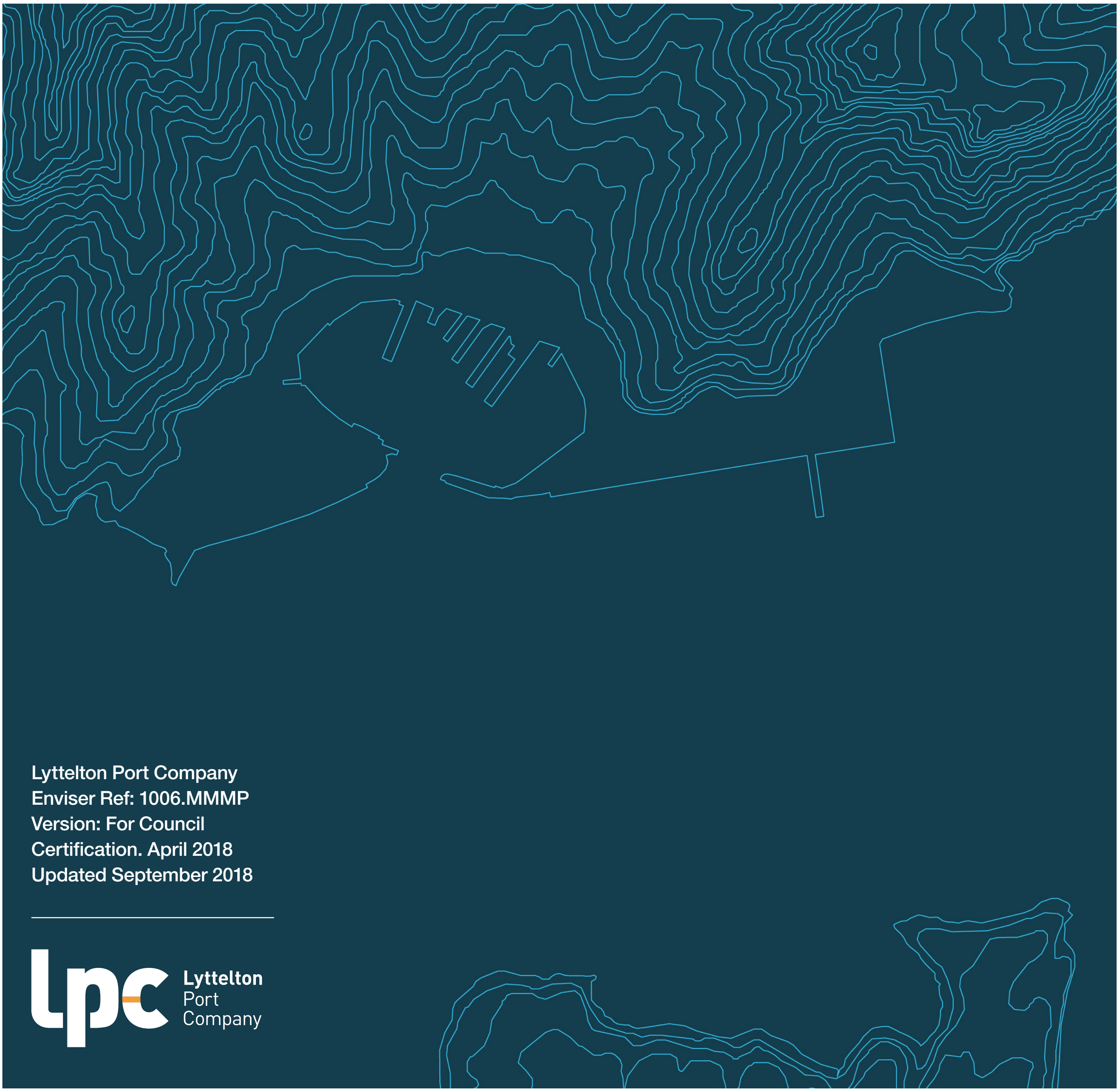
enviser

Baseline Report

LPC Channel Deepening Project: Stage 1



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1 Introduction

Lyttelton Port Company (LPC) is undertaking a Channel Deepening Project (CDP) to deepen, widen and extend the existing navigational channel in Lyttelton Harbour/Whakaraupō to allow larger vessels access to Lyttelton Port. The seabed deposition and disposal activities associated with the CDP are authorised under resource consents CRC172455 and CRC172522 (collectively, "the Consents") issued by the Canterbury Regional Council (CRC).

The conditions of the Consents, require LPC to undertake a monitoring programme to assess the impacts (if any) of the CDP on the different environments around Lyttelton Harbour/Whakaraupō and offshore Banks Peninsula. The monitoring required is outlined in the CDP Environmental Monitoring and Management Plan[1]. As part of this monitoring programme, at least 12-months of baseline data of the coastal, ecological, marine mammal and water quality environments in Lyttelton Harbour and offshore Banks Peninsula is required to compare if the dredging activities impacts on these environments. This report is a summary of the baseline data that has been completed by LPC.

