

SUPPLEMENTARY REPORT – ENTRANCE CHANNEL DEPTH - WAVES

BACKGROUND

Cardno Lawson Treloar (CLT) Head Technical Report (HTR) was prepared for the SEES and forms Technical Appendix 45 to the SEES. CLT has been asked to consider any implications for the results in the original report if it is assumed that the Great Ship Channel scours to depth of -22 m CD. Additional modelling was carried out to investigate this situation.

This supplementary report addresses potential changes to the waves in the Entrance and sediment transport near the Entrance, in particular the beaches of Lonsdale Bight. An earlier supplementary report presented the changes to the hydrodynamics, that is tides and currents, due to a scoured depth of -22 m CD. A further report will also be prepared to address changes which may impact on the channel design, in particular the hydrodynamics and waves as they may affect vessel motions in the Great Ship Channel.

It is assumed that the reader is familiar with the Cardno Lawson Treloar Head Technical Report. The technical terms and general background to the hydrodynamics of the Bay are discussed in that report and thus are not repeated in the present document.

Results are presented for three cases with comparisons between the cases. The cases are:

- Existing: Uses the bathymetry as it was known in early 2007.
- Dredged: This is the case used for preparation of the HTR. The existing bathymetry was modified to reflect the expected depths after completion of the dredging associated with the Channel Deepening Project. In the Entrance, where it is proposed to provide channels with a declared depth of -17.3 m CD, the areas within the channel were modified such that, if the existing depth is deeper than -17.3 m CD, there was no change, but, if the existing depth was shallower than -17.3 m CD, then the depth was modified to -18.2 m CD, the average dredge line from the Project Description.
- Scoured: The dredged-case bathymetry was modified by changing the depth for any point within the channel over Rip and Nepean Banks where it was shallower than -22 m CD to -22 m CD. The scoured case is arguably conservative as it assumes the bathymetry to be all at or below -22 m CD rather than at various depths as was the situation for the dredged case.

The scoured case has been examined by running the SWAN model for ten different offshore wave conditions (provided in Table 5.3 HTR). These wave conditions were obtained from the analyses of measured data from three different offshore buoys. Each wave condition was run for three current conditions, peak ebb, peak flood and slack water. These 30 cases represent the majority of the wave conditions in the Entrance. These cases are the same as those used for modelling the existing and the dredged cases.

WAVES

Figure 1 (a, b and c) shows the change in wave height for a single event at peak ebb flow, slack water and peak flood flow. These figures can be compared with figure 7.24 in the HTR, but note the change in the colour scale and contour interval.

There are two major processes occurring as waves propagate through the Entrance. The first is the spreading caused by the refraction due to the bathymetry where the wave front travels faster in the deeper section of the channel and this leads to the wave energy “curving away” from the channel and impinging on the headlands on either side. This results in a reduction in the wave heights along the alignment of the channel. The second effect is refraction due to the currents. In simplistic terms, when the wave front meets the ebb tide jet, it is slowed down and the front on either side of the jet, where it is affected by lower currents, propagates faster leading to a concentration or focussing of the wave energy along the axis of the jet. For the flood tide, where the current and the waves are travelling in the same direction, the opposite occurs where the wave is spread in the same way as the bathymetric refraction. The observed wave patterns are then the result of the complex interaction of all these two effects.

Figure 1a shows the change in wave conditions for one incoming wave between the existing and the dredged case. The major effects are on the ebb tide when the refraction over the offshore sand bar and that due to the ebb-tide jet results in a focussing of wave energy adjacent to the Great Ship Channel over Rip Bank, a small focussing towards Point Lonsdale and other small changes. There are very small changes for the flood tide and slack water when plotted on this scale.

Figure 1b shows the changes between the existing and the scoured cases for the same incoming waves and there is now a marked change in the wave conditions for all states of the tide. For slack water, when there are no currents, the effects of the bathymetric refraction can be seen, with higher waves on either side of the channel and reduced waves inshore into Lonsdale Bight. The situation for the flood tide is very similar. For the ebb tide, however, the strengthening of the ebb tide jet and the increased refraction due to the additional deepening increases the changes over the dredged case (figure 1a). There are now increased wave heights over Rip Bank and across Nepean Bank with a small increase into Lonsdale Bight, plus a marked reduction in wave height immediately to the west of the channel over Rip Bank.

Figure 1c, which is the difference between the dredged case and the scoured case, confirms that it is the scoured case which leads to most of the changes.

As in the HTR, the waves were modelled for 10 incoming wave conditions and the three tidal states. For each combination, the wave conditions were extracted at 20 locations in the Entrance. The locations are shown in figure 2. The predicted change in wave parameters between the three cases at four locations are shown in tables 1 to 3. The changes for other locations are given in the Appendix. These results can be compared with those in table 7.9 in the HTR.

In the course of preparing this report, a small error was detected in the computation of the percentage changes presented in table 7.9 and appendix I of the HTR. The corrected values are presented in table 1 and the appendix to this report. The changes are not substantial and do not alter any of the conclusions presented in the HTR. The only data affected are the percentage changes in the wave heights; all other parameters are unchanged.

The values in table 2 show that at the Rip Bank Trial location, there is general reduction in wave heights by about 8% in the scoured case compared with the existing conditions. At Rip Bank Outer Centreline, there is a general reduction in wave heights by between 2 and 3% for most cases with reductions up to 9% for the ebb-tide flow. At Corsair Rock there are very small changes in the dredged case, but increases of over 30% in some conditions for the slack and flood-tide cases. There is very little change in the ebb-tide case. At Shortland Bluff, which represents the wave energy propagating into the Sands region north of South Channel, there are generally small changes for the dredged case, but reductions in wave height of up to 9% for the flood-tide flow and increases of the same magnitude for the ebb tide.

COASTAL PROCESSES

There are two pathways for sediment transport from Point Lonsdale to Shortland Bluff. The first is across the bay, offshore. In this case, in general terms, the sand is placed in suspension by the waves and transported by the currents. Whilst there are some changes in the predicted levels of wave activity, there will still be significant stirring in terms of sediment transport and the currents in this area do not change under the scoured scenario. It is therefore predicted that there will be no change in the sediment transport across the bay offshore.

The second pathway is the longshore transport along the beach where the longshore currents generated by the waves result in sediment transport inside the surf zone. The strength of this transport is the result of the wave heights as well as the angles at which the waves break on the beach.

