Pakiri Sand Extraction Consent Application

Water Quality Technical Report

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McCallum Brothers Limited

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List of Abbreviations

Acronym	Meaning
AEE	Assessment of Environmental Effect
ADCP	Acoustic Doppler Current Profiler
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG (2018)	Australian and New Zealand Guidelines for Freshwater and Marine Water Quality
AUP(OP)	Auckland Unitary Plan (Operative in Part)
CMA	Coastal Marine Area
CTD	Conductivity, temperature and depth
MBL	McCallum Brothers Ltd
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Total Polychlorinated Biphenyls
SQGs	Sediment Quality Guidelines
TSS	Total Suspended Solids
WETlabs	WETlabs WQM

1. Introduction

This document presents a technical assessment of the potential effects to water quality from sand extraction operations at Mangawhai-Pakiri. McCallum Brothers Ltd (MBL) have been extracting sand within the Mangawhai-Pakiri embayment for over 75 years and this assessment forms a component of the environmental effects assessment associated with the re-consenting of the dredge zone area, see Figure 1.1.

Extraction activities at Mangawhai-Pakiri rely on dredging and pumping of a sand slurry from the seabed to a dredge vessel.

The sand extraction operations are likely to result in some localised environmental effects on water quality within the receiving environment. Studies have demonstrated the potential effects on water quality from dredging activities (Erftmeijer & Robin Lewis III, 2006), including the suspension of sediments within the water column (Fisher, et al., 2015). Suspended sediments result in increased turbidity, with potential 'downstream' impacts on benthic habitats as a result of increased light attenuation and subsequenty reduced benthic light availabilty (Erftmeijer & Robin Lewis III, 2006). In addition, suspended contaminated sediments from the seabed could lead to additional effects on water quality and associated marine fauna (Filho et al., 2004). However, as Pennekamp, et al., (1996) outlines, the extent and degree of these effects is greatly dependent on a number of factors including:

- Quantity, frequency and duration of dredging;
- Physical dimensions and water depth of the dredge location;
- Grain size composition;
- Density and degree of contamination of dredged material;
- Background water quality (particularly suspended matter and turbidity);
- Seasonal variations in weather conditions (particularly wind and waves); and
- Proximity and distance of ecologically sensitive or economically important areas or species relative to the location of the dredging or disposal site.

Therefore, this study focuses and highlights the potential effects of the proposed dredging activities on the background water quality, in particular total suspended solids (TSS) and turbidity water quality parameters.

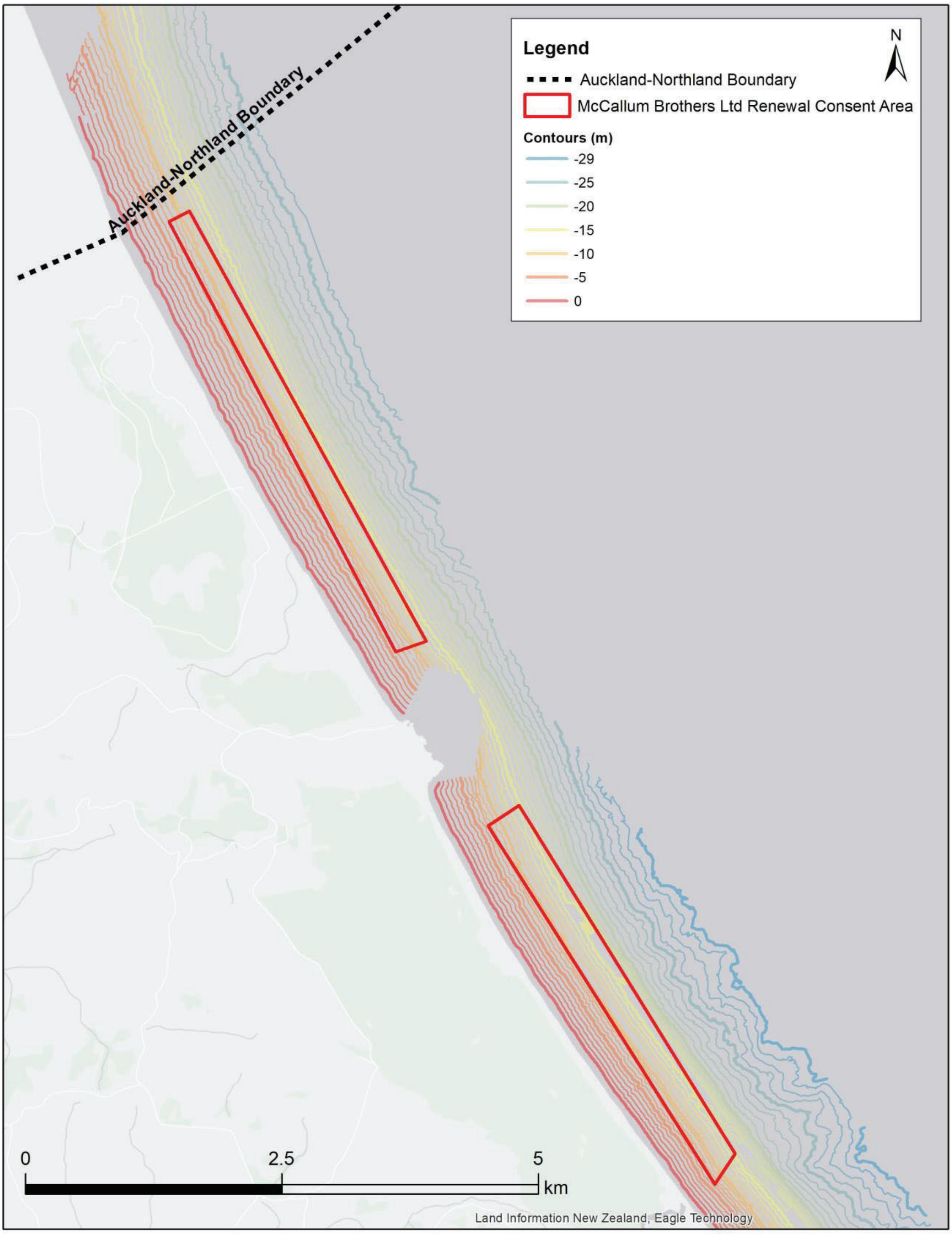

Figure 1.1: Overview of Proposed Re-Consent Area

1.1 Project background

The proposal is located at Pakiri, North Auckland between Mangawhai Harbour and Poutawa Stream, within the 5 m to 10 m bathymetric contour in the nearshore area of the Coastal Marine Area (CMA). Pakiri is located on the east coast and faces the northern approach to the Hauraki Gulf. The coastline features a series of sandy surf beaches running from Goat Island to Mangawhai Heads (Figure 1.2).

MBL have been dredging sand in the Mangawhai-Pakiri embayment for more than 75 years. The high-quality sand has been primarily used to supply concrete plants in the greater Auckland area. With MBL's current consents and related operations further off-shore under consents held by Coastal Resources Limited, MBL supplies, from the Mangawhai-Pakiri embayment, approximately 45% of construction sand for the Auckland Region. Pakiri sand extracted by MBL is also used for sports fields, beach re-nourishments and equine activities.

The current coastal permits were granted by the Environment Court in May 2006 for a 14-year period, which allows MBL to extract sand up to 76,000 m^3/year from the inshore area between the Auckland/Northland regional boundary and the Poutawa Stream as shown in Figure 1.2. This consent application is for the renewal of this existing extraction activity, at the same combined annual volume (76,000 m^3/per consecutive 12-month period).

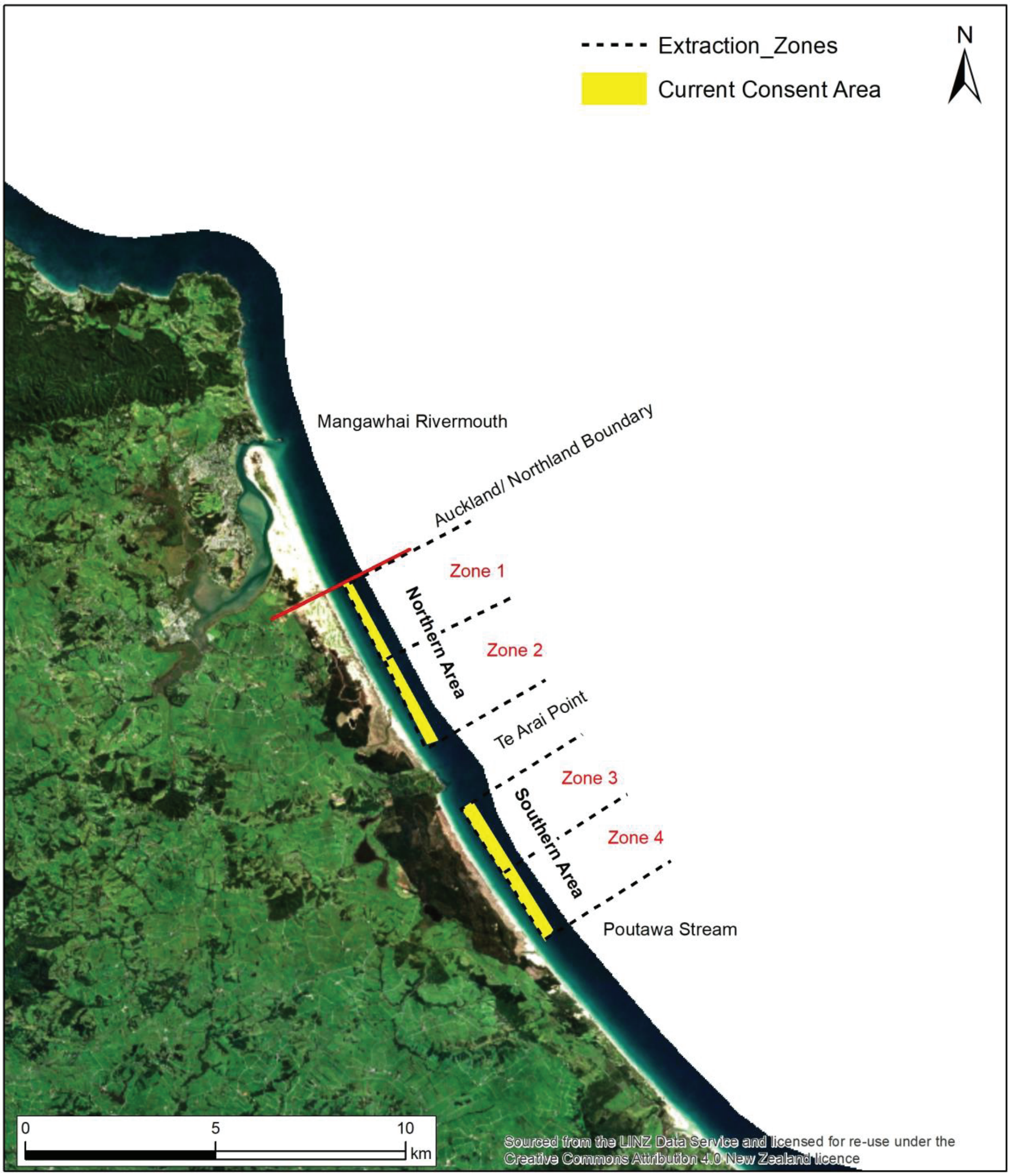

Figure 1.2: Overview of Extraction Zones and Current Consent Area

1.2 Purpose

The purpose of this technical report was to analyse the existing environmental conditions at the site with respect to water quality and assess any changes in water quality from dredging operations. This report utilises primary data sources collected from within the current consented area before and during a dredge event and compares these results to appropriate guideline values and long-term ambient water quality data sets from the region.

Utilising the water quality baseline conditions, the report assesses the potential effects on water quality from the proposed dredging operations. This report also sets out any applicable mitigation and monitoring recommendations and provides an assessment of residual effects.

It should be noted that this report should be read in conjunction with the other technical assessments which support the consent application. Reference and links to these reports will be provided as applicable in this report.

1.3 Document structure

The report has the following structure:

- Section 2: Relevant policy and objectives
- Section 3: Description of activity
- Section 4: Describes the existing environment in terms of water quality
- Section 5: Dredge plume water quality sampling methodology and results
- Section 6: Assessment of effects
- Section 7: Mitigation and monitoring
- Section 8: Conclusion

2. Relevant Policy and Objectives

This section provides an overview of the Objectives and Policies relevant to water quality that are outlined in the Auckland Unitary Plan Operative in Part (AUP(OP)) as shown in Table 2.1 below. Consideration of these Objectives and Policies is incorporated into this Technical Assessment report. For a full list of applicable Policy and Objectives for the Project please refer to the Consent Application Report.