2 Consent Requirements

Condition 8.13 of the Consents requires that a baseline monitoring report is prepared which presents and discusses the results of the baseline monitoring. Condition 8.14 states the report shall be provided to the TAG, PRG, ALG and Canterbury Regional Council (CRC) at least two months prior to the first commencement of Dredging.

The types of monitoring required, and corresponding consent condition, are as follows:

- Water Quality Monitoring: Conditions 8.4 – 8.5
- Ecological Surveys: Conditions 8.6 – 8.8
- Physical Shoreline Monitoring: Condition 8.9
- Marine Mammal Monitoring: Condition 8.10

This report summarises the results of the baseline monitoring. Detailed information on the methodology and results can be found in the individual monitoring reports (Appendices A – D).

[1] Environmental Management and Monitoring Plan, LPC Channel Deepening Project: Stage 1, Enviser, 2018.

3 Baseline Monitoring

The following monitoring has been completed as part of the 12-month baseline monitoring period:

Table 1. Summary of baseline monitoring

Type of Monitoring	Undertaken by	Monitoring Period	Appendix
Water quality monitoring	Vision Environment	November 2016 – October 2017	Appendix A
Physical Shoreline Monitoring	Tonkin & Taylor	January 2017 – December 2017	Appendix B
Ecological Monitoring	Cawthron Institute	Three surveys: Jan – Mar 2017 July – Sep 2017 Dec 2017	Appendix C
Marine Mammal Monitoring	Styles Group	January 2017 – February 2018	Appendix D

4 Monitoring Summaries

4.1 Water Quality Baseline Monitoring

Water quality monitoring was undertaken by Vision Environment for a 12-month baseline monitoring period from 1 November 2016 to 31 October 2017. The water quality monitoring included data collection of the climatic and oceanic conditions, real-time surface turbidity, benthic turbidity, benthic photosynthetically active radiation (BPAR), sedimentation, physiochemical parameters and water sample analysis and depth profiling. Monitoring collection was undertaken via instrumentation located at 15 sites throughout Lyttelton Harbour/Whakaraupō and offshore Banks Peninsula.

A monthly monitoring report outlining the results of monitoring was completed by Vision Environment and sent to LPC for each month of the monitoring period. The reports included a summary of the methodology as well as results and discussion of the metocean conditions (wind, precipitation and currents), continuous physicochemistry loggers (turbidity, temperature, pH, conductivity and dissolved oxygen), physicochemistry depth profiling, continuous BPAR loggers, continuous sedimentation loggers and water sampling (nutrients, dissolved metals and biannual organics).

A summary of the data collection, reporting and results is given below. All 12 monthly reports comprising the baseline monitoring period are attached in Appendix A.

4.1.1 Data Collection and Reporting

Instrument issues due to weather conditions, fouling and burial resulted in isolated interruptions to the data collection over the baseline monitoring period. These events are not always foreseeable or avoidable due to the variable nature of Lyttelton Harbour waters. When fouling or instrument issues occur, the data becomes noisy and the two sondes start to record divergent readings. This signals to Vision Environment that the sondes need to be swapped for new, clean ones as soon as inclement weather conditions allow. This process ensures instrument anomalies are detected in real-time and solved as soon as possible. Any data that is noisy may then be removed from the dataset as part of the manual (or SMART) validation procedure.

As the benthic instruments are self-logging, the same procedure cannot be followed as often instrument issues are not discovered until data collection at the end of the month. The unreliability in this data is one of the reasons these instruments are not as part of consent compliance.

Table 2 summarises the main methodology changes and instrumentation issues encountered each month over the monitoring period.

Table 2: Commentary on data collection and method changes

Month	Data collection issues	Methodology updates
November 2016	OS3 was offline from 16 - 21 November. Both sondes[2] at OS7 became fouled on 22 November and thus this data was removed until logger exchange. In addition, no data was able to be retrieved from either sondes at OS6 due to both being flooded.	N/A
December 2016	OS2 was offline from 3 – 6 December 2016 while repairs were being undertaken.	
January 2017	Due to flooding, no data was recorded from the OS3 benthic sondes until 21 January 2017.	
February 2017	No data collected from OS5 on 1 – 2 February 2017. Minimal quality data collected from OS7 over 24 - 28 February 2017 due to fouling of sondes.	
April 2017		A rose chart of the Watchkeeper speed and direction was added to the appendices of the monthly monitoring report (titled Figure 27). Figure 2 of the monthly report was also amended to include the Watchkeeper wave height along with the rainfall, flow and Cashin Quay (CQ) wind results already included in the figure.
May 2017	Laboratory analytical issues associated with total aluminium concentration occurred leading to no recordings of the concentrations of the metal for this month.	
June 2017		
July 2017		Euphotic depth calculations for each monitoring site were added to the discussion and results section of the monthly monitoring report. This calculation gives the depth at which net