The longshore transport across selected beach profiles along Lonsdale Beach, shown in figure 3 (figure 4.3 of the HTR), was determined using the LITPAK model with wave and current conditions from the model results. The results are presented in table 4 which is an extension of table 7.12 of the HTR. This computation provides a coarse estimate of the actual transport as only a limited number of the infinite possible wave and current conditions were used. The conditions are those shown in table 5.3 of the HTR. These conditions were combined in proportion to their approximate annual frequency of occurrence, as shown in table 5.3 of the HTR, to yield the annual-average sediment-transport through each cross-section.

The results show that there is a significant reduction in sediment transport at all locations. However, it is important to keep in mind that the sediment transport computation is sensitive to small changes in parameters. For example, Lawson and Treloar (1998) indicate sensitivities to changes in wave direction relative to the profile direction for a change in relative direction of $\pm 5^\circ$, these values are shown in table 7.13 of the HTR.

In order to investigate the causes of the changes in sediment transport, table 5 presents the changes in wave conditions at three locations which are close to the shore along Lonsdale Bight, namely Clarke, which is between profiles 2 and 5, Wyuna, which is close to profile 11, and Shortland Bluff which is east of profile 14. The table allows comparison of the changes from existing conditions for the dredged and the scoured conditions for these three locations. It can be seen that there is a substantial increase in the change in wave heights for the scoured conditions compared with the dredged case. Some of the changes are increases, some decreases. There are also larger changes in wave direction, again with some increases, and some decreases. The changes are consistent with the computed changes in longshore transport.

CONSEQUENCES

WAVES

Apart from sediment transport, which is considered separately below, there are some potential consequences of the changes in wave conditions. There is a change in the details of the wave patterns in the entrance with some increases and some decreases at the selected observation locations as the effects of the changes in the refraction result in changes in the focussing and spreading of waves. These changes are unlikely to have observable effects given the highly variable nature of the wave conditions in this area with marked variations in wave conditions over short time and spatial scales.

As can be seen in figure 1b, there is the suggestion of increased wave heights impinging on both Point Nepean and Point Lonsdale in the scoured case. The waves reaching the shore on the exposed sections of these points must cross wave-cut platforms and will thus be depth-limited breaking waves. Very detailed inshore surveys would be required to quantify any change in this area. It is possible that the predicted increase in wave heights in the scoured case could lead to a small increase in the rate of erosion due to wave attack, however this study is unable to provide any quantitative estimate of such a change. Such detailed bathymetry of the rock platforms is not included in the modelling for this study. Any change is likely to be a small change in a highly variable natural process.

SEDIMENT TRANSPORT

The model predicts a reduction in sediment transport along Lonsdale Bight beach. It is important to recognise that the model predicts the potential sediment transport, that is, it computes the amount of energy available to transport the sediment if there is an adequate supply of sediment.

The beach at Lonsdale Bight is the result of the balance of wave forces and sediment transport between the two headlands at either end, Point Lonsdale and Shortland Bluff. In general terms, a beach will align so as to be close to parallel with the incoming wave fronts. If waves approach a beach at an angle, sediment tends to be transported alongshore by the component of wave energy directed along the beach. If the beach is parallel with the wave fronts, there is no longshore transport. The headlands “anchor” the ends of the beach and the sediment will be deposited in such a way as to try and balance the incoming wave energy with the sediment supply. The resulting beach plan form is known as a “zeta-spiral” shape. Lonsdale Bight has such a shape. Other examples include the Barwon Heads – Ocean Grove beach and there are many other occurrences along the Victorian coast. The significance of this feature is that the beach position in plan is dominated by the location of the headlands. Provided there is an adequate sediment supply the beach plan will adjust to the incoming wave energy and will maintain the zeta-spiral form.

In the case of Lonsdale Bight, the beach position in plan is fixed by a rock wall from Point Lonsdale to the location of profile 8. The amount of sediment entering the system at Point Lonsdale is not changing due to the project. At present the majority of the sediment entering the littoral (beach) system at Point Lonsdale is transported by the waves along the beach to Shortland Bluff. A relatively small amount is captured by the groynes constructed off the Point Lonsdale township, but very little settles in front of the rock wall. East of the rock wall, the beach is in a dynamic equilibrium. That is, the shape and form of the beach is a response to the incoming wave energy and the sediment supply and under storm conditions, the beach may be cut back as increased wave energy transfers some sand from the beach to create bars in the surf zone, while in times of lower wave energy, the sand is returned to the beach. Over time, the position of the beach is stable, with cycles of slow accretion as sand is carried by wind into the dunes and fixed by vegetation. However, this is not

permanent as severe storms, or a series of storms, can eat into the dunes. Provided there is a supply of sand, the long-term average position of the beach will remain in the same. If the supply of sand were to be interrupted, the beach may retreat to form a new “zeta-spiral” based on the end of the rock wall and Shortland Bluff.

The modelling predicts a reduction in the longshore transport along the Lonsdale Bight beach in the scoured case. One possible outcome is that some sand will be deposited in front of the rock wall to form a wider beach in this area. This is not considered likely as the breaking of waves on the rocks at high tide leads to very strong stirring which lifts sand into suspension to be carried along in the longshore current. It is normally necessary to either construct a groyne to trap the sand or renourish the beach sufficiently to avoid waves impinging on the rocks. Thus, it is most likely that the same amount of sand will reach the eastern end of the rock wall as at present. If this is so, the beach plan location between there and Shortland Bluff is unlikely to change as such a change would result in a change in the longshore sediment-transport balance and any departure from the beach at present would then be at an angle to the incoming waves and thus subject to erosion in order to restore the equilibrium.

If the modelling predicted an increase in the longshore transport, then the conclusions as to the stability of the beach system would be different, however it is considered that the predicted reductions in potential sediment transport will have little, if any, observable impact on the beaches of Lonsdale Bight. This means that the supply of sand to the Sands and the beaches of Queenscliff will not be impacted by these changes.

SUMMARY

A summary of the potential changes resulting from scour are;

Waves	<ul style="list-style-type: none"> • Increased refraction due to bathymetry results in greater spreading of waves away from the axis of the channel; • Changes in the current patterns lead to changes in refraction due to currents with both increases and decreases; • Some changes in the details of the wave patterns in the Entrance; and • Possibility of slight increase in erosion due to waves on Point Nepean and Point Lonsdale, but not quantifiable at this time.
Coastal Processes	<ul style="list-style-type: none"> • Predicted decrease in potential longshore sediment transport in Lonsdale Bight; • Beach plan position will not change as long as the supply of sediment is not reduced and the project does not have any impact on this; and • There will be no impact on the supply of sand to the beaches of Queenscliff and the Sands.

