

In May 2016 the Special Minister of State asked Infrastructure Victoria to provide advice on the future capacity of Victoria's commercial ports. Specifically, the Minister has asked for advice on when the need for a second container port is likely to arise and which variables may alter this timeline. The Minister has also asked for advice on where a second container port would ideally be located and under what conditions, including the suitability of, and barriers to investing in, sites at the Port of Hastings and the Bay West location.

In undertaking this task, Infrastructure Victoria reviewed work that was completed as part of the Port of Hastings development project before it was cancelled in 2014. This document forms part of the initial work undertaken for the proposed port development at Hastings. Infrastructure Victoria considers that much of the previous Hastings work, although preliminary in nature, is relevant and suitable for informing a strategic assessment. Therefore, Infrastructure Victoria has made the reports previously commissioned for the development project part of the evidence base on which Infrastructure Victoria will use in providing the Minister with advice.

The opinions, conclusions and any recommendations in this document are based on conditions encountered and information reviewed at the date of preparation of the document and for the purposes of the Port of Hastings Development Project.

Infrastructure Victoria and its consultants have used the information contained in these reports as an input but have not wholly relied on all the information presented in these reports.

Memo

HASKONING AUSTRALIA PTY LTD

To : Christian Taylor
From : Ali Watters
Date : 12/02/2015
Copy : Greg Britton, Nick Lewis, Matt Potter
Our reference : mo8A300-22caw150205_sand scoping
Your Reference : POHDA 2014 HY-WP-22c
Subject : Desktop Investigation of Offshore Sand Availability

EXECUTIVE SUMMARY

Investigations being undertaken at Western Port by the Port of Hastings Development Authority (the Authority) include studies associated with dredged material management. The studies have identified that a significant quantity of capital dredging and land reclamation will be required as part of proposed works associated with a potential second container port and future expansion of bulk and other trades at the port.

In the event that sufficient suitable sand is not available for reclamation purposes from dredging, an offshore source of sand may be required. A desktop review of existing available literature on sediment types offshore from Western Port has been undertaken to identify possible sources of sand.

The information identified through the desktop review indicates that there is likely to be sand offshore of Western Port. This is likely to be a fine to coarse grained, carbonate dominated sand and potentially suitable for reclamation. However, there is a distinct lack of sediment data in the 10 km to 30 km area offshore of Western Port (only 2 recorded samples). Although the desktop review indicates that there is likely to be sand in this area, insufficient data is available to confirm this or to map suitable sources of sand within an economic distance of the port. In addition, where sand has been identified offshore of Western Port, the thickness of the sand deposit is not available (surface samples only were available in the existing studies).

Reef was observed at a number of locations in the studies identified in the desktop review. The southern extent of the nearshore reef and the distribution of reef further offshore needs further investigation.

The following could be undertaken to confirm the existence of a suitable source of sand for reclamation:

- further investigation of possible additional existing data sources through direct consultation with government agencies, universities and the like;
- seabed mapping to confirm the extent of sediment and reef within an economic distance of the Western Port entrance. Techniques could include multibeam survey, sidescan sonar, and remotely operated vehicle (ROV); and

- offshore sampling, possibly in a staged approach, in an area(s) of interest (determined from constraints mapping and other factors). It is important that the method of sampling captures and retains the complete range of particle sizes, e.g. no loss of fines. The method of sampling should also establish the thickness of the sand deposit to a target depth of, say, 4 to 6 m. This would require vibrocoreing techniques.

1 INTRODUCTION

The Port of Hastings is one of four major commercial trading ports operating in Victoria. Each year petroleum product (oil and gas) is handled through the State owned jetties in Western Port. The Port of Hastings Development Authority (the Authority) is assisting the Victorian Government with studies to determine the location of a second container port as well as investigating the potential for future expansion of bulk and other trades at the port. These studies include hydrodynamics, water quality data collection and dredged material management.

The studies have identified that a significant quantity of capital dredging will be required as part of the works to deepen, widen and extend the existing shipping channel into Western Port and to create a berthing and turning area for the proposed container terminal. A significant area of land reclamation is also required.

In the event that sufficient suitable sand is not available for reclamation purposes from dredging of shipping areas within Western Port, an offshore source of sand may be required. A desktop review of existing available literature on sediment types offshore from Western Port has been undertaken to identify possible sources of sand. The offshore sand could be sourced by a Trailer Suction Hopper Dredger (TSHD).

This Memo sets out the findings of the desktop review, includes a map compiling relevant information and provides a description of the available sediment data having regard to its potential use as reclamation material. At the request of PoHDA, no consultation with government agencies, universities or the like has been undertaken to date.

2 GENERAL MORPHOLOGY AND SEDIMENTS OF BASS STRAIT

Bass Strait is a channel (~250km wide) separating southern Victoria from Tasmania. It is bounded by deep ocean on the east and west and forms a shallow continental shelf in comparison to the surrounding 5000 m deep abyssal plains of the Southern Ocean and Tasman Sea (refer **Figure 1**). It consists of a large, shallow central basin named Bass Basin, which has a maximum water depth of 83 m (refer **Figure 2**). The rim of Bass Strait is between 40-50 m deep. Along the rim of Bass Strait are many islands, including King Island and Flinders Island.

North-east of the strait is Gippsland Basin, while Otway Basin lies to the north-west. Prevailing westerly winds cause an overall net flow of water to travel from the west to the east through the Strait.

