EASTLAND PORT MAINTENANCE DREDGING AND DISPOSAL PROJECT

Summary of effects: Offshore disposal ground

Report prepared for Eastland Port

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MetOcean SOLUTIONS

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1. INTRODUCTION

As part of their Resource Consent requirements Eastland Port are required to provide regular updates on the condition of the offshore disposal ground, including an assessment of the long-term capacity of the disposal ground and any potential impact of the disposal ground on the coastal processes. Findings are to be reported by a coastal scientist and provided to both the Council and Liaison Group.

Details of the Poverty Bay hydrodynamics and wave climate can be found in MetOcean Solutions (2017a, 2017b), as well as in various historical reports (e.g. Braddock, 2006; Chappell, 2016; Gibb, 2014; Healy et al., 1998; WorleyParsons, 2015), and as such are not reproduced here.

This report focuses on the observed morphological characteristics of the disposal ground, including observed bathymetric changes and surficial sediment characteristics. Numerical modelling results from MetOcean Solutions (2019) are used to place the observed seabed characteristics of the offshore disposal ground into context.

This report is structured as follows. Section 2 details the methodology applied to investigate both the *in-situ* surficial sediment and the morphological response of the disposal ground while Section 3 presents the results of the analysis. A brief summary is provided in Section 4, while references cited are provided in the final section.

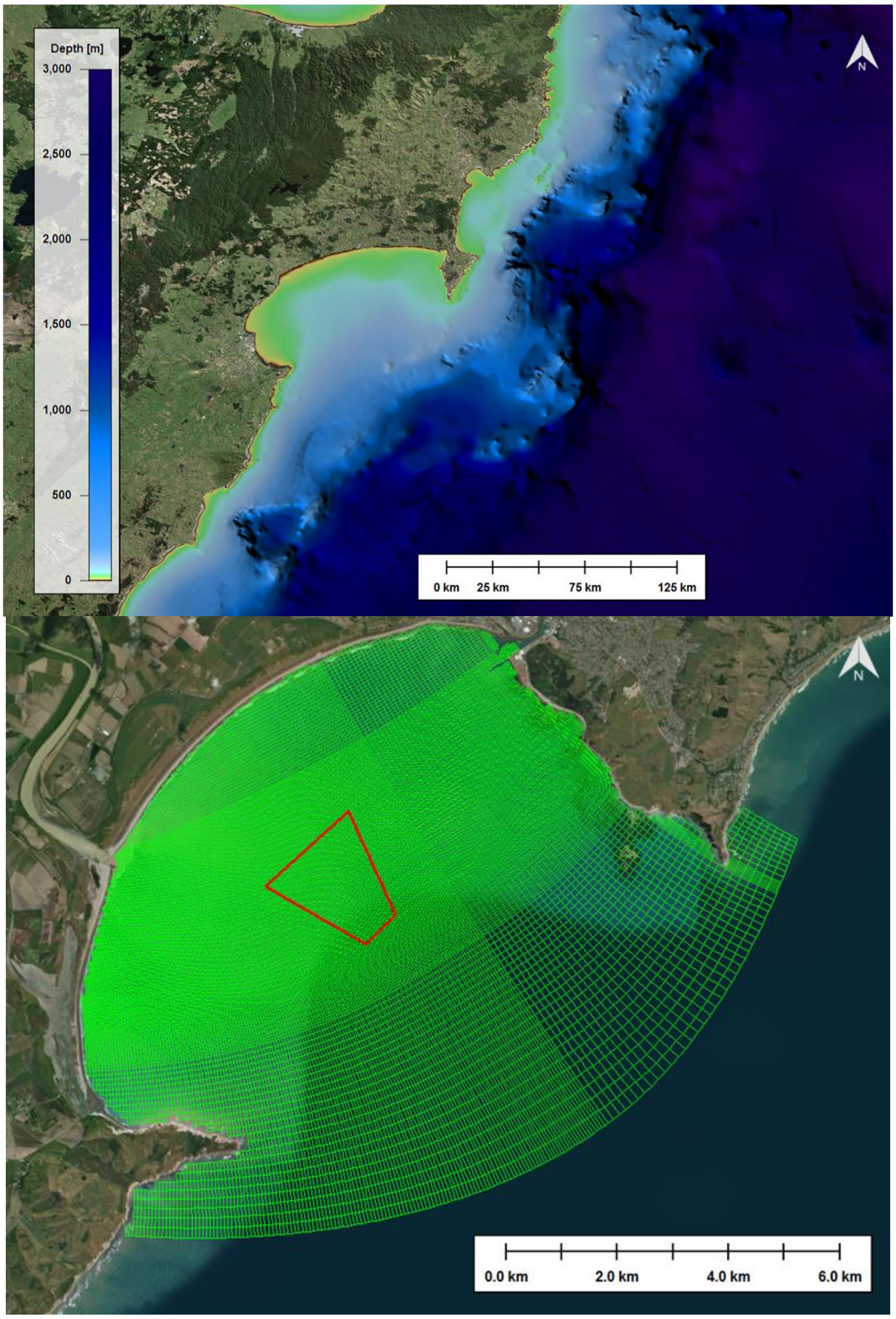


Figure 1.1 Maps showing the location of Poverty Bay (top) and the Delft3D – FLOW and MOR grids used to replicate the hydro- and morpho-dynamics over northern Poverty Bay and the disposal ground (red polygon).The resolution of the grid ranged from 30 m to 200 m.

2. METHODOLOGY

2.1. Surficial sediment

Surficial sediment samples were collected at a total of 44 sites within and adjacent to the offshore disposal ground and included 9 'control' sites (see Figure 2.1) in October, 2017. The control site locations were chosen to be in approximately similar water depths to the offshore disposal ground and are intended to be used to identify potential trends in the *in-situ* surficial sediment characteristics that are not attributable to the disposal of dredged sediment. The surficial sediment grain size data has been used to examine the morphological response of the offshore disposal ground and is intended to be used to provide a broader understanding of the morphological response of the disposal ground to the discharging of dredge material. As such, it is recommended that surficial sediment sampling be continued on a regular basis (i.e. every 1-2 years). Sample locations and summary statistics are provided in the appendix.

Because surficial sediment in Poverty Bay is a mixture of sand (> 62.5 μm) and mud (< 62. 5 μm) limitations are imposed on the available analysis techniques. In order to get a good representation of the sediment textural distribution, sample analysis was performed using a Malvern laser particle size analyser; model *MSS17* (Figure 2.2), which has the ability to concurrently measure both the sand and the mud sizes. The Malvern laser particle size analyser uses the principle of laser light scattering to yield information on particle size and distribution characteristics (Malvern Instruments Ltd.). Sediment grain size distribution, mean, median and modes were calculated using the Malvern software.