Table 1 Change in wave height and direction predicted for a number of cases after the dredging. Dredged minus Existing

Offshore Wave Conditions			Rip Bank Trial		Rip Bank Outer Centreline		Corsair Rock		Shortland Bluff	
Hs m	Tp s	Dir deg T	Hs %	Dir deg	Hs %	Dir deg	Hs %	Dir deg	Hs %	Dir deg
Slack water										
1.7	13	220	-8.7%	-6.5	-0.6%	-0.1	2.2%	0.3	-0.4%	0.0
1.7	11	220	-8.6%	-3.3	-0.4%	-0.1	1.8%	0.3	-0.2%	0.0
1.7	15	220	-8.8%	-8.4	-0.8%	-0.1	2.3%	0.3	-0.5%	0.0
1.7	17	220	-8.9%	-9.3	-0.9%	-0.1	2.7%	0.3	-0.6%	0.0
2.5	13	220	-9.1%	-6.6	-0.6%	-0.1	1.6%	0.1	-0.3%	0.0
1.7	13	225	-9.1%	-6.9	-0.5%	-0.1	1.9%	0.1	-0.3%	0.0
1.7	13	215	-8.2%	-5.5	-0.7%	-0.1	2.6%	0.4	-0.4%	0.0
1.7	13	210	-7.5%	-4.3	-0.7%	-0.2	3.1%	0.6	-0.4%	0.0
1.7	13	205	-6.7%	-2.9	-0.7%	-0.2	2.9%	0.8	-0.3%	0.0
1.7	13	200	-5.8%	-1.7	-0.7%	-0.2	3.2%	1.1	-0.2%	0.0
Flood tide flow										
1.7	13	220	-8.7%	-11.2	-1.1%	0.0	1.5%	-0.8	-2.6%	-0.3
1.7	11	220	-9.4%	-6.0	-0.9%	0.1	1.6%	-0.2	-3.0%	-0.4
1.7	15	220	-8.1%	-13.5	-1.3%	0.1	1.5%	-1.3	-2.2%	-0.3
1.7	17	220	-7.6%	-13.4	-1.5%	0.1	1.4%	-1.8	-2.3%	-0.2
2.5	13	220	-8.7%	-11.1	-1.1%	0.0	1.4%	-0.7	-2.5%	-0.3
1.7	13	225	-8.9%	-10.8	-0.9%	0.0	1.5%	-1.1	-4.2%	-0.4
1.7	13	215	-8.2%	-10.9	-1.3%	0.0	1.6%	-0.6	-0.9%	-0.2
1.7	13	210	-7.6%	-9.9	-1.4%	0.0	1.7%	-0.4	1.0%	-0.1
1.7	13	205	-6.8%	-8.3	-1.4%	-0.1	2.0%	-0.2	3.0%	0.0
1.7	13	200	-6.0%	-6.4	-1.3%	-0.2	2.2%	-0.2	4.7%	0.1
Ebb tide flow										
1.7	13	220	-1.9%	0.1	8.6%	-2.7	0.6%	-1.3	3.8%	0.6
1.7	11	220	-2.5%	0.3	7.2%	-3.4	0.5%	-0.8	5.6%	0.5
1.7	15	220	-1.8%	0.0	7.6%	-1.9	-0.3%	-0.6	0.3%	0.5
1.7	17	220	-1.6%	-0.1	6.9%	-1.5	0.0%	-0.6	0.4%	0.6
2.5	13	220	-3.3%	0.3	6.2%	-2.7	-0.3%	0.1	-0.6%	0.3
1.7	13	225	0.1%	0.3	9.5%	-2.9	-0.5%	-0.5	2.0%	0.6
1.7	13	215	-5.1%	0.0	6.3%	-2.1	-0.2%	0.0	0.3%	0.4
1.7	13	210	-7.0%	-0.3	4.8%	-1.5	0.0%	0.3	-0.1%	0.3
1.7	13	205	-8.8%	-0.6	3.5%	-0.7	0.1%	0.3	0.4%	0.3
1.7	13	200	-11.4%	-1.0	1.6%	0.5	0.3%	0.1	1.3%	0.3

Hs = significant wave height; Tp = spectral peak wave period; Dir = wave direction (coming from)

Table 2 Change in wave height and direction predicted for a number of cases after the scouring. Scoured minus Existing