Table 2.1: AUP(OP) Relevant Objectives and Policies

AUP(OP) Plan Provision	Details
Objective B6.3.1	(1) Mana Whenua values, mātauranga and tikanga are properly reflected and accorded sufficient weight in resource management decision-making. (2) The mauri of, and the relationship of Mana Whenua with, natural and physical resources including freshwater, geothermal resources, land, air and coastal resources are enhanced overall. (3) The relationship of Mana Whenua and their customs and traditions with natural and physical resources that have been scheduled in the Unitary Plan in relation to natural heritage, natural resources or historic heritage values is recognised and provided for.
Policy B6.3.2	(1) Enable Mana Whenua to identify their values associated with all of the following: (a) ancestral lands, water, air, sites, wāhi tapu, and other taonga; (b) freshwater, including rivers, streams, aquifers, lakes, wetlands, and associated values; (c) biodiversity; (d) historic heritage places and areas; and (e) air, geothermal and coastal resources. (2) Integrate Mana Whenua values, mātauranga and tikanga: (a) in the management of natural and physical resources within the ancestral rohe of Mana Whenua, including: (i) ancestral lands, water, sites, wāhi tapu and other taonga; (ii) biodiversity; and (iii) historic heritage places and areas. (b) in the management of freshwater and coastal resources, such as the use of rāhui to enhance ecosystem health; (c) in the development of innovative solutions to remedy the long-term adverse effects on historical, cultural and spiritual values from discharges to freshwater and coastal water; and (d) in resource management processes and decisions relating to freshwater, geothermal, land, air and coastal resources. (3) Ensure that any assessment of environmental effects for an activity that may affect Mana Whenua values includes an appropriate assessment of adverse effects on those values. (4) Provide opportunities for Mana Whenua to be involved in the integrated management of natural and physical resources in ways that do all of the following: (a) recognise the holistic nature of the Mana Whenua world view; (b) recognise any protected customary right in accordance with the Marine and Coastal Area (Takutai Moana) Act 2011; and (c) restore or enhance the mauri of freshwater and coastal ecosystems. (6) Require resource management decisions to have particular regard to potential impacts on all of the following: (a) the holistic nature of the Mana Whenua (b) the exercise of kaitiakitanga; (c) mauri, particularly in relation to freshwater and coastal resources;

	(d) customary activities, including mahinga kai; (e) sites and areas with significant spiritual or cultural heritage value to Mana Whenua; and (f) any protected customary right in accordance with the Marine and Coastal Area (Takutai Moana) Act 2011.
Objective B7.2.1	(1) Areas of significant indigenous biodiversity value in terrestrial, freshwater, and coastal marine areas are protected from the adverse effects of subdivision, use and development. (2) Indigenous biodiversity is maintained through protection, restoration and enhancement in areas where ecological values are degraded, or where development is occurring.
Policy B7.2.2	(5) Avoid adverse effects on areas listed in the Schedule 3 of Significant Ecological Areas – Terrestrial Schedule and Schedule 4 Significant Ecological Areas – Marine Schedule.
Objective B7.4.1	(1) Coastal water, freshwater and geothermal water are used within identified limits while safeguarding the life-supporting capacity and the natural, social and cultural values of the waters. (2) The quality of freshwater and coastal water is maintained where it is excellent or good and progressively improved over time where it is degraded. (6) Mana Whenua values, mātauranga and tikanga associated with coastal water, freshwater and geothermal water are recognised and provided for, including their traditional and cultural uses and values.
Policy B7.4.2	(7) Manage the discharges of contaminants into water from subdivision, use and development to avoid where practicable, and otherwise minimise, all of the following: (b) adverse effects on the quality of freshwater and coastal water; (c) adverse effects from contaminants, including nutrients generated on or applied to land, and the potential for these to enter freshwater and coastal water from both point and non-point sources; (d) adverse effects on Mana Whenua values associated with coastal water, freshwater and geothermal water, including wāhi tapu, wāhi taonga and mahinga kai;
Objective B8.2.1	(1) Areas of the coastal environment with outstanding and high natural character are preserved and protected from inappropriate subdivision, use and development. (2) Subdivision, use and development in the coastal environment are designed, located and managed to preserve the characteristics and qualities that contribute to the natural character of the coastal environment. (3) Where practicable, in the coastal environment areas with degraded natural character are restored or rehabilitated and areas of high and outstanding natural character are enhanced.
Policy B8.2.2	(3) Preserve and protect areas of outstanding natural character and high natural character from inappropriate subdivision, use and development by: (a) avoiding adverse effects of activities on natural character in areas of the coastal environment scheduled as outstanding natural character; and (b) avoiding significant adverse effects and avoid, remedy or mitigate other adverse effects of activities on natural character in all other areas of the coastal environment. (4) Avoid significant adverse effects and avoid, remedy or mitigate other adverse effects on natural character of the coastal environment not identified as outstanding natural character and high natural character from inappropriate subdivision, use and development.
Objective B8.3.1	(1) Subdivision, use and development in the coastal environment are located in appropriate places and are of an appropriate form and within appropriate limits, taking into account the range of uses and values of the coastal environment. (2) The adverse effects of subdivision, use and development on the values of the coastal environment are avoided, remedied or mitigated.
Policy B8.3.2	(4) Require subdivision, use and development in the coastal environment to avoid, remedy or mitigate the adverse effects of activities above and below the mean high-water springs, including the effects on existing uses and on the coastal receiving environment. (5) Adopt a precautionary approach towards proposed activities whose effects on the coastal environment are uncertain, unknown or little understood, but could be significantly adverse.

Objective B8.5.1	(1) The management of the Hauraki Gulf gives effect to sections 7 and 8 of the Hauraki Gulf Marine Park Act 2000. (3) Economic well-being is enabled from the use of the Hauraki Gulf's natural and physical resources without resulting in further degradation of environmental quality or adversely affecting the life-supporting capacity of marine ecosystems.
Policies B8.5.2	(5) Avoid use and development that will compromise the natural character, landscape, conservation and biodiversity values of the islands, particularly in areas with natural and physical resources that have been scheduled in the Unitary Plan in relation to natural heritage, Mana Whenua, natural resources, coastal, historic heritage and special character. (13) Require management and decision-making to take into account the historical, cultural and spiritual relationship of Mana Whenua with the Hauraki Gulf, and the ongoing capacity to sustain these relationships.
Policy E1.3	(26) Prevent or minimise the adverse effects from construction, maintenance, Investigation and other activities on the quality of freshwater and coastal water by: (a) adopting best management practices and establishing minimum standards for the discharges; or (b) where Policy E1.3(26)(a) is not practicable, have regard to the following: (i) the nature, volume and concentration of the contaminants in the discharge; (ii) the sensitivity of the receiving environment to the contaminants in the discharge; (iii) other practicable options for the discharge, including reuse or discharge to the trade sewer; and (iv) practicable measures to reduce contaminant concentrations prior to discharge or otherwise mitigate adverse effects.
Policies E18.3	(3) Manage the effects of subdivision, use and development in the coastal environment to avoid significant adverse effects, and avoid, remedy or mitigate other adverse effects, on the characteristics and qualities that contribute to natural character values, taking into account: (a) the location, scale and design of the proposed subdivision, use or development; (b) the extent of anthropogenic changes to landform, vegetation, coastal processes and water movement; (c) the presence or absence of structures, buildings or infrastructure; (d) the temporary or permanent nature of any adverse effects; (e) the physical and visual integrity of the area, and the natural processes of the location; (f) the intactness of any areas of significant vegetation, and vegetative patterns; (g) the physical, visual and experiential values that contribute significantly to the wilderness and scenic values of the area; (h) the integrity of landforms, geological features and associated natural processes, including sensitive landforms such as ridgelines, headlands, peninsulas, cliffs, dunes, wetlands, reefs, freshwater springs, streams, rivers and surf breaks; (i) the natural characteristics and qualities that exist or operate across mean high-water spring and land in the coastal environment, including processes of sediment transport, patterns of erosion and deposition, substrate composition and movement of biota, including between marine and freshwater environments.
Objective F2.6.2	(1) The extraction of minerals, sand, shingle, shell, petroleum, and other natural material occurs in a manner that does not have significant adverse effects on the coastal marine area or near-shore environments.
Policy F2.6.3	(1) Provide for the extraction of minerals, sand, shingle, shell, and other natural material from appropriate areas, having regard to the values of the area and the natural rate of sediment being deposited over sediment lost from the area where extraction is proposed. (2) Adopt a precautionary approach to applications for petroleum exploration and for mineral extraction within the coastal marine area, which may include using an adaptive management approach in terms of the following:

	(a) staging the operation; (b) the location of the activity; (c) the maximum volume of minerals, sand, shingle, shell and other natural material to be extracted; (d) the term of consent; or (e) environmental monitoring. (4) Require applications for petroleum exploration or mineral extraction in the coastal marine area to include measures to manage any adverse effects, including remediation and mitigation measures.
Objectives F2.11.2	(1) Water and sediment quality in the coastal marine area is maintained where it is excellent or good and progressively improved over time in degraded areas. (2) The life-supporting capacity and resources of the Hauraki Gulf are protected and, where appropriate, enhanced.
Policies F2.11.3	(1) Avoid the discharge of contaminants where it will result in significant modification of, or damage to any areas identified as having significant values. (2) Require any proposal to discharge contaminants or water into the coastal marine area to adopt the best practicable option to prevent or minimise adverse effects on the environment, having regard to all of the following: (a) whether it is practicable or appropriate to discharge to land above mean high water springs; (b) whether there is a wastewater network in place that should be used; (c) whether the receiving environment has the capacity to assimilate the discharged contaminants after reasonable mixing, particularly within areas identified as degraded or as having significant ecological value; (d) the extent to which present or foreseeable future adverse effects have been avoided, remedied or mitigated on: (i) areas of high recreational use; (ii) relevant initiatives by Mana Whenua established under regulations relating to the conservation or management of fisheries; (iii) the collection of fish and shellfish for consumption (e) high ecological values; (f) cleaner production methods are used where practicable to minimise the volume and level of contaminants being discharged; and (g) the discharge after reasonable mixing, does not either by itself or in combination with other discharges results in any or all of the following effects: (i) oil or grease films, scums or foams, or floatable or suspended materials; (ii) conspicuous change in the colour or visual clarity; (iii) any emission of objectionable odour; (iv) any significant adverse effects on aquatic life; or (v) any significant effects of aesthetic or amenity values. (3) Provide for discharges that are unavoidable but intermittent, where: (a) the discharge occurs infrequently; (b) there are technical and practical difficulties which prevent measures being taken to avoid, remedy or mitigate adverse effects of the discharge;

3. Description of Activity

This section summarises the description of activity with a focus on information pertaining to water quality. For a more detailed description of activity, refer to the Description of Activity in the main Assessment of Effects on the Environment (AEE).

3.1.1 Background

MBL maintain permits that allow the extraction of sand up to 76,000m^3/year from the inshore area between the Auckland/Northland regional boundary and the Poutawa Stream as shown in Figure 1.2.

Currently MBL use two vessels for sand extraction, the Pohonui and the Coastal Carrier. However, a new purpose-built dredge vessel, the 'William Fraser' will be commissioned and operational in November 2019 replacing both vessels. For the purpose of this report, the Coastal Carrier was used to measure potential water quality effects as it was the most comparable in operation to the new vessel (William Fraser) in how it extracts and processes the sand.

The William Fraser adopts a 'trailing suction' method which operates by sucking material from the seabed as a sand slurry using a trailing suction head fitted to pipes that trail over the bed as the ship sails over the extraction area. The sand pumps lift the extracted sand slurry through the pipework to pass through sand screens which is deposited in the onboard hopper.

The Coastal Carrier also extracts sand using trailing suction dredging. There are two main methods by which suspended sediments are discharged into the receiving waters as a result of the dredging operations.

- Discharge spoil containing oversized materials that are too large to pass through the sand screens to the hopper; and
- Overflow spoil through the weir boards as the hopper fills with sand.

For a more detailed description of each vessel refer to the main AEE report.

3.1.2 Over-Sized Material Discharge

The existing by-wash and over-sized material discharge from the dredge vessel occurs from the end of the 250 mm diameter flume pipes as shown in Figure 3.1. The majority of the over-sized material comprises shell fragments greater than 3.15 mm (the maximum limit of the sand screens).

Figure 3.1: Discharge from the Dredge Vessel of Spoil from Overhead Flumes and from the Deck Over-Hopper Weir Boards

3.1.3 Discharge Over Hopper Weir Boards

The current dredge vessel (‘Coastal Carrier’) allows the sand to settle out in the hopper with the water and finer particles at the top, passing over a series of weir boards across gaps in the hopper sides that are raised in height as the hopper fills. This material flows over the deck of the vessel around the outside of the hopper to discharge over the side of the vessel to the sea surface as shown in Figure 3.2.

Figure 3.2: Weir Board Discharge Indicated by Blue Rectangle

With the ‘William Fraser’, hopper weir boards will still be used to drain excess water and fines from the hopper, however this material will be collected in six “moon pools” that discharge below the keel of the vessel, at least 1.5 m below the sea surface.

4. Description of Existing Environment

This section of the report provides a discussion of the baseline water quality conditions within the project area. Secondary data sources (i.e. existing literature and reports) as well as primary data collected in-situ in May 2019 have been used.

4.1 Regional Overview of Ambient Water Quality Parameters

In order to characterise existing water quality conditions within the consented sand extraction area, reference sites close to the project location were selected that contained similar physical characteristics to that of the project site. The data associated with these reference sites were then compared to the data from *in-situ* samples collected in May 2019. The two reference sites identified as suitable comparisons include:

- Goat Island Marine Reserve[1]; and
- Mair Bank[2].

