



Manukau Harbour Port Feasibility Study

Fieldwork - Final Technical Working
Paper

Prepared for

Ministry of Transport | Te Manatū Waka

Prepared by

Tonkin & Taylor Ltd

Date

June 2024

Job Number

1018198-FR v1.0



**Together we create and
sustain a better world**

www.tonkintaylor.co.nz

Document control

Title: Manukau Harbour Port Feasibility Study					
Date	Version	Description	Prepared by:	Reviewed by:	Authorised by:
19/02/24	0.1	Fieldwork – Final Technical Working Paper (draft)	Peter Quilter	Tom Shand	Richard Reinen-Hamill
10/06/24	1.0	Fieldwork – Final Technical Working Paper (final)	Peter Quilter	Tom Shand	Richard Reinen-Hamill

Distribution:

Ministry of Transport | Te Manatū Waka

1 PDF copy

Beca

1 PDF copy

HR Wallingford

1 PDF copy

Tonkin & Taylor Ltd (FILE)

electronic copies

Table of contents

1	Introduction	1
1.1	Purpose of the document	1
2	Fieldwork overview	1
3	Fieldwork components	4
3.1	Bathymetry	4
3.2	Water levels	7
3.3	Waves	8
3.3.1	Wave buoys	8
3.3.2	Fixed camera	10
3.4	Currents	12
3.4.1	Bed mounted ADCP	12
3.4.2	Boat mounted ADCP	13
3.4.3	Drifter deployment	14
3.5	Sediment	17
3.5.1	Sampling	17
3.5.2	Laboratory testing	18
3.6	Suspended sediment	22
4	Applicability	24
Appendix A	Bathymetric survey	
Appendix B	Water levels	
Appendix C	Wave buoy data	
Appendix D	Current data	
Appendix E	Sediment data	

1 Introduction

Te Manatū Waka / the New Zealand Ministry of Transport has appointed Tonkin & Taylor Ltd and their subconsultants (Royal HaskoningDHV, MetOcean Solutions, Pacific Marine Management, the University of Auckland, Discovery Marine Limited, and RMA Science) to undertake a feasibility study to understand whether it would be technically possible to locate a port in the Manukau Harbour from a navigation and operational reliability perspective.

The Manukau Harbour has previously been identified as a potential port location, however there are unanswered questions around the technical feasibility of this given the complex and dynamic nature of the harbour entrance along with other factors associated with greenfield port development. This is an engineering study, and environmental, social, and economic factors are not part of the current scope of work.

1.1 Purpose of the document

This report has been prepared by Tonkin & Taylor Ltd and provides a summary of fieldwork and associated factual reporting undertaken in conjunction with the Manukau Harbour Port Feasibility study.

2 Fieldwork overview

A wide range of fieldwork data collection was undertaken to support this study which is summarised in Figure 2-1 and Table 2-1. More detailed information is included in the sections that follow.

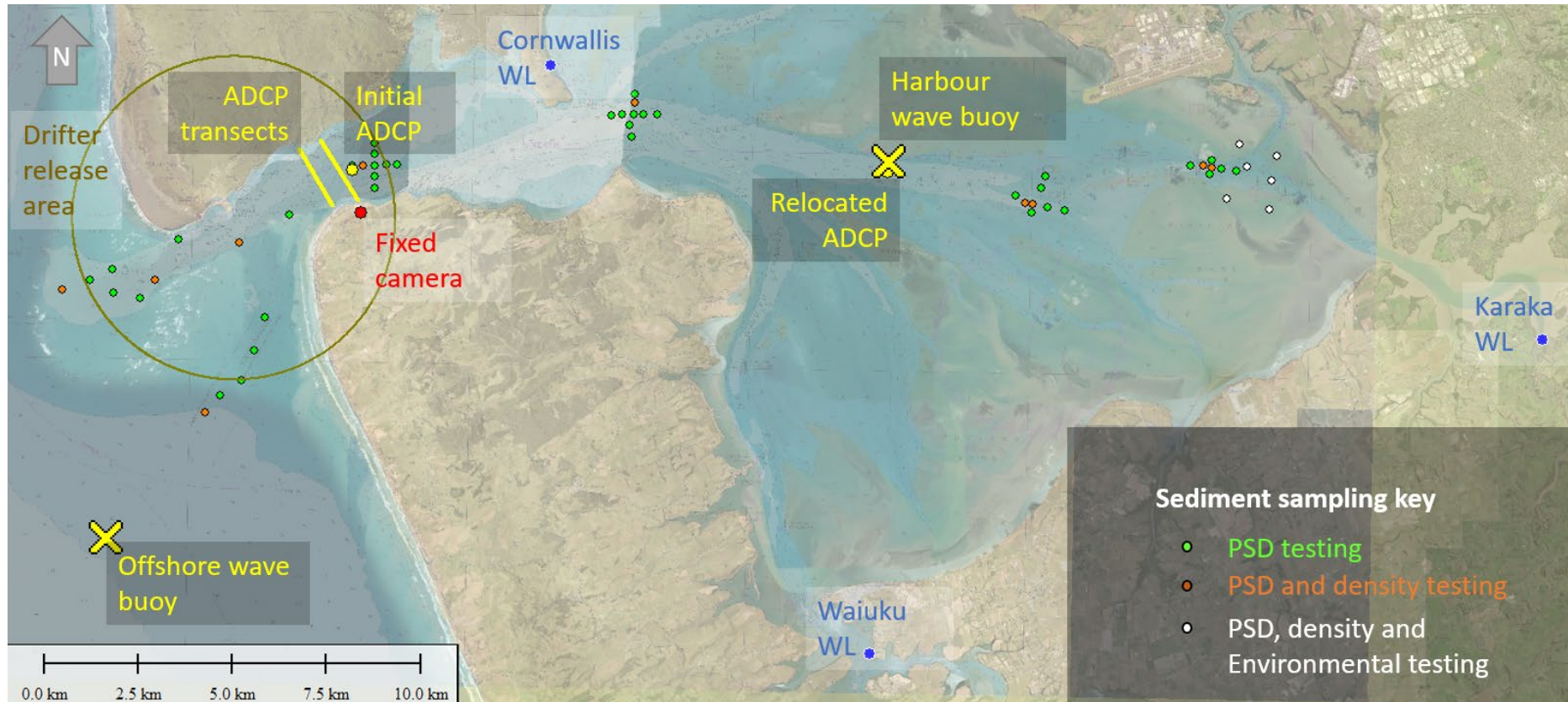


Figure 2-1: Overview of field investigations (extent of bathymetric survey shown separately in Figure 3-1)

Table 2-1: Fieldwork data collection overview

Section	Data collection	Data use	Completed scope	Deployment/survey details			Total deployment
				Deployment/survey 1	Deployment/survey 2	Deployment/survey 3	
3.1	Bathymetry	Provide a contemporary surface of the seafloor over the study area for use in the numerical models and for the navigation channel design	Inner harbour single beam echosounder	25/05/23 – 27/05/23			3 days
			Open coast single beam echosounder	08/06/23 – 11/06/23			4 days
			Pressure transducer dipping to fill data gaps from the vessel soundings	26/06/2023			1 day
3.2	Water levels	Calibration/verification data for the numerical modelling	Bed mounted ADCP in the inner harbour used to measure currents but can also retrieve water level	24/03/2023 - 25/03/2023	13/04/2023 - 10/06/2023		60 days
			Pressure transducer deployed at Waiuku	24/03/2023 - 17/07/2023			3 months
			Pressure transducer deployed at Karaka	Equipment missing	1/07/2023 - 17/07/2023		2 weeks
			Pressure transducer deployed at Cornwallis	24/03/2023 – 18/07/2023			3 months
3.3	Waves	Calibration/verification data for the numerical modelling	Wave buoy deployed offshore	24/03/2023 - 28/03/2023	13/04/2023 - 21/05/2023	10/06/2023 - 3/08/2023	2 months
			Inner harbour wave buoy deployed in the inner harbour	24/03/2023 -13/04/2023	25/05/23 – 1/11/23		5 months
		Characterise wave breaking across the bar and general observation	Fixed camera located on South Head observing the harbour entrance	29/03/2023 – 1/11/23			7 months
3.4	Currents	Calibration/verification data for the numerical modelling	Bed mounted ADCP	24/03/2023 - 25/03/2023			2 days
			Boat mounted ADCP in the harbour entrance collecting hourly measurements for 13 hrs over a spring tide	28/03/2023			1 day
			5 x drifter deployments on incoming and outgoing tides	10/06/2023 – 12/06/2023			1 day
3.5	Sediment	Input to numerical modelling and dredge assumptions	57 particle size distribution tests	24/03/2023 – 25/03/2023	25/05/2023		n/a
			15 sediment density tests	24/03/2023 – 25/03/2023	25/05/2023		n/a
		Visual to support physical testing	Macrophotography of sediment samples	24/03/2023 – 25/03/2023	25/05/2023		n/a
		Input to dredge assumptions	Contaminant testing of 6 sediment samples	26/05/2023			n/a
3.6	Suspended sediment	To validate sediment transport modelling parameters	Water column sampling device deployed on the open coast to measure sediment flux using catch device	1/11/2023			1 day

3 Fieldwork components

3.1 Bathymetry

Discovery Marine Ltd (DML) was engaged to undertake hydrographic survey using a single beam echo sounder across the study area. This information was collected to enable the development of a bathymetric model that reflects present day conditions, primarily for the purposes of hydrodynamic modelling, navigation channel design and dredge volume calculations.

Survey of the inner Harbour was undertaken using a 7.7 m alloy vessel, mounted with a single beam echo sounder in late May 2023, and outer Harbour over the bar in early June 2023 during calm conditions. Extents for the survey are shown in Figure 3-1. The DML report that documents this work is included in Appendix A.

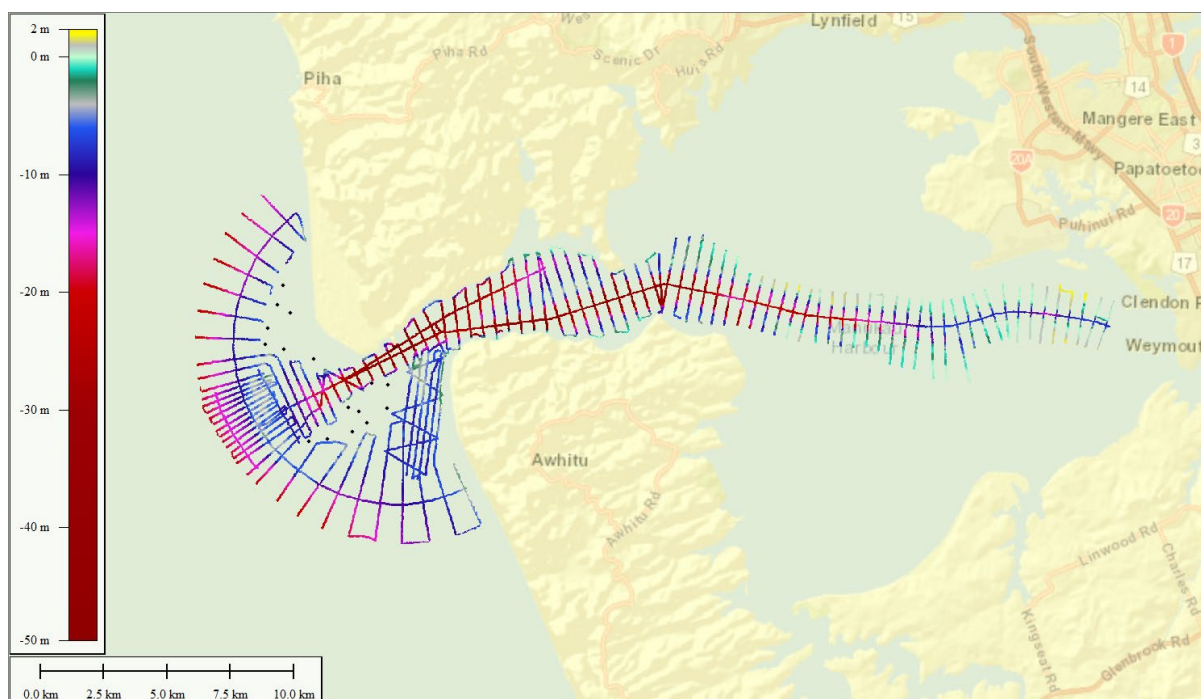


Figure 3-1: Coloured lines indicate the path of the single beam echo sounder survey. Black dots show where point measurement using a pressure transducer dipped from a helicopter have been undertaken to supplement the surveyed area.

Wave breaking in shallow water prevented survey of some areas by boat. To infill these areas, helicopter dipping with a pressure transducer was undertaken in spot locations on 26 June 2023. The methodology for this is shown in Figure 3-2, pictures taken during deployment are provided in Figure 3-3 and the flight path shown in Figure 3-4.

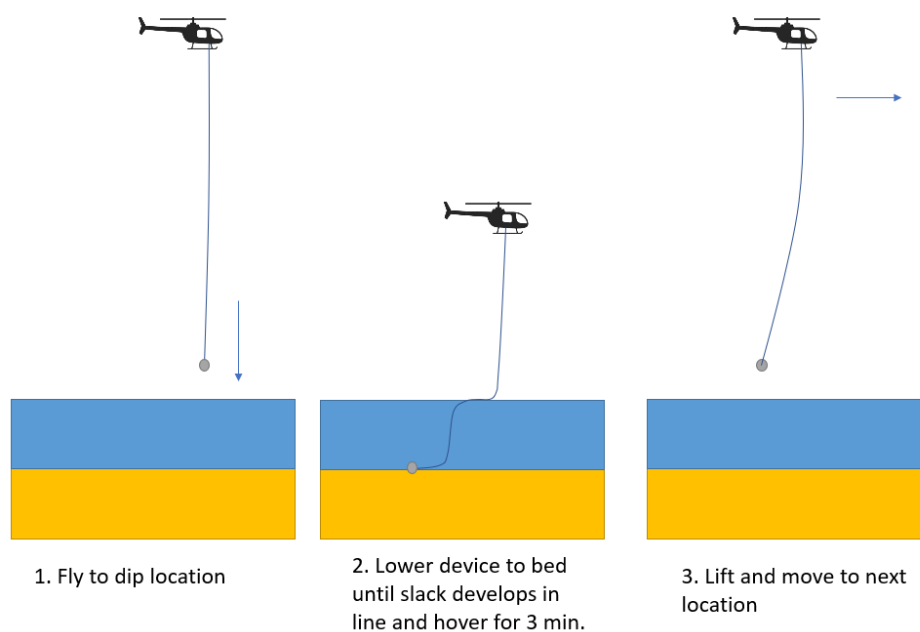


Figure 3-2: Helicopter dipping.

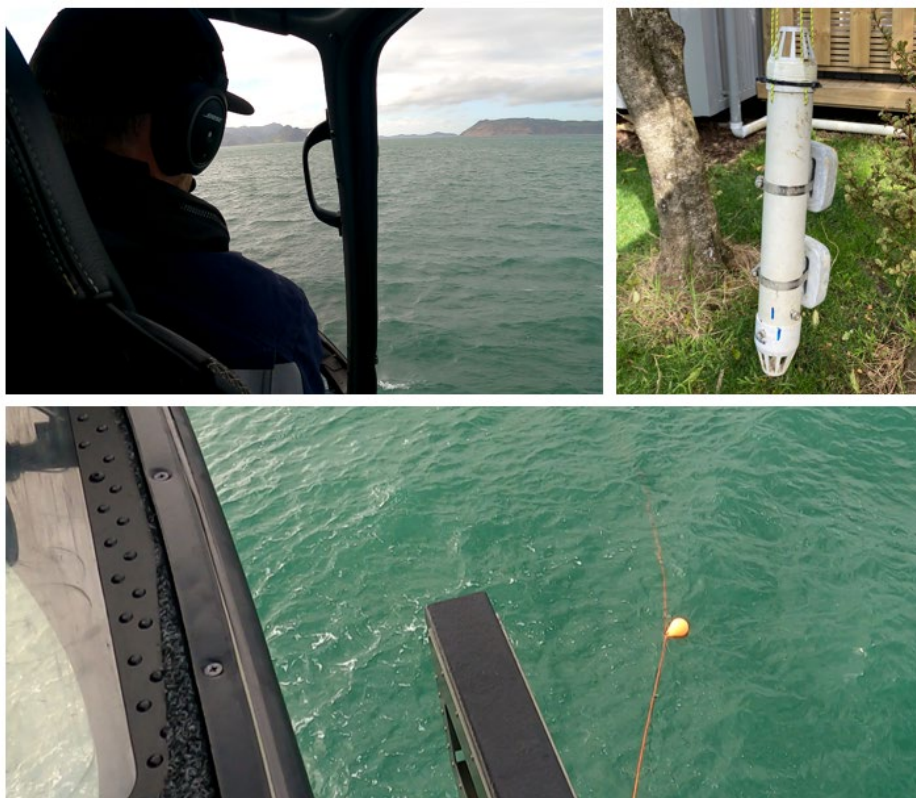


Figure 3-3: Helicopter dipping. Top left = pilot hovering helicopter in fixed position. Top right = pendulum weighted enclosure containing pressure sensors. Lower image = float positioned approximately midway along line (top half slack out of view beneath the helicopter) to serve as a visual aid for the pilot whilst hovering during the dip duration.

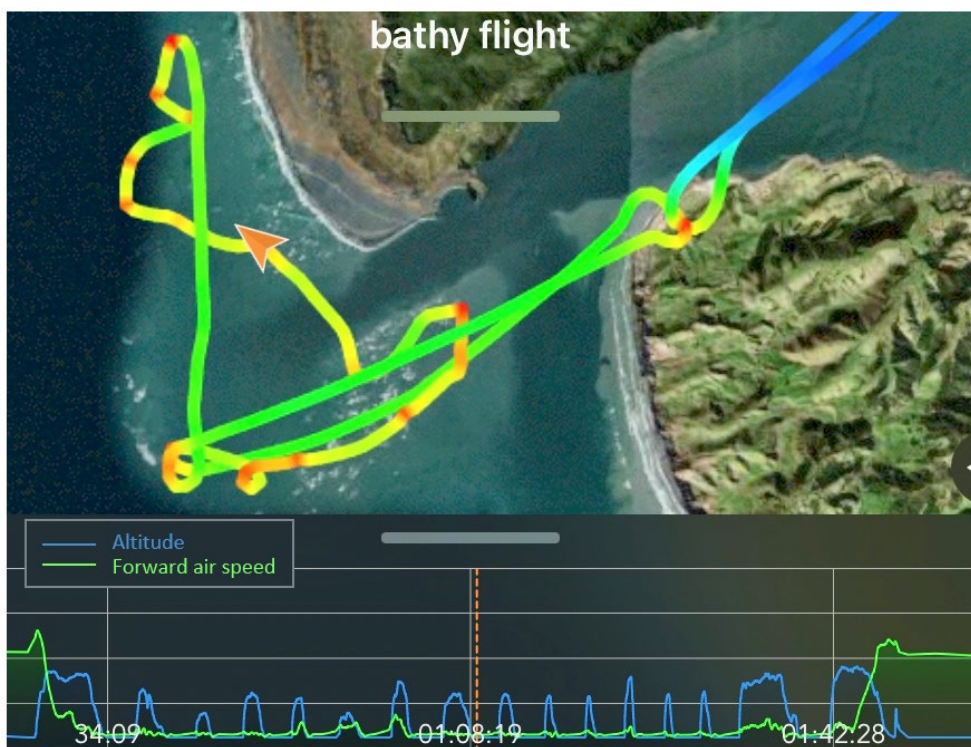


Figure 3-4: Image shows helicopter moving from one location to the next, periodically reducing altitude and hovering in position while water levels were measured. Note an additional flight was undertaken to measure depths on the south bank.

Depths were calculated by time-averaging water levels recorded at a frequency of 8 Hz for the duration of the dip, not less than two minutes. Depths were derived from pressure measurements using a hydrostatic equation, assuming a density of saltwater of 1.03 g/cm^3 and an atmospheric pressure of 10.1324 dbar. Example output data is shown in Figure 3-5.

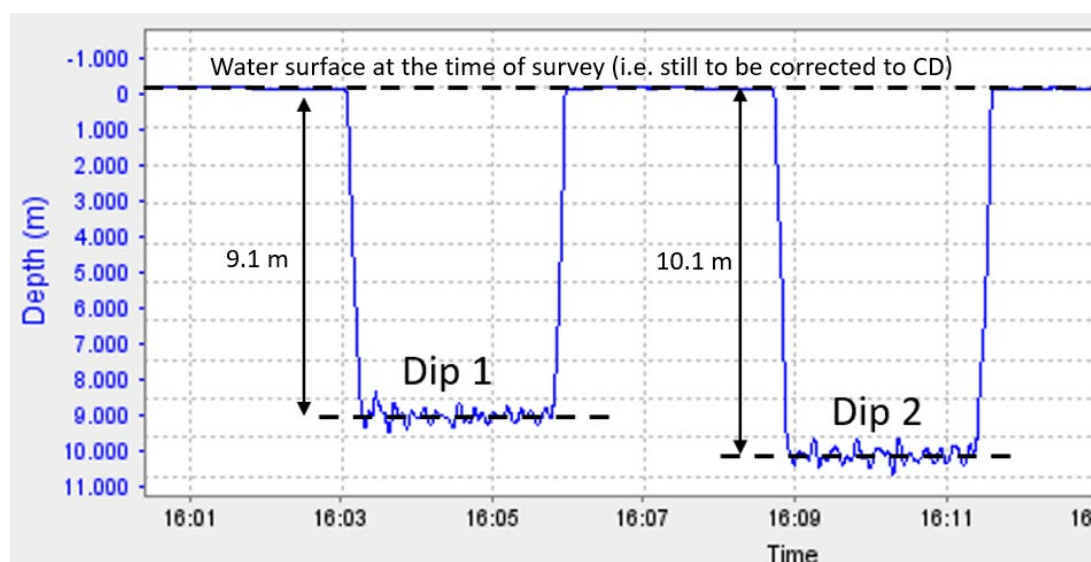


Figure 3-5: Example of pressure transducer data.

Water depths were measured using the pressure transducers at the location of a control point (NZTM long 1729580.109, lat 5895207.099) previously surveyed by DML at -6.8 m CD Onehunga, to reduce water depth measurements to bed-level measurements. Control point measurements were undertaken on three occasions to characterise tidal water level change over the duration of the dipping measurements (Figure 3-6). Corrected depths are also therefore in m CD Onehunga. The accuracy of control point measurements was assessed by comparing changes in water levels between control point dip measurements and measurements of water level change at the Paratutae gauge (refer Appendix A). This indicates an accuracy of measurement in the order of ± 0.1 m.

Linearly interpolated corrections for tide applied to dip measurements between control point dips differ from changes in the true tidal waveform. The resulting potential exists for overestimation of water depth up to 0.1 m. The horizontal accuracy of the onboard Cabri G2 GPS has been taken as ± 10 m. Placement of the pressure transducer is located within ± 20 m of the hover location. Overall horizontal accuracy is therefore taken as ± 30 m.

An overall error in bathymetric measurement by helicopter dipping is therefore estimated to be $+0.2$ m to -0.1 m.

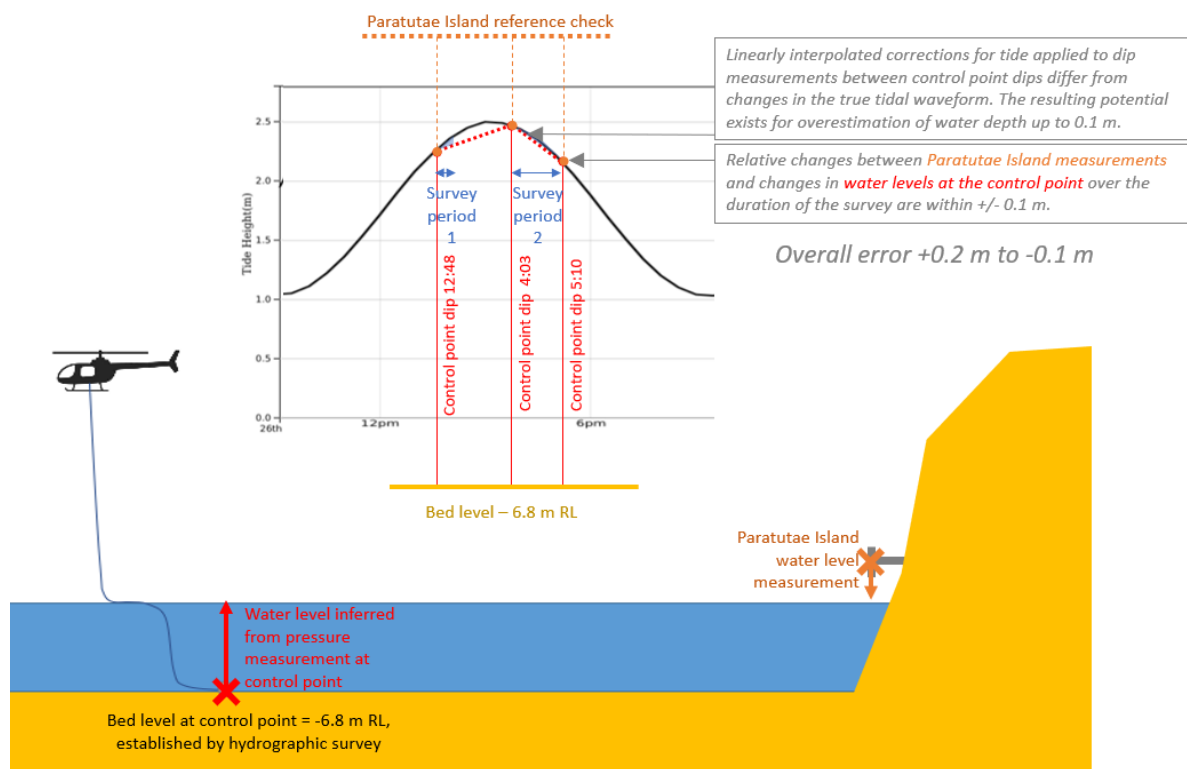


Figure 3-6: Errors associated with bathymetric dipping.

Accuracy of dipping measurements has been assessed by comparing the relative change in water levels at the control point location, to water level changes measured at Paratutae Island.

3.2 Water levels

Pressure transducers were deployed in three locations around the perimeter of the harbour at the locations shown in Figure 3-7 to ensure a range of locations to validate and calibrate a hydrodynamic model. Water level measurements were undertaken at 1 minute time intervals and deployed for up to a 3-month duration. Vertical datum calibration will be undertaken through the deduction of Mean Sea Level. Additionally, the level of instrumentation relative to adjacent structures has been documented as part of the installation.

Waiuku and Cornwallis measurements were undertaken in NZ Daylight Time (NZDT, UTC+13), and Karaka in NZ Standard Time (NZST, UTC+12). Sample output data is provided in Appendix B.

Mid-way through the deployment period the pressure transducer in Karaka was removed from the site through unknown circumstances. A second pressure transducer was deployed between 1 July and 17 July in a similar position.



Figure 3-7: Water level measurement – deployment locations.

3.3 Waves

3.3.1 Wave buoys

Wave buoys were deployed outside the Manukau Bar in 30 m of water for six months, and inside the Manukau Harbour in 10 m of water for three months as shown in Figure 3-8.



Figure 3-8: Locations of wave buoys and fixed camera observing wave breaking over the Bar.

Both wave buoys were connected to a catenary mooring system as per the manufacturer’s specifications. This involved an anchored mooring leading up to a large float (left float in Figure 3-9) connected to a secondary float that isolates the wave buoy (right float in Figure 3-9) at the end of this system from tension in the mooring line.

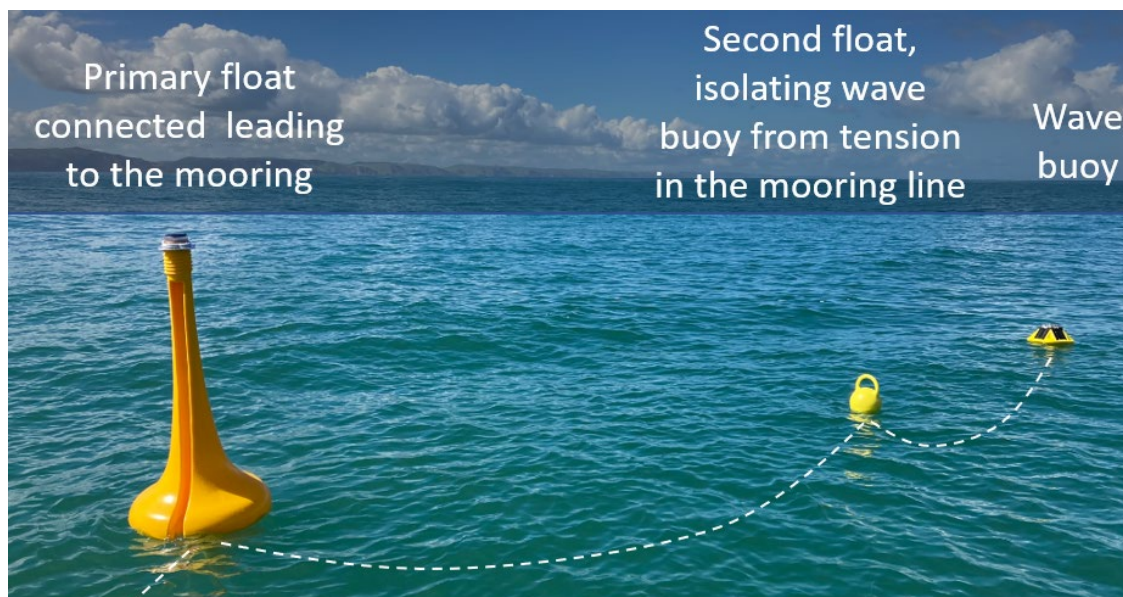


Figure 3-9: Catenary mooring system for the wave buoys.

An Obscape OBS-Buoy 400 was deployed at the offshore location to measure both swell and wind waves. A SofarOcean Spotter buoy was deployed at the inner harbour location to characterise wind waves generated within the Manukau Harbour. Both buoys had a fixed sampling interval of 30 minutes. Example data outputs are provided in Figure 3-10 for the harbour buoy and Figure 3-11 for the offshore buoy, also presented in Appendix C.

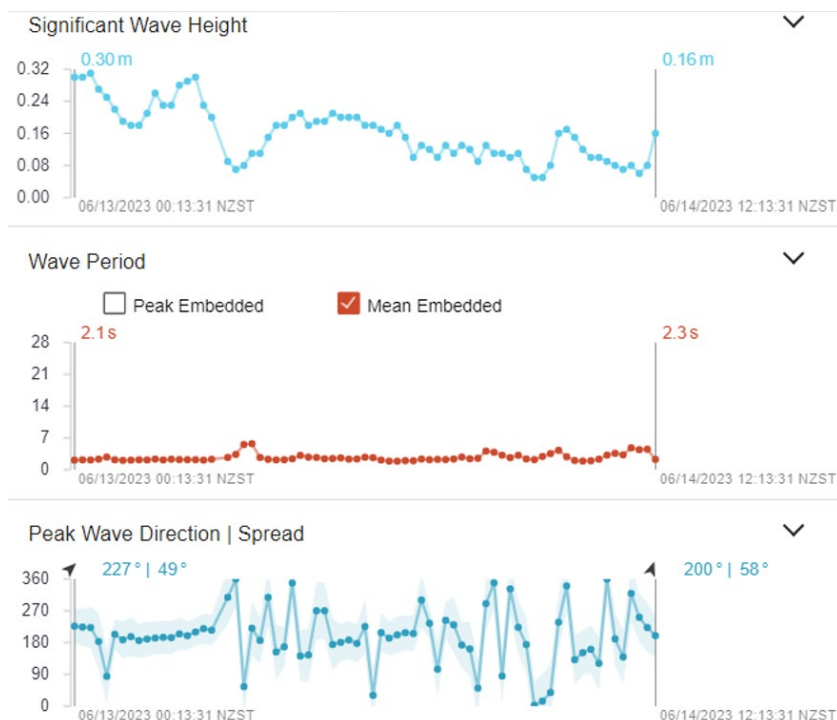


Figure 3-10: Sample of data collected from the harbour wave buoy between 13 and 14 June 2023.

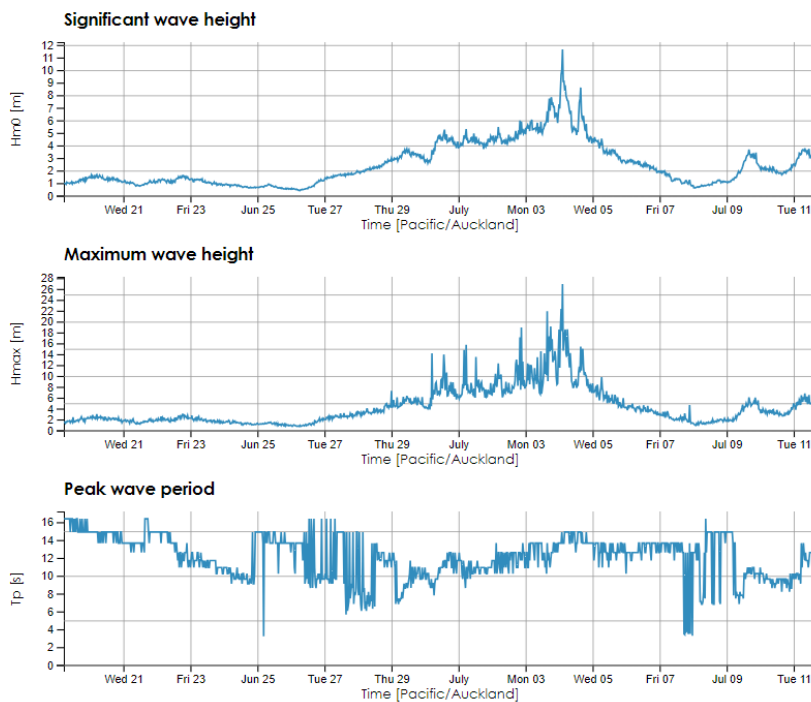


Figure 3-11: Sample of data collected from the offshore wave buoy between 21 June and 11 July 2023.

Various independent validation studies have been undertaken on the equipment used for this deployment and this information is summarised in Table 3-1.

Table 3-1: Root-Mean Square Errors of wave buoy equipment sourced from independent studies

Bulk wave parameters	Root mean square error	
	Offshore buoy	Harbour buoy
Wave Height	0.1 m (H_{m0})	0.1 m (H_{sig})
Peak Period	1.3 sec	1.7 sec
Mean Direction	19 deg	22 deg

Equipment failure of the offshore wave buoy on two occasions required several additional redeployments which required settled weather conditions, resulting in data not being measured during these times.

During higher energy wave conditions, particularly when wave heights exceeded 4 m, measurements appeared 'spiky' and considered questionably high. These measurements are considered to be an overestimation of wave conditions at this time (i.e. biased high) due to the catenary mooring becoming fully extended, which reduced the ability of the mooring lines to dampen restraint between mooring ballast and the wave buoy. Care needs to be taken for model calibration when considering large wave heights in field data.

3.3.2 Fixed camera

As shown in Figure 3-12 the fixed camera was installed close to the lighthouse on South Head. Images were taken each second for the first 15 minutes of every hour. Pixel resolution in images measured 3904 W x 2200 H.