Offshore Wave Conditions			Rip Bank Trial		Rip Bank Outer Centreline		Corsair Rock		Shortland Bluff	
Hs m	Tp s	Dir deg T	Hs %	Dir deg	Hs %	Dir deg	Hs %	Dir deg	Hs %	Dir deg
Slack water										
1.7	13	220	-6.3%	2.9	-2.9%	0.5	13.6%	1.0	-0.1%	0.2
1.7	11	220	-5.9%	4.2	-1.6%	0.4	11.0%	1.5	0.1%	0.2
1.7	15	220	-6.6%	1.2	-3.9%	0.6	11.6%	0.6	-0.3%	0.1
1.7	17	220	-6.8%	0.1	-4.4%	0.7	15.5%	0.3	-0.3%	0.1
2.5	13	220	-6.5%	2.9	-2.9%	0.5	8.0%	0.6	0.0%	0.2
1.7	13	225	-5.0%	3.9	-3.6%	0.4	6.3%	0.4	-0.5%	1.5
1.7	13	215	-7.7%	1.7	-2.6%	0.6	15.2%	1.7	-0.7%	0.9
1.7	13	210	-8.9%	0.7	-2.6%	0.7	15.7%	2.5	-0.9%	1.0
1.7	13	205	-9.8%	0.1	-2.8%	0.7	23.3%	4.5	-0.1%	-1.0
1.7	13	200	-10.2%	0.0	-3.2%	0.6	19.9%	6.0	-0.7%	0.1
Flood tide flow										
1.7	13	220	-8.5%	8.4	-3.8%	0.9	23.4%	1.3	-10.7%	-0.8
1.7	11	220	-8.8%	8.8	-3.0%	0.9	21.1%	3.0	-12.1%	-1.0
1.7	15	220	-8.2%	6.0	-4.3%	1.0	24.2%	-0.3	-9.1%	-0.6
1.7	17	220	-8.1%	3.8	-4.5%	1.2	24.9%	-2.0	-8.5%	-0.6
2.5	13	220	-8.5%	8.3	-3.8%	0.9	18.6%	1.5	-9.8%	-0.7
1.7	13	225	-6.0%	8.6	-4.2%	0.8	25.4%	-1.4	-9.0%	-0.9
1.7	13	215	-9.3%	3.1	-3.5%	1.0	31.1%	0.9	-4.8%	-0.6
1.7	13	210	-10.4%	-1.4	-3.4%	1.0	33.6%	2.2	-1.6%	-0.5
1.7	13	205	-10.9%	-5.4	-3.3%	0.9	35.3%	4.1	2.2%	-0.4
1.7	13	200	-10.8%	-7.7	-3.0%	0.7	34.7%	6.7	5.9%	-0.2
Ebb tide flow										
1.7	13	220	-6.9%	-0.1	1.4%	-2.9	-0.3%	2.1	7.0%	0.9
1.7	11	220	-5.2%	0.3	2.3%	-3.5	-0.5%	3.2	10.2%	0.6
1.7	15	220	-8.0%	0.0	-1.2%	-2.4	-0.7%	2.4	2.8%	0.8
1.7	17	220	-8.8%	-0.7	-2.9%	-2.0	-0.2%	2.1	2.0%	0.7
2.5	13	220	-8.3%	1.1	-1.1%	-3.1	-1.7%	3.5	3.7%	0.9
1.7	13	225	-6.5%	-0.6	0.5%	-3.0	-1.4%	2.8	3.7%	0.9
1.7	13	215	-8.5%	1.3	0.4%	-2.3	-1.2%	3.1	4.8%	0.7
1.7	13	210	-8.1%	2.2	0.6%	-1.8	-0.1%	2.4	8.4%	0.6
1.7	13	205	-8.5%	2.8	-0.1%	-0.8	0.4%	2.5	9.4%	0.2
1.7	13	200	-11.1%	2.9	-2.8%	0.7	-0.1%	3.2	5.2%	-0.8

Hs = significant wave height; Tp = spectral peak wave period; Dir = wave direction (coming from)

Table 3 Change in wave height and direction predicted for a number of cases after the scouring. Scoured minus Dredged.

Offshore Wave Conditions			Rip Bank Trial		Rip Bank Outer Centreline		Corsair Rock		Shortland Bluff		
Hs m	Tp s	Dir deg T	Hs %	Dir deg	Hs %	Dir deg	Hs %	Dir deg	Hs %	Dir deg	
Slack water											
1.7	13	220	2.6%	9.3	-2.3%	0.6	10.3%	0.7	-0.1%	0.2	
1.7	11	220	2.9%	7.4	-1.3%	0.5	9.3%	1.3	0.5%	0.1	
1.7	15	220	2.4%	9.7	-3.1%	0.7	8.2%	0.3	-0.9%	0.1	
1.7	17	220	2.3%	9.4	-3.6%	0.8	10.8%	0.0	-1.0%	0.1	
2.5	13	220	2.9%	9.5	-2.3%	0.6	7.0%	0.5	0.2%	0.1	
1.7	13	225	4.6%	10.8	-3.0%	0.5	3.6%	0.3	-1.9%	1.5	
1.7	13	215	0.5%	7.3	-2.0%	0.8	12.2%	1.3	-2.4%	0.9	
1.7	13	210	-1.6%	5.0	-1.9%	0.8	13.8%	1.9	-3.3%	1.0	
1.7	13	205	-3.4%	3.0	-2.1%	0.9	25.3%	3.7	-0.2%	-1.0	
1.7	13	200	-4.7%	1.7	-2.5%	0.8	23.5%	4.9	-2.9%	0.1	
Flood tide flow											
1.7	13	220	0.2%	19.7	-2.7%	0.9	21.6%	2.1	-8.3%	-0.5	
1.7	11	220	0.7%	14.7	-2.1%	0.9	19.3%	3.2	-9.4%	-0.6	
1.7	15	220	0.0%	19.5	-3.0%	1.0	22.3%	0.9	-7.1%	-0.4	
1.7	17	220	-0.5%	17.2	-3.0%	1.1	23.1%	-0.2	-6.4%	-0.3	
2.5	13	220	0.3%	19.4	-2.7%	0.9	16.9%	2.2	-7.5%	-0.4	
1.7	13	225	3.2%	19.4	-3.3%	0.7	23.5%	-0.4	-4.9%	-0.5	
1.7	13	215	-1.2%	14.1	-2.3%	1.0	29.1%	1.5	-4.0%	-0.4	
1.7	13	210	-3.0%	8.5	-2.0%	1.0	31.4%	2.6	-2.6%	-0.4	
1.7	13	205	-4.4%	2.9	-1.9%	1.0	32.6%	4.3	-0.8%	-0.4	
1.7	13	200	-5.1%	-1.3	-1.8%	0.9	31.9%	6.8	1.1%	-0.3	
Ebb tide flow											
1.7	13	220	-5.1%	-0.2	-6.7%	-0.2	-0.9%	3.3	3.2%	0.2	
1.7	11	220	-2.8%	0.0	-4.6%	-0.1	-1.0%	4.0	4.4%	0.1	
1.7	15	220	-6.3%	-0.1	-8.1%	-0.5	-0.4%	3.0	2.5%	0.3	
1.7	17	220	-7.4%	-0.6	-9.2%	-0.6	-0.2%	2.8	1.6%	0.1	
2.5	13	220	-5.2%	0.9	-6.9%	-0.4	-1.4%	3.4	4.3%	0.7	
1.7	13	225	-6.6%	-0.9	-8.2%	-0.1	-0.9%	3.3	1.7%	0.3	
1.7	13	215	-3.6%	1.3	-5.6%	-0.2	-1.0%	3.1	4.5%	0.3	
1.7	13	210	-1.2%	2.5	-4.0%	-0.3	0.0%	2.2	8.5%	0.2	
1.7	13	205	0.4%	3.4	-3.5%	-0.1	0.3%	2.1	9.0%	-0.1	
1.7	13	200	0.3%	3.9	-4.3%	0.2	-0.4%	3.1	3.9%	-1.1	

Hs = significant wave height; Tp = spectral peak wave period; Dir = wave direction (coming from)

