Portsea Front Beach Remediation

Long Term Options Assessment

16th November 2016

Level 12, 141 Walker St
North Sydney NSW 2060
Australia

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Synopsis

Options to ameliorate the erosion processes at Portsea Front Beach have been designed, modelled and assessed for their effectiveness, sustainability, cost and environmental impacts.

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<table>
<thead>
<tr>
<th>Rev</th>
<th>Description</th>
<th>Author</th>
<th>Review</th>
<th>Advisian Approval</th>
<th>Date</th>
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<tbody>
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</tbody>
</table>

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# Contents

Summary ........................................................................................................... xi

1  Introduction ........................................................................................................ 1

   1.1  Preamble ........................................................................................................ 1

   1.2  Options .......................................................................................................... 1

      1.2.1  Erosion Control Options ........................................................................ 1

      1.2.2  Further Options ..................................................................................... 6

   1.3  Basis for Options Assessment ..................................................................... 11

   1.4  Community Consultation ........................................................................... 11

2  Coastal Processes ........................................................................................... 14

   2.1  Existing Conditions ...................................................................................... 14

      2.1.1  Wave Energy Distribution ...................................................................... 14

      2.1.2  Cross-shore Transport of Littoral Drift ................................................ 15

      2.1.3  Alongshore Sediment Transport Rates and Budget ............................. 15

      2.1.4  Implications and Prognosis for Shoreline Change .............................. 16

   2.2  Configuration Dredging ............................................................................... 17

      2.2.1  Introduction ............................................................................................ 17

      2.2.2  Wave Energy Distribution ...................................................................... 17

      2.2.3  Cross-shore Transport of Littoral Drift ................................................ 17

      2.2.4  Alongshore Transport of Littoral Drift ................................................ 17

      2.2.5  Implications and Prognosis for Shoreline Change .............................. 19

   2.3  Offshore Breakwater .................................................................................... 20

      2.3.1  Introduction ............................................................................................ 20

      2.3.2  Wave Energy Distribution ...................................................................... 20

      2.3.3  Cross-shore Transport of Littoral Drift ................................................ 22
2.3.4 Alongshore Transport of Littoral Drift ........................................ 22
2.3.5 Implications and Prognosis for Shoreline Change ...................... 23

2.4 Groyne ................................................................................. 24
2.4.1 Introduction ....................................................................... 24
2.4.2 Wave Energy Distribution .................................................. 24
2.4.3 Cross-shore Transport of Littoral Drift ................................. 24
2.4.4 Alongshore Transport of Littoral Drift ................................ 24
2.4.5 Implications and Prognosis for Shoreline Change ................. 26

2.5 Beach Nourishment .............................................................. 27
2.5.1 Introduction ....................................................................... 27
2.5.2 Wave Energy Distribution .................................................. 27
2.5.3 Cross-shore Transport of Littoral Drift ................................. 27
2.5.4 Alongshore Transport of Littoral Drift ................................ 28
2.5.5 Implications and Prognosis for Shoreline Change ................. 28

2.6 Rock Revetment ..................................................................... 28
2.6.1 Introduction ....................................................................... 28
2.6.2 Wave Energy Distribution .................................................. 28
2.6.3 Cross-shore Transport of Littoral Drift ................................. 28
2.6.4 Alongshore Transport of Littoral Drift ................................ 28
2.6.5 Implications and Prognosis for Shoreline Change ................. 28

2.7 Removal of the Sandbag Revetment ....................................... 29
2.7.1 Introduction ....................................................................... 29
2.7.2 Wave Energy Distribution .................................................. 29
2.7.3 Cross-shore Transport of Littoral Drift ................................. 29
2.7.4 Alongshore Transport of Littoral Drift ................................ 29
2.7.5 Implications and Prognosis for Shoreline Change ........................................ 29
3 Cost Estimates ........................................................................................................ 31
4 Options Assessment ............................................................................................... 32

4.1 Configuration Dredging ....................................................................................... 32
  4.1.1 Impacts on Coastal Processes (including Degree of Protection) ........ 32
  4.1.2 Beach Restoration ......................................................................................... 32
  4.1.3 Impact on Marine Ecology, Visual Amenity and Safety ....................... 32
  4.1.4 Effectiveness and Uncertainties ................................................................. 32
  4.1.5 Construction Cost and Timing ................................................................. 33

4.2 Detached Offshore Breakwater ......................................................................... 34
  4.2.1 Impacts on Coastal Processes (including Degree of Protection) ........ 34
  4.2.2 Beach Restoration ......................................................................................... 34
  4.2.3 Impact on Marine Ecology, Visual Amenity and Safety ....................... 34
  4.2.4 Technical Effectiveness and Uncertainties ............................................... 34
  4.2.5 Construction Cost and Timing ................................................................. 35

4.3 Attached Breakwater ......................................................................................... 35
  4.3.1 Impacts on Coastal Processes (including Degree of Protection) ........ 35
  4.3.2 Beach Restoration ......................................................................................... 35
  4.3.3 Impact on Marine Ecology, Visual Amenity and Safety ....................... 35
  4.3.4 Technical Effectiveness and Uncertainties ............................................... 36
  4.3.5 Construction Cost and Timing ................................................................. 36

4.4 Point Franklin Groyne ..................................................................................... 36
  4.4.1 Impacts on Coastal Processes (including Degree of Protection) ........ 36
  4.4.2 Beach Restoration ......................................................................................... 37
  4.4.3 Impact on Marine Ecology, Visual Amenity and Safety ....................... 37
4.4.4 Technical Effectiveness and Uncertainties .................................................. 37
4.4.5 Construction Cost and Timing .................................................................... 37

4.5 Portsea Front Beach Groyne ......................................................................... 38
4.5.1 Impacts on Coastal Processes (including Degree of Protection) .......... 38
4.5.2 Beach Restoration ....................................................................................... 38
4.5.3 Impact on Marine Ecology, Visual Amenity and Safety ......................... 38
4.5.4 Technical Effectiveness and Uncertainties ................................................. 38
4.5.5 Construction Cost and Timing .................................................................... 38

4.6 Beach Nourishment ......................................................................................... 39
4.6.1 Impacts on Coastal Processes (including Degree of Protection) .......... 39
4.6.2 Beach Restoration ....................................................................................... 39
4.6.3 Impact on Marine Ecology, Visual Amenity and Safety ......................... 39
4.6.4 Technical Effectiveness and Uncertainties ................................................. 39
4.6.5 Construction Cost and Timing .................................................................... 40

4.7 Rock Revetment ............................................................................................. 40
4.7.1 Impacts on Coastal Processes (including Degree of Protection) .......... 40
4.7.2 Beach Restoration ....................................................................................... 40
4.7.3 Impact on Marine Ecology, Visual Amenity and Safety ......................... 40
4.7.4 Technical Effectiveness and Uncertainties ................................................. 41
4.7.5 Construction Cost and Timing .................................................................... 41

4.8 Summary Comparative Assessment Matrix .................................................. 41

5 Summary and Conclusions .............................................................................. 43
6 References ......................................................................................................... 44
Appendices

Appendix A: Concept Designs
Appendix B: Modelling
Appendix C: Costing
Appendix D: Marine Ecology
Appendix E: Glossary
Appendix F: Brief
Appendix G: Drawings
Appendix H: Videos

Figures

Figure 1. Portsea Front Beach shoreline 5 June 2014 showing sand bag revetment to the east and rock revetment around the root of Portsea Pier. Since this photograph was taken, the rock revetment has been extended westward to protect the eroding shoreline there. (photos credit WorleyParsons).

Figure 2. Configuration Dredging Options. Top: Schematic diagrams of possible wave reflection trenches on the Quarantine Bank (left) and inshore of the Portsea Hole (right). Centre: Yellow area denotes the planform extent of beach nourishment. Subaerial beach widening with dredged material would be some 30 m. Bottom: Typical cross-section of nourished beach at Portsea Pier. The beach is shown to extend some 30 m from RL +2 m AHD to −4 m AHD.

Figure 3. Offshore Breakwater. The structure depicted is a rock-fill rubble-mound armoured with large rock. An alternative form of breakwater structure could comprise a braced sheet piling wall. Length = 220 m, distance offshore = 180 m. A pile of sand, termed a salient, would build up on the lee shore behind the breakwater. For a salient extending 56 m from the shore, 24,000m$^3$ of sand nourishment is required. A further 60,000 m$^3$ of nourishment sand would be required to widen the beach some 20 m as indicated.

Figure 4. Attached Breakwater. The structure is a rubble-mound “T-type” attached breakwater of length 260 m some 180 m offshore. The western “T” extension (70 m) protects the fillet of littoral drift (sand), which accumulates against the western side of the breakwater root, from swell wave incidence and, hence, offshore sand transport and erosion. A sand bypassing system would be required to transport the up-drift sand fillet to the down-drift beaches beyond Point Franklin. On
the eastern side of the breakwater root, beach sand would accumulate slowly adjacent to the Portsea Pier. 60,000 m$^3$ of nourishment sand would be required to widen the beach some 20 m. ...