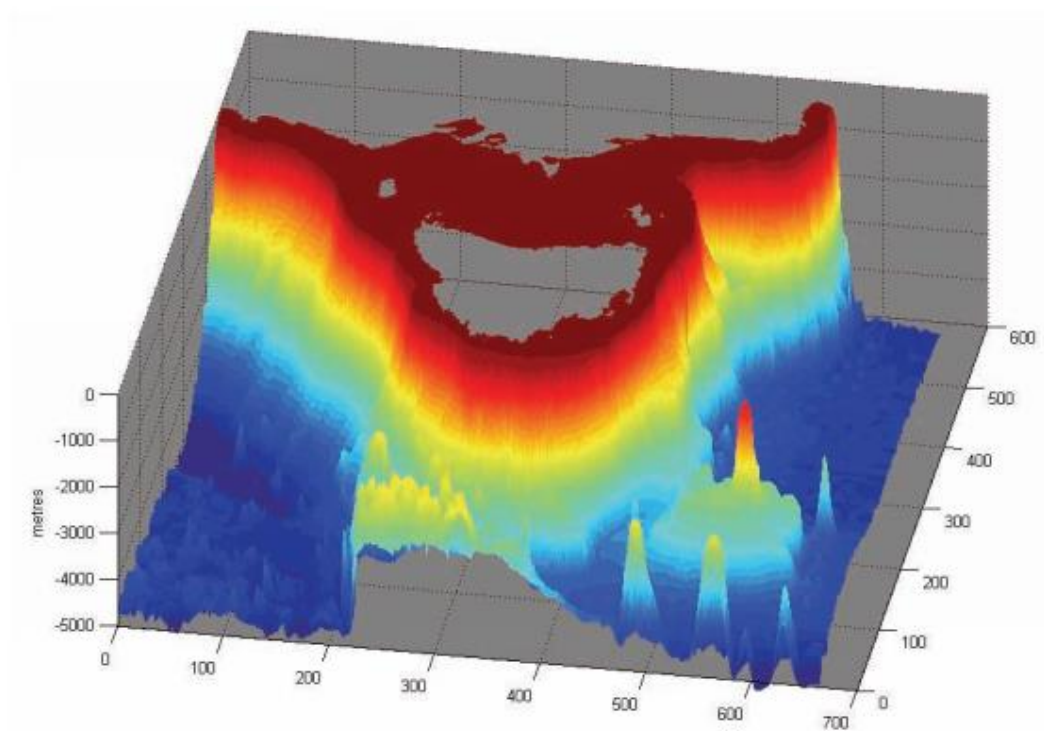


Figure 1 3D View of Bass Strait in Comparison to the Surrounding Ocean Bathymetry (ASR, 2007)

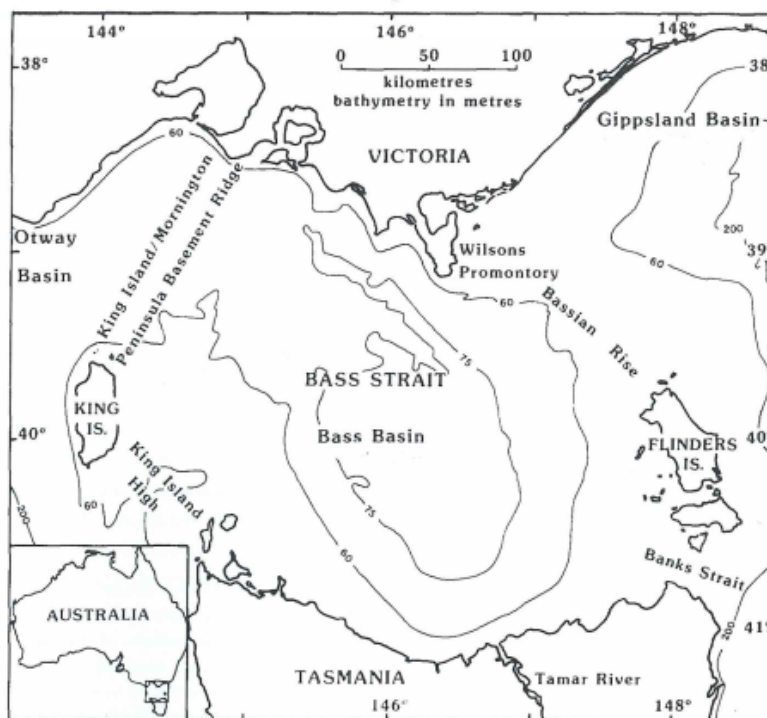


Figure 2 Bathymetry and Geography of Bass Strait (Blom and Alsop, 1988).

Two significant Bass Strait studies undertaken by Jones and Davies (1983) and Blom and Alsop (1988), mapped grain size distribution and carbonate content on the eastern and western margins of Bass Strait. Blom and Alsop (1988) also described the sediments in central Bass Strait. In general, the seabed is characterised by cool-water carbonates with a low terrigenous¹ content (Passlow et al, 2004).

The grain size distribution of surficial sediments in Bass Strait has been mapped (refer **Figure 3**) and described in the report *Sediments and Benthic Biota of Bass Strait: An Approach to Benthic Habitat Mapping* (Passlow et al, 2004). Based on this mapping, the sediments offshore of Western Port are likely to be fine to coarse grained sand. Please note that this map shows that the surficial sediment within Western Port is medium grained sand which is incorrect. Surficial sediments within Western Port are typically sands (various size fractions), silts and clays (refer **Figure 5**).

