PORT OTAGO DREDGE DISPOSAL GROUNDS

Monitoring effects of Q1-Q2 2014 disposal at the Heyward Ground and the proposed plan for Q3-Q4 2014

Prepared for Port Otago Limited

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MetOcean Solutions Ltd: Report P0140-05a

July 2014

Report status

Version	Date	Status	Approved by
RevA	25/07/2014	Draft for internal review	Weppe
RevB	06/08/2014	Draft for client review	McComb

It is the responsibility of the reader to verify the currency of the version number of this report.

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1. INTRODUCTION

The functional effects of the morphological features of the Heyward Ground on the local wave dynamics were investigated in a previous report P0140-05a using the nearshore wave models SWAN and CGWAVE, with a particular focus on how they influence the surfing conditions at Whareakeake. That report provided a baseline on the wave processes, and was used to define a disposal plan for Q1-Q2 2014 that would ensure conservation of the main processes that are beneficial for the surfing wave quality on the north coast.

The present report continues this approach; making an assessment of the effects of the disposal at Heyward Ground over the first half of 2014, and provides a plan for the upcoming Q3-Q4 disposal of up to 100 000 m^3. The same SWAN and CGWAVE simulations as undertaken in study P0140-05a have been reproduced using the updated bathymetry of the Heyward Ground and vicinity surveyed, at the end of June 2014. The reader is directed to report P0140-05a for a full description of the methods employed.

2. RESULTS

2.1. June 2014 bathymetry survey

A bathymetric survey of the Aramoana Beach and Heyward disposal ground (and adjacent areas) was conducted on 29/06/2014. Spatial analysis of those data indicated a spatial bias of approximately 0.10 m was presented, which is consistent with the stated survey accuracy. After discussion with the survey operator, a uniform bias correction of 0.10 m was applied to the June 2014 data to allow effective comparisons with the data from 2013 to be made.

2.2. Effects of disposal during Q1-Q2 2014

Simulations undertaken in study P0140-05a were reproduced with the updated Heyward Ground bathymetry. The 2013 (pre-disposal) and June 2014 (post-disposal) bathymetries are shown in Figure 2.1. The proposed and completed disposal plans for Q1-Q2 are provided in Figure 2.2 and corresponding bathymetric changes are compared in Figure 2.3. Over 2014 Q1 and Q2, the Heyward Ground received ~88,000 m^3 of sediment out of the maximum 100,000 m^3 specified in the disposal plan, with no sediment disposed in the northwest cells (P9, P10).

Predicted wave fields over the 2013 (pre-disposal) and post-disposal bathymetries are compared in Figures 2.4 and 2.5 for a range of offshore direction. Variations are very limited, with height difference of up to ± 20 cm in the direct vicinity of the mound where refraction and focusing process are the most intense, tapering off to ± 5-10 cm further nearshore towards Whareakeake. The wave heights predicted along the 6 m depth contour for the two cases show very little variation (Figure 2.6). Note the obtained patterns and general magnitudes of wave height difference are very similar to these predicted in the previous report P0140-05a, based on the estimated post-disposal bathymetry. Tables of wave height transformation from the offshore A0 site to inshore WRB and W1 (just off Whareakeake Point) sites are provided in Tables 2.1 and 2.2 for the pre and post-disposal cases respectively.

Wave crest patterns developing over the post-disposal bathymetry were simulated using the phase-resolving CGWAVE model. As suggested in the previous report, the modification of the morphology of the mound within the Heyward Ground does not appear to adversely impact the beneficial primary wave focusing process over the circular mound.

In addition to the recent northwest mound ridge within the ground, particular care will also be required regarding what happen outside of the ground. As the dumped sediments are dispersed, notably, over the shallower area between the ground and Heyward Point, these may influence the path of the mound-focused wave crests.

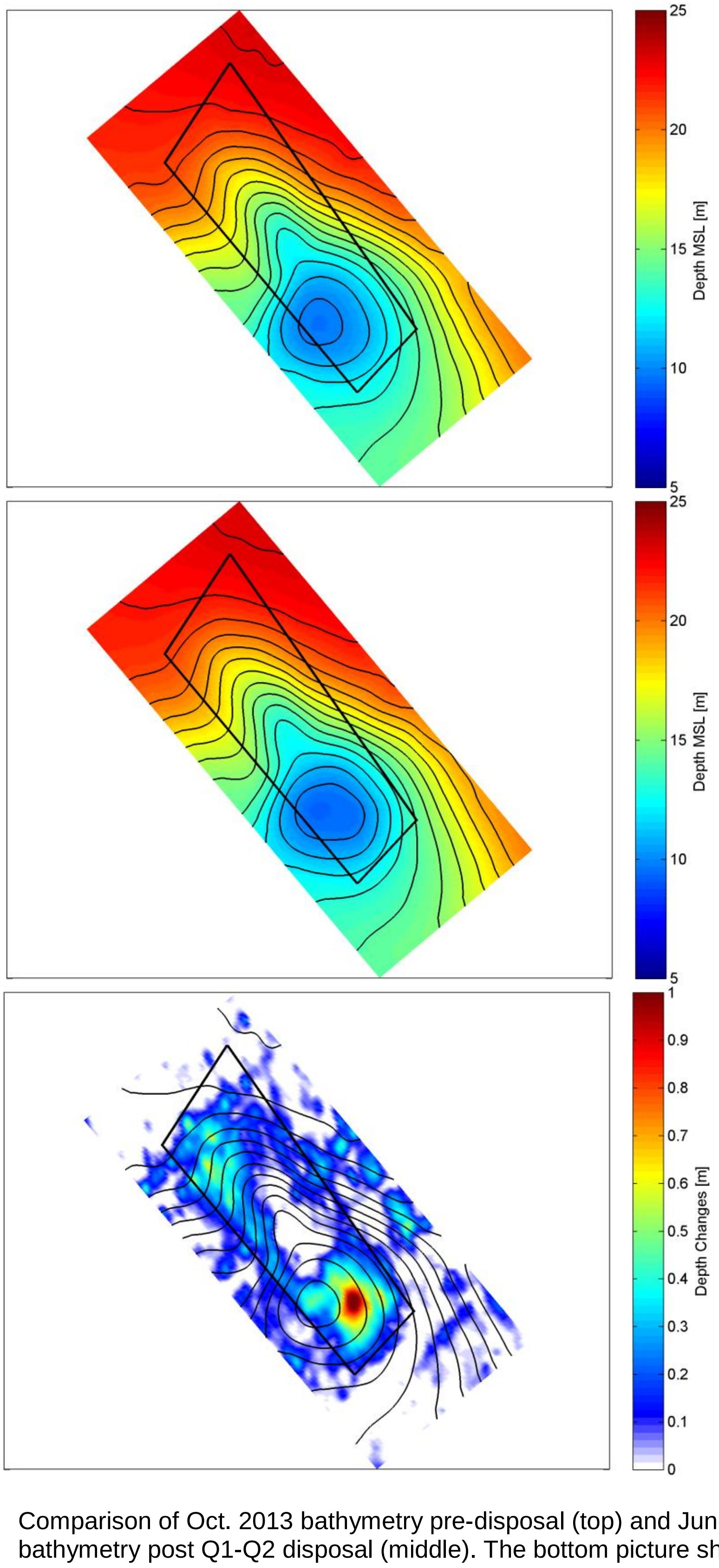
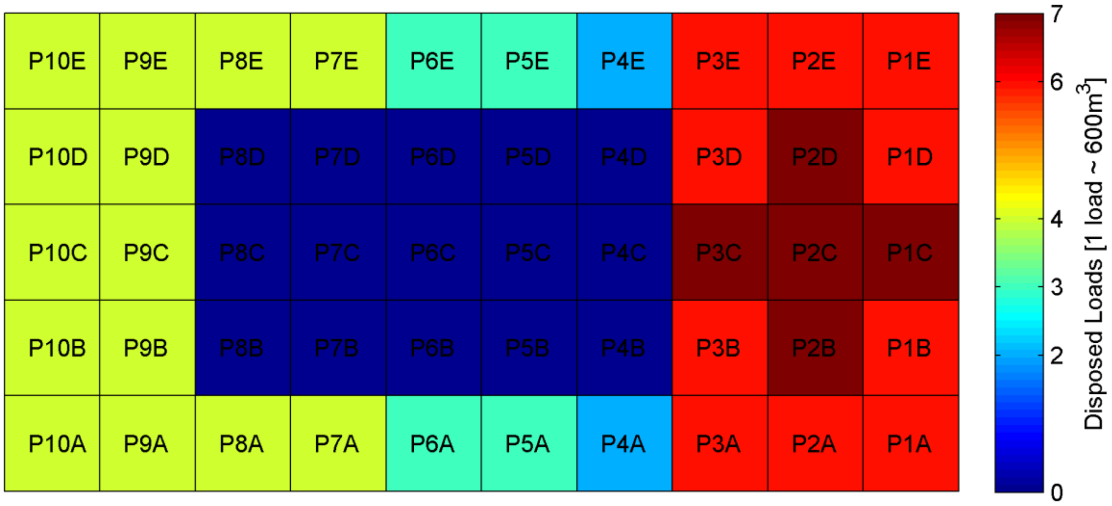