[1] Marine Water Quality Annual Report 2016, Melanie R Vaughan, (Research and Evaluation Unit Auckland Council) December 2017. Technical Report 2017/033

[2] https://www.nrc.govt.nz/media/11217/coastalwaterqualitymonitoring20102014results.pdf

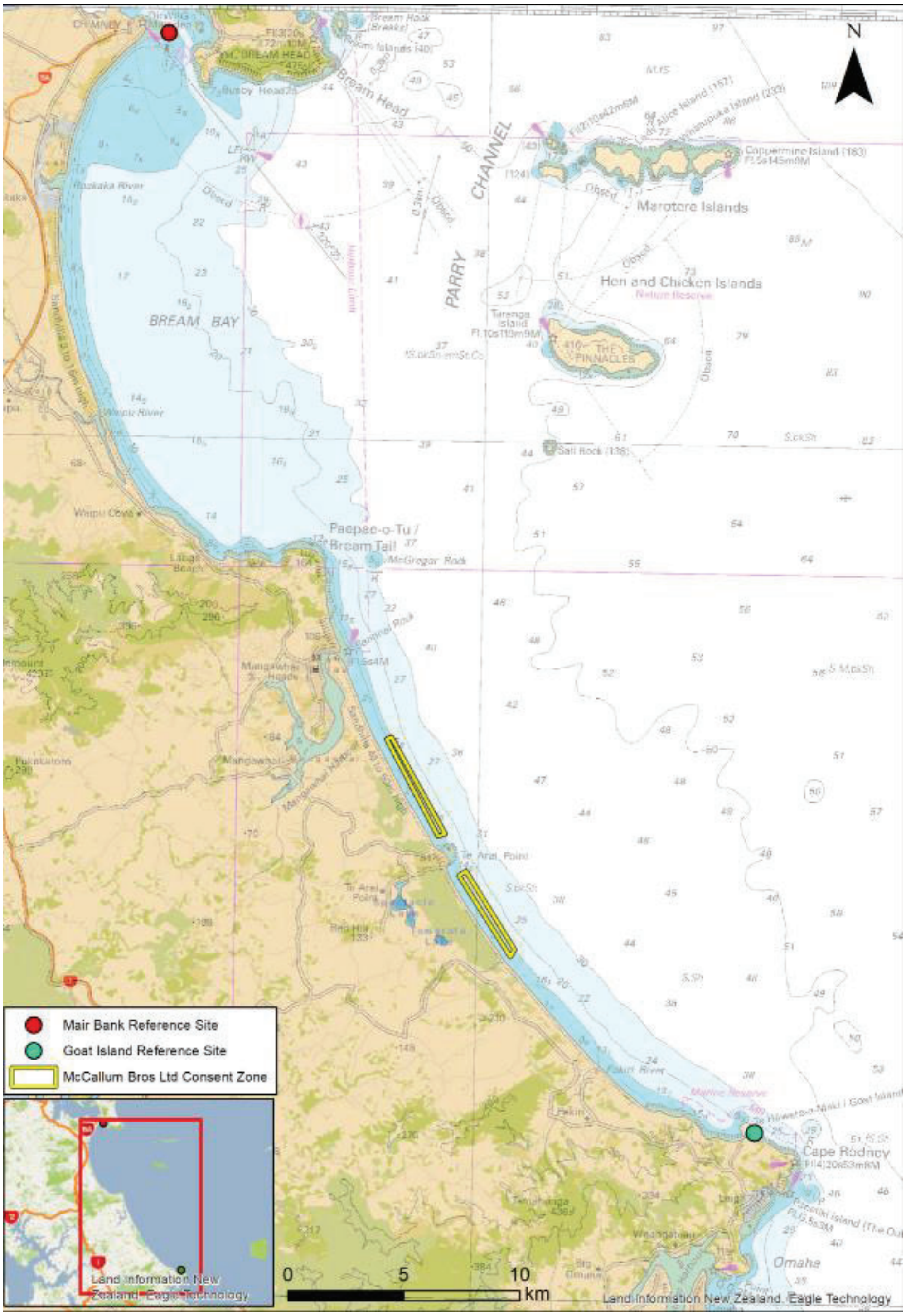

Figure 4.1: Goat Island and Mair Bank Reference Site Locations

4.1.1 Mair Bank

The annual water quality monitoring report[2] undertaken by Northland Regional Council in June 2015 contained water quality results for 17 sites sampled in and around Whangarei Harbour. Of these sites, the Mair Bank monitoring site was considered a suitable proxy for ambient water quality at the project site. This is due to it being an open coast site on the east cost of the North Island and is located outside the entrance of Whangarei Harbour, approximately 38 kms (direct path) north of the project site (Figure 4.1). The Northland Regional Council collected water quality data from this area from January 2010 to December 2014 which was used in the annual marine monitoring report. Physical properties of Mair bank include:

- Soft sandy seabed; and
- Adjacent to a deep sandy-shell channel in the lower harbour.

Table 4.1 outlines key water quality parameters for Mair Bank in comparison with the Goat Island reference site.

4.1.2 Goat Island

Auckland Council have collected marine ambient water quality data from their existing Goat Island monitoring site since 1993. Goat Island is a marine reserve located approximately 17 kms south of the project site (Figure 4.1). The site is a small island with steep cliffs approximately 100 m offshore, the eastern side of the island is exposed to the full influence of the Pacific from the north to east[3]. The steep cliffs of the eastern side of Goat island continue subsurface to a sandy bottom at 23 m.

Goat Island was selected as a reference site due to its proximity to the project area, and the similarity in its physical and hydrodynamic properties (i.e. sandy bottom composition and exposure to the open coast).

The water quality data collected from this monitoring site was sourced from Auckland Council's online database[4]. Table 4.1 below provides a summary of water quality trends using data obtained from the Goat Island monitoring station, with data obtained from 1993 to 2019 and the Mair Bank reference site (data obtained from Jan 2010 to December 2014). Water quality samples are taken on a monthly basis using a helicopter to take a sample from the sea surface (approximately 30 – 40 cm depth).

Table 4.1: Mean Values for Key Water Quality Parameters associated with Goat Island (data obtained from 1993-2019) and Mair Bank (data obtained from Jan 2010 to December 2014) Reference Sites

Parameter	Mair Bank	Goat Island
Salinity (ppt)	34.4	34.3
Temperature (°C)	17.5	17.3
Total Suspended Solids (mg/L)	N/A	4.0
Turbidity (NTU)	0.8	0.59
Dissolved Oxygen (%)	99.5	103.30
Conductivity (mS/cm)	Not measured	52.85

4.2 Ambient Site-Specific Water Quality and Sediment Conditions

In order to determine the potential site-specific effects of the activity on the receiving environment, sediment quality and water quality conditions were measured and evaluated. This section of the report outlines the

[3] Russell, B. C. (1969). A checklist of the fishes of Goat Island, North Auckland, New Zealand, with an analysis of habitats and associations. *Tane*, *15*(3), 105-113.
[4] https://environmentauckland.org.nz/Data/Location/Summary/Location/6315/Interval/Yearly/Calendar/CALENDARYEAR/1993

methodologies and results of *in-situ* sediment and water quality sampling undertaken within the current consented area.

4.2.1 Sediment Quality

Within the consented area, sediment samples were collected at three locations from two water depths (5 m and 20 m bathymetric contour) offshore of Pakiri River, Poutawa Stream, and Te Arai Stream in order to determine sediment quality. Samples were collected by MBL personnel while undertaking other field sampling on the 16th April 2019 and samples were consigned and sent for analysis to RJ Hill Laboratories.

The samples were analysed for the following parameters:

- Heavy Metals:
  - Arsenic
  - Cadmium
  - Chromium
  - Copper
  - Lead
  - Mercury
  - Nickel
  - Zinc
- Total Polycyclic Aromatic Hydrocarbons (PAHs); and
- Total Polychlorinated Biphenyls (PCBs).

Sediment quality guideline values are included in the revised Australia and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2018), released in 2018. These guideline values have been applied to the sediment analysis results. Both the Default Guideline Value (DGV) and Guideline Value (GV)-High values have been utilised in determining the contamination status of the sample results.

Concentrations below the DGVs indicate there is a low risk of unacceptable effects occurring. The GV-High provide an indication of concentrations at which toxicity related adverse effects are expected to occur. As such the GV-High is used only as an indicator of potential high-level toxicity issues.

The sediment sample results were compared to both the default and high guideline values ANZG (2018), the results of this are shown in Table 4.2 below.

Table 4.2: Sediment Quality Results Compared Against ANZG Guidelines

Contaminant	ANZG DGV	ANZG GV-High	Pakiri River 5 m	Pakiri River 20 m	Poutawa Stream 5 m	Poutawa Stream 20 m	Te Arai Stream 5m	Te Arai Stream 20 m
Heavy Metals (mg/kg dry weight)								
Total Recoverable Arsenic	20	70	5.9	6.2	6.2	6.2	5.9	8.8

Contaminant	ANZG DGV	ANZG GV-High	Pakiri River 5 m	Pakiri River 20 m	Poutawa Stream 5 m	Poutawa Stream 20 m	Te Arai Stream 5m	Te Arai Stream 20 m
Total Recoverable Cadmium	1.5	10	< 0.010	< 0.010	< 0.010	< 0.010	< 0.010	0.011
Total Recoverable Chromium	80	370	10.8	11.7	9.4	12.4	10.5	14.1
Total Recoverable Copper	65	270	0.5	0.5	0.4	0.4	0.6	0.5
Total Recoverable Lead	50	220	0.89	1.79	0.84	1.48	1.06	1.7
Total Recoverable Mercury	0.15	1	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Total Recoverable Nickel	21	52	2.6	2.4	2.3	2.8	2.4	2.8
Total Recoverable Zinc	200	410	10.6	10.7	9.4	11.7	17.9	12.4
Total Polycyclic Aromatic Hydrocarbons (PAH) (µg/mg dry weight)								
Total PAH	10,000	50,000	< 1,500 (0.2% TOC)	< 1,500 (0.2% TOC)	< 1,500 (0.2% TOC)	< 1,500 (0.2% TOC)	< 1,500 (0.2% TOC)	< 1,500 (0.2% TOC)
Total Polychlorinated Biphenyls (PCB) (µg/mg dry weight)								
Total PCB	34	280	< 5 (0.2% TOC)	< 5 (0.2% TOC)	< 5 (0.2% TOC)	< 5 (0.2% TOC)	< 5 (0.2% TOC)	< 5 (0.2% TOC)

Analysis of these results showed that none of the samples exceed either the DGV or GV-High and therefore it can be concluded that the sediment within the sampled areas have not been subject to contamination from heavy metals, PCBs or PAHs.

Based on the above, it was determined that given the sediment quality at the project site is below DGVs, then it was not necessary to analyse water samples for heavy metal, PAH or PCB contamination as the sediment concentrations can be regarded as being at background levels.

4.2.2 Ambient Water Quality

Data was gathered for this project to identify the ambient water quality at the location of sand extraction. This section outlines the methodologies and results associated with *in-situ* water sampling, collected via a Van Dorn sampler, a Conductivity, Temperature and Depth (CTD) instrument and long-term monitoring results collected by the WETlabs WQM instrument.

4.2.3 Ambient Water Quality Sampling Methodology

4.2.3.1 WETlabs WQM Instrument

A µWQ (micro water quality) buoy was deployed at a water depth of 25 m near the project site (see Figure 4.2) and included a downward-facing RDI Sentinel V50 500kHz Acoustic Doppler Current Profiler (ADCP) mounted to the base of the buoy and a WETlabs WQM (water quality instrument) attached via a 20 m line to a position just above the seabed (Figure 4.3). The ADCP measured water column current velocities and near-surface temperatures, whilst the WETlabs WQM measured; temperature, salinity, chlorophyll-*a,* turbidity, conductivity and dissolved oxygen near the seabed. The data relating to the ADCP deployment is discussed further in the Assessment of Effects on Coastal Processes report.

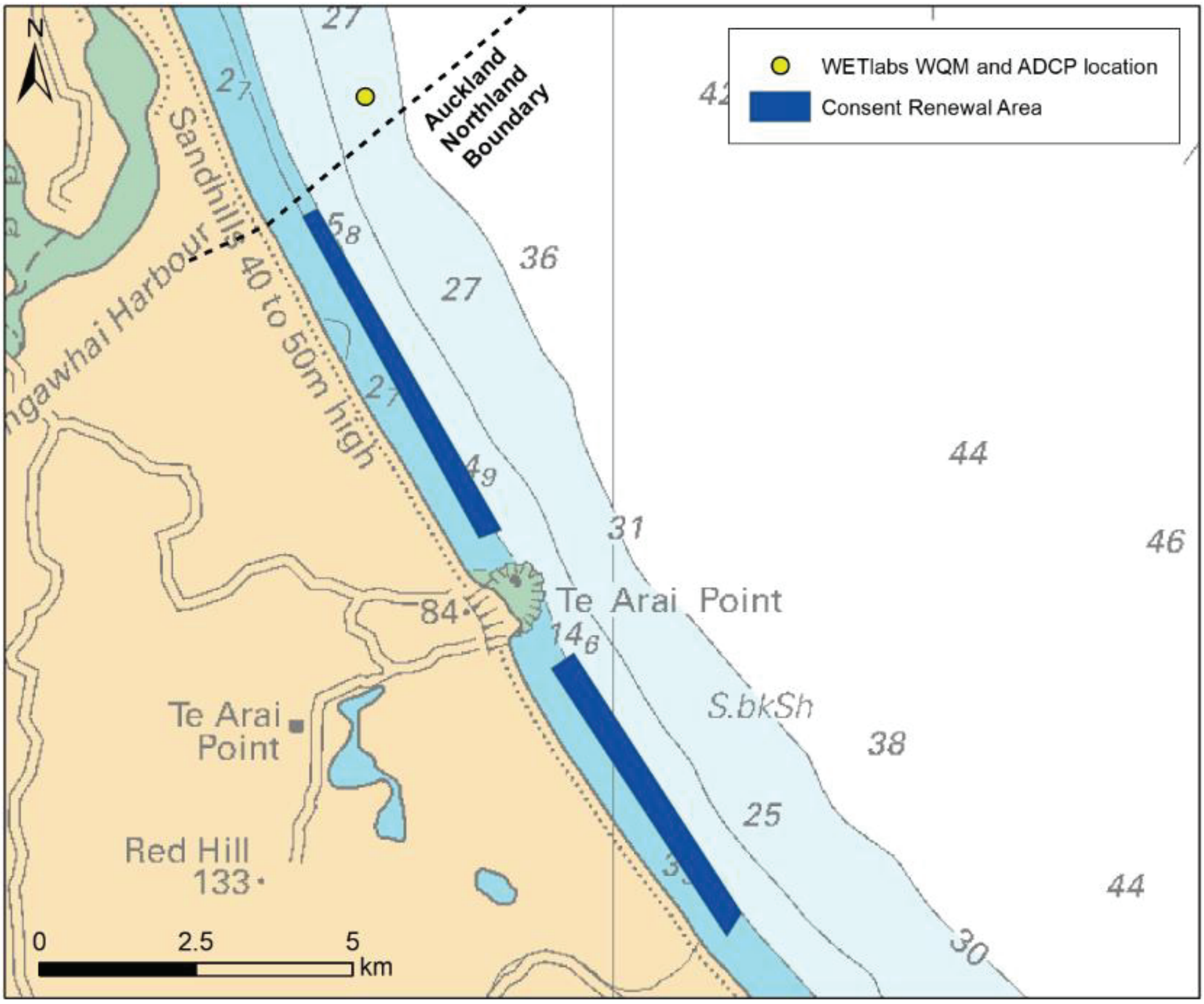

Figure 4.2: WETlabs Monitoring Locations in Relation to Consent Boundaries

Figure 4.3: Deployment of ADCP and WETlabs WQM Devices

In order to obtain site specific, ambient water quality data, the ADCP and WETlabs WQM instrument were deployed for a two-month duration. Deployment was undertaken on the 20th May 2019 and retrieval of the instruments occurred on the 23rd July 2019. The results of the WETlabs deployment is discussed in Section 4.2.2.2 below.