Table 4 Estimated annual longshore sediment-transport (,000 m³) into Port Phillip Bay

Profile	Existing	Dredged	Scoured	Dredged - Existing		Scoured - Existing		Scoured - Dredged	
				Difference	% Difference	Difference	% Difference	Difference	% Difference
				2	197	192	171	-5	-2.5%
5	57	50	31	-8	-13.2%	-26	-51.8%	-18	-36%
8	61	57	32	-4	-7.3%	-29	-51.7%	-25	-44%
11	107	105	86	-1	-1.0%	-21	-19.5%	-20	-19%
14	272	252	192	-20	-7.3%	-80	-31.8%	-60	-24%

Table 5 Comparison of wave conditions at inshore locations for change in the dredged and scoured cases

Slackwater

Input Conditions			Dredged-existing		Scoured - existing		Dredged-existing		Scoured - existing		Dredged-existing		Scoured - existing	
			Clarke		Clarke		Wyuna		Wyuna		Shortland Bluff		Shortland Bluff	
Hs	Tp	Dir	Change in Hs	Change in Dir (°)	Change in Hs	Change in Dir (°)	Change in Hs	Change in Dir (°)	Change in Hs	Change in Dir (°)	Change in Hs	Change in Dir (°)	Change in Hs	Change in Dir (°)
1.7	13	220	-5.3%	0.7	-13.4%	1.4	1.5%	-0.1	4.0%	-0.5	-0.4%	0.0	-0.1%	0.2
1.7	11	220	-4.4%	0.8	-12.2%	1.8	0.5%	-0.1	-0.4%	-0.3	-0.2%	0.0	0.1%	0.2
1.7	15	220	-5.8%	0.6	-14.1%	1.1	2.2%	-0.1	7.2%	-0.5	-0.5%	0.0	-0.3%	0.1
1.7	17	220	-6.0%	0.4	-13.8%	1.0	2.4%	-0.2	8.2%	-0.5	-0.6%	0.0	-0.3%	0.1
2.5	13	220	-5.1%	0.6	-13.8%	1.2	1.4%	-0.1	3.7%	-0.5	-0.3%	0.0	0.0%	0.2
1.7	13	225	-4.6%	0.7	-12.8%	1.5	0.1%	0.0	3.9%	-0.4	-0.3%	0.0	-0.5%	1.5
1.7	13	215	-5.8%	0.6	-14.1%	1.1	3.0%	-0.2	4.5%	-0.4	-0.4%	0.0	-0.7%	0.9
1.7	13	210	-6.1%	0.4	-14.3%	0.8	4.4%	-0.3	5.0%	-0.4	-0.4%	0.0	-0.9%	1.0
1.7	13	205	-6.1%	0.2	-14.6%	0.4	5.5%	-0.3	5.5%	-0.5	-0.3%	0.0	-0.1%	-1.0
1.7	13	200	-6.0%	0.0	-14.1%	0.1	6.5%	-0.3	6.9%	-0.3	-0.2%	0.0	-0.7%	0.1

Flood Tide

Input Conditions			Clarke		Clarke		Wyuna		Wyuna		Shortland Bluff		Shortland Bluff	
			Change in Hs	Change in Dir (°)	Change in Hs	Change in Dir (°)	Change in Hs	Change in Dir (°)	Change in Hs	Change in Dir (°)	Change in Hs	Change in Dir (°)	Change in Hs	Change in Dir (°)
1.7	13	220	-5.2%	0.7	-13.6%	2.3	-3.3%	0.0	-10.0%	-0.5	-2.6%	-0.3	-10.7%	-0.8
1.7	11	220	-3.2%	0.7	-10.9%	2.6	-4.0%	0.0	-13.4%	-0.5	-3.0%	-0.4	-12.1%	-1.0
1.7	15	220	-6.0%	0.7	-14.4%	2.1	-2.8%	0.0	-7.2%	-0.4	-2.2%	-0.3	-9.1%	-0.6
1.7	17	220	-6.5%	0.7	-14.6%	1.9	-2.5%	0.0	-5.4%	-0.4	-2.3%	-0.2	-8.5%	-0.6
2.5	13	220	-5.1%	0.7	-14.0%	2.4	-3.3%	0.0	-10.3%	-0.4	-2.5%	-0.3	-9.8%	-0.7
1.7	13	225	-3.7%	0.7	-11.9%	2.3	-3.5%	0.0	-8.1%	-0.6	-4.2%	-0.4	-9.0%	-0.9
1.7	13	215	-6.4%	0.7	-14.8%	1.9	-2.9%	0.0	-9.9%	-0.4	-0.9%	-0.2	-4.8%	-0.6
1.7	13	210	-7.4%	0.6	-15.7%	1.4	-2.2%	0.0	-9.7%	-0.3	1.0%	-0.1	-1.6%	-0.5
1.7	13	205	-7.9%	0.4	-15.5%	0.7	-1.4%	0.0	-8.0%	-0.2	3.0%	0.0	2.2%	-0.4
1.7	13	200	-7.7%	0.1	-14.4%	0.1	-0.7%	0.1	-5.7%	-0.1	4.7%	0.1	5.9%	-0.2

Ebb Tide

Input Conditions			Clarke		Clarke		Wyuna		Wyuna		Shortland Bluff		Shortland Bluff	
			Change in Hs	Change in Dir (°)	Change in Hs	Change in Dir (°)	Change in Hs	Change in Dir (°)	Change in Hs	Change in Dir (°)	Change in Hs	Change in Dir (°)	Change in Hs	Change in Dir (°)
1.7	13	220	-5.2%	0.7	-0.1%	-2.4	5.0%	-0.1	21.0%	-1.0	3.8%	0.6	7.0%	0.9
1.7	11	220	-3.2%	0.7	-0.4%	-1.7	4.5%	-0.1	19.7%	-1.2	5.6%	0.5	10.2%	0.6
1.7	15	220	-6.0%	0.7	-0.5%	-2.5	5.4%	-0.2	18.9%	-0.8	0.3%	0.5	2.8%	0.8
1.7	17	220	-6.5%	0.7	1.1%	-2.3	6.9%	-0.3	16.9%	-0.7	0.4%	0.6	2.0%	0.7
2.5	13	220	-5.1%	0.7	-4.7%	-2.0	4.2%	-0.2	22.1%	-0.9	-0.6%	0.3	3.7%	0.9
1.7	13	225	-3.7%	0.7	0.0%	-2.3	4.2%	-0.1	15.5%	-0.8	2.0%	0.6	3.7%	0.9
1.7	13	215	-6.4%	0.7	-3.3%	-2.6	3.1%	-0.2	22.6%	-1.3	0.3%	0.4	4.8%	0.7
1.7	13	210	-7.4%	0.6	-3.4%	-2.7	3.1%	-0.3	27.2%	-1.5	-0.1%	0.3	8.4%	0.6
1.7	13	205	-7.9%	0.4	-5.1%	-2.8	3.6%	-0.3	30.1%	-1.8	0.4%	0.3	9.4%	0.2
1.7	13	200	-7.7%	0.1	-8.4%	-3.2	4.0%	-0.5	31.0%	-2.3	1.3%	0.3	5.2%	-0.8