Figure 2.1 Comparison of Oct. 2013 bathymetry pre-disposal (top) and June 2014 bathymetry post Q1-Q2 disposal (middle). The bottom picture shows the depth difference between the two surveys.

Proposed disposal plan for Q1-Q2 2014



Completed disposal at the end of Q1-Q2014.

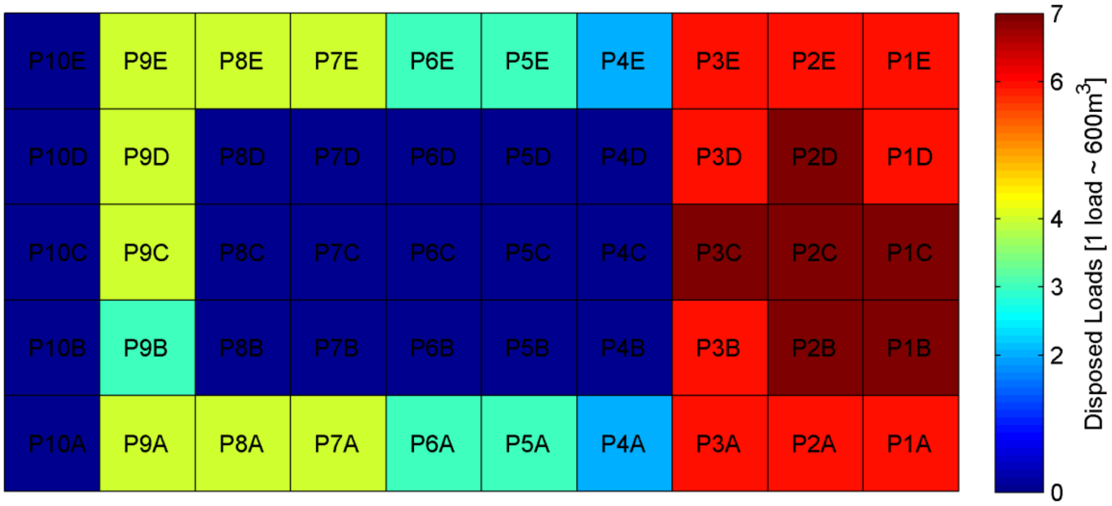


Figure 2.2 Proposed disposal plan for Q1-Q2 2014 in report P0140-05a (top), totalling 100 000m^3 and disposal effectively completed over Q1-Q2 2014 (bottom), totalling to ~88,000 m^3.

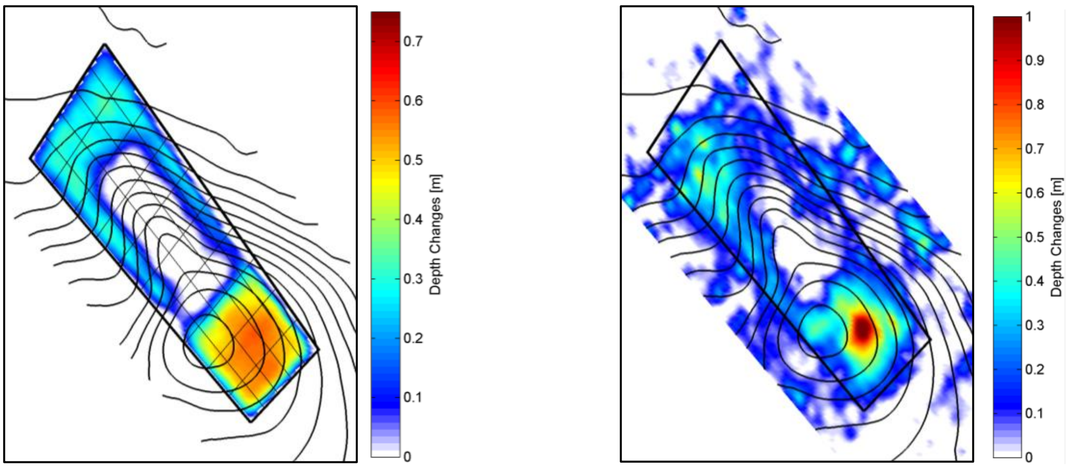


Figure 2.3 Comparison of estimated (left) and measured (right) bathymetric difference post Q1-Q2 disposal.