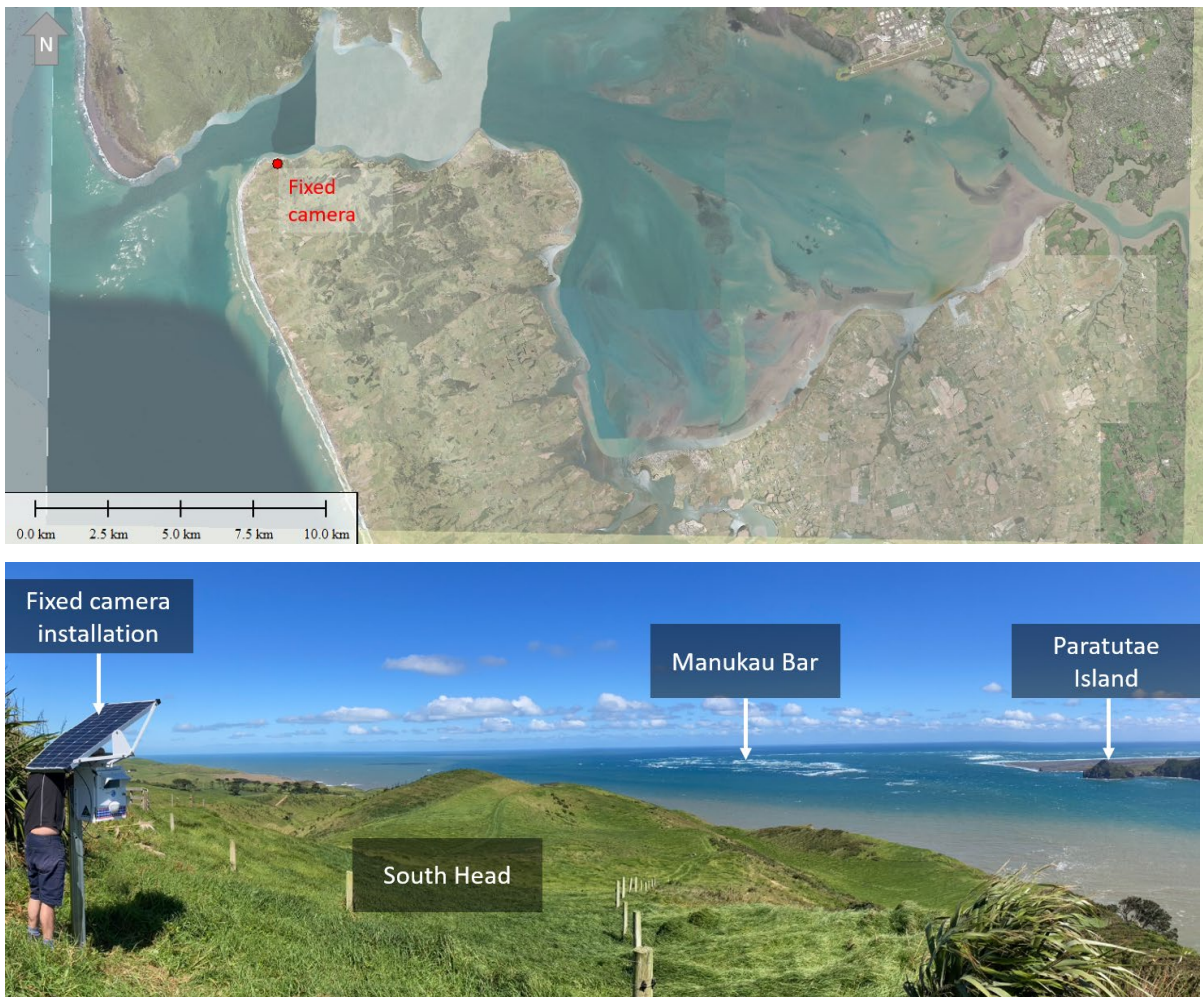


Figure 3-12: Still camera placement location on South Head.

On 10 July 2023 the GPS track of a boat encircling the Manukau Bar was recorded and select way points recorded (shown indicatively as red dots in Figure 3-13) for later use in the georeferencing of still images.

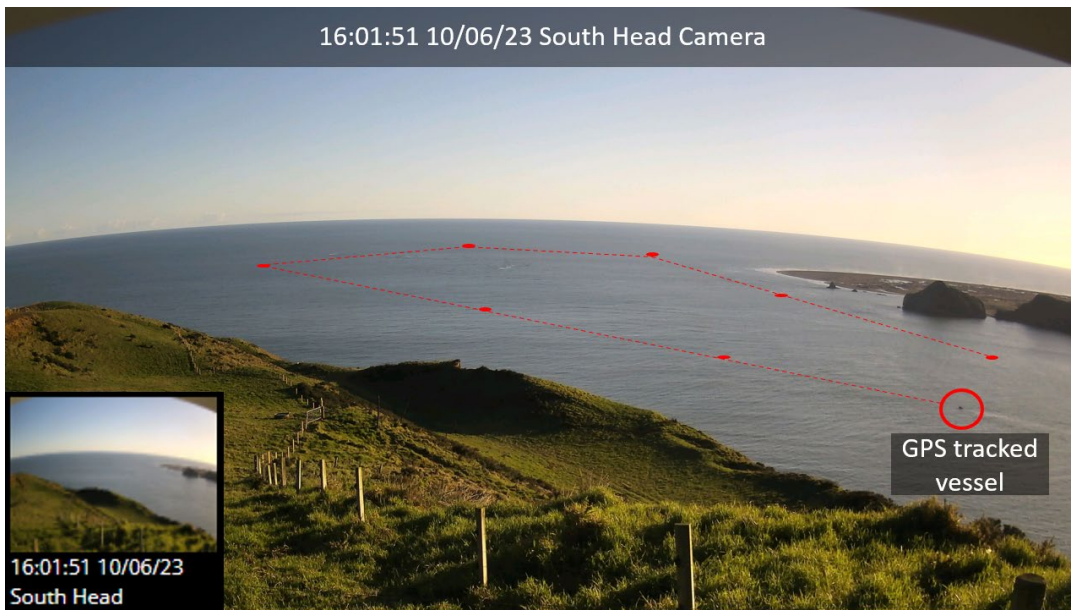


Figure 3-13: Georeferencing of still imagery.

3.4 Currents

3.4.1 Bed mounted ADCP

A bed mounted ADCP was deployed in two subtidal locations as shown in Figure 3-14.



Figure 3-14: Current measurement locations.

A bed mounted ADCP was initially deployed in the centre of the channel entrance for a period of 24 hours at a depth of approximately 15m. Multibeam in this area detected large sandy bed forms that exceeded the height of the equipment raising the possibility this equipment would be buried. Part way through the brief deployment, it appears the instrument was buried. Velocity measurements ceased at this time and a tilt in the device of around 5 degrees was detected. Following reversal of tidal currents, tilt measurements indicated the device re-levelled and current measurements resumed. Current measurements from this initial deployment are provided in Table 3-2. The instrument detects the height of water above it and uses that information to split the water column above into three equal depth layers. Data collected for the duration that the ADCP was buried is not considered in Table 3-2 results.

This instrument was then relocated further inside the harbour to an area with more benign bed load transport (refer Figure 3-14 identified as 'Relocated ADCP'). After this device was relocated, data corruption midway through a month long deployment period resulted in this information becoming unusable.

Table 3-2: Current measurement statistics from ADCP deployment in channel entrance

		Upper	Middle	Lower	Unit
Speed	Mean	1.26	1.17	1.02	m/s
	Max	2.09	1.98	1.73	m/s
	Min	0.09	0.08	0.10	m/s
	Std. dev	0.55	0.50	0.42	m/s



The diagram shows a vertical cross-section of the water column. A dashed line represents the ADCP's field of view, which is divided into three horizontal layers labeled 'Top', 'Middle', and 'Lower'. The ADCP is positioned at the bottom of the 'Lower' layer.

3.4.2 Boat mounted ADCP

A boat mounted ADCP was used on 23 March 2023 to measure currents along the transect shown in Figure 3-15. Transects were repeated with a RDI workhorse owned by the Port of Auckland on a 1-hour frequency over the duration of a spring tidal cycle (between approximately 7am and 9pm NZDT). The transects were carried out across the channel off Manukau Heads. The first four transects were located between -37.0326775; 174.53151433 and -37.045933; 174.54171467. The remaining 26 transects were located between -37.03046133; 174.5378965 and -37.044628; 174.54938867. The two sets of survey were approximately 600 m apart. Example output data from this is shown in Figure 3-16. Further information is included in Appendix A.



Figure 3-15: ADCP transect location.

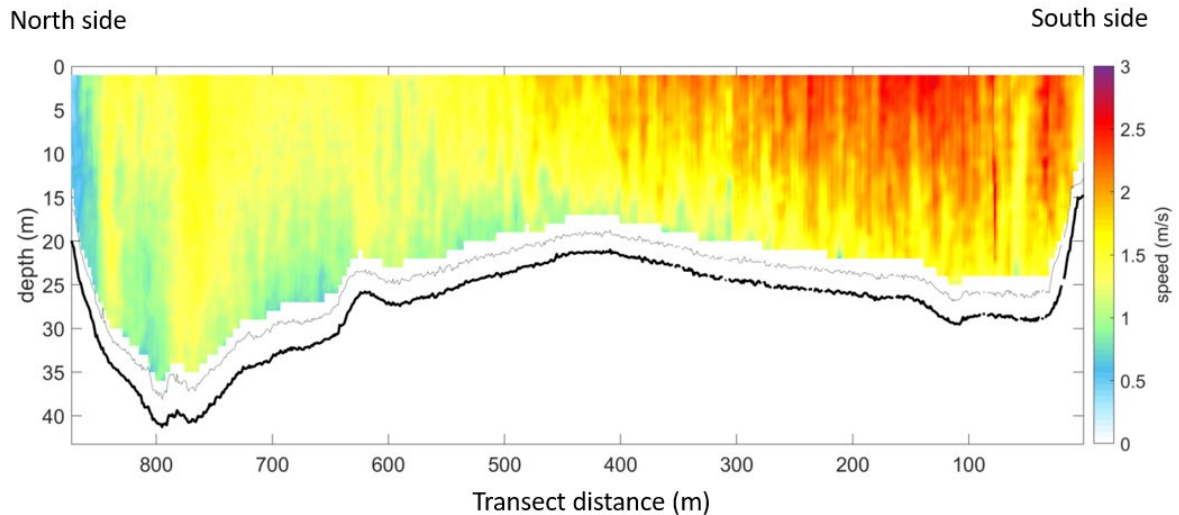


Figure 3-16: Example of ADCP transect data during the ebb tide showing current speed through the water column.

The survey team lost data from a few of the transects so returned at the end of the day to plug the gaps of the hourly transects they had missed.

3.4.3 Drifter deployment

Initially dye studies in conjunction with aerial survey were considered to improve understanding of currents around the harbour entrance, and over the bar. However, following peer review it was suggested that tracking drifters would be a useful exercise to gain an insight into the flows in and out of the harbour to help verify the numerical model outputs, so this approach was adopted.

A series of 5 drifters were designed and built to measure currents between the Manukau Harbour entrance and the bar. The main body of the drifter was designed to extend 1.3 m below the water surface and move with surface currents, a GPS tracker was attached to the tip of a mast (refer Figure 3-17). Three drifters were released on 10 June 2023 on the incoming tide, with two placed in the northern channel, and one in the southern channel. Two additional drifters were then introduced upstream of the initial three to measure outgoing current speeds (refer Figure 3-18). Time series measurements were undertaken at a fixed frequency of approximately 30 seconds. The release location and tracks are shown in Figure 3-19. GPS units used were Oyster 3 from Digital Matter and have a stated positional accuracy of 10 m. Consecutive GPS locations could only be recorded until drifters had travelled more than 20 m from their previous position. GPS measurements were recorded in WGS84 (projection) as decimal degrees to 9 significant figures for latitude and 10 significant figures for longitude (i.e. precision less than 1 m). The inferred time-averaged speed between consecutive GPS positions was smoothed using a 20-window moving mean (i.e. 10 minute period) and a gaussian blur to account for positional inaccuracies to ensure drifter speeds were more representative of the true drifter movement, based on independent vessel track and observations during deployment.

None of the drifters re-entered the harbour, and only information within the first 24 hours of this deployment was used. Wind conditions at the time of deployment were very light (variable, less than 5 knots), meaning negligible effects of wind on drifter movement. Offshore swell was small on this day (significant wave heights less than 1 m).



Figure 3-17: Drifters used to measure surface currents.

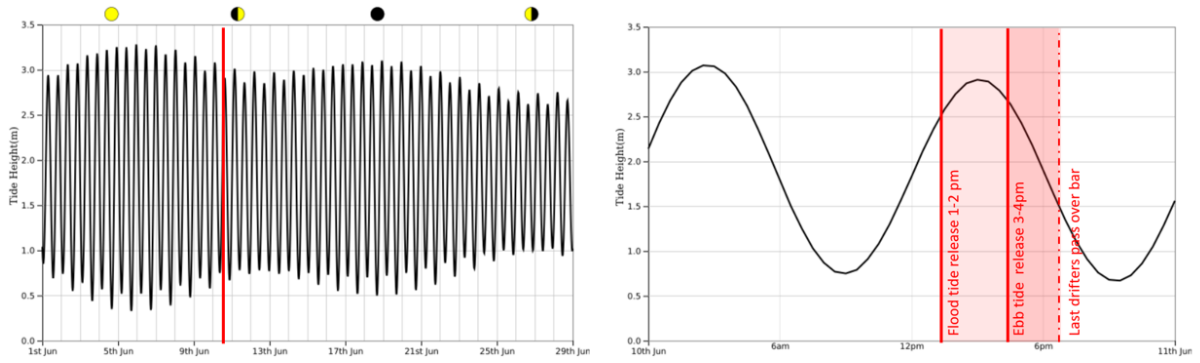


Figure 3-18: Timing of drifter deployment.

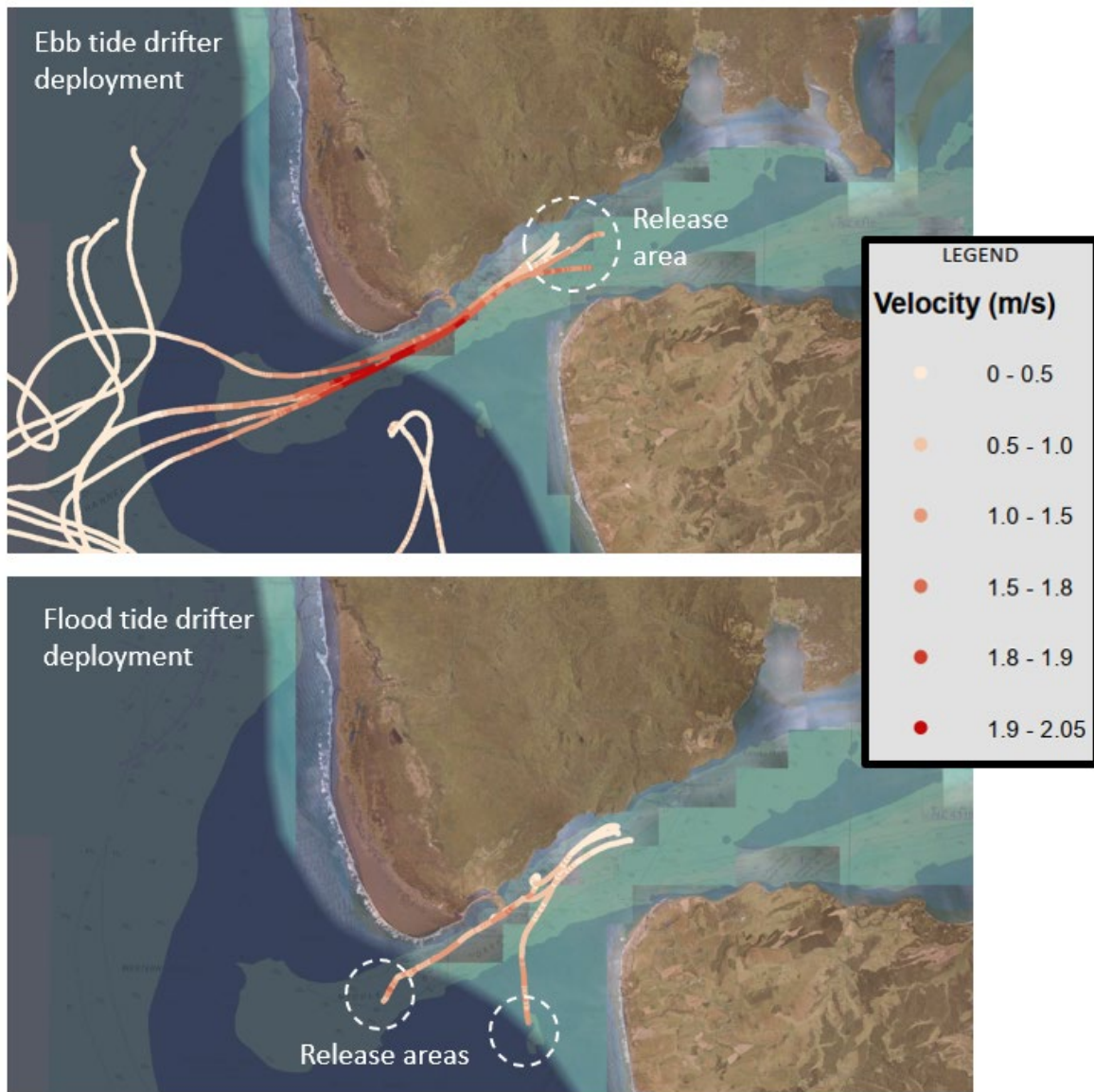


Figure 3-19: Drifter release area and tracks.

3.5 Sediment

3.5.1 Sampling

Sediment samples were collected in 57 locations indicated in Figure 3-20. In a number of locations sufficient quantity of sample was obtained to enable a solid density test.

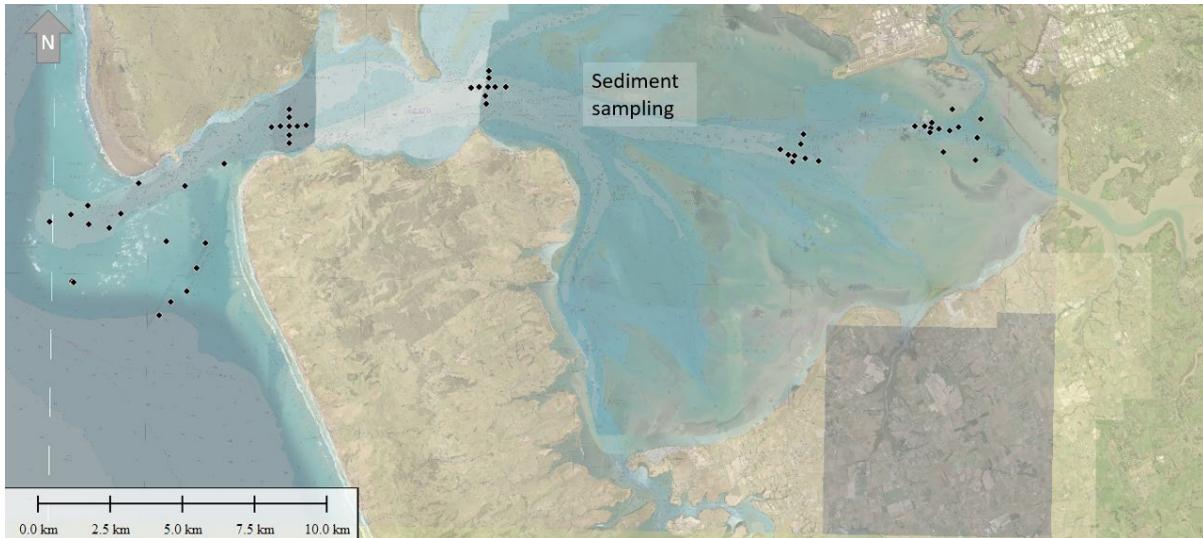


Figure 3-20: Sediment sampling locations.

Sampling was undertaken using a Van Veen grab sampler (Figure 3-21). This involves lowering the sampler to the seafloor on a rope. As the sampler makes contact with the seabed it unweights the lowering line resulting in the release of a split pin and the closure of the jaws capturing a sample that can then be hauled back to the surface.



Figure 3-21: Van Veen grab sampler.

In some instances, samples could not be retrieved, likely due to dense materials at the bed resulting in the jaws not penetrating, particularly in the upper reaches of the Papakura Channel. In other instances, retrieved samples contained a mix of both sand and coarse shell, possibly meaning the bed was primarily comprised of sand, with a layer of overlying shell.

A laboratory sub-sample was selected by hand from the larger mass within the sampler at each test location. By observation efforts were made to select material that was representative within the

sampler, however some small differences could occur between multiple sub-samples of the same retrieved mass. The significance of these differences are minimised to an extent overall by collecting and testing clusters of multiple samples through the study area.

When a sampler is lifted out of the water it contains a sieve in the top from which water is drained before opening the jaws. In the process of raising the sampler through the water column some material could be lost through this sieve, particularly fine material when the sampler is agitated. Care was taken when lifting the sampler to raise it smoothly hand over hand.

Upon reaching the surface, care is required not to shake the sampler and suspend sediments that could then make their way out through the metal sieve as the sample is drained over the side of the boat. By observation this loss appears to be very small in comparison to the overall sample mass. Fine silt would likely make up the larger portion of any potential loss however, overall, this loss is not expected to be significant.

3.5.2 Laboratory testing

The following laboratory testing was undertaken for the purposes of determining physical parameters of bed sediment for modelling and dredge assumptions:

- 57 particle size distributions were undertaken by the University of Waikato using laser diffraction on 50-gram sub-samples, sieved down to 63 micron prior to processing. Refer to Figure 3-20 for locations and Figure 3-22 and Figure 3-23 for median grain size results.
- 15 density tests were undertaken on 50-gram sub-samples by the University of Waikato, to provide information that broadly characterises the range of bed sediment materials recovered. Refer to Figure 3-24 for locations and results.
- 6 environmental tests on 250-gram sub-samples were undertaken by Hills Laboratory (refer Figure 3-25 for locations). This information was gathered to inform environmental constraints regarding the potential disposal or reuse (i.e. reclamation) of dredged material discussed in the associated dredging report TWP06. The following environmental tests were undertaken:
 - Heavy metals screen level As, Cd, Cr, Cu, Ni, Pb, Zn.
 - Organochlorine Pesticides UltraTrace in Soil.
 - Polycyclic Aromatic Hydrocarbons Screening in Solids.
 - Total Recoverable digestion.
 - Total Recoverable Mercury.
 - Total Organic Carbon.

Field test results with photographs and laboratory reports provided in Appendix E.

Outside the harbour entrance a large variation in grain size distribution was observed. In areas close the main channels grain sizes were larger (typically $D_{50} = 300$ to 500 microns). Further away from these channels grain sizes became smaller (typically $D_{50} = 150$ to 300 microns).

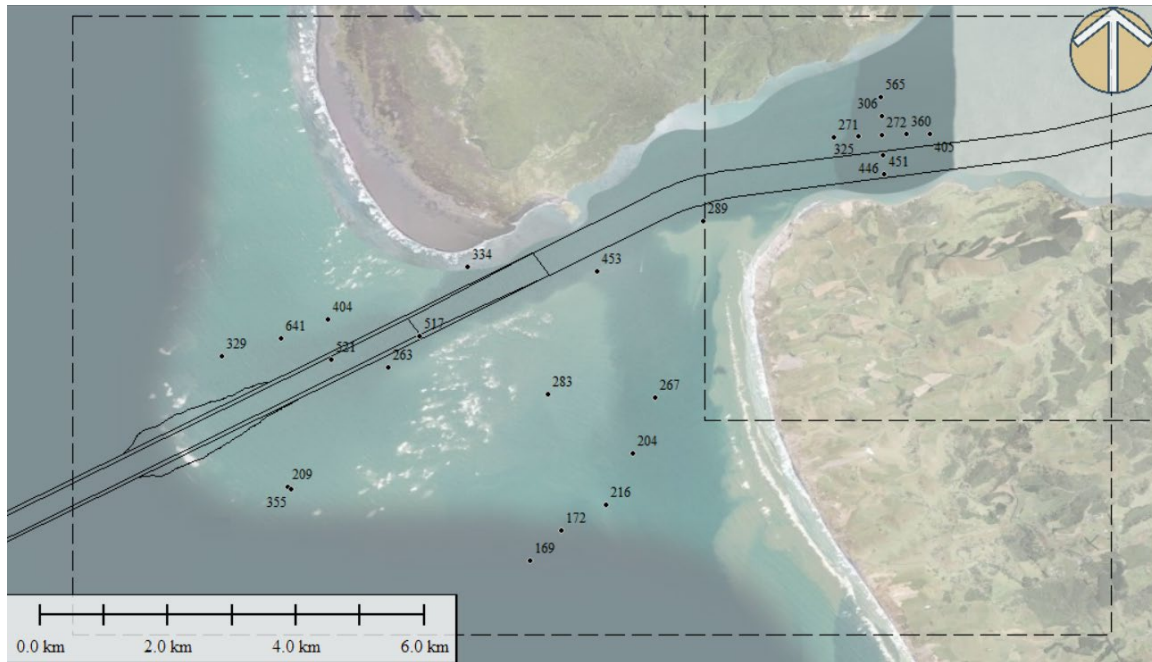


Figure 3-22: Median grain sizes (microns) from sampling outside the harbour entrance (Black line indicates concept channel alignment).

Moving up inside the harbour median grain sizes reduced, typically becoming less than 200 microns. In the base of channels this material became silty in places (less than 63 micron). Rare coarse loose shell deposits were encountered over some of this material. Outside of the channels in shallower depths, material reverted to a fine sand.

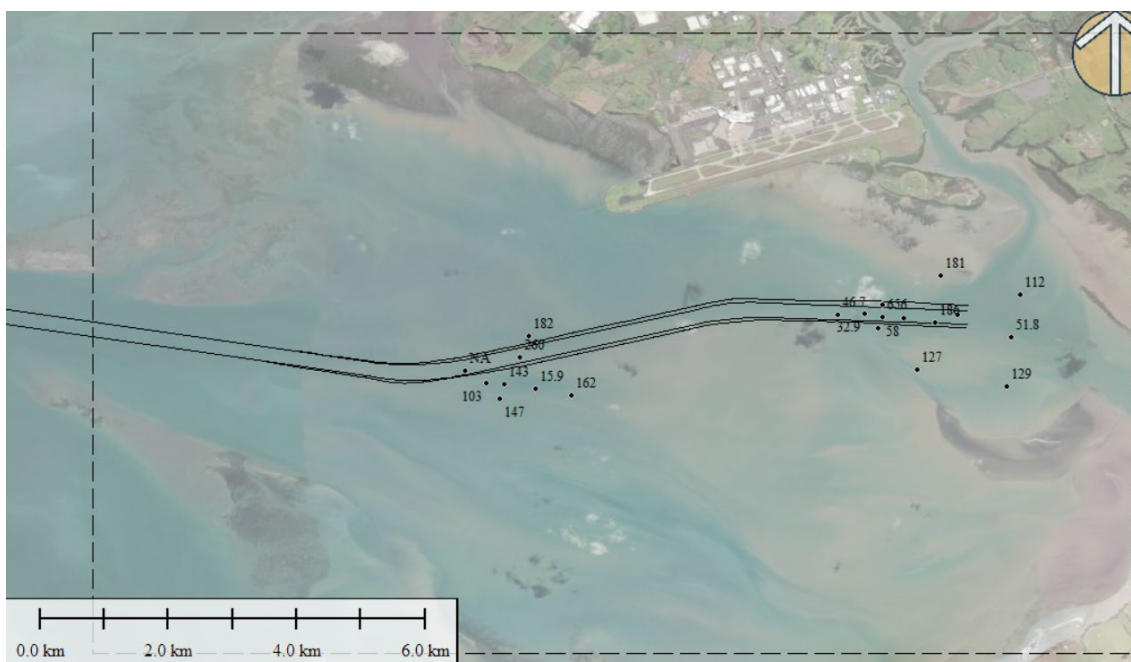


Figure 3-23: Median grain sizes (microns) from T+T (2023) sampling inside the harbour. Black line indicates the concept channel alignment.

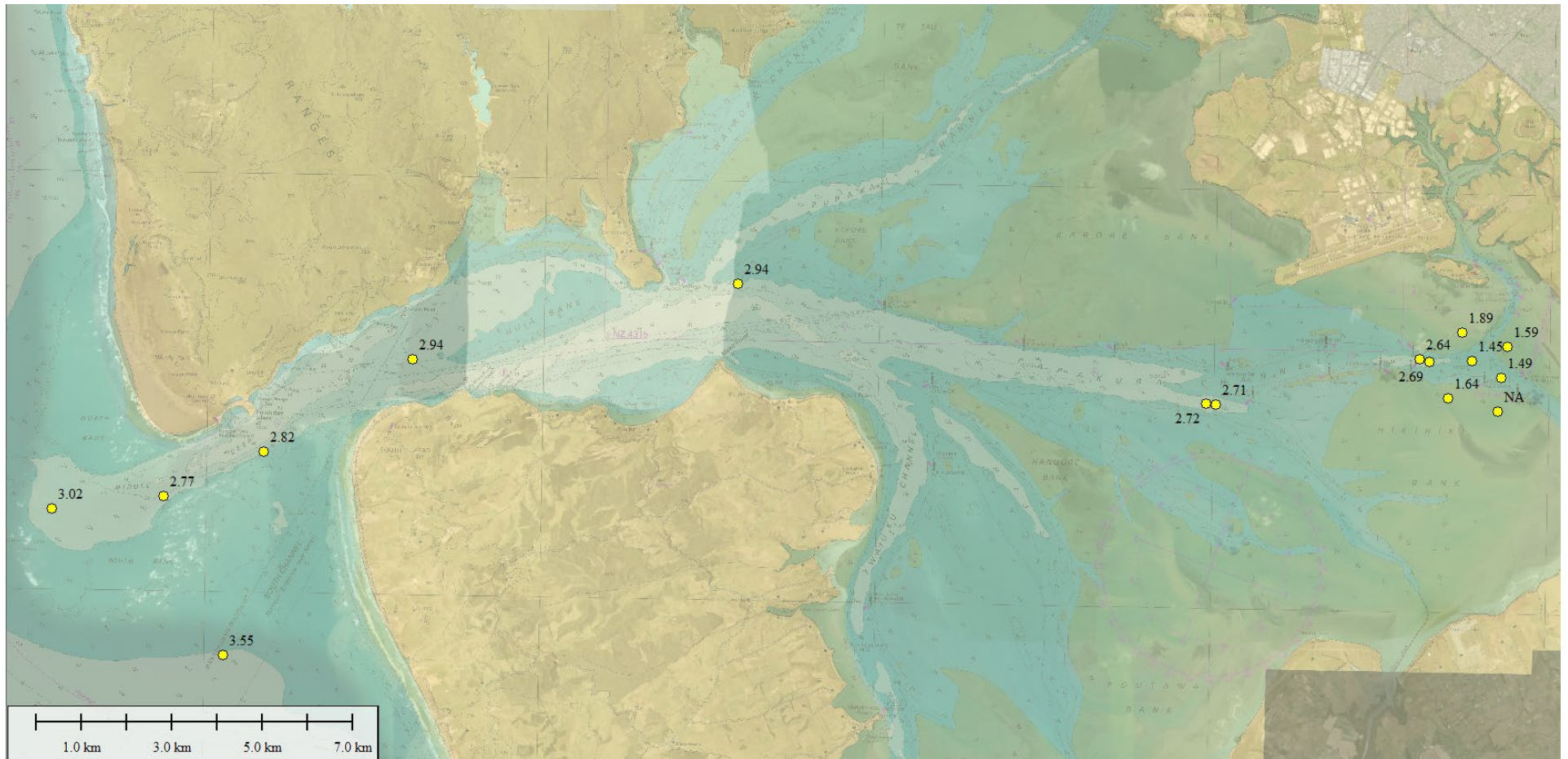


Figure 3-24: Density (g/cm³) results from select sampling locations.



Figure 3-25: Environmental test locations (note that these samples were also tested for particle size distribution and density).

Due to the range of bed sediments recovered, all samples were photographed to assist with the assessment of sediment transport and coastal morphodynamics (example in Figure 3-26). Photographs were taken to provide additional context regarding the makeup of this material and its origins.

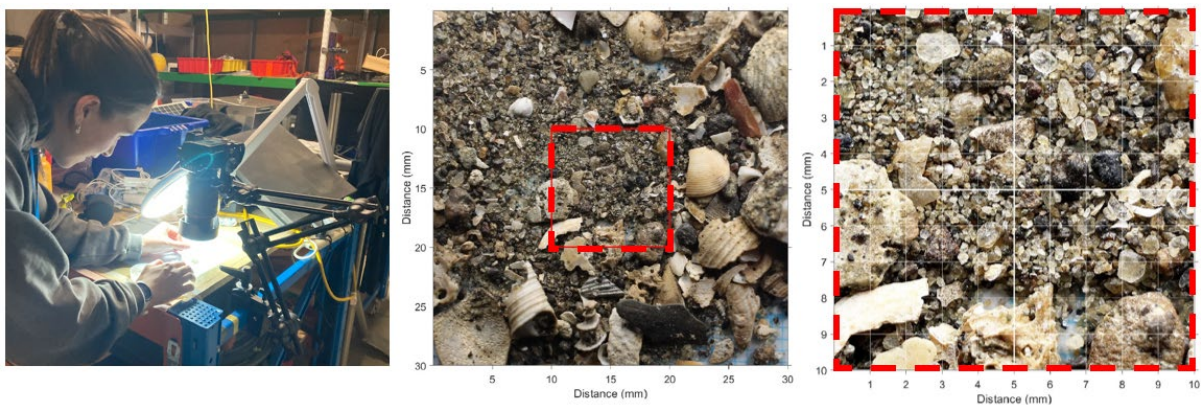


Figure 3-26: Macrophotography of sediment samples.

The laboratory testing was undertaken by third party laboratories following their own in-house quality assurance procedures. For the environmental testing the samples were kept refrigerated and there was a chain of custody to ensure that no samples were tampered with.

3.6 Suspended sediment

The modelling approach allows for the two-dimensional (2D) representation of sediment transport. To build confidence in the sediment transport model schema and parameters, a sediment catch device was developed to measure suspended sediment. Suspended sediment monitoring was initially proposed during high energy events using a helicopter in the same manner as bathymetric dipping. During bathymetric dipping it was difficult for the pilot to maintain a steady hover over breaking waves despite the calm conditions at that time. For health and safety reasons it was decided not to proceed with sediment sampling over a large sea state. Instead, a sediment sampler was developed for deployment by boat in comparatively calmer conditions.

As tidal current flowed through this sampler, suspended sediment in the current was filtered out and collected. After retrieval, the weight of collected material was measured. The speed of the tidal current passing through the sampler was inferred from a drag tilt sensor, located next to the sampler (Figure 3-27 and Figure 3-28). Measurements of speed are taken as an average over the distance between the seabed and the mouth of the sampler.

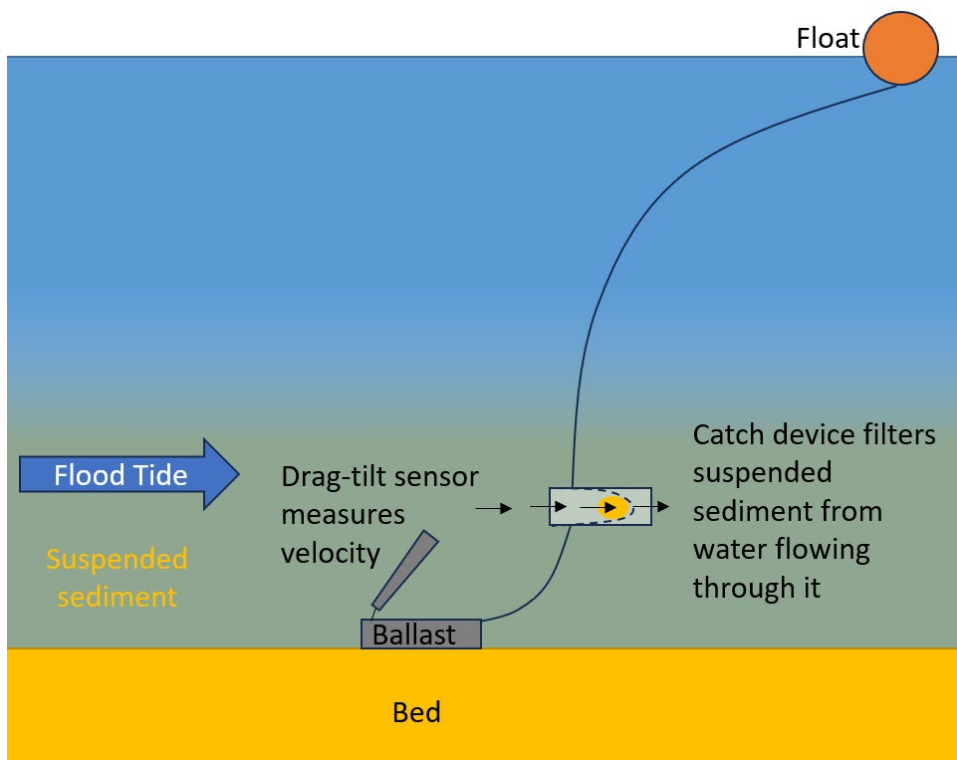


Figure 3-27: Schematic indicating deployment of catch device.