Figure 5. Point Franklin headland groyne. Top: Planform of groyne and subaerial beach extension. The groyne is a rubble-mound structure founded on bedrock. The beach fill required to widen the beach some 20 m and to obviate erosion of down-drift beaches is some 100,000 m$^3$. Maintenance nourishment at a rate of 16,000 m$^3$/a would be required to maintain the beach. Bottom: Cross-section of groyne and beach fill. ...

Figure 6. Portsea Front Beach headland Groyne. The groyne is a rubble-mound structure. The beach fill required to widen the beach some 20 m and to obviate erosion of down-drift beaches is some 65,000 m$^3$. Maintenance nourishment at a rate of 8,000 m$^3$/a would be required to maintain the beach. ...

Figure 7. Rock Revetment. The slope of the structure ensures the geotechnical stability of the dune with an acceptable factor of safety against slope instability. The armour rock units would be 700 kg and tightly packed. ...

Figure 8. Beach Nourishment. The initial volume of sand required would be in the order of 150,000 m$^3$, which would widen the beach to some 50 m. This would last around 5 years. To maintain a beach, maintenance nourishment would be required to be undertaken periodically at a rate of 30,000 m$^3$/a. ...

Figure 9. Images and sizes of Reef Balls (from Reef Ball Australia brochure) ...

Figure 10. Short breakwaters 40 m long with 50 m spaces at 80m offshore of nourished beach ...

Figure 11. Typical formats for the Artificial Marine Habitat invention as portrayed in the patent application ...

Figure 12. Artificial Marine Habitat layout suggested by Mr Samuel Bennett ...

Figure 13. Poster used for the first Community Consultation meeting ...

Figure 14. Results from the wave transformation modelling (Boussinesq) for existing conditions. Top: The distribution of swell wave heights in the vicinity of Portsea Front Beach for an offshore significant wave height of 1.5 m with a peak wave period of 12 seconds on mid-tide level. Colour shading represents increasing wave height and energy from blue (lowest wave height) to dark red (largest wave height). Bottom: Wave crest patterns. The green lines depict wave crests. The brighter the green tone the higher the wave crest. At Portsea Front Beach the green tone is much brighter than that along the western shoreline of Weeroona Bay, indicating wave energy focussing there. 14

Figure 15. Alongshore variation in simulated wave height coefficients along Portsea Front Beach at the −5 m AHD isobath between Police Point and Point King for existing conditions as obtained with the Boussinesq wave model. The wave height coefficient is the ratio of the wave height nearshore to the incoming wave height from offshore. 15
Figure 16. Calculated annual rates of littoral drift transport from 350 m west of Police Point to 400 m east of Point Franklin for existing conditions..............................15

Figure 17. Projected shoreline change for the existing conditions (Baseline Case). This projection has assumed that the existing sand bag revetment will remain effective in arresting foreshore recession.................................................................16

Figure 18. Top: Plan of a configuration dredging depression being a 700 m × 160 m × 10 m deep pyramidal parallelogram. Area of footprint is some 110,000 m². The volume of dredging is 650,000 m³ with 350,000 m³ of sand to be used for beach nourishment of Weeroona Bay and 300,000 m³ of calcareous sandstone side-casted over an area 700 m × 150 m on the seaward side of the trench, raising the seabed there by around 4 m. Yellow to red shading denotes areas of higher wave energy, red being the highest. Bottom: Wave crest patterns. The modelling shows that the dredged configuration would cause swell wave energy to be reflected away from Portsea Front Beach to be dissipated on sandbanks to the east.................................................................18

Figure 19. Distribution of wave height coefficients at -5 m isobath along Weeroona Bay for the nearshore dredged configuration as shown in Figure 18. The wave height coefficient at Portsea Pier has been reduced from a maximum of 0.2 for existing conditions (Figure 15) to 0.12, representing a 65% reduction in incident wave energy.................................................................19

Figure 20. Calculated annual rates of littoral drift transport from 350 m west of Police Point to 400 m east of Point Franklin for the nearshore dredged configuration option. The significant reduction in the potential rate of littoral drift transport has resulted in the elimination of any differential in the transport rates along the Weeroona Bay foreshore, which, along with a significant reduction in the degree of cross-shore sand transport, thereby eliminating the cause of beach erosion at Portsea Pier.................................................................19

Figure 21. Projected shoreline change for the nearshore dredged trench configuration. Note that the projection has not included initial widening of the beach by 30 m.................................20

Figure 22. TOP: Boussinesq wave modelling for a 220 m long detached breakwater at the −6 m AHD isobath at Portsea Front Beach shows the breakwater reflecting swell wave energy away from Portsea Front Beach to be dissipated on sandbanks to the north-east. Some wave energy leaks around the ends of the breakwater. Yellow to red shading denotes areas of higher wave energy, red being the highest. Bottom: Wave crest patterns. Note the north-easterly wave reflection patterns off the detached breakwater and the reduced wave height intensity inshore of the detached breakwater.................................................................21

Figure 23. Wave height coefficients along the −5 m AHD isobath inshore of the detached breakwater. At the shoreline the wave height would be distributed more evenly due to wave diffraction inshore of the breakwater, as indicated by the dashed curve. The detached breakwater has little impact on shoreline wave conditions west of Portsea Pier and east of Point Franklin........22

Figure 24. Calculated annual rates of littoral drift transport along the existing shoreline from 350 m west of Police Point to 400 m east of Point Franklin for the detached breakwater options.............22
Figure 25. Projected shoreline change for the detached breakwater option. The extent of salient development was modelled to be 50 m (Appendix B). Note that the projection has not included initial widening of the beach by 20 m................................................................. 23

Figure 26. Calculated annual rates of littoral drift transport from 350 m west of Police Point to 400m east of Point Franklin for the Point Franklin groyne option........................................... 25

Figure 27. Calculated annual rates of littoral drift transport from 350 m west of Police Point to 400m east of Point Franklin for the Portsea Front Beach groyne option........................................... 25

Figure 28. Model prognosis for shoreline change for a groyne at Point Franklin assuming no initial beach nourishment............................................................................................................ 26

Figure 29. Model prognosis for shoreline change for a groyne on Portsea Front Beach assuming no initial beach nourishment............................................................................................................ 27

Figure 30. Prognosis for shoreline change with the removal of the revetment........................................... 30

Tables

Table 1. Options Developed and Assessed in this Investigation.................................................. 2

Table 2. Summary Cost Estimates.................................................................................................. 31

Table 3. Timing Estimate for the Configuration Dredging Option.................................................. 33

Table 4. Timing Estimate for the Detached Breakwater Option................................................... 35

Table 5. Timing Estimate for the Attached Breakwater Option................................................... 36

Table 6. Timing Estimate for the Point Franklin Groyne Option................................................... 37

Table 7. Timing Estimate for the Portsea Front Beach Groyne Option........................................ 39

Table 8. Timing Estimate for the Beach Nourishment Option..................................................... 40

Table 9. Timing Estimate for the Rock Revetment Option........................................................... 41

Table 10. Summary Comparative Assessment Matrix..................................................................... 42
Summary

In recent years some 400 m of the Portsea Front Beach foreshore has been eroded severely by swell waves resulting in an estimated 25 m to 30 m of beach erosion near the Portsea Pier and necessitating the construction of revetment protection with the consequential loss of the subaerial beach.

A wave monitoring and modelling investigation to inform future management options was undertaken (Advisian 2016) and herein options have been examined utilising the tidal hydrodynamics, wave transformation and sediment transport models developed in the investigation stage.

The following options to ameliorate the erosion processes at Portsea Front Beach have been designed, modelled and assessed for their effectiveness, sustainability, cost and environmental impacts:

- Configuration Dredging
- Breakwaters
- Groynes
- Sand Nourishment
- Revetments

Consideration has been given also to the removal of the recently-constructed sandbag revetment.

Of the options considered, only the configuration dredging and offshore breakwater options address the primary cause of erosion at Portsea Front Beach. Groynes and sand nourishment options come with ongoing sand nourishment maintenance costs. Removal of the recently-constructed sand bag revetment protection structure would result in the loss of several buildings within 10 years.

Should further consideration be given to the nearshore configuration dredging option, some preliminary geotechnical investigation would need to be undertaken to prove its feasibility.
1 Introduction

1.1 Preamble

In recent years some 400 m of the Portsea Front Beach foreshore has been eroded severely by swell waves, resulting in an estimated 25 m to 30 m of beach erosion near the Portsea Pier. The Victorian Department of Environment, Land, Water and Planning (“the Department”) has responded to this erosion by protecting the foreshore and assets through reconditioning existing shoreline protection structures, constructing rock revetments and a 160 m long geotextile sandbag seawall, depicted in Figure 1.

![Portsea Front Beach shoreline 5 June 2014 showing sand bag revetment to the east and rock revetment around the root of Portsea Pier. Since this photograph was taken, the rock revetment has been extended westward to protect the eroding shoreline there. (photos credit WorleyParsons).](image)

The Department commissioned WorleyParsons (now branded Advisian) to undertake a wave monitoring and modelling investigation in consultation with the Portsea community and stakeholders with the objective to inform future management options. That work was reported in January 2016 (Advisian 2016).