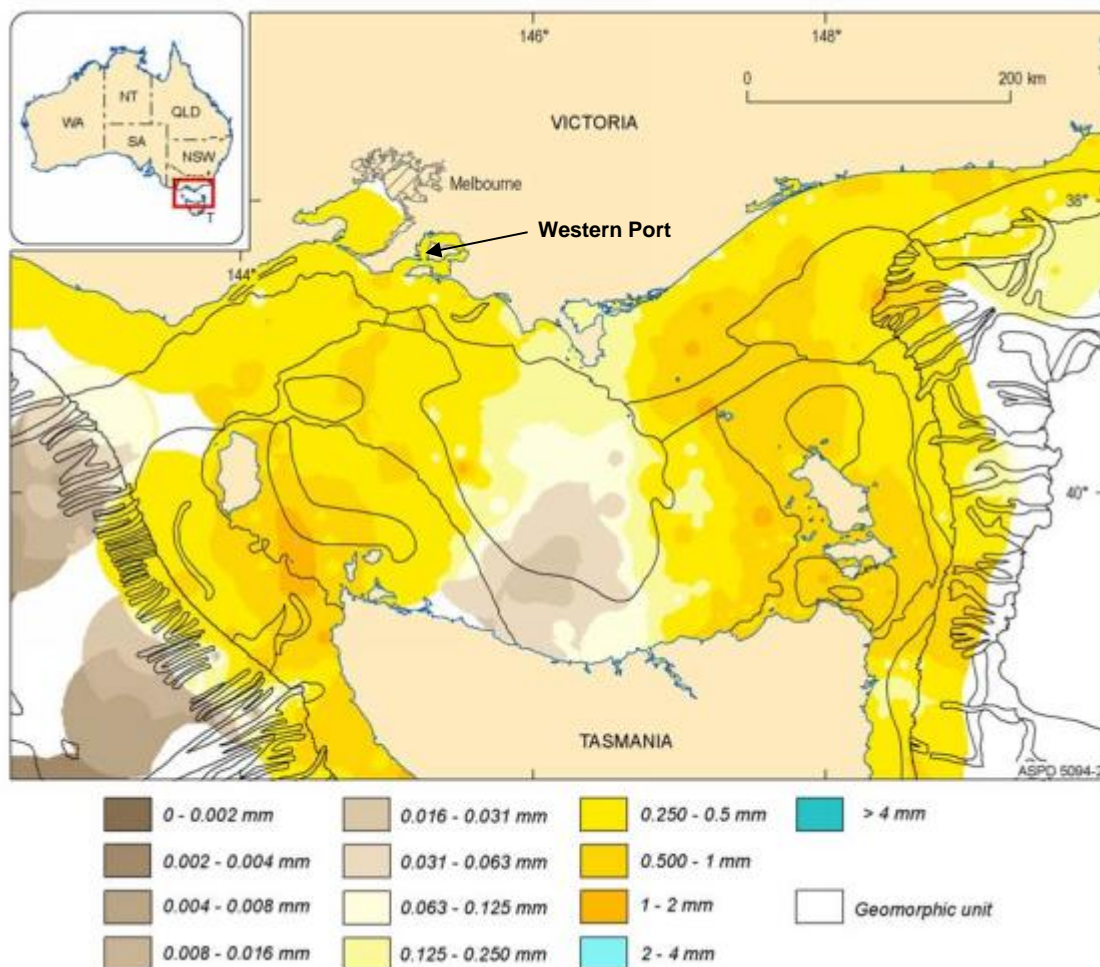


Figure 3 Map Showing Mean Grain Size in Bass Strait (Passlow et al, 2004)

¹ terrigenous - made of material eroded from the land

As described by Passlow et al (2004), fine-grained sediments (muds and silty sands) are restricted to the deeper waters of Bass Basin. Gravels and sands cover the remainder of the shelf (Jones and Davies, 1983). Fine shelly sands occur along the inner shelf of the south-eastern Victorian coast and north of Flinders Island. Moderately well and well sorted² sediments are restricted to nearshore environments and to areas between Flinders Island and Mornington Peninsula. Sediments over the remainder of Bass Strait are poorly to very poorly sorted³ and include quartzose sands, and bryozoan (carbonate) sands and gravels (Passlow et al, 2004).

The carbonate content of sediments in Bass Strait by weight is generally greater than 50%, ranging to over 90% in central Bass Strait (Jones and Davies, 1983; Blom and Alsop, 1988). The carbonate fraction in the coarse sediments generally consists of recognisable skeletal debris derived from bryozoans, molluscs and foraminifera (Jones and Davies, 1983). Mapping of carbonate concentrations in surface sediments in Bass Strait has been undertaken and is shown in **Figure 4**. Based on this mapping the carbonate content of the sediments offshore of Western Port is likely to be between 20% and 60%.

The non-carbonate fraction generally consists of quartz, with minor amounts of lithic⁴ fragments, feldspar and ferromagnesian minerals (Jones and Davies, 1983; Blom and Alsop, 1988). Silica, in the form of sponge spicules, is present in small quantities throughout. Quartz and clay are present also in the mud fraction of basin sediments (Blom and Alsop, 1988).

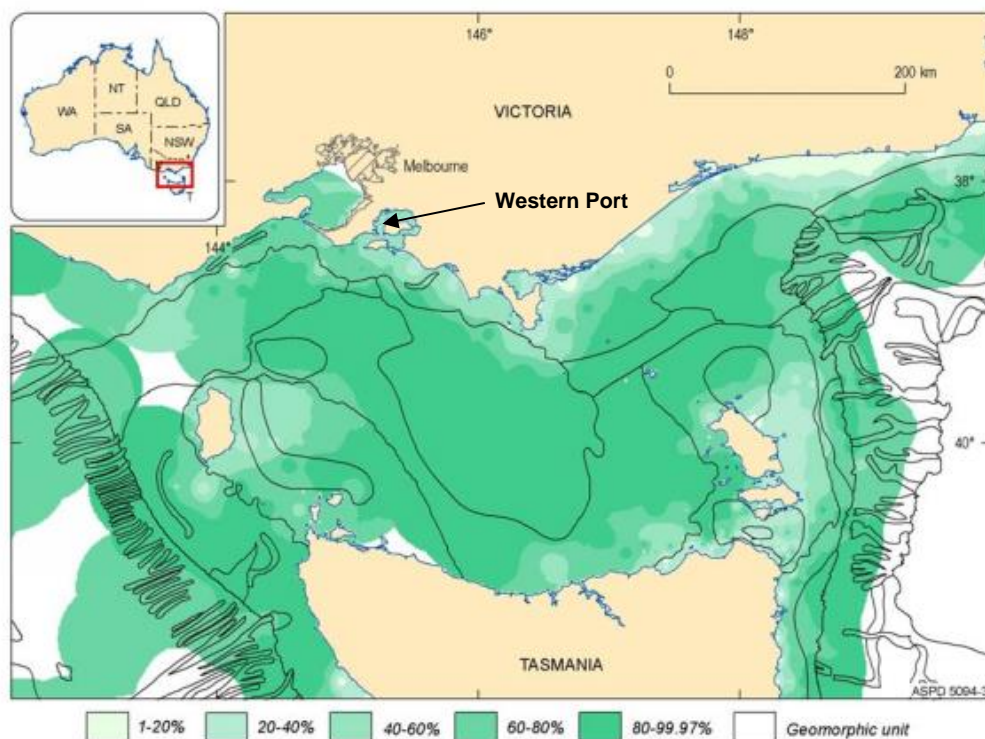


Figure 4 Map of Carbonate Concentrations in Surface Sediments in Bass Strait

² well sorted - sediment sizes are similar (low variance).

³ poorly sorted – sediment sizes are mixed (large variance);

⁴ lithic fragments - pieces of other rocks that have been eroded down to sand size, can be derived from sedimentary, igneous or metamorphic rocks

The low terrigenous content of the Bass Strait sediments is explained as follows by Blom and Alsop (1988):

- sedimentation around Australia's passive margins reflects the continent's history of stability, relative aridity and its low relief (Quilty, 1984).
- low precipitation, and hence low run off rates, has meant that carbonate production during high stands in sea level is little diluted by terrigenous input (Blom and Alsop, 1988)
- most of the modern sediments carried by major rivers, such as the Tamar River in Tasmania, are trapped in estuaries and are unable to deposit into Bass Strait.

3 AVAILABLE DATA

In order to identify specific locations offshore of Western Port where seabed sampling and testing has been undertaken, a desktop review of available information was undertaken. This included:

- searches of State and Commonwealth websites including available online publications and mapping tools;
- searches of online libraries;
- review of publicly available information for recent major projects in the region such as
 - BassGas
 - Basslink
 - the Victorian Desalination Project
- general Google searches using relevant key words.

Sediment sample locations in the vicinity of Western Port identified from the above searches are shown on **Figure 5** and summarised in the table included on **Figure 5**. A description of the source of each dataset is provided below. Note that the sediment data from each source has been retained in its original format, or classification method, for purposes of this report.