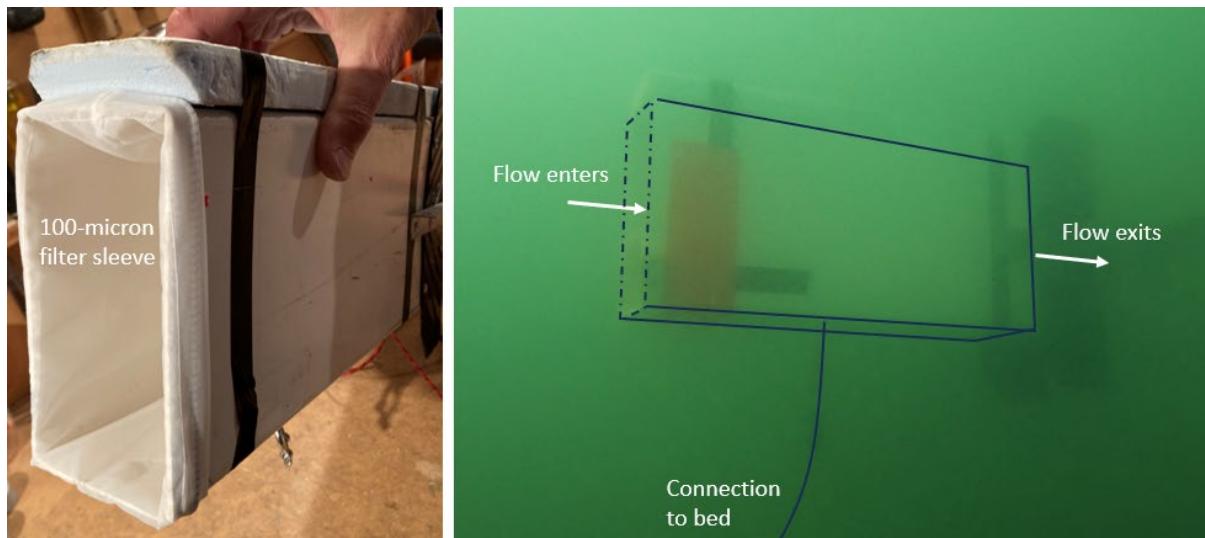


Figure 3-28 Catch device function

Deployment of the catch device was undertaken on 1 November 2023 at 0930 hrs NZST mid-incoming tide, on the southern side of the south-west channel at NZTM 1729580.109 E, 5895207.099 N. The sea state offshore from the bar was considered calm, with significant wave heights less than 1 m. The device was suspended 1 m above the seabed for a period of 6 minutes during an early stage of the flood tide. The sampler collected 180 grams using a 100-micron cloth filter over this duration. An average current speed of 1.4 m/s was recorded at this time. How this information is related to the modelling results is discussed in the Numerical Modelling Report TWP03b.

Testing of the device was through deployment in a number of comparatively safer coastal settings featuring a range of current speeds, wave conditions, water depths and sediment types. The stability of the device and function of the filter, including deployment and retrieval was observed by a diver on these occasions. Tests indicated the potential for sample loss during collection due to orbital velocities from shoaling waves and wave breaking. This limited deployment to calmer areas/deeper water conditions in the tidal channel.

4 Applicability

This report has been prepared for the exclusive use of our client Ministry of Transport | Te Manatū Waka, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd
Environmental and Engineering Consultants

Report prepared by:

Authorised for Tonkin & Taylor Ltd by:



Peter Quilter
Senior Coastal Engineer



Richard Reinen-Hamill
Project Director

PWQ

t:\auckland\projects\1018198\issueddocuments\final report\final (final) word\twp02 (tt) - fieldwork.docx

Appendix A Bathymetric survey

REPORT OF SURVEY

Bathymetric Survey of Manukau Harbour Auckland, New Zealand

REPORT PREPARED FOR:



REPORT PREPARED BY:



Surveyed by:
Surveyor in Charge:
Vessels:
Survey dates:
Report date:
Report version:

Discovery Marine Ltd.
W. Roest, NZCHS, MNZ SRL
Tupaia, MNZ 142238
23 to 24 March 2023, 25 to 26 May 2023, 09 to 12 June 2023
20 June 2023
1.0

1. EXECUTIVE SUMMARY

Discovery Marine Ltd (DML) was contracted by Tonkin + Taylor (T&T) on behalf of the Ministry of Transport to conduct a bathymetric survey of the Manukau Harbour entrance and main channels. In addition, a vessel mounted Acoustic Doppler Current Profiler (ADCP) survey was undertaken over a 13hr spring tide cycle along with deployment of seabed mounted gauges and sediment samples to aid with the Port feasibility study.

The survey was planned to be conducted in multiple phases as weather conditions and tide allowed. To complete the survey, 3 phases were required as follows:

- **Phase 1** - 23 to 24 March 2023. An ADCP survey over a 13-hour spring tide was undertaken in the vicinity of Middle Deep channel, between South Head and Beacon Point. T&T's seabed mounted ADCP and wave buoys deployed, and sediment samples taken at given locations.
- **Phase 2** - 25 to 26 May 2023. Inner Harbour bathymetric survey using Single Beam Echosounder (SBES) of Papakura channel, from opposite the LPG Terminal to near Mako Point. Sediment samples were collected at specified locations.
- **Phase 3** - 09 to 12 June 2023. – Bathymetric survey of the Manukau bar prioritising the harbour entrances (South West and South channel) using SBES. Completion of the survey from Middle Deep channel to Huia Bank.

Figure 1 Figure 1 depicts the approximate survey area and phases of the survey operations.

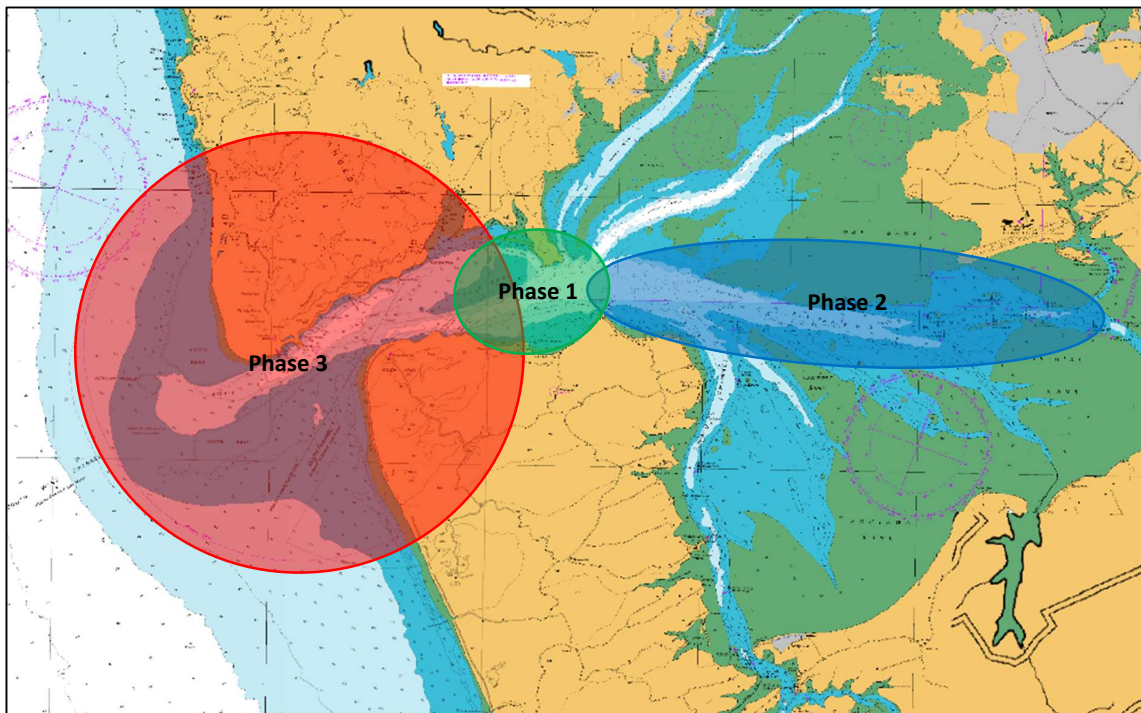


Figure 1: Manukau Survey Area

2. WEATHER AND SEA CONDITIONS

Phase 1: Day 1 weather conditions were favourable for working inside the harbour entrance. However, strong ebb tide currents and slight SW wind caused turbulent water near South Head requiring the ADCP survey line to be relocated 200m further east after the first pass. On Day 2, moderate sea conditions were experienced on the Manukau bar during the flood tide and short cresting 1m waves whilst transiting the South channel.

Phase 2: Good weather and calm sea conditions were experienced for the inner harbour survey.

Phase 3: Weather predictions proved accurate with a sustained high-pressure system over the west coast. Initial sea conditions were variable 10 knot E wind with a consistent chop that wasn't always comfortable but manageable. Near the end of the survey sea conditions deteriorated as the wind intensified gusting 30 knots and swung to the SW. This caused a washing machine effect in the South West entrance and restricted sounding over the North and South Bank. Data acquisition continued in the more sheltered waters of South entrance and inner harbour.

3. SURVEY PLATFORMS AND EQUIPMENT

3.1 SURVEY VESSEL TUPAIA

DML used their 7.7m Senator survey vessel *Tupaia* for this project as it offered a safe working platform for the Manukau bar, having an enclosed cabin, twin outboards and a shallow draught. The vessel is an inshore survey boat fitted with a modern survey suite comprising GNSS positioning systems, motion sensor and high frequency digital SBES. The survey equipment is fully calibrated and all offsets between sensors are known. All survey data is logged directly into a hydrographic software package, QPS Qinsy. The vessel is operated under Maritime New Zealand MOSS.



Figure 2 Survey Vessel, Tupaia



Figure 3: Helms Survey and Navigation Screens onboard Tupaia

Table 1: Specifications of Survey Vessel *Tupaia*

Name	<i>Tupaia</i>
MNZ number	142238
Owner	Discovery Marine Limited
Type	Senator 770
Year Built	2019
Dimensions	Length: 7.7m Beam: 2.49m Draught: 0.7m
Propulsion	Twin Mercury 150HP 4 stroke outboard engines
Survey Class	MNZ Survey for 8 Pax – Inshore Waters, (within 12nm) and Enclosed Waters
H&S Considerations	Operates under the direction of the vessel skipper and within MNZ MOSS requirements, MBES and SVP deployment and recovery SOP.

3.2 POSITIONING SYSTEM AND ATTITUDE CORRECTION

An Applanix POSMV Wavemaster II (POSMV) provided position, attitude, and heave data for this survey.

Table 2: *Tupaia* Positioning System Details

Key Components:	POSMV Wavemaster II
Position Accuracy:	Horizontal: <0.1m (95%), Vertical: <0.1m (95%) (G4+)
Roll and Pitch Accuracy:	0.02°
Heading Accuracy:	0.03°
True Heave Accuracy:	0.02m or 2%
Position Aiding	G4+ correction

3.3 SINGLEBEAM ECHO SOUNDER (SBES)

A Tritech PA500 SBES was fitted to *Tupaia* and measured the bathymetric depth data.

Table 3: Tritech PA500 Details

Single beam Echo Sounder:	Tritech PA500 SBES
Sonar Operating Frequency:	500khz @ 10Hz
Swath Opening Angle:	6°
Rated Accuracy	+/- 1cm

3.4 SPEED OF SOUND SENSOR

An AML SVP was used to measure the sound velocity, pressure and temperature through the water column at various locations during the survey.

Table 4: AML 3 LGR Details

Speed of sound sensor:	AML 3 LGR (sound velocity, pressure, temperature sensor)
Resolution:	0.01m/s
Precision:	0.01m/s

4. SURVEY CONTROL & POSITIONING

4.1 HORIZONTAL DATUM

The horizontal datum and projections parameters that the survey is referenced to are provided in Table 5.

Table 5: Horizontal Datum and Projection

Datum:	New Zealand Geodetic Datum 2000 (NZGD2000) Reference Ellipsoid: GRS80
Projection:	New Zealand Transverse Mercator 2000 (NZTM2000)

4.2 VERTICAL DATUM

The vertical datum that the survey is referenced to is provided in Table 6

Table 6: Vertical Datum

Datum:	Chart Datum Onehunga
Datum Description:	5.593m below LINZ mark B.M. CC 65 (code ADLT)

4.3 CONNECTION TO DATUM

The survey was connected to datum using tide stations at Onehunga (Auckland Council) and Paratutae Island (LINZ). A transfer of sounding datum (TSOD) was undertaken between the Onehunga tide gauge and the Paratutae tide gauge to establish the height of tide above datum.

5. CONDUCT OF SURVEY

5.1 PHASE 1

Phase 1 was conducted between 23 March and 24 March 2023.

The Acoustic Doppler Current Profiler (ADCP) survey required repeat transits by the survey vessel across the narrow harbour entrance, over 13-hour observation period during spring tides. This provides current data at its highest expected velocity. Day 1 (23 March) provided the opportunity with improving sea conditions and spring tides to complete the survey. The team experienced turbulent and potentially hazardous sea conditions across the initial route provided by the client (shown red, Figure 4) so a decision was made on the water to relocate the transect approximately 200m further east (shown blue, Figure 4) in more favourable water. During the day, sediment samples were taken at a location within proximity to the ADCP route.

The survey was completed to the full extent of the requirements and the ADCP results given to the client for analysis by a 3rd party.

Day 2 (24 March) was allocated for the deployment of the client's two wave bouys and additional sediment samples at given locations. The morning flood tide period allowed for transiting the Manukau bar via the South Channel in cresting 1m waves. A trip report was lodged with Coast Guard prior to and returning from crossing the bar. The outer bar wave buoy was deployed, and sediment samples taken at convenient locations. Sediment sample locations were logged and provided to the client.

On returning to the harbour, the second wave buoy was deployed and further sediment samples taken.

Some exploratory and ad hoc seabed mapping was undertaken on Day 1 using DML's Multibeam Echosounder (MBES) in the vicinity of the seabed mounted ADCP. The real time results indicated the presence of significant sand waves in area where the ADCP was deployed. There were then concerns the strong current and sand wave movements could possibly bury the ADCP and a decision was made by T&T to recover it and reconsider the deployment location.

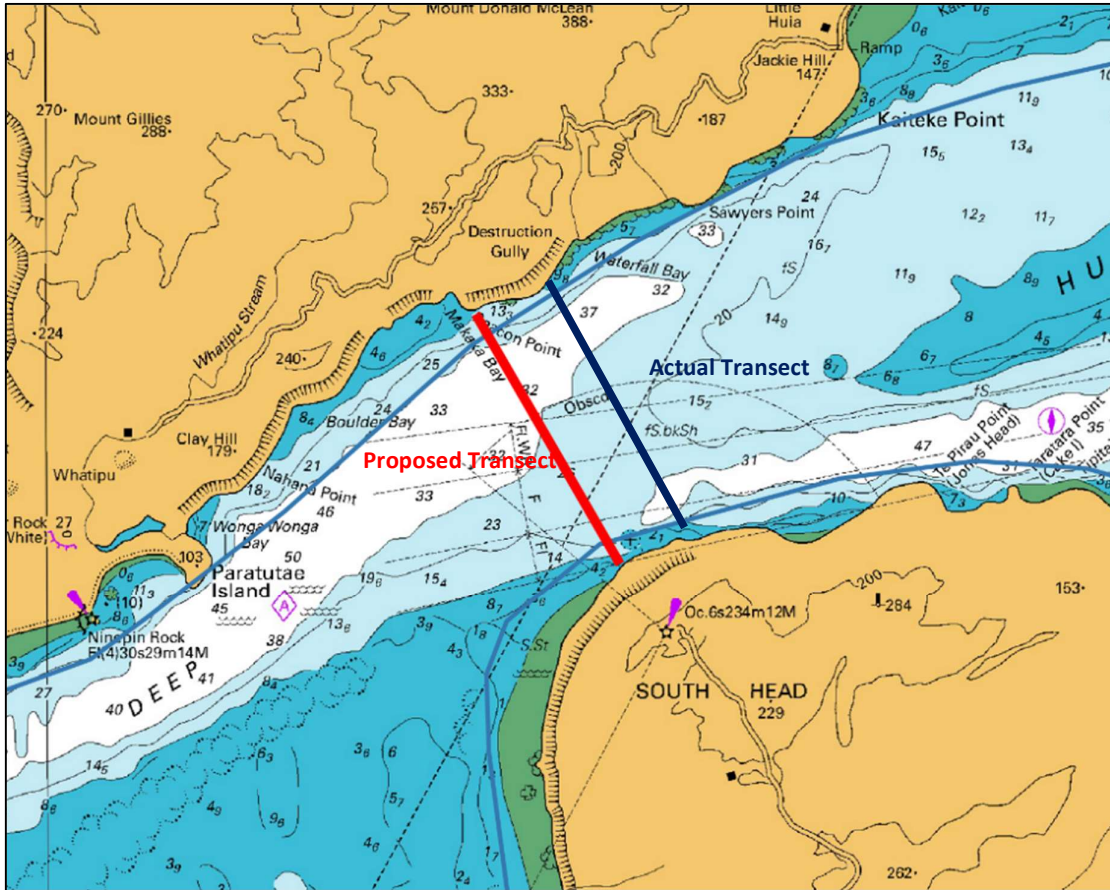


Figure 4: Phase 1 ADCP Transect



Figure 5: ADCP surface buoy in strong tidal current

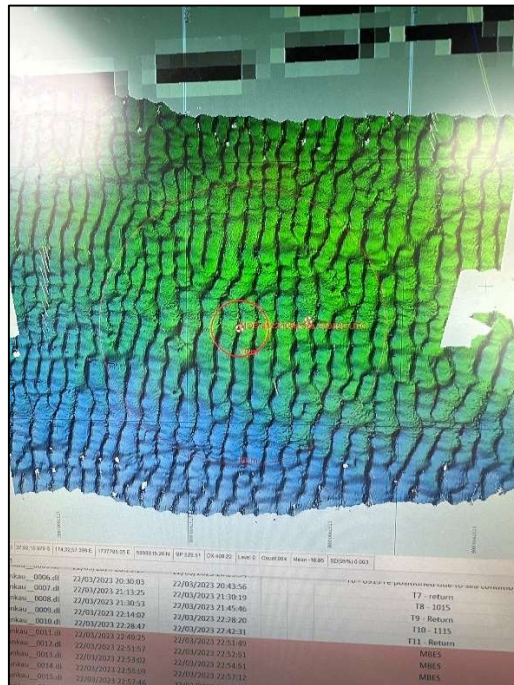


Figure 6: MBES image of sand waves near ADCP

5.2 PHASE 2

Phase 2 was conducted between 25 May and 26 May 2023.

The goal for Phase 2 was to maximise the high tide water levels and complete SBES data capture and sediment samples over the shallow banks of the Papakura channel.

Priority was given to the collection of sediment samples at specified locations. Samples were refrigerated until they could be delivered to Hill Laboratories. Guidelines for sample collection (provided by the client) were adhered to and involved disinfecting the Van Veen grab and the use of plastic sheets and disposal gloves for each sample. This ensured there was no cross contamination.



Figure 7: Sediment sampling with Van Veen grab

The bathymetric survey of Papakura channel and surrounding shallows achieved good results and coverage. The extent of survey spanned from opposite the LPG Terminal to Mako Point, see Figure 8.

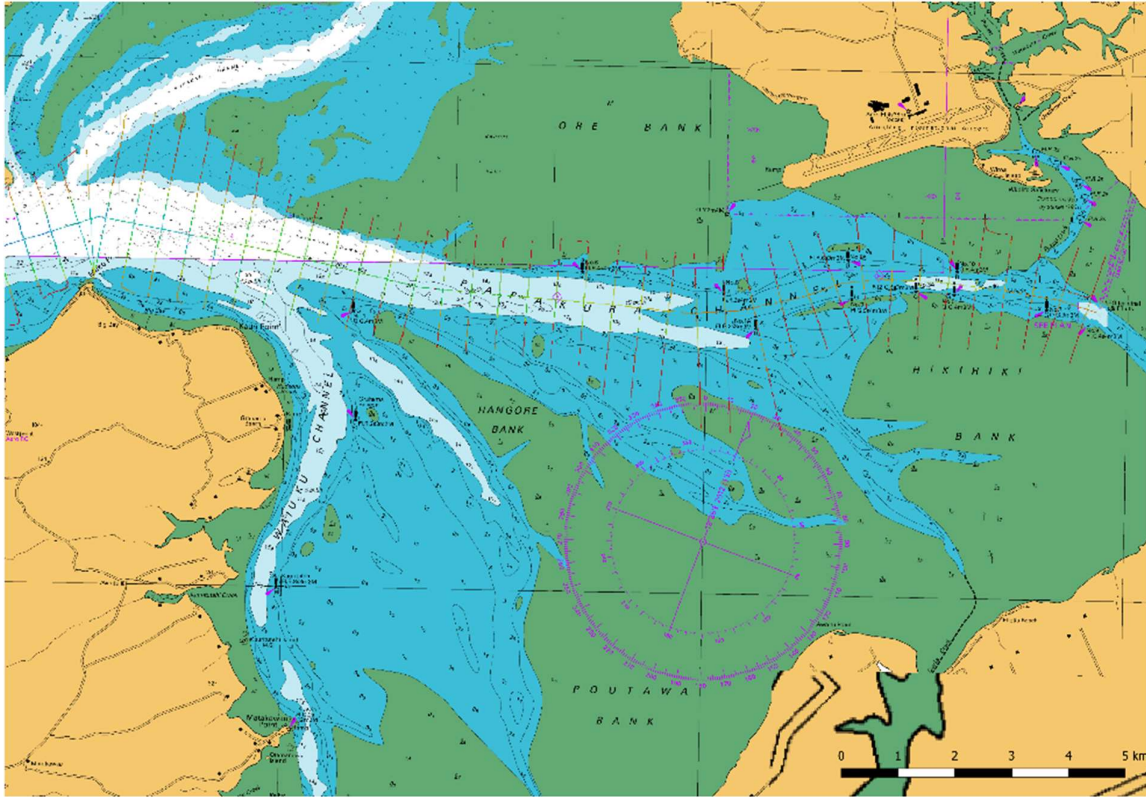


Figure 8: Phase 2 Bathymetric survey coverage

5.3 PHASE 3

Phase 3 was conducted between 9 June and 12 June 2023.

9 June - With a promising marine weather forecast, intentions were to survey the remaining harbour channel while awaiting the sea conditions to improve and allow surveying of the Manukau bar and outer harbour survey area.

After a few hours SBES surveying in sheltered water and waiting for the tide to flood, the South Channel Harbour Entrance became navigable. A trip report was lodged with Coast Guard (CH18) and a 30-minute bar watch commenced. Surveying of the Manukau bar started by following pre-determined runlines over the priority area, South West channel. This worked well and depth measurements were recorded from beyond the Pilot Limit, up over the shoal bank and back into deeper water of Middle Deep. Minimum depths experienced over the entrance shoal were 4 - 5m. At the end of day, the priority area with denser survey line spacing was near complete. Maui dolphin were observed in the channel and made brief approaches to the vessel on a few occasions. These sightings were reported on the Department of Conservation website.

10 June - Good sea conditions and a continuous Coast Guard bar watch, allowed for a full day surveying on the Manukau bar.

11 June – With deteriorating conditions predicted (gusting 30knt SW), focus was on finishing the middle deep channel first and then South channel. This was achieved however marginal conditions along the edges of Middle Deep restricted survey efforts from progressing far into the shallows of the North and South Bank. The calmer water of South channel allowed for extended coverage. As

predicted the conditions became unworkable in the entrance so the survey progressed inside South Head.

12 June – The final area of survey (Huia Bank) was completed in the morning and the afternoon spent demobilising and driving back to Tauranga.

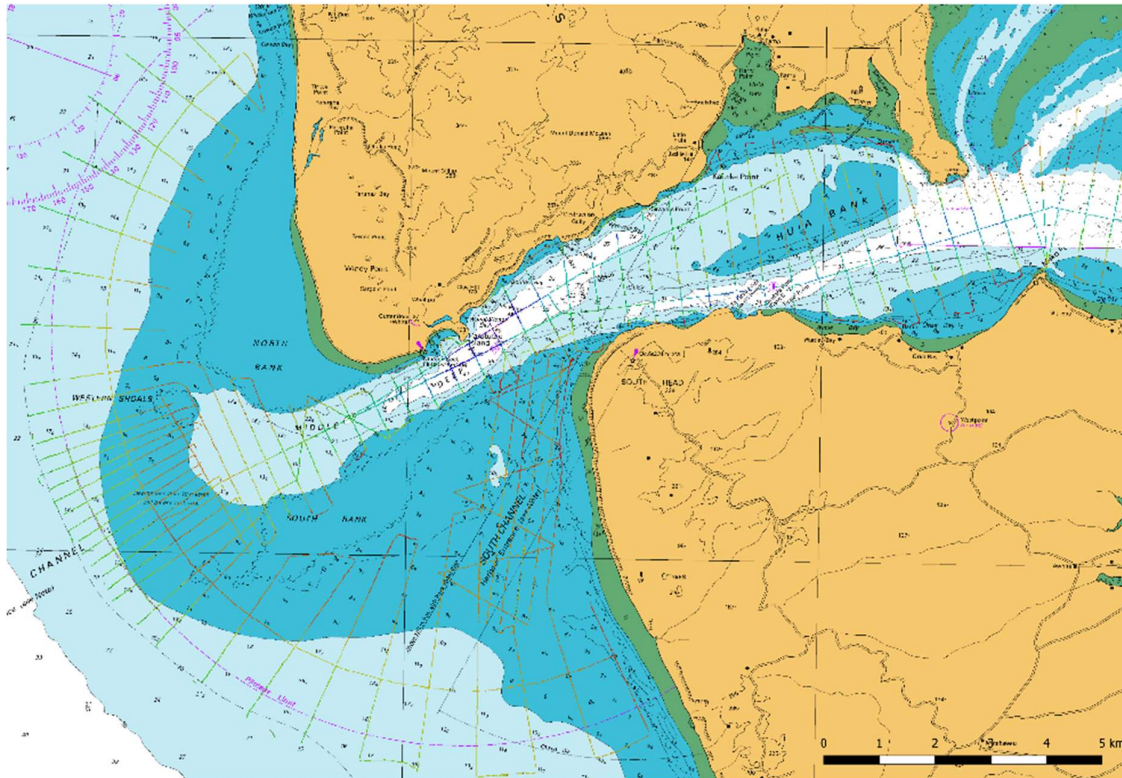


Figure 9: Phase 3 Bathymetric survey coverage

5.4 ON SITE VERIFICATION AND ACCURACY CHECKS

The following calibrations, checks and verifications were conducted on site.

- Vessel positions provided by the POSMV were compared with an independent positioning system on the chart plotter for verification.
- A bar check was conducted with the SBES to confirm offsets and correct sounder operation.
- Comparisons of overlapping depth data surveyed at different times/day, the differences observed and confirmed within expected tolerances.
- Measurements of sound velocity were conducted daily and at changes of tide or location. Measurements ranged between 1,504 to 1,513 m/s.

6. DATA POST PROCESSING

Once the field work was complete, all data was transferred to DML’s office IT environment for post processing.

6.1 SBES

SBES bathymetric data was processed and validated using Qimera with any spurious soundings cleaned from the dataset using 3D point editing. Depths were reduced to be in terms with Chart Datum Onehunga by using tidal data recorded at Onehunga and Paratutae Island. Data for the Onehunga gauge was accessed through the Auckland Council data portal. Data for the Paratutae tide gauge was accessed via the LINZ website.

A transfer of sounding datum (TSOD) was undertaken to establish CD at the Paratutae Gauge, from the existing Standard Port of Onehunga. After reducing the Paratutae tidal data to CD, tidal curves for both locations were compared, and several anomalies noted, especially at the Paratutae gauge where spurious data was regularly evident. Spurious data from both tide files was removed where possible or smoothed in the final tide file used for reduction to CD.

The survey area was split into two tidal reduction blocks by a line joining Puponga Point in the north to Mako Point in the south. SBES data to the east was reduced on Onehunga gauge data and SBES data to the west, including the outer harbour area was reduced on Paratutae gauge data.

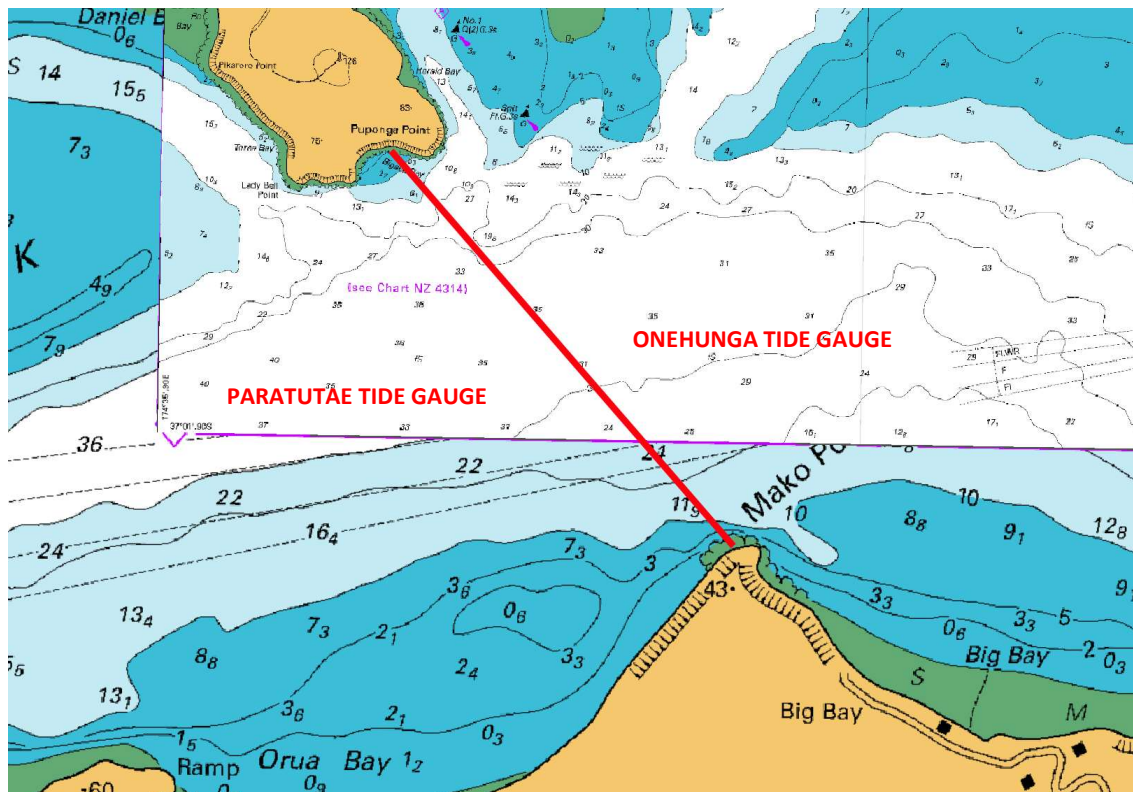


Figure 10: Tidal Reduction Blocks

Generally, where cross lines overlap other data inside the harbour there is good agreement between lines run at different times and different states of tide. In the outer harbour area however, there

appears to be an offset between the mainlines and cross lines running along the contour on the seaward side of the bar. The offset is in the order of 0.5m in some places. The exact cause of this difference is unknown although we suspect it is the tide and current flow in the outer harbour area, on the seaward side of the bar differing to that recorded at the Paratutae tide gauge.

6.2 EXPORT AND DELIVERY

The SBES data from Phase 2 and 3 was combined into a single SBES data set and exported as an XYZ ASCII XYZ file.

7. ESTIMATED DEPTH ACCURACY

The accuracy of SBES bathymetry depths for this survey is assessed as +/-0.15m (Hz and Vz) inside the harbour and +/-0.35m outside the harbour as determined by average crossline checks, position checks, and inspection of overlapping data.

Accuracy of soundings is within the LINZ-1 TVU hydrographic survey specification.

8. DIFFICULTIES ENCOUNTERED

All equipment operated well, weather was fine and sea conditions were manageable. Boat launching and recovery was done at the Waiau Pa boat ramp. It was advantageous to become Boat club members to have the use of the security gate-controlled boat parking and launching facilities. Other local boat ramps were visited but ease of launching depended on tide levels, and they didn't have pontoons.

Tide data from the Onehunga tide gauge was initially supplied by Auckland Council for the wrong sensor. A query was raised with the Council and the correct data was eventually supplied. Data for the Paratutae tide gauge, accessed from the LINZ website is noisy and required the removal of spurious data and eventual interpolation/smoothing to establish a final tide curve.

9. PERSONNEL

The personnel involved in this project including their role and qualifications are tabulated below.

Table 7: Survey Personnel

Name	Qualifications	Role
Declan Stubbing	BSurv, CPHS1	Project Manager
Wade Roest	NZCHS, MNZ SRL	Surveyor in Charge
Jimmy Van der Pauw	BSurv, CPHS1	Phase 1 - Hydrographic Surveyor
Dirk Immenga	MNZ Commercial Launchmaster	Phase 1 - Skipper
Cam Low	MNZ SRL	Phase 2 & 3 - Skipper
Marc Tecofsky	MNZ Coastal/Offshore	Phase 2 - Alt Skipper
Josh Fowden	MNZ Commercial Launchmaster	Phase 3 - Skipper

10.COMMENTS & RESULTS

The SBES bathymetric survey completed all objectives within specification. Successful coverage of the Manukau bar and harbour was achieved within the weather and tidal constraints.

Sea bed sediment samples were collected as requested and sent for analysis.





Figure 11: Papakura Channel, Manukau Harbour

11. RETENTION OF DATA

DML will retain copies of the project deliverables, including source data files, on its servers for a period of 12 months from completion of the project. The data will then be archived to a digital medium and retained for 7 years. After the initial 12-month period client requests to access and supply project data will incur a fee.

DML wishes to thank the T&T for the opportunity to undertake this project and looks forward to working together again in the future.