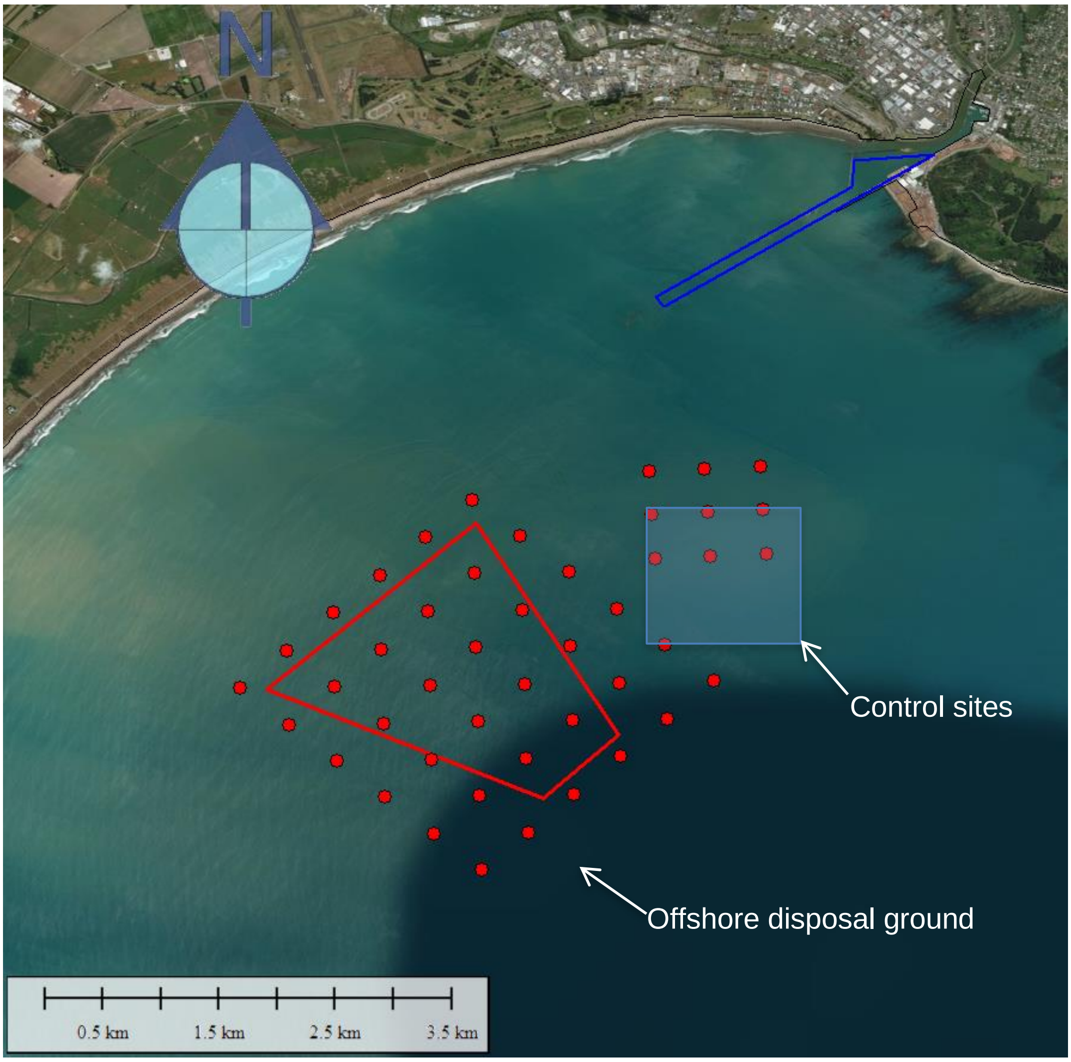


Figure 2.1 Surficial Sediment sample locations at both the disposal ground and control sites.

Figure 2.2 Malvern laser particle size analyser, showing the sample dispersion unit used to treat the sample with ultrasonic noise used to disperse the flocculated particles.

2.2. Hydrographic surveys

Eastland Port undertakes regular hydrographic surveys of the offshore disposal ground, and these data are used to determine the morphological response of the disposal ground during the intervening periods.

Five hydrographic surveys of the offshore disposal ground are available for analysis, providing four periods over which the morphological response of the disposal ground can be examined, i.e.

- 01/2005 to 08/2007
- 08/2007 to 11/2009
- 11/2009 to 06/2012, and
- 06/2012 to 02/2017

During each of these periods, maintenance dredge material was disposed of at the site.

The spatial coverage of each of the measured hydrographic datasets is shown in Figure 2.3. Prior to 2017 hydrographic surveys were undertaken using a single-beam echo-sounder, with variable coverage between survey periods. Survey coverage in 2009 was relatively poor, while coverage in 2005, 2007 and 2012 is considered appropriate to infer morphological responses at the offshore disposal ground. Better coverage of the offshore disposal ground was achieved in 2017 due to the use of a multibeam echo-sounder (Figure 2.3).