[2] The 'sonde' is the portion of the instrument that has the sensors which take the various readings.

		photosynthesis occurs in a light intensity of about 1% of surface and gives a further indication of the water clarity.
August 2017		
September 2017	Apparent sensor burial of benthic OS3 and benthic OS4 resulted in limited data collection over the second half of the month.	
October 2017	Limited benthic turbidity data was recovered from OS6 (less than a week of data over the months)	

4.1.2 Results Summary

Climatic and Oceanic Data

- Waimakariri flow data was provided from ECan monitoring site CH4 (Waimakariri at SH1, above the Old Highway Bridge). In general, river flows were less than 160 m^3/s over the monitoring period. This is consistent with average flows for the river which generally oscillate between around 50 m^3/s up to 150 m^3/s during the day (due to tidal influence). The highest recorded flow over the monitoring period was over 2000 m^3/s recorded during a storm event over 19 - 22 January 2017.
- Rainfall data was collected at the LPC rainfall gauge in at Lyttelton Port. Rainfall was highest in July 2017 with a total of 30.6 mm of rain recorded over two days. This lead to widespread flooding in Christchurch and large changes in sedimentation were observed in the Upper Harbour. In contrast, the driest month of the monitoring period – February 2017 – in which only 4.8 mm of rain was recorded over the entire month.
- In general, recorded surface currents at the offshore disposal ground were higher than benthic throughout the monitoring period. Maximum recorded monthly currents ranged from approximately 350 – 650 mm/s (surface and benthic) with site SG1 tending to record slightly higher currents than SG3.Inside the Harbour, currents vary with state of tide, location and spring/neap cycle with typical currents speeds in the order of 50-350mm/s

Water Quality Data

- In general, results of turbidity collection showed that surface turbidity is highest at the inshore monitoring sites compared to offshore locations. There was a clear spatial similarity in the 24-hour rolling average surface turbidity between sites despite the large distances between monitoring instrumentation – where surface turbidity increases at outer shore monitoring sites would be recorded first and then inner shore monitoring locations would later record similarly proportional turbidity increases.
- There is also a clear correlation between river flow and turbidity – as mentioned above the largest river flow event was recorded in January 2017 and this coincided with the largest turbidity readings at each of the monitoring locations. This indicates that Outer Harbour sediment sources (e.g. river flows into Pegasus Bay) may contribute to sediment accumulation within Lyttelton Harbour.