For Discovery Marine Ltd

Authored by		Date: 16 June 2023
	Wade Roest (NZCHS, MNZ SRL)	Hydrographic Surveyor
Approved by		Date: 20 June 2023
	Declan Stubbing (BSurv, CPHS1)	Chief Executive Officer

Digital Data pack:

- A. Report of Survey (.pdf)
- B. Survey Data: All points, 2m and 5m Grid

APPENDIX A – METADATA

Survey Company	Discovery Marine Ltd		
Project Name	Manukau Harbour Bathymetry Survey		
Project Number	2255		
Location	Clarks Beach, Auckland		
Client	Tonkin + Taylor		
Contract Number	-		
Survey Dates	Phase 1: 23-24/03/2023	Phase 2: 25-26/05/2023	Phase 3: 09-12/06/2023
Surveyor In Charge	D. Stubbing / W. Roest		
Field Personnel	W. Roest, D. Stubbing, J. VDP, D. Immenga, C. Low, M. Tecofsky, J. Fowden		
Office Personnel	D. Stubbing, W. Roest		
Horizontal Datum and Projection	NZTM2000		
Vertical Datum	Chart Datum Onehunga. Elevations supplied as heights positive above datum, negative below datum.		
Water Level Reduction	Tide	Tide Stations:	Onehunga and Paratutae Island
Origin of Coordinates and Levels	Chart Datum Onehunga being 5.593m below LINZ mark B.M. CC 65 (code ADLT)		
Survey Vessel	MV <i>Tupaia</i>		
Positioning System	Applanix POSMV Wavemaster II. G4+ correction		
Sonar System	Tritech PA500, 500kHz		
Acquisition Software	QPS Qinsy		
Processing and Delivery Software	QPS Qimera		
Data Collected	SBES Bathymetry		
Coverage Achieved	Transects with crosslines		
Accuracy Standard Achieved	Yes		
Bathymetric Gridded Surface Method	Average		
Bathymetric Gridded Surface Resolution			
Seafloor backscatter file type	NA		
File Format	ASCII XYZ		
Data Custodian Contact Details	Declan@dmlsurveys.co.nz		

Appendix B Water levels

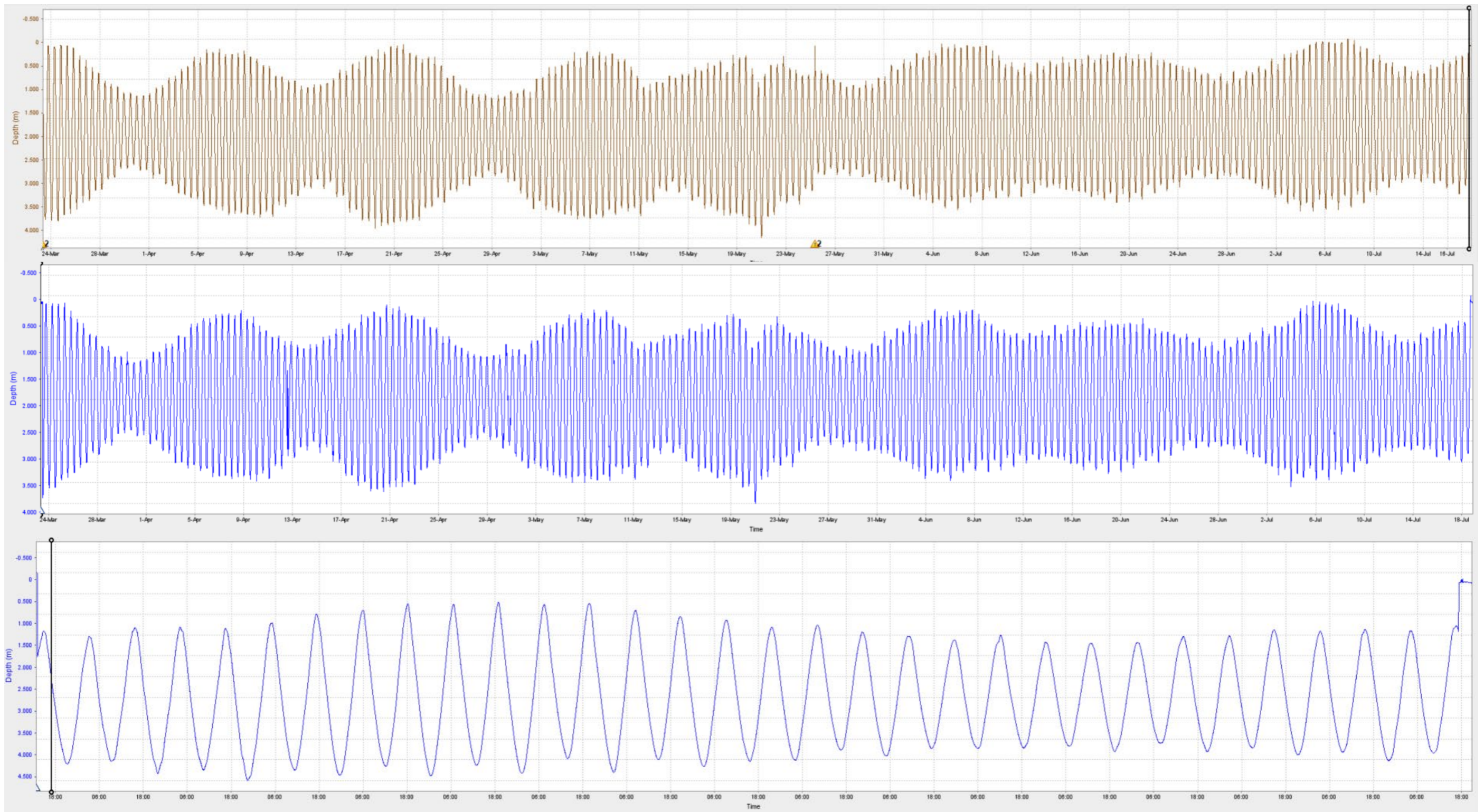


Figure Appendix B.1: Water depths measured by pressure transducers (Top = Waiuku, Middle = Cornwallis, Bottom = Karaka)

Appendix C Wave buoy data

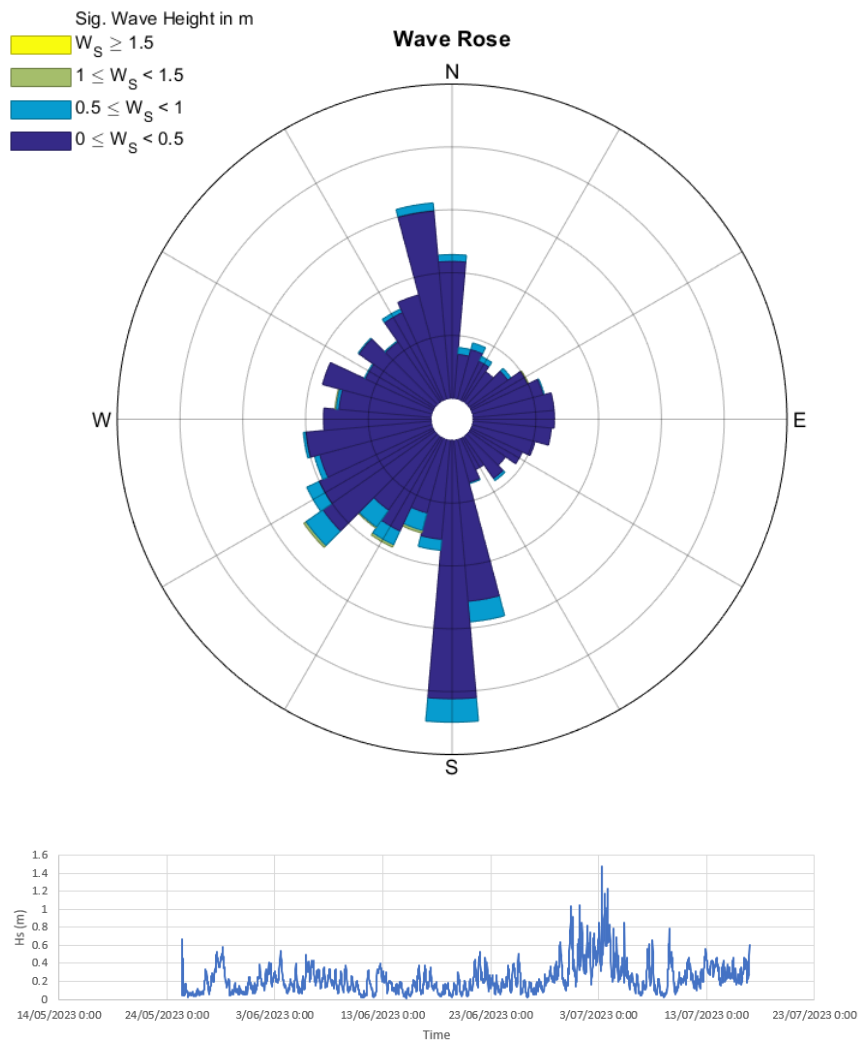


Figure Appendix C.1: Wave rose showing H_{sig} . and Peak period for harbour wave buoy for five month deployment from May through November 2023.

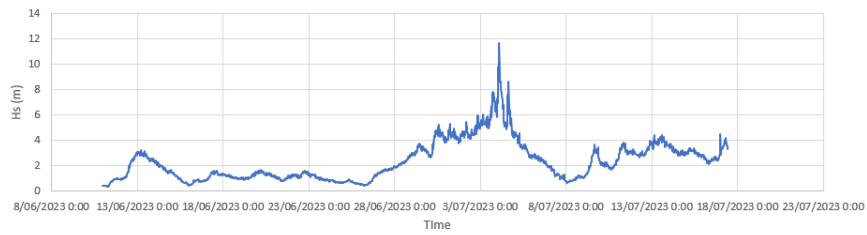
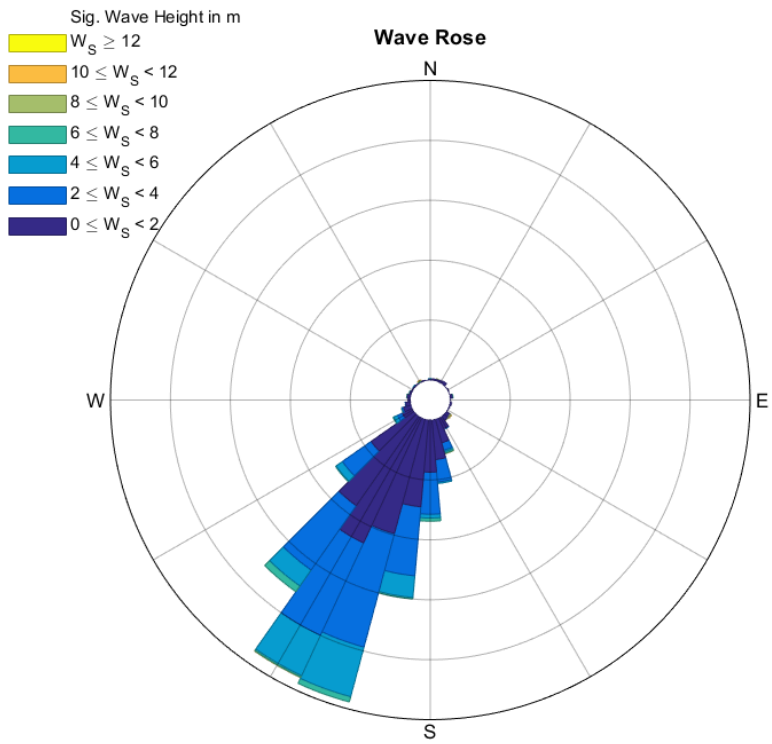


Figure Appendix C.2: Wave rose showing Hsig. and Peak period for offshore wave buoy for two month deployment from June through July 2023

Appendix D Current data

Table of Contents

Mission	3
General info	3
Statistics (for Report Date Range only)	3
Location	4
Figures	5
Polar Scatter Plots	5
Histogram of Speed	7
Histogram of Direction	9
Speed/Direction Occurence Frequency	11
Direction and Maximum Speed	13
Direction and Mean Speed	15
Direction and Flow	17
Enviroment	19
Deployment Comments	21
Nortek Eco	22
Measurement principle	23
How to interpret the data	23
Sources of error	24

Mission

This section contains basic mission information, including information about the instrument used in this deployment mission, a location map and basic data statistics from the mission. All times are referenced to the local time of the device used to configure the Eco. All depths are referenced to the water surface

General info

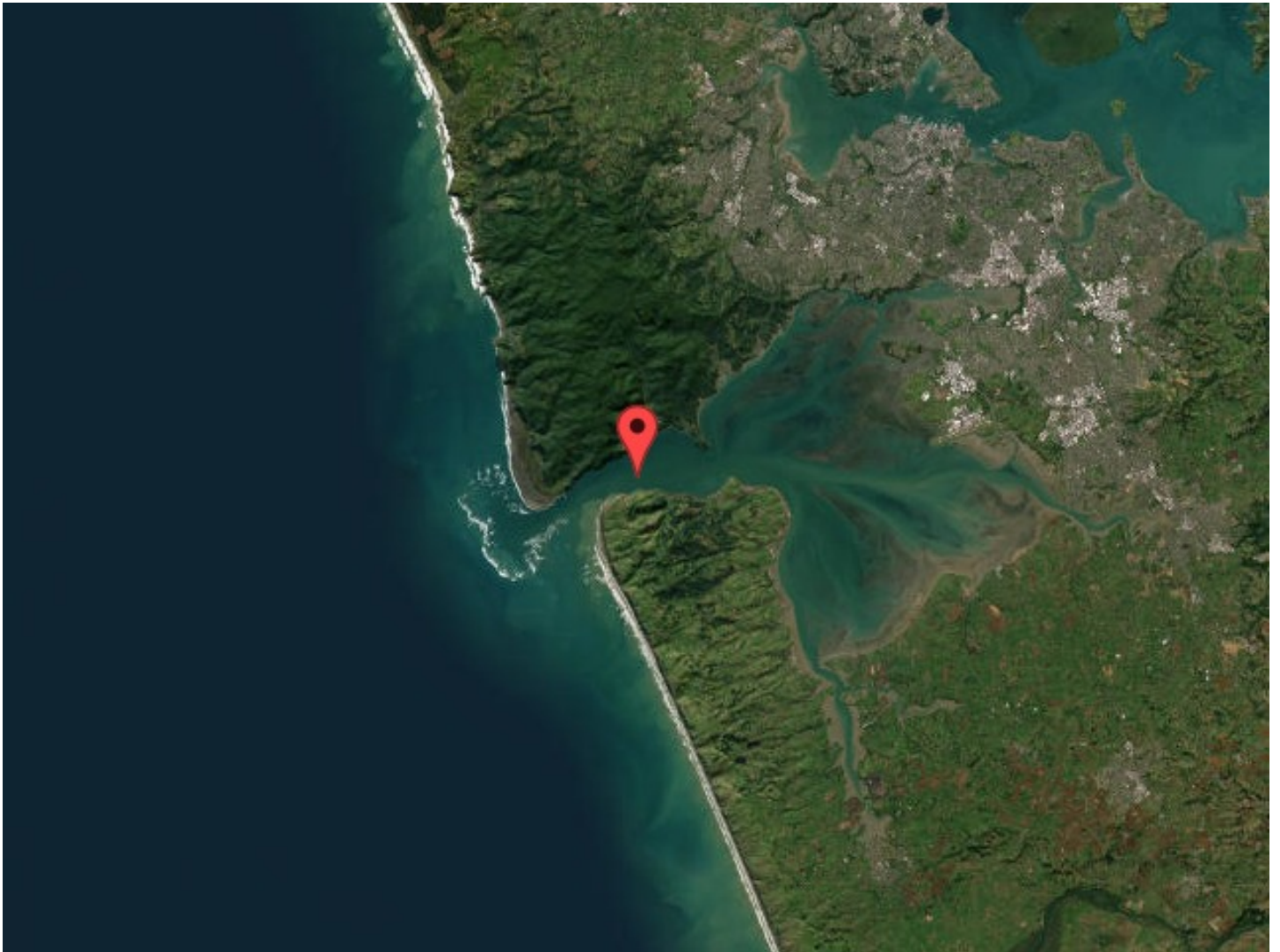
Deployment/File Name: Eco38_20230323094724			
Operator: Peter Quilter			
Full Deployment Date Range: 23/03/2023, 9:47:31 am to: 24/03/2023, 7:57:31 pm			
ID	Eco_0038	Firmware	8008.4
Samples	411	Interval (minutes)	5
Salinity	Salt water	35 ppt	
Latitude	-37.036148	Longitude	174.560608
Magnetic declination	20.2222		
Average direction	195.6 deg	Average speed	1.15 m/s
Max Depth Below Surface	17.14 m		
Upper layer depth	8.67 m		
Middle layer depth	11.50 m		
Lower layer depth	14.32 m		
User id	CCAA9622-A3B4-42DD-8E45-DCF58FF1FB28		
Data id	144D9F43-B5F1-4ADB-A0AB-FF52F18578B3		
Created	24/03/2023, 8:11:11 pm		
Processor version	1.0.22.0		
Processed	24/03/2023, 8:25:44 pm		

Statistics (for Report Date Range only)

		Upper	Middle	Lower	Unit	
Speed	Mean	1.26	1.17	1.02	m/s	
	Max	2.09	1.98	1.73	m/s	
	Min	0.09	0.08	0.10	m/s	
	Std. dev	0.55	0.50	0.42	m/s	
		Mean	Max	Min	Std. dev	Unit
Temperature	20.7	28.2	19.9	1.5	°C	
Pressure	12.6	17.1	0.0	6.2	m	
Tilt	9.3	73.9	1.2	15.1	deg	

Location

Deployment location: Latitude -37.036148 and Longitude 174.560608.



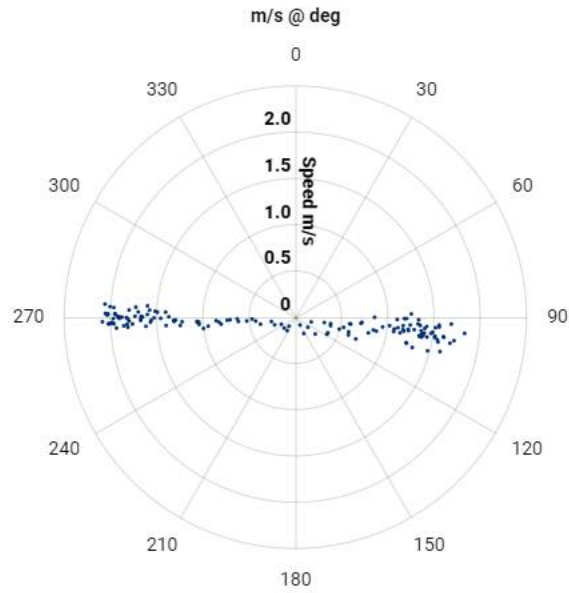
Tiles © Esri — Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, UPR-EGP, and the GIS User Community

Figures

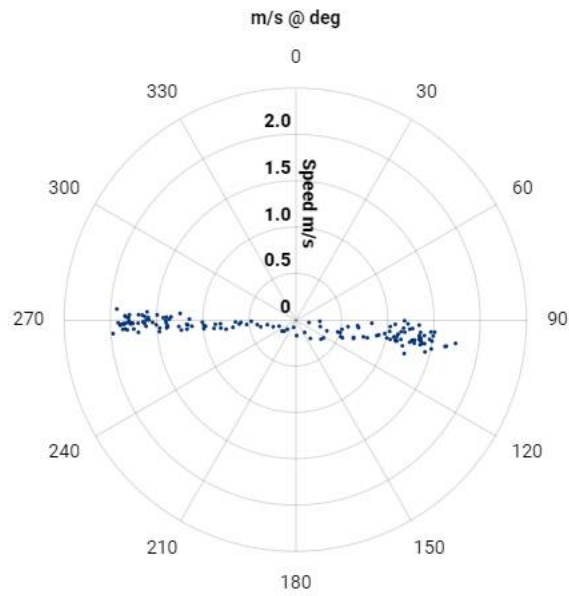
Polar Scatter Plots

These plots show the current speed and direction in a polar coordinate graph (North at the top, 0°) for each of the three depth layers. Data is shown for the Report Date Range. The numbers on the outside of the graph indicate the direction the current is flowing towards for that layer. For example, if a dot is plotted along the 40° line, then it indicates current flowing towards the Northeast. The distance away from the center of the graph indicates how fast the current is flowing: the closer to the center, the slower the water is moving.

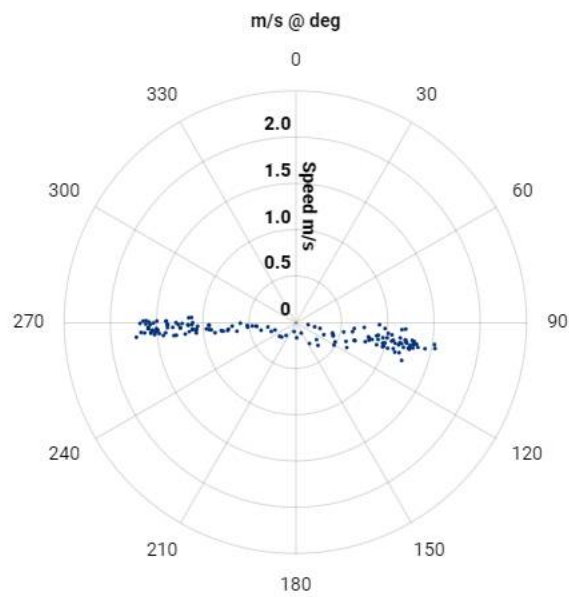
Upper Layer 8.67 m



Middle Layer 11.5 m



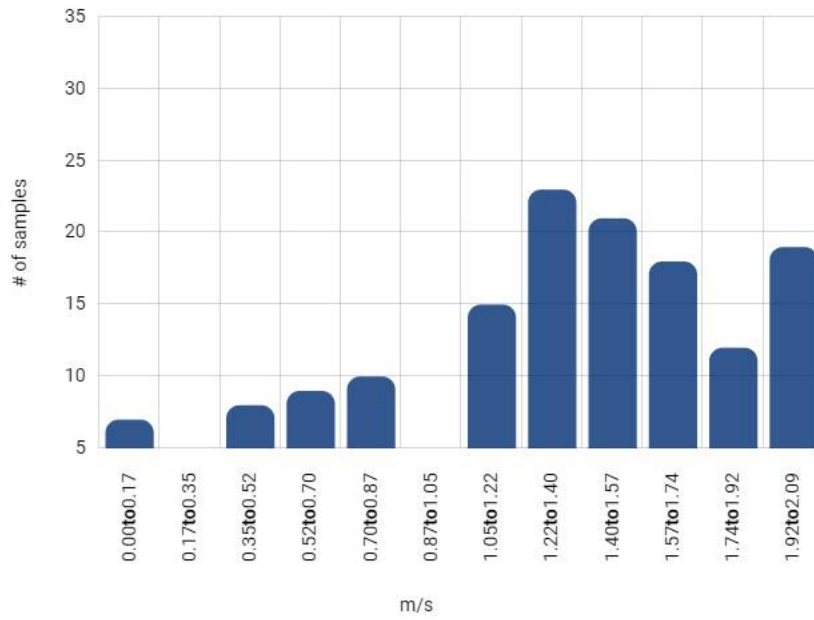
Lower Layer 14.32 m



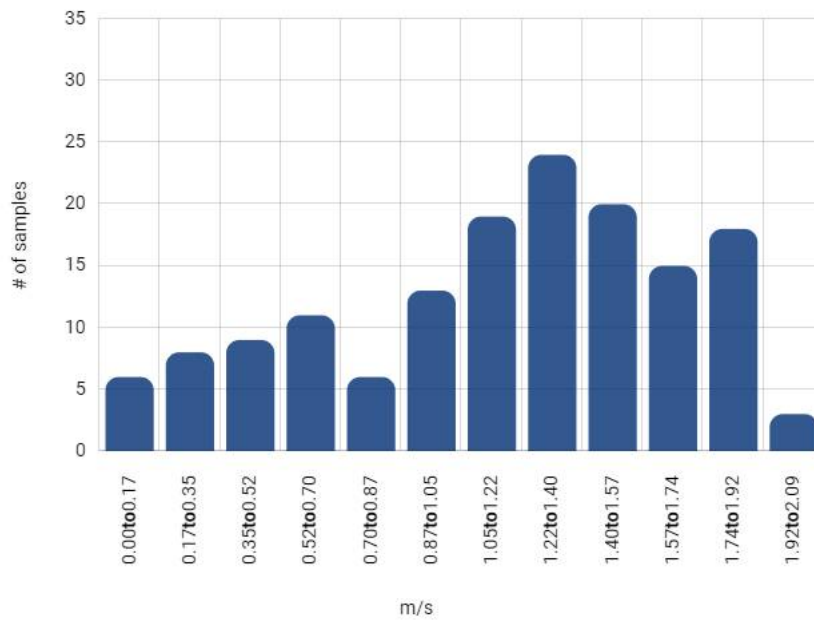
Histogram of Speed

These plots indicate the distribution of current speed for each of the three depth layers. The graph is generated by first taking the current speed data from the Report Date Range and dividing it into intervals of equal size. Then, the number of samples (i.e. an individual measurement interval) in each interval is counted. The numbers on the bottom (X-axis) indicate the speed intervals. The numbers on the left (Y-axis) indicate the number of samples in each interval. For example, if the highest bar on the graph is from the 0.3-0.4 m/s range, then that means that the current speed in this range happens more often than any other speed in the Report Date Range.

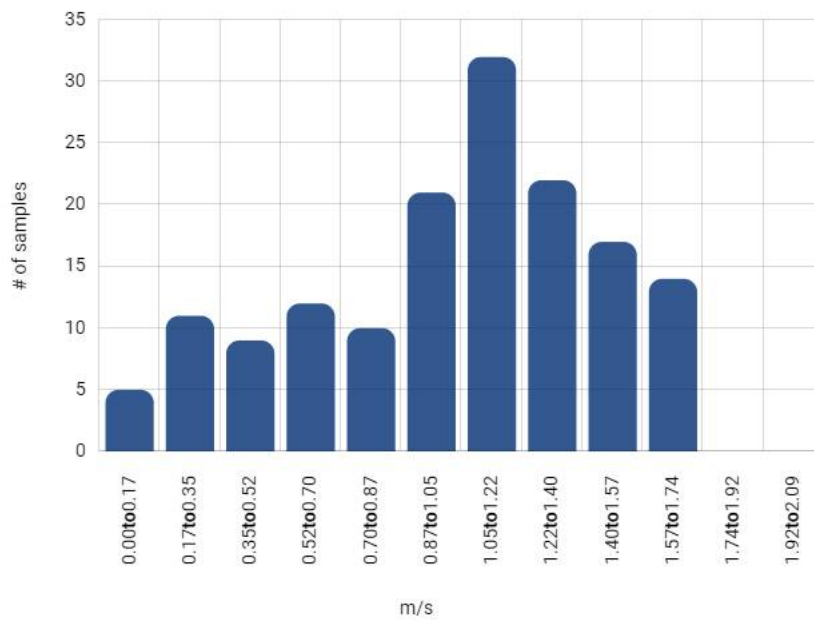
Upper Layer 8.67 m



Middle Layer 11.5 m



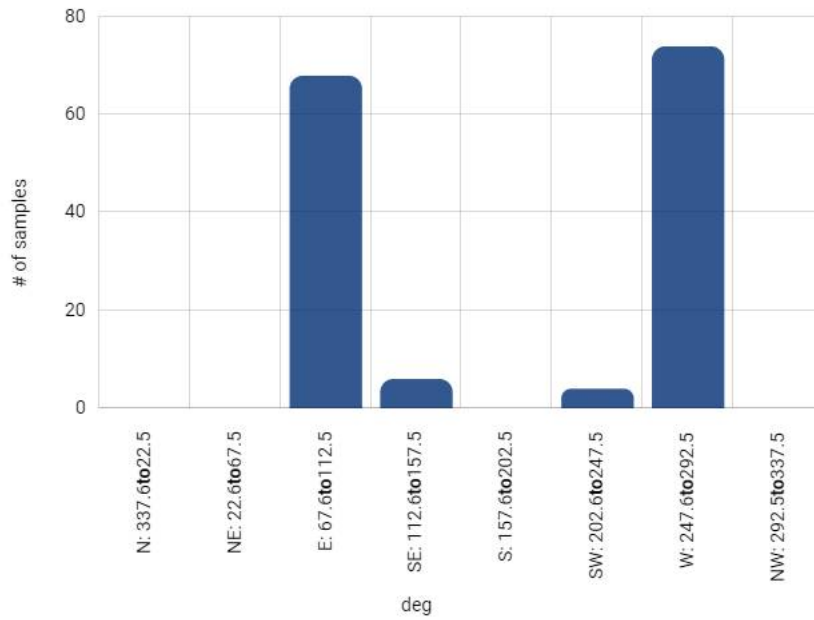
Lower Layer 14.32 m



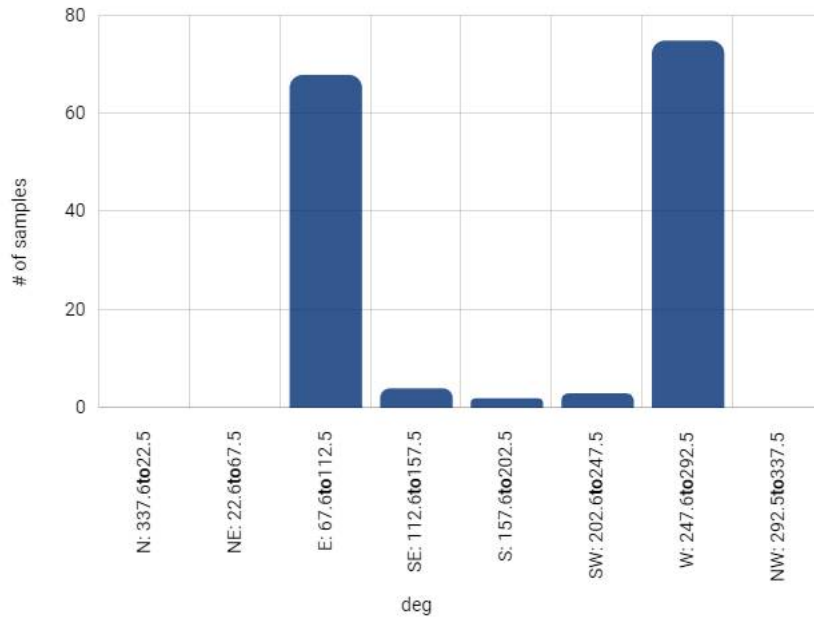
Histogram of Direction

These plots indicate the distribution of current direction for each of the three depth layers. The graph is generated by first taking the current direction data from the Report Date Range and dividing it into ranges of equal size. Then, the number of samples (i.e. an individual measurement interval) in each range is counted. The numbers on the bottom (X-axis) indicate the direction ranges. The numbers on the left (Y-axis) indicate the number of samples in each range. For example, if the highest bar on the graph is from the 90-120° range, then that means that the current direction in this range happens more often than any other direction during the Report Date Range.

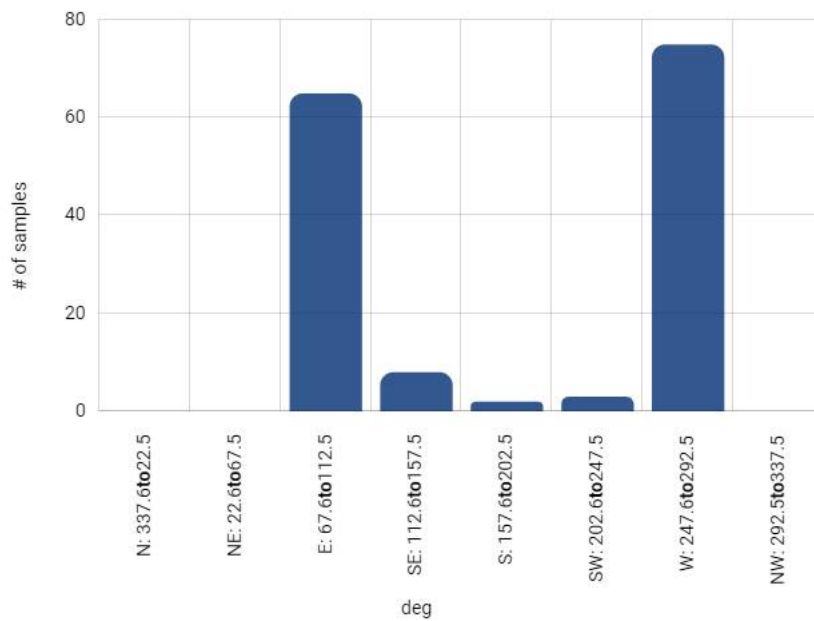
Upper Layer 8.67 m



Middle Layer 11.5 m



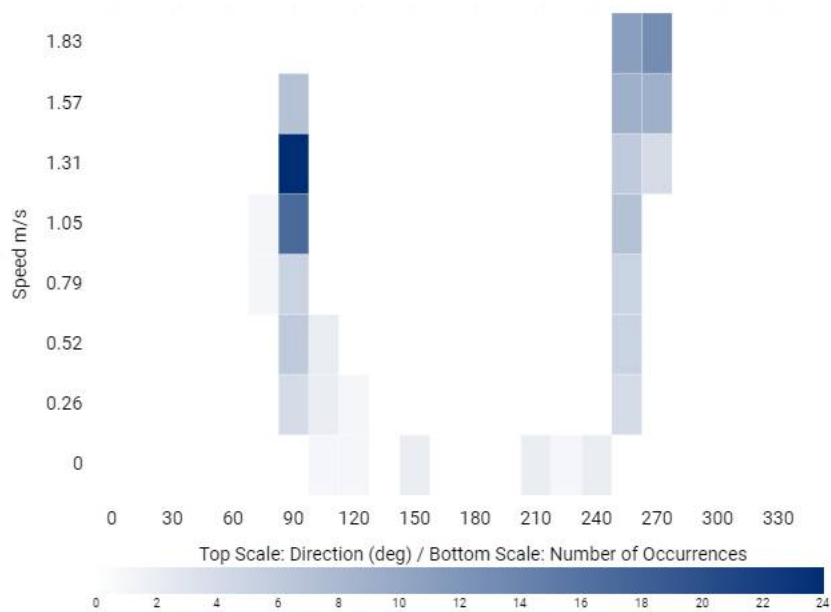
Lower Layer 14.32 m



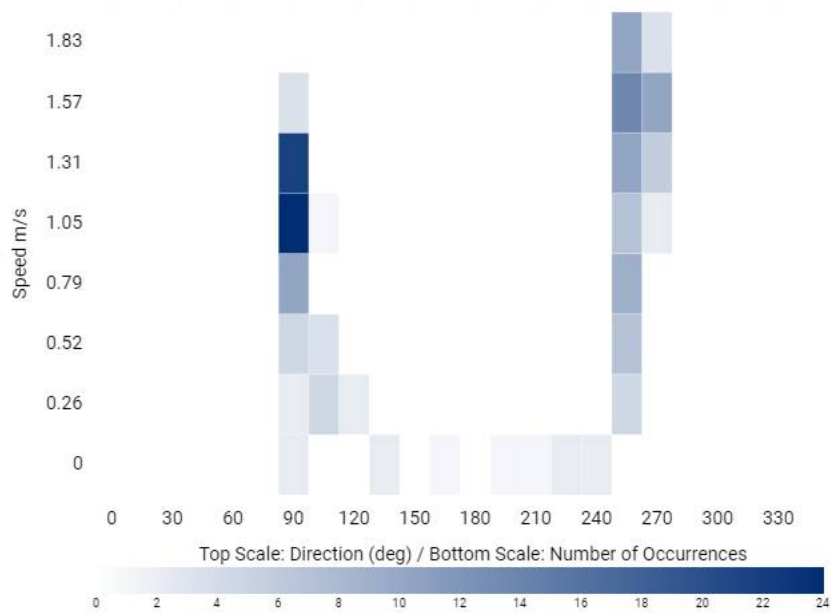
Speed/Direction Occurrence Frequency

These plots combine the speed and direction histograms to show the occurrence frequency of current speed and direction for each of the three depth layers in a cartesian coordinate graph. Data is shown for the Report Date Range. The numbers on the left (Y-axis) indicate the current's speed while the numbers along the lower (X-axis) indicate the direction the current is flowing towards. The color of each block inside the graph indicates the occurrence frequency of that particular speed/direction combination, scaled by the color bar on the bottom. For example, if the block with the darkest color is the intersection of 270° and 0.3 m/s, then that means that the currents are moving at this speed and direction more often than any other speed/direction.