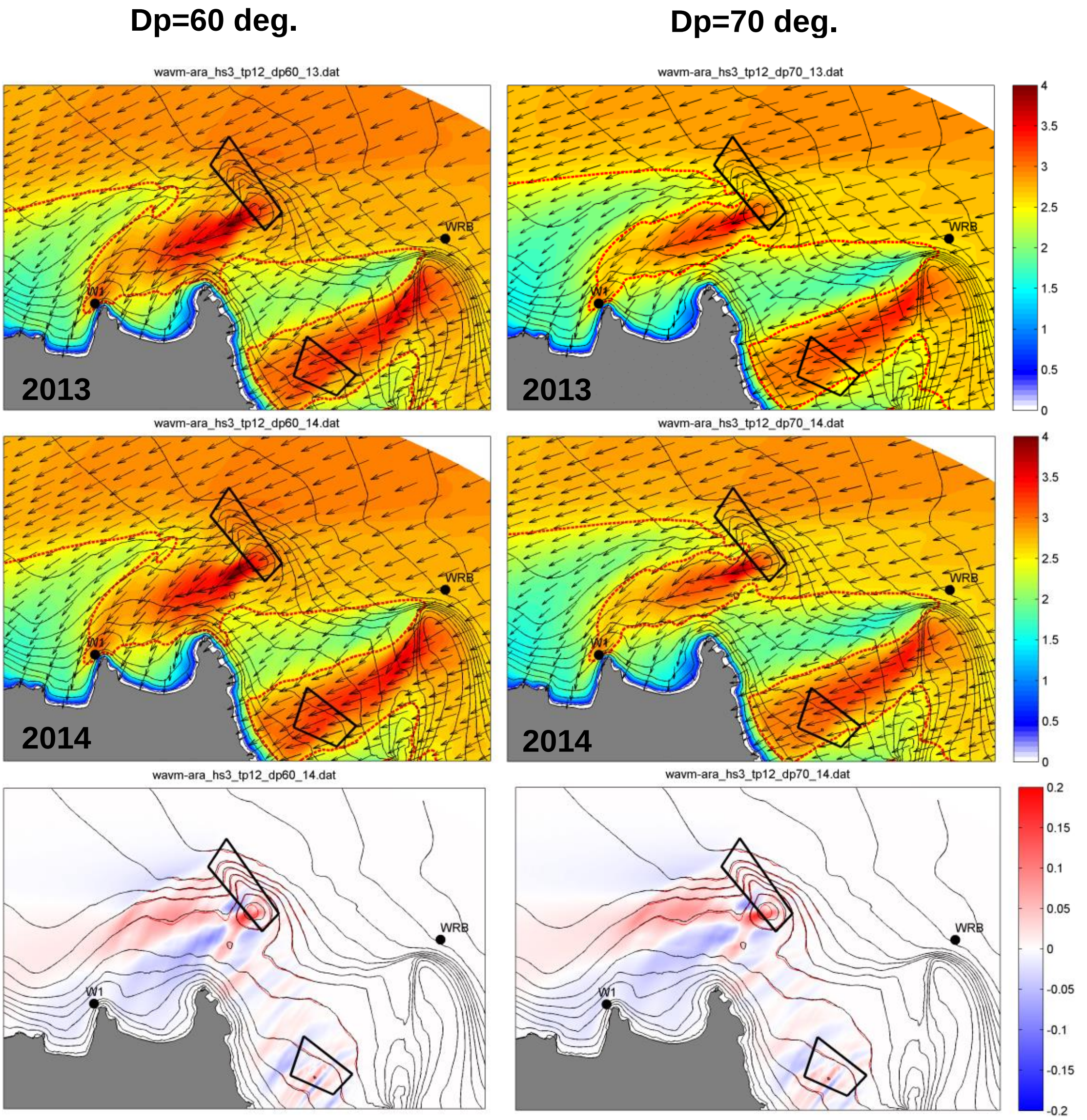


Figure 2.4 Predicted significant wave heights for offshore directions of 60 (left) and 70 (right) degrees over the 2013 pre-disposal (top) and 2014 post Q1-Q2 disposal (middle) bathymetries and differences (bottom). The dotted red line is the 2.5 m wave height contour (top, middle). In difference maps (bottom), positive values indicate wave height larger over the 2014 bathymetry than over the 2013 bathymetry. 2013 contours are shown in red and 2014 contours are shown in black.

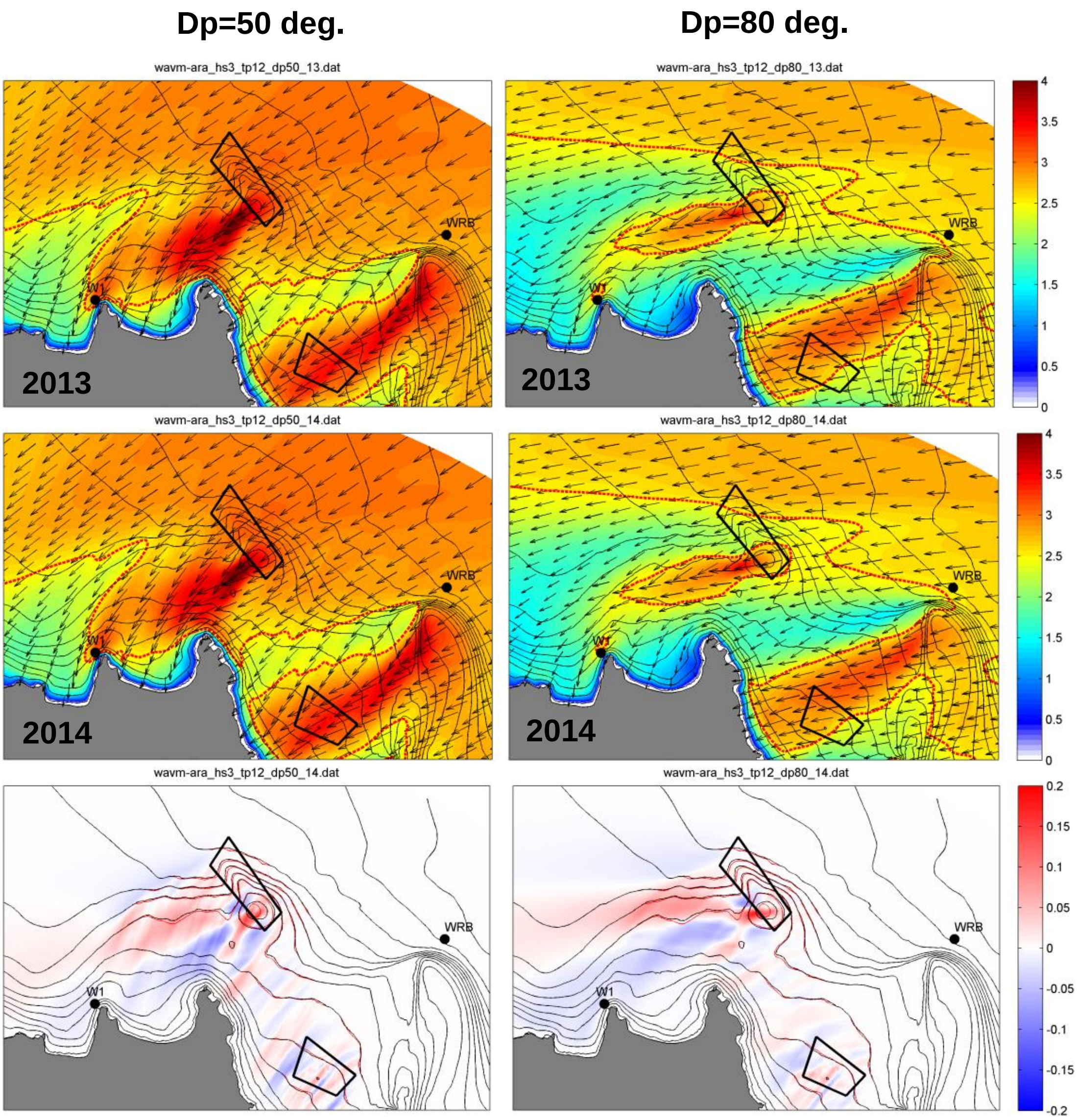


Figure 2.5 Predicted significant wave heights for offshore directions of 50 (left) and 80 (right) degrees over the 2013 pre-disposal (top) and 2014 post-disposal (middle) bathymetries and differences (bottom). The dotted red line is the 2.5 m wave height contour (top, middle). In difference maps (bottom), positive values indicate wave height larger over the 2014 bathymetry than over the 2013 bathymetry. 2013 contours are shown in red and 2014 contours are shown in black.

