Andrew,

CULLEN BAY EIS - BAR VOLUMES

The question has been raised about the actual quantity of sand in the sandbar. This depends on how the bar is defined.

In the 1992 coastal report, the bar volume was quoted at 3,000,000 m³. This was based on the volume above the line drawn through the bar between the RL-5 contour and the RL-14 contour, for the length of the bar from the southern tip to the northern extent of dredging.

A more appropriate definition of the bar is to take a cross section from the rear of the bar down at an average slope of about 1 in 15, then horizontally out to the front face. This cross section is illustrated for a variety of different depths in the following sketch.



Earl James and Associates (licensed surveyors) have calculated the volume in the bar for the full length of the bar, as follows:

<u>Toc depth</u>	<u>Bar volume</u>
RL-30	48,780,000 m ³
RL-23	29,810,000 m ³
RL-14	11,030,000 m ³

The proposed dredge volume of 850,000 m³ is a very small proportion of the total bar volume.

Regards,

Tony Byrne

KINHILL

NORTHERN TERRITORY OF AUSTRALIA

Crown Lands Act

MISCELLANEOUS LICENCE NO 1820

Licence to go upon Crown lands and take therefrom stone, sand, gravel, clay or earth not being or supposed to be metalliferous.

Whereas Thiess Contractors Pty Ltd of 1627 Coonawarra Road, Winnellie NT applied for a licence to go upon Crown lands and to take therefrom stone, sand, gravel, clay or earth not being or supposed to be metalliferous.

Now, therefore, in pursuance of the Crown Lands Act, the said Thiess Contractors Pty Ltd is hereby licensed to go upon the Crown lands situated at Emery Point Sandbar ("the sandbar") in the Town of Darwin as edged red on Attachment A and to take therefrom a volume of 300,000m³ of the abovementioned substance or article during the period from the ninth day of October 1992 to the thirty-first day of January 1993, subject to the provisions of the said Act and the Regulations thereunder. This Licence is subject to:

1. Dredging of the sandbar is only to be carried out in accordance with dredging profiles and program approved by the Secretary of the Department of Transport and Works.
2. The Licensee will ensure that the permitted works and those operations associated with the permitted works do not impinge upon the existing integrity of the sandbar.
3. Final form of the sandbar is to be to the satisfaction of the Secretary of the Department of Transport and Works.
4. The Licensee shall meet its obligation with respect to any requirements of the Darwin Port Authority, and shall comply with any conditions set out in the letter of consent to dredge from that Authority.
5. The Licensee will notify the Work Health Authority with regard to the scope of the permitted works prior to their commencement as per the requirements of the Construction Safety Act.
6. The Licensee shall meet its obligations in respect to any requirements of the Power and Water Authority concerning the protection of live power cables situated within the sandbar.

7. The Licensee shall arrange for a licensed surveyor to survey both the extraction area and the location where the fill is to be deposited to determine the quantity of sand dredged. The survey is also to be carried out half way through the dredging as well as on completion.

The Licensee will also carry out surveys of both areas at any other times as directed by the Minister administering the *Crown Lands Act*, provided that the interval between surveys is not less than 30 days.

The Licensee shall provide copies of all surveys and reports on quantities of sand dredged, certified by the surveyor, to the Director, Property Client Services within seven days of the completion of the survey.

The Licensee shall maintain continuous records of the quantity of material dredged and shall provide estimates of the quantity sand dredged based upon this information, at least weekly, to the Director, Property Client Services, together with details of profile monitoring and conformity with approved profiles.

8. The Licensee shall comply with all conditions of subdivision consent contained in Instrument of Determination S2131 dated 8 March 1991, as applicable to the land held under this Miscellaneous Licence No 1820.
9. The Licensee shall comply with any direction of the Minister administering the Crown Lands Act or his delegate duly delivered to the Licensee.
10. Notwithstanding any of the above the Licensee shall ensure that the requirements of all relevant authorities are met.

DATED this NINTH

day of OCTOBER

1992



MICHAEL JOHN RENNIE
Delegate of the Minister

• The proponent should:

- a) undertake a full clearance survey of the area dredged for the existing dredging operation (approved extraction volume of 300,000 m³ - Miscellaneous Licence 1820) to the satisfaction of the Department of Transport and Works prior to the commencement of any additional dredging; and
- b) rectify and restore any area where dredging tolerance levels had been exceeded, to the satisfaction of the Department of Transport and Works, prior to the commencement of any additional dredging.