4.2.3.2 *In-Situ* Sampling During WETlabs WQM Deployment and Retrieval

During the deployment and retrieval of the WETlabs instrument, *in-situ* water quality sampling was also undertaken using a Seabird SBE19plus CTD instrument (Figure 4.4) with integrated WETlabs fluorometer (Chl-*a* and Turbidity) and Van Dorn (Figure 4.5). A water sample using the Van Dorn was collected at the sea surface (<1 m), mid water (10 m) and just above the seabed (20 m) in order to provide an understanding of water quality variances through the water column. Water samples from the Van Dorn were tested for Total Suspended Solids (TSS). The CTD was deployed at the same time as the Van Dorn and collected data on the following parameters:

- Temperature;
- Salinity
- Turbidity
- Conductivity

- Dissolved Oxygen
- Density
- Photosynthetic Active Radiation (PAR)

The CTD cast measurements provided point-in-time measurements of vertical variation for each of these parameters throughout the water column. The Van Dorn and CTD cast profiles were taken on two separate occasions; on ADCP and WETlabs WQM instrument deployment (20th May 2019) and retrieval (23rd July). The sampling results are discussed in Section 4.2.2.2 below.

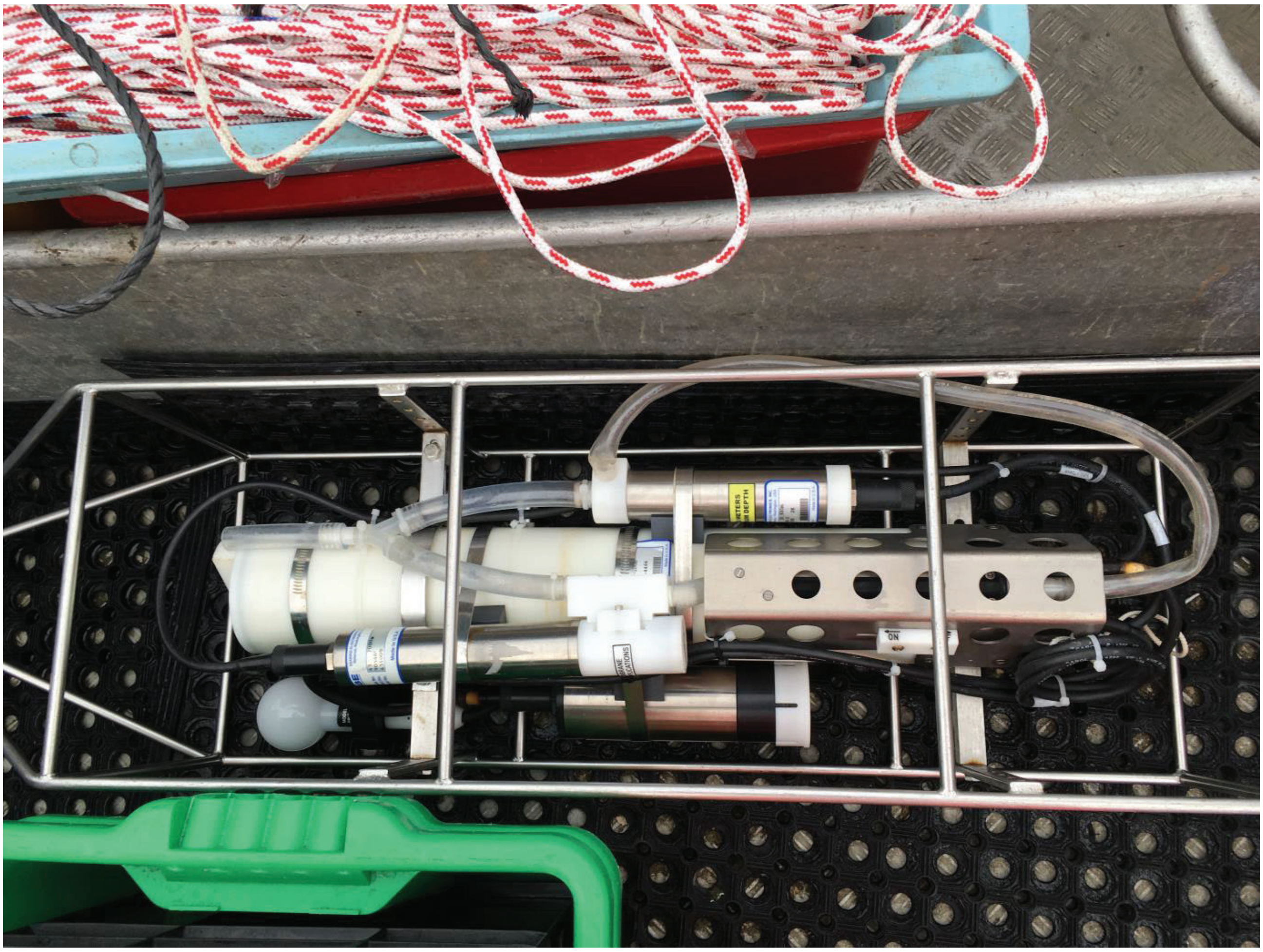

Figure 4.4: CTD Instrument

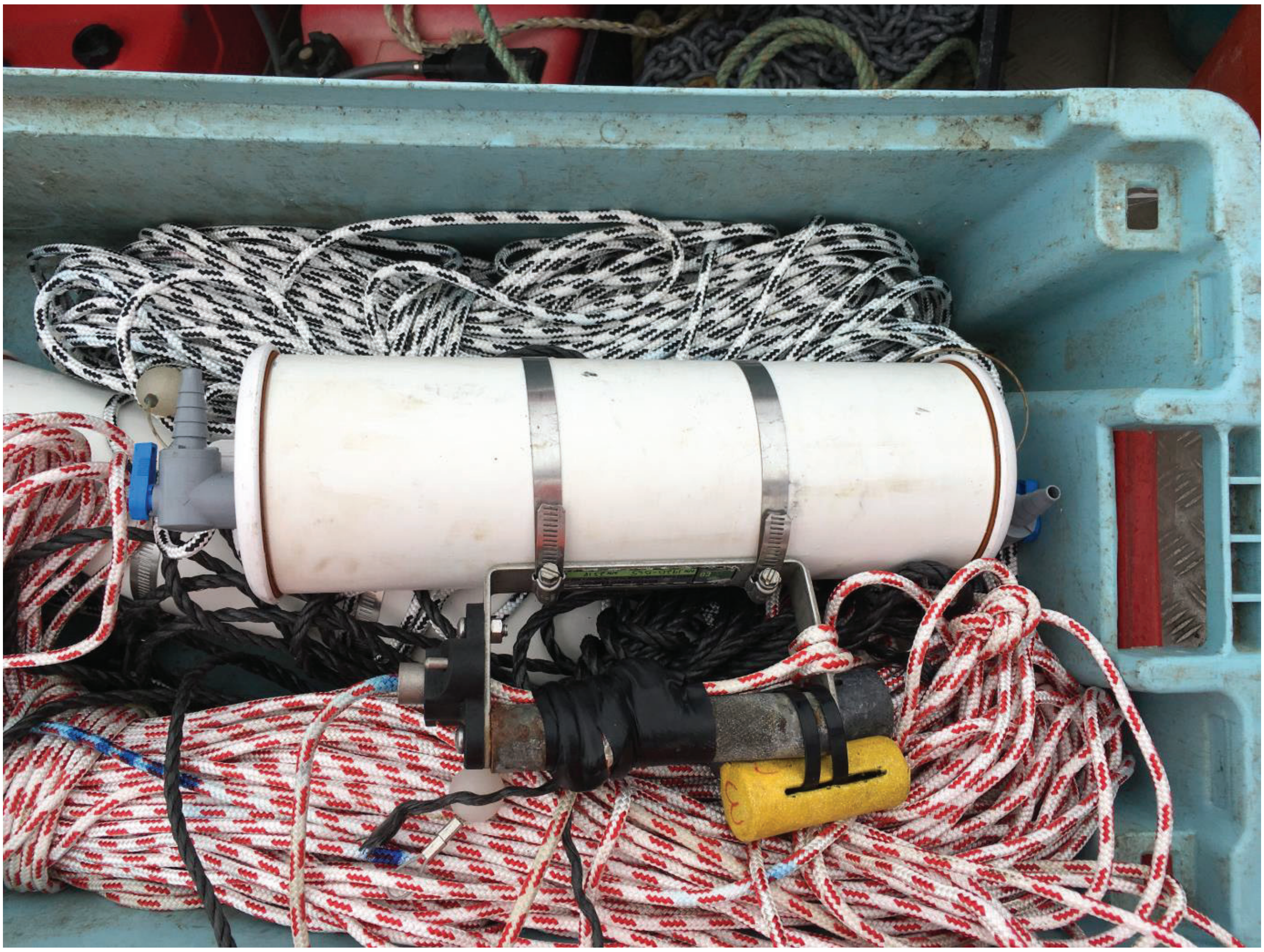

Figure 4.5: Van Dorn

4.2.3.3 *In-Situ* Sampling Prior to Dredge Plume Sampling

Site-specific water quality sampling was undertaken prior to the dredge plume sampling (dredge plume sampling is further discussed in Section 5.2 of this report), in order to determine ambient water quality conditions specific to the dredge site. A water sample using the Van Dorn was collected at the sea surface (<1 m), mid water (5 m) and just above the seabed (9 m) in order to provide an understanding of water quality variances through the water column. Water samples from the Van Dorn were tested for TSS. A CTD was also deployed at the same time as the Van Dorn to collect data on the same parameters outlined in the section above. The sampling results are discussed in Section 4.2.2.2 below.

4.2.4 Ambient Water Quality Sampling Results

This section provides a summary overview of results from the ambient water quality sampling undertaken as outlined in Section 4.2.3 above. A full record of results can be found in Appendix A.

There are no applicable guidelines that provide threshold levels for parameters measured. Both Auckland Council and Northland Regional Council recognise that the ANZECC 2000 Guidelines provide no threshold for TSS and that the turbidity range from the ANZECC 2000 Guidelines provide a range of 0.5 – 10 NTU which is acknowledged as not suitable for open coastal waters. As such it is considered that the WETlabs baseline data provides a more accurate representation of baseline water quality conditions at the project site.

4.2.4.1 WETlabs WQM Instrument Results

Outlined in Table 4.3 below are the mean results for parameters measured by the WETlabs WQM over the two-month deployment period.

Table 4.3: WETlabs WQM Mean Results Over Deployment Period

Temperature (ºC)	Salinity (ppm)	Chlorophyll-*a* (µg/L)	Turbidity (NTU)	TSS (mg/l)	Conductivity (mS/cm)	Oxygen (mg/l)
16.65	35.58	1.17	0.31	1.04	45.2	7.76

Figure 4.6 and 4.7 below show mean TSS and turbidity concentrations over the deployment period. As noted in these figures there is limited variance in TSS and turbidity concentrations across the deployment period.

Figure 4.6: WETlabs WQM Mean Turbidity Results

Figure 4.7: WETlabs WQM Mean TSS (mg/l) Results

4.2.4.2 *In-Situ* Sampling During WETlabs WQM Deployment and Retrieval Results

Outlined in Table 4.4 below are the results from the *in-situ* sampling using the CTD during WETlabs WQM deployment and retrieval.

Table 4.4: CTD Cast Results during WETlabs WQM Deployment and Retrieval

Month	Temperature (°C)	Salinity (ppm)	Fluorescence (mg/m^3)	Conductivity (mS/cm)	Oxygen (mg/l)
May	18.15	35.56	1.27	46.70	7.02
July	15.64	35.48	1.22	44.12	7.58

Water quality sample results relevant to this technical report are TSS and turbidity and these are outlined in Table 4.5 below.

Table 4.5: TSS (mg/l) and Turbidity (NTU) Concentrations at WETlabs WQM Deployment and Retrieval Site

Parameter	Equipment Deployed	Date	Results as Received by Hill Laboratories		
			Shallow Water (<1 m)	Mid Water (10 m)	Bottom Water (20 m)
TSS (mg/l)	ADCP and WETlabs WQM deployment	20 May 2019	<3	<3	<3
	ADCP and WETlabs WQM retrieval	23 July 2019	<3	<3	<3
Turbidity (NTU)	ADCP and WETlabs WQM deployment	20 May 2019	1.29	1.29	1.29
	ADCP and WETlabs WQM retrieval	23 July 2019	2.33	1.28	1.28

Water samples collected using the Van Dorn during deployment and retrieval of the WETlabs WQM instrument, showed no variation in TSS concentrations through the water column and between the two sample dates. Similarly, turbidity results from the CTD showed little variation through the water column and between the samples dates. A small increase in turbidity in shallow water in July 2019 is still within normal natural variation ranges as noted in the WETlabs and Auckland Council data. Natural variation is to be expected due to the ability for this parameter to be easily influenced by site specific conditions and natural events such as storm surge, sediment run off and extreme wave events.

4.2.4.3 *In-Situ* Sampling Prior to Dredge Plume Sampling Results

Table 4.6 outlines the ambient water quality results that were collected at the dredge site prior to the dredge plume sampling occurring (dredge plume sampling is further discussed in Section 5.2 of this report). Specifically, TSS concentration results are displayed from the Van Dorn Samples collected (**Appendix B1**) and turbidity results were collected by *in-situ* readings obtained via the CTD Cast.

Table 4.6: TSS (mg/l) and Turbidity (NTU) Results Relating to Dredge Site, Prior to Dredge Plume Sampling

***In-situ* Parameters Measured**			
Parameter	Shallow Water (<1 m)	Mid Water (5 m)	Bottom Water (9 m)
TSS (mg/l)	1.3	1.5	1.5
Turbidity (NTU)	1.3	1.3	1.3

The results shown in Table 4.6 for water quality samples from prior to dredge plume sampling show little variance through the water column. Results are also similar to the water quality results from the deployment and retrieval of the WETlabs WQM instrument both in terms of turbidity and TSS.