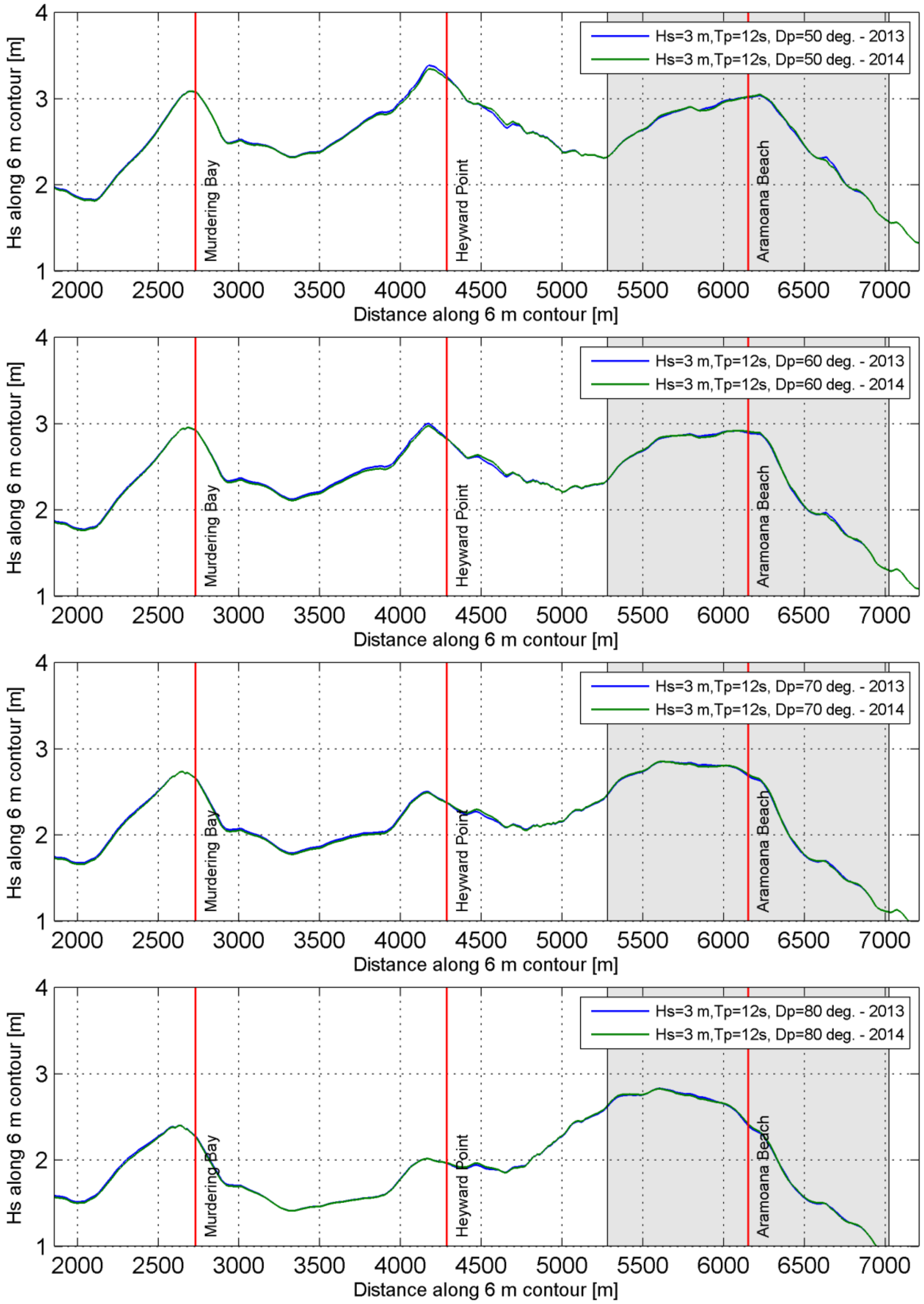


Figure 2.6 Significant wave heights along the 6 m contour for wave incidences of 50, 60, 70, and 80 degrees over the 2013 (pre-disposal) and 2014 post-disposal bathymetries.

Table 2.1 Wave conditions at the A0, WRB and W1 sites for all the simulated idealized wave events over the 2013 pre-disposal bathymetry. Significant wave heights (Hs) are in meters, Peak direction (Dp) are degrees, and peak periods (Tp) in seconds.

2013 Pre-Disposal								
A0 - Site			**WRB - Site**			**W1 - Site**		
Hs (A0)	**Dp (A0)**	**Tp (A0)**	**Hs (WRB)**	**Dp (WRB)**	**Tp (WRB)**	**Hs (W1)**	**Dp (W1)**	**Tp (W1)**
3.0	90	12.0	2.5	88	11.9	2.0	17	11.9
3.0	80	12.0	2.5	84	11.9	2.4	17	11.9
3.0	70	10.0	2.6	72	9.9	2.2	16	10.1
3.0	70	12.0	2.6	76	11.9	2.7	16	11.9
3.0	70	14.0	2.7	84	14.1	2.6	16	14.2
3.0	70	16.0	2.7	84	16.0	2.7	16	16.0
3.0	60	10.0	2.6	64	9.9	2.6	16	10.1
3.0	60	12.0	2.7	68	11.9	2.8	16	11.9
3.0	60	14.0	2.8	68	14.1	3.0	16	14.2
3.0	60	16.0	2.8	72	16.0	3.0	16	16.0
3.0	50	12.0	2.8	60	11.9	2.9	15	11.9
3.0	40	12.0	2.9	52	11.9	2.9	15	11.9

Table 2.2 Wave conditions at the A0, WRB and W1 sites for all the simulated idealized wave events over the post-disposal bathyemtry. Significant wave heights (Hs) are in meters, Peak direction (Dp) are degrees, and peak periods (Tp) in seconds.

2014 - Post Q1-Q2 disposal										
A0 - Site				**WRB - Site**				**W1 - Site**		
Hs (A0)	**Dp (A0)**	**Tp (A0)**		**Hs (WRB)**	**Dp (WRB)**	**Tp (WRB)**		**Hs (W1)**	**Dp (W1)**	**Tp (W1)**
3.0	90	12.0		2.5	88	11.9		2.0	17	11.9
3.0	80	12.0		2.5	84	11.9		2.4	17	11.9
3.0	70	10.0		2.6	72	9.9		2.2	16	10.1
3.0	70	12.0		2.6	76	11.9		2.7	16	11.9
3.0	70	14.0		2.7	84	14.1		2.6	16	14.2
3.0	70	16.0		2.7	84	16.0		2.7	16	16.0
3.0	60	10.0		2.6	64	9.9		2.6	16	10.1
3.0	60	12.0		2.7	68	11.9		2.8	16	11.9
3.0	60	14.0		2.8	68	14.1		3.0	16	14.2
3.0	60	16.0		2.8	72	16.0		3.0	16	16.0
3.0	50	12.0		2.8	60	11.9		2.9	15	11.9
3.0	40	12.0		2.9	52	11.9		2.9	15	11.9