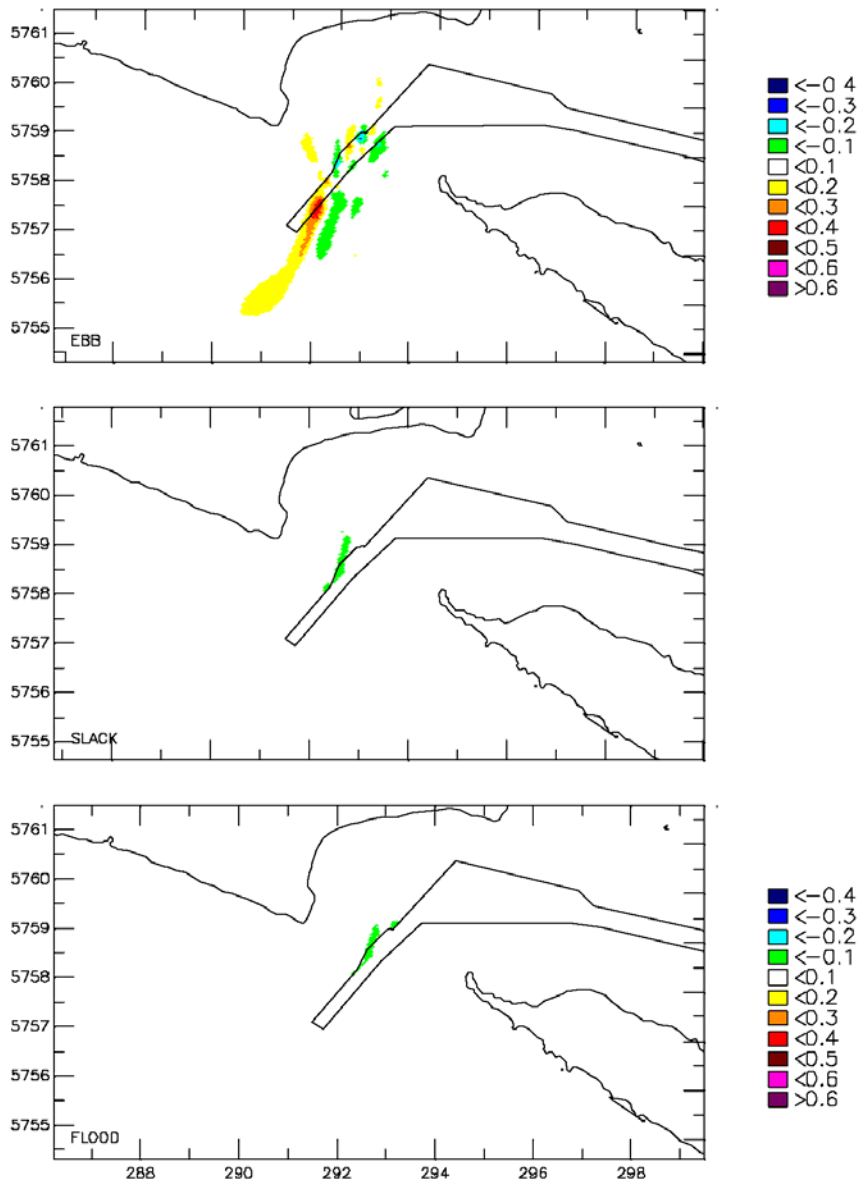


Figure 1a Change in significant wave height due to dredging from existing conditions for incoming wave with $H_s = 2.0$ m, $T_p = 12$ s and a direction of 225° .