The seabed mapping by Marsden et al (1979) shown on **Figure 5** has been classified using the phi scale. The phi unit scale is an alternative measurement to millimetres of the grain size, defined as $\Phi = -\log_2(\text{diameter in millimetres})$. **Table 1** provides a conversion between phi and millimetres.

Table 1 Classification of sediment particles according to size [based on the Udden-Wentworth scale (Wentworth, 1922)]

Particle Size				Size Class	
ϕ		Millimetres			
Lower	Upper	Lower	Upper		
-2	-6	4	64	Pebble	
-1	-2	2	4	Granule	
0	-1	1	2	Very Coarse Sand	
1	0	0.5	1	Coarse Sand	
2	1	0.25	0.5	Medium Sand	
3	2	0.125	0.25	Fine Sand	
4	3	0.063	0.125	Very Fine Sand	
8	4	0.004	0.063	Silt	Mud
Greater Than 8		Less Than 0.004		Clay	

3.1 MARS Sediment Database

Geoscience Australia is a prescribed Australian Government agency that provides geoscience information, services and capability to the Australian Government, industry and stakeholders. Geoscience Australia's Seabed Mapping and Coastal Management project is a collaborative effort between the National Oceans Office and Geoscience Australia. The aim of the project included identification and collation of existing marine sediment data within the Australian marine jurisdiction and development and population of Australia's Marine Sediment (MARS) Database.

The MARS database contains detailed information on seabed sediment characteristics for samples collected from Australia's marine jurisdiction. It includes survey and sample information such as locations, water depths and sample descriptions. Where available, data are also provided from quantitative analyses of the sediments, such as grain size (mud, sand, gravel percentages), carbonate concentrations, mineralogy, age determinations, geochemical properties, and physical attributes for down-core samples including bulk density, p-wave velocity, porosity and magnetic susceptibility.

The MARS online mapping tool has been interrogated. Sample locations within 50 km of Western Port are shown on **Figure 5**. Available sediment texture data is shown in the table on **Figure 5**. Data available from the MARS database was referenced from the following two sources:

1. Ferns, L.W., (ed) (1999), *Environmental Inventory of Victoria's Marine Ecosystems Stage 4 (Part 1) – Physical classification of soft sediment ecosystems*, Parks, Flora and Fauna Division, Department of Natural Resources and Environment, East Melbourne, Australia.

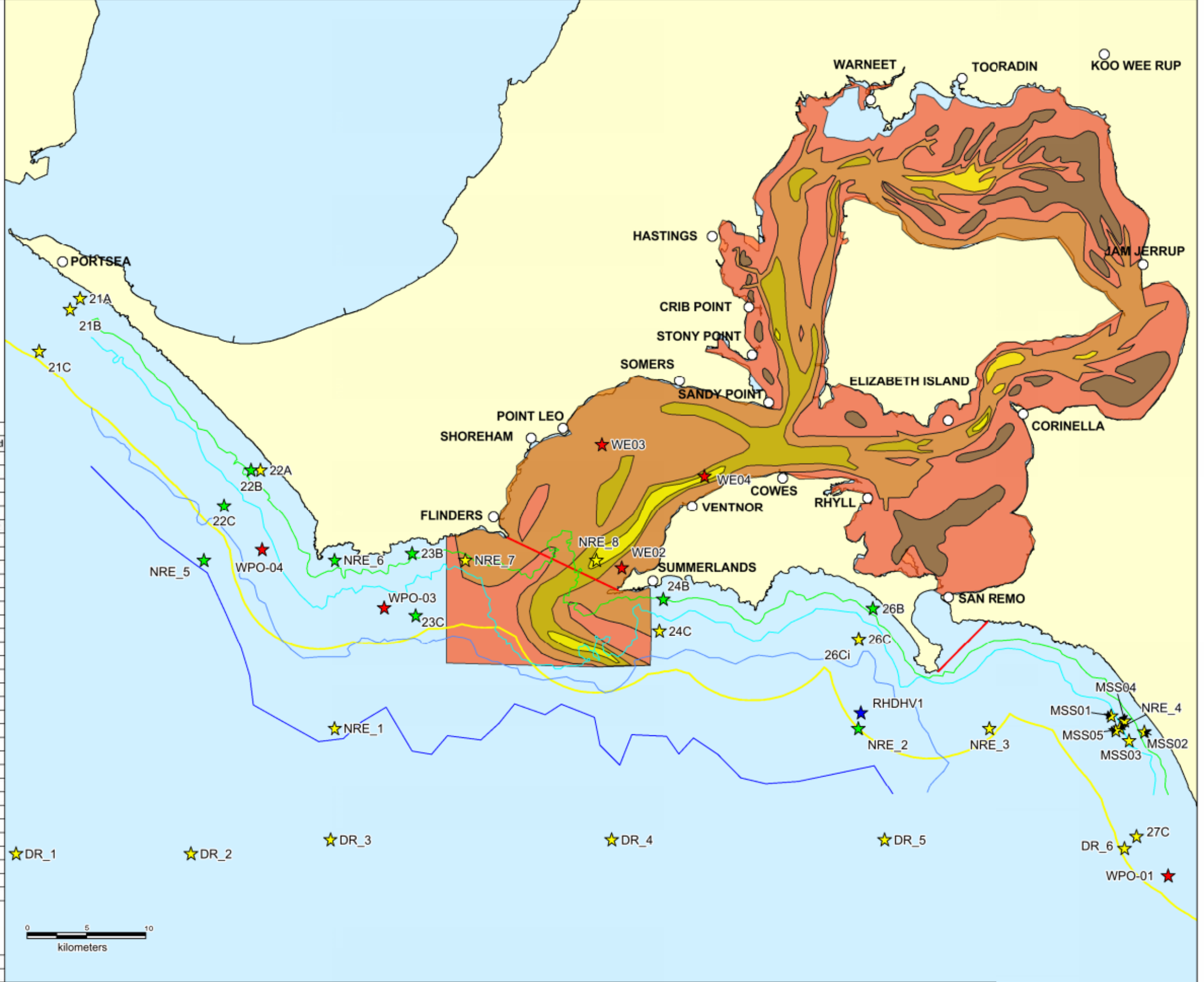
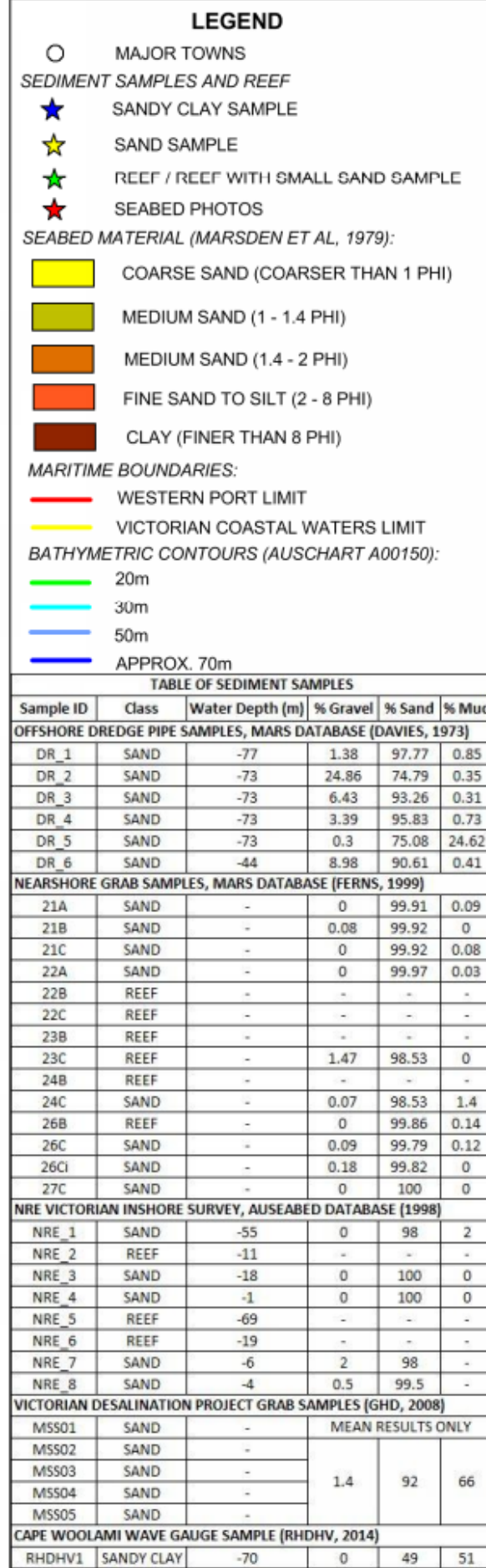
This project included sediment samples from Victorian inshore waters (10m, 20m and 40m depth ranges) with 123 settling column grain size and carbonate analyses. The sites were arranged in shore-normal transects separated by an average of 20 km along the coastline. Sample locations are shown on **Figure 5**. Reef was observed at approximately half the locations near Western Port. The remainder of the samples comprised 98% to 100% sand.