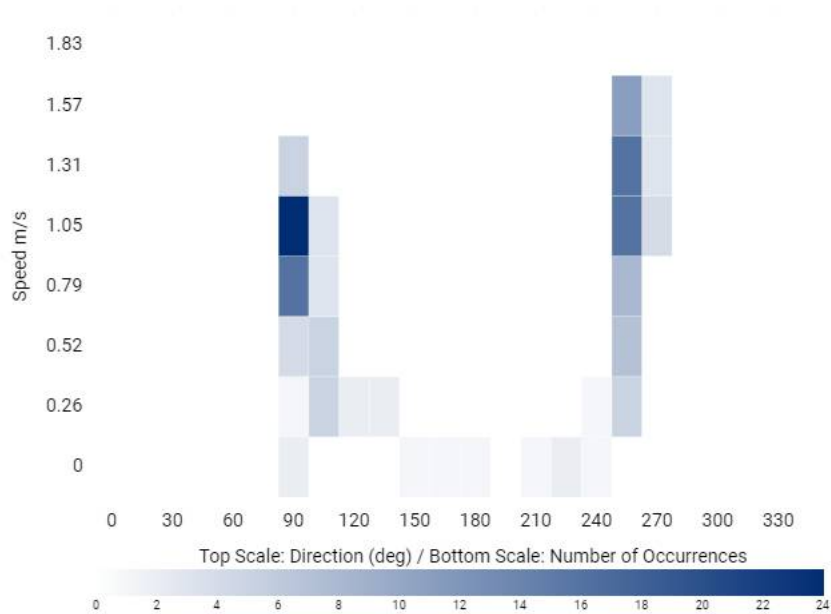
Upper Layer 8.67 m



Middle Layer 11.5 m



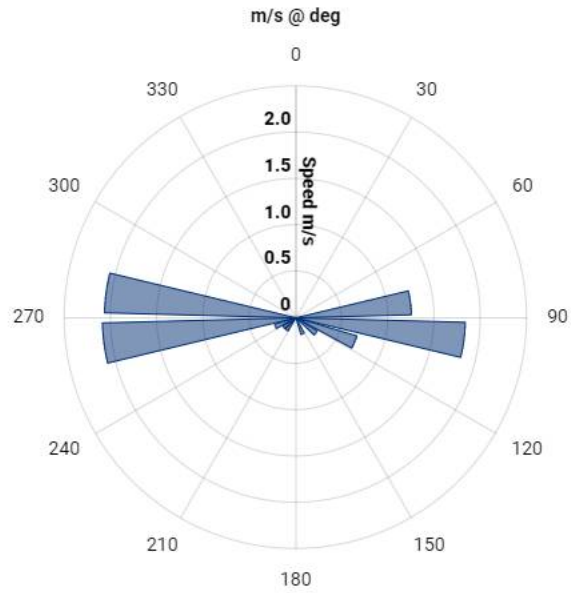
Lower Layer 14.32 m



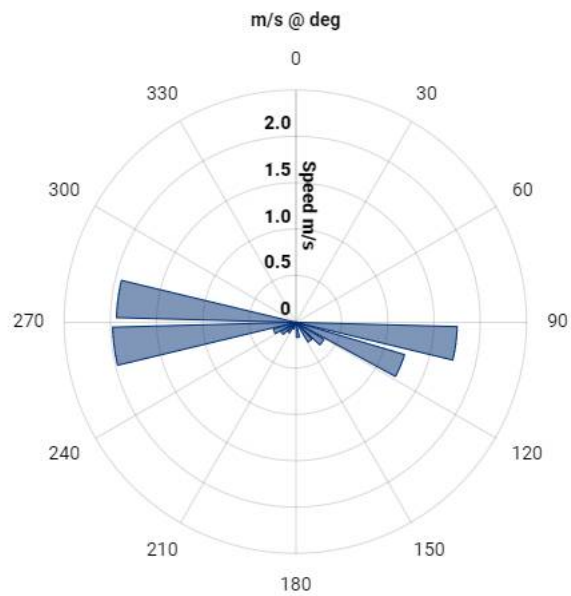
Direction and Maximum Speed

Similar to the Polar Scatter plots, these plots show the current speed and direction in a polar coordinate graph (North at the top; 0°) for each of the three depth layers. However, here only the maximum current speed, and its corresponding direction, are shown. The data are plotted as bars extending from the center of the graph. For example, if the longest bar (the one extending the farthest from the center of the graph) is at 270° , then that means the highest current speed was measured along this direction for this particular depth layer.

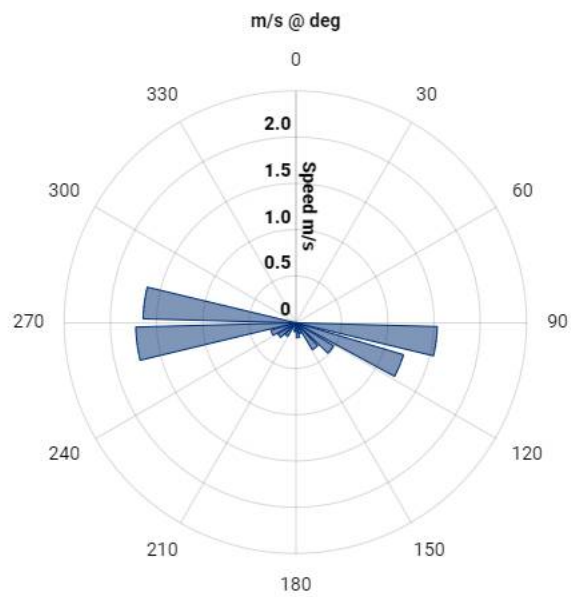
Upper Layer 8.67 m



Middle Layer 11.5 m



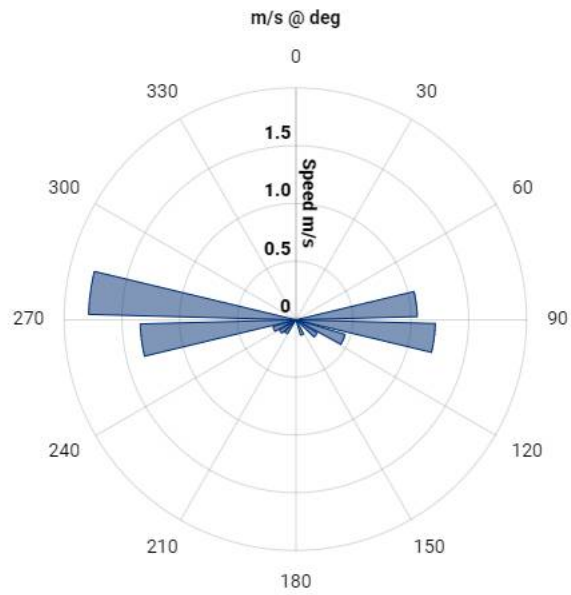
Lower Layer 14.32 m



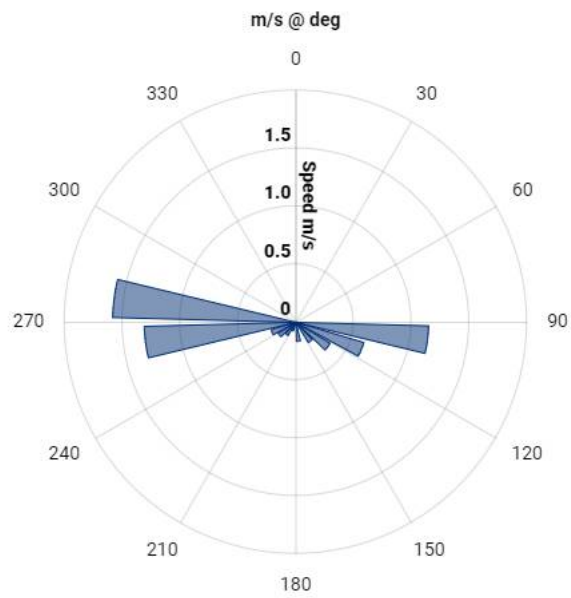
Direction and Mean Speed

Similar to the Polar Scatter plots, these plots show the current speed and direction in a polar coordinate graph (North at the top; 0°) for each of the three depth layers. However, here only the mean current speed, and its corresponding direction, are shown. The data are plotted as bars extending from the center of the graph. For example, if the longest bar (the one extending the farthest from the center of the graph) is at 180°, then that means the mean (average) current speed was measured along this direction for this particular depth layer.

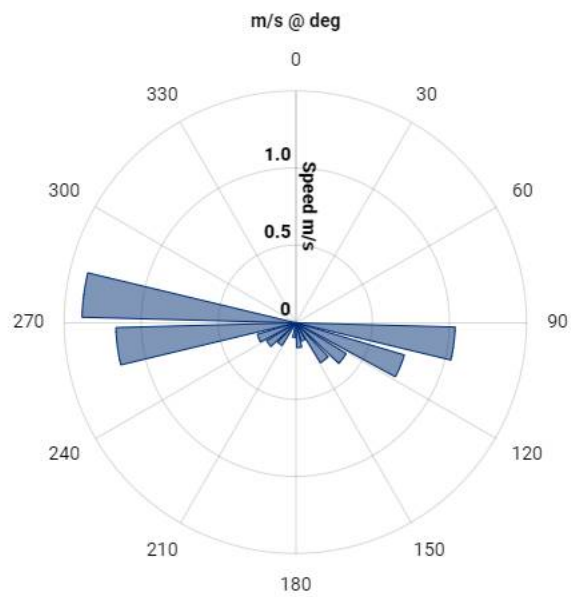
Upper Layer 8.67 m



Middle Layer 11.5 m



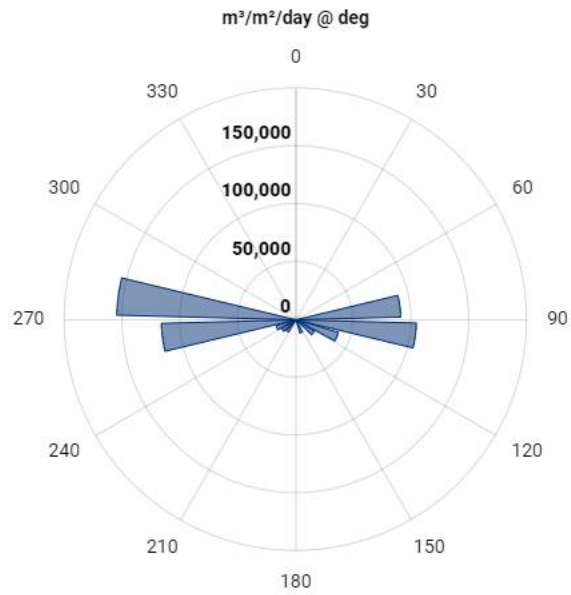
Lower Layer 14.32 m



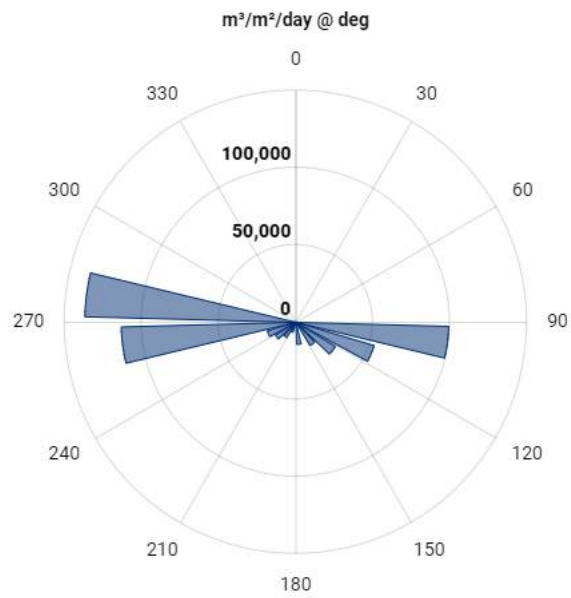
Direction and Flow

These plots show the average volume of water per day (flow) over the cross sectional area of the acoustic cone above the instrument. Data has units of $\text{m}^3/\text{m}^2/\text{day}$ (cubic meter per square meter per day). The data are plotted as bars extending from the center of the graph. For example, if the longest bar (the one extending the farthest from the center of the graph) is at 320° , and the distance from the center of the graph is along the 10,000 inner circle, that means that an average of 10,000 m^3 of water per day flows across the acoustic cone of the instrument for that particular depth layer.

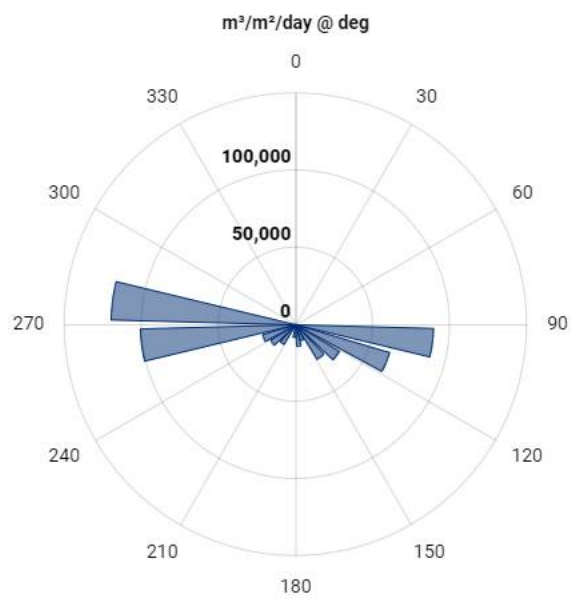
Upper Layer 8.67 m



Middle Layer 11.5 m



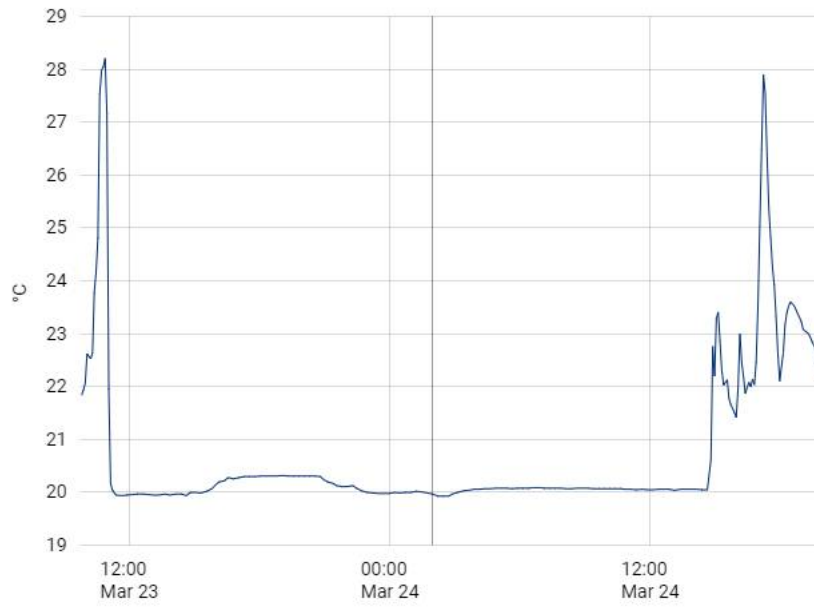
Lower Layer 14.32 m



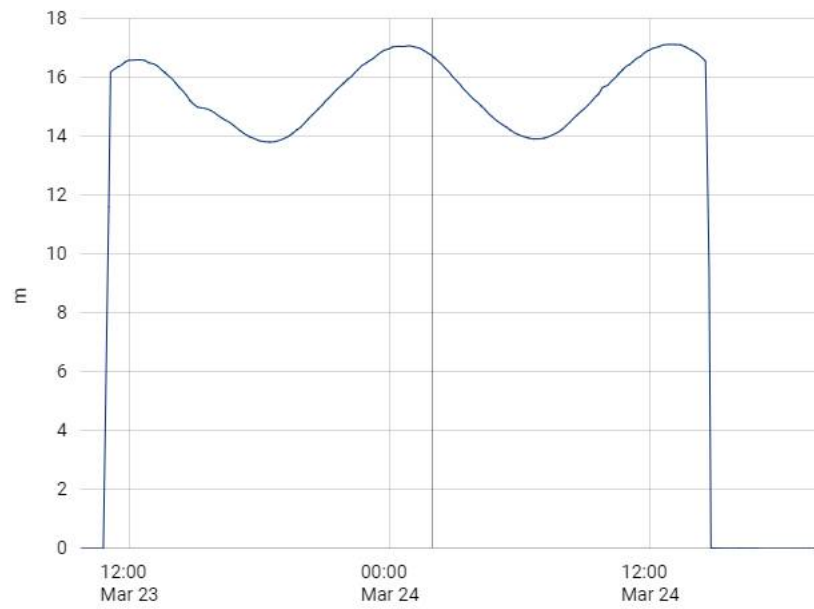
Environment

Three plots provide details about the environment over time (i.e. a time-series). These include: water temperature, water pressure (depth) and instrument tilt angle. Data is shown for the Report Date Range. The number on the bottom (X-axis) indicate the date/time while the numbers of the left (Y-axis) indicate the respective data value.

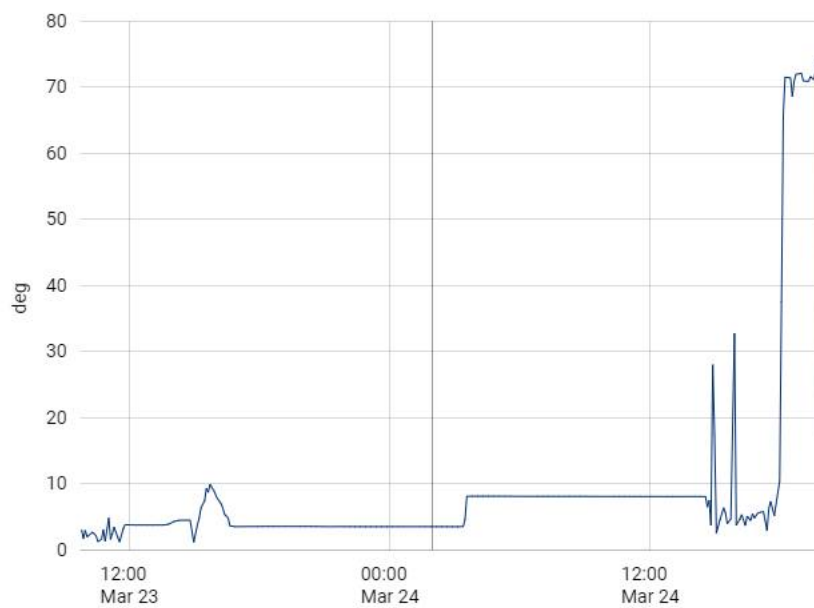
Temperature



Pressure



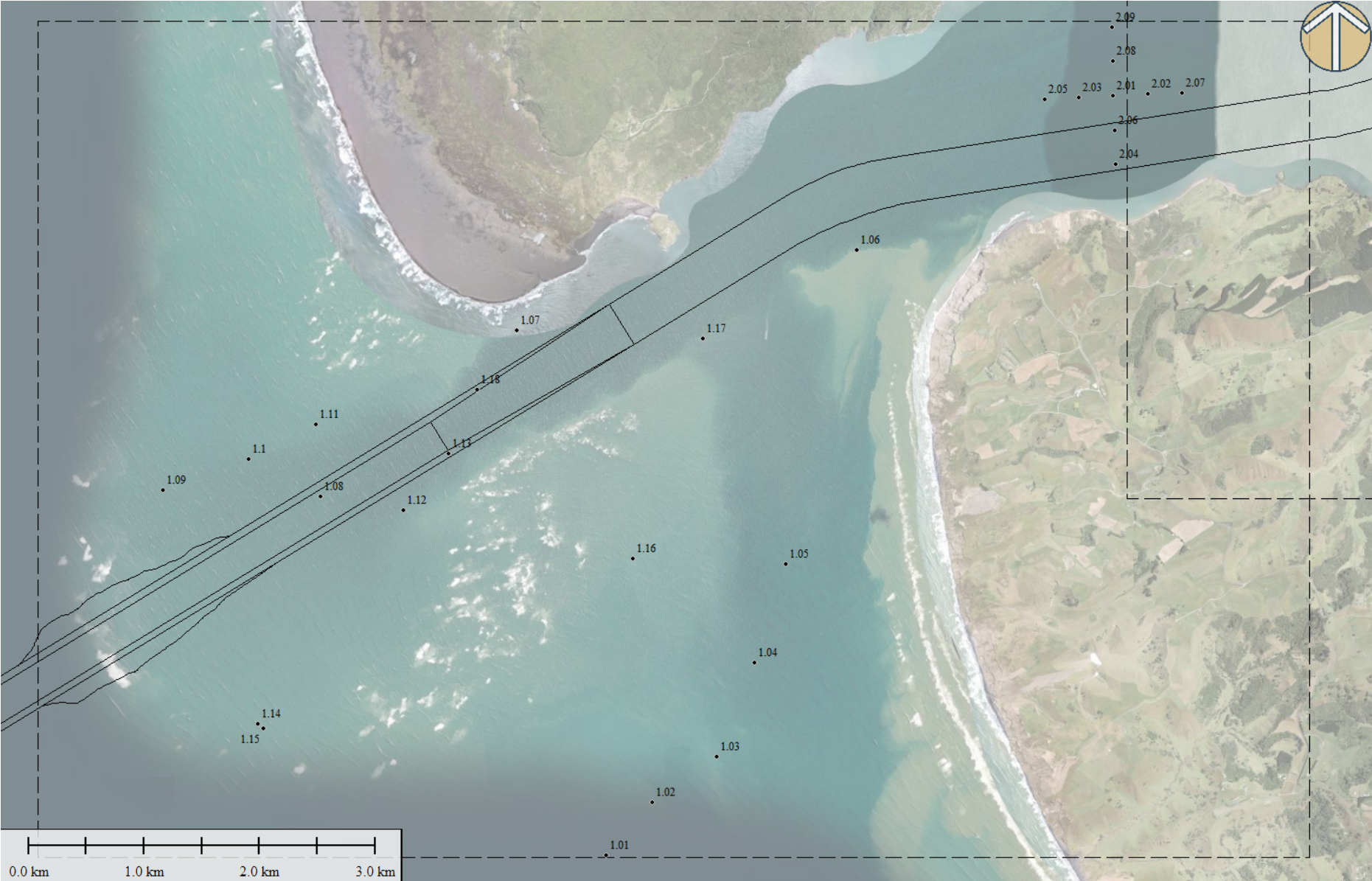
Tilt



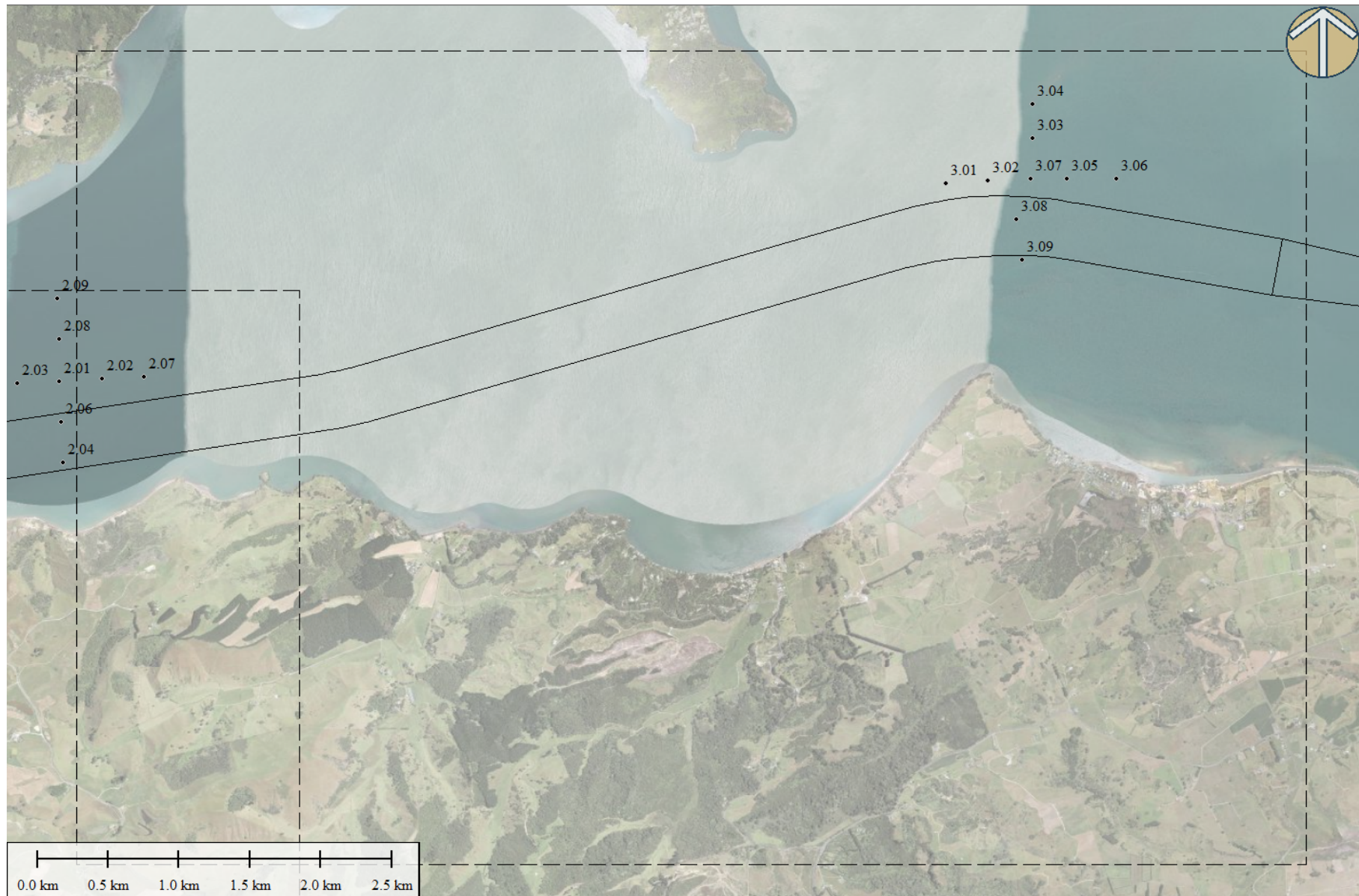
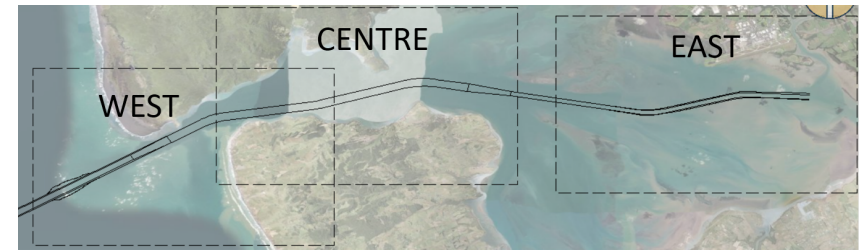
Appendix E Sediment data



Sampling location plan - Bar Area (west)

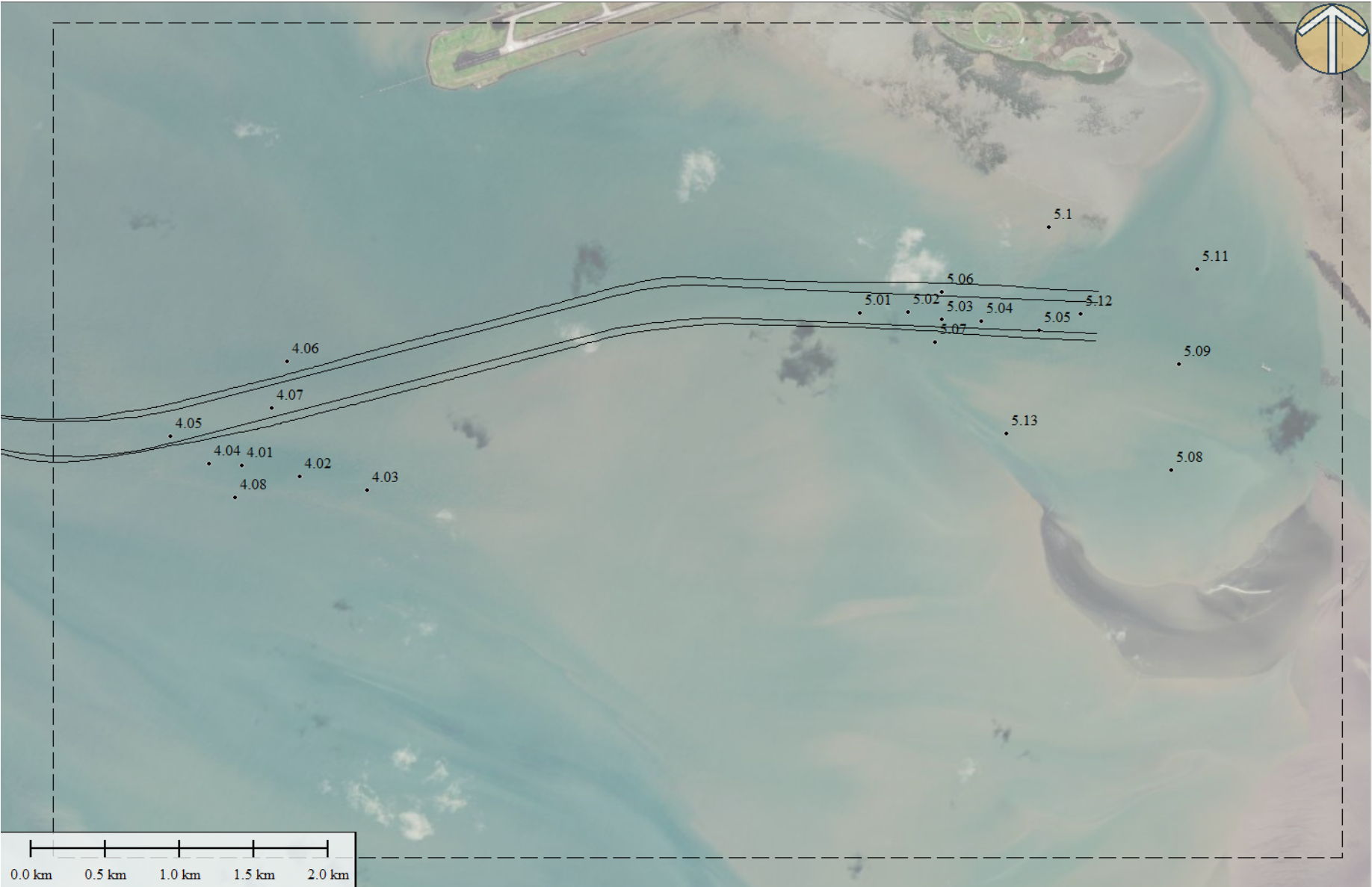


Sampling location plan - Central Area



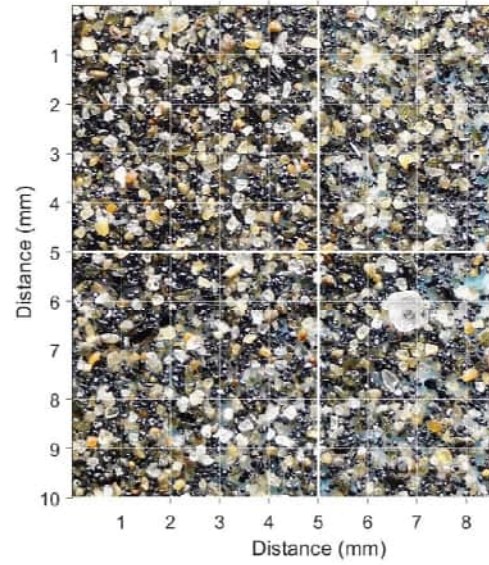
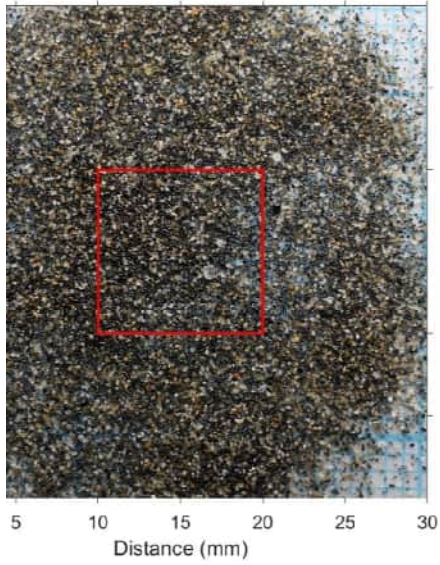


Sampling location plan - Upper harbour Area (east)

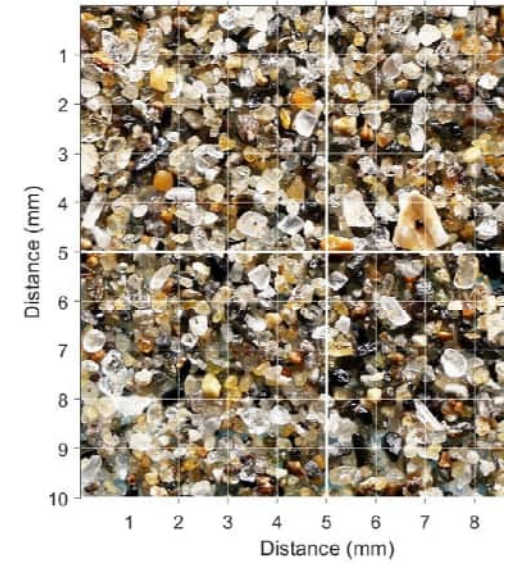
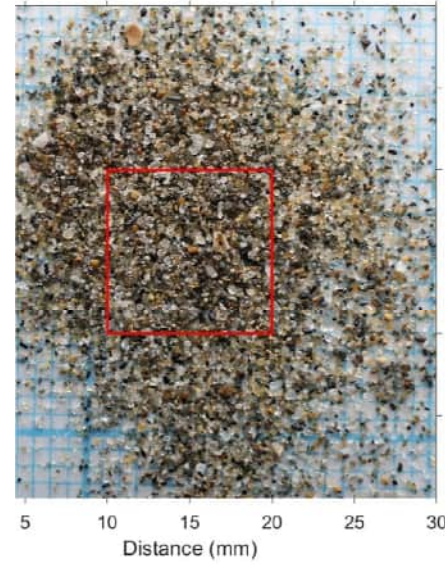


Sample photographs

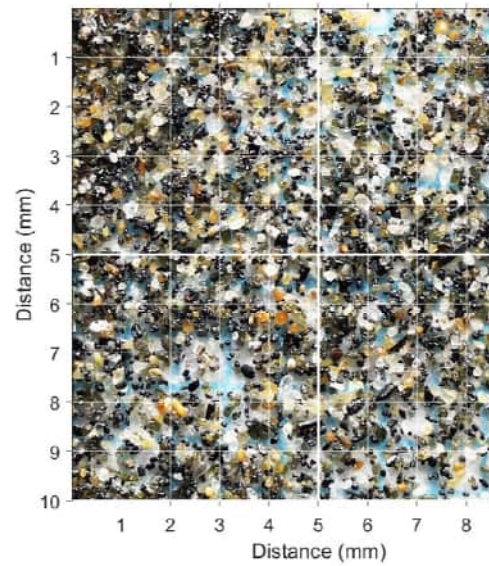
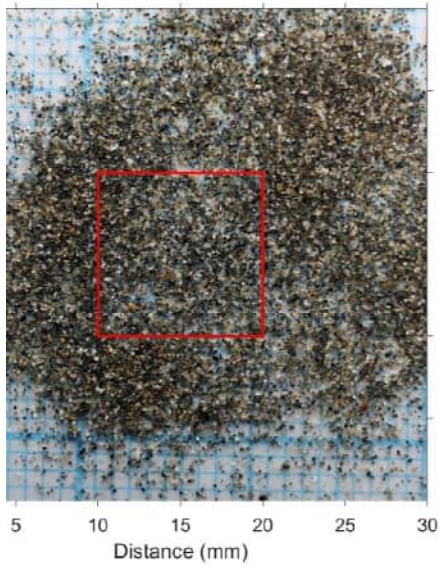
1.02.JPG



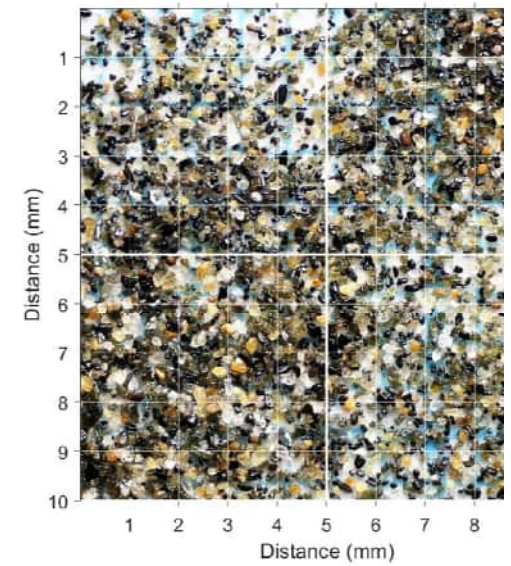
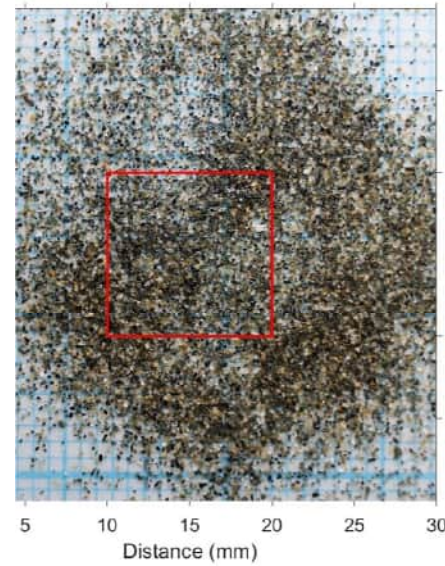
1.04.JPG