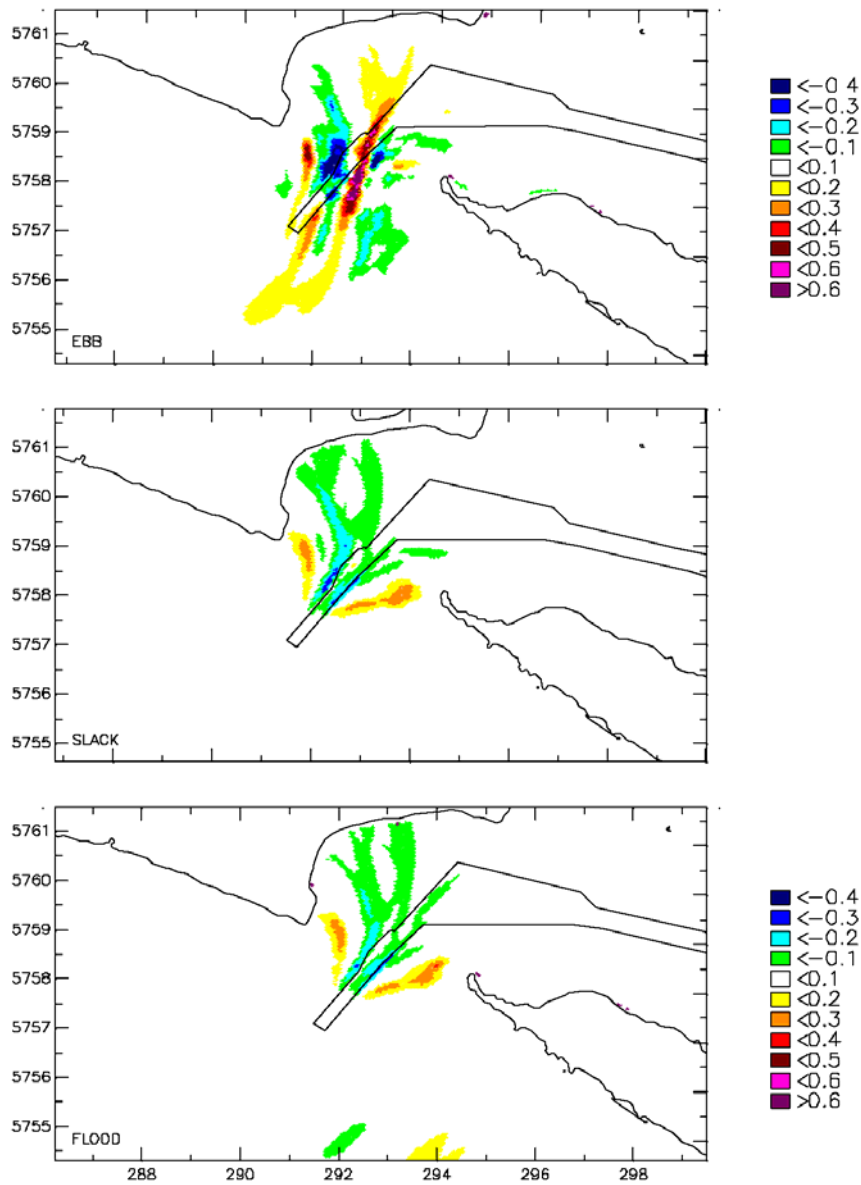


Figure 1b Change in significant wave height due to scouring from existing conditions for incoming wave with $H_s = 2.0$ m, $T_p = 12$ s and a direction of 225° .

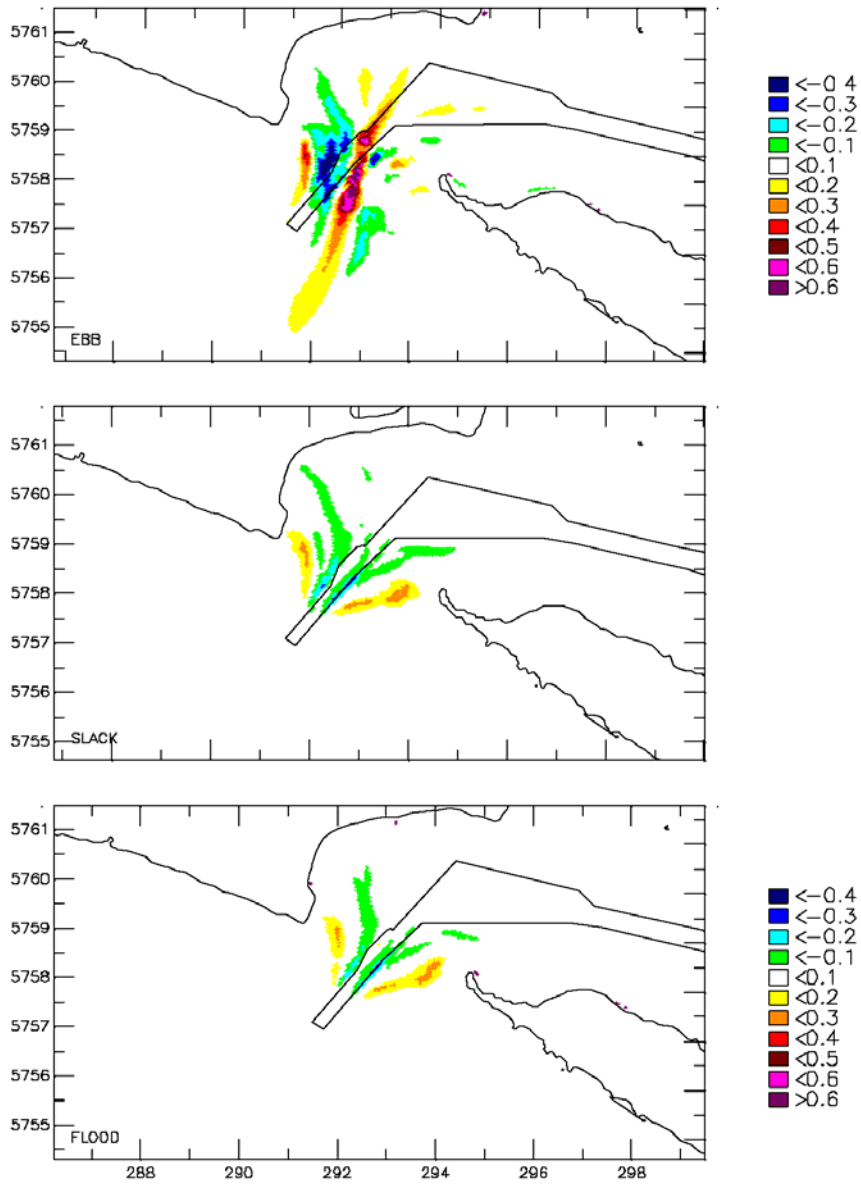


Figure 1c Change in significant wave height due to scouring from dredged conditions for incoming wave with $H_s = 2.0$ m, $T_p = 12$ s and a direction of 225° .