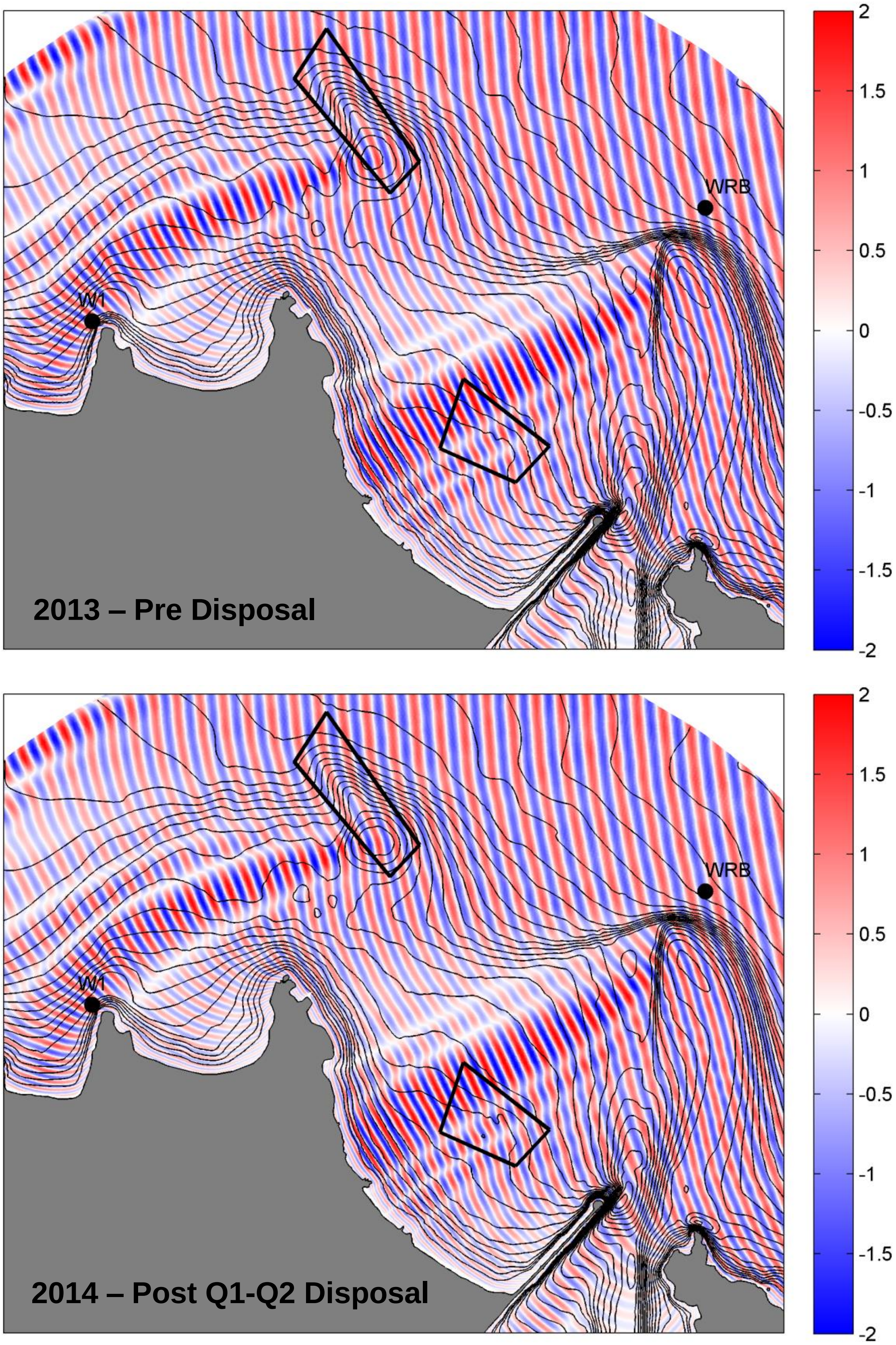


Figure 2.7 Predicted wave crest patterns for a monochromatic surfing wave event Hs=2.6 m Dir=75 deg, Tp=12 sec., over the 2013 pre-disposal and post-disposal (bottom) bathymetries.

2.3. Proposed disposal regime for Q3-Q4 2014

As outlined in the previous report 0140-05a, the 6-month disposal plan is guided by the conservation of the wave focusing processes developing over the Heyward Ground morphology that produce benefit surfing conditions at Whareakeake. Based on the surveyed bathymetric changes, it is recommended to continue the loading of the northwest part of the ground where it is deepest and has received little sediment volumes during 2014 to date (see Figure 2.1). Modification of this part the ground are expected to have relatively small effects on refraction patterns. As for the previous disposal plan, no significant sediment volume is to be disposed over the longitudinal ridge branching from the circular mound that was built up in the 2012-2013 year. In the southeast half of the ground, sediment volume is distributed to homogenise the circular mound as much as possible. The exposed part of the circular mound is loaded by 5 loads per cell, except the central cell P2C that has already been subject to significant accretion over 2014 Q1-Q2 (see Figure 2.1). The inner mound cells that are presently the shallowest P3B, P3A (~9.5 MSL) receive smaller volumes (i.e. only 2 loads).

The proposed disposal plan for 2014 Q3-Q4 is provided in Figure 2.8. Similarly to the previous report, the bathymetry post Q3-Q4 disposal was estimated by homogenously spreading the sediment volume to be received in each cell over its surface. The resulting bathymetry and associated bathymetric changes are shown in Figure 2.9. Measured Q1-Q2 bathymetric changes and projected Q3-Q4 changes are shown in Figure 2.10.

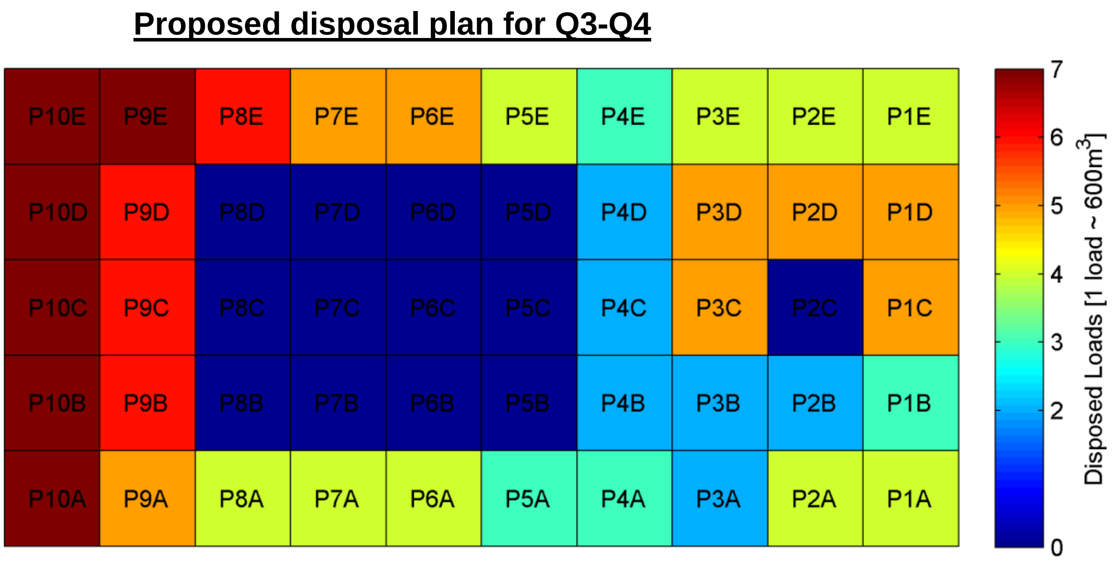


Figure 2.8 Proposed disposal plan for Q3-Q3 2014, totalling 100 000m^3.