In April 2016 the Department commissioned Advisian to examine options to ameliorate the erosion and to remediate Portsea Front Beach; the options to be examined utilising the tidal hydrodynamics, wave transformation and sediment transport models developed in the investigation stage and to be assessed for their effectiveness and sustainability, cost and environmental impact.

1.2 Options

1.2.1 Erosion Control Options

Six options designed to ameliorate coastal erosion at Portsea Front Beach were identified for assessment in this investigation, with some options having a number of scenarios as outlined in Table 1.
Table 1. Options Developed and Assessed in this Investigation

<table>
<thead>
<tr>
<th>No.</th>
<th>Option</th>
<th>Description</th>
<th>Scenarios Examined</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
<td>Configuration Dredging</td>
<td>Shaping the seabed with dredging to modify the distribution of wave energy along the Portsea Front Beach shoreline to minimise erosion. Dredged material could be used to restore the beach.</td>
<td>Nearshore and offshore configurations.</td>
</tr>
<tr>
<td></td>
<td>(Figure 2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Breakwater</td>
<td>This is a shore-parallel structure offshore of Portsea Pier that would block the incoming swell wave energy that is causing erosion at Portsea Front Beach.</td>
<td>Attached and detached breakwaters.</td>
</tr>
<tr>
<td></td>
<td>(Figure 3, Figure 4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Groyne</td>
<td>A structure extending seaward from the shore that would capture beach sand being transported eastward, thereby building the beach and providing a sand buffer to erosion.</td>
<td>Two groyne configurations, one at Point Franklin and another on Portsea Front Beach.</td>
</tr>
<tr>
<td></td>
<td>(Figure 5, Figure 6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Rock Revetment</td>
<td>A rock revetment would halt recession of the shoreline.</td>
<td>With and without sand nourishment.</td>
</tr>
<tr>
<td></td>
<td>(Figure 7)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Beach restoration with sand nourishment</td>
<td>The periodic placement of sand mined from the offshore sand banks to feed the erosion process.</td>
<td>One scenario.</td>
</tr>
<tr>
<td></td>
<td>(Figure 8)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Remove sandbag revetment</td>
<td>This explores what would be the extent of erosion that could occur if no remedial works are undertaken.</td>
<td>One scenario.</td>
</tr>
</tbody>
</table>
Figure 2. Configuration Dredging Options. Top: Schematic diagrams of possible wave reflection trenches on the Quarantine Bank (left) and inshore of the Portsea Hole (right). Centre: Yellow area denotes the planform extent of beach nourishment. Subaerial beach widening with dredged material would be some 30 m. Bottom: Typical cross-section of nourished beach at Portsea Pier. The beach is shown to extend some 30 m from RL +2 m AHD to −4 m AHD.
Figure 3. Offshore Breakwater. The structure depicted is a rock-fill rubble-mound armoured with large rock. An alternative form of breakwater structure could comprise a braced sheet piling wall. Length = 220 m, distance offshore = 180 m. A pile of sand, termed a salient, would build up on the lee shore behind the breakwater. For a salient extending 56 m from the shore, 24,000 m$^3$ of sand nourishment is required. A further 60,000 m$^3$ of nourishment sand would be required to widen the beach some 20 m as indicated.

Figure 4. Attached Breakwater. The structure is a rubble-mound “T-type” attached breakwater of length 260 m some 180 m offshore. The western “T” extension (70 m) protects the fillet of littoral drift (sand), which accumulates against the western side of the breakwater root, from swell wave incidence and, hence, offshore sand transport and erosion. A sand bypassing system would be required to transport the up-drift sand fillet to the down-drift beaches beyond Point Franklin. On the eastern side of the breakwater root, beach sand would accumulate slowly adjacent to the Portsea Pier. 60,000 m$^3$ of nourishment sand would be required to widen the beach some 20 m.
Figure 5. Point Franklin headland groyne. **Top:** Planform of groyne and subaerial beach extension. The groyne is a rubble-mound structure founded on bedrock. The beach fill required to widen the beach some 20 m and to obviate erosion of down-drift beaches is some 100,000 m$^3$. Maintenance nourishment at a rate of 16,000 m$^3$/a would be required to maintain the beach. **Bottom:** Cross-section of groyne and beach fill.

Figure 6. Portsea Front Beach headland Groyne. The groyne is a rubble-mound structure. The beach fill required to widen the beach some 20 m and to obviate erosion of down-drift beaches is some 65,000 m$^3$. Maintenance nourishment at a rate of 8,000 m$^3$/a would be required to maintain the beach.
The slope of the structure ensures the geotechnical stability of the dune with an acceptable factor of safety against slope instability. The armour rock units would be 700 kg and tightly packed.

The initial volume of sand required would be in the order of 150,000 m$^3$, which would widen the beach to some 50 m. This would last around 5 years. To maintain a beach, maintenance nourishment would be required to be undertaken periodically at a rate of 30,000 m$^3$/a.

**1.2.2 Further Options**

Options that have been suggested during public consultation have included a variety of artificial reefs, including the system of Reef Balls Australia and an invention of Mr Samuel Bennett, being Artificial Marine Habitat.

**Reef Balls**

Reef Balls are artificial concrete units placed on the seabed. The standard single Reef Ball unit is hemispherical with a hollow centre and a varying number of holes through the side walls as well as the top (Figure 9).
Reef Balls are marketed by Reef Balls Australia for the following applications:

- Artificial reefs for fishing, diving, snorkelling
- Marine and freshwater habitat enhancement
- Compensatory artificial reefs for environmental permits; *e.g.* dredging and development applications
- Oyster substrate for oyster restoration
- Reefs for beach protection and tourism; *e.g.* multipurpose breakwaters
- Fish friendly structures for coastal developments, jetties, resorts, marinas
- Rest-In-Reef: memorial reefs and modules.

![Images of Reef Balls](image)

Figure 9. Images and sizes of Reef Balls (from Reef Ball Australia brochure)

According to Reef Ball Australia, Reef Balls have proven to be effective in over 56 countries and have been selected by the Queensland, New South Wales and Victorian Government for construction of fishing reefs in Australia.

Reef Balls have not been used in Australia for coastal protection. The Reef Ball brochures show the system being deployed in shallow tropical zones where the wave climate is relatively benign and the tidal range is small.
Advice from the Chairman, Reef Ball Foundation (Florida, USA) stated that two meters was the “practical” limit for the Reef Ball solution and that the tops of the Reef Balls should be at around mean sea level. These constraints would put the Reef Ball in around two metres water depth (Figure 10) and it would need anchoring as it would be subject to large horizontal forces resulting from breaking wave action.

![Figure 10. Short breakwaters 40 m long with 50 m spaces at 80m offshore of nourished beach](image)

The Reef Ball would be subjected to a 2 m breaking wave and would need to have a required mass well in excess of 4 t, the current maximum unit under manufacture. Such a structure would need significant anchoring into the sand substrate, for which testing may need to be undertaken. Such severe conditions are beyond the experience of Reef Ball.

Portsea Front Beach, inshore of the Pier Head, is a very popular SCUBA diving and swimming location, including the Portsea Swim Classic and nippers training, and dive charter boats work regularly at Portsea Pier. The segmented Reef Ball breakwater would present obstacles for navigation, obstacles to swimmers and could generate currents adverse to swimmers. For these reasons this nearshore segmented breakwater option, with either Reef Ball or rock, has not been considered further.

**Artificial Marine Habitat**

The Artificial Marine Habitat is the subject of a patent application by Mr Samuel Bennett. As stated in the patent application:

> The Artificial Marine Habitat comprises a vertically-disposed structure incorporating a plurality of deep, open, radially-disposed cells arranged in multiple tiers, the structure can be made monolithic by moulding a suitable material over a plurality of radially-arranged moulds or assembled from pre-moulded, modular elements in stacked arrangement (Figure 11).
The stated objectives of the Artificial Marine Habitat invention are to:

1) provide a method and apparatus for the creation of durable artificial marine habitats homologous with natural reefs
2) be able to provide such artificial marine habitats with a minimum of expense
3) provide such artificial marine habitats in modular form permitting configurations adapted to a variety of marine environments to be readily created
4) provide such artificial marine habitats in a form permitting them to be relocated as required to test or improve their effectiveness or productive efficiency in a variety of marine environments.

According to the patent application:

The present invention creates an artificial marine habitat by stacking pre-moulded, modular elements with complementary surface shaping positioned in opposition such that more or less radially-arranged, open cells are created between said elements. Said components are made from a variety of materials and their said surface shaping take a variety of configurations. Said components are secured together in their assembled state by one or more elongated fastenings extending throughout their stacked depth. Small galleries or apertures extending between adjacent said cells and between said cells and a co-axially arranged gallery permit a free flow of water throughout an assembly of said stacked components. In use, one or more said assemblies are lowered to the floor of a body of water and are rapidly adopted as a habitat by fish or other marine or aquatic life. Said invention is intended for use in all aquatic or marine environments and with any fish or marine animal.