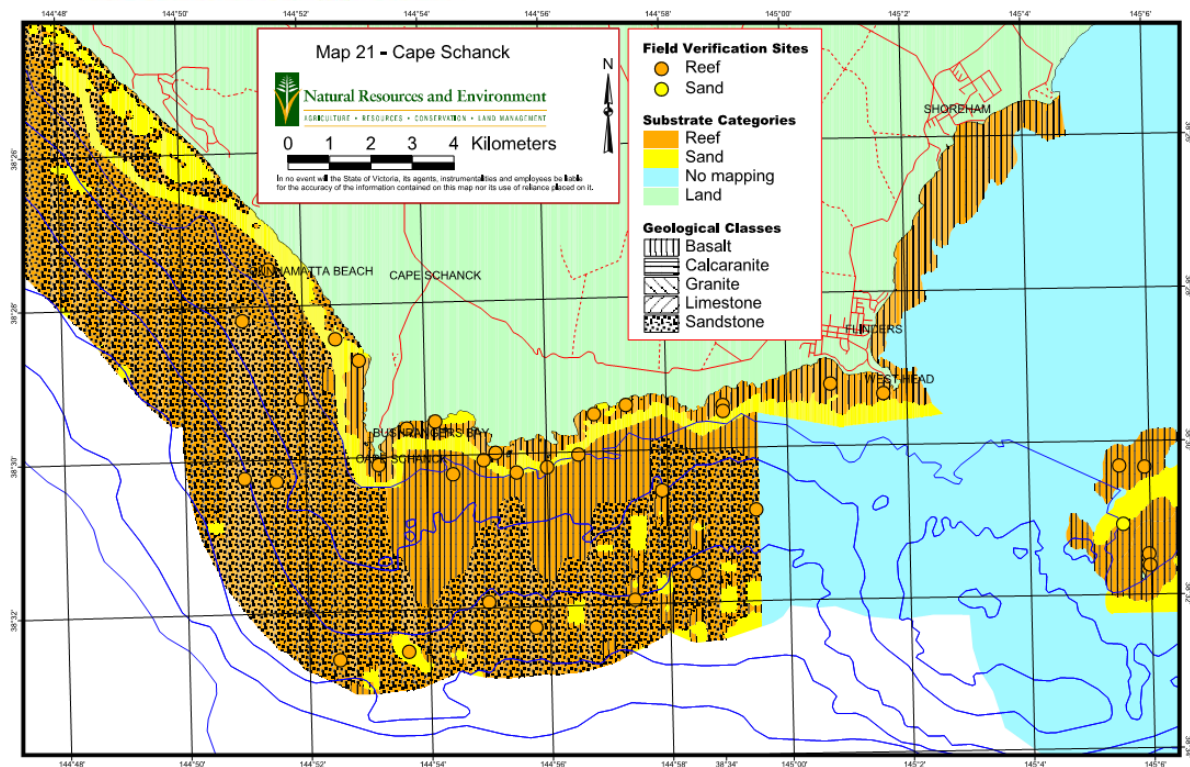
Nearshore mapping of the seabed substrate was also undertaken for the Ferns (1999) report and has been included separately as **Figure 6**.

2. Davies, P.J., Marshall, J.F., (1973), *BMR marine geology cruise in Bass Strait and Tasmanian waters*, Bureau of Mineral Resources, Australia, Record 1973/134 (unpublished).

This dataset comprises an extensive number of sample locations covering Bass Strait. The data was then published in:
Jones, H.A. and Davies, P.J., (1983), *Superficial sediments of the Tasmanian continental shelf and part of Bass Strait*, Bureau of Mineral Resources, Geology and Geophysics Bulletin 218. 25pp.

These samples all comprised 75% to 98% sand.