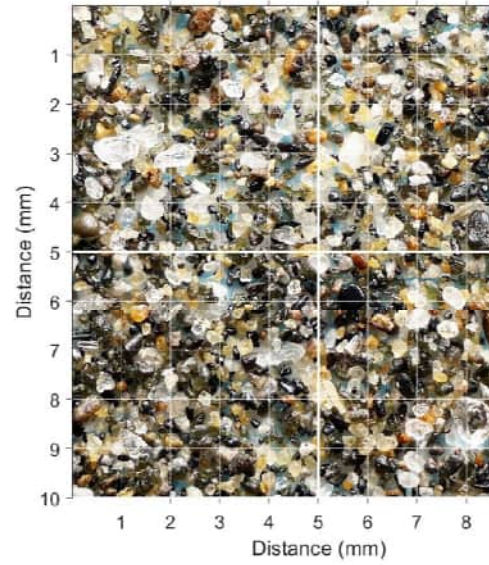
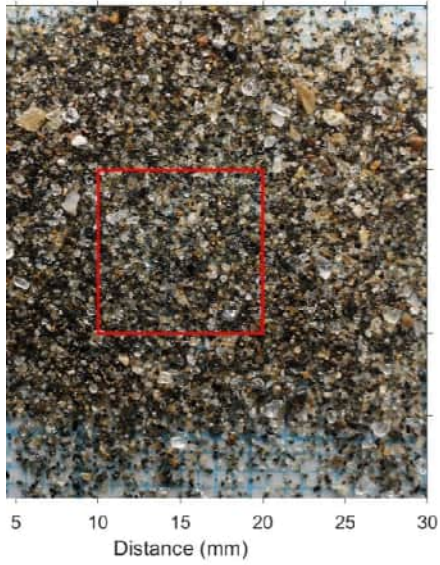
1.01.JPG



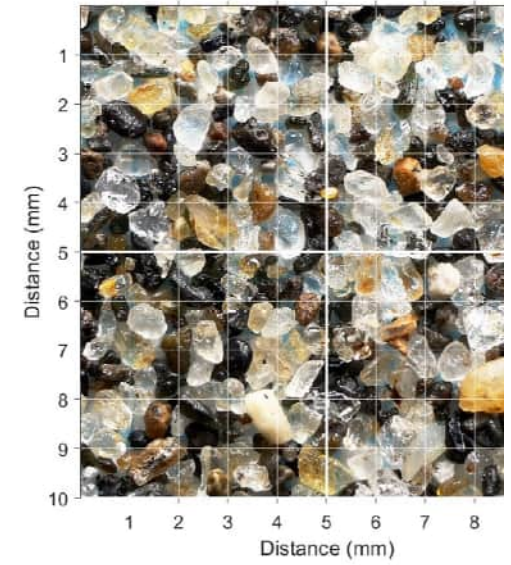
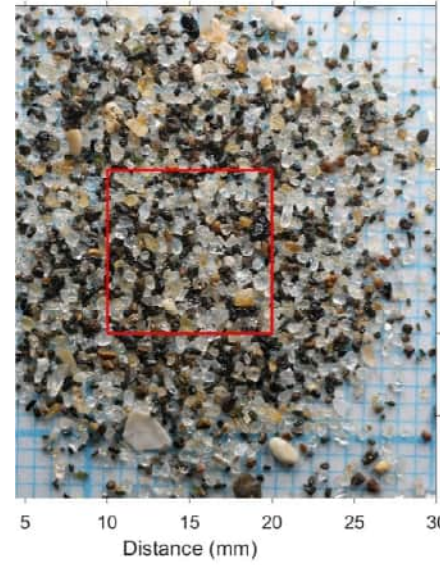
1.03.JPG



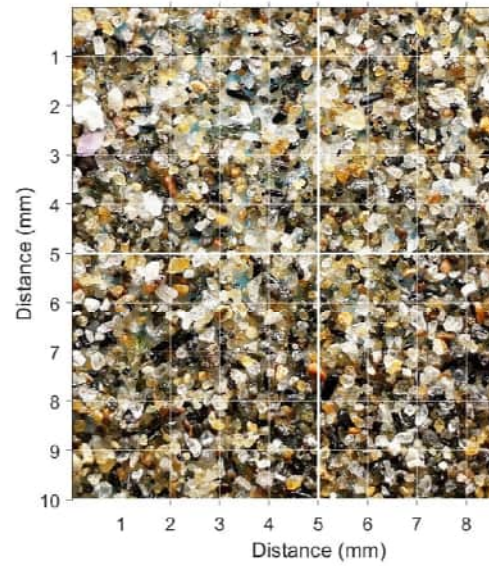
1.06.JPG



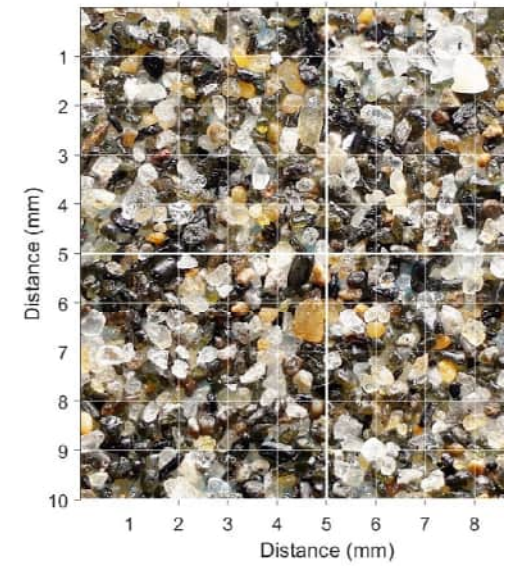
1.08.JPG



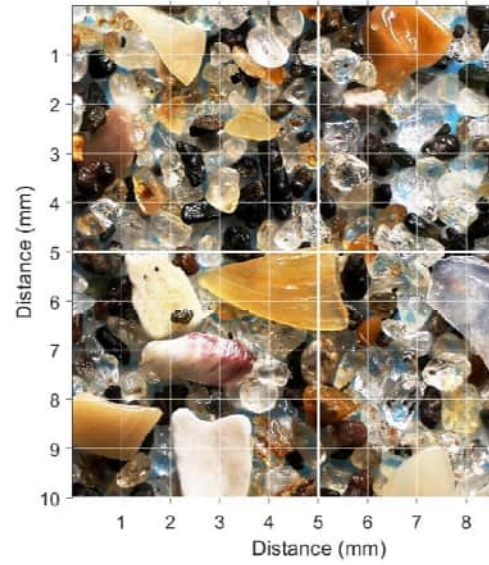
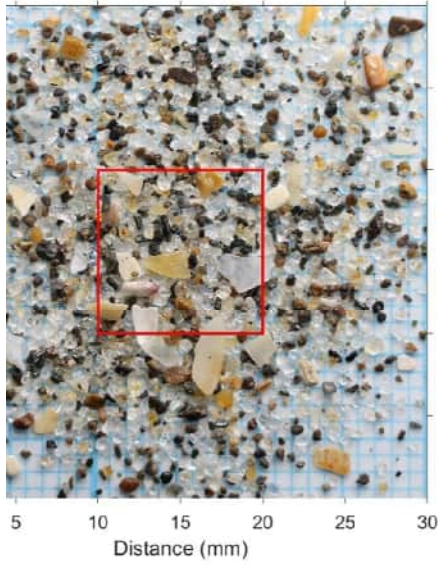
1.05.JPG



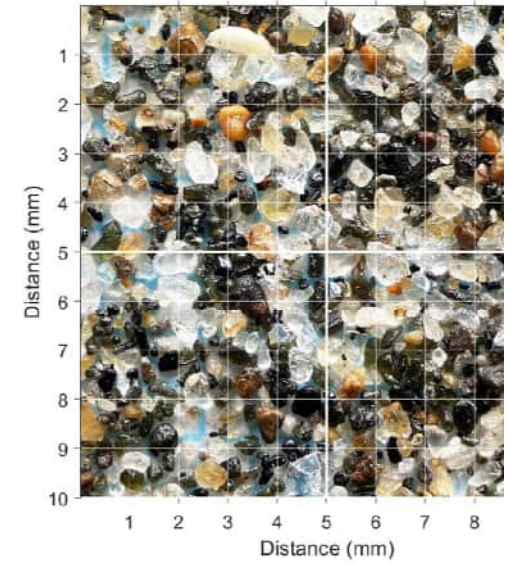
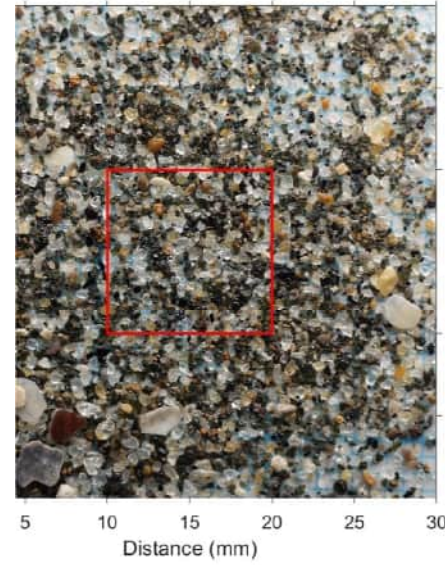
1.07.JPG



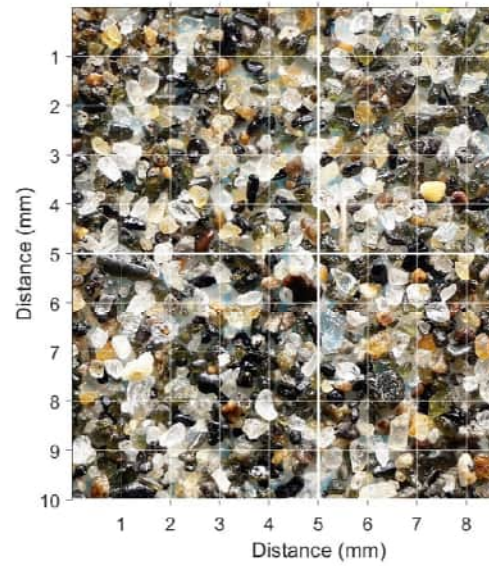
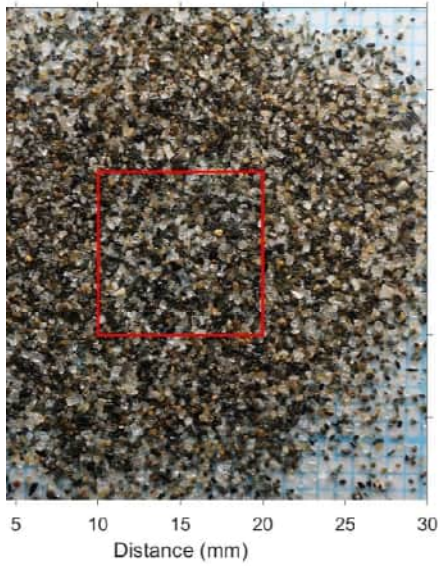
1.10.JPG



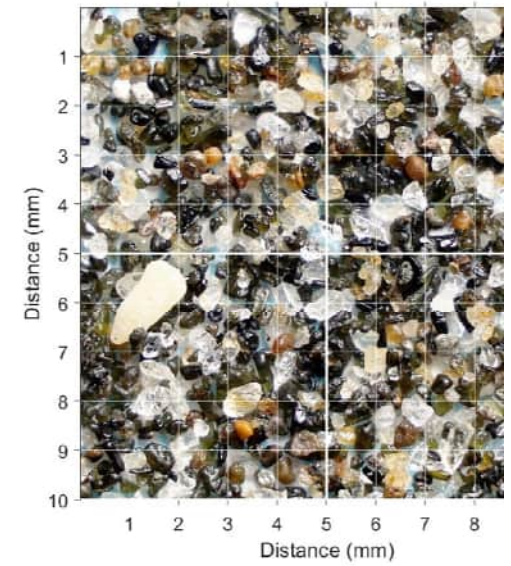
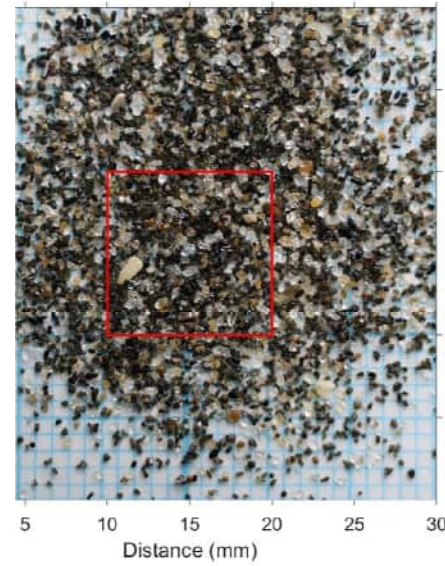
1.12.JPG



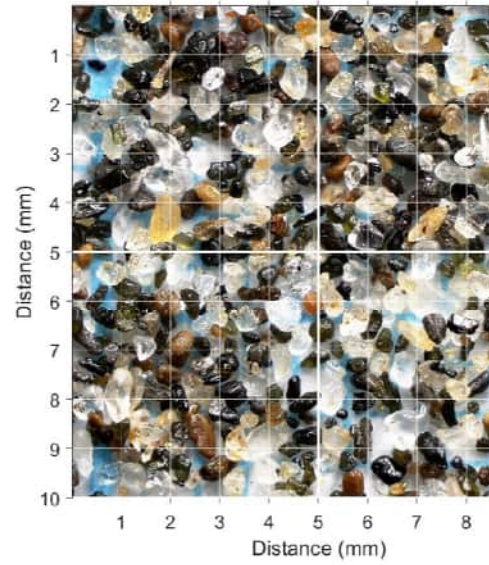
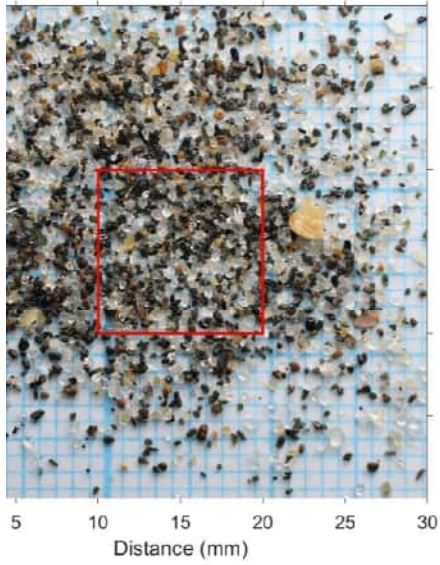
1.09.JPG



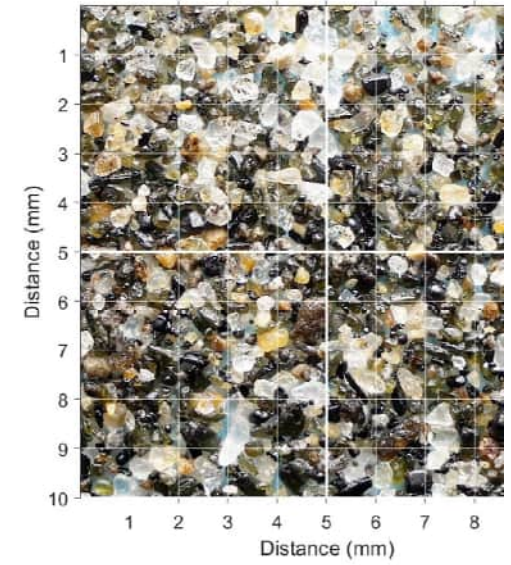
1.11.JPG



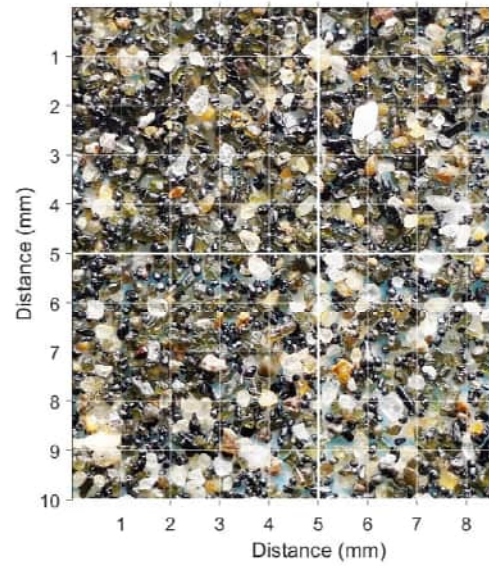
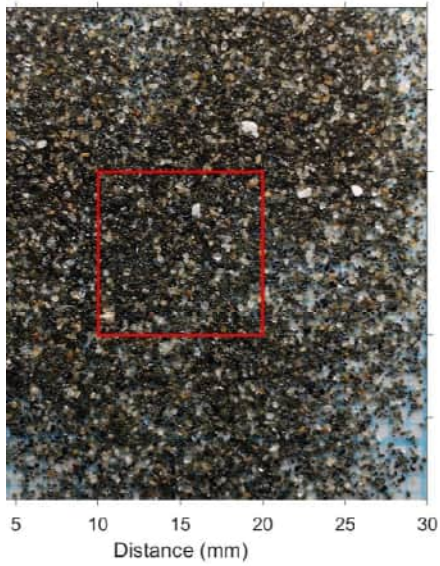
1.14.JPG



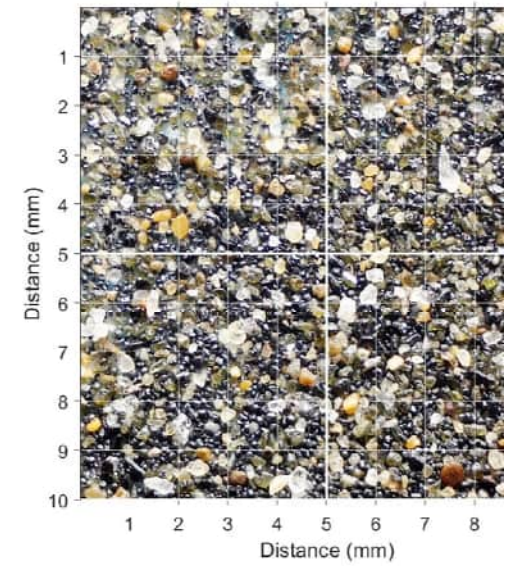
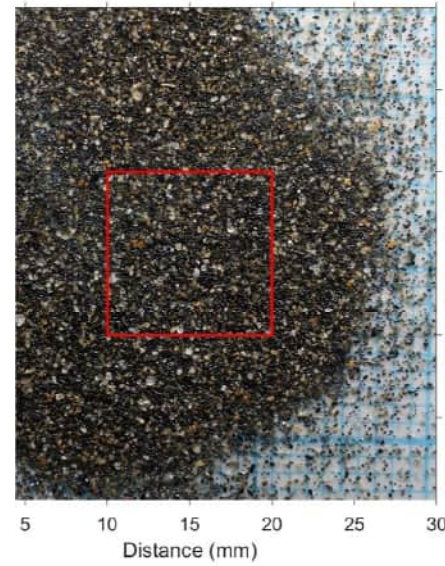
1.16.JPG



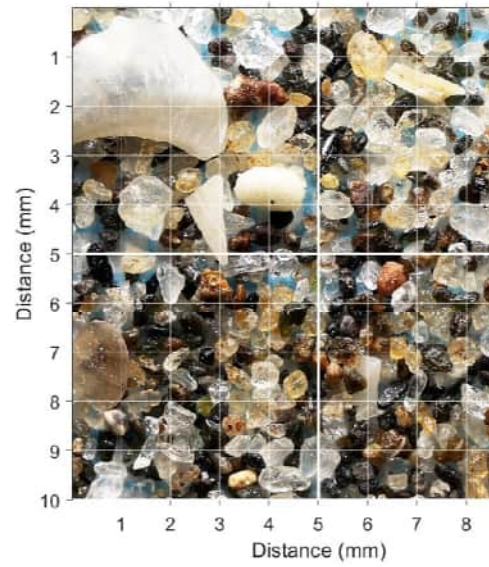
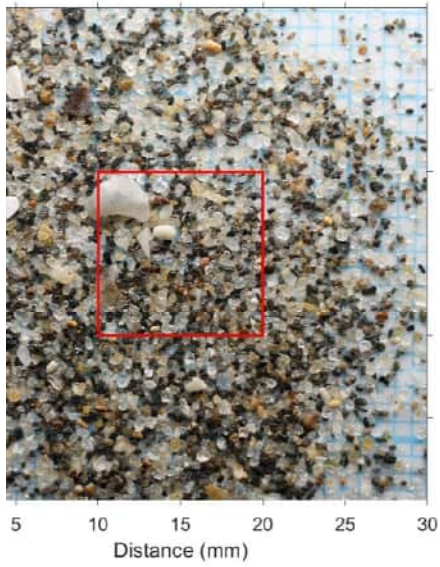
1.13.JPG



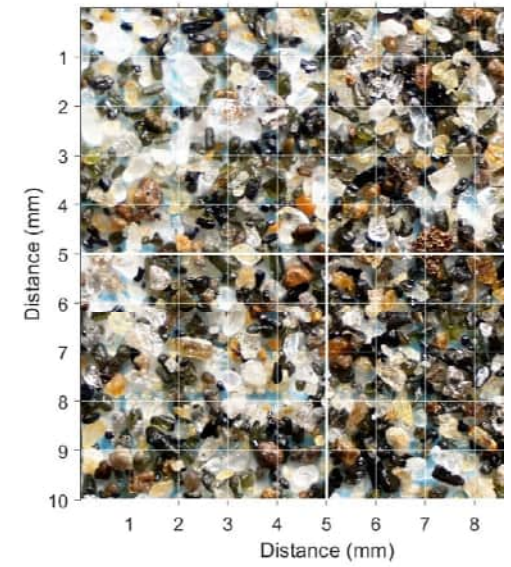
1.15.JPG



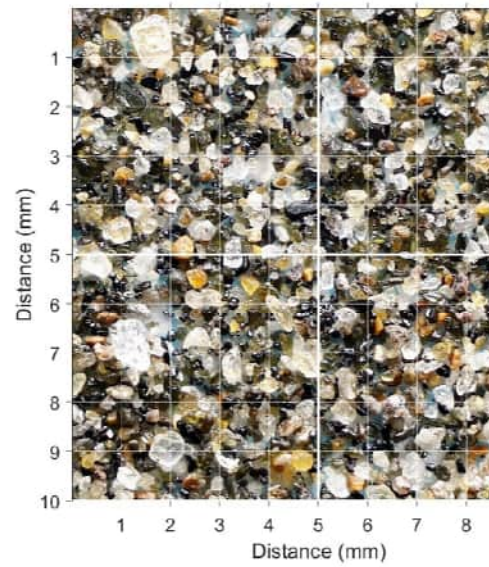
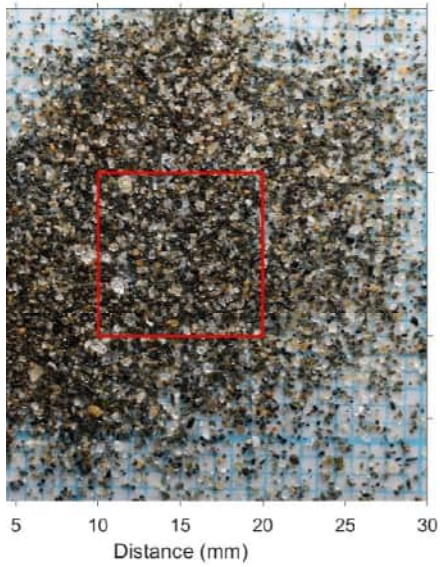
1.18.JPG



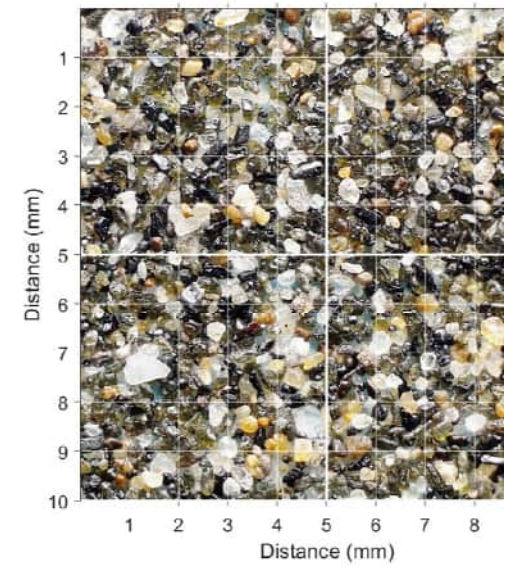
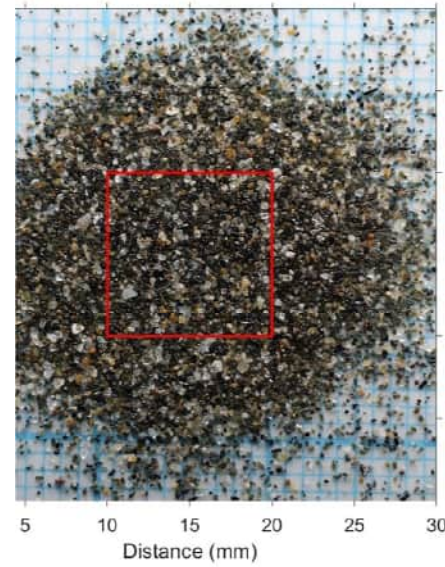
2.02.JPG



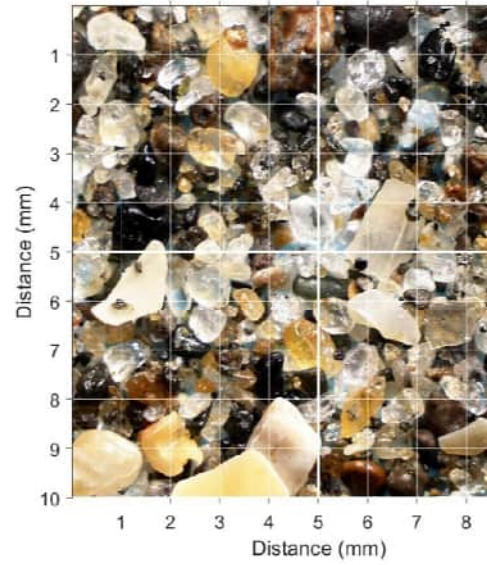
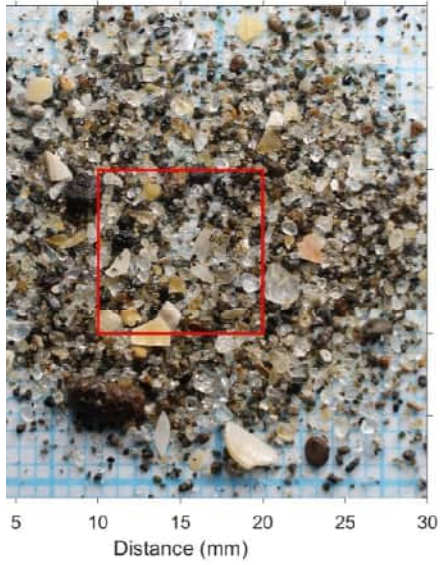
1.17.JPG



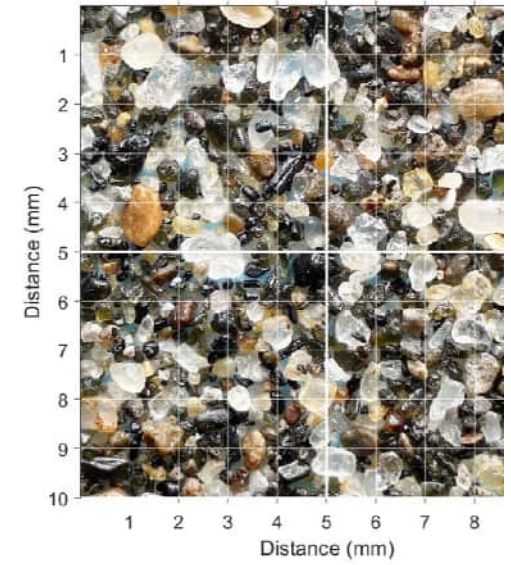
2.01.JPG



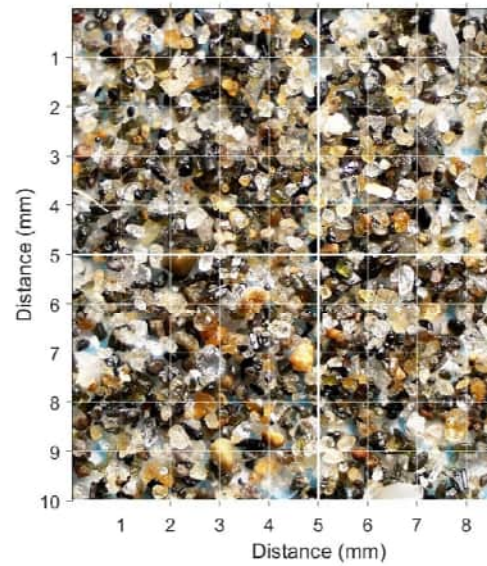
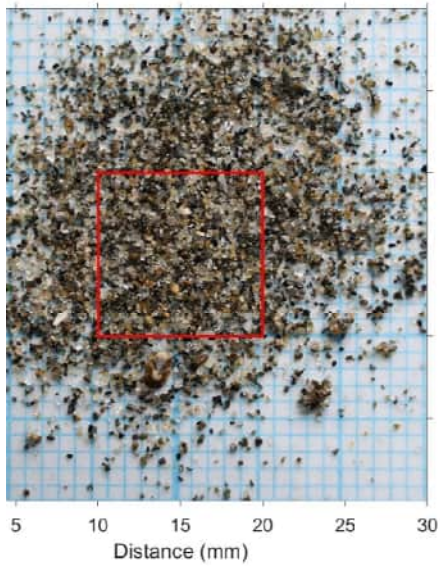
2.04.JPG



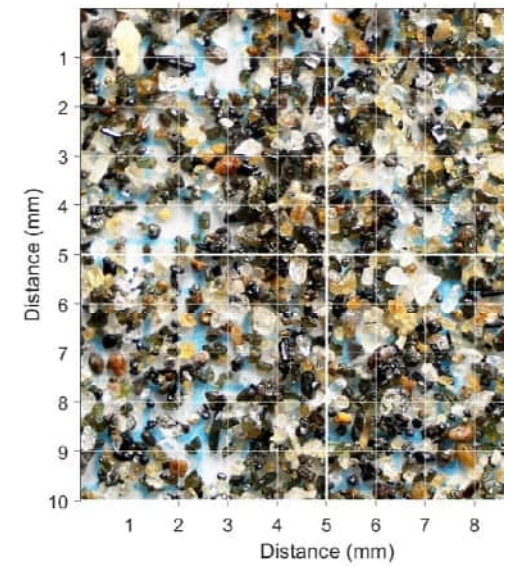
2.06.JPG



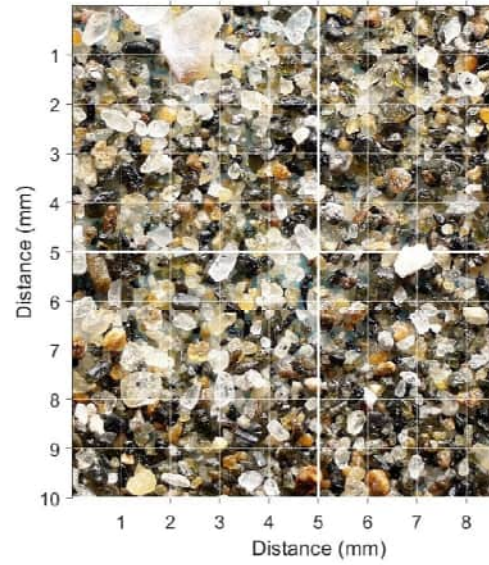
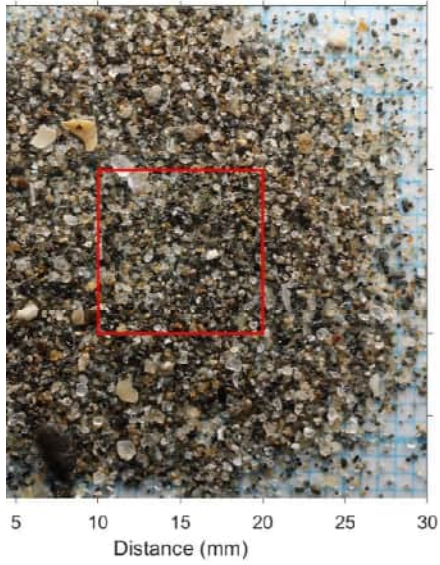
2.03.JPG



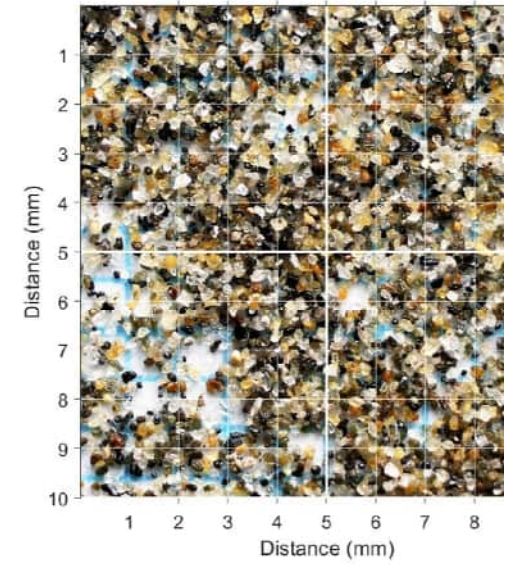
2.05.JPG



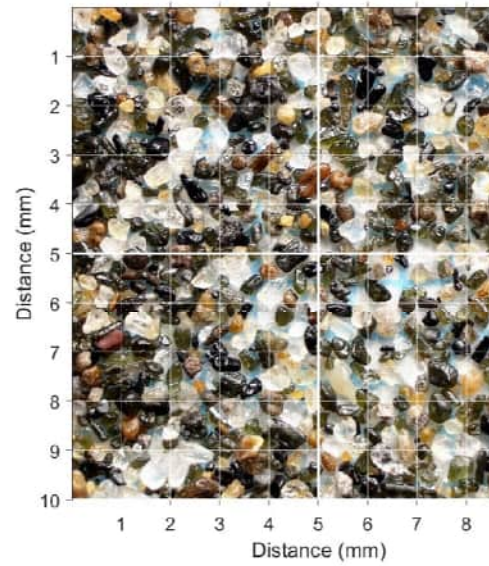
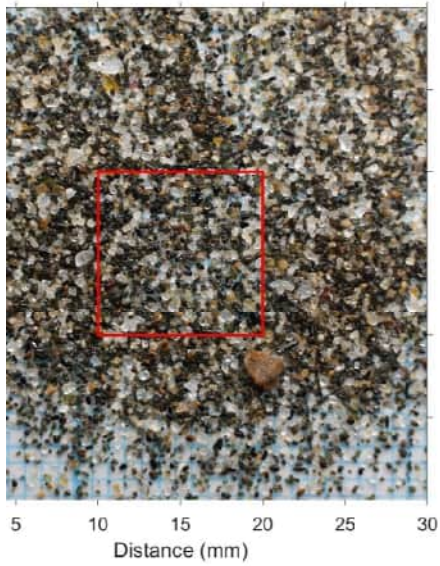
2.08.JPG



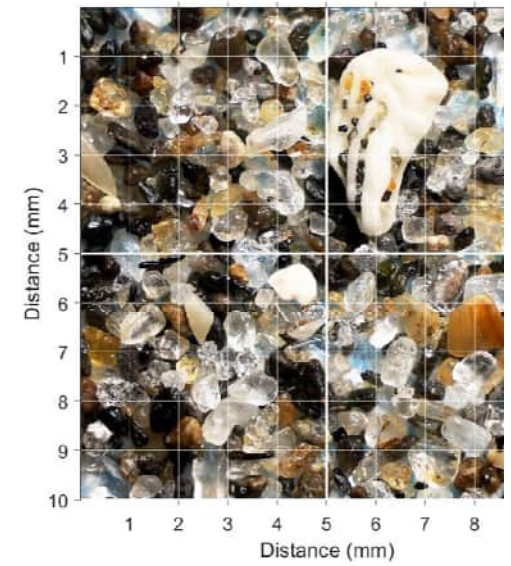
3.01.JPG



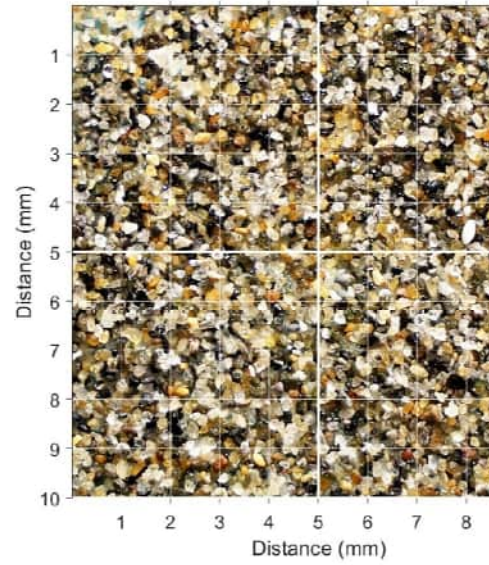
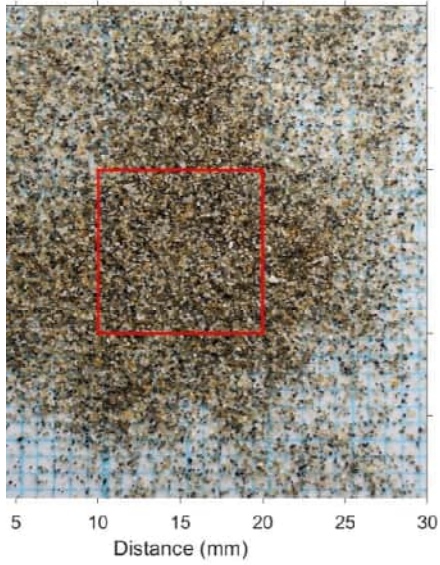
2.07.JPG