Mr Bennett has suggested a layout for the Portsea Front Beach project as shown in Figure 12.
The layout in Figure 12 of units such as those in Figure 11 would not be practical and would not provide effective coastal protection for Portsea Front Beach for the following reasons:

- **Effective wave protection** will require the units to extend virtually to the water surface. For the units offshore of the Pier, the water depth is some 6 m to 9 m. As such the units would be massive structures that have not been tried previously. The units under the pier would be subjected to breaking wave action. Breaking wave forces are very high and the units have not been tested for such environments. Specifically, the units would need to be monolithic and the detail to effect that would be subjected to impulsive cyclic forces for which the invention has no development, testing or experience.

- **Effective protection against swell wave incidence** traditionally comprises structures that achieve virtually total wave reflection. The layout in Figure 12 is porous in the two-dimensional horizontal space and would enable too high a percentage of wave energy to pass through to the beach. It would not offer sufficient protection for the incident wave energy.

The invention relates generally to the creation of artificial marine habitats for the purpose of rendering marine environments more productive. It relates specifically to apparatus and methods employed in the creation of marine habitats closely homologous with natural reefs. The invention is not a dedicated coastal protection structure.

While not having been tested, it is considered that the invention would lack the robustness required to withstand the degree of swell wave action that occurs on Portsea Front Beach and the layout suggested would not provide adequate protection. For these reasons this proposal has not been given further consideration herein. Further consideration could be given to these units if comprehensive flume testing results by a recognised coastal engineering hydraulic laboratory can be undertaken to prove their effectiveness as coastal protection structures.
1.3 Basis for Options Assessment

The following criteria have been used to assess and evaluate the options for a 50 year design life:

1) Effectiveness of protection to foreshore assets and land
2) Effectiveness of beach restoration with renourishment
3) Cost of capital and maintenance over the design life and planning period, including the cost of any actions required to manage potential impacts, such as erosion and sediment transport
4) Timing to implement options, giving consideration to detailed design, EES and construction
5) Environmental impacts on waves, currents and sediment transport
6) Marine ecology and visual amenity
7) Safety to beach, water and boating activities, navigation for recreational vessels
8) Technical effectiveness, flexibility and uncertainties, including climate change sea level rise.

1.4 Community Consultation

The Portsea Options Assessment is the second stage of an investigation into addressing the issue of coastal erosion and the need for foreshore protection at the Portsea Front Beach.

In late 2013, following concerns from community members about the impacts of coastal erosion, DELWP commissioned a Wave Modelling and Monitoring Investigation. DELWP engaged the consulting firm Advisian to undertake detailed primary data collection and develop numerical models to examine tidal hydrodynamics, wave transformation and sediment transport processes occurring at Portsea Front Beach (Stage 1).

The first Advisian report was made available to interested stakeholders and community members and was also put on the DELWP website.

At the completion of the first stage – the Wave Modelling and Monitoring - DELWP advised that it could now investigate coastal zone management options for Portsea Front Beach (Stage 2). The data collected and the numerical models developed in Stage 1, as well as local input, provided the basis of the information required for the Portsea Options Assessment. After a competitive tender process Advisian was selected to undertake this work.

The Portsea Options Assessment project has been managed by a working group of DELWP staff.

A Stakeholder Group comprising local community representatives, councillors, local businesses and, recently, Parks Victoria and Mornington Peninsula Shire Council staff, was formed for the first investigation (Stage 1) by Advisian and its membership was widened for Stage 2.

Prior to the start of the options assessment the Stakeholder Group discussed the process, and the framework for the options assessment, as well as the options to be assessed and the assessment criteria. This discussion helped inform the brief for the selection of a consultant.

There have been two meetings between the Stakeholder Group and the consultant during the options assessment project.
The first meeting provided the Stakeholder Group with the details of the project, confirming the details of the options to be assessed, that is, the range of scenarios for each option and the proposed time frame. The group also posed questions to the consultant on issues relating to the investigation, and provided local input.

The second Stakeholder Group meeting was held in early August 2016 and the consultant briefed the group on the progress of the assessment of the options, providing some of the initial findings and costings.

In addition to the Stakeholder Group meetings, DELWP also engaged more broadly with the local community through project updates via email to a list of interested community members and community open house meetings. As part of the project, DEWLP is committed to holding two community information sessions to provide the community with an opportunity to meet the consultant, learn about the options assessment and provide feedback and local knowledge.

The first community session was held in Portsea in May 2016 and was attended by around 50 people. DELWP staff and the consultant were available for discussion throughout the drop-in session and information on the six options was provided in poster form (Figure 13). Information on the options was also put on the DELWP website.

The second community session will be held in Portsea in November 2016 to provide the opportunity for the community to view and comment on the final Portsea Options Assessment and speak with the consultant.

The final Portsea Options Assessment report will be a public document made available on the DELWP website.
Figure 13. Poster used for the first Community Consultation meeting.
2 Coastal Processes

2.1 Existing Conditions

2.1.1 Wave Energy Distribution

Under existing conditions there is a significant variation in incident wave energy along the Weeroona Bay foreshore (Figure 14 and Figure 15; Appendix B). Wave energy incident at Portsea Pier is some ten times larger than that on the western shores of Weeroona Bay.

Figure 14. Results from the wave transformation modelling (Boussinesq) for existing conditions. Top: The distribution of swell wave heights in the vicinity of Portsea Front Beach for an offshore significant wave height of 1.5 m with a peak wave period of 12 seconds on mid-tide level. Colour shading represents increasing wave height and energy from blue (lowest wave height) to dark red (largest wave height). Bottom: Wave crest patterns. The green lines depict wave crests. The brighter the green tone the higher the wave crest. At Portsea Front Beach the green tone is much brighter than that along the western shoreline of Weeroona Bay, indicating wave energy focusing there.
Figure 15. Alongshore variation in simulated wave height coefficients along Portsea Front Beach at the −5 m AHD isobath between Police Point and Point King for existing conditions as obtained with the Boussinesq wave model. The wave height coefficient is the ratio of the wave height nearshore to the incoming wave height from offshore.

2.1.2 Cross-shore Transport of Littoral Drift

The cross-shore potential for littoral drift transport at Portsea Pier would extend to around the −4 m AHD isobath (Appendix B). For determining beach nourishment requirements, an active beach profile from +2 m AHD to −4 m AHD has been adopted.

2.1.3 Alongshore Sediment Transport Rates and Budget

The assessment of the sediment budget and the rates of littoral drift transport for Portsea Front Beach have been derived empirically and from modelling in Appendix B.

Annual averaged potential rates of littoral drift transport from 350 m west of Police Point to 400 m east of Point Franklin for existing conditions are shown in Figure 16, indicating that there is the potential for severe erosion of the foreshore as a result of the significant differential in the potential rates of littoral drift transport across Portsea Pier. The calculations indicate an average annual erosion rate of some 30,000 m$^3$/a over this area.

Figure 16. Calculated annual rates of littoral drift transport from 350 m west of Police Point to 400m east of Point Franklin for existing conditions.
Cross-shore distribution of alongshore littoral drift transport potential at Portsea Pier is confined above the −2m isobath (Advisian 2016).

### 2.1.4 Implications and Prognosis for Shoreline Change

Wave focussing around Portsea Pier, as shown in Figure 14 and Figure 15, has created a severe differential in the eastward rate of littoral drift transport, as shown in Figure 16, which has contributed to severe beach erosion there.

The relatively low wave climate over the western part of Weeroona Bay shoreline, as shown in Figure 14 and Figure 15, points to a relatively low rate of alongshore transport of littoral drift towards the east, as shown in Figure 16 and results in a severe differential in the littoral drift transport system through Weeroona Bay. This lack of sediment supply to the eastern part of Weeroona Bay has contributed to erosion there; that is, an unfavourable re-distribution of wave energy along the Weeroona Bay foreshore has contributed to the severe erosion in the vicinity of Portsea Pier, which is likely to continue unless the incident wave climate is altered.

The projected shoreline change for 50 years is depicted in Figure 17.

*Figure 17. Projected shoreline change for the existing conditions (Baseline Case). This projection has assumed that the existing sand bag revetment will remain effective in arresting foreshore recession.*
For this case it has been assumed that the existing sandbag revetment will be sustained and hold foreshore recession along the revetment alignment. Farther to the east the foreshore will re-align to become normal to the direction of the incoming swell wave energy. The strong differential in littoral drift transport along Weeroona Bay would, in the longer term, result in erosion of the western shores of Weeroona Bay.

2.2 Configuration Dredging

2.2.1 Introduction

Nearshore and offshore dredged configurations have been investigated (Appendix A) and the nearshore configuration dredging option was preferred and has been adopted and designed to modify the distribution of wave energy along the Weeroona Bay shoreline to minimise erosion at Portsea Front Beach. Some of the sandy dredged material would be used to restore the beach. Dredged hardpan would be placed on the seaward side of the trench and forms an integral aspect of the configuration dredging schema.

2.2.2 Wave Energy Distribution

The impact of the nearshore dredged configuration on the nearshore wave climate is depicted in Figure 18 and Figure 19, which show a significant reduction in incident wave height at Portsea Pier. There is virtually no change in the wave energy distribution to the east of Point Franklin.

2.2.3 Cross-shore Transport of Littoral Drift

Under the much-reduced nearshore wave climate, cross-shore transport would be reduced significantly (Appendix B).