- As expected, and due to shallow water depths, the Upper Harbour sediments are more susceptible wave induced res-suspension of the seabed. The mid-upper harbour is also more impacted by local rainfall events which cause sediment runoff into the harbour.
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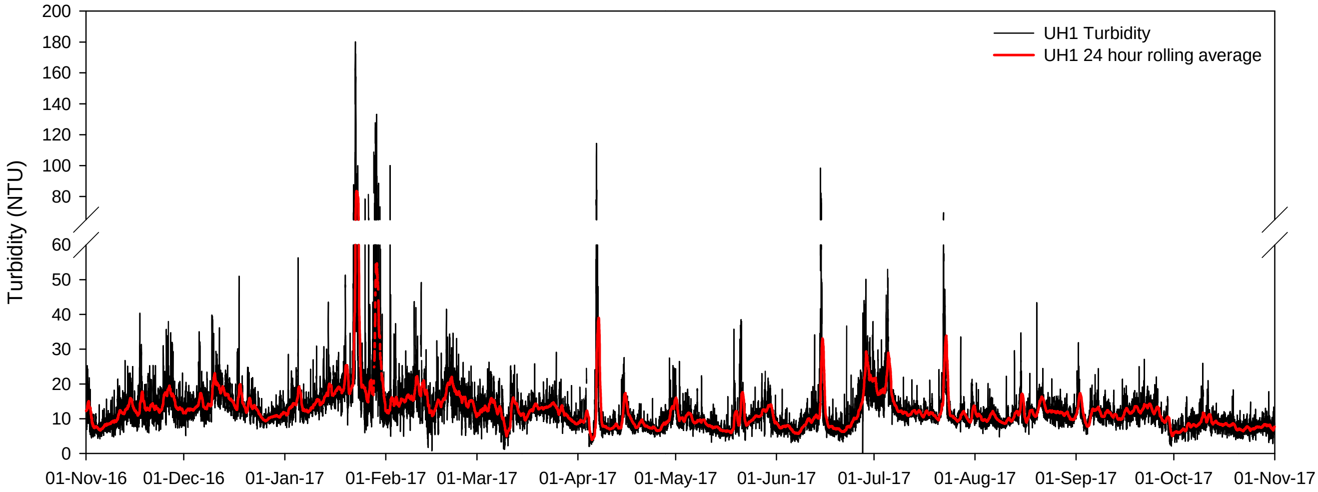
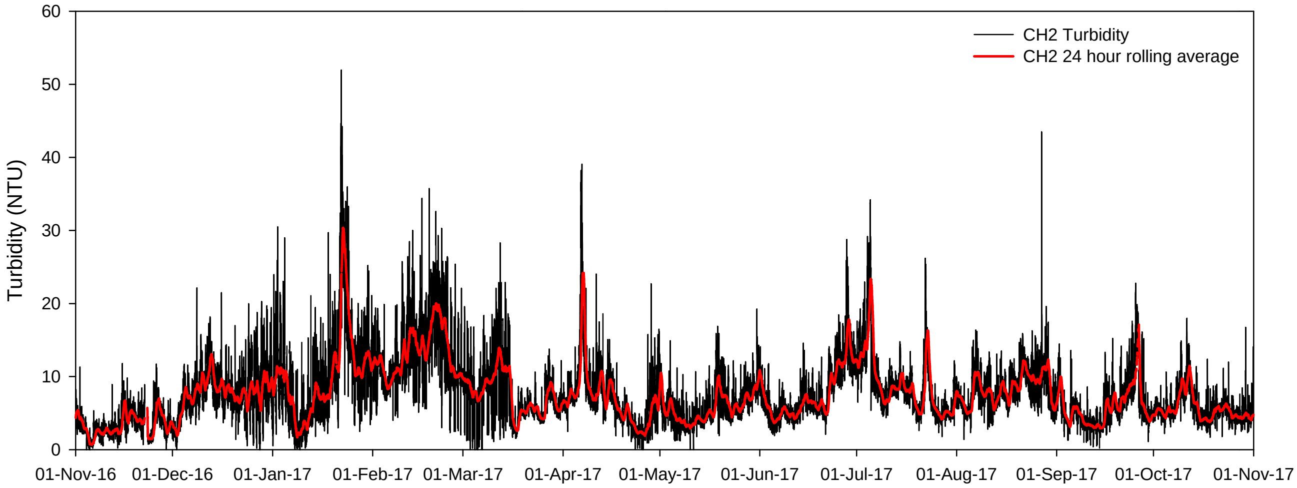
- A snapshot of the surface turbidity collected over the monitoring period at one of each of the Upper Harbour, Channel and Offshore monitoring sites (UH1, CH2 and SG1) is shown in Figure 1 below.
- Benthic monitoring sites indicated a highly variable turbidity regime and as such a clear correlation between benthic turbidity and surface turbidity was not evident throughout much of the monitoring period. This lack of clear correlation was especially evident when comparing BPAR readings to the surface turbidity. A high surface turbidity should indicate a lower BPAR as the suspended sediment prevents light reaching lower parts of the water column. However, for most of the baseline monitoring period this inverse relationship between BPAR and surface turbidity did not appear to exist.
- Biannual water quality collection for organics occurred twice during the monitoring period in December 2016 and June 2017. Due to analytical laboratory error the no results of benzene, toluene, ethylbenzene, o-xylene, m&p-xylene and hexythiazox were unable to be determined in June 2017.





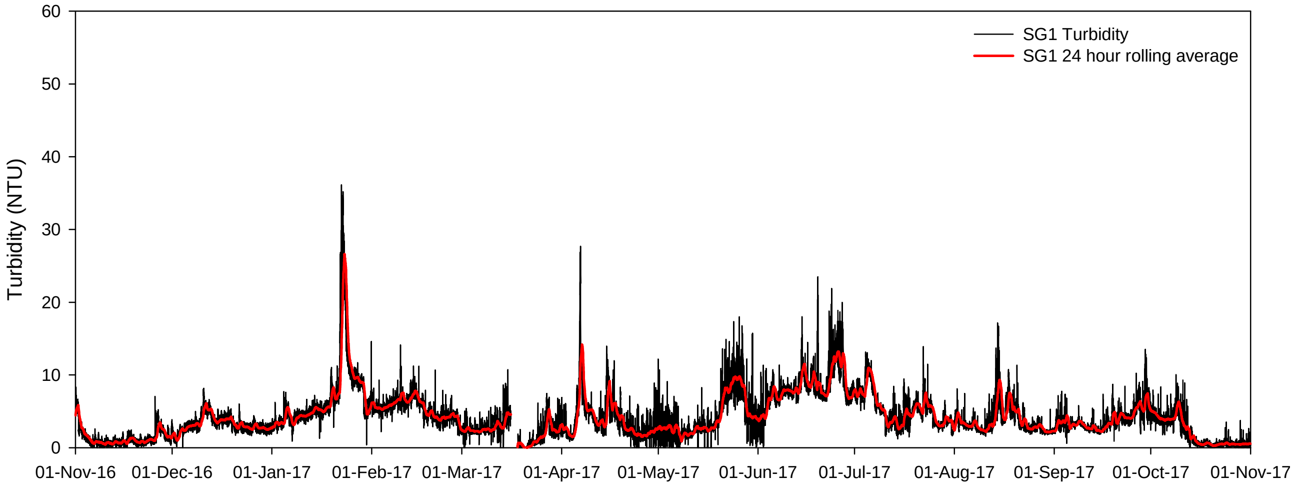


Figure 1. Surface turbidity collected at UH1 (top), CH1 (middle) and SG1 (bottom) over the 12-month monitoring period. Graphs show both the 15 minute turbidity recordings and the smoothed 24-hour averaged turbidity.