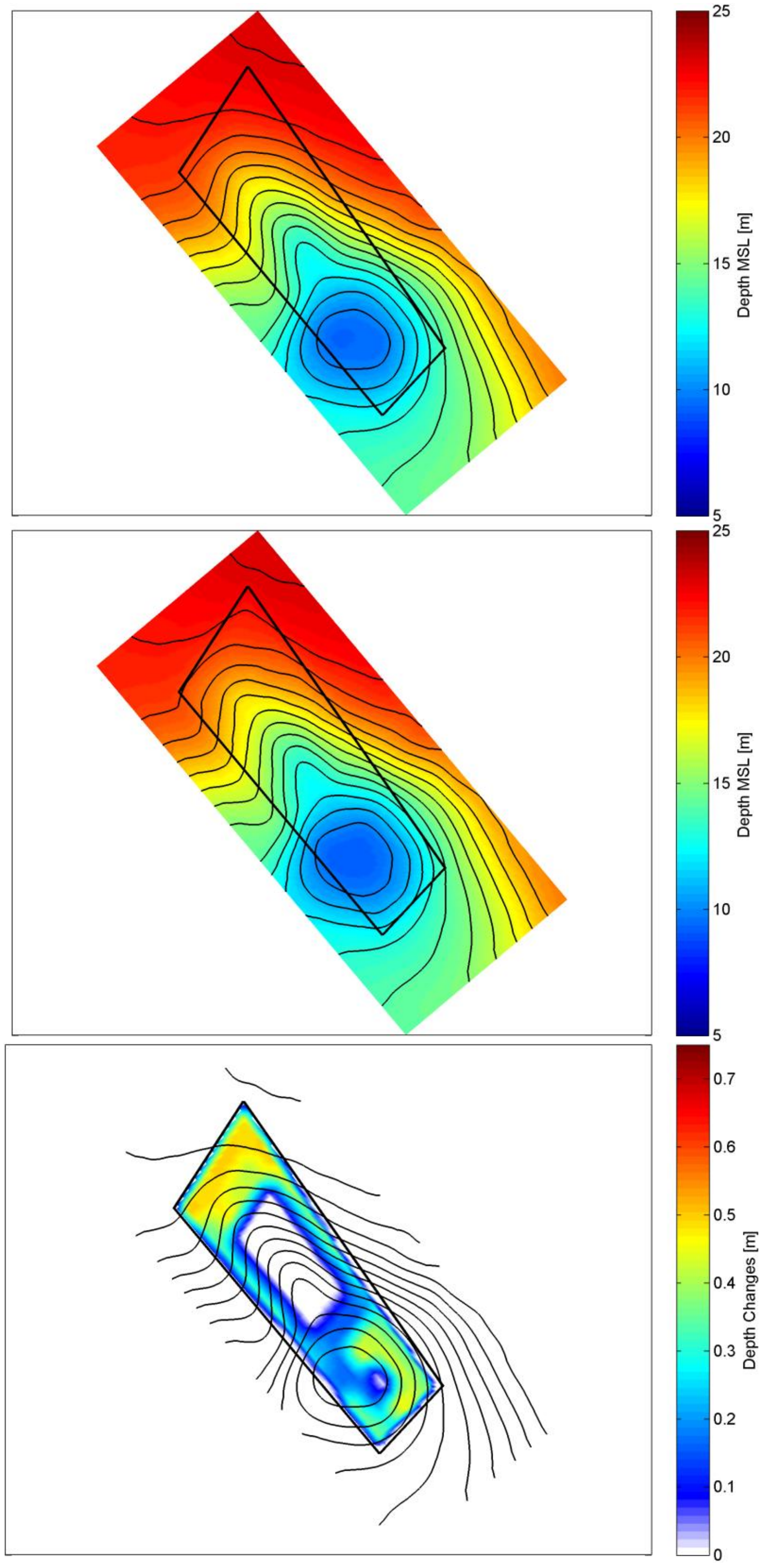


Figure 2.9 Comparison of the existing bathymetry post Q1-Q2 disposal (top) and estimated bathymetry post Q3-Q4 disposal (middle). The bottom picture shows the depth difference.

The SWAN and CGWAVE simulations were reproduced using this new bathymetry. The predicted wave height fields post Q3-Q4 disposal are virtually unchanged relative to the existing predictions (i.e. surveyed bathymetry post Q1-Q2 disposal) (Figures 2.11 and 2.12). Wave height changes range within ± 10 cm over the throughout the ground region ground and tapper off to less than ±5 cm changes further inshore. Wave heights predicted along the 6 m depth contour are virtually identical (Figure 2.13). The wave transformation table from the offshore A0 site, to the WRB and W1 sites near the channel entrance and off Whareakeake are provided in Table 2.3 for comparison with precedent values (Tables 2.1 and 2.2 and see report P0140-05a).

The comparison of wave crest patterns developing over the ground pre and post Q3-Q4 disposal does not show any significant modification of the wave refraction and focusing processes due to the modification of the mound morphology (Figure 2.14).

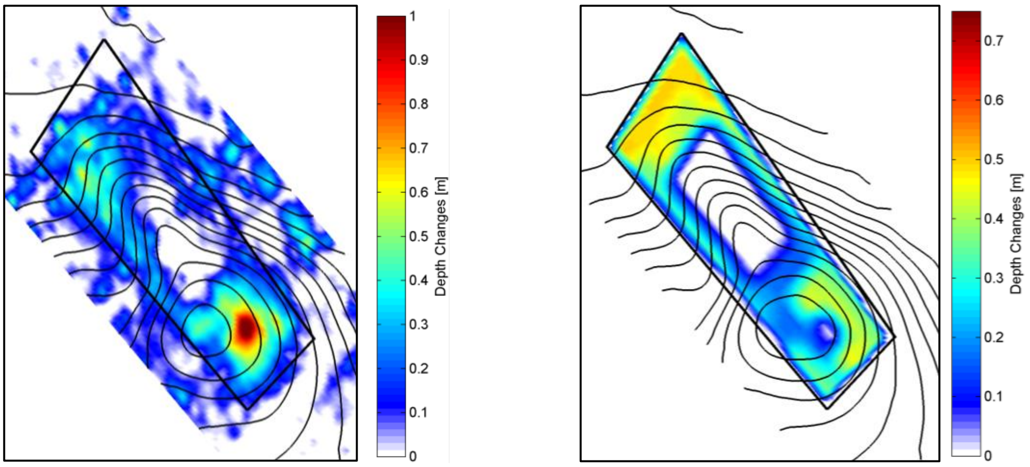


Figure 2.10 Comparison of measured Q1-Q2 bathymetric changes (left) and planned Q3-Q4 (right) bathymetric changes.