4.2.4.4 Summary of Ambient Water Quality Results

Outlined in Table 4.7 below are further analysis of the turbidity and TSS concentrations for the WETlabs WQM, Auckland Council long term monitoring for Goat Island and the *in-situ* water quality samples from the Van Dorn and CTD cast data. In comparing across the data, whilst the *In-Situ* water quality samples from the Van Dorn and CTD casts are slightly elevated against the mean values for WETlabs and Goat Island, they are below the maximum values observed. All *In-Situ* sampling for TSS and turbidity show little variance both between samples and through the water column.

Table 4.7: Analysis and Comparison between WETlabs WQM, Goat Island and *In-Situ* Sampling

Parameter	Analysis	WETlabs WQM	Goat Island	*In-Situ Sampling*		
				WETlabs Deployment	WETlabs Retrieval	Prior to Dredge Plume Sampling
Turbidity (NTU)	Result	*N/A*	*N/A*	1.29	1.28 – 2.33	1.3
	Mean	0.31	0.58			
	Median	0.29	0.40			
	Max	3.11	13.30			
	Min	0.14	0.15			

	80th Percentile	0.34	0.64			
	90th Percentile	0.39	0.95			
	Standard Deviation	0.15	0.86			
TSS (mg/l)	Result	*N/A*	*N/A*	<3	<3	1.30 – 1.5
	Mean	1.04	4.03			
	Median	0.98	3.10			
	Max	10.46	28.00			
	Min	0.47	0.40			
	80th Percentile	1.14	5.68			
	90th Percentile	1.31	7.65			
	Standard Deviation	0.51	3.27			

In comparing WETlabs WQM to *in-situ* sampling it should be noted that WETlabs WQM was recording data at 20 m water depth compared to the *in-situ* samples which were recording TSS and turbidity through the water column up to 10 m water depth. In addition, it is anticipated that turbidity would increase as the distance to shore decreases due to resuspension of sediment from wave action. This as well as the use of different equipment between *in-situ* sampling and the WETlabs may account for the slight variances seen between the data sets.

The small variances seen should be set in the context of turbidity and TSS concentrations across New Zealand. Data collected by unitary, district and regional councils for over 2,000 monitoring sites ranging from estuarine to coastal environments across New Zealand were sampled for a range of parameters between 2013 – 2017[5]. Shown in Figure 4.8 and 4.9 below are median suspended solids and turbidity values over this monitoring period. Shown in Figure 4.10 and 4.11 are the median values for suspended solids and turbidity over this monitoring period and across four different environments. What is clear from all these figures are that for a coastal environment broadly similar to Pakiri, suspended solids and turbidity values are higher than those found from the WETlabs WQM and *in-situ* sampling data.

[5] Stats NZ Tatauranga Aotearoa – https://www.stats.govt.nz/indicators/coastal-and-estuarine-water-quality

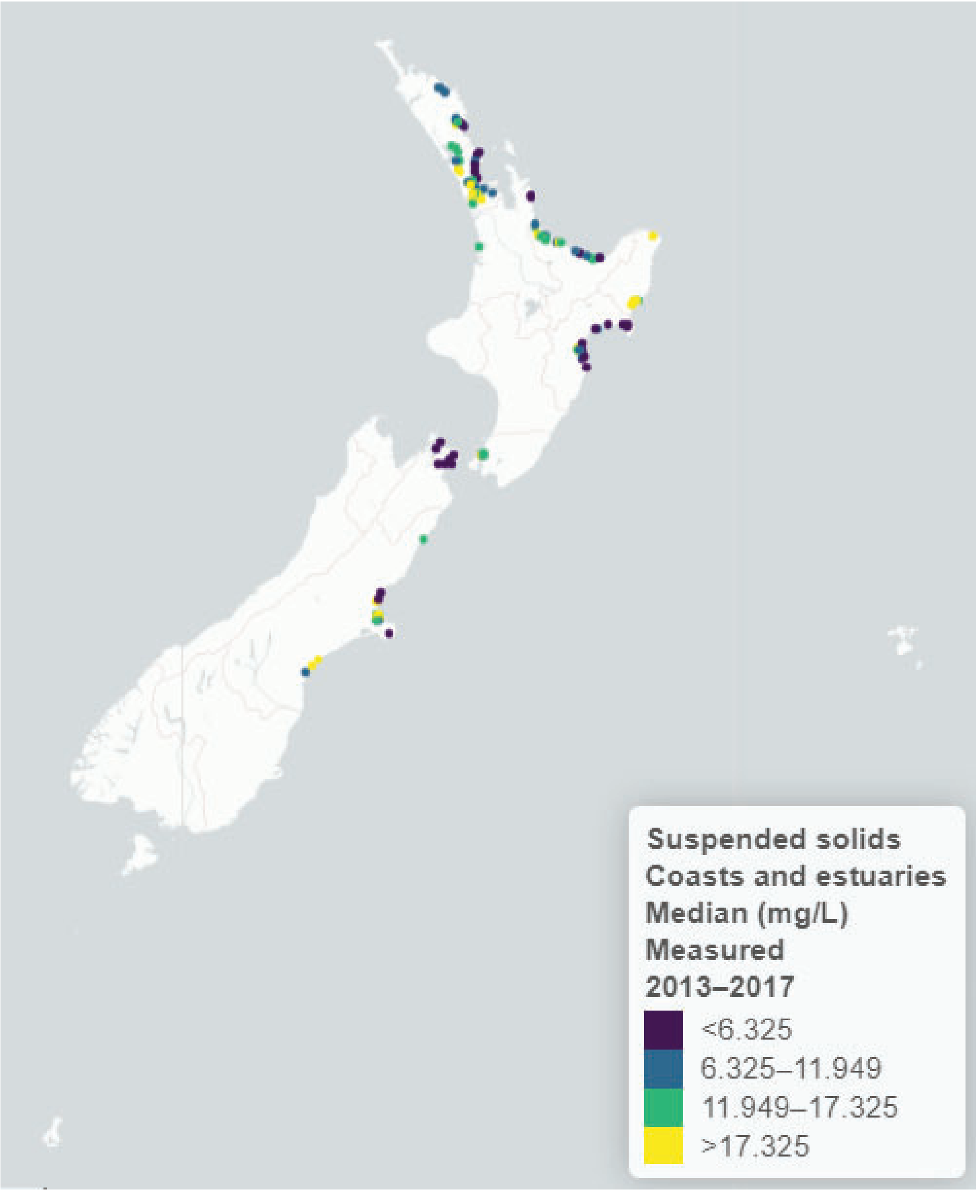

Figure 4.8: Median Values for Suspended Solids (Source: Stats NZ Tatauranga Aotearoa)

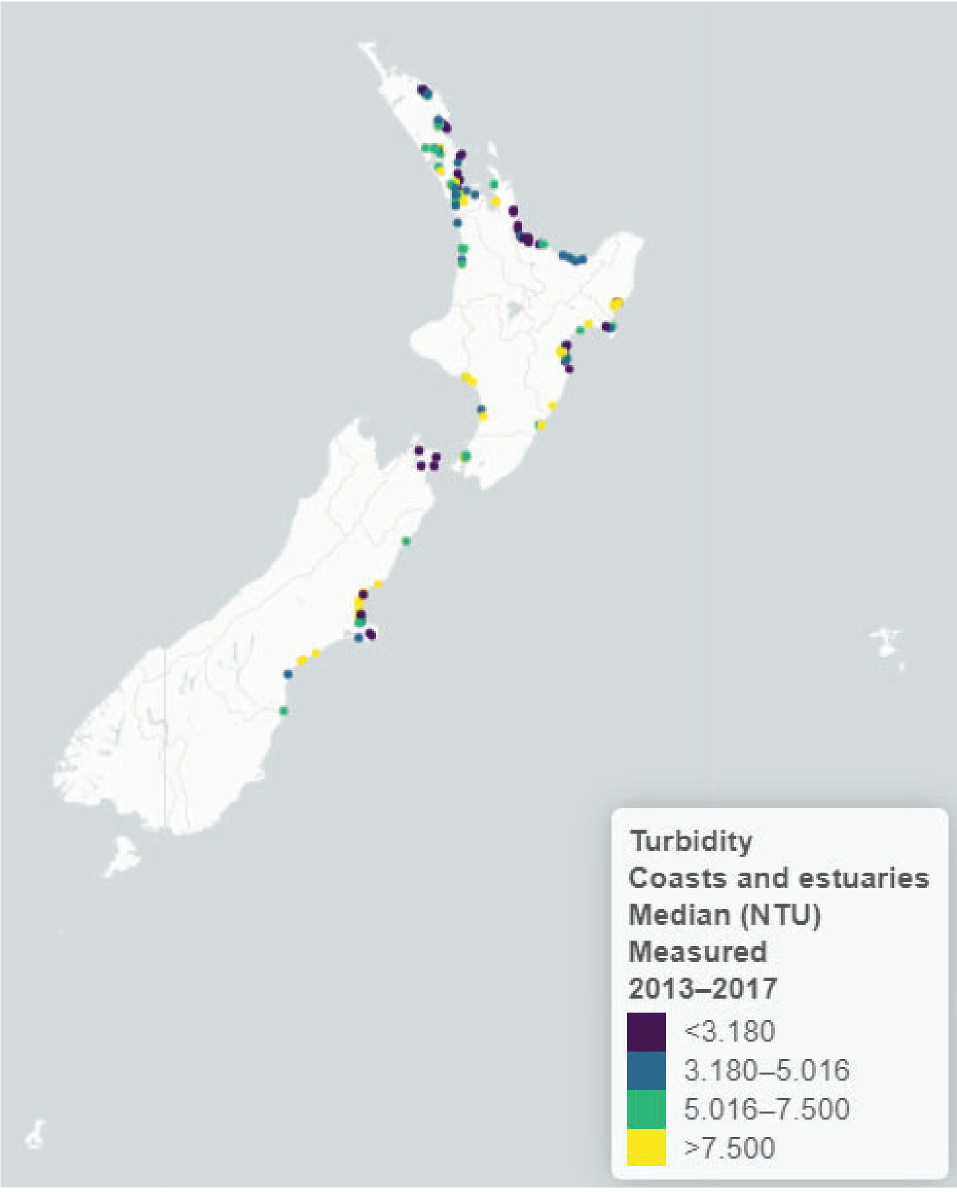

Figure 4.9: Median Values for Turbidity (Source: Stats NZ Tatauranga Aotearoa)

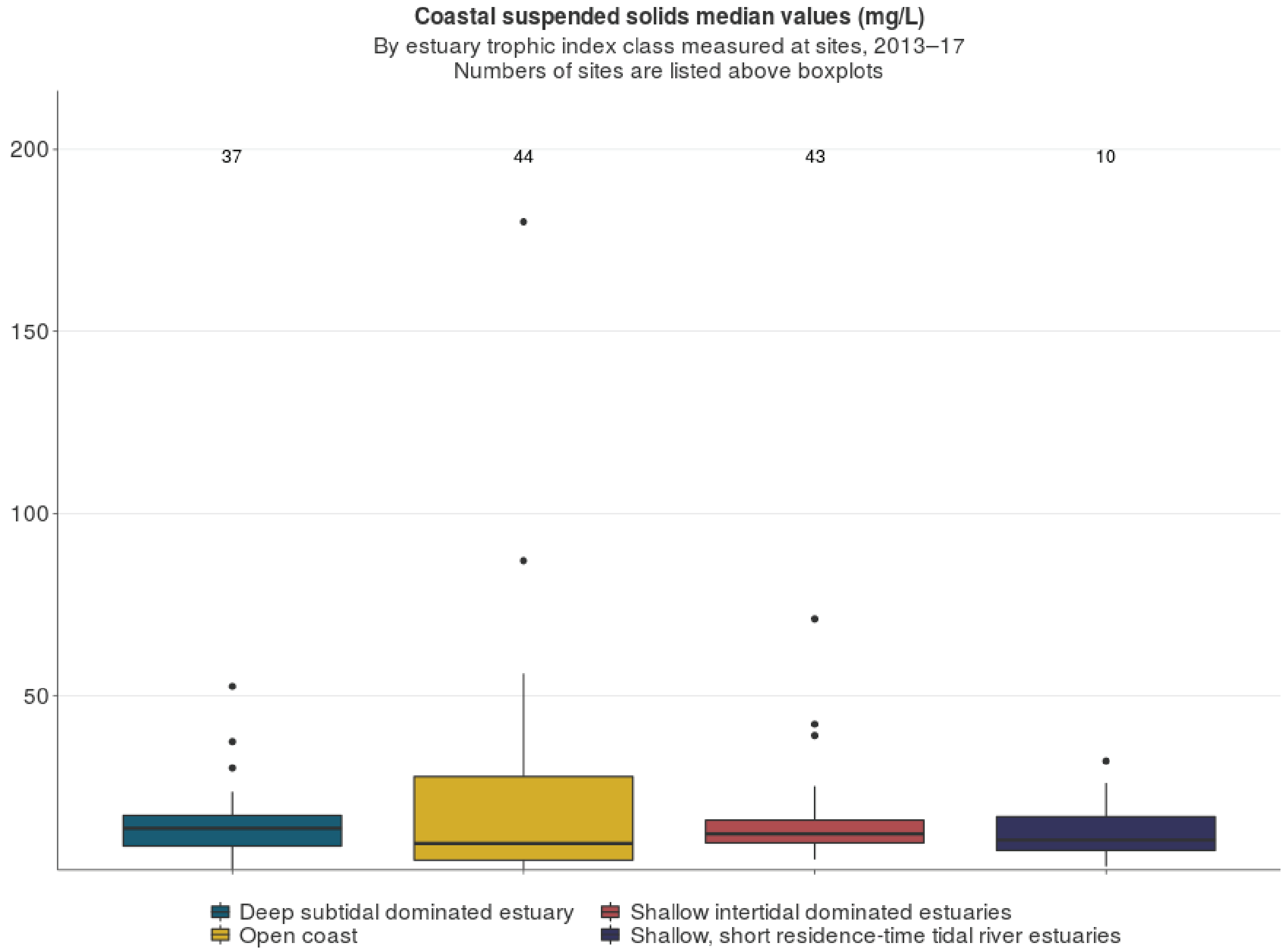

Figure 4.10: Comparison of Median Values for Suspended Solids Across Environments (Source: Stats NZ Tatauranga Aotearoa)