• The proponent should:

- a) undertake a full clearance survey of the area dredged for the additional dredging operation (volume of 550,000 m³) to the satisfaction of the Department of Transport and Works prior to the decommissioning of the dredge plant; and
- b) rectify and restore any area where dredging tolerance levels had been exceeded, to the satisfaction of the Department of Transport and Works, prior to the decommissioning of the dredge plant.

• Further dredging of the Emery Point Sandbar should be suspended for 12 months following the extraction of the additional 550,000 m³ of material to allow for investigations to confirm the integrity of the sandbar.

• The proponent should:

- a) survey the sandbar 12 months after the additional material has been extracted and thereafter re-survey the sandbar each May and October for a period of four years;
- b) submit the survey results to the Minister for Lands, Housing and Local Government together with an annual explanatory statement by a qualified coastal engineer;
- c) 12 months after the additional material has been extracted, audit the effects of dredging the sandbar (which would include physical and mathematical modelling to determine the accuracy of predictions concerning the protective function of the sandbar), in accordance with Clause 15 (i) of the Administrative Procedures of the *Environmental Assessment Act*; and prepare and submit an audit report to the Minister for Conservation.

• Turbidity testing should not be made a condition of consent should the dredging be approved.



3. CLEARANCE SURVEY

A clearance survey shall be carried out by Davidson Dredging on completion of dredging in accordance with 2.2.2 of the Technical Specification 105.

The results of the clearance survey are to be supplied to Thiess who will have Earl James check the profiles.

4. WEEKLY PROGRESS REPORT

Davidson Dredging shall provide to Thiess a weekly progress report which details the following, separately for Dredge 12 & 14.

- (a) Operational hours;
- (b) Delay hours and major causes of delays;
- (c) Quantities for : Dredge 14 from density flow meter,
Dredge 12 estimated.
- (d) Quantities to date.

5. SECHI DISK READING

Secchi disk readings are required to be taken weekly as listed in Appendix B. These readings will be taken mutually by Thiess and Davidson Dredging.

6. ALLOWABLE TOLERANCES FOR DREDGING

(Extract from Technical Specification 105)

2.4 DREDGING OF SANDBAR

Dredging of the sandbar shall be carried out in the areas and within the limits shown on the drawings, as directed by the Superintendent to adequately obtain the reclamation volumes.

Dredging operations shall be conducted in such a way that the amount of turbidity generated is a minimum.

The limits of dredging on the sandbar as defined by the shapes, lines and levels on the Drawings are hereinafter referred to as 'dredging lines'.

The dredging lines shown on the drawings for the sandbar represent the form and shape of the sandbar which must remain after completion of dredging.

Dredging shall be confined within the dredging lines and no dredging shall extend beyond the dredging lines by more than the allowable tolerance. Allowable tolerance shall be 5m horizontally and 2m vertically.

KINHILL RIEDEL & BYRNE

Kinhill Engineers Pty Ltd

ACN 007 660 317

47 Burswood Road

Victoria Park Perth

Western Australia 6100

Telephone (09) 362 5900

Facsimile (09) 362 5627

FACSIMILE TRANSMISSION

Attention Andrew Read

CC to

Company CCNTFax no. (089) 89 4403From Tony ByrneOur reference PE1044/200Number of pages including cover sheet 1Date 19 December 1993