2.2.4 Alongshore Transport of Littoral Drift

Annual rates of littoral drift transport along the Portsea foreshore resulting from the nearshore dredged configuration are presented in Figure 20 and compared with those as existing, showing that the nearshore dredged configuration trench would be very effective in reducing the rates of alongshore transport of beach sand away from Portsea Front Beach. The transport rates along the western shores of Weeroona Bay would remain unchanged and the rates of littoral drift transport eastward would be equilibrated along the whole of the Weeroona Bay foreshore, thereby eliminating beach erosion resulting from any differential in the rate of littoral drift transport there. There would be a slight increase in the rates east of Point Franklin, which may assist in removing the excess deposits of sand there.
Figure 18. Top: Plan of a configuration dredging depression being a 700 m × 160 m × 10 m deep pyramidal parallelogram. Area of footprint is some 110,000 m². The volume of dredging is 650,000 m³ with 350,000 m³ of sand to be used for beach nourishment of Weeroona Bay and 300,000 m³ of calcareous sandstone side-casted over an area 700 m × 150 m on the seaward side of the trench, raising the seabed there by around 4 m. Yellow to red shading denotes areas of higher wave energy, red being the highest. Bottom: Wave crest patterns. The modelling shows that the dredged configuration would cause swell wave energy to be reflected away from Portsea Front Beach to be dissipated on sandbanks to the east.
Figure 19. Distribution of wave height coefficients at -5 m isobath along Weeroona Bay for the nearshore dredged configuration as shown in Figure 18. The wave height coefficient at Portsea Pier has been reduced from a maximum of 0.2 for existing conditions (Figure 15) to 0.12, representing a 65% reduction in incident wave energy.

Figure 20. Calculated annual rates of littoral drift transport from 350 m west of Police Point to 400m east of Point Franklin for the nearshore dredged configuration option. The significant reduction in the potential rate of littoral drift transport has resulted in the elimination of any differential in the transport rates along the Weeroona Bay foreshore, which, along with a significant reduction in the degree of cross-shore sand transport, thereby eliminating the cause of beach erosion at Portsea Pier.

2.2.5 Implications and Prognosis for Shoreline Change

The nearshore dredged configuration would eliminate the erosion processes from Portsea Front Beach. It could also have a slight beneficial effect in aiding removal of excess sand build up to the east of Point Franklin.

The projected shoreline change is depicted in Figure 21, which indicates that the modified wave climate would result in a stable shoreline alignment along the entire foreshore of Weeroona Bay. It is noted that the option would result in some 30 m widening of the beach (see Figure 2), which has not been shown in Figure 21.
2.3 Offshore Breakwater

2.3.1 Introduction

An offshore breakwater is a shore-parallel structure offshore of Portsea Pier along the −6 m AHD isobath that would block the incoming swell wave energy that is causing erosion at Portsea Front Beach and could be detached, as shown in Figure 3, or attached to form a boat harbour as shown in Figure 4.

2.3.2 Wave Energy Distribution

The detached breakwater would result in the blocking of and reflection of incident wave energy away from Portsea Front Beach (Figure 22) with a concomitant reduction of wave energy at the shoreline, thereby obviating the beach erosion process. At the −5 m AHD isobath the wave height coefficient is reduced by an order of magnitude (Figure 23). An attached breakwater would block completely most of the wave energy reaching the shoreline in its lee as there would be no diffraction of wave energy around its western end.
Figure 22. TOP: Boussinesq wave modelling for a 220 m long detached breakwater at the −6 m AHD isobath at Portsea Front Beach shows the breakwater reflecting swell wave energy away from Portsea Front Beach to be dissipated on sandbanks to the north-east. Some wave energy leaks around the ends of the breakwater. Yellow to red shading denotes areas of higher wave energy, red being the highest. Bottom: Wave crest patterns. Note the north-easterly wave reflection patterns off the detached breakwater and the reduced wave height intensity inshore of the detached breakwater.
2.3.3 Cross-shore Transport of Littoral Drift

Both the detached and attached breakwaters would eliminate virtually the cross shore transport of littoral drift in their lee (Appendix B).

2.3.4 Alongshore Transport of Littoral Drift

The rates of alongshore transport of littoral drift would be reduced significantly in the lee of a detached breakwater (Figure 24). The calculated rates indicate that a salient would form in the lee of the breakwater. Without initial nourishment the beach would erode at a point 170 m east of the Pier and adjacent to the Pier on the western side, as would be expected with salient formation. As the salient would form very slowly, given the low rates of transport as modelled, it would be necessary to build it artificially at the start. Sediment transport rates would not be changed over the western portion of Weeroona Bay or beyond Point Franklin.
Once a salient has been developed it is anticipated that there would be a continuation of eastward transport of littoral drift along the shoreline past the detached breakwater.

An attached breakwater would block the eastward transport of littoral drift.

### 2.3.5 Implications and Prognosis for Shoreline Change

A widening of the beach, called a salient, would be established shoreward of the detached structure and shoreline erosion both to the east and west would occur, which would need to be supplemented with beach nourishment to obviate down-drift beach erosion.

The modelling has projected a salient growth of 50 m (Appendix C), which coincides closely with the empirical estimate of 27 m to 56 m (Appendix A).

![Projected shoreline change: Breakwater 2](image)

**Figure 25.** Projected shoreline change for the detached breakwater option. The extent of salient development was modelled to be 50 m (Appendix B). Note that the projection has not included initial widening of the beach by 20 m.

The attached breakwater, which would block the eastward transport of littoral drift, would need to provide for the bypassing of that sand.
2.4 Groyne

2.4.1 Introduction

A groyne is a rockfill structure extending seaward from the shore that would capture beach sand (littoral drift) being transported to the east, thereby building the beach and providing a sand buffer to erosion. Two structures have been considered, one at Point Franklin and one on Portsea Front Beach. Both structures are supplemented with beach nourishment to obviate down-drift beach erosion. With both structures there would be a continuation of eastward transport of littoral drift.

2.4.2 Wave Energy Distribution

There would be no change to the distribution of wave energy along the beach.

2.4.3 Cross-shore Transport of Littoral Drift

There would be no change from the existing cross-shore sand transport processes on the beach. However, there is a tendency for groynes to form rips, thereby transporting sand seaward and reducing the amount of sand trapping relative to theoretical models. These rips do not cause a groyne to be unviable, just less effective than theory may suggest.

2.4.4 Alongshore Transport of Littoral Drift

2.4.4.1 Point Franklin Groyne

Annual rates of littoral drift transport along the Portsea foreshore resulting from a groyne at Point Franklin are presented in Figure 26 and compared with those as existing. The change in beach alignment that the groyne would induce would result in a reduction in the rates of alongshore transport of littoral drift. However, given the small degree to which the coastal alignment could be changed in the eroded area by the Point Franklin groyne, there would be still a significant deficit in the sediment budget and erosion of the western shore of Weeroona Bay would occur at a rate of 16,000 m$^3$/a.
2.4.4.2 Portsea Front Beach Groyne

Annual rates of littoral drift transport along the Portsea foreshore resulting from a groyne situated on Portsea Front Beach some 250 m east of the Pier are presented in Figure 27 and compared with those as existing.

The significant change in beach alignment that the groyne would induce would result in a significant reduction in the rates of alongshore transport of littoral drift in the eroded area. However, there would be still a deficit in the sediment budget and erosion of the western shore of Weeroona Bay would occur at a rate of 8,000 m$^3$/a. Maintenance sand nourishment would be required periodically to service this erosion potential.
2.4.5 Implications and Prognosis for Shoreline Change

While either groyne system would result in a sizeable sand buffer against dune erosion, neither would arrest the focusing of wave energy onto the shoreline. Hence, during storms there is likely to be significant cross-shore transport of beach sand causing severe foreshore erosion along the shoreline adjacent to the Pier. Re-orientation of the shoreline east of the Pier would reduce the net eastward rate of littoral drift transport, reducing the rate of foreshore erosion. However, with both options there would be a requirement for periodic sand nourishment.

2.4.5.1 Point Franklin Groyne

The model prognosis for shoreline change is depicted in Figure 28.

As shown in Figure 28, without initial nourishment the groyne would take some 20 years to fill up, following this Portsea Front Beach would remain stable and the groyne would commence bypassing. However, the western shoreline of Weeroona Bay would begin to erode as a result of a deficit in the sediment budget generated by a differential in the rates of littoral drift transport along the shoreline.

![Figure 28. Model prognosis for shoreline change for a groyne at Point Franklin assuming no initial beach nourishment.](image)

2.4.5.2 Portsea Front Beach Groyne

The model prognosis for shoreline change is depicted in Figure 29.
Figure 29. Model prognosis for shoreline change for a groyne on Portsea Front Beach assuming no initial beach nourishment.

As shown in Figure 29, without initial nourishment the groyne would take some 10 years to fill up unless filled artificially with beach nourishment at the start. Following this, Portsea Front Beach would remain stable and the groyne would commence bypassing. However, in the longer term the western shoreline of Weeroona Bay would begin to erode as a result of a deficit in the sediment budget generated by a remaining but smaller differential in the net rates of littoral drift transport along the shoreline.