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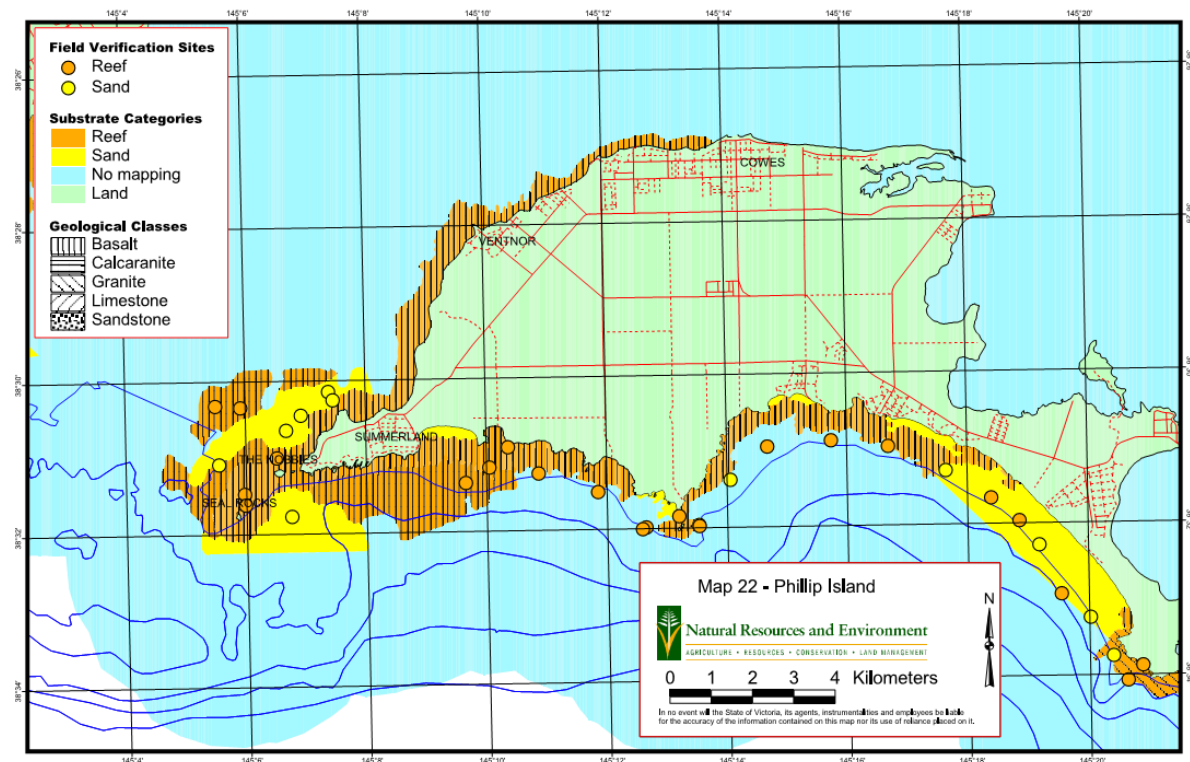


Figure 6 Nearshore Mapping of Seabed Substrate (Ferns, 1999)

3.2 AUSEABED Database

AUSEABED was created by Dr Chris Jenkins, a former staff member of the School of Geoscience, Sydney University, to describe the seabed materials of the Australian maritime region. The AUSEABED database contains over 200,000 sample sites Australia-wide. The information has been built up steadily since 1990 in a database structure which is able to combine numerical (analytical) and word-based (descriptive) forms of information (Jenkins, 1997).

The AUSEABED online mapping tool has been interrogated. Sample locations within 50 km of Western Port are shown on **Figure 5**. Data not included in the MARS database but available from the AUSEABED mapping included an additional 8 locations. The source of these locations was referred to in AUSEABED as the NRE Victorian Inshore Survey (1998). It has not been possible to determine the exact source of this data but it is considered most likely to be associated with one of the stages of the Department of Natural Resources' project titled Environmental Inventory of Victoria's Marine Ecosystems.

There is also some uncertainty around the accuracy of these 8 sample locations as the coordinates for the sample locations recorded in AUSEABED are provided in decimal degrees rounded to only one decimal place.

Reef was observed at approximately half the locations near Western Port. The remainder of the samples comprised 98% to 100% sand.

3.3 Marsden et al (1979)

This report assesses the physical and geological features of Western Port and gives an overview of the types and distribution of the sediment within the Port. Approximately 600 bottom sediment samples were collected throughout Western Port and in a nearshore area of Bass Strait.

Depths in the western entrance channel normally exceed 20m and reach 30m, dropping typically to about 70m in Bass Strait about 12km offshore. This report shows that the sediments at Western Port in the nearshore area of Bass Strait are fine to coarse grained sands. The sediments become progressively sandier in the outer parts of the Port, typically grading from sandy muds to muddy sands. Mapping of the seabed material prepared as part of this study is shown on **Figure 5**. As noted earlier, the seabed material has been classified using the phi scale for this project. **Table 1** provides a conversion between phi and millimetres.

3.4 Recent Major Bass Strait Projects

The desktop review did not identify any publically available information in the vicinity of Western Port that was associated with the BassGas or Basslink projects.

Review of the Environmental Effects Statement (EES) for the Victorian Desalination project identified 5 sediment sampling locations near the desalination intake. Offshore sediment sampling was undertaken in April 2008. The sediments were sampled using a Van Veen grab sampler from a boat. The samples were all described as sand. It is noted in the EES (GHD, 2008) that numerous additional sample locations were attempted but the area was dominated by

reef. The sample locations are shown on **Figure 5** however they are a significant distance from the area likely to be of most interest if sand is to be sourced from offshore of Western Port.

The field observations of the physical characteristics of the 5 samples indicated that the sediment was sand dominant, fine to very coarse grained and sub angular to rounded (GHD, 2008). The sand types were described as predominantly calcareous and quartz with a variable percentage of shell grit and reef debris (10% to 50%) (GHD, 2008).

Particle size testing of the samples was undertaken and the following summary table included in the EIS.

Table 2 Victorian Desalination Project Particle Size Analysis Summary (GHD, 2008)

Size Fraction		Mean (%)	SD (%)	Minimum (%)	Maximum (%)
Fine to Coarse Gravel	>2.36 mm	1.4	1.7	0.0	4.0
Medium to Coarse Sand	0.3 – 2.36 mm	77.0	13.5	59.0	88.0
Fine Sand	0.075-0.3 mm	15.0	12.4	4.0	34.0
Silt and Clay	<0.075 mm	6.6	4.3	3.0	14.0

3.5 RHDHV sample

In September 2014, a sediment sample was recovered during the retrieval operations for the Cape Woolamai wave gauge frame (the sample was adhered to the frame when lifted to the surface). The sample location is shown on **Figure 5** (water depth of 70 m). The sample has been tested for its particle size distribution and the results show it is a sandy clay (49% sand).

In addition, photographs of the seabed have been captured during deployment of instruments. The location of each photograph is included on **Figure 5**. A copy of the photographs and description of the seabed is included in **Attachment 1**.