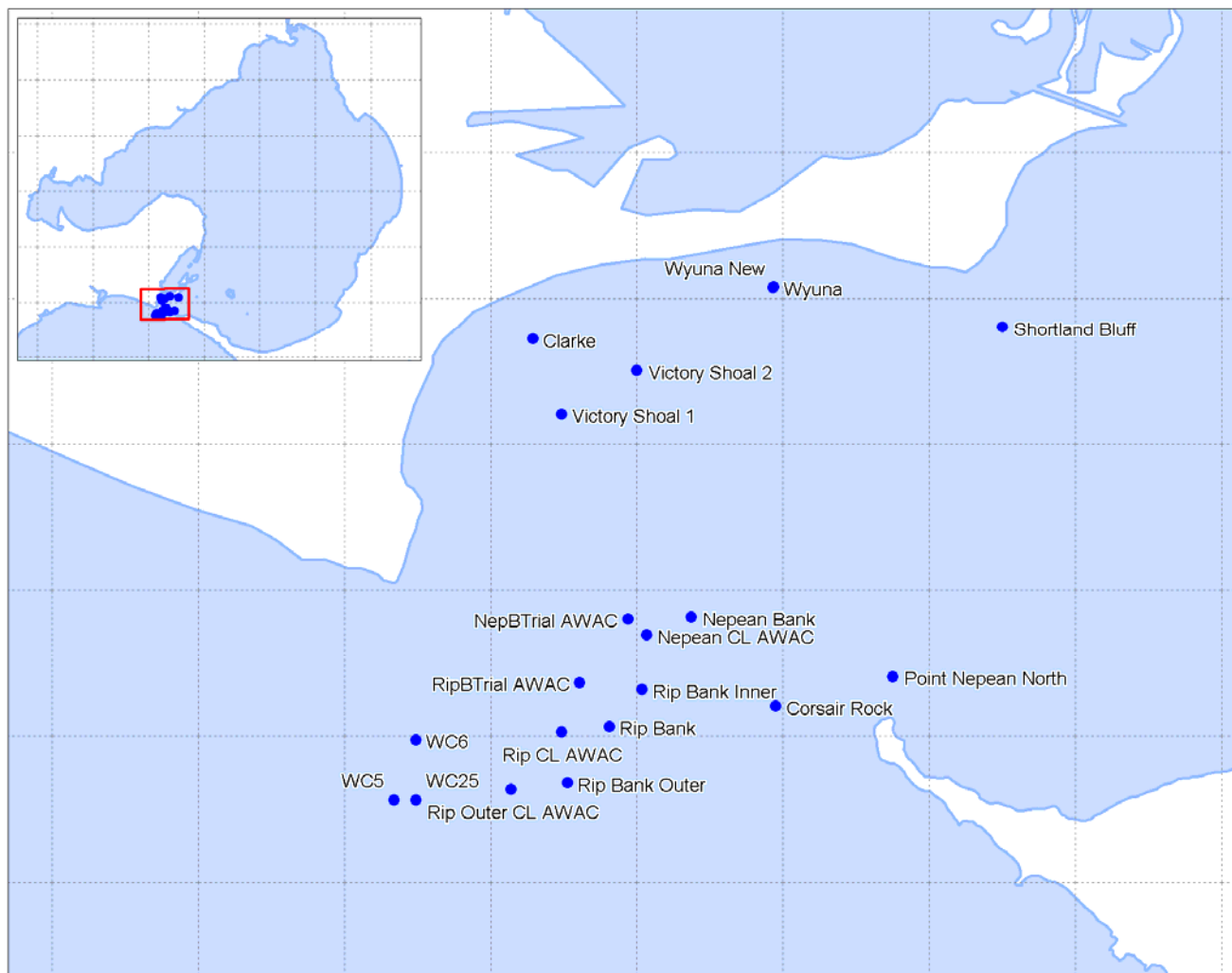


Figure 2 Location points for extraction of modelled wave data in the Entrance

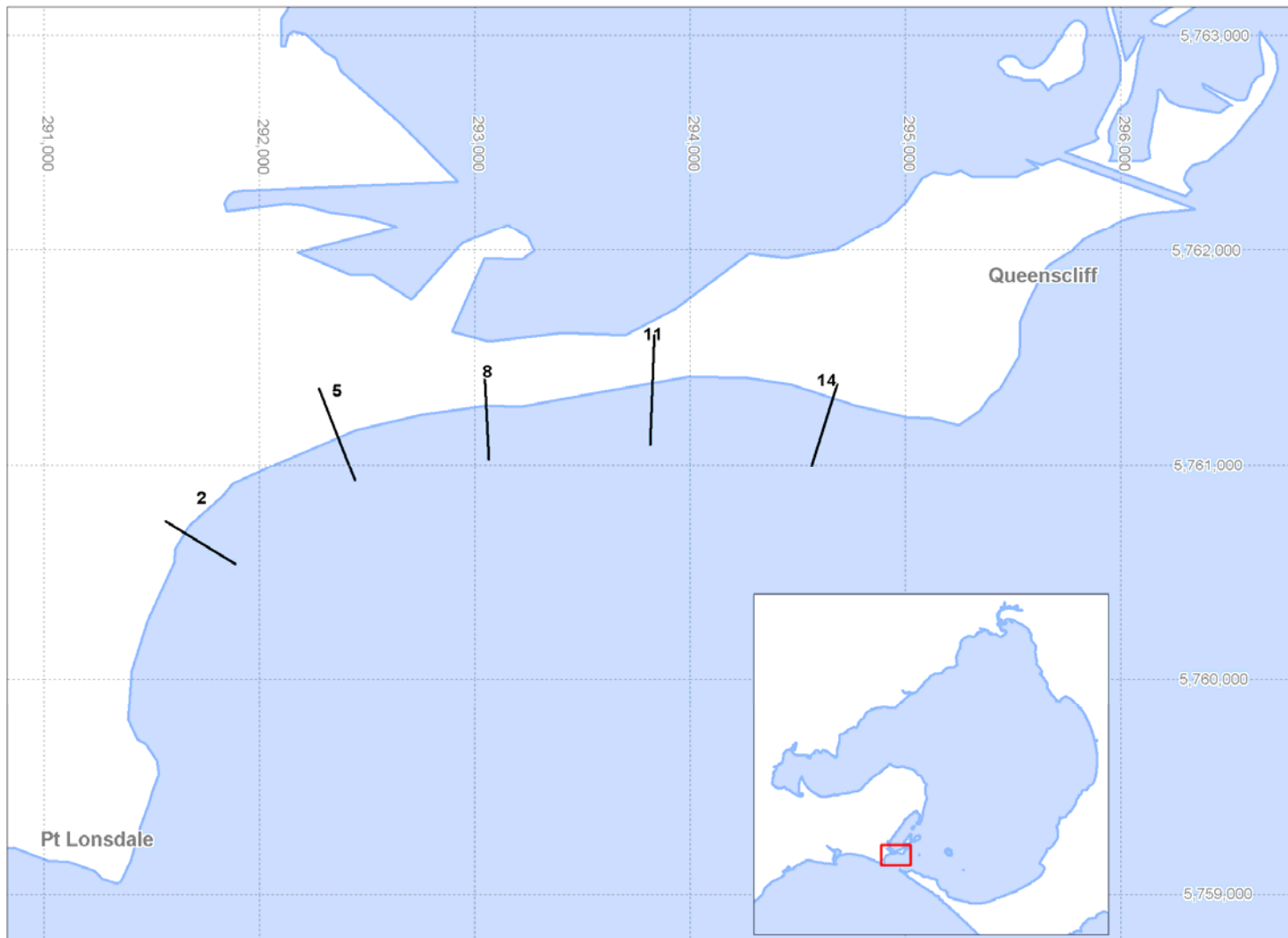


Figure 3 Lonsdale Bight beach profiles