4.2 Ecological Monitoring

Surveys of the reef habitat and soft sediment benthic environments were undertaken according to Conditions 8.6, 8.7 and 8.8 of the Consents. The reef surveys characterised the subtidal and intertidal reef substrate and ecological communities along the Banks Peninsula coastline of southern Pegasus Bay and within Lyttelton Harbour.

Triplicate surveys of 19 benthic, six subtidal and four intertidal monitoring sites – located within Lyttelton Harbour, outside the Harbour Heads and at the offshore disposal ground - were undertaken three times during 2017 (i.e. the baseline year) as outlined in Table 3 below. The monitoring locations were chosen from a subset of 24 benthic, 6 intertidal and 4 subtidal sites which were surveyed in February 2016 – this is referred to baseline survey BL0 by Cawthron Institute (refer Appendix B).

Table 3. Ecological monitoring sampling dates

Survey	Dates	Components
BL1	19 Feb – 20 Jan 2017 28 Feb – 1 Mar 2017	Benthic sampling, intertidal reef survey Subtidal reef survey
BL2	25 -26 July 2017 13-14 Sept 2017	Benthic sampling, intertidal reef survey Subtidal reef survey
BL3	5 – 8 Dec 2017	Benthic sampling, intertidal and subtidal reef surveys

The completion of the baseline surveys as strict four-monthly intervals was not possible due to the conditions required for the subtidal work, which requires good underwater visibility. The dependency of the monitoring on the weather was recognised in the consent conditions (refer Appendix 1 of the Consents which states that ecological surveys should be undertaken at four-monthly intervals, subject to weather conditions). As such, the frequency of the surveys given in Table 2 above complies the conditions of the Consents.

4.2.1 Data collection and reporting

Reef surveys characterised the habitat and ecological communities at six subtidal and four intertidal sites along the Banks Peninsula coastline of southern Pegasus Bay and within Lyttelton Harbour. Subtidal work by scientific divers comprised quantitative quadrat surveys along paired 30 m long isobathic transects (in 4 m and 7 m water depths) and 50 m littoral fringe (0.5 m Chart Datum) transects focusing on pāua density and size distribution. Intertidal surveys collected semi-quantitative (relative abundance) and photographic data from a 50 m stretch of shoreline

Soft sediments were sampled in triplicate using the van Veen grab method to provide cores for analysis of substrate, macrofaunal communities, (Polycyclic aromatic hydrocarbons (PAHs) and metals. 19 benthic stations were surveyed in Lyttelton Harbour and its approaches and the offshore spoil ground.

4.2.2 Results Summary

4.2.2.1 Reef surveys (subtidal and intertidal)

Reef habitats at all sites supported communities considered representative of the wider bioregion. High spatial variability in the subtidal quadrat data is considered to have contributed to apparent temporal variability. This variability is likely to be driven by the complex physical structure and bathymetry of reef habitats and must be accommodated in any interpretation of the data.

There was a high degree of overlap in the dominant taxa and overall community structure for both subtidal and intertidal reef habitats; however, there were also areas of distinctness associated with the communities at individual sites. These were generally consistent with observed differences in physical habitat structure, wave exposure and background turbidity.

Diversity indices from the subtidal reef monitoring show an even distribution in community composition (i.e. not numerically dominated by just a few taxa). Despite some consistent differences between sites, spatial trends were largely quite subtle. However, a gradient of increasing algal cover with distance eastward from Adderley Head was observed, along with higher coverage also for the north Godley Head site where greater water clarity is typically observed.

Pāua were observed to be common to abundant at all six subtidal monitoring sites but counts on the set transects could be highly variable between sites and across surveys, with no apparent trends. Some of this variability is believed to result from small changes in the exact depth line of the transect due to changing tidal state and surge conditions between surveys.

Despite differences in the physical habitat between the four intertidal survey sites, all had a similar number of intertidal taxa recorded at each location. Common across sites were encrusting and turfing coralline algae, Neptune's necklace (*Hormosira banksii*, zig-zag weed (*Cystophora scalaris*), the red alga *Gelidium caulacantheum* and giant or bladder kelp (*Macrocystis pyrifera*).