MESSAGE

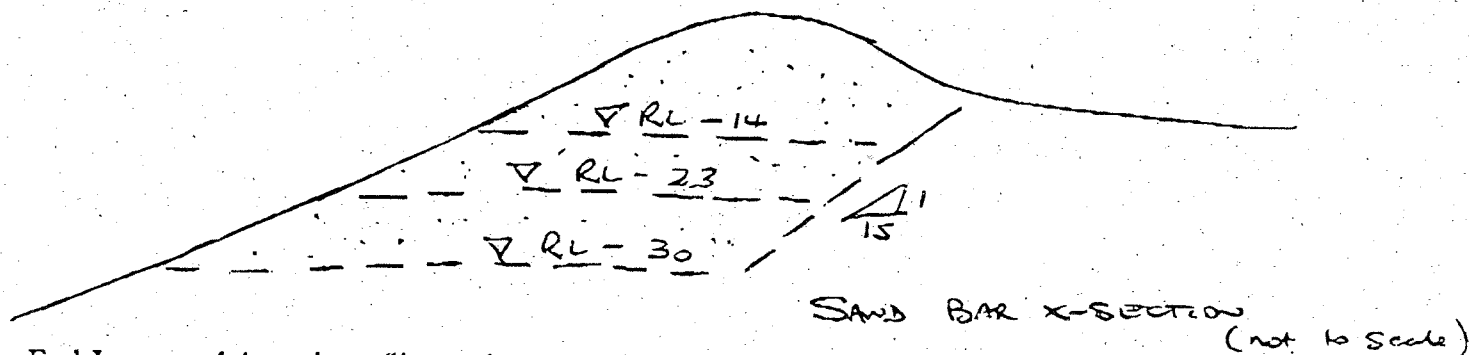
Andrew,

CULLEN BAY EIS - BAR VOLUMES

The question has been raised about the actual quantity of sand in the sandbar. This depends on how the bar is defined.

In the 1992 coastal report, the bar volume was quoted at 3,000,000 m³. This was based on the volume above the line drawn through the bar between the RL-5 contour and the RL-14 contour, for the length of the bar from the southern tip to the northern extent of dredging.

A more appropriate definition of the bar is to take a cross section from the rear of the bar down at an average slope of about 1 in 15, then horizontally out to the front face. This cross section is illustrated for a variety of different depths in the following sketch.



Earl James and Associates (licensed surveyors) have calculated the volume in the bar for the full length of the bar, as follows:

<u>Toc depth</u>	<u>Bar volume</u>
RL-30	48,780,000 m ³
RL-23	29,810,000 m ³
RL-14	11,030,000 m ³

The proposed dredge volume of 850,000 m³ is a very small proportion of the total bar volume.

Regards,

Tony Byrne

KINHILL



Except that dredging below -14.0 m AHD may be permitted as directed by the Superintendent between chainage 0.00 and chainage 1,000.00 to a maximum depth of - 23.0 m and to a line defined by the extension of the design slope designated on the Drawings.

If dredging is carried out beyond the dredging lines by an amount exceeding the allowable tolerance then the over-dredging shall be made good by filling to restore the sandbar to the dredging lines as shown on the Drawings.

2.4 DREDGING OF OUTER HARBOUR

Dredging of the outer harbour and entrance channel shall be carried out to the dredging lines shown on the drawings.

The dredging lines represent the clearance lines for the harbour and channel. All material shall be removed from within the dredging lines.

Allowable tolerance on dredging within the outer harbour shall be: *(to RL -7.2) (changed)*

- Horizontal dimensions; minus zero, plus 1.0m
- Levels; plus 0.2m, minus 0.3m *(changed)*.

Allowable tolerances on dredging lines for the entrance channel, clear of breakwater, shall be: *(to RL -7.2) (changed)*

- Horizontal dimension; minus zero, plus 2.0 m
- Levels; plus 0.2m, minus 0.3m *(changed)*.

Over excavation, beyond allowable tolerance limits shall be made good by filling unless otherwise directed by the Superintendent.

2.5 DREDGING OF INNER HARBOUR

Dredging of the inner harbour shall be carried out to the dredging lines and levels shown on the Drawings.

The dredging lines for the inner harbour represent clearance lines and all material shall be removed from within the dredging lines.

Allowable tolerances on dredging for inner harbour are:

- Horizontal dimensions; plus or minus 0.5
- Levels; plus zero, minus 0.3m *(changed)*.

Over-excavation, beyond the allowable tolerances, shall be made good by filling unless otherwise directed by the Superintendent.

(end extract)



3. CLEARANCE SURVEY

A clearance survey shall be carried out by Davidson Dredging on completion of dredging in accordance with 22.2 of the Technical Specification 105.

The results of the clearance survey are to be supplied to Thiess who will have Earl James check the profiles.

4. WEEKLY PROGRESS REPORT

Davidson Dredging shall provide to Thiess a weekly progress report which details the following, separately for Dredge 12 & 14.

- (a) Operational hours;
- (b) Delay hours and major causes of delays;
- (c) Quantities for : Dredge 14 from density flow meter;
Dredge 12 estimated.
- (d) Quantities to date.

5. SECHI DISK READING

Secchi disk readings are required to be taken weekly as listed in Appendix B. These readings will be taken mutually by Thiess and Davidson Dredging.

6. ALLOWABLE TOLERANCES FOR DREDGING

(Extract from Technical Specification 105)

2.4 DREDGING OF SANDBAR

Dredging of the sandbar shall be carried out in the areas and within the limits shown on the drawings, as directed by the Superintendent to adequately obtain the reclamation volumes.