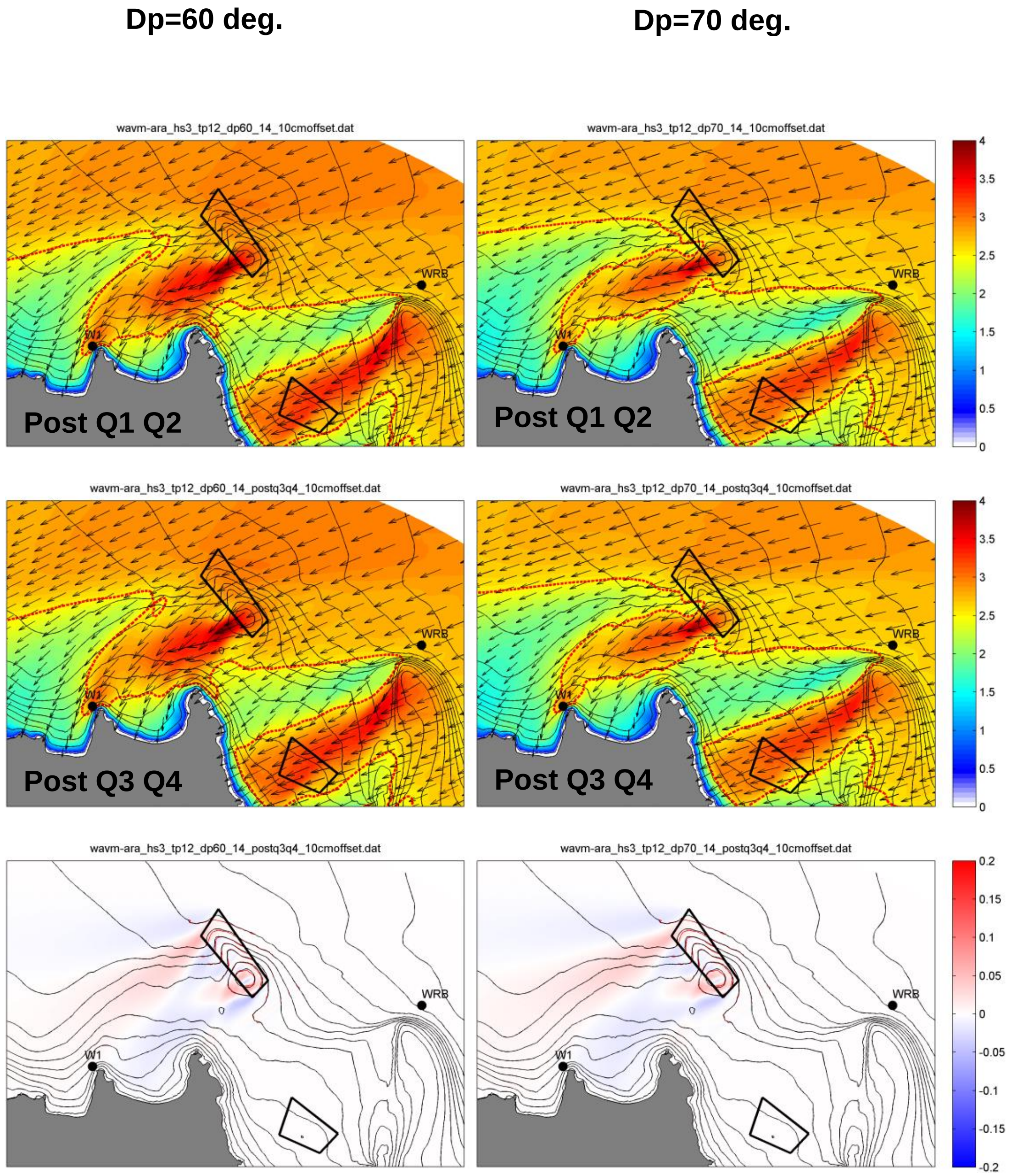


Figure 2.11 Predicted significant wave heights for offshore directions of 60 (left) and 70 (right) degrees over the post Q1-Q2 (top) and post Q3-Q4 disposal (middle) bathymetries and differences (bottom). The dotted red line is the 2.5 m wave height contour (top, middle). In difference maps (bottom), positive values indicate wave height larger over the post Q3-Q4 disposal bathymetry than over the post Q1-Q2 bathymetry. Post Q1-Q2 contours are shown in red and post Q3-Q4 contours are shown in black.

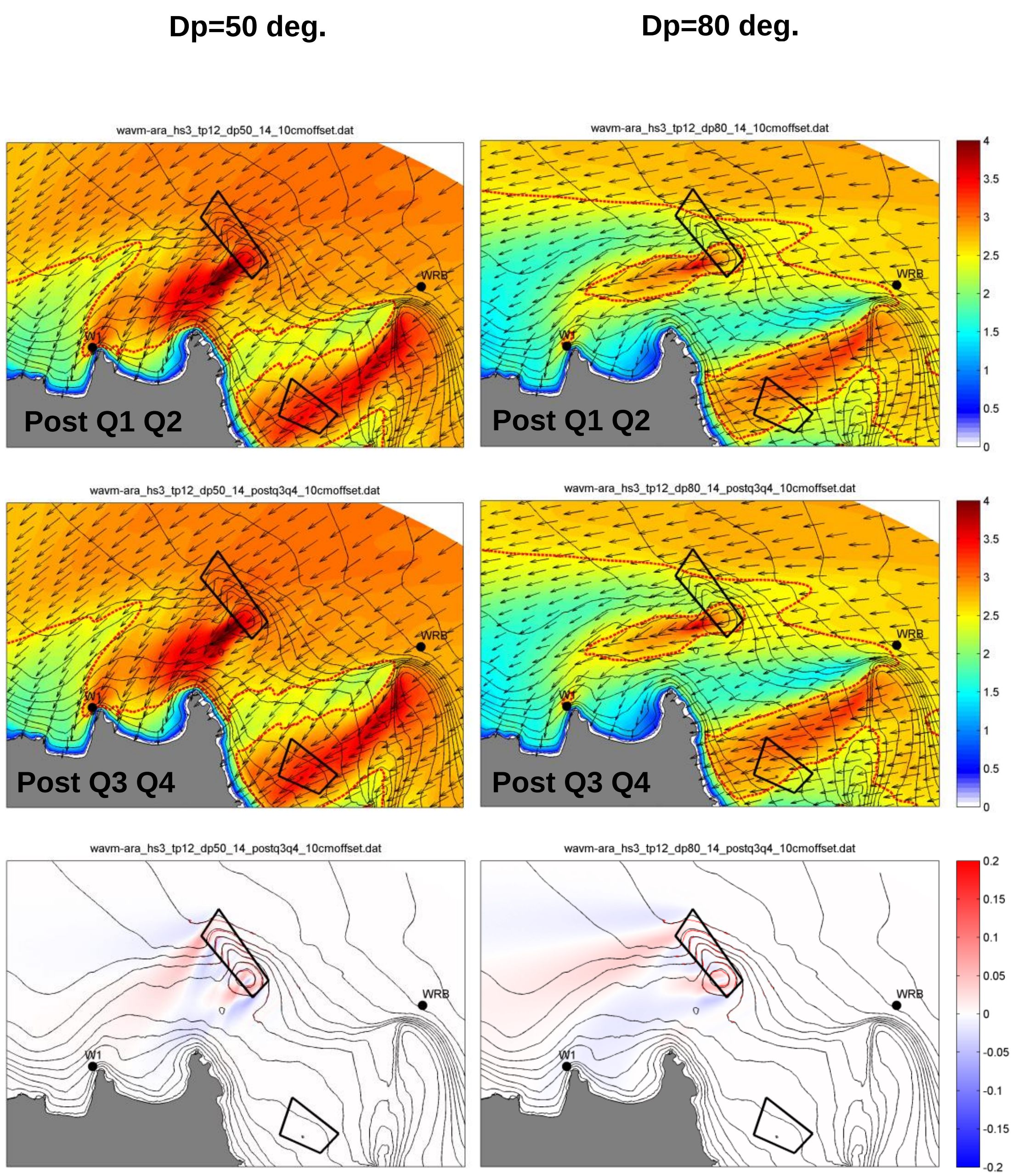


Figure 2.12 Predicted significant wave heights for offshore directions of 50 (left) and 80 (right) degrees over the post Q1-Q2 (top) and post Q3-Q4 disposal (middle) bathymetries and differences (bottom). The dotted red line is the 2.5 m wave height contour (top, middle). In difference maps (bottom), positive values indicate wave height larger over the post Q3-Q4 disposal bathymetry than over the post Q1-Q2 bathymetry. Post Q1-Q2 contours are shown in red and post Q3-Q4 contours are shown in black.