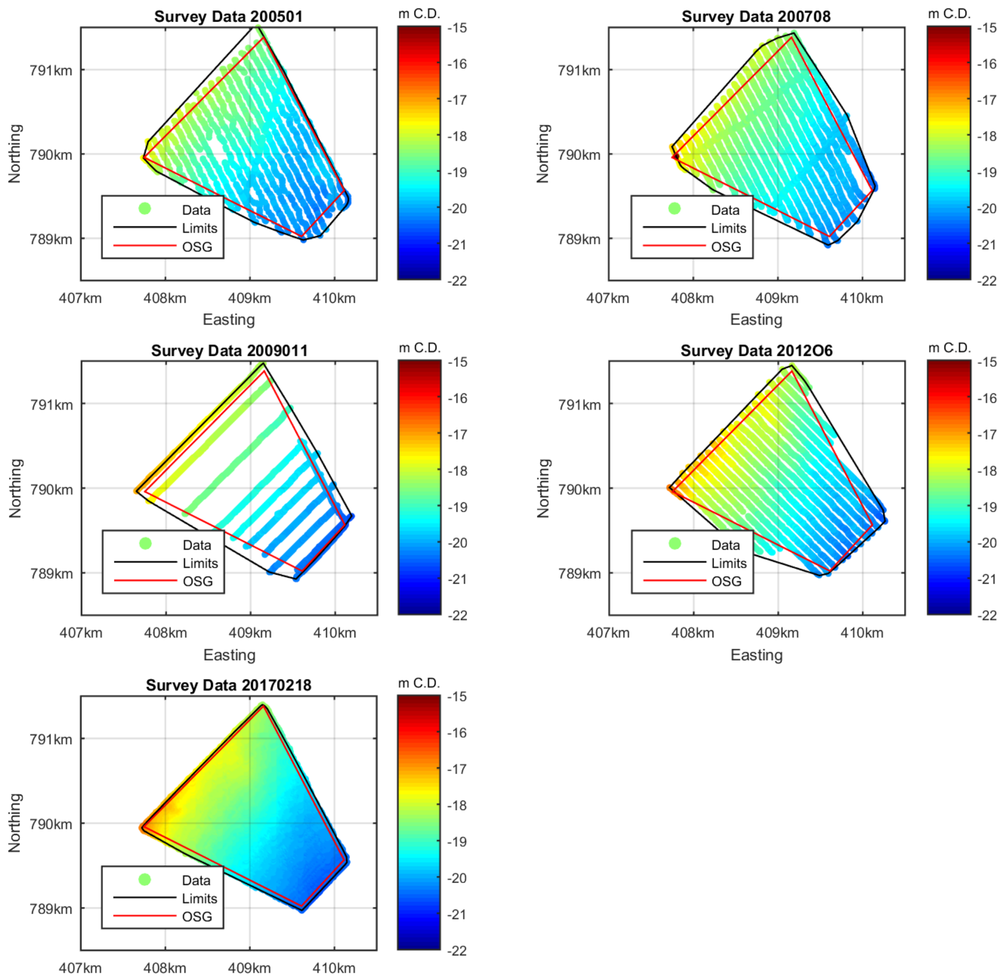
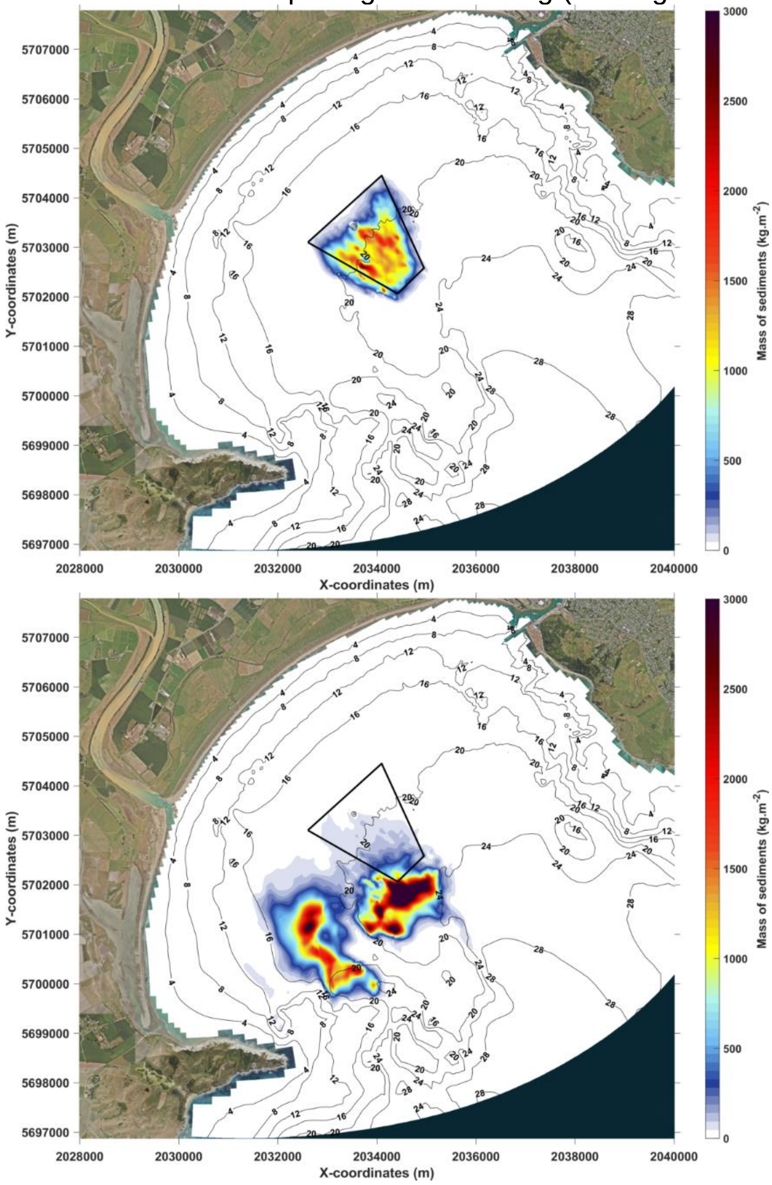


Figure 2.3 Hydrographic survey coverage for each of the periods available.

3. RESULTS

3.1. Disposal ground in-situ grain size

The *in-situ* grain size within the offshore disposal ground ranges from Fine Sand (> 62. 5 μm) through to mud (< 62. 5 μm), with the last survey results (October, 2017) showing a general trend for relatively finer sediment in the offshore and in the southerly (i.e. directly offshore the Waipaoa River mouth) sections of the disposal ground (Figure 3.1). This trend is consistent with the morphological modelling (see Figure 3.2 and



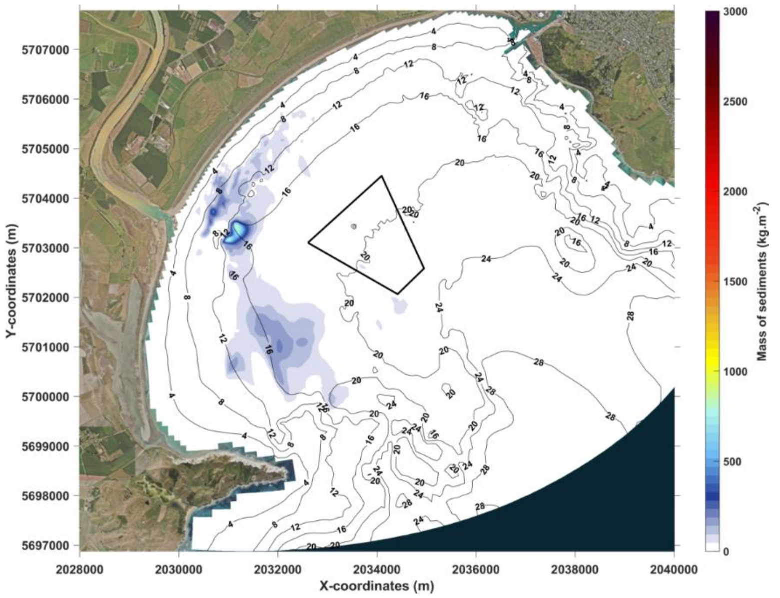


Figure 3.3), which suggests an offshore diabathic transport of the finer sand sized fraction of the disposed sediment (i.e. ~19% by volume of the dredged sediment - see MetOcean Solutions (2019)) leading to a winnowing of the fine sand component out of the southern and offshore section of the offshore disposal ground.

These data provide a baseline from which to assess the response of the offshore disposal ground to continuing maintenance disposal. Tabulated data is presented in the appendix.