4 SUMMARY COMMENTS

The information identified through this desktop review indicates that there is likely to be sand offshore of Western Port. This is likely to be a fine to coarse grained, carbonate dominated sand and potentially suitable for reclamation. Where sand has been identified offshore of Western Port, the thickness of the sand deposit is not available (surface samples only were available in the existing studies). There is also a distinct lack of sediment data in the 10 km to 30 km area offshore of Western Port.

Reef was observed at a number of locations in the studies identified in the desktop review. The southern extent of the nearshore reef and the distribution of reef further offshore needs further investigation. Investigation techniques to confirm the extent of sediment and reef within an economic distance of the Western Port entrance could include multibeam survey, sidescan sonar, and remotely operated vehicle (ROV).

Further investigation of possible additional existing data sources through direct consultation with government agencies, universities and the like could be undertaken to try to fill the data gap. In

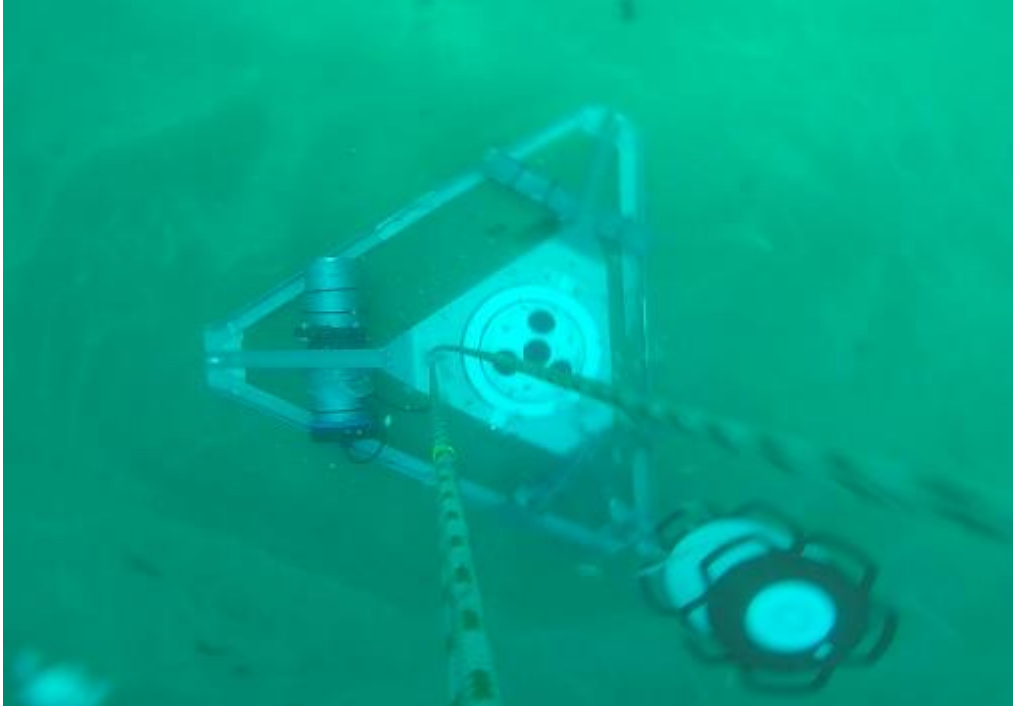
addition, offshore sampling, possibly in a staged approach, in an area(s) of interest (determined from constraints mapping and other factors) could be undertaken to confirm the presence of a suitable source of sand for reclamation activities. Should sampling be undertaken, it is important that the method of sampling captures and retains the complete range of particle sizes, e.g. no loss of fines. The method of sampling should also establish the thickness of the sand deposit to a target depth of, say, 4 to 6 m. This would require vibrocoreing techniques.

5. REFERENCES

- ASR (2007), *Description of the Bass Strait Physical and Geological Marine Environment*, report prepared for the Victorian Desalination Project Environmental Effects Statement.
- Blom W A and Alsop D B (1988), Carbonate mud sedimentation on a temperate shelf.
- Davies, P.J., Marshall, J.F., (1973), *BMR marine geology cruise in Bass Strait and Tasmanian waters*. Bureau of Mineral Resources, Australia, Record 1973/134 (unpublished).
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- Jones H A and Davies P J (1983), *Superficial sediments of the Tasmanian continental shelf and part of Bass Strait*, BMR Bulletin 21.
- Marsden et al (1979), *Geological and Physical setting, sediments and environments*, Western Port, Victoria.
- Passlow et al (2004), *Sediments and Benthic Biota of Bass Strait: An Approach to Benthic Habitat Mapping*, Geoscience Australia, Canberra.
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- Quilty, P.G (1984), *Phanerozoic climates and environments of Australia*, Oxford Geological Series, 2.