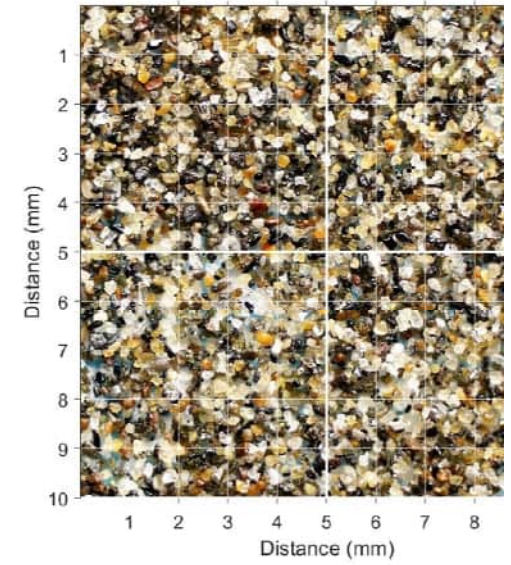
2.09.JPG



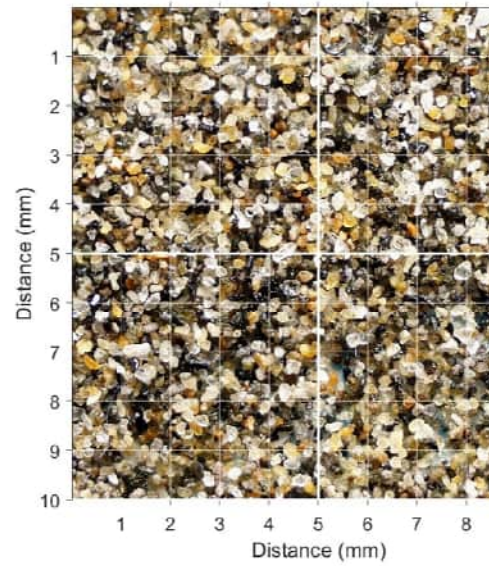
3.03.JPG



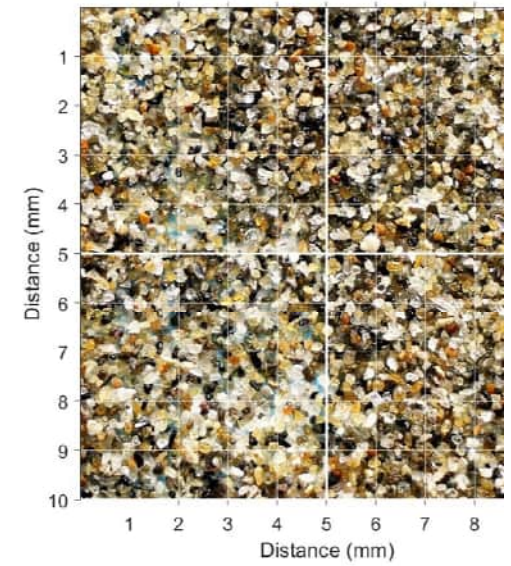
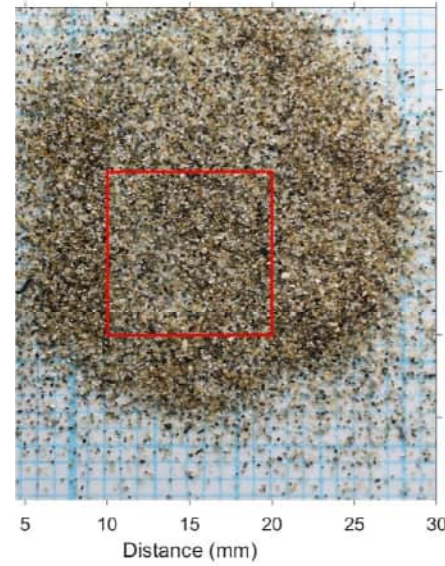
3.05.JPG



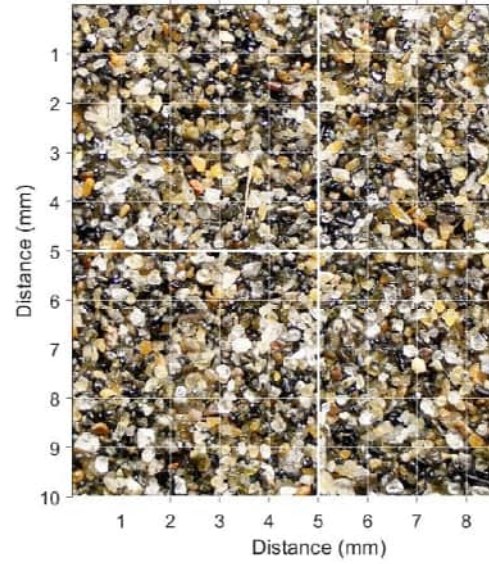
3.02.JPG



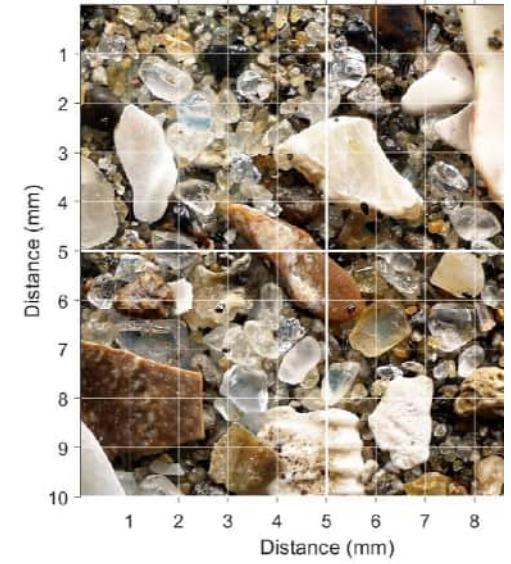
3.04.JPG



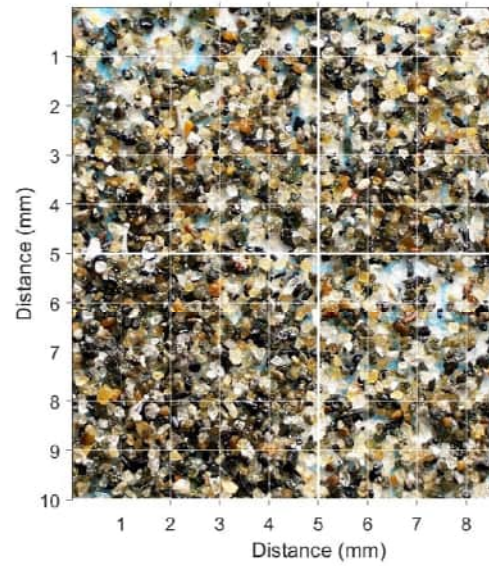
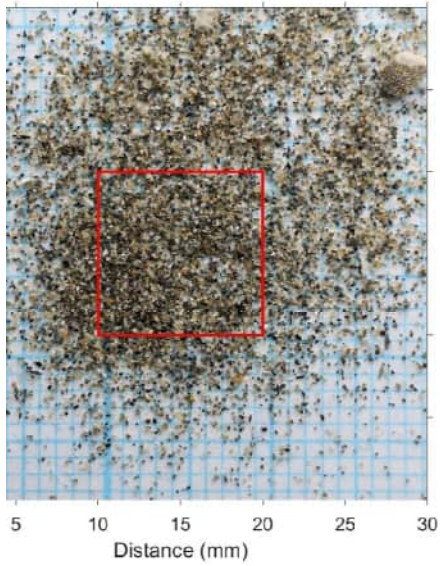
3.07.JPG



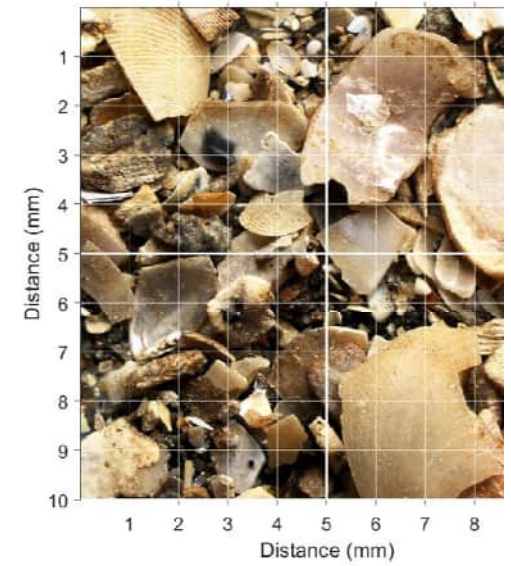
3.09.JPG



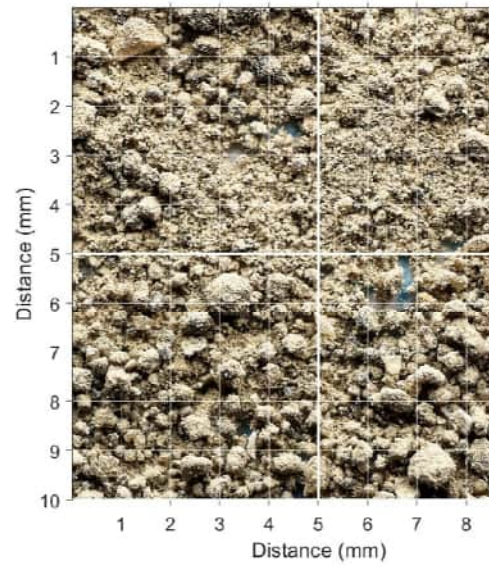
3.06.JPG



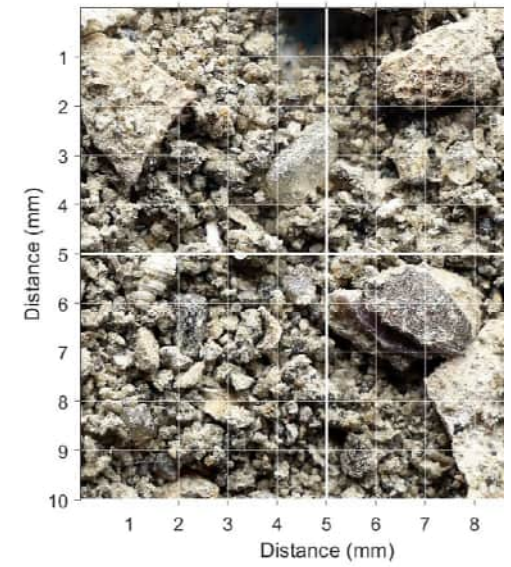
3.08.JPG



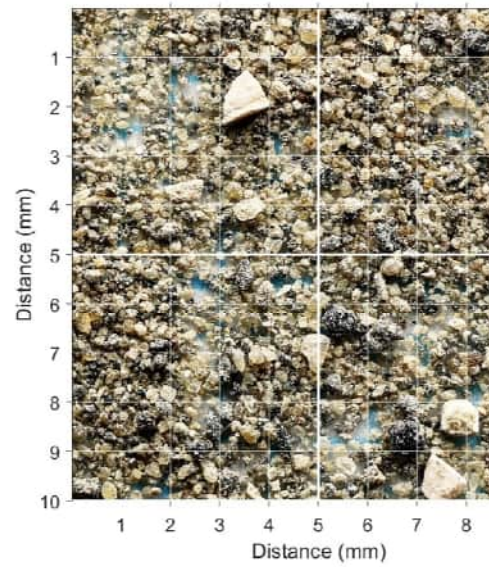
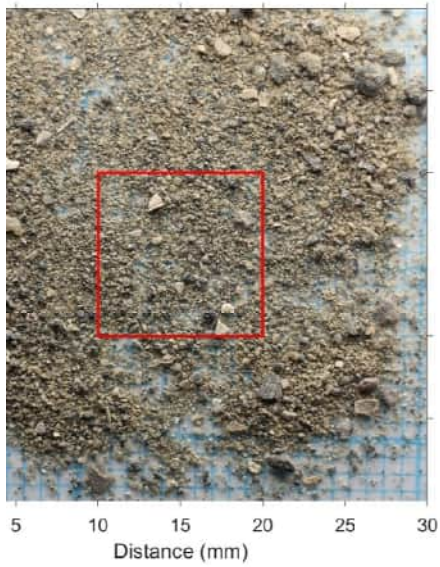
4.02.JPG



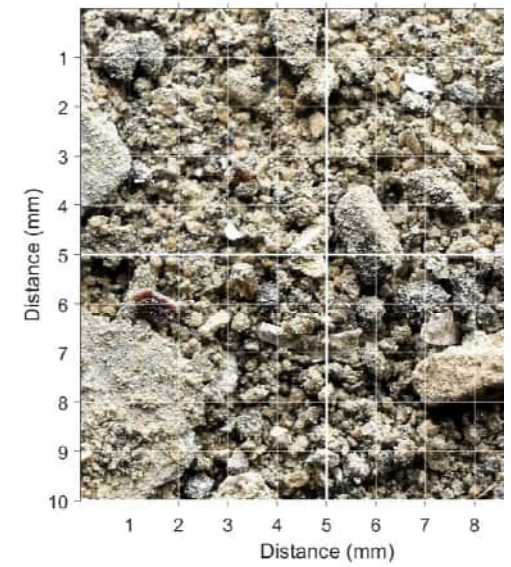
4.04.JPG



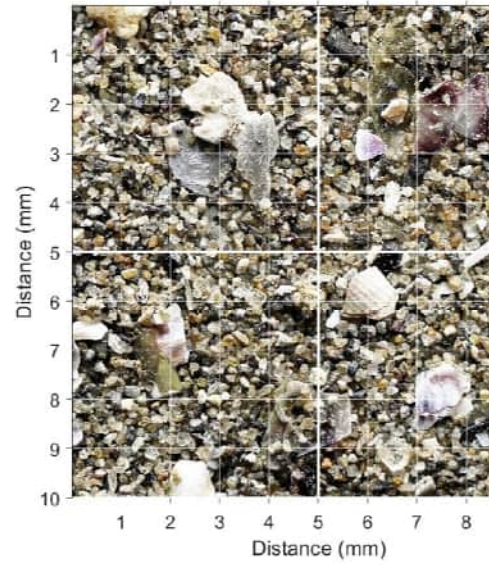
4.01.JPG



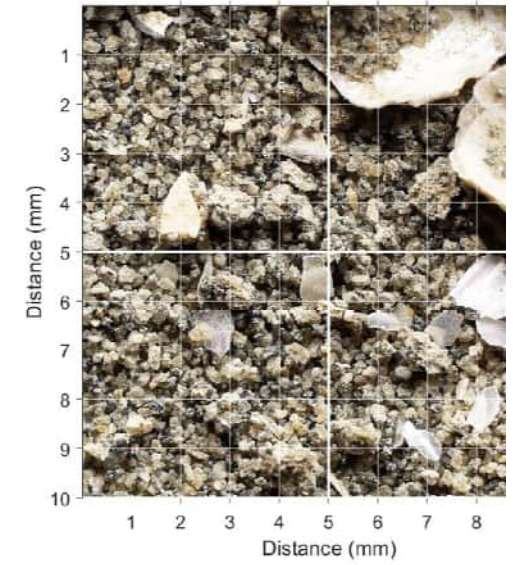
4.03.JPG



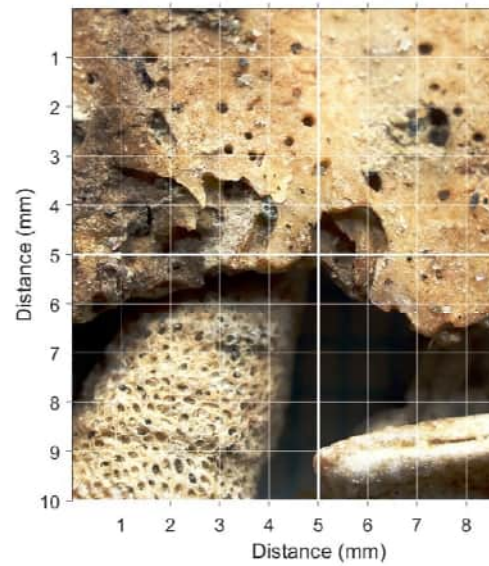
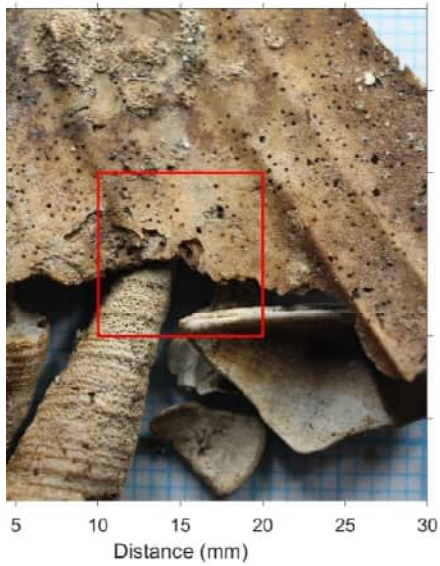
4.06.JPG



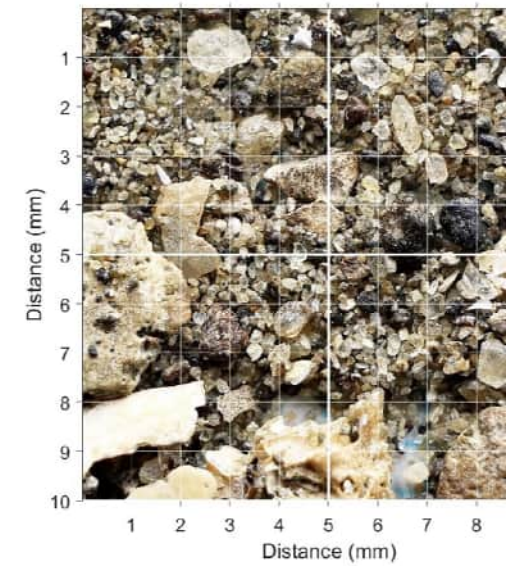
4.08.JPG



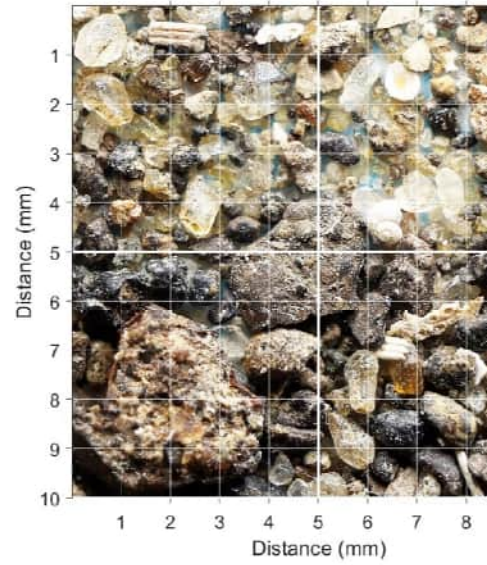
4.05.JPG



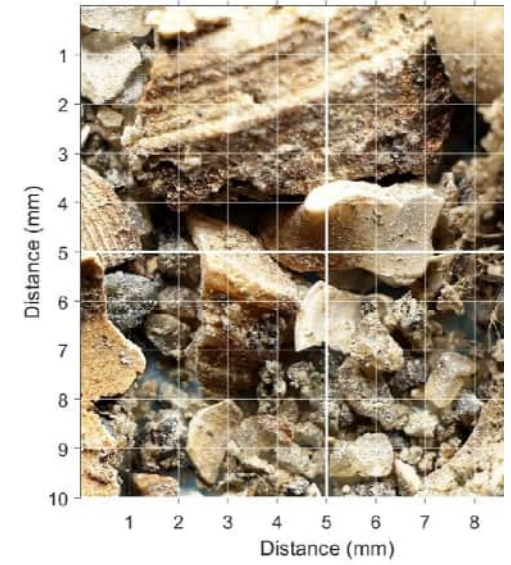
4.07.JPG



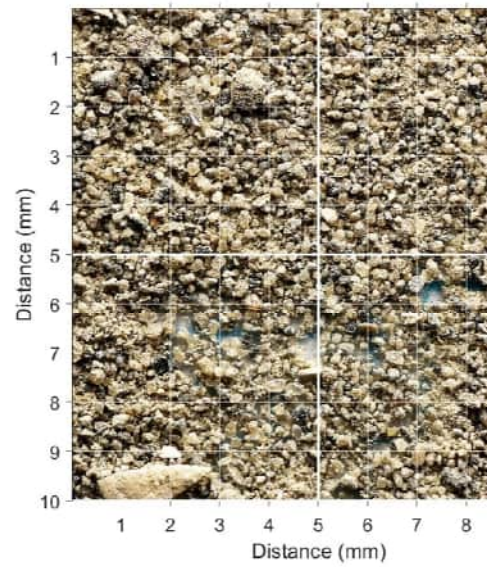
5.02.JPG



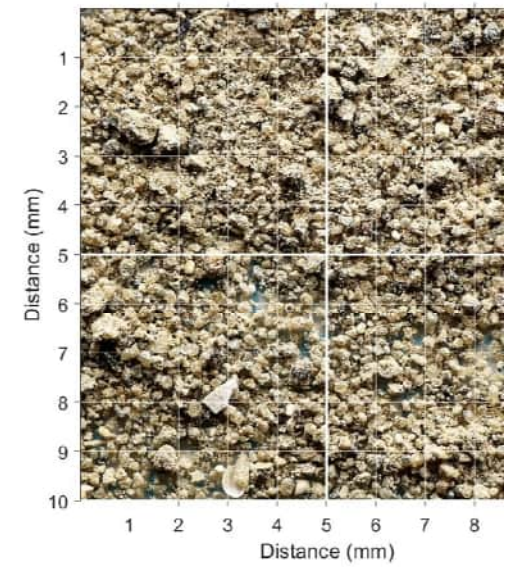
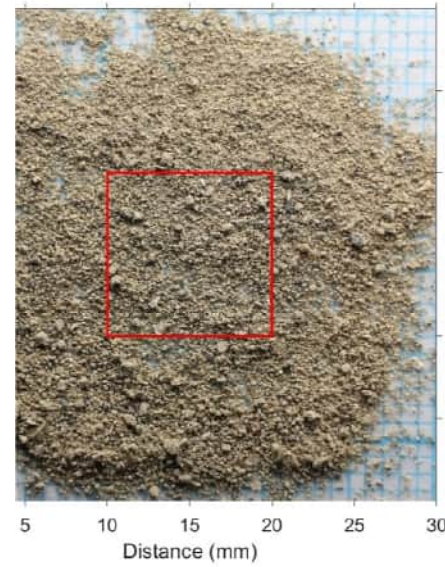
5.05.JPG



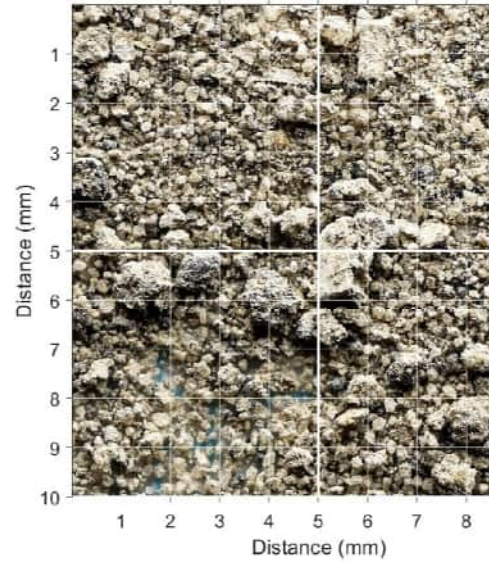
5.01.JPG



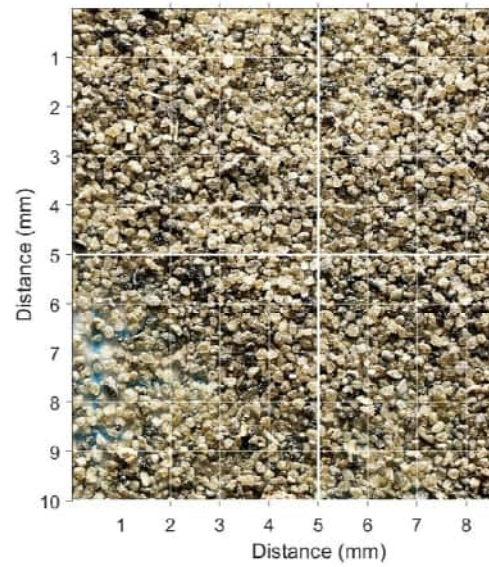
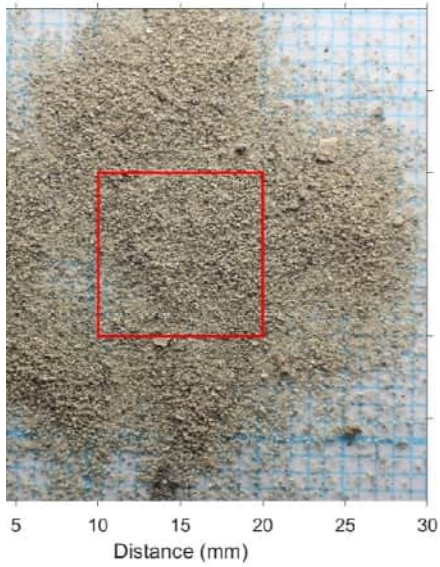
5.04.JPG



5.07.JPG



5.06.JPG



Job Number	3289872	Client Reference:	Manukau Port
Client	Tonkin & Taylor	Contact:	Hayley Jones
Description	Photos of Density samples for client		
Analyst	Gina McNamara	Date:	21/06/2023

Scope:

Take photos of each sample for client, so a visual comparison can be made for each sample and it's density result.

Methodology:

As each sample is measured for density, a separate portion is placed on a foil tray and photographed.

Results:

Sample 5.10 - 3289872.1 – contains bivalve shellfish, mud and sand



Sample 5.11 - 3289872.2 – contains pieces of shell, and mud

Non-Routine, Experiment. Job: 3289872



Sample 5.12 - 3289872.3– contains a lot of large univalve shells, periwinkles, pieces of shell and mud



Sample 5.09 - 3289872.4 – contains a lot of small univalve shells, periwinkles, pieces of shell and mud



Sample 5.13 - 3289872.5 – contains pieces of shell, find sand, mud and free water

Non-Routine, Experiment. Job: 3289872



Sample 5.08 - 3289872.6 – contains small pieces of shell, fine sand and mud

Particle Size Distribution (PSD) testing

Measurement Details

Sample Name 1.01 SC1
SOP File Name Sediment.msop
Lab Number 2023133/1
Operator Name rodgers

Measurement Details

Analysis Date Time 13/06/2023 12:08:10 PM
Measurement Date Time 13/06/2023 12:08:10 PM
Result Source Measurement

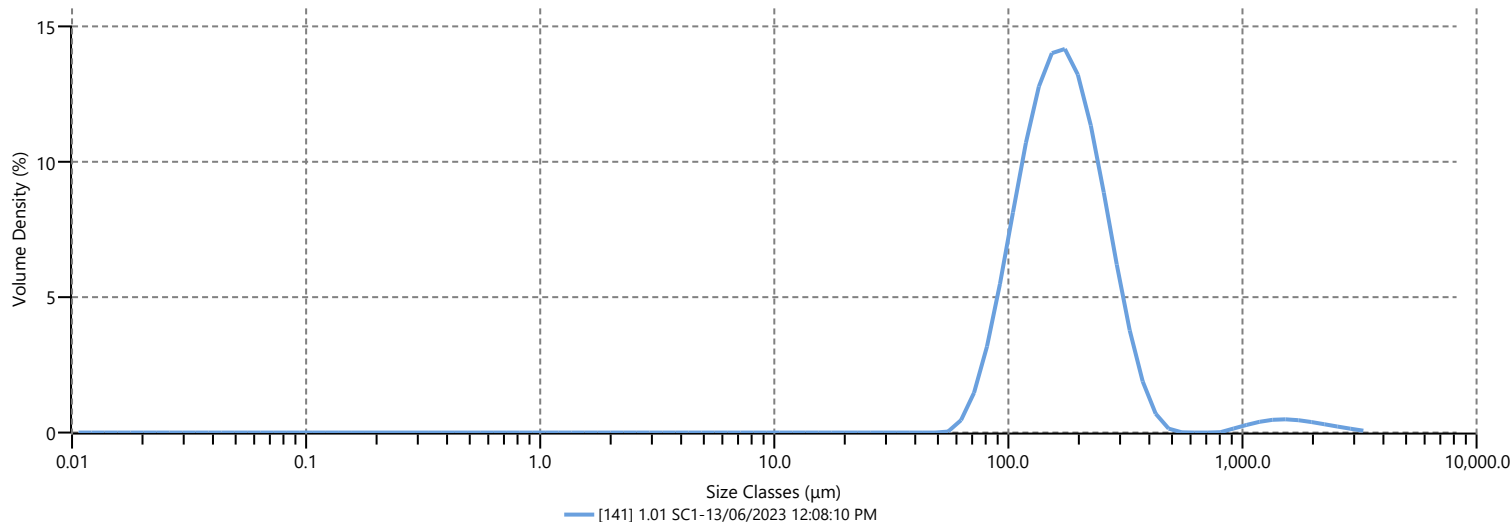
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.24 %
Laser Obscuration 15.99 %

Result

Concentration 0.3582 %
Span 1.151
Uniformity 0.570
Specific Surface Area 37.78 m²/kg
D [3,2] 159 μm
D [4,3] 222 μm
Dv (10) 101 μm
Dv (50) 169 μm
Dv (90) 295 μm
Dv (95) 351 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	4.79	350	94.91	1410	98.22
0.0600	0.00	15.6	0.00	105	12.28	420	96.76	1680	98.77
0.120	0.00	31.0	0.00	125	23.49	500	97.15	2000	99.26
0.240	0.00	37.0	0.00	149	38.34	590	97.17	2380	99.63
0.490	0.00	44.0	0.00	177	54.28	710	97.17	2830	99.86
0.980	0.00	53.0	0.00	210	69.43	840	97.18	3360	99.98
2.00	0.00	63.0	0.18	250	81.78	1000	97.34		
3.90	0.00	74.0	1.27	300	90.66	1190	97.72		

Measurement Details

Sample Name 1.02 SC2
SOP File Name Sediment.msop
Lab Number 2023133/2
Operator Name rodgers

Measurement Details

Analysis Date Time 13/06/2023 12:19:39 PM
Measurement Date Time 13/06/2023 12:19:39 PM
Result Source Measurement

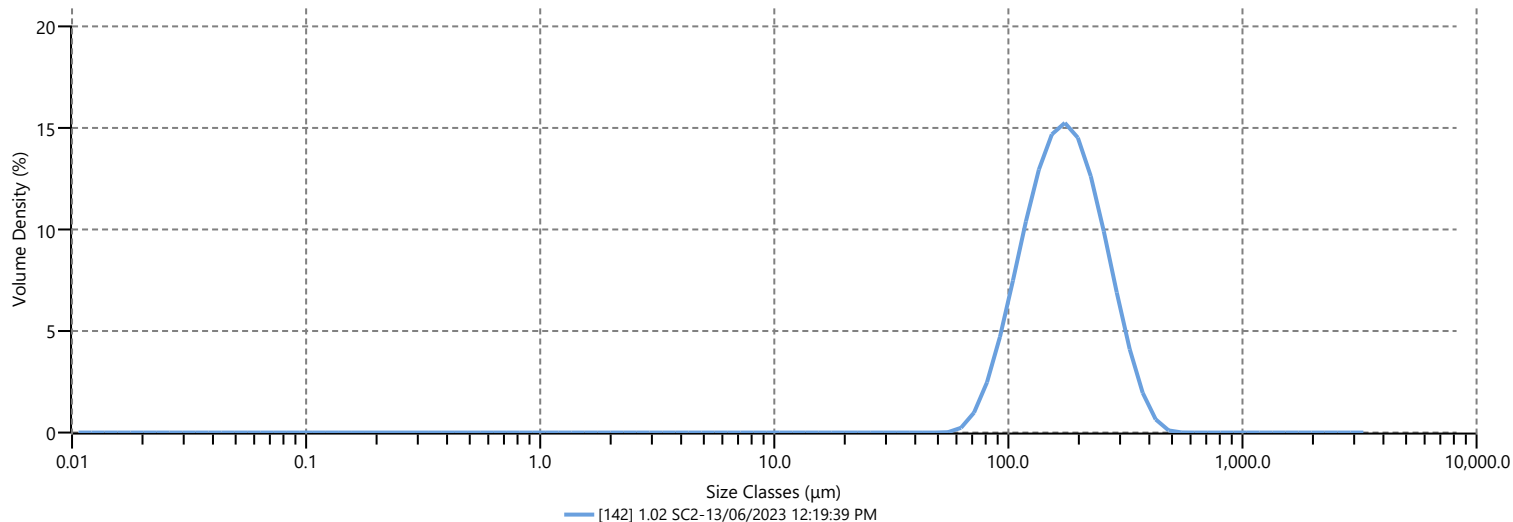
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.21 %
Laser Obscuration 12.14 %

Result

Concentration 0.2689 %
Span 1.019
Uniformity 0.312
Specific Surface Area 37.42 m²/kg
D [3,2] 160 μm
D [4,3] 184 μm
Dv (10) 105 μm
Dv (50) 172 μm
Dv (90) 280 μm
Dv (95) 315 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	3.51	350	97.76	1410	100.00
0.0600	0.00	15.6	0.00	105	10.13	420	99.65	1680	100.00
0.120	0.00	31.0	0.00	125	20.85	500	99.99	2000	100.00
0.240	0.00	37.0	0.00	149	35.97	590	100.00	2380	100.00
0.490	0.00	44.0	0.00	177	52.89	710	100.00	2830	100.00
0.980	0.00	53.0	0.00	210	69.45	840	100.00	3360	100.00
2.00	0.00	63.0	0.09	250	83.21	1000	100.00		
3.90	0.00	74.0	0.76	300	93.11	1190	100.00		

Measurement Details

Sample Name 1.03 SC3
SOP File Name Sediment.msop
Lab Number 2023133/3
Operator Name rodgers

Measurement Details

Analysis Date Time 13/06/2023 4:01:12 PM
Measurement Date Time 13/06/2023 4:01:12 PM
Result Source Measurement