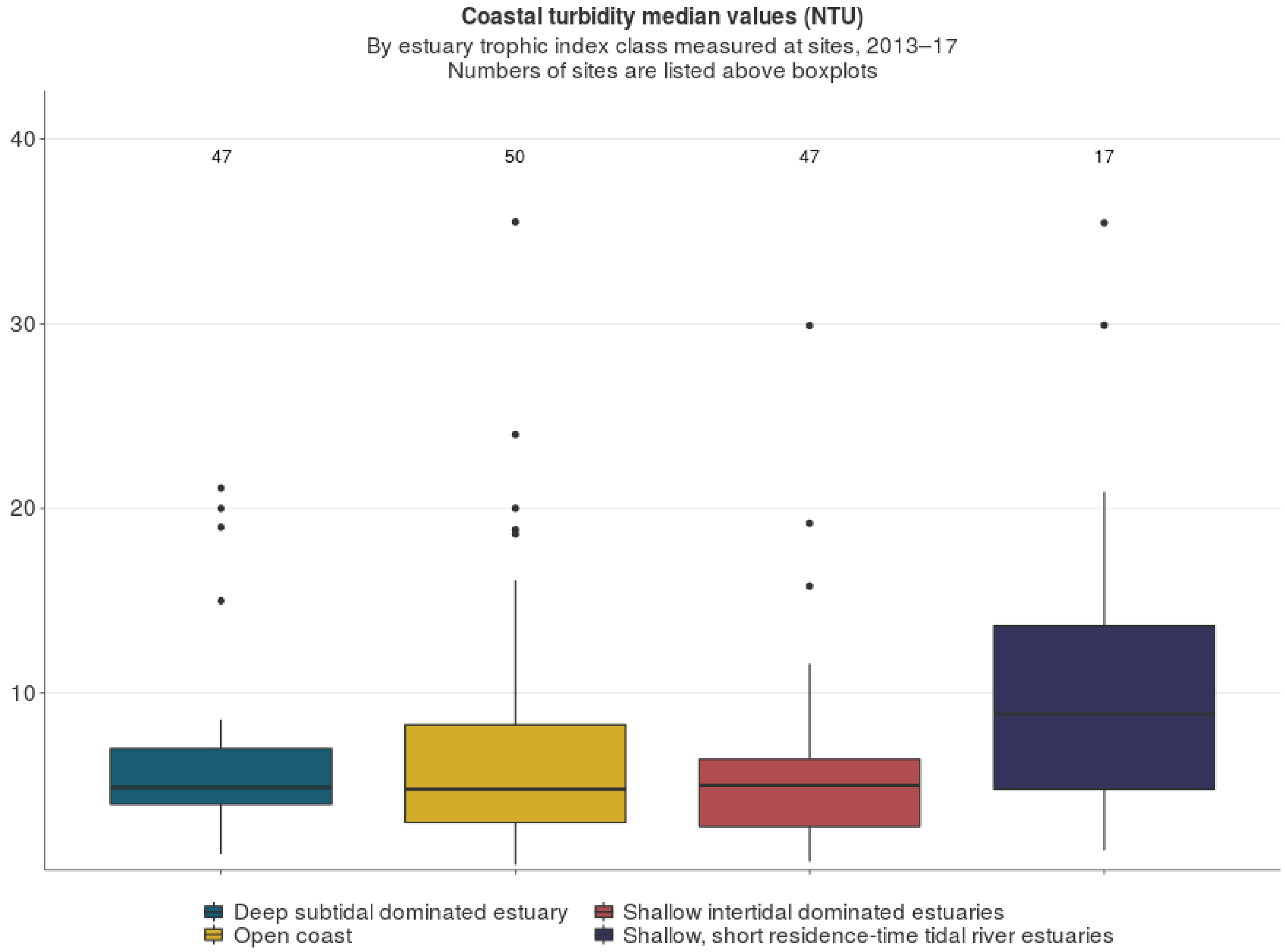

Figure 4.11: Comparison of Median Values for Turbidity Across Environments (Source: Stats NZ Tatauranga Aotearoa)

5. Dredge Plume Water Quality Sampling

This section outlines sampling undertaken on the 20th May 2019 during dredging in order to understand any water quality changes (namely TSS and turbidity) in the receiving environment that may occur as a result of the dredging activities.

5.1 Discharge Source Sampling Rationale and Methodology

As discussed in Section 3, the Coastal Carrier discharges water containing fine sediment particles from two locations, the hopper weir boards and the flume overflow (Figure 5.1). Discharges from these sources are expected to represent the highest (or worst case) TSS concentrations. Water samples were collected from the weir board only due to health and safety risks associated with accessing the end of the flume overflow. Samples were collected to understand what the highest TSS concentrations are from dredging which can then be used to compare against changes in TSS concentrations once the discharge water enters the marine environment. In addition, it can be used to compare against ambient background concentrations as discussed in Section 4.

Sampling of the source discharge overflowing the weir boards was undertaken by personnel on board the dredge vessel (‘Coastal Carrier’) on the 20th May 2019 under calm conditions. Staff were supervised from the survey vessel to ensure samples were carried out appropriately.

Figure 5.1: Hopper Weir Board (left) and Overflow Sample (right) Locations, indicated by Blue Rectangle

The sample bottle was rinsed at least three times with the sample water before a sample was taken. A total of three samples were taken from three weir board discharge locations. All samples were collected and once back on land couriered to Hill Laboratory for testing for TSS and Particle Size Distribution (PSD)

5.2 Discharge Source Results

Table 5.1 below provides a summary of the TSS results from the weir board discharges. The results as received by Hill Laboratory are provided in **Appendix B3.** As outlined in Table 5.1, weir board 1 contained the highest TSS concentration, however all results are above 100 mg/l.

Table 5.1: TSS (mg/l) Concentrations for Weir Board Sampling Locations

	Weir Board 1	Weir Board 2	Weir Board 3
TSS (mg/l)	196	118	107

Table 5.2 provides a summary of the PSD results from the weir board discharges. The results (as indicated in Table 5.2) when analysed against the Wentworth Scale indicates that the majority (60 – 85%) of material being discharged are classified as coarse silt to very fine sand.

Table 5.2: PSD Results from Weir Board Samples

Sample	PSD (Mean) µm	Percentage (%) of Silts (10.0 – 62.5 µm)	Percentage (%) of Sands (62.5 – 500 µm)
Weir Board 1	129.53	13.97	86.04
Weir Board 2	81.36	40.88	59.12
Weir Board 3	121.11	13.45	86.55

5.3 Dredge Plume Sampling Rationale and Methodology

Water quality sampling was undertaken during dredging to determine the concentration gradient over distance and depth, of TSS and turbidity from the fine sediment plume derived from water discharged from the Coastal Carrier.

Dredge plume sampling was undertaken from a survey vessel (Figure 5.2) which was positioned immediately adjacent to the point of discharge (Figure 5.3) from the ‘Coastal Carrier’ without compromising health and safety risks to personnel onboard the survey vessel. Once the survey vessel reached the point immediately adjacent to the point of discharge, the vessel dropped anchor and three water samples were taken using a Van Dorn, one each at the following depths; shallow (<1 m), mid (5 m) and bottom water (9 m), that were later analysed for TSS concentrations. At the same time a CTD cast was deployed to collect data on turbidity, temperature, dissolved oxygen, salinity, pH, PAR, conductivity and fluorescence through the water column.

Figure 5.2: Survey Vessel

Figure 5.3: First Dredge Plume Sample Point (Indicated by Blue Rectangle)

As the dredge vessel continued operations, the survey vessel maintained its anchored position directly behind the dredge vessel within the sediment plume and continued sampling (following the same methodology as above e.g. three water samples and a CTD cast) at 100 m intervals until the dredge vessel reach 1,000 m distance. The 100 m intervals were measured based on the time taken for the dredge vessel to travel 100 m at a steady 1.5 knots – approximately every two minutes. Figure 5.4 below provides an overview of the survey methodology and intervals.

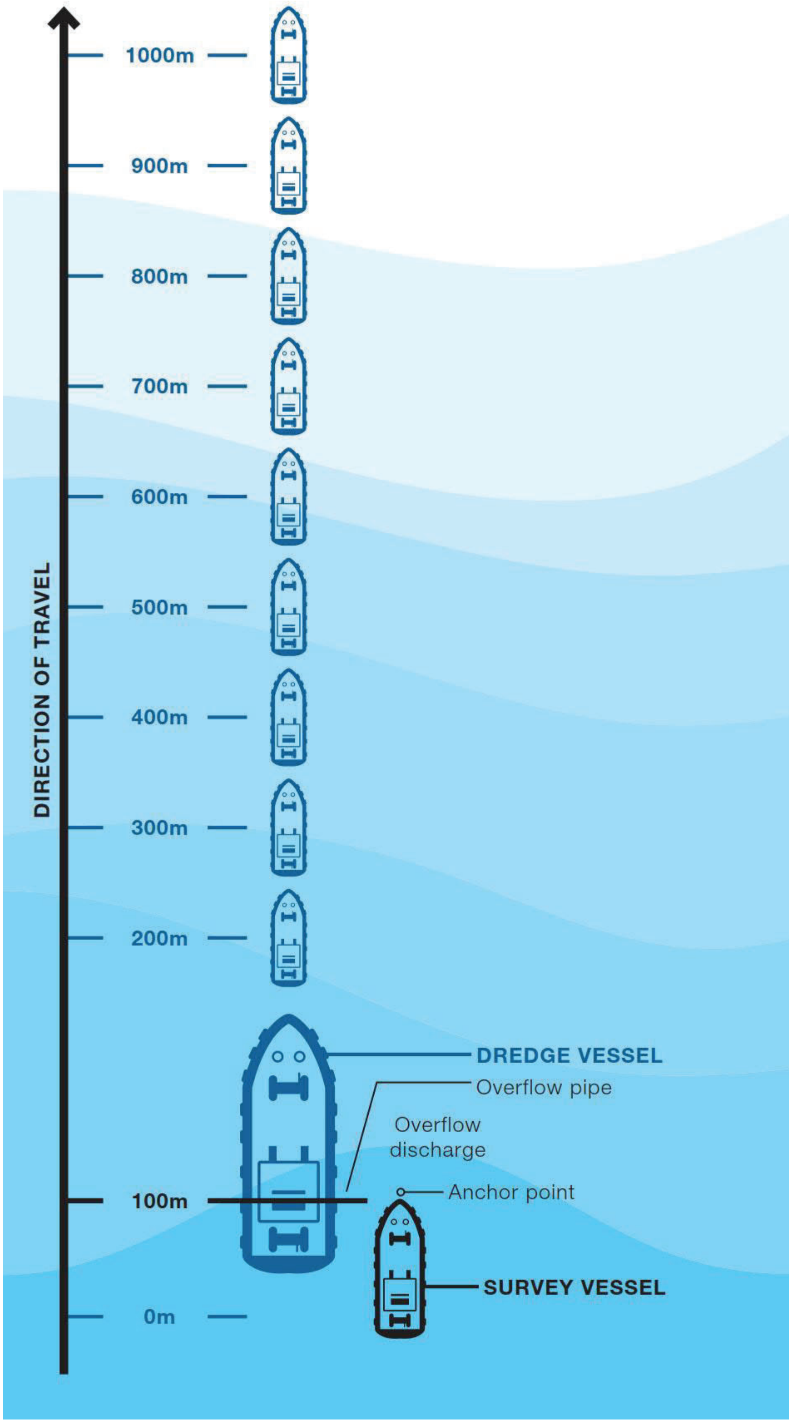

Figure 5.4: Overview of Dredge Plume Survey Methodology and Intervals

The above process was repeated for a second time, but to only a maximum distance of 200 m utilising a 50 m interval. This second round of sampling provides increased granularity of TSS and turbidity concentrations changes over 200 m.

5.4 Dredge Plume Sampling Results

All data collected from the field was stored and processed in Microsoft Excel. Results collected from the CTD Casts (used mainly for turbidity readings) was averaged relative to depth (shallow (<1 m), mid (5 m) and bottom water (9 m)), with mean values presented in the subsequent graphs in this section. TSS concentration data is presented as results received by Hill laboratory (unless otherwise stated). All results are provided in Appendix B.

The following graphs display a variety of results associated with TSS concentrations and turbidity readings. The data identified as; shallow water (<1 m), mid water (5 m) and bottom water (9 m), represent the data collected during the dredge plume sampling. This data is compared to ambient water quality data that was collected prior to the dredge plume sampling occurring and is indicated in the following graphs as; ambient -shallow water (<1 m), ambient – mid water (5 m) and ambient – bottom water (9 m).

Figure 5.5 below shows that TSS concentrations at shallow water at the point of discharge were at 3 mg/l and steadily declined back to ambient concentrations at 1.5 mg/l over the 1,000 m, with the spike at 700 m being the only anomaly. Mid water follows a similar trend to shallow water whilst bottom water follows a trend of ambient TSS concentrations at the point of discharge, increasing to approximately 3 – 4 mg/l at the 700 – 800 m point before returning close to ambient concentrations by 1,000 m. This trend is in line with the typical movement of sediment through the water column and demonstrates that TSS concentrations return to ambient by 1,000 m. From a temporal perspective, the dredge vessel depending on weather conditions travels at 1 – 1.5 knots. On the day of sampling the conditions were calm and therefore the dredge vessel was travelling at 1.5 knots (0.77 m/s). The time taken for the dredge vessel to reach 1,000 m or from the point of discharge for TSS to return to ambient concentrations is 22 minutes. In addition, whilst there are increases of TSS concentrations above the *in-situ* ambient results they are still below the TSS concentrations observed from the Stats NZ Tatauranga Aotearoa data.