Dredging operations shall be conducted in such a way that the amount of turbidity generated is a minimum.

The limits of dredging on the sandbar as defined by the shapes, lines and levels on the Drawings are hereinafter referred to as 'dredging lines'.

The dredging lines shown on the drawings for the sandbar represent the form and shape of the sandbar which must remain after completion of dredging.

Dredging shall be confined within the dredging lines and no dredging shall extend beyond the dredging lines by more than the allowable tolerance. Allowable tolerance shall be 5m horizontally and 2m vertically.



APPENDIX E:

WORK PROCEDURE FOR RECORDING OF DREDGING PROFILES AND VERIFICATION OF QUANTITIES DREDGED. (DRED)

1. PRE DREDGE VERIFICATION SURVEY

- (a) Sandbar : Hydrographic survey conducted by Davidson Dredging has been submitted to Earl James for clarification. Any discrepancies in levels to be mutually verified in accordance with section 2.2.1 of the Technical Specification.
- (b) Outer Harbour : Davidson Dredging have agreed to adopt Earl James pre dredge survey.
- (c) Inner Harbour : Davidson Dredging to conduct a pre dredge survey as agreed between Davidson Dredging and Thiess Contractors.

2. INTERIM PROGRESS SURVEYS

As agreed Davidson Dredging are to conduct progress surveys of all areas dredged during the previous month. These shall be at 1 month intervals and are to be on the following lines:

- (a) Sandbar @ 15m centres;
- (b) Outer harbour @ 20m centres;
- (c) Inner Harbour @ approximately 20m centres or random lead lining.

The progress survey is to be conducted using current methods presently in place by Davidson Dredging and generally as follows:

- (a) Boat to be positioned at start of line by use of surveyor on shore or fixed marks on shore.
- (b) Echo sound using Raytheon De-719B along line with position fixing at intervals using a pulsar hand held EDM.
- (c) Tide level to be recorded at end of each line.

The results from the hydrographic survey are to be plotted as long sections and the required dredging profile is to be marked on these sections. Total volume excavated from natural surface is to be calculated and supplied with the long section on a monthly basis. These are to be submitted to Thiess Contractors who will advise Earl James to verify if required.

Any dredging outside the specified tolerances will be notified as a non-conformance and Thiess will advise the action required following discussions with Davidson Dredging.

- The proponent should:

- a) undertake a full clearance survey of the area dredged for the existing dredging operation (approved extraction volume of 300,000 m³ - Miscellaneous Licence 1820) to the satisfaction of the Department of Transport and Works prior to the commencement of any additional dredging; and
- b) rectify and restore any area where dredging tolerance levels had been exceeded, to the satisfaction of the Department of Transport and Works, prior to the commencement of any additional dredging.

- The proponent should:

- a) undertake a full clearance survey of the area dredged for the additional dredging operation (volume of 550,000 m³) to the satisfaction of the Department of Transport and Works prior to the decommissioning of the dredge plant; and
- b) rectify and restore any area where dredging tolerance levels had been exceeded, to the satisfaction of the Department of Transport and Works, prior to the decommissioning of the dredge plant.

- Further dredging of the Emery Point Sandbar should be suspended for 12 months following the extraction of the additional 550,000 m³ of material to allow for investigations to confirm the integrity of the sandbar.

- The proponent should:

- a) survey the sandbar 12 months after the additional material has been extracted and thereafter re-survey the sandbar each May and October for a period of four years;
- b) submit the survey results to the Minister for Lands, Housing and Local Government together with an annual explanatory statement by a qualified coastal engineer;
- c) 12 months after the additional material has been extracted, audit the effects of dredging the sandbar (which would include physical and mathematical modelling to determine the accuracy of predictions concerning the protective function of the sandbar), in accordance with Clause 15 (i) of the Administrative Procedures of the *Environmental Assessment Act*; and prepare and submit an audit report to the Minister for Conservation.

- Turbidity testing should not be made a condition of consent should the dredging be approved.

NORTHERN TERRITORY OF AUSTRALIA

Crown Lands Act

MISCELLANEOUS LICENCE NO 1820

Licence to go upon Crown lands and take therefrom stone, sand, gravel, clay or earth not being or supposed to be metalliferous.

Whereas Thiess Contractors Pty Ltd of 1627 Coonawarra Road, Winnellie NT applied for a licence to go upon Crown lands and to take therefrom stone, sand, gravel, clay or earth not being or supposed to be metalliferous.