2.5 Beach Nourishment

2.5.1 Introduction

Beach nourishment is the periodic placement of sand mined from the offshore sand banks and placed along the shore where erosion has been severe to restore the beach and dune and to feed the erosion process (Figure 8).

2.5.2 Wave Energy Distribution

There would be no change to the distribution of wave energy along the beach

2.5.3 Cross-shore Transport of Littoral Drift

There would be no change from the existing cross-shore sand transport processes.
2.5.4 Alongshore Transport of Littoral Drift

There would be no change to the alongshore sand transport processes.

2.5.5 Implications and Prognosis for Shoreline Change

The rates of foreshore erosion and sand transport would remain as at present. The beach would continue to erode and sand nourishment would need to be repeated periodically. For an annual erosion rate of 30,000 m$^3$/a, prograding the beach some 50 m at the pier would take some 150,000 m$^3$ of sand, which would require replenishment after 5 years.

This is a flexible option in that in time, as changes to the morphology on the Quarantine Bank are effected by natural processes or dredging, the wave transformation processes may change, ameliorating or, perhaps, exacerbating the current rates of sand transport and foreshore erosion.

2.6 Rock Revetment

2.6.1 Introduction

A rock revetment (Figure 7) could protect the dune from further foreshore recession.

2.6.2 Wave Energy Distribution

There would be no change to the distribution of wave energy along the beach.

2.6.3 Cross-shore Transport of Littoral Drift

The rate of cross-shore sand transport would increase as the revetment becomes exposed to wave impact. This would cause the seabed along the shore to deepen.

2.6.4 Alongshore Transport of Littoral Drift

There would be no change to the potential rate of alongshore sand transport. Such a structure would lock up dune sand from the littoral drift transport system.

2.6.5 Implications and Prognosis for Shoreline Change

The prognosis for shoreline change is depicted in Figure 17. Without supplementary beach nourishment, it is anticipated that sand from in front of the revetment would continue to be eroded from the beach, the subaerial part of the beach would disappear and the seabed would deepen over time. Access to the beach further to the east would need to be made along the top of the revetment. As erosion continues, the water depth in front of the revetment would increase progressively, undermining the toe foundation of the revetment necessitating maintenance.
2.7 Removal of the Sandbag Revetment

2.7.1 Introduction

Removal of the sandbag revetment would result in further foreshore recession.

2.7.2 Wave Energy Distribution

There would be no change to the distribution of wave energy along the beach.

2.7.3 Cross-shore Transport of Littoral Drift

There would be no change from the existing cross-shore sand transport processes.

2.7.4 Alongshore Transport of Littoral Drift

There would be no change to the potential rate of alongshore sand transport.

2.7.5 Implications and Prognosis for Shoreline Change

The prognosis for shoreline change with the removal of the revetment is depicted in Figure 30.
Figure 30. Prognosis for shoreline change with the removal of the revetment

Figure 30 shows a significant re-alignment of the shoreline with severe erosion at the western end of Portsea Front Beach near the pier, which would result in the loss of several buildings there within 10 years.
3 Cost Estimates

Cost estimates are detailed in Appendix C and summarised in Table 2. The costing has included maintenance costs for a 50 year project life.

Table 2. Summary Cost Estimates

<table>
<thead>
<tr>
<th>Option</th>
<th>Direct Construction &amp; 50y Maintenance Cost</th>
<th>Design Allowance (15%)</th>
<th>Common Distributables (3%)</th>
<th>EPCM(^1) (10%)</th>
<th>Contingency (20%)</th>
<th>Total Build Budget Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Revetment with sand nourishment</td>
<td>$22,000,000</td>
<td>$3,300,000</td>
<td>$660,000</td>
<td>$2,200,000</td>
<td>$4,400,000</td>
<td>$32,560,000</td>
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<td>Beach nourishment</td>
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<td>$3,090,000</td>
<td>$618,000</td>
<td>$2,060,000</td>
<td>$4,120,000</td>
<td>$30,488,000</td>
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<td>Attached Breakwater Rubblemound</td>
<td>$19,500,000</td>
<td>$2,925,000</td>
<td>$585,000</td>
<td>$1,950,000</td>
<td>$3,900,000</td>
<td>$28,860,000</td>
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<td>Configuration dredging nearshore</td>
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<td>$414,000</td>
<td>$1,380,000</td>
<td>$2,760,000</td>
<td>$20,424,000</td>
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<td>Pt Franklin Rockfill Headland Groyne</td>
<td>$12,900,000</td>
<td>$1,935,000</td>
<td>$387,000</td>
<td>$1,290,000</td>
<td>$2,580,000</td>
<td>$19,092,000</td>
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<tr>
<td>PSFB(^-) Rockfill Headland Groyne</td>
<td>$8,300,000</td>
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<td>$830,000</td>
<td>$1,660,000</td>
<td>$12,284,000</td>
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<td>Detached rubblemound breakwater(^2)</td>
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<td>$1,076,250</td>
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<td>$717,500</td>
<td>$1,435,000</td>
<td>$10,619,000</td>
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<td>Detached SPW(^3) Breakwater(^2)</td>
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<td>Revetment alone</td>
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<td>$45,000</td>
<td>$150,000</td>
<td>$300,000</td>
<td>$2,220,000</td>
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Notes:

1. EPCM denotes Engineering Procurement Construction Management
2. Estimates for detached breakwaters are increased from Appendix C for additional quantities for lengths 220 m (cf 170 m)
3. SPW denotes Sheet Pile Wall
4. PSFB denotes Portsea Front Beach
4 Options Assessment

4.1 Configuration Dredging

4.1.1 Impacts on Coastal Processes (including Degree of Protection)

A nearshore configuration dredging option can be designed to divert away harmlessly the destructive incident swell wave energy, equilibrating the rates of littoral drift transport along the whole of the Weeroona Bay foreshore, thereby restoring an equilibrium beach alignment. There would be no change to the littoral drift processes beyond Portsea Front Beach.

4.1.2 Beach Restoration

The project would result in winning sand that could be used to restore the entire Weeroona Bay foreshore, prograding the beach by some 30 m in width. The beach would remain protected for the long term without maintenance.

4.1.3 Impact on Marine Ecology, Visual Amenity and Safety

The visual amenity and safety of Portsea Front Beach would be enhanced considerably. A wide stable beach would be restored with a benign wave climate. However, there would be still wind waves and some swell wave energies incident at the shore, which would maintain a clean sand quality. There would be no adverse impacts on the subaerial (terrestrial) domain.

Near the shoreline, some 1200 m × 100 m (12 ha) of nearshore seabed would be smothered with sand. This would result in a temporary loss of some seagrass and benthic fauna in the area. However, the bare sand areas would re-colonise in time.

Offshore, in some 8 m depth between the Pier and Portsea Hole, a seabed area of some 700 m × 340 m (24 ha) would be disturbed. One third of this area would be lowered by some 8 m with the remainder raised by some 4 m. This would introduce new habitat over a portion of a somewhat regular flat area, which may enhance local biodiversity. The trench dredged into calcareous sandstone would provide habitat for marine flora and fauna, a “mini Portsea Hole”, which would be attractive to recreational divers and fishers.

4.1.4 Effectiveness and Uncertainties

There is confidence in the modelling, which is based on sound and well-understood physics and the models used have been validated with field data for the site. The design has been tested for the full range of wave conditions expected at the site and has shown that the option tested would be very effective in ameliorating the inclement wave conditions incident on Portsea Front Beach.

The dredged depression is unlikely to fill in. Bed sand transport rates generally are directed westward. The direction from which any sand infilling would come would be easterly from offshore of Point Franklin. Near the trench, video transects across Point Franklin show that the seabed is
colonised by dense Amphibolis, a seagrass that forms meadows on calcareous sands, the interweaving roots and leaves of which consolidate the substrate, protecting it from erosion by currents and waves. There is no indication that there would be any sand movement towards the trench.

This option would continue to perform effectively under moderate levels of sea level rise and changes in wave climate. The refraction process is controlled by wavelength (that is, wave period) and the range of swell wave periods is not expected to change with climate change. Nevertheless, should they increase then the option would become more effective. As water depth increases the effectiveness of the dredged trench will increase. The trench would remain effective with any relatively large changes to the incident wave conditions.

There are uncertainties in respect of the amount of sand that would be won for nourishment and the amount and character of the rock that would need to be dredged. It has been assumed that some 2 m of sand overlies the rock over the dredging area and that the rock comprises calcareous sandstone which has a compressive strength of around 5 MPa; that is, it can be dredged with a backhoe. These uncertainties would need to be addressed with a geotechnical investigation. Preliminary work could include some seismic survey calibrated to some borehole drilling undertaken off the end of the Pier. Vibrocoring could be undertaken over the project footprint to assess the depth of sand overlying hardpan.

### 4.1.5 Construction Cost and Timing

The construction cost for this option has been estimated at $13.8 million.

Timing to completion is estimated as 36 months as detailed in Table 3.