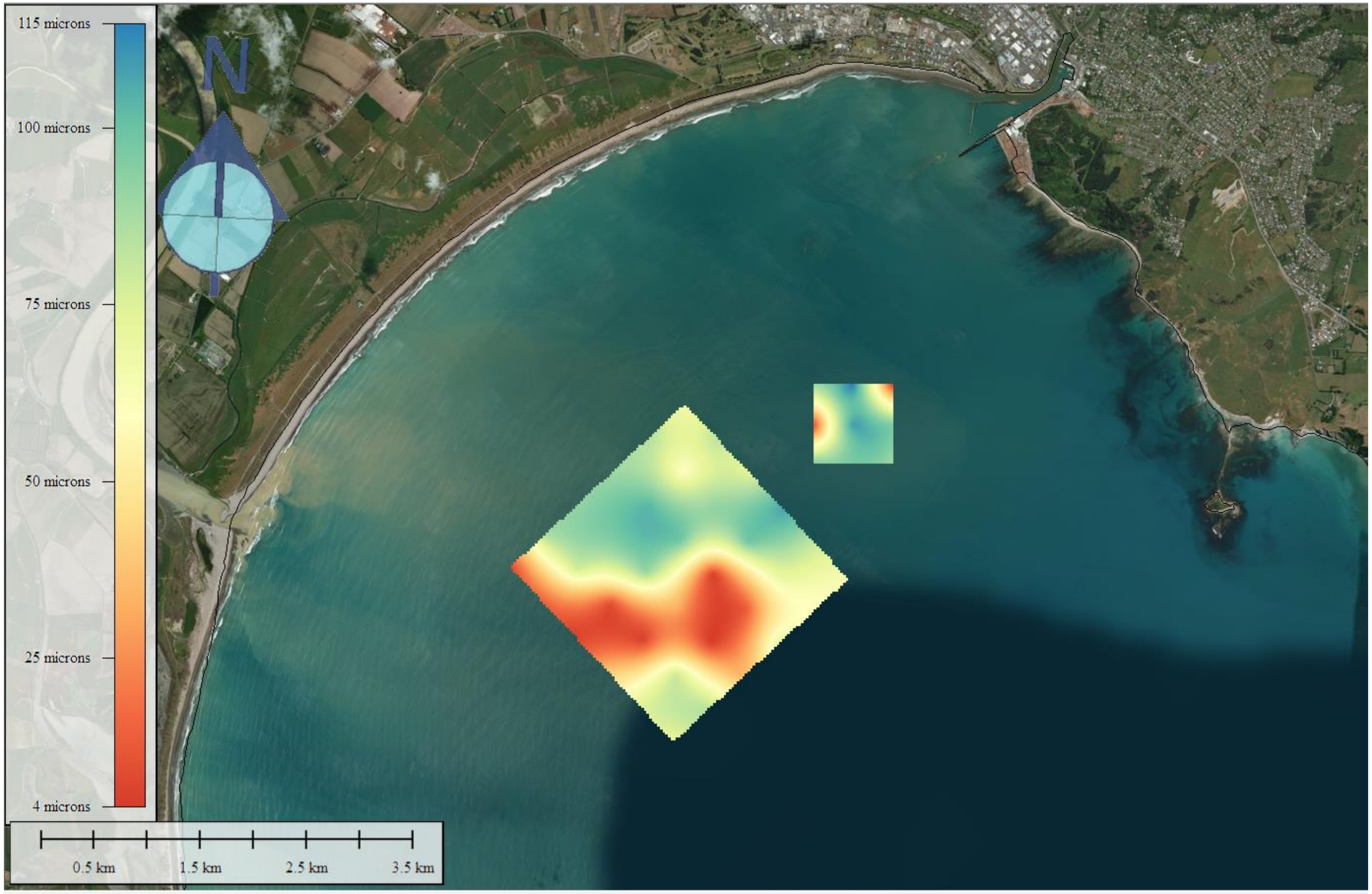


Figure 3.1 Surficial Sediment grain size at both the disposal ground and control sites

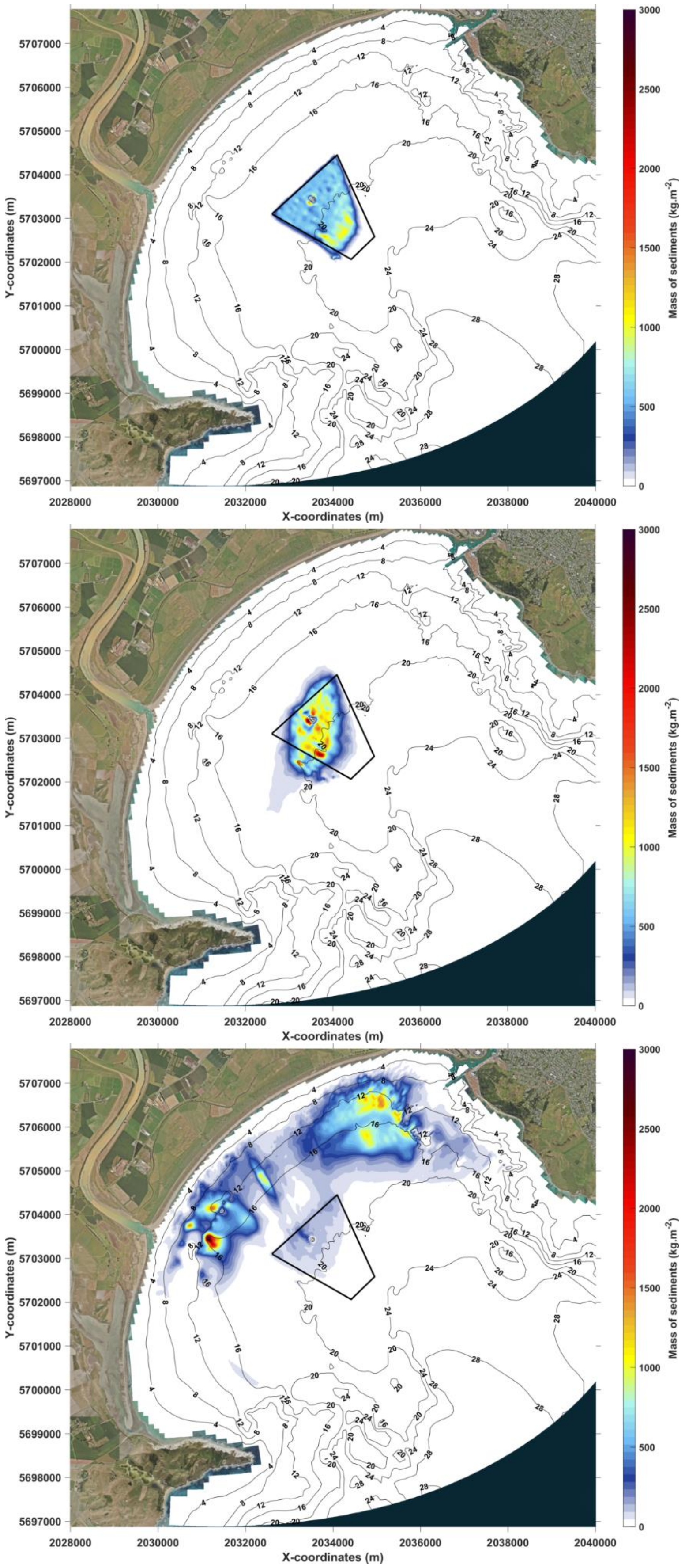


Figure 3.2 Mass of fine sand (top), very fine sand (middle) and silt (bottom) after one year characterised by the “La Niña” phase of ENSO.