Now, therefore, in pursuance of the Crown Lands Act, the said Thiess Contractors Pty Ltd is hereby licensed to go upon the Crown lands situated at Emery Point Sandbar ("the sandbar") in the Town of Darwin as edged red on Attachment A and to take therefrom a volume of 300,000m³ of the abovementioned substance or article during the period from the ninth day of October 1992 to the thirty-first day of January 1993, subject to the provisions of the said Act and the Regulations thereunder. This Licence is subject to:

1. Dredging of the sandbar is only to be carried out in accordance with dredging profiles and program approved by the Secretary of the Department of Transport and Works.
2. The Licensee will ensure that the permitted works and those operations associated with the permitted works do not impinge upon the existing integrity of the sandbar.
3. Final form of the sandbar is to be to the satisfaction of the Secretary of the Department of Transport and Works.
4. The Licensee shall meet its obligation with respect to any requirements of the Darwin Port Authority, and shall comply with any conditions set out in the letter of consent to dredge from that Authority.
5. The Licensee will notify the Work Health Authority with regard to the scope of the permitted works prior to their commencement as per the requirements of the Construction Safety Act.
6. The Licensee shall meet its obligations in respect to any requirements of the Power and Water Authority concerning the protection of live power cables situated within the sandbar.

7. The Licensee shall arrange for a licensed surveyor to survey both the extraction area and the location where the fill is to be deposited to determine the quantity of sand dredged. The survey is also to be carried out half way through the dredging as well as on completion.


The Licensee will also carry out surveys of both areas at any other times as directed by the Minister administering the *Crown Lands Act*, provided that the interval between surveys is not less than 30 days.

The Licensee shall provide copies of all surveys and reports on quantities of sand dredged, certified by the surveyor, to the Director, Property Client Services within seven days of the completion of the survey.

The Licensee shall maintain continuous records of the quantity of material dredged and shall provide estimates of the quantity sand dredged based upon this information, at least weekly, to the Director, Property Client Services, together with details of profile monitoring and conformity with approved profiles.

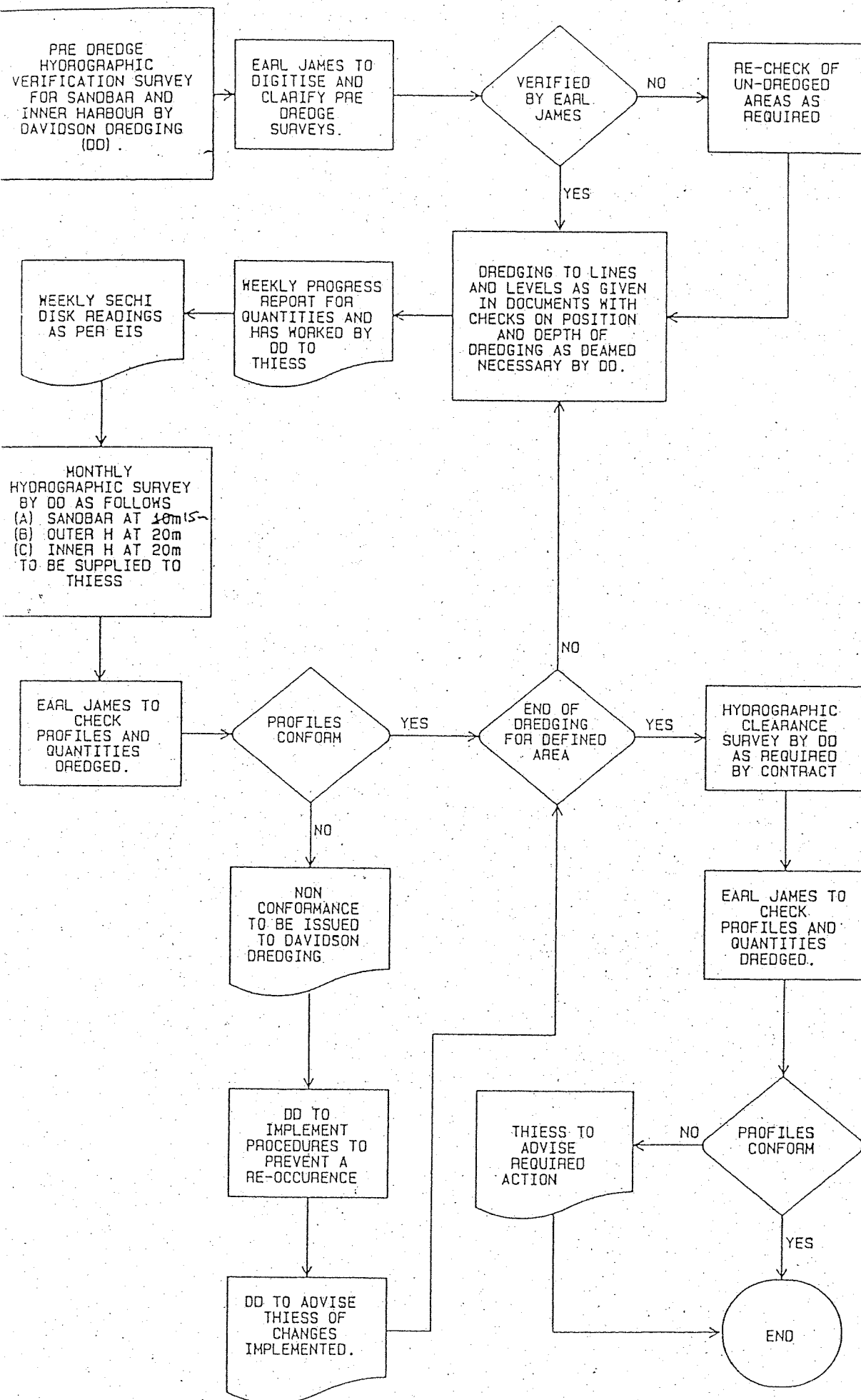
8. The Licensee shall comply with all conditions of subdivision consent contained in Instrument of Determination S2131 dated 8 March 1991, as applicable to the land held under this Miscellaneous Licence No 1820.
9. The Licensee shall comply with any direction of the Minister administering the Crown Lands Act or his delegate duly delivered to the Licensee.
10. Notwithstanding any of the above the Licensee shall ensure that the requirements of all relevant authorities are met.