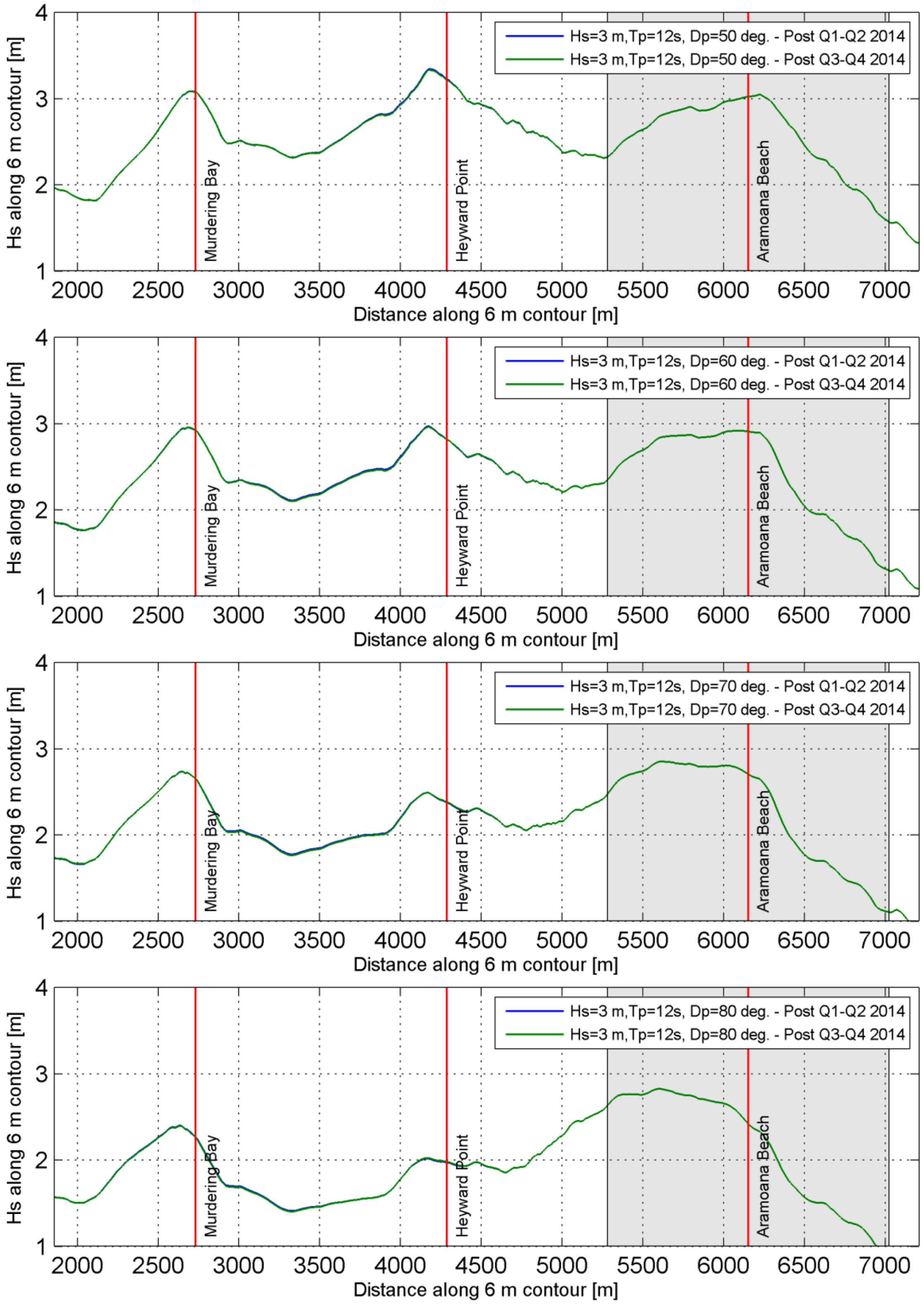


Figure 2.13 Significant wave heights along the 6 m contour for wave incidences of 50, 60, 70, and 80 degrees over the post Q1-Q2 disposal and post Q3-Q4 disposal bathymetries.

Table 2.3 Wave conditions at the A0, WRB and W1 sites for all the simulated idealized wave events over the estimated post Q3-Q4 bathymetry. Significant wave heights (Hs) are in meters, Peak direction (Dp) are degrees, and peak periods (Tp) in seconds.

2014 - Post Q3-Q4 Disposal								
A0 - Site			**WRB - Site**			**W1 - Site**		
Hs (A0)	**Dp (A0)**	**Tp (A0)**	**Hs (WRB)**	**Dp (WRB)**	**Tp (WRB)**	**Hs (W1)**	**Dp (W1)**	**Tp (W1)**
3.0	90	12.0	2.5	88	11.9	2.0	17	11.9
3.0	80	12.0	2.5	84	11.9	2.4	17	11.9
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3.0	70	12.0	2.6	76	11.9	2.7	16	11.9
3.0	70	14.0	2.7	84	14.1	2.6	16	14.2
3.0	70	16.0	2.7	84	16.0	2.7	16	16.0
3.0	60	10.0	2.6	64	9.9	2.6	16	10.1
3.0	60	12.0	2.7	68	11.9	2.8	16	11.9
3.0	60	14.0	2.8	68	14.1	3.0	16	14.2
3.0	60	16.0	2.8	72	16.0	3.0	16	16.0
3.0	50	12.0	2.8	60	11.9	2.9	15	11.9
3.0	40	12.0	2.9	52	11.9	2.9	15	11.9

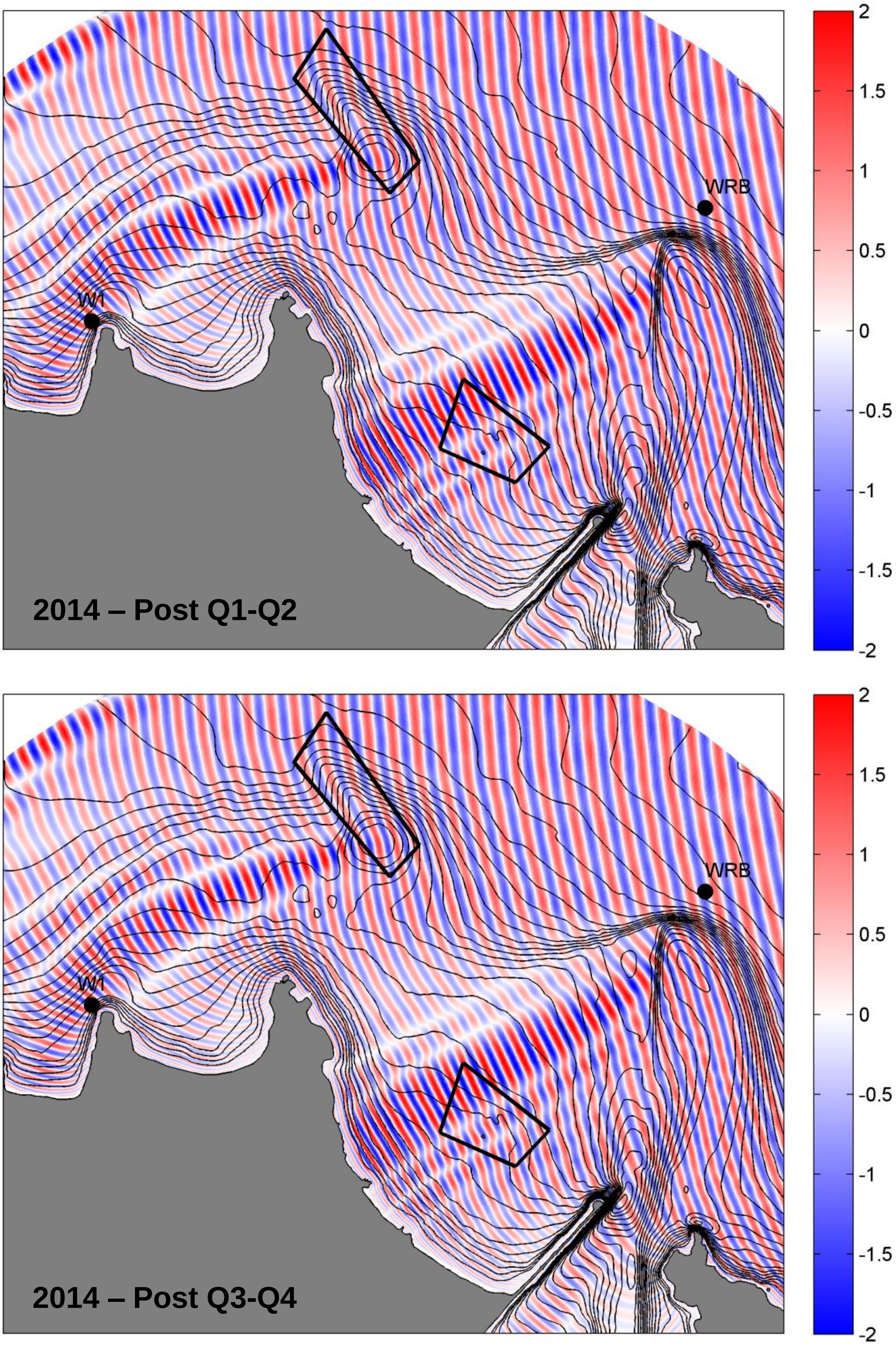

Figure 2.14 Predicted crest patterns for a monochromatic wave event Hs=2.6 m Dir=75 deg, Tp=12 sec., over the post 2014 Q1-Q2 disposal and post 2014 Q3-Q4 disposal (bottom) bathymetries.

3. REFERENCES

Metocean Solutions Ltd., Report 0140-05a, 2013. Port Otago Dredge disposal grounds - Functional effects of the Heyward Ground on wave dynamics and a proposed dumping plan. Technical report prepared for Port Otago Limited.