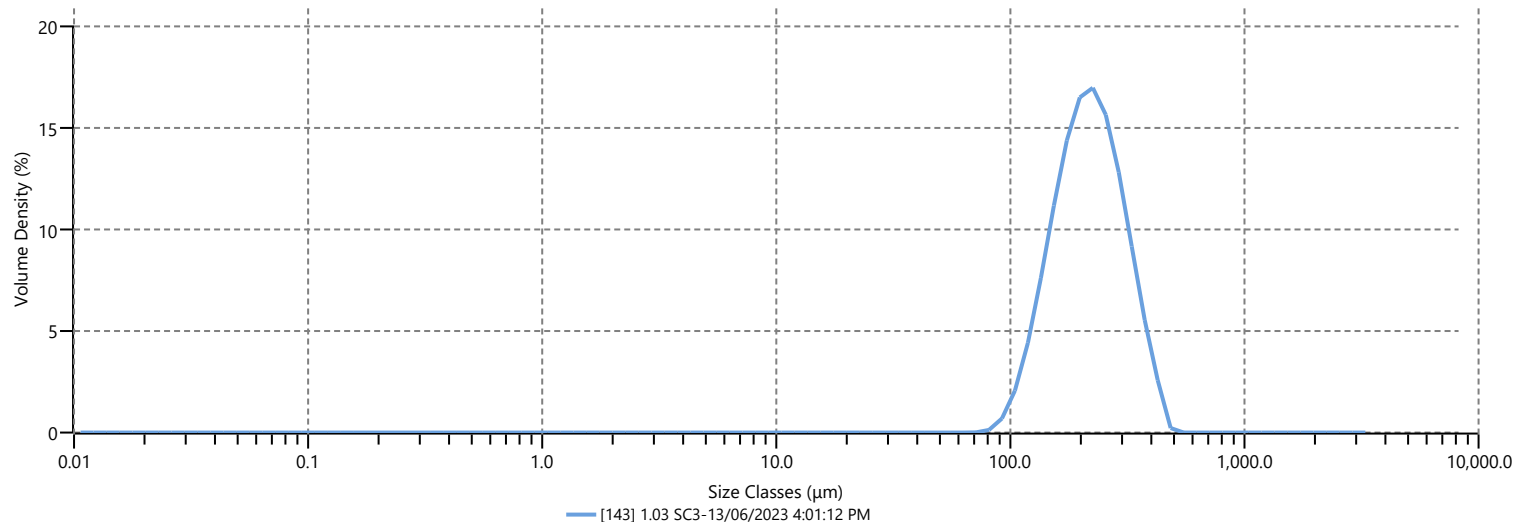
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.35 %
Laser Obscuration 15.88 %

Result

Concentration 0.4555 %
Span 0.904
Uniformity 0.276
Specific Surface Area 29.54 m²/kg
D [3,2] 203 μm
D [4,3] 226 μm
Dv (10) 138 μm
Dv (50) 216 μm
Dv (90) 333 μm
Dv (95) 369 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.16	350	93.01	1410	100.00
0.0600	0.00	15.6	0.00	105	1.48	420	98.70	1680	100.00
0.120	0.00	31.0	0.00	125	5.50	500	100.00	2000	100.00
0.240	0.00	37.0	0.00	149	14.75	590	100.00	2380	100.00
0.490	0.00	44.0	0.00	177	29.05	710	100.00	2830	100.00
0.980	0.00	53.0	0.00	210	46.94	840	100.00	3360	100.00
2.00	0.00	63.0	0.00	250	66.06	1000	100.00		
3.90	0.00	74.0	0.00	300	83.03	1190	100.00		

Measurement Details

Sample Name 1.04 SC4
SOP File Name Sediment.msop
Lab Number 2023133/4
Operator Name rodgers

Measurement Details

Analysis Date Time 13/06/2023 4:07:40 PM
Measurement Date Time 13/06/2023 4:07:40 PM
Result Source Measurement

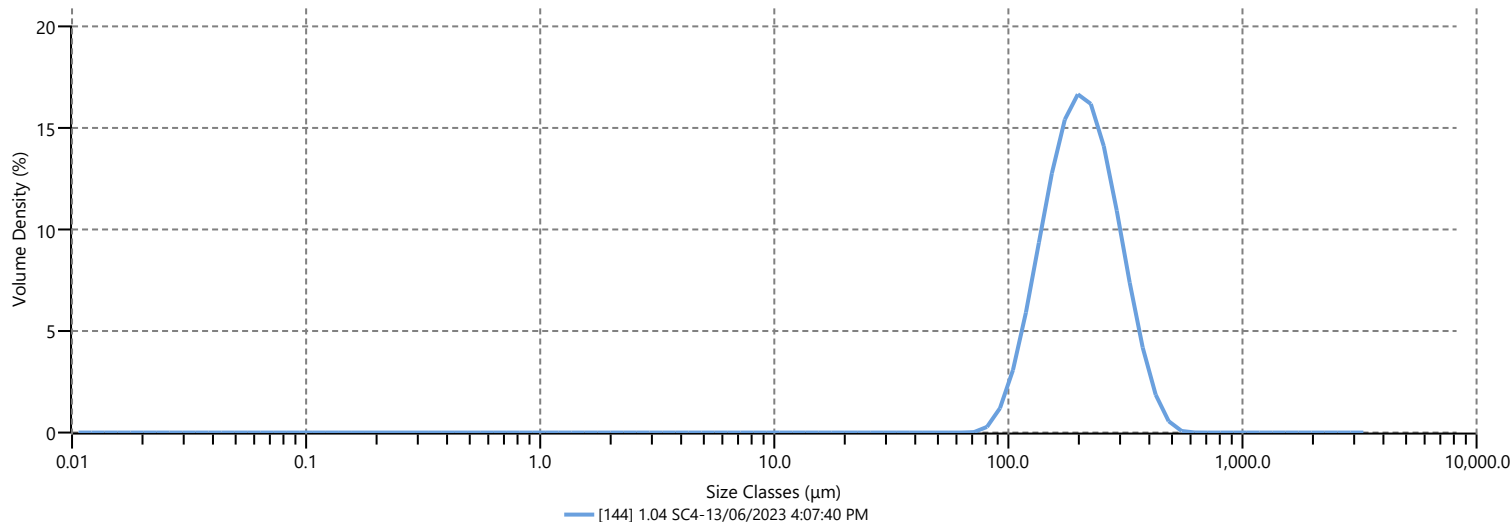
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.39 %
Laser Obscuration 16.96 %

Result

Concentration 0.4632 %
Span 0.930
Uniformity 0.287
Specific Surface Area 31.22 m²/kg
D [3,2] 192 μm
D [4,3] 216 μm
Dv (10) 130 μm
Dv (50) 204 μm
Dv (90) 319 μm
Dv (95) 356 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.33	350	94.42	1410	100.00
0.0600	0.00	15.6	0.00	105	2.45	420	98.66	1680	100.00
0.120	0.00	31.0	0.00	125	8.00	500	99.86	2000	100.00
0.240	0.00	37.0	0.00	149	19.22	590	100.00	2380	100.00
0.490	0.00	44.0	0.00	177	35.05	710	100.00	2830	100.00
0.980	0.00	53.0	0.00	210	53.41	840	100.00	3360	100.00
2.00	0.00	63.0	0.00	250	71.43	1000	100.00		
3.90	0.00	74.0	0.00	300	86.30	1190	100.00		

Measurement Details

Sample Name 1.05 SC5
SOP File Name Sediment.msop
Lab Number 2023133/5
Operator Name rodgers

Measurement Details

Analysis Date Time 14/06/2023 8:20:57 AM
Measurement Date Time 14/06/2023 8:20:57 AM
Result Source Measurement

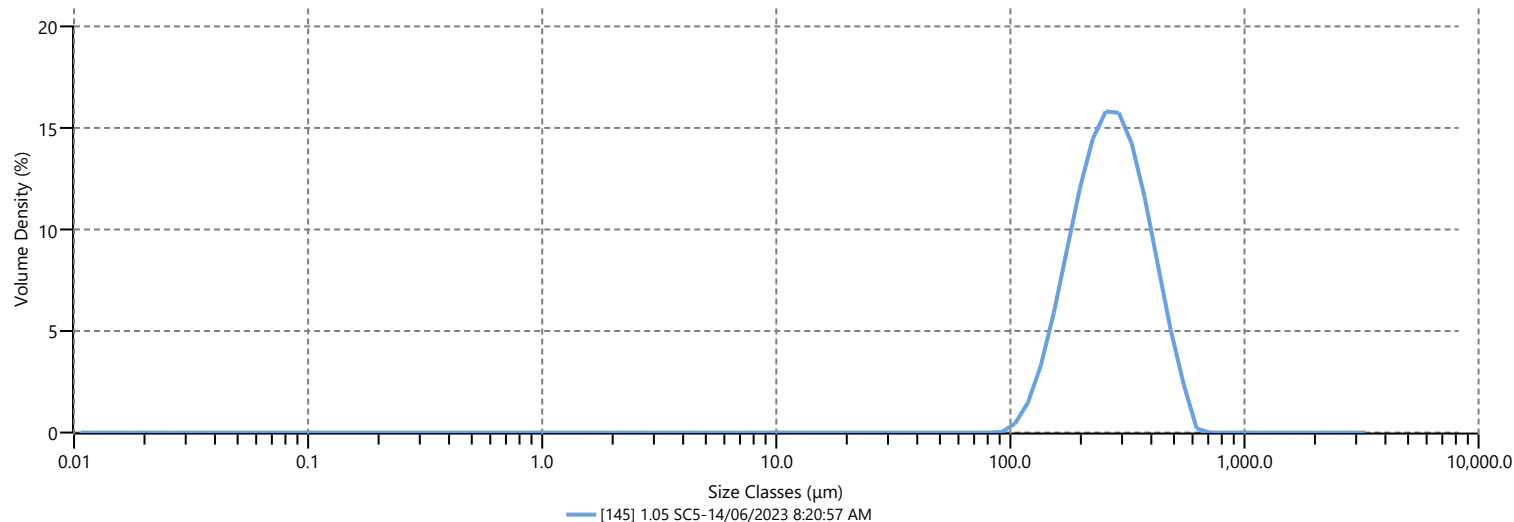
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.55 %
Laser Obscuration 13.67 %

Result

Concentration 0.4746 %
Span 0.962
Uniformity 0.294
Specific Surface Area 24.04 m²/kg
D [3,2] 250 μm
D [4,3] 282 μm
Dv (10) 166 μm
Dv (50) 267 μm
Dv (90) 423 μm
Dv (95) 470 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

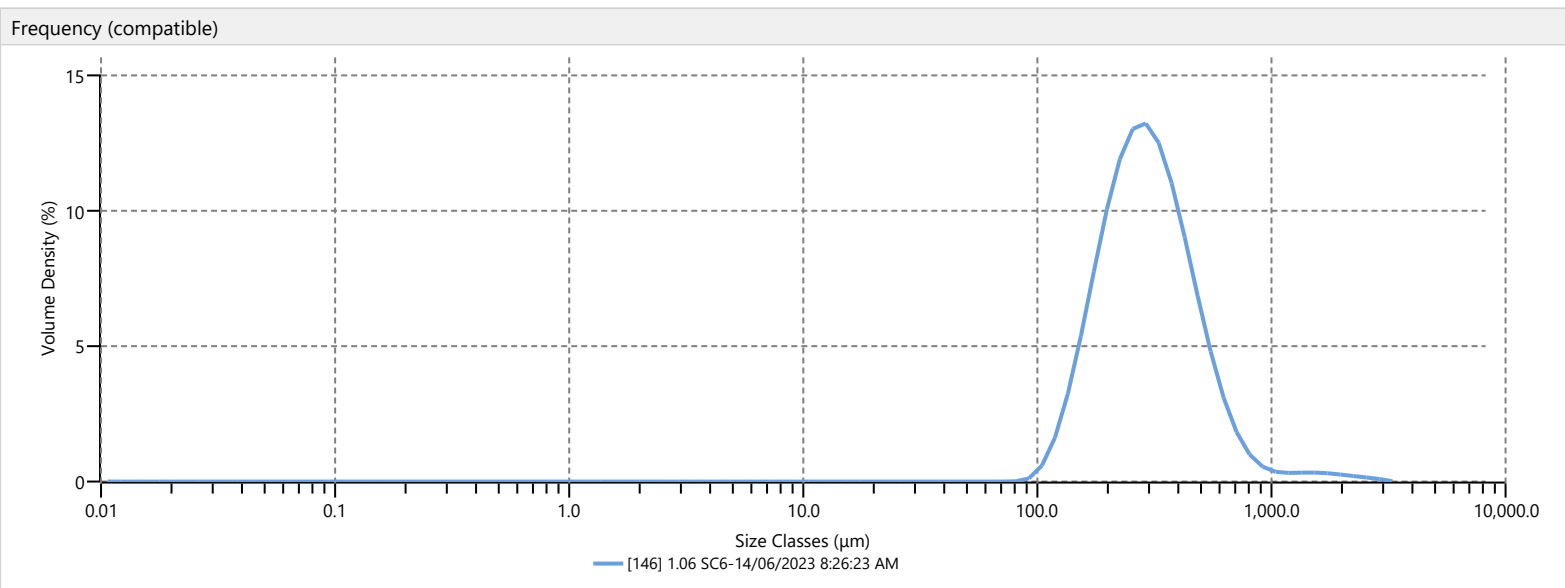
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	76.79	1410	100.00
0.0600	0.00	15.6	0.00	105	0.17	420	89.63	1680	100.00
0.120	0.00	31.0	0.00	125	1.37	500	97.01	2000	100.00
0.240	0.00	37.0	0.00	149	5.53	590	99.99	2380	100.00
0.490	0.00	44.0	0.00	177	13.75	710	100.00	2830	100.00
0.980	0.00	53.0	0.00	210	26.24	840	100.00	3360	100.00
2.00	0.00	63.0	0.00	250	43.12	1000	100.00		
3.90	0.00	74.0	0.00	300	62.05	1190	100.00		

Measurement Details	
Sample Name	1.06 SC6
SOP File Name	Sediment.msop
Lab Number	2023133/6
Operator Name	rodgers

Measurement Details	
Analysis Date Time	14/06/2023 8:26:23 AM
Measurement Date Time	14/06/2023 8:26:23 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.34 %
Laser Obscuration	14.50 %

Result	
Concentration	0.5449 %
Span	1.278
Uniformity	0.453
Specific Surface Area	22.31 m ² /kg
D [3,2]	269 μm
D [4,3]	343 μm
Dv (10)	167 μm
Dv (50)	289 μm
Dv (90)	537 μm
Dv (95)	656 μm
Volume Below (31) μm	0.00 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.01	350	65.91	1410	98.83
0.0600	0.00	15.6	0.00	105	0.31	420	78.47	1680	99.21
0.120	0.00	31.0	0.00	125	1.70	500	87.37	2000	99.54
0.240	0.00	37.0	0.00	149	5.72	590	92.88	2380	99.79
0.490	0.00	44.0	0.00	177	12.99	710	96.05	2830	99.94
0.980	0.00	53.0	0.00	210	23.51	840	97.45	3360	100.00
2.00	0.00	63.0	0.00	250	37.38	1000	98.09		
3.90	0.00	74.0	0.00	300	53.11	1190	98.47		

Measurement Details

Sample Name 1.07 SC7
SOP File Name Sediment.msop
Lab Number 2023133/7
Operator Name rodgers

Measurement Details

Analysis Date Time 14/06/2023 8:33:55 AM
Measurement Date Time 14/06/2023 8:33:55 AM
Result Source Measurement

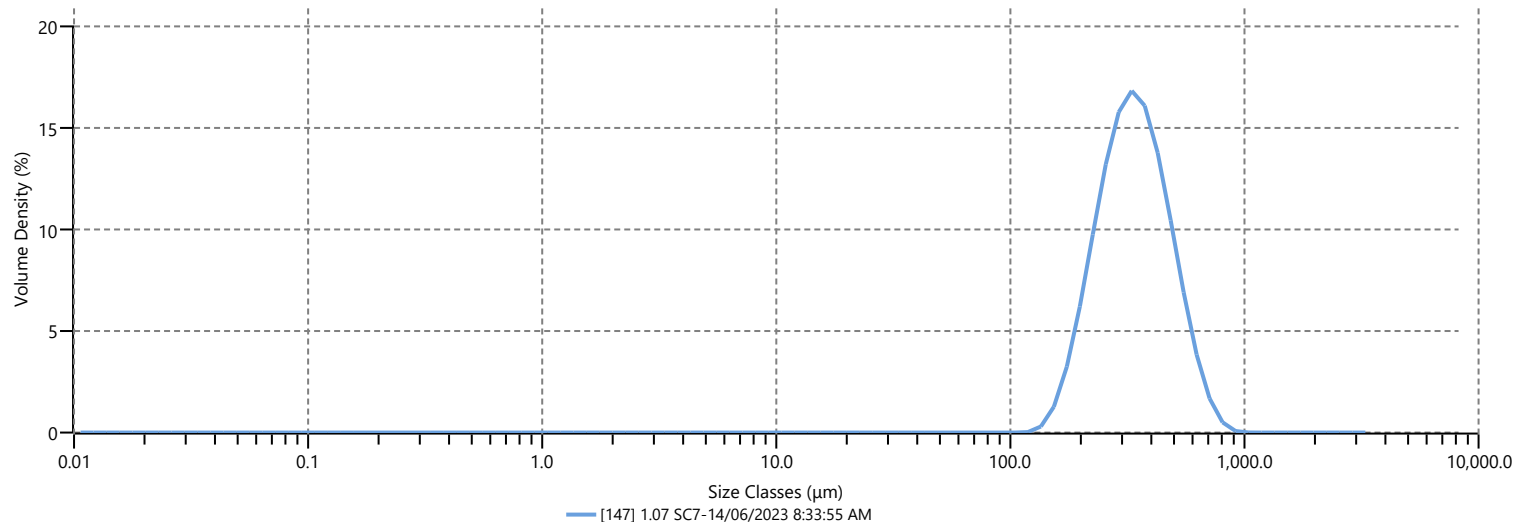
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.32 %
Laser Obscuration 23.08 %

Result

Concentration 1.0704 %
Span 0.921
Uniformity 0.284
Specific Surface Area 18.97 m²/kg
D [3,2] 316 μm
D [4,3] 354 μm
Dv (10) 215 μm
Dv (50) 334 μm
Dv (90) 523 μm
Dv (95) 584 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	55.07	1410	100.00
0.0600	0.00	15.6	0.00	105	0.00	420	73.64	1680	100.00
0.120	0.00	31.0	0.00	125	0.00	500	87.28	2000	100.00
0.240	0.00	37.0	0.00	149	0.47	590	95.30	2380	100.00
0.490	0.00	44.0	0.00	177	2.83	710	98.94	2830	100.00
0.980	0.00	53.0	0.00	210	8.76	840	99.90	3360	100.00
2.00	0.00	63.0	0.00	250	20.72	1000	100.00		
3.90	0.00	74.0	0.00	300	38.19	1190	100.00		

Measurement Details

Sample Name 1.08 SC8
SOP File Name Sediment.msop
Lab Number 2023133/8
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 8:34:21 AM
Measurement Date Time 16/06/2023 8:34:21 AM
Result Source Measurement

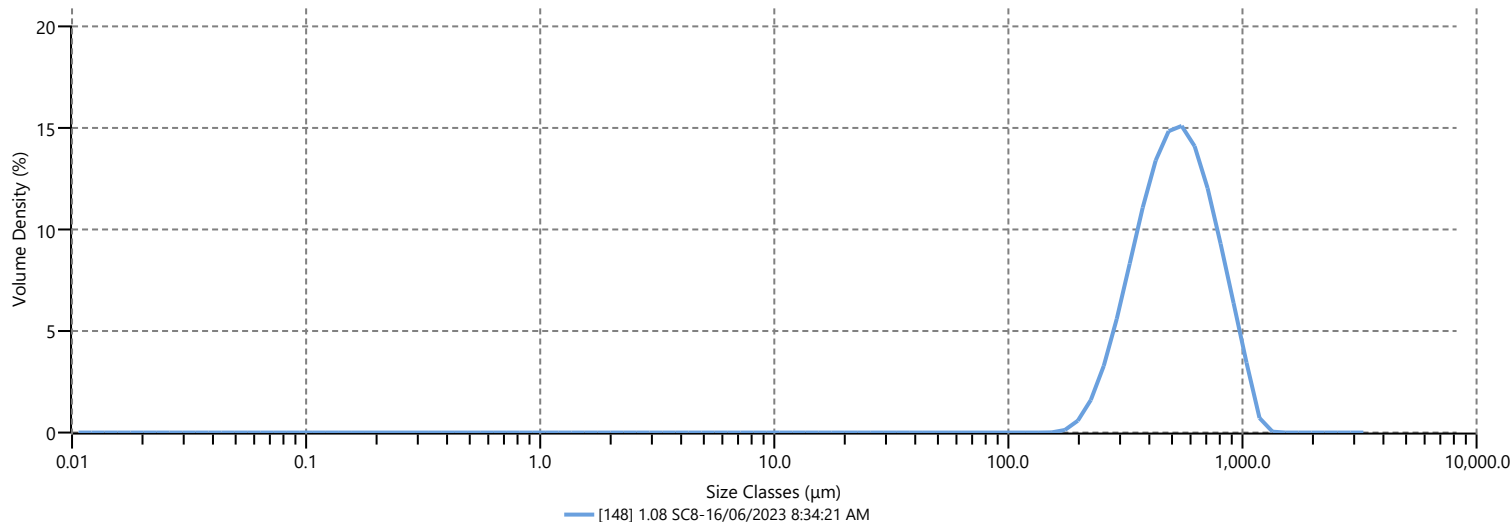
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.61 %
Laser Obscuration 18.06 %

Result

Concentration 1.2344 %
Span 1.009
Uniformity 0.310
Specific Surface Area 12.45 m²/kg
D [3,2] 482 μm
D [4,3] 551 μm
Dv (10) 314 μm
Dv (50) 521 μm
Dv (90) 840 μm
Dv (95) 937 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	15.83	1410	100.00
0.0600	0.00	15.6	0.00	105	0.00	420	29.74	1680	100.00
0.120	0.00	31.0	0.00	125	0.00	500	46.01	2000	100.00
0.240	0.00	37.0	0.00	149	0.00	590	62.35	2380	100.00
0.490	0.00	44.0	0.00	177	0.05	710	78.62	2830	100.00
0.980	0.00	53.0	0.00	210	0.51	840	90.00	3360	100.00
2.00	0.00	63.0	0.00	250	2.70	1000	97.24		
3.90	0.00	74.0	0.00	300	8.02	1190	99.81		

Measurement Details

Sample Name 1.09 SC9
SOP File Name Sediment.msop
Lab Number 2023133/9
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 8:41:52 AM
Measurement Date Time 16/06/2023 8:41:52 AM
Result Source Measurement

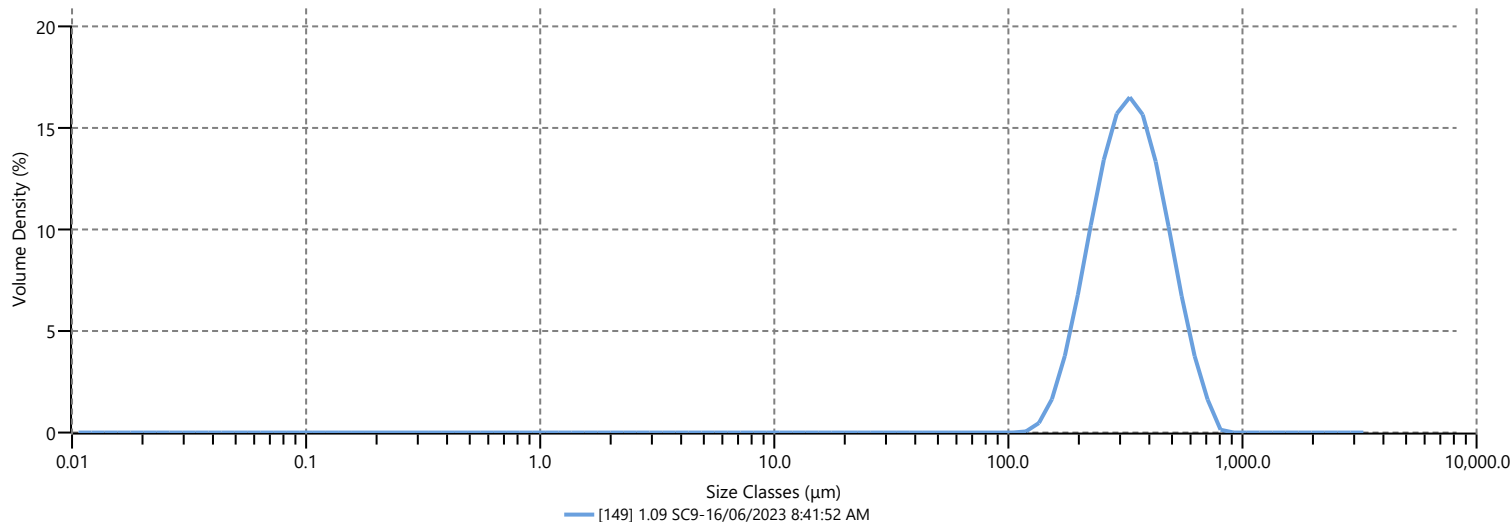
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.34 %
Laser Obscuration 18.61 %

Result

Concentration 0.8236 %
Span 0.931
Uniformity 0.285
Specific Surface Area 19.35 m²/kg
D [3,2] 310 μm
D [4,3] 348 μm
Dv (10) 209 μm
Dv (50) 329 μm
Dv (90) 516 μm
Dv (95) 578 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	56.71	1410	100.00
0.0600	0.00	15.6	0.00	105	0.00	420	74.76	1680	100.00
0.120	0.00	31.0	0.00	125	0.02	500	87.97	2000	100.00
0.240	0.00	37.0	0.00	149	0.71	590	95.76	2380	100.00
0.490	0.00	44.0	0.00	177	3.58	710	99.34	2830	100.00
0.980	0.00	53.0	0.00	210	10.14	840	100.00	3360	100.00
2.00	0.00	63.0	0.00	250	22.57	1000	100.00		
3.90	0.00	74.0	0.00	300	40.11	1190	100.00		

Measurement Details

Sample Name 1.10 SC10
SOP File Name Sediment.msop
Lab Number 2023133/10
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 8:49:02 AM
Measurement Date Time 16/06/2023 8:49:02 AM
Result Source Measurement

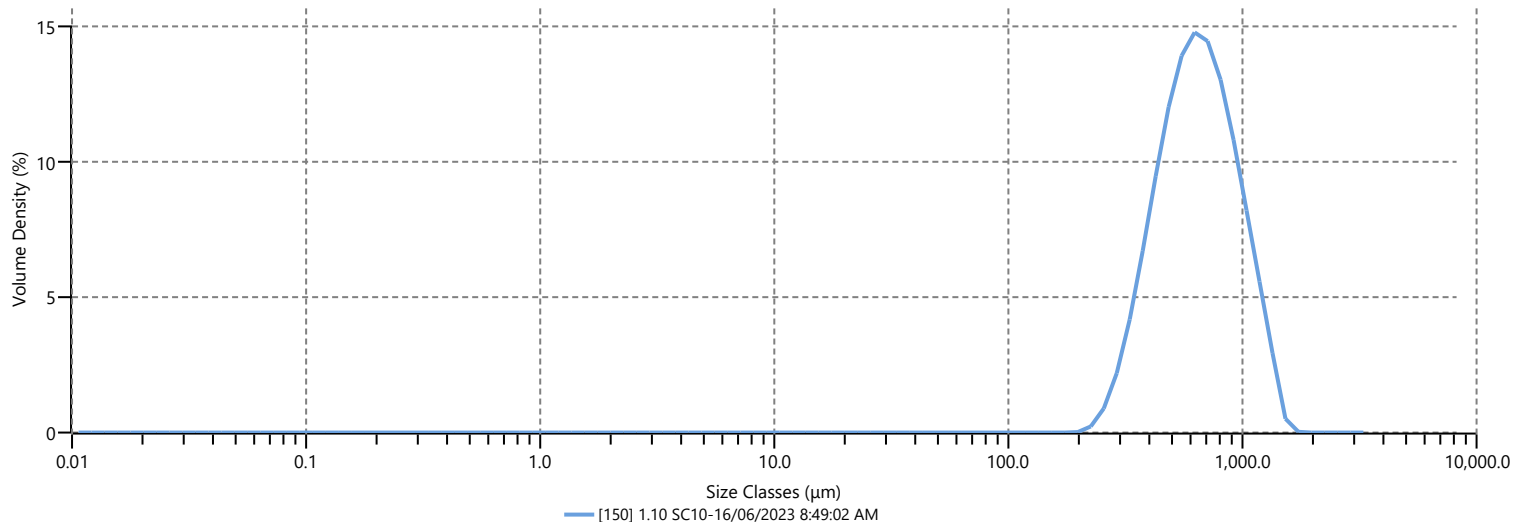
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.69 %
Laser Obscuration 13.91 %

Result

Concentration 1.1428 %
Span 1.048
Uniformity 0.318
Specific Surface Area 10.10 m²/kg
D [3,2] 594 μm
D [4,3] 684 μm
Dv (10) 385 μm
Dv (50) 641 μm
Dv (90) 1060 μm
Dv (95) 1180 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	5.95	1410	99.44
0.0600	0.00	15.6	0.00	105	0.00	420	14.75	1680	100.00
0.120	0.00	31.0	0.00	125	0.00	500	27.19	2000	100.00
0.240	0.00	37.0	0.00	149	0.00	590	41.97	2380	100.00
0.490	0.00	44.0	0.00	177	0.00	710	59.83	2830	100.00
0.980	0.00	53.0	0.00	210	0.00	840	74.81	3360	100.00
2.00	0.00	63.0	0.00	250	0.39	1000	87.08		
3.90	0.00	74.0	0.00	300	2.20	1190	95.19		

Measurement Details

Sample Name 1.11 SC11
SOP File Name Sediment.msop
Lab Number 2023133/11
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 8:57:32 AM
Measurement Date Time 16/06/2023 8:57:32 AM
Result Source Measurement

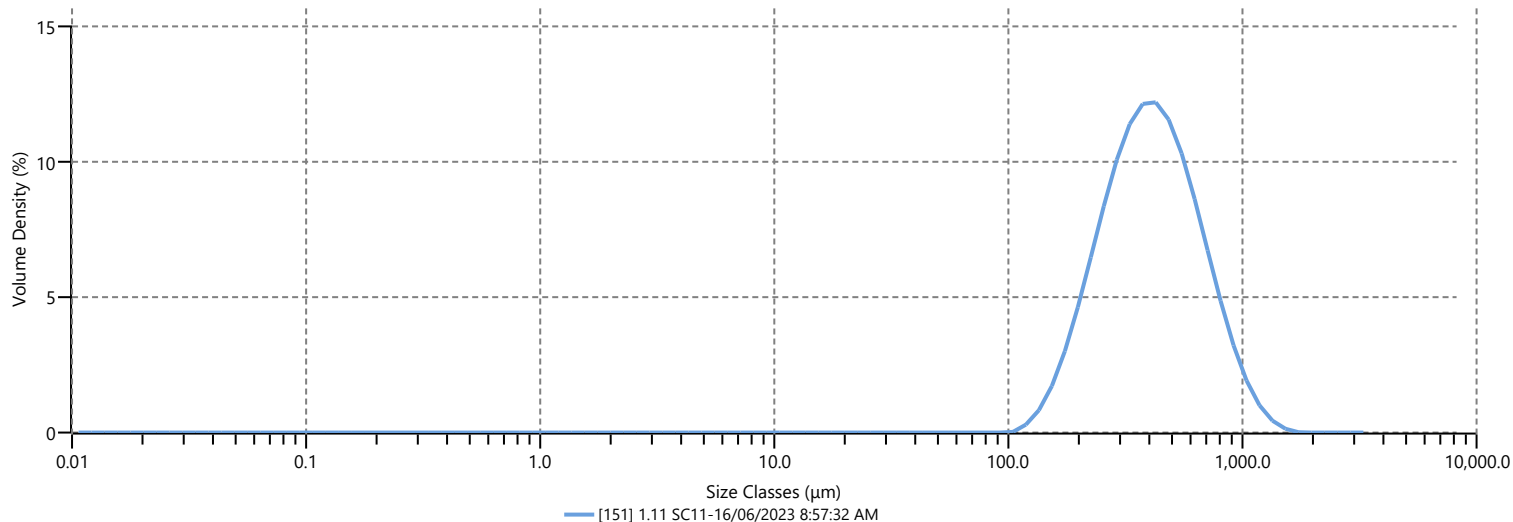
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.30 %
Laser Obscuration 12.35 %

Result

Concentration 0.6168 %
Span 1.313
Uniformity 0.410
Specific Surface Area 16.53 m²/kg
D [3,2] 363 μm
D [4,3] 451 μm
Dv (10) 218 μm
Dv (50) 404 μm
Dv (90) 749 μm
Dv (95) 880 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	38.61	1410	99.85
0.0600	0.00	15.6	0.00	105	0.00	420	53.12	1680	100.00
0.120	0.00	31.0	0.00	125	0.20	500	66.67	2000	100.00
0.240	0.00	37.0	0.00	149	1.27	590	78.03	2380	100.00
0.490	0.00	44.0	0.00	177	3.84	710	87.68	2830	100.00
0.980	0.00	53.0	0.00	210	8.47	840	93.78	3360	100.00
2.00	0.00	63.0	0.00	250	16.30	1000	97.45		
3.90	0.00	74.0	0.00	300	27.36	1190	99.18		

Measurement Details

Sample Name 1.12 SC11
SOP File Name Sediment.msop
Lab Number 2023133/12
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 9:04:31 AM
Measurement Date Time 16/06/2023 9:04:31 AM
Result Source Measurement

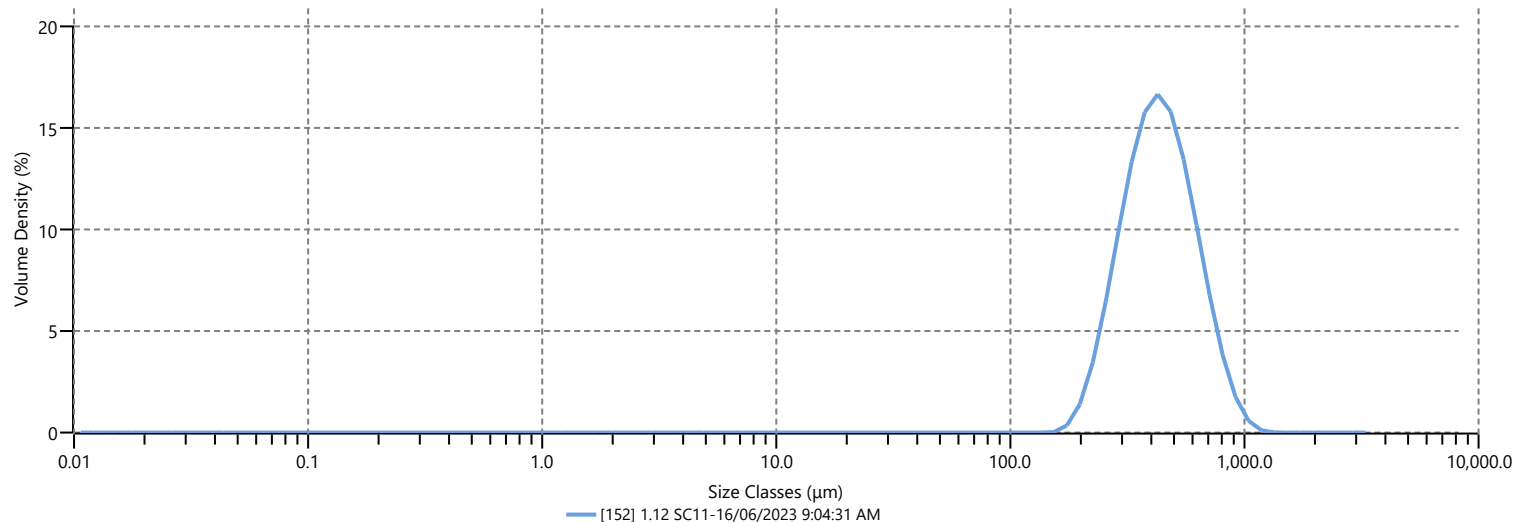
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.44 %
Laser Obscuration 13.08 %

Result

Concentration 0.7319 %
Span 0.935
Uniformity 0.288
Specific Surface Area 14.80 m²/kg
D [3,2] 405 μm
D [4,3] 456 μm
Dv (10) 275 μm
Dv (50) 429 μm
Dv (90) 675 μm
Dv (95) 757 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	28.62	1410	100.00
0.0600	0.00	15.6	0.00	105	0.00	420	47.77	1680	100.00
0.120	0.00	31.0	0.00	125	0.00	500	66.35	2000	100.00
0.240	0.00	37.0	0.00	149	0.00	590	81.31	2380	100.00
0.490	0.00	44.0	0.00	177	0.15	710	92.19	2830	100.00
0.980	0.00	53.0	0.00	210	1.30	840	97.54	3360	100.00
2.00	0.00	63.0	0.00	250	5.90	1000	99.58		
3.90	0.00	74.0	0.00	300	15.79	1190	99.97		

Measurement Details

Sample Name 1.13 SC12
SOP File Name Sediment.msop
Lab Number 2023133/13
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 9:11:48 AM
Measurement Date Time 16/06/2023 9:11:48 AM
Result Source Measurement