DATED this NINTH day of OCTOBER 1992


MICHAEL JOHN RENNIE
Delegate of the Minister

DREDGING TO LINES AND LEVELS AS GIVEN IN DOCUMENTS WITH CHECKS ON POSITION AND DEPTH OF DREDGING AS DEAMED NECESSARY BY DD.

MULLEN BAY MARINA: (Work procedure DRED)



Conclusion

The quantity of material proposed to be dredged from the Emery Point Sandbar is relatively small in relation to the overall quantity of sand in the sandbar. It is also clear from further investigations conducted on the sandbar that it is a significantly larger feature than that identified in the 1987 EIS and early modelling tests. It is considered that the current EIS and supporting documentation provides adequate information on the existing coastal environment and functions of the Emery Point Sandbar to allow confident predictions to be made on the potential impacts of additional dredging of the sandbar. This conclusion is supported by Government advisory bodies and the independent assessment.

From the studies undertaken by the proponent, being the best available information on the sandbar and local coastal processes, it is concluded that the form and function of the sandbar would not be altered as a result of additional dredging as described in the EIS. Dredging would not result in any measurable change to waves and currents, and would not alter the supply of sediment or the processes which form and shape the sandbar and adjacent beaches. The proposed dredging should not significantly alter the profile or wave attenuation characteristics of the Emery Point Sandbar.

Natural accretion of the sandbar will continue, however, this rate is not critical to the protective function of the sandbar.

The recommendations in this report concerning the monitoring program and the commitments made by the proponent will ensure that the dredging volumes can be accurately determined and that the form and function of the sandbar will be properly monitored.

The independent assessment by Port and Harbour Consultants Pty. Ltd. concurs with the above conclusion, and considers that the additional dredging "in the form proposed should result in minimum impacts to the sandbar and beach coastal processes and also should maintain cyclone protection currently afforded to the Cullen Bay area".

Port and Harbour Consultants Pty. Ltd. also concluded that the "dredging of the Emery Point Sandbar should be restricted to a maximum quantity of 850,000 m³ within the specified design lines and grades until further monitoring allows better quantitative estimates of the dynamics of the sandbar". The assessment has shown this maximum quantity to be conservative.

Finally, it is concluded that, in general, the proponent has adequately addressed all relevant issues and those comments raised by Government and the public on the Draft EIS.

The Conservation Commission considers that the requirements and objective of the *Environmental Assessment Act 1982* and the Administrative Procedures have been met by the proponent.