Pāua measured along the littoral fringe transects occupied a fairly narrow size range with only a small proportion (2.7%) being above legal harvestable size. Densities of the Cook's turban snail within the littoral fringe transects were also highly variable between sites and across surveys, with the only consistent trend observed being lower numbers recorded from site BP01 (Adderley Head).

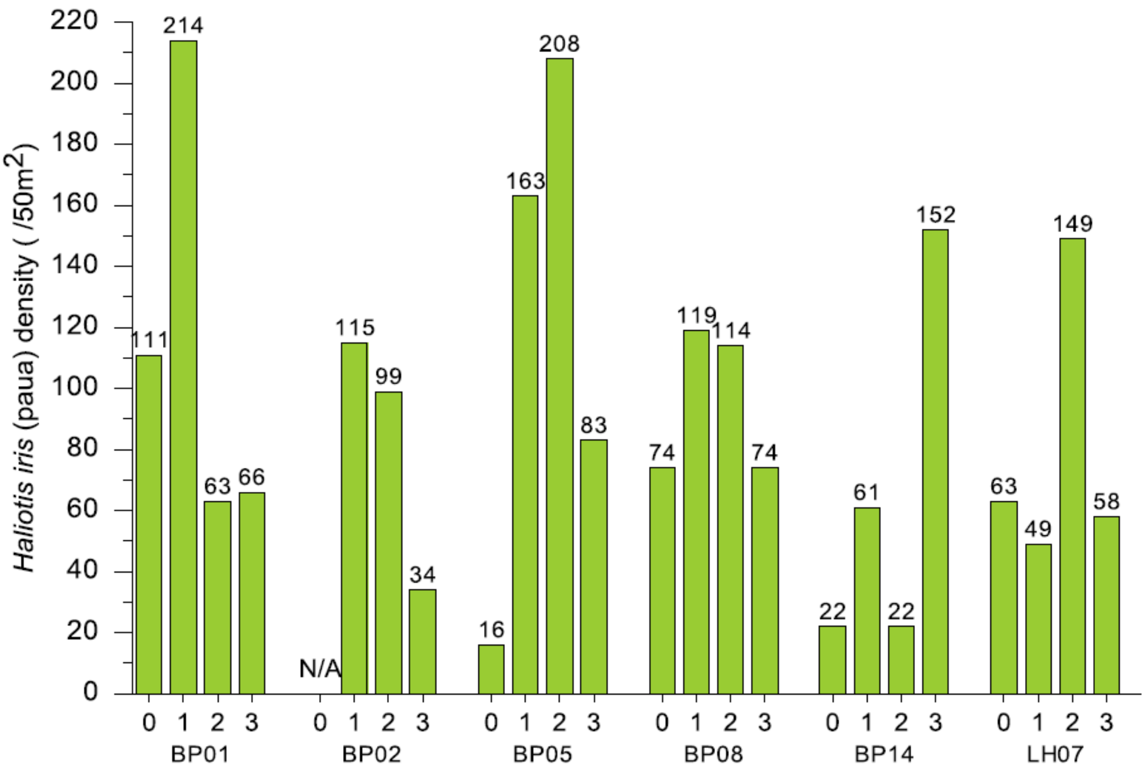


Figure 2. Density of Paua with littoral fringe transect for each survey at each site (Cawthron, 2018)

4.2.2.2 **Benthic Surveys**

Substrates at 16 of the 19 benthic sampling stations were comprised of fine soft muds, with grain size dominated by the silt/clay fraction. A less consolidated surface layer 4-10 cm thick was often present at these sites. Two of the Lyttelton Harbour stations (LHB2 and LHB3) and the eastern-most offshore station (CTL2) were set apart by substrates of fine and very fine sands. While the Harbour stations showed high spatial variability in substrates, there was generally low temporal variability in the dominant particle size fractions at all stations.

No clear spatial gradients between macrofaunal communities were identified, with community diversity and density similar across all stations. Abundance, taxa richness and diversity of communities were positively (if weakly) correlated with water depth. Taxa richness was negatively correlated with organic carbon and trace metal concentrations.

Statistical analysis of the data indicated that water depth explained the largest amount of variation in macrofaunal community data, followed by sediment texture and organic carbon.

4.3 Monitoring of Physical Parameters

Monitoring of physical parameters is being undertaken (in accordance with Condition 8.9) to evaluate how (if at all) the CDP will impact on the coastal environment in Lyttelton Harbour/ Whakaraupō and offshore Banks Peninsula.

The monitoring includes photo-point monitoring, sediment size analysis, beach profile surveys, seabed surveys and shoreline analysis. 12-months of baseline monitoring was undertaken by Tonkin & Taylor (T+T) at the frequencies outlined in Table 4 below. Refer to Appendix C for the full report (LPC Channel Deepening Project, Physical Monitoring Baseline Results) which summaries the results and data collected at each round of baseline monitoring.