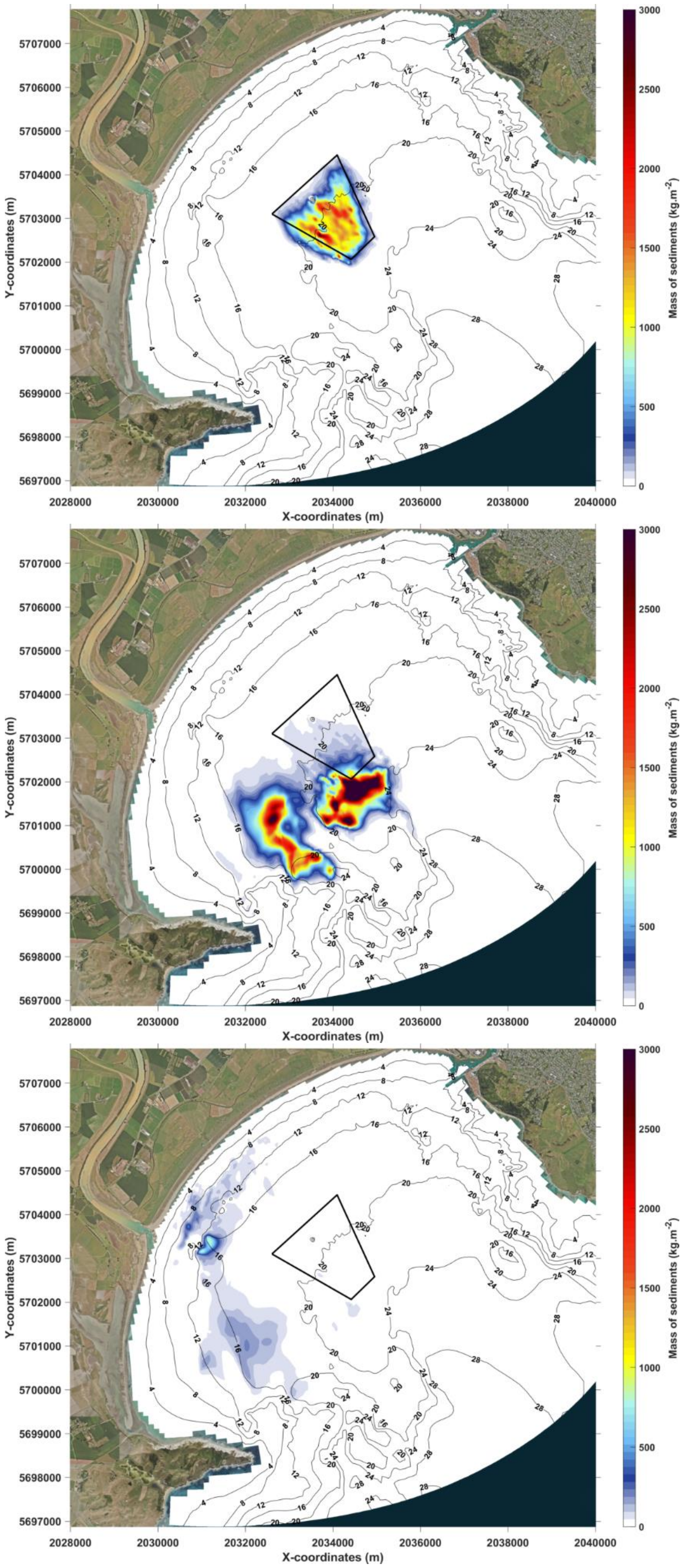


Figure 3.3 Mass of fine sand (top), very fine sand (middle) and silt (bottom) after one year characterised by the “El Niño” phase of ENSO.

3.2. Disposal ground bed level trends

The morphology at the disposal ground is controlled by the hydrodynamic processes at the site (waves, tidal and residual current velocities) and sediment inputs. The offshore disposal ground receives sediment inputs from maintenance dredge disposal and Waipaoa River plume discharges, as well as parabathic and diabathic sediment transport. The combination of processes and various sediment sources makes it difficult to isolate the effect of maintenance disposal activities on the overall morphological response of the offshore disposal ground, with morphological changes at the offshore disposal ground varying over the measurement periods available (i.e. no consistent trend). As such, it is impossible to quantitatively distinguish the impact of maintenance dredging on the morphological response of the system. However, qualitatively these data can be used to examine morphological response of the disposal ground to the combined sediment inputs.

The annual volume of sediment dredged and disposed of at the offshore disposal site is given in Table 3.1, with the total and average yearly amounts between consecutive surveys noted. Within the last three survey periods (2007-2009, 2009-2012 and 2012-2017) a relatively consistent yearly average volume of sediment has been disposed of at the site (i.e. ~80,000-90,000 m^3).

Between 01/2005-08/2007 the majority of the disposal area experienced accretion of the order 0.1-0.2 m (average) and a maximum of approximately 0.5 m, while the south eastern corner experienced a net deficit of sediment, with depths increasing by ~0.2 m (Figure 3.4).

Between 08/2007-11/2009 sediment accretion of the order 0.2 m is observed within the north-western corner of the disposal ground (inshore), while net erosion of a similar magnitude is expected within the S-SE section of the disposal ground (Figure 3.4).

Between 11/2009-06/2012 the majority of the disposal area experienced accretion of the order 0.1-0.2 m (average) and a maximum of approximately 0.4 m (Figure 3.4).

Between 06/2012-02/2017 the offshore disposal ground experienced a net negative sediment budget, with water depths increasing by ~0.1-0.2 m and a maximum of approximately 0.4 m. Minor areas of accretion were measured within the inner most sections of the disposal ground (Figure 3.4).

The Southern Oscillation Index (SOI) for the period spanning the surveys are provided in Figure 3.5. ‘El Niño’ events typically strengthen the westerly flow over New Zealand increasing the chance of drought in the Gisborne region. By contrast, winds from the northeast often bring rain to the east coast during ‘La Niña’ phases, which potentially result in more fluvial inputs of sediment into Poverty Bay. The survey periods between 08/2007-11/2009 and 11/2009-06/2012 were characterised as being predominantly in a ‘La Niña’ phases, while the latest period (06/2012-02/2017) is predominantly neutral with a trend towards ‘El Niño’ during the later stages. No clear correlation between the SOI and annual dredging volumes is apparent.

Table 3.1 Maintenance dredging volumes between 2003-2017. Total maintenance dredge material discharged between surveys is also noted. Also shown is the yearly averaged quantity dredged in brackets.