<table>
<thead>
<tr>
<th>Task</th>
<th>Duration (months)</th>
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<tbody>
<tr>
<td>Planning approval entailing preliminary geological investigation, preliminary design and EES</td>
<td>18</td>
</tr>
<tr>
<td>Detailed design/contract documentation</td>
<td>6</td>
</tr>
<tr>
<td>Procurement</td>
<td>3</td>
</tr>
<tr>
<td>Construction</td>
<td>9</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>
4.2 Detached Offshore Breakwater

4.2.1 Impacts on Coastal Processes (including Degree of Protection)

An offshore breakwater would protect the Portsea Front Beach area experiencing severe coastal erosion by blocking much of the incident wave energy, reflecting it offshore. Littoral drift transport to the east can be maintained provided that a tombolo is not formed. Nourishment sand would need to be imported to prevent down-drift erosion.

4.2.2 Beach Restoration

The sand imported for the construction of the salient would nourish and restore a sandy beach at Portsea Front Beach. There would be no works done on the western shores of Weeroona Bay.

4.2.3 Impact on Marine Ecology, Visual Amenity and Safety

The footprint of either the sheet pile wall option or the rubble mound option would be relatively small and cause an insignificant amount of disturbance to the seabed. A rubble mound option would enhance biodiversity locally.

At the nourishment borrow site some 8 ha of active seabed could be disturbed. These sand shoals are subjected to dynamic tidal processes and would be restored naturally.

At the beach face where nourishment would be placed some 6 ha of seabed would be smothered, impacting some seagrass and benthic fauna. This nearshore habitat is subjected to dynamic beach processes and would be restored naturally.

The structures would need to have crest levels at around RL 2 m AHD, so they would be visible from the beach and from the Pier. However, while they could be overlooked standing on the pier, the structures would block views of the Bay from some boats using the pier, as well as from the beach.

The breakwaters would generate currents during times of heavy swell. Currents may affect navigation.

4.2.4 Technical Effectiveness and Uncertainties

There are uncertainties in predicting the extent of salient formation accurately. Hence, there will be uncertainties in ensuring an adequate throughput of littoral drift.

The structures would continue to be effective with sea level rise, although their effectiveness would be diminished somewhat if overtopped. Nevertheless, the structures could be adjusted by raising their crest levels, otherwise, higher crest levels to cater for sea level rise could be incorporated at inception.
4.2.5 Construction Cost and Timing

The construction cost for this option has been estimated as follows:

- Detached sheet pile wall breakwater - $5.7 million
- Detached rubble mound breakwater - $5.6 million

Timing to completion is estimated as 33 months as detailed in Table 4.

<table>
<thead>
<tr>
<th>Task</th>
<th>Duration (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EES and Coastal Management Act approval</td>
<td>18</td>
</tr>
<tr>
<td>Detailed design/contract documentation</td>
<td>6</td>
</tr>
<tr>
<td>Procurement</td>
<td>3</td>
</tr>
<tr>
<td>Construction</td>
<td>6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>33</strong></td>
</tr>
</tbody>
</table>

4.3 Attached Breakwater

4.3.1 Impacts on Coastal Processes (including Degree of Protection)

An attached breakwater would protect the Front Beach area experiencing severe coastal erosion by blocking all of the incident wave energy, absorbing and reflecting it offshore. Littoral drift transport to the east would be blocked, necessitating periodic bypassing.

4.3.2 Beach Restoration

The nourishment sand would be imported to restore a sandy beach at Portsea Front Beach. There would be no works done on the western shores of Weeroona Bay.

4.3.3 Impact on Marine Ecology, Visual Amenity and Safety

The footprint of the rubble mound would be relatively small and a rubble mound option would enhance biodiversity locally. However, with reduced flow the species composition on the pier would be most likely to change as good tidal flow is required to encourage fauna diversity. The reduced wave action may attract a few extra species that are less tolerant but, overall, minimal change would be expected. The seagrass Amphibolis would not survive in the lee of the structure.
as it needs open water and waves to thrive and, most likely, would be replaced by Zosteraceid species.

The structure would need to have crest levels at around RL 2 m AHD, so it would be visible from the beach and from the Pier. However, while it could be overlooked standing on the pier, the structure would block some views of the Bay from boats using the pier and from beach users.

The structure would provide a safe haven for boats in inclement weather. It is likely that an EES would be required given the major impact the structure would have on beach usage, which is likely to be controversial.

4.3.4 Technical Effectiveness and Uncertainties

The structure would continue to be effective with sea level rise and higher crest levels to cater for sea level rise would need to be incorporated at inception.

4.3.5 Construction Cost and Timing

The construction cost for this option has been estimated at $19.5 million.

Timing to completion is estimated as 36 months as detailed in Table 5.

Table 5. Timing Estimate for the Attached Breakwater Option

<table>
<thead>
<tr>
<th>Task</th>
<th>Duration (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EES and Coastal Management Act approval</td>
<td>18</td>
</tr>
<tr>
<td>Detailed design/contract documentation</td>
<td>6</td>
</tr>
<tr>
<td>Procurement</td>
<td>3</td>
</tr>
<tr>
<td>Construction</td>
<td>9</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>36</strong></td>
</tr>
</tbody>
</table>

4.4 Point Franklin Groyne

4.4.1 Impacts on Coastal Processes (including Degree of Protection)

A groyne at Point Franklin would provide limited protection to the eroding section of Portsea Front Beach due to its distance from the eroding site. The change that could be effected to the shoreline orientation in the eroding area is small, the increase in beach width would be limited and there would be no impact on the amount of incident wave energy. Continued protection would rely on regular sand nourishment maintenance programmes.
4.4.2 Beach Restoration

Beach restoration by sand nourishment is required to obviate down-drift erosion and would be dependent upon regular re-nourishment at an annual average rate of 16,000 m³/a (Appendix B).

4.4.3 Impact on Marine Ecology, Visual Amenity and Safety

The rock groyne would cover a relatively small area of rocky seabed and would have a minimal adverse impact on the local marine ecology. The structure would provide additional new habitat and encourage biodiversity.

At the nourishment borrow site some 19 ha of active seabed could be disturbed. These sand shoals are subjected to dynamic tidal processes and would be restored naturally. At the beach face where nourishment would be placed some 7 ha of seabed would be smothered, impacting some seagrass and benthic fauna. This nearshore habitat is subjected to dynamic beach processes and would be restored naturally.

Visually, the groyne is somewhat removed from and, therefore, would not impact the beach amenity adversely. A groyne may encourage offshore rip currents along it, which may present a safety hazard to novice swimmers during larger wave conditions.

4.4.4 Technical Effectiveness and Uncertainties

Due to its relative remoteness, a groyne at Point Franklin would provide only a modest degree of protection to the eroding shoreline at Portsea Front Beach where wave energy is focussed, which would reduce gradually with any climate change sea level rise.

4.4.5 Construction Cost and Timing

The construction cost for this option has been estimated at $12.9 million. Timing for the project is summarised in Table 6.

Table 6. Timing Estimate for the Point Franklin Groyne Option

<table>
<thead>
<tr>
<th>Task</th>
<th>Duration (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal Management Act approval</td>
<td>6</td>
</tr>
<tr>
<td>Detailed design/contract documentation</td>
<td>6</td>
</tr>
<tr>
<td>Procurement</td>
<td>3</td>
</tr>
<tr>
<td>Construction</td>
<td>6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>21</strong></td>
</tr>
</tbody>
</table>
4.5 Portsea Front Beach Groyne

4.5.1 Impacts on Coastal Processes (including Degree of Protection)

A groyne at the centre of Portsea Front Beach would provide adequate protection to the eroding section of the beach. Continued protection would rely on regular sand nourishment maintenance programmes.

4.5.2 Beach Restoration

Beach restoration by sand nourishment is required to obviate down-drift erosion and would be dependent upon regular re-nourishment at an annual average rate of 8,000 m$^3$/a (Appendix B).

4.5.3 Impact on Marine Ecology, Visual Amenity and Safety

The rock groyne would cover a relatively small area of seabed and would have a minimal adverse impact on the local marine ecology. The structure would provide additional new habitat and encourage biodiversity.

At the nourishment borrow site some 7 ha of active seabed could be disturbed. These sand shoals are subjected to dynamic tidal processes and would be restored naturally. At the beach face where nourishment would be placed some 3 ha of seabed would be smothered, impacting some seagrass and benthic fauna. This nearshore habitat is subjected to dynamic beach processes and would be restored naturally.

Visually, the groyne would impact the beach amenity, dividing the beach into two sections. A groyne may encourage offshore rip currents along it, which may present a safety hazard to novice swimmers during larger wave conditions.

4.5.4 Technical Effectiveness and Uncertainties

Due to its relative proximity, a groyne bisecting Portsea Front Beach would provide a good degree of protection to the eroding shoreline. However, the protection would diminish gradually with any climate change sea level rise.

4.5.5 Construction Cost and Timing

The construction cost for this option has been estimated at $8.3 million.

Project timing for this option is summarised in Table 7.
Table 7. Timing Estimate for the Portsea Front Beach Groyne Option

<table>
<thead>
<tr>
<th>Task</th>
<th>Duration (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal Management Act approval</td>
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</tr>
<tr>
<td>Detailed design/contract documentation</td>
<td>6</td>
</tr>
<tr>
<td>Procurement</td>
<td>3</td>
</tr>
<tr>
<td>Construction</td>
<td>6</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>21</strong></td>
</tr>
</tbody>
</table>

4.6 Beach Nourishment

4.6.1 Impacts on Coastal Processes (including Degree of Protection)

Beach nourishment would have no impact on the current coastal processes other than supplying littoral drift to meet the potential transport rates. The supply of sand to the littoral drift process may result in unwanted accumulation down-drift.