Table 4. Summary of physical monitoring – Tonkin + Taylor, 2018

Name	2017 Baseline Year Monitoring Executed			
	Round 1	**Round 2**	**Round 3**	**Round 4**
Photo-Point Monitoring	30 January – 14 February.	12 May - 9 June.	15 August – 11 September. Locations 14 and 15 not photographed at this round due to weather and were instead undertaken on 17 October.	17 October – 3 November.
Sediment Size Analysis	30 January – 1 February		15 August – 17 October	
Beach Profile Survey	ECan cycle: 22 February – 2 March. Eliot Sinclair cycle: 3 February.		ECan cycle: 18 August – 5 September. Eliot Sinclair cycle: 6 November.	
Seabed Survey	February 2017 – additional lines (1a, 4a and 5a) were surveyed in March 2018			
Shoreline Analysis	5 December (with reference to 2015-16 aerial data).			

4.3.1 Data Collection and Reporting

In general, monitoring frequency was undertaken in accordance with consent conditions 8.9 and 8.11 with the following exceptions:

- A marine exclusion zone at Gollans Bay, implemented by the Christchurch City Council and McConnell Dowell, prevented access to location 7 after February 2017, therefore no monitoring was undertaken at this site for the duration of the monitoring period.
- Poor weather conditions caused delays in the data collection for Rounds 2 and 4.

4.3.2 Results Summary

- **Photo-point monitoring:** Photo point monitoring is intended to highlight any changes occurring in the morphology of the beach as seen from the ground. 15 sites were monitored four times over the course of the 12-month baseline period. No significant changes in morphology were observed at any of the monitored sites over the monitoring period. Changes in beach appearance were mainly in relation to the movement of driftwood, shells and seaweed. The only other noteworthy changes came with some isolated cases of changing sand colour.
- **Sediment Size analysis:** Sediment size sampling was undertaken at eight locations. Analysis showed changes in the composition of each bay over the course of the year. The sampled sites consistently presented with sediment size distributions that were very finely skewed. New Brighton and Sumner show poorly sorted, fine to medium sand across the profiles with very little change through the year - consistent with exposed open coast beaches.

Taylors Mistake showed course sand in the lower profile increasing to very course through the year. The Harbour beaches showed more widely graded, fine to course sands with size grading changing throughout the year, though no clear trend was discernible - likely indicating that sands are layered according to grain size and results dependent on exactly where the sample is taken. This indicates the baseline grain size for these beaches is widely graded with the mean size varying depending on sample location. The low tide sample at Purau Bay was very fine to fine sand and may be more representative of an intertidal platform than beach environment.

Beach profile surveys: Beach profile surveys were carried out bi-annually over the course of the baseline year of monitoring. The New Brighton Profiles were very stable over the monitoring period with the upper beach fluctuating in level by 100 to 400 mm. In contrast, previous studies (T+T, 2017) have shown vertical fluctuations of up to 1.5 m associated with significant storm events indicating that this monitoring period was particularly benign. T&T therefore recommends that *"future profiles are compared to the historic profile record here rather than just these baseline records".*

The lower parts of the Sumner profile adjacent to the Avon-Heathcote estuary mouth moved landward by up to 50 m – this is not unexpected due to the dynamic coastal environment. The harbour profiles have been more stable showing profile level changes of less than 200-300 mm, although the outer portions of Camp Bay appear to have accreted by up to 0.5m.

- **Seabed survey:** Two seabed surveys were carried out (February 2017 and March 2018). Between the two surveys ten transects were taken down the channel and at the offshore disposal site. From these surveys a defined channel is clear within the harbour and relatively flat seabed offshore.
- **Shoreline analysis:** Shoreline analysis post-dredging will be carried out using historic aerial imagery from 2015 - 2016 to assess whether and how the shoreline extents change due to the dredging activities. The shoreline was digitised for all fifteen sites, based on LINZ's 2015-16 Urban and Rural aerial sets for Christchurch. In general, the shoreline was defined by the vegetation line.

4.4 Marine Mammal Monitoring

Styles Group Ltd. and Vision Environment undertook monitoring of marine mammal (Hector's Dolphins) acoustic detections at four locations throughout Lyttelton Harbour/Whakaruapō and offshore Banks Peninsula. Data was collected using C-PODs, from 27 January 2017 to 7 February 2018. Pooled across all sites and deployments, approximately 34,200 hours of data were recorded over 12 monthly deployments. The C-PODs recorded Detection Positive Minutes (DPMs) – minutes in which at least one dolphin sound was detected.

4.4.1 Data Collection and Reporting

No physical problems with either the CPOD units or mooring systems were reported, although a date-stamp issue was corrected for data obtained from site MM2 from Deployment 2 (February 2017), and sites MM3 and MM4, Deployment 6 (July 2017). Those issues were caused by a misalignment of the date format between the units and software, and this was corrected during the data processing. 34,200 hours of data were collected over the year and 10,642 of these contained at least one Hector's dolphin detection.