Year	Pukunui	New Era	Kawatiri	Brage R	Albatross	Total (m^3)	Survey interval total
2003	22400	60000				82400	
2004	31650					31650	
2005	16500					16500	
2006	20100	57000				77100	
2007	57000					57000	**150,600 (50,200)**
2008	52000					52000	
2009	110800		20825			131625	**183,625 (91,813)**
2010	95100					95100	
2011	106300		31900			138200	
2012	77700					77700	**277,700 (92,567)**
2013	79480					79480	
2014	62080					62080	
2015	38200			44000		82200	
2016	41440		72950			114390	
2017	52400				18161	70561	**414,731 (82,946)**

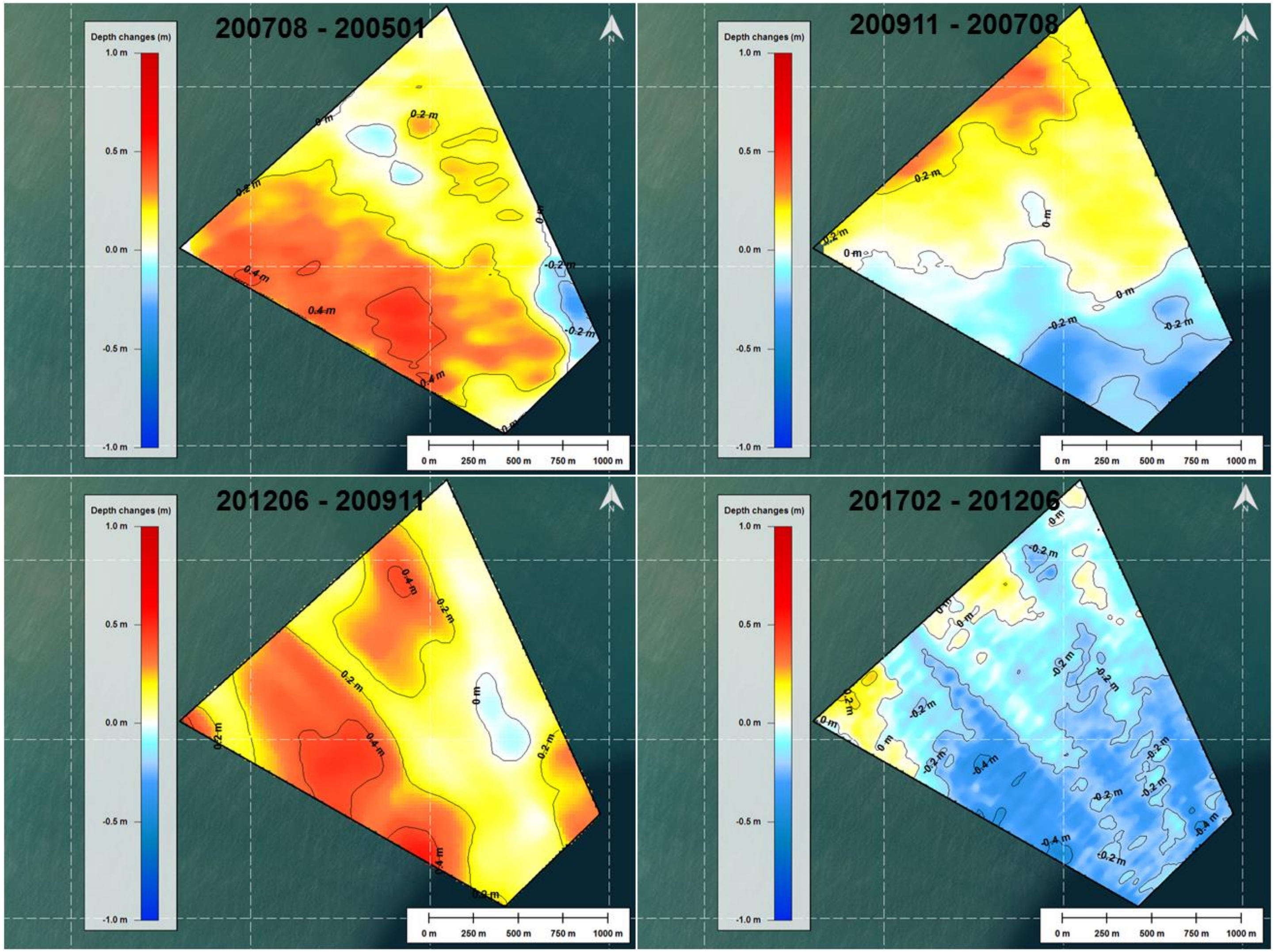


Figure 3.4 Measured depth changes over the disposal area for four different periods.

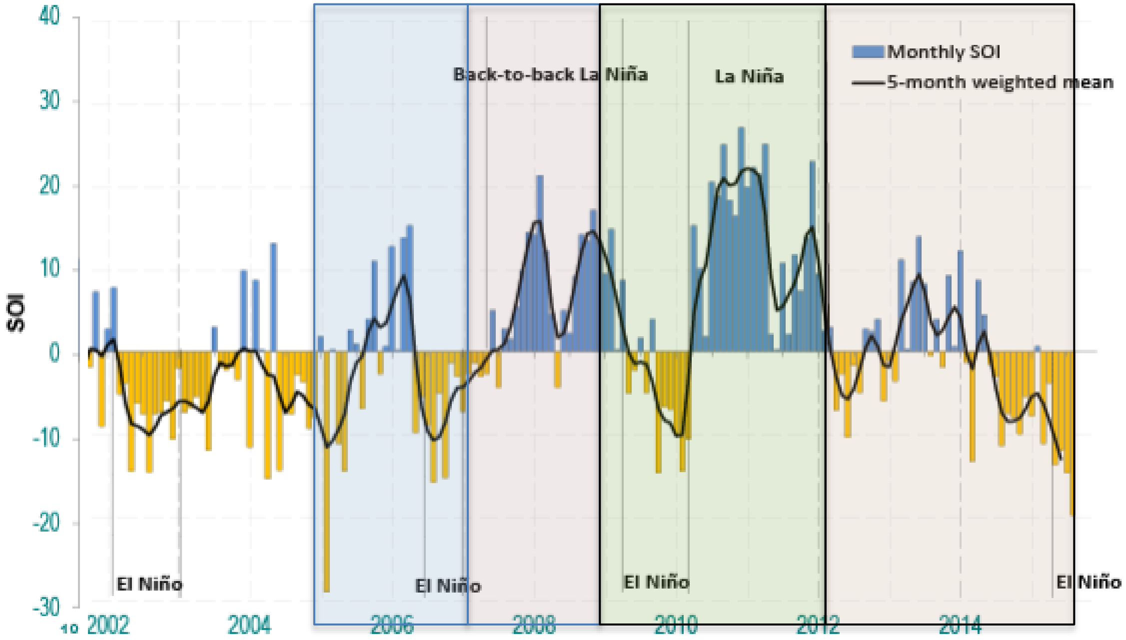


Figure 3.5 Southern Oscillation Index spanning the period for which survey data is available.