4.6.2 Beach Restoration

The beach would be restored in width by some 50 m, which would last around 5 years, and would depend on regular re-nourishment programs at an average rate of 30,000 m$^3$/a (Appendix B).

4.6.3 Impact on Marine Ecology, Visual Amenity and Safety

At the nourishment borrow site some 15 ha of active seabed could be disturbed. These sand shoals are subjected to dynamic tidal processes and would be restored naturally. At the beach face where nourishment would be placed some 5 ha of seabed would be smothered, impacting some seagrass and benthic fauna. This nearshore habitat is subjected to dynamic beach processes and would be restored naturally. Down-drift accumulation may result in the smothering of some benthic flora.

4.6.4 Technical Effectiveness and Uncertainties

Theoretically, while beach nourishment would protect the foreshore effectively from erosion, including any impacts from climate change sea level rise, the maintenance re-nourishment requirements would be a major challenge for this option under the present circumstances. Nevertheless, the option is entirely flexible and can be tailored to suit any changed circumstances.
4.6.5  Construction Cost and Timing

Cost for a 50 year life project has been estimated at some $20.6M, mainly for the maintenance nourishment requirements.

To implement the initial stage is estimated to take 16 months (Table 8).

Table 8. Timing Estimate for the Beach Nourishment Option

<table>
<thead>
<tr>
<th>Task</th>
<th>Duration (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal Management Act approval</td>
<td>6</td>
</tr>
<tr>
<td>Detailed design/contract documentation</td>
<td>3</td>
</tr>
<tr>
<td>Procurement</td>
<td>3</td>
</tr>
<tr>
<td>Construction</td>
<td>4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>

4.7  Rock Revetment

4.7.1  Impacts on Coastal Processes (including Degree of Protection)

A rock revetment would provide protection from foreshore recession. However, its impact will be the progressive loss of the beach. Sand will continue to be removed from the beach and the beach level will drop progressively with time. As the seabed is lowered the toe of the structure will become undermined and subsidence of the structure will commence. This will entail ongoing maintenance of the fabric of the revetment. Further, wave run-up levels will increase as deeper water fronting the structure will allow greater penetration of wave energy onto the structure.

The revetment will prevent any release of dune sands into the littoral drift system, which may have an exacerbating impact on any down-drift erosion rates. The modelling has indicated that a beach may still exist farther to the east of Portsea Pier.

4.7.2  Beach Restoration

The rock revetment would not restore a beach unless accompanied by beach nourishment.

4.7.3  Impact on Marine Ecology, Visual Amenity and Safety

The longer term impact of a rock revetment without beach nourishment would be the complete loss of the sandy beach and the progressive lowering and deepening of the seabed in front of it.
While the impact on the marine ecology would be minimal, there would be a significant adverse impact on the visual and recreational amenity of Portsea Front Beach. Beach safety would become compromised due to the restriction that the longer term impacts would have on beach access.

### 4.7.4 Technical Effectiveness and Uncertainties

A rock revetment could be designed, constructed and maintained to protect the foreshore from recession including the impacts of climate change sea level rise.

### 4.7.5 Construction Cost and Timing

The construction cost for the rock revetment has been estimated at $1.5M, but $22.0M with beach nourishment.

Estimated timing is in Table 9.

<table>
<thead>
<tr>
<th>Task</th>
<th>Duration (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coastal Management Act approval</td>
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</tr>
<tr>
<td>Detailed design/contract documentation</td>
<td>3</td>
</tr>
<tr>
<td>Procurement</td>
<td>3</td>
</tr>
<tr>
<td>Construction</td>
<td>4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>16</strong></td>
</tr>
</tbody>
</table>

### 4.8 Summary Comparative Assessment Matrix

A summary comparative assessment is presented in Table 10.
## Table 10. Summary Comparative Assessment Matrix

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Options</th>
<th>Configuration Dredging</th>
<th>Breakwater</th>
<th>Groynes</th>
<th>Nourishment</th>
<th>Revetment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Impacts on Coastal Processes</strong></td>
<td></td>
<td>Modifies beneficially swell wave incidence and sediment transport on Portsea Front Beach. No impact on littoral processes on western Weeroona Bay or east of Point Franklin.</td>
<td>Reduces high wave energy incidence in eroded area. Shields beach from wind waves. Creates rips during severe swell wave events.</td>
<td>No impact on wave incidence and hence storm erosion. Reduces the rate of littoral drift transport. Creates rips.</td>
<td>No impact on the coastal erosion processes. High rates of erosion continue to deliver large volumes of sand east of Point Franklin.</td>
<td>Prevents recession. Less beach near pier. Reduces sand supply to down-drift beaches.</td>
</tr>
<tr>
<td><strong>Beach Restoration</strong></td>
<td></td>
<td>Provides nourishment material for the restoration of the whole of Weeroona Bay for 50 years and beyond. Restores pre-existing rates of littoral drift transport.</td>
<td>Beach would be restored in front of eroded area only.</td>
<td>Beach would be restored east of Portsea Pier. Periodic maintenance nourishment required.</td>
<td>Beach would be restored east of Portsea Pier. Periodic maintenance nourishment required.</td>
<td>No Beach. Beach restoration would be effected only with nourishment.</td>
</tr>
<tr>
<td><strong>Environmental impact (including marine ecology, safety and visual amenity)</strong></td>
<td></td>
<td>Large footprint on nearshore and offshore benthic habitats. Improves boating and swimmer safety by reducing nearshore wave climate. No adverse visual impact.</td>
<td>Small footprint on offshore benthic habitat. May cause strong currents under higher wave conditions. Unsightly.</td>
<td>Large nearshore footprint and high impact on reef if at Point Franklin. Rips compromise swim safety. Unsightly visual impact if on beach.</td>
<td>Large loss of nearshore benthic habitat. No change to boating or swimmer safety.</td>
<td>Without nourishment, would exacerbate down-drift erosion.</td>
</tr>
<tr>
<td><strong>Technical Effectiveness and uncertainties</strong></td>
<td></td>
<td>Permanent solution. Maintains effectiveness under climate change sea level rise. Flexibility allows modification should conditions change. Uncertainties with extent of sand and rock for dredging.</td>
<td>Permanent solution to beach erosion at Portsea Front Beach only. Not flexible. Uncertainties in extent of salient formation and sand transport rate.</td>
<td>No beneficial impact on high wave energy incidence. Beach will continue to erode at high rates. Not flexible.</td>
<td>Beachfront would need to be restored regularly, every 6 years, due to high erosion rate. Flexible solution to suit changing conditions.</td>
<td>Prevents dune recession at Portsea Front Beach under all sea level conditions. Not flexible.</td>
</tr>
<tr>
<td><strong>Construction Timing; Project Timing; Construction Impacts on Village</strong></td>
<td></td>
<td>Construction 9 months; project 36 months; minimal impact on village.</td>
<td>Detached: Construction 6 months; project 21 months; minimal impact on village. Attached: project timing 36 months.</td>
<td>Construction 6 months; project 21 months; large impact on village.</td>
<td>Construction 6 months; project 21 months; minimal impact on village.</td>
<td>Construction 4 months; project 16 months; minor impact on village.</td>
</tr>
<tr>
<td><strong>Construction Cost</strong></td>
<td></td>
<td>$13.8 M</td>
<td>$7.2 M detached $19.5 M attached</td>
<td>$8.3 M</td>
<td>$20.6 M</td>
<td>$1.5 M; $22.0 M with nourishment</td>
</tr>
</tbody>
</table>

*Advisian*
5 Summary and Conclusions

The following options to ameliorate the adverse impacts of coastal erosion processes at Portsea Front Beach have been designed and modelled:

- Configuration Dredging
- Breakwaters
- Groynes
- Sand Nourishment
- Revetment

Consideration has been given also to an option of removing the existing sandbag revetment and its consequences.

The options have been assessed comparatively using the following criteria:

- impacts on coastal processes (waves, currents and sediment transport)
- effectiveness of beach restoration with renourishment
- environmental impact on marine ecology and visual amenity, safety to beach, water and boating activities, navigation for recreational vessels
- effectiveness of protection to foreshore assets and land, technical effectiveness, flexibility and uncertainties, including climate change sea level rise
- timing to implement options, giving consideration to detailed design, EES and construction
- cost of capital and maintenance over the design life and planning period (50 years), including the cost of any actions required to manage potential impacts, such as erosion and sediment transport.

Of the options considered, only the dredged configuration and breakwater options address the primary cause of erosion at Portsea Front Beach. Groynes and sand nourishment options come with ongoing sand nourishment maintenance costs. Removal of the existing protection works would result in the loss of some existing foreshore buildings within ten years.

Should further consideration be given to the nearshore configuration dredging option, some preliminary geotechnical investigation would need to be undertaken to prove its feasibility.
6 References