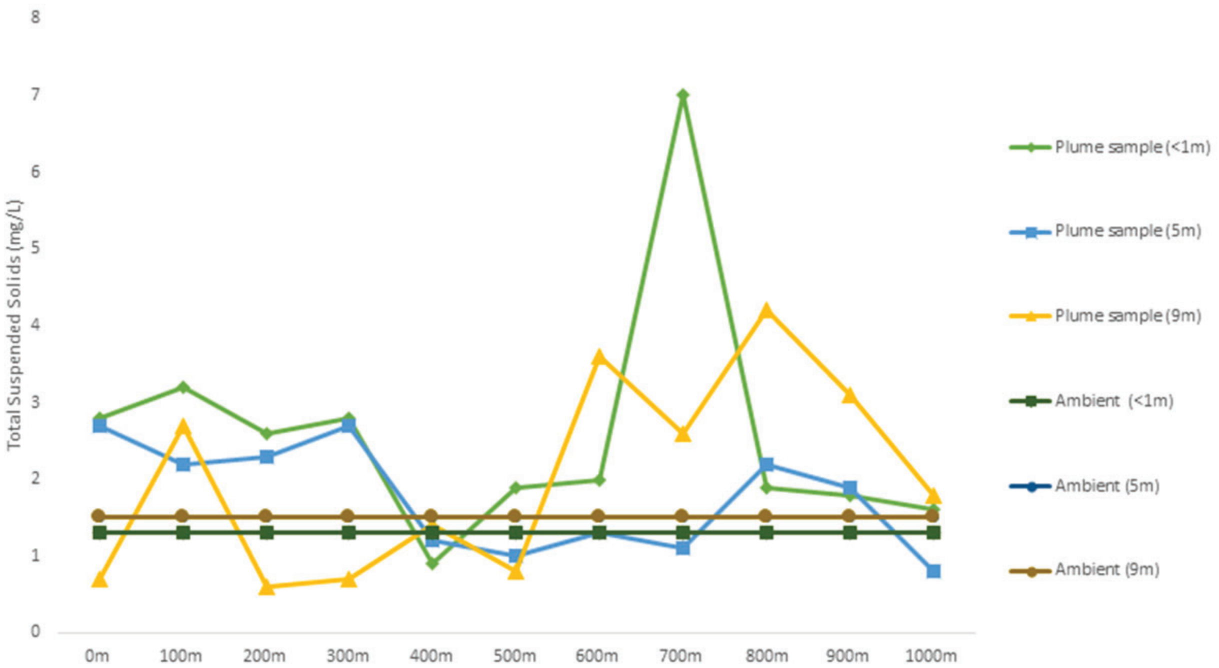

Figure 5.5: TSS (mg/l) Concentrations at 100 m Intervals from Plume Source

Note: Ambient (Mid Water) cannot be seen as it is same values as Ambient (Bottom Water)

Figure 5.6 below represents the repeat dredge plume results for TSS, based on samples being taken at 50 m intervals up to 200 m from the dredge plume source. TSS concentrations at shallow water at the point of discharge are 196 mg/l, which is the same value at the TSS concentration from the weir board discharge 1 stated in Section 5.2 above. However, the TSS concentrations decline rapidly after 50 m. Figure 5.7 provides the same data but excludes the 196 mg/l value, in order to provide a clearer picture of TSS concentrations over the remainder of the 200 m distance, and in comparison with ambient i*n-situ* sampling results. TSS concentrations in shallow water decline to 4 mg/l by 50 m and continue to decline to 1 mg/l (below ambient concentrations) by 200 m. For mid water and bottom water TSS concentrations start at approximately 2 mg/l and decline either below or close to ambient concentrations over the 200 m period. These results provide clear indication of the elevated TSS concentrations at the point of discharge but the rapid return to ambient concentrations over the 200 m distance (or four and half minutes).

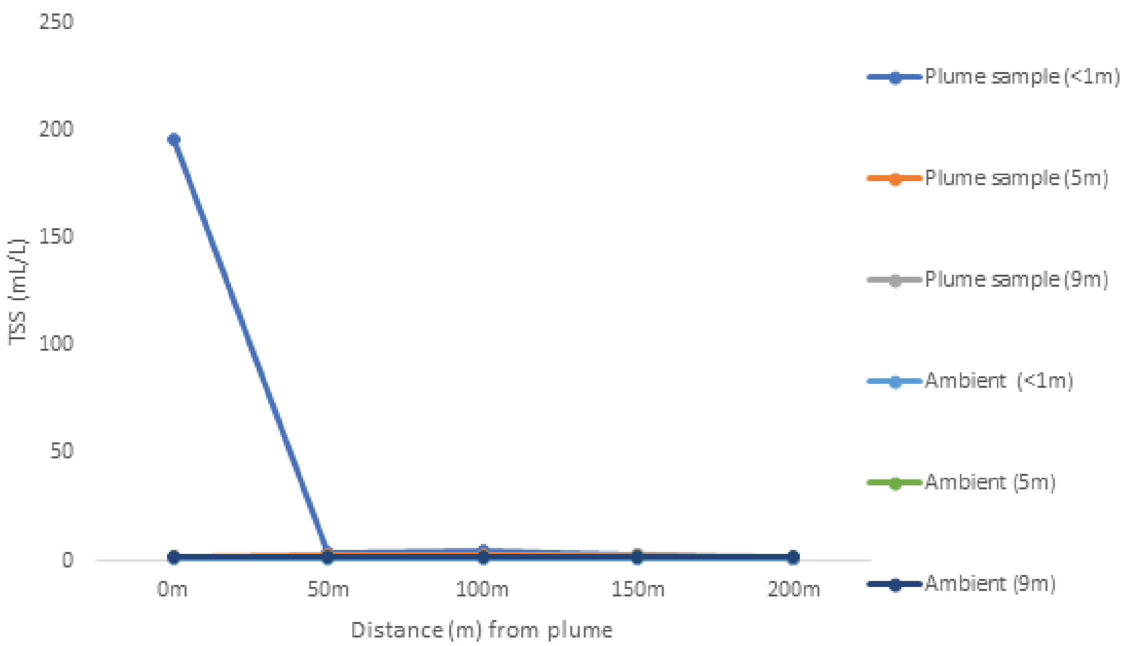

Figure 5.6: TSS (mg/l) at 50m Intervals from Plume Source

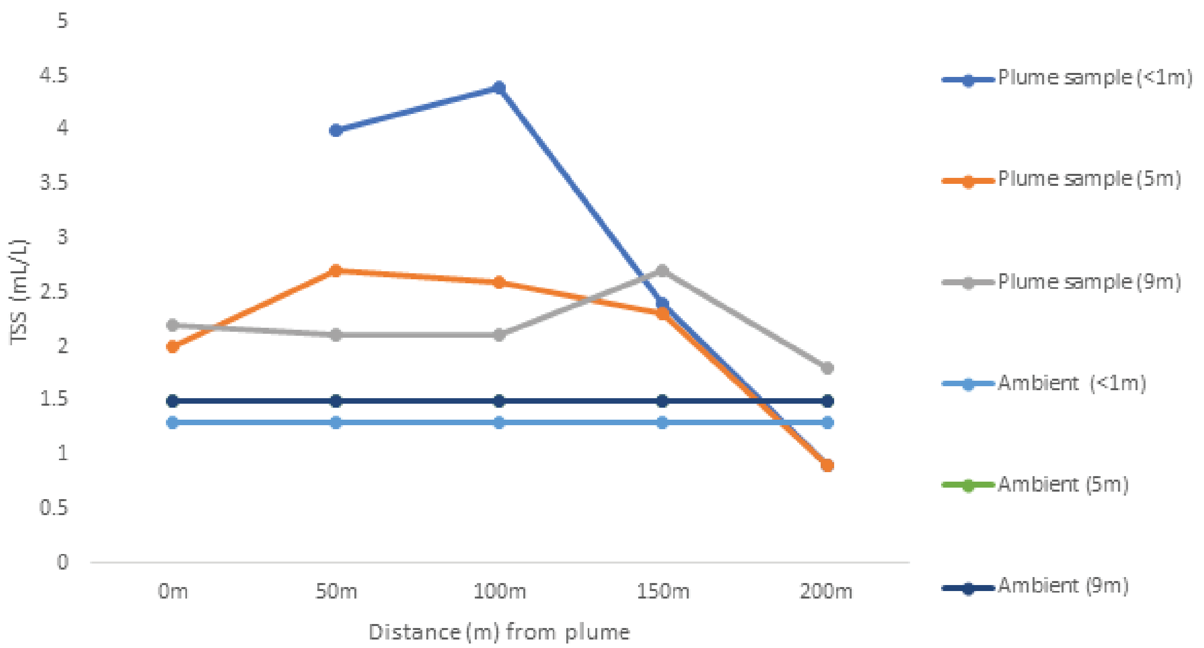

Figure 5.7: TSS (mg/l) at 50m Intervals from Plume Source

Note: Ambient (Mid Water) cannot be seen as it is same values as Ambient (Bottom Water)

Figure 5.8 below shows that turbidity values in the shallow water at the point of discharge are around 3 NTU which declined after 300 m to 1.5 NTU before increasing back to 3 NTU and declining back to ambient concentrations (1.3 NTU) at approximately 800 m. In comparison mid water and bottom water turbidity concentrations stayed at ambient concentrations across the 1,000 m apart from a small spike at mid water.

The turbidity results in line with the TSS results show an increase against ambient particularly in the shallow water and at the point of discharge however, turbidity returns to ambient concentrations within 800 m from the point of discharge or after 17 and a half minutes. In addition, whilst there are increases of turbidity concentrations above the *in-situ* ambient results they are still below the median TSS concentrations observed from the Stats NZ Tatauranga Aotearoa data which are in the range of <6.325 to >17.325.

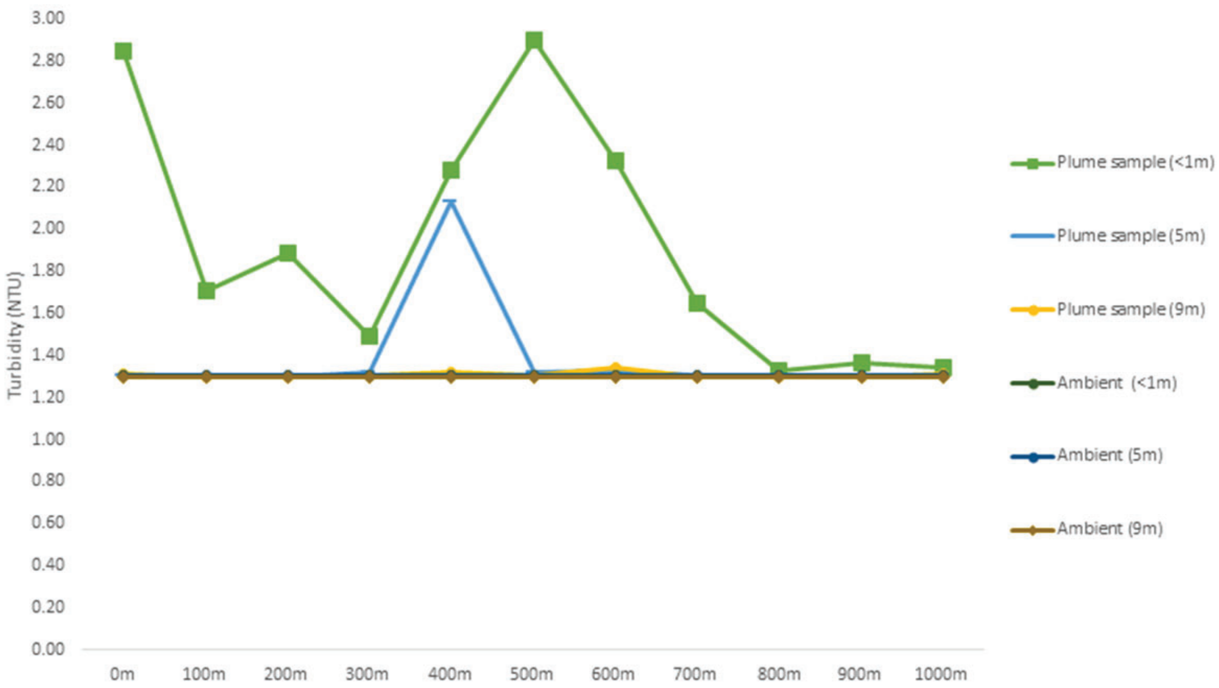

Figure 5.8: Turbidity Results at 100 m Intervals from Plume Source

Note: Ambient (Mid Water) cannot be seen as it is same values as Ambient (Bottom Water)

Figure 5.9 below represents the repeat dredge plume results for turbidity, based on samples being taken at 50 m intervals up to 200 m from the dredge plume source. Similar to TSS concentrations over the 50 m intervals, turbidity concentrations at the point of discharge were approximately 12 NTU but after 50 m had dropped to 4 NTU and after 150 m had returned to ambient turbidity concentrations. Mid water and bottom water concentrations both increase concentrations from the point of discharge up to approximately 4 NTU at 100 m but then returned to ambient concentrations at 150 m. These results provide a clear indication of the elevated turbidity concentrations at the point of discharge but the rapid return to ambient concentrations over the 200 m distance.