3.3. Disposal ground dynamics

The morphological response of the offshore disposal ground has been examined in detail in MetOcean Solutions (2019), which also details the applied methodology. A summary of those findings are presented here.

The annual morphological changes of the disposal mound under both “La Niña” and “El Niño” climatic conditions, with disposal mounds of 0.028 to 0.044 m, are given in Figure 3.6. To isolate the effect of dredged sediment discharged at the disposal ground, the initial model conditions assumed sediment available only within the disposal ground, which is then progressively dispersed throughout the sequence of representative events. Simulations of “La Niña” conditions suggest an overall erosion of the sediment mound and dominant north and northwest inshore deposition of sediment, with maximum sediment accretion of 0.05 m. Sediment transport for “El Niño” simulations are predominantly south and southwest with peak sediment accretion of 0.15 m expected within confined region.

Between 68% – 83% of the disposed material associated with maintenance dredging is expected to be eroded and transported. This corresponds to between 50,000 m^3 and 100,000 m^3 of sediment being advected from the disposal ground over a 1-year period (for “La Niña” and “El Niño” respectively). Most of the eroded material consists of the weakly-consolidated silt in the disposed sediment which is predicted to be winnowed from the disposal ground, diffused through the lower water column, and transported towards the shore or continental shelf by suspended-load transport.

According to the findings in Bever (2010), silt particles deposited inshore at Poverty Bay are likely to be resuspended and transported to the continental shelf whereas relatively coarse material tend to move onshore, based on the wave climate of the region.

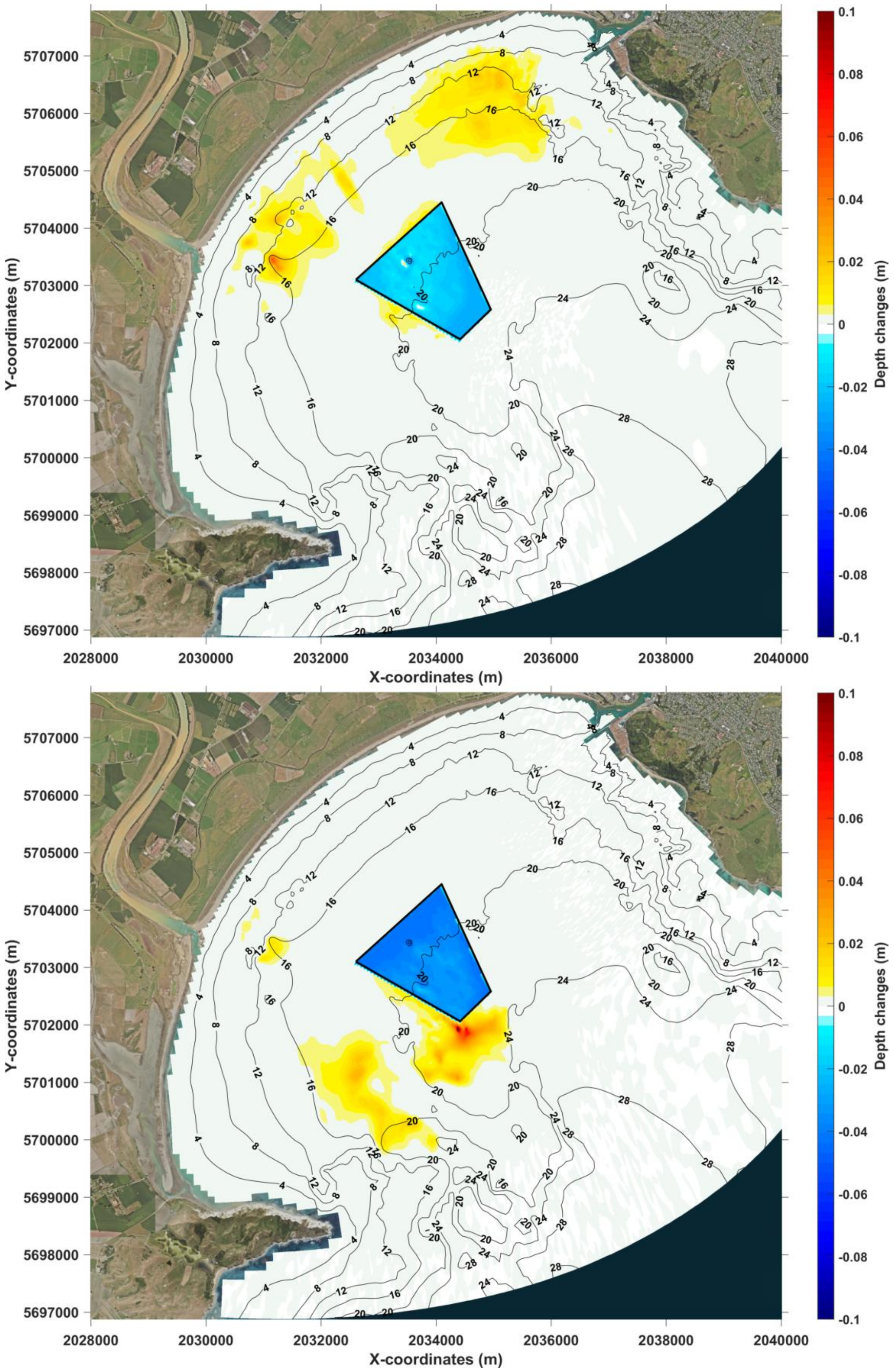


Figure 3.6 Disposal ground change predicted at the end of the 1-year "La Niña" (top) and "El Niño" (bottom) simulated periods considering disposal volumes of 75,000 m^3 and 120,000 m^3, respectively.

4. SUMMARY

With respect to the surficial sediment, grain size characteristics within the offshore disposal ground were assessed in 2017, with results suggesting a general trend for relatively finer sediment in the offshore and in the southerly (i.e. directly offshore the Waipaoa River mouth) sections of the disposal ground (Figure 3.1). These data provide a baseline from which to assess the response of the offshore disposal ground to continuing maintenance disposal.

A review of the available hydrographic survey data through to 2017 suggests that the morphology at the disposal ground is controlled by the hydrodynamic processes at the site (waves, tidal and residual current velocities) and sediment inputs, with the offshore disposal ground receiving sediment inputs from maintenance dredge disposal, Waipaoa River plume discharges, as well as parabathic and diabathic sediment transport. In general, the combination of processes and various sediment sources makes it difficult to isolate the effect of maintenance disposal activities on the overall morphological response of the offshore disposal ground, with morphological changes at the offshore disposal ground varying over the measurement periods available (i.e. no consistent trend).

Comparisons of sequential hydrographic surveys do not suggest any obvious trend in the offshore disposal grounds response to the disposal of maintenance dredge material. Survey data for 2017 indicate that offshore disposal ground has experienced a net reduction in bed level (i.e. deepening) of the order ~0.1-0.2 m and a maximum of approximately 0.4 m. Minor areas of accretion were measured within the inner most sections of the disposal ground (Figure 3.4). These survey results suggest that, for the approximate volume of maintenance dredge material (i.e. ~100K m^3) the offshore disposal ground is dispersive, thought there is significant inter-annual variability due to the various sediment inputs to the system. Not considering the inter-annual variability in the sediment inputs to the offshore disposal ground, morphological modelling (see summary in Section 3.3 and (MetOcean Solutions, 2019) suggests that the disposal ground can be considered dispersive.