4.4.2 Result Summary

The results indicate there are temporal, spatial and seasonal variations in the habitat used by Hector's dolphins around Lyttelton Harbour. Highest dolphin detection rates were recorded at site MM3, located outside Port Levy, which was also an important day-time habitat. The data collected shows dolphin presence within Lyttelton Harbour (represented by site MM1) is generally highest between 3pm and 8am the following day.

While detection rates inside Lyttelton Harbour were less compared to the coastal sites near the entrance (represented by sites MM2 and MM3), the highest proportion of feeding buzzes were detected at site MM1 during the summer and autumn months compared to the other sites. By winter, foraging activity is below 10%, compared to 18.5% and 13.2% at sites MM3 and MM4, respectively. In general, the limited year of data did not suggest that any one monitoring location was more important for foraging compared to other sites.

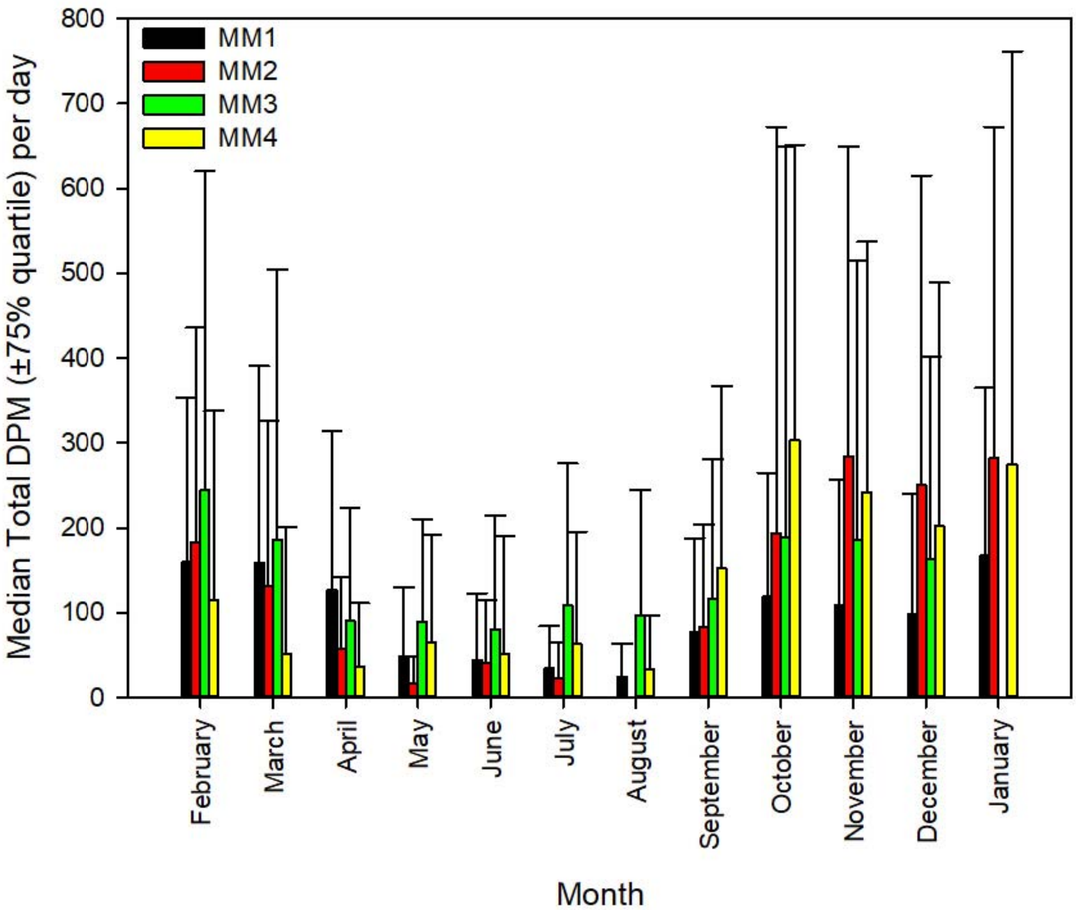


Figure 3. Median Detection Positive Minutes (DPMs) recorded at each monitoring site between February 2017 and January 2018 ((Styles Group , 2018)

5 Recommendations

There is only one recommended adjustment to the monitoring regime which relates to physical shoreline monitoring - to compare future beach profile data to historical data, not just that recorded throughout the baseline monitoring period.

6 Applicability

Enviser Ltd has prepared this report for Lyttelton Port Company in accordance with the agreed scope. No other party may rely on this report, or any conclusions or opinions within it, for any purpose without the express written permission of Enviser Ltd.

The opinions and conclusions within this report are based on the information that was viewed during preparation of the report.

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