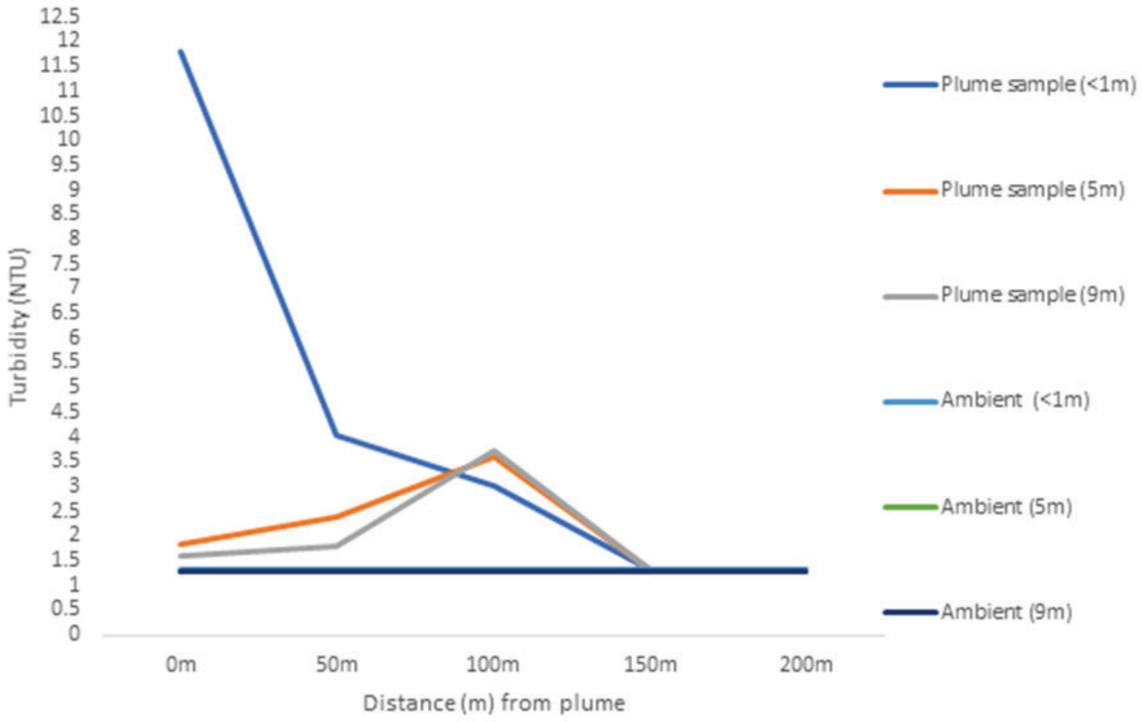

Figure 5.9: Turbidity Results at 50 m Intervals from Plume Source

Note: Ambient (Shallow and Mid Water) cannot be seen as it is same values as Ambient (Bottom Water)

6. Assessment of Effects

This section of the report outlines the assessment methodology and rationale used to assess the effects of dredge operations on water quality within and adjacent to the proposed consent area. As noted in Section 4, the key considerations for this assessment are:

- Effects of discharges of fine sediment or oversized material from dredging on ambient TSS and turbidity concentrations.

6.1 Assessment Methodology

The assessment methodology determines the sensitivity of the receiving environment, identifies potential impacts and then assesses the magnitude and overall significance of environmental impacts. Impact significance involves a process of determining the acceptability of a predicted impact.

6.1.1 Defining Effect

There are a number of ways that effects may be described and quantified. The Resource Management Act (1991) defines the meaning of effect as:

In this Act, unless the context otherwise requires, the term effect includes—

(a) any positive or adverse effect; and

(b) any temporary or permanent effect; and

(c) any past, present, or future effect; and

(d) any cumulative effect which arises over time or in combination with other effects— regardless of the scale, intensity, duration, or frequency of the effect, and also includes

(e) any potential effect of high probability; and

(f) any potential effect of low probability which has a high potential impact.

The assessment of the significance of effects and determination of residual effects takes account of any planned mitigation measures incorporated into the Project by the nature of its design.

In general terms, effect significance can be characterised as the result of the degree of change predicted (i.e. the magnitude of effect) and the value of the receptor/resource that is subjected to that change. For each impact the likely magnitude of the effect and the sensitivity of the receptor are defined. Criteria for the definition of magnitude and sensitivity are summarised below.

6.1.2 Direct vs Indirect Effects

A direct effect, or first order effect, is any change to the environment, whether adverse or beneficial, wholly or partially, resulting directly from an environmental aspect related to the project. An indirect effect may affect an environmental, social or economic component through a second order effect resulting from a direct effect.

6.1.3 Magnitude Criteria

The assessment of effect magnitude is undertaken by categorising identified effects of the Project as beneficial or adverse. Then effects are categorised as ‘major’, ‘moderate’, ‘minor’ or ‘negligible’ based on consideration of parameters such as:

- Duration of the effect – ranging from 'well into operation' to 'temporary with no detectable impact'.
- Spatial extent of the effect – for instance, within the site boundary, within district, regionally, nationally, and internationally.
- Reversibility – ranging from 'permanent thus requiring significant intervention to return to baseline' to 'no change'.
- Likelihood – ranging from 'occurring regularly under typical conditions' to 'unlikely to occur'.
- Compliance with legal standards and established professional criteria – ranging from 'substantially exceeds national standards or international guidance' to 'meets the standards' (i.e. effects are not predicted to exceed the relevant standards) presents generic criteria for determining effect magnitude (for adverse impacts). Each detailed assessment in the accompanying AEE defines the effect magnitude in relation to its environmental or social aspect.
- Any other effect characteristics of relevance.

Table 5.1 below presents generic criteria for determining effect magnitude (for adverse effects). Each detailed assessment will define effect magnitude in relation to its environmental or social aspect.

Table 6.1: General Criteria for Determining Effect Magnitude

Category	Description
Major	Fundamental change to the specific conditions assessed resulting in long term or permanent change, typically widespread in nature and requiring significant intervention to return to baseline; would violate national standards or Good International Industry Practice (GIIP) without mitigation.
Moderate	Detectable change to the specific conditions assessed resulting in non-fundamental temporary or permanent change.
Minor	Detectable but small change to the specific conditions assessed.
Negligible	No perceptible change to the specific conditions assessed.

6.1.4 Sensitivity Criteria

Sensitivity is specific to each aspect and the environmental resource or population affected, with criteria developed from baseline information. Using the baseline information, the sensitivity of the receptor is determined – factoring in proximity, number exposed, vulnerability and the presence of receptors on site or the surrounding area. Generic criteria for determining sensitivity of receptors are outlined in Table 5.2 below. Each detailed assessment will define sensitivity in relation to its environmental or social aspect.

Table 6.2: General Criteria for Determining Effect Sensitivity

Category	Description
High	Receptor (human, physical or biological) with little or no capacity to absorb proposed changes
Medium	Receptor with little capacity to absorb proposed changes
Low	Receptor with some capacity to absorb proposed changes
Negligible	Receptor with good capacity to absorb proposed changes

6.1.5 Effect Evaluation

The determination of effect significance involves making a judgment about the importance of project impacts. This is typically done at two levels:

- The significance of project effects factoring in the mitigation inherently within the design of the project; and
- The significance of project effects following the implementation of additional mitigation measures.

The effects are evaluated taking into account the interaction between the magnitude and sensitivity criteria as presented in the effect evaluation matrix in Table 5.3 below.

Table 6.3: Effect Matrix

		Magnitude			
		Major	**Moderate**	**Minor**	**Negligible**
Sensitivity	**High**	Major	Major	Moderate	Negligible
	Medium	Major	Moderate	Minor	Negligible
	Low	Moderate	Minor	Negligible	Negligible
	Negligible	Minor	Negligible	Negligible	Negligible

The objective of the accompanying AEE is to identify the likely significance of effects on the environment and values of the project area. In this effects assessment, effects determined to be 'moderate' or 'major' are deemed significant. Consequently, effects determined to be 'minor' or 'negligible' are not significant. Where impacts are determined to be significant then mitigation measures are required to reduce these effects.

6.2 Assessment of Water Quality Effects from Dredging

The results discussed in Section 5 show elevated TSS (196 mg/l) and turbidity (12 NTU) concentrations at the point of discharge that rapidly decline over 50 m back to just above ambient concentrations (TSS 4 mg/l and turbidity 4 NTU). The TSS concentrations return to ambient levels (TSS - 1.5 mg/l and turbidity 1.3 NTU) within 1,000 m (approximately 22 and a half minutes) and NTU concentrations within 800 m (approximately 17 and a half minutes) from the point of discharge. The rapid initial decline indicates that the majority of the water at the point of discharge comprises over-sized material that falls rapidly through the water column. TSS and turbidity concentrations after the initial 50 m are still just above ambient demonstrating some residual sediment fines settling through the water column over 800 to 1,000 m. The TSS and turbidity concentrations observed after 50 m are below the observed concentrations from the Stats NZ Tatauranga Aotearoa data, demonstrating they are within ranges expected of a coastal marine environment. For any discussion in relation to potential effects on benthic ecology from dredging activities, please refer to the Benthic Ecology Technical Report and main AEE report.

As outlined in the main AEE report, dredging using the Coastal Carrier will only dredge the same location up to four times per year before the annual extraction volume of 76,000 m^3 is reached. Given the infrequent level of dredging and the temporary duration and extent of the dredge plume found, there are no anticipated long-term water quality effects arising from dredging operations at Pakiri. The water quality effects are expected to be reduced further with the William Fraser as it has a greater dredge collection efficiency than the Coastal Carrier (81% versus 42% - see main AEE report) it is anticipated that a single pass per trench strip per year would be required rather than the potential four per year for the Coastal Carrier before the extraction volume of 76,000 m^3 is reached.

The dredging operations within the deeper water Kiapara Ltd offshore consent area will not occur in parallel with dredging in the current consented area as the Coastal Carrier is used to dredge both consent areas. In addition, even if dredging was to occur in parallel, due to the temporary nature and small extent of any plume generated from the current consented area, there are no anticipated cumulative effects on water quality within the area.

In line with the sensitivity criteria outlined in Table 5.2, the marine environment at Pakiri with respect to water quality can be considered to be of '*good capacity to absorb the proposed changes*' and is therefore considered to be of Negligible Sensitivity. It is evident from the results of the sampling undertaken, that the magnitude of effects from the sand extraction activity, on TSS and turbidity concentrations are Negligible as there are '*no perceptible changes to the conditions assessed'.* As such overall the overall significance of project effects on water quality is determined to be of **Negligible Significance**.

It should be noted that whilst plume sampling was only carried out with the Coastal Carrier, the William Fraser vessel contains a number of modifications compared to that of the Coastal Carrier that were specifically designed to result in less effects on the receiving environment from the sand extraction activity. The William Fraser will contain a series of six 'moon pools' which will discharge over-sized material and fines below the keel of the vessel, at least 1.5 m below the sea surface. This replaces the weir board and overflow flume discharges to the sea surface that is currently in place on the Coastal Carrier. The use of moon pools will result in less visual effects at the sea surface (for full visual effects assessments see the Visual Effects Technical Report and main AEE report), a smaller but potentially more concentrated plume footprint as sediment will be released at a point closer to the seabed. Furthermore, given the locations of the moon pools directly underneath the keel of the vessel, the majority of the sediment plume is expected to rapidly settle back into the area just dredged. Whilst the plume at the point of discharge could potentially be more concentrated, the physical properties of the sediment fines and over-sized material will remain the same and therefore it is expected that the extent of the plume and the time required to return to ambient TSS, and turbidity concentrations will not change from use of the William Fraser. As such the level of overall significance of project effects on water quality from use of the William Fraser is still determined to be of **Negligible Significance**.

7. Mitigation and Monitoring

As outlined in Section 5 of this report, the effects of the sand extraction activity on the receiving water quality parameters are considered to be of Negligible Significance. In addition, the future use of the William Fraser and the utilisation of the six moon pools is considered a significant improvement with respect to water quality. Whilst specific mitigation measures are not required to reduce potential effects, recommendations have been provided below in line with good international industry practice.

- All project associated vessels to have and implement a waste management plan compliant with the International Convention for the Prevention of Pollution from Ships (1973/1978) (Marpol 73/78) and its Annexes.
- An Oil Spill Prevention and Response Plan to be produced and implemented prior to dredging.
- All project associated vessels to work to Maritime New Zealand standards and the International Maritime Organisation (IMO) standards.
- Non-routine discharges to be kept to a minimum through the use of good practice codes on collision avoidance and vessel manoeuvring. All staff and any contractors to undertake training and maintain good housekeeping standards including appropriate occupational health and safety.

There are no additional specific monitoring recommendations for the project.

8. Conclusion

This report focused on the potential effects from the sand extraction activity on TSS and turbidity concentrations. Results from dredge plume sampling were compared to site specific *in-situ* ambient sampling results, long-term (2 month) ambient results and Auckland Council long term monitoring data at a reference site (Goat Island).

*In-situ a*mbient water quality results for TSS and turbidity are slightly higher than the long-term monitoring data from the WETlabs WQM and the Goat Island reference site. However, in the context of the New Zealand wide long-term data set for turbidity and TSS within coastal and estuarine monitoring locations (Stats NZ Tatauranga Aotearoa), both the *in-situ* and the WETlabs and the Goat Island reference site are below the median values recorded for coastal environments.

The dredge plume sampling results show elevated TSS (196 mg/l) and turbidity (12 NTU) concentrations at the point of discharge that rapidly decline over 50 m back to just above ambient concentrations (TSS 4 mg/l and turbidity 4 NTU). The TSS concentrations return to ambient levels (TSS - 1.5 mg/l and turbidity 1.3 NTU) within 1,000 m (approximately 22 and a half minutes) and NTU concentrations within 800 m (approximately 17 and a half minutes) from the point of discharge. The rapid initial decline indicates that the majority of the water at the point of discharge comprises over-sized material that falls rapidly through the water column. TSS and turbidity concentrations after the initial 50 m are still just above ambient demonstrating some residual sediment fines settling through the water column over 800 to 1,000 m. The TSS and turbidity concentrations observed after 50 m are below the observed concentrations from the Stats NZ Tatauranga Aotearoa data, demonstrating they are within ranges expected of a coastal marine environment.

In consideration of the limited temporal and spatial extent of any plume generated from dredging activities at Mangawhai-Pakiri this report has concluded that the effects to water quality from both the Coastal Carrier and William Fraser are of **Negligible Significance.**

9. References

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Auckland Council Environmental Data Portal (2019) – Goat Island @ Waterfall Bay – Water Quality Site – https://environmentauckland.org.nz/Data/Location/Summary/Location/6315/Interval/Yearly/Calendar/CALENDARYEAR/1993

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Stats NZ Tatauranga Aotearoa (2019) – Coastal and Estuarine Water Quality – https://www.stats.govt.nz/indicators/coastal-and-estuarine-water-quality

Appendix A. Sediment Quality Results and Comparison to ANZG (2018) Guidelines

Appendix B. Water Quality Results

B.1 Ambient Water Quality Results from CTD and Van Dorn

B.2 WETlabs WQM Results

B.3 Dredge Plume Sampling Results