ATTACHMENT 1

Site: WE02, **Location:** 145°7.160, -38°30.273, **Depth:** approx. 10m



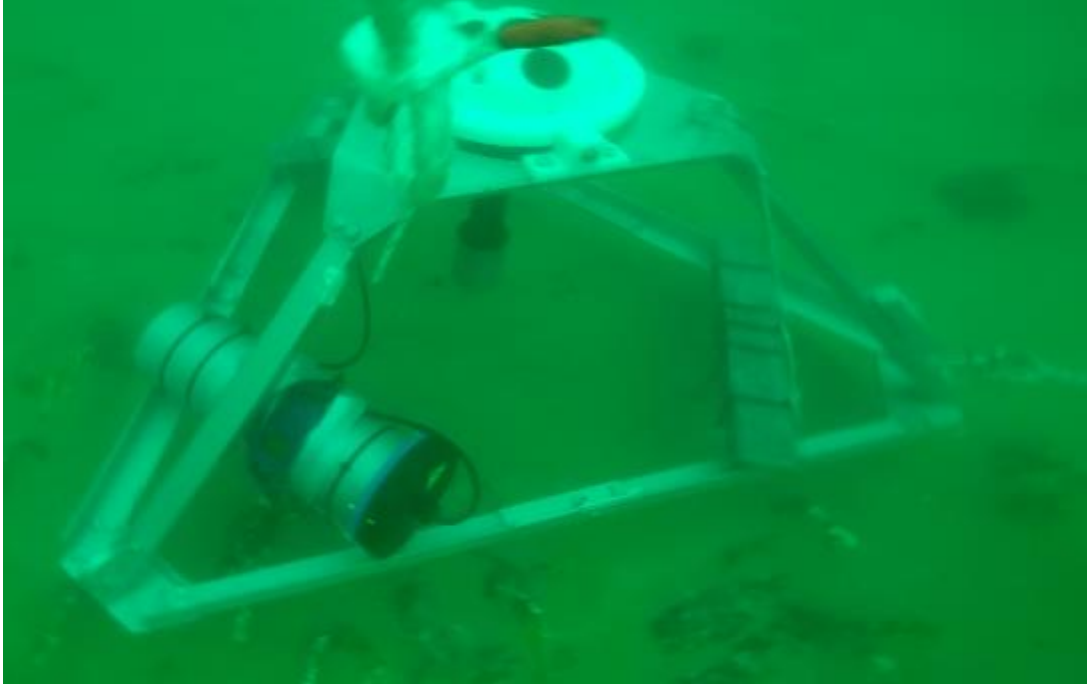
Comments: Predominantly sandy substrate

Site: WE03, **Location:** 145°6.255, -38°25.845, **Depth:** approx. 9.5m



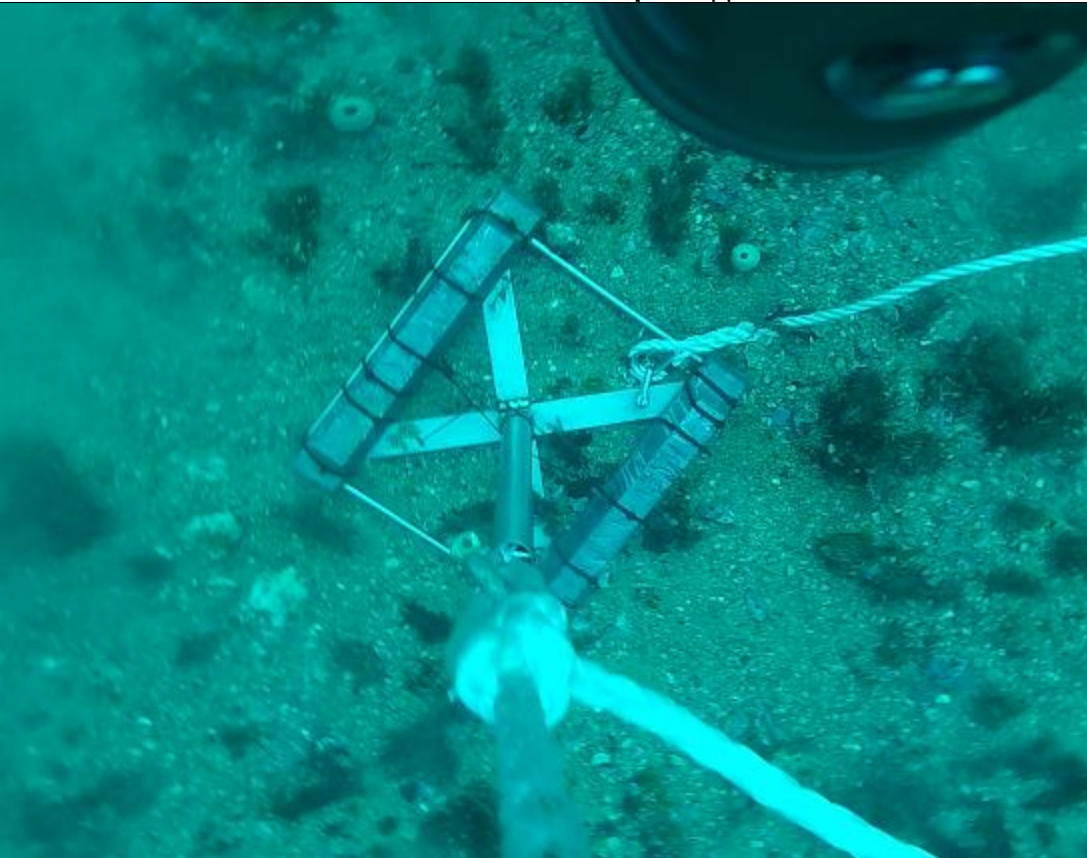
Comments: Predominantly sandy substrate with patches of sea-grass

Site: WE04, **Location:** 145°10.958, -38°26.980, **Depth:** approx. 20m



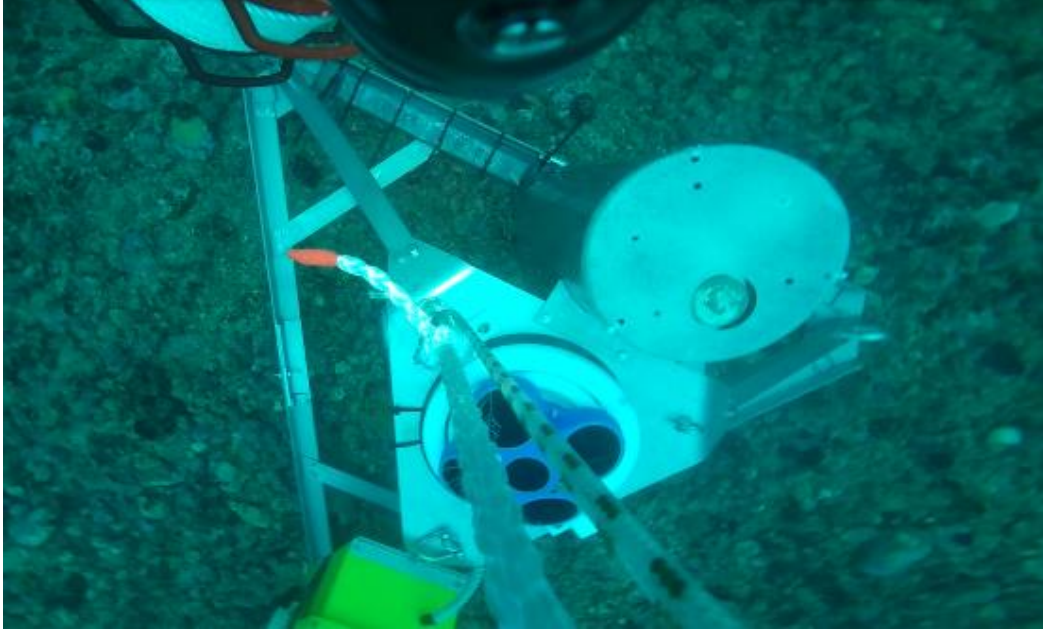
Comments: Predominantly fine sand substrate with patches of sea-grass

Site: WPO-01, **Location:** 145°32.189, -38°41.268, **Depth:** approx. 37m



Comments: coarse sand and shell fragments with patches of sea-grass and reef

Site: WPO-03, **Location:** 144°56.276 -38°31.689, **Depth:** approx. 36m



Comments: hard rock substrate with shell fragments and pebbles

Site: WPO-04, **Location:** 144°50.663, -38°29.615, **Depth:** approx. 38m



Comments: hard rock substrate with shell fragments and pebbles, coarse sand and shell fragments with patches of sea-grass and reef