REFERENCES

Braddock, H., 2006. Potential suitability of maintenance dredged sediments for beach renourishment at Pilot Bay. University of Waikato, New Zealand.

Chappell, P.R., 2016. The climate and weaterh of Gisborne, 2nd Edition (No. ISSN 1173-0382). NIWA.

Gibb, J.G., 2014. SHORELINE MOVEMENTS ALONG MIDWAY AND WAIKANAE BEACHES, EASTERN POVERTY BAY, GISBORNE DISTRICT (A Contribution to the Gisborne Boardwalk Project).

Healy, T.R., Stephens, S., Black, K.P., Gorman, R.M., Beamsley, B.J., 1998. Numerical and physical process studies for Port of Gisborne redesign for the 21st century. J. Coast. Res. Spec. 26, 304–311.

MetOcean Solutions, 2019. Eastland Port Maintenance Dredging and Disposal Project. Morphological response of the offshore disposal ground (No. P0331-10).

MetOcean Solutions, 2017a. Eastland Port Maintenance Dredging and Disposal Project. Hydrodynamic hindcast validation (No. P0331- 01).

MetOcean Solutions, 2017b. Eastland Port Maintenance Dredging and Disposal Project. Wave hindcast validation (No. P0331- 05).

WorleyParsons, 2015. Maintenance Dredging and disposal: Coastal Process Engineering Report. WorleyParsons.

APPENDIX

Surficial sediment sample location and grain size statistics.

Sample Name	Lat	Lon	Dx (10)	Dx (50)	Dx (90)	D [4,3]	D [3,2]	Kurtosis [3]	Skew [3]	Mode
E1	-38.72885863	177.9913027	12.1	70.1	125	72.4	14.2	0.201	0.334	76.8
E2	-38.72605451	177.9875794	36.4	74.4	121	75.7	19.2	0.178	0.036	78.7
E3	-38.72325027	177.9838564	1.58	40.4	111	47.4	5.18	-0.682	0.634	81.5
E4	-38.72044588	177.9801337	0.938	5.82	25	11.1	2.76	33.015	4.774	11.7
E5	-38.71483669	177.9726891	0.924	6.05	25.9	12.7	2.75	34.197	5.164	11.5
E6	-38.71764135	177.9764113	1.32	14.6	48.9	22.7	4.28	25.687	4.193	21.8
E7	-38.72594194	177.9948823	35.4	84.5	145	87.4	19.1	0.361	0.291	89.7
E8	-38.72313795	177.991159	31.7	79.7	133	81.4	17	0.3	0.141	84.2
E9	-38.72033381	177.987436	0.901	4.95	25.2	14.2	2.57	75.646	7.607	7.7
E10	-38.71752954	177.9837133	0.981	8.24	111	34	3.17	14.51	3.011	9.93
E11	-38.71192057	177.9762688	17.5	86.7	171	100	17.5	17.927	3.336	91.3
E12	-38.71472512	177.979991	3.4	77.8	153	82	9.28	10.841	2.101	91.5
E13	-38.72302517	177.9984615	2.15	34.6	127	51.5	6.53	3.262	1.698	44.1
E14	-38.72022129	177.9947383	0.815	3.78	18.2	46.3	2.19	59.936	7.355	3.39
E15	-38.71741726	177.9910154	1.71	33.1	155	60.3	5.5	1.055	1.223	104
E16	-38.7146131	177.9872927	18.7	91.6	173	97.9	18	1.057	0.708	99.3
E17	-38.70900435	177.9798483	8.26	91.1	178	97.3	12.4	3.449	1.109	103
E18	-38.71180879	177.9835704	19.9	96.1	184	108	19.3	19.052	3.29	102
E19	-38.72010831	178.0020405	29.3	70.5	126	74.4	17.2	0.59	0.497	74.2
E20	-38.71730454	177.9983173	1.24	12.7	119	38.7	4.01	4.36	2.055	11.9
E21	-38.71450063	177.9945944	0.834	4.72	25.3	10.3	2.39	15.411	3.437	7.87
E22	-38.71169657	177.9908718	29	100	190	108	20.4	0.76	0.667	110
E23	-38.70608805	177.9834274	30.2	88.4	181	99.4	20.2	6.034	1.576	95.8
E24	-38.70889238	177.9871495	28.5	103	194	110	21.7	0.861	0.682	111
E25	-38.71719135	178.0056192	3.32	58.1	144	68.7	8.8	3.312	1.443	73.3
E26	-38.71427429	178.0091975	8.7	62.9	143	74.3	13.2	5.209	1.766	66.8
E27	-38.71438768	178.001896	15.8	70.6	133	76	16.7	2.057	0.898	74.3
E28	-38.71147075	178.0054744	4.04	78.8	182	88.8	9.98	1.575	1.073	101
E29	-38.71158389	177.9981731	10	99.2	215	114	15.3	8.815	2.16	111
E30	-38.70866707	178.0017516	42.1	107	203	118	23.8	9.936	2.001	113
E31	-38.70877995	177.9944505	24.8	92.3	179	99.7	20.1	0.89	0.737	102
E32	-38.70586324	177.998029	10.6	73.3	154	81.4	14.6	1.24	0.924	81.4
E33	-38.70317166	177.9870063	16.3	85	169	92.8	17.7	1.004	0.808	92.4
E34	-38.70597588	177.9907283	3.46	58.7	146	72.4	9.06	6.889	2.204	68.1
E35	-38.70305928	177.9943068	29.5	83.1	176	97	20	8.27	2.151	85.5
E36	-38.70025518	177.9905848	13.8	64.7	138	79.3	15.8	15.466	3.277	67.1
E37	-38.69807003	178.0042214	9.85	88.1	179	94	14.5	0.588	0.718	107
E39	-38.69788565	178.0085173	56	115	200	121	24.6	0.575	0.419	121
E38	-38.70125214	178.0087527	20	109	208	122	18.8	18.833	3.283	117
E40	-38.70143655	178.0044567	0.956	6.47	59.1	27.5	2.91	60.213	6.974	9.18
E41	-38.6977011	178.0128132	0.96	7.49	69	32.3	3.03	23.456	4.534	10.9
E42	-38.70106758	178.0130488	33.3	96.5	208	119	21.9	14.947	3.213	102
E43	-38.70461864	178.0089882	na	na	na	na	na	na	na	na
E44	-38.70480307	178.0046919	48.2	98.9	177	106	30.1	0.791	0.623	103
E45	-38.70443406	178.0132845	17.9	88.2	179	100	18.5	12.212	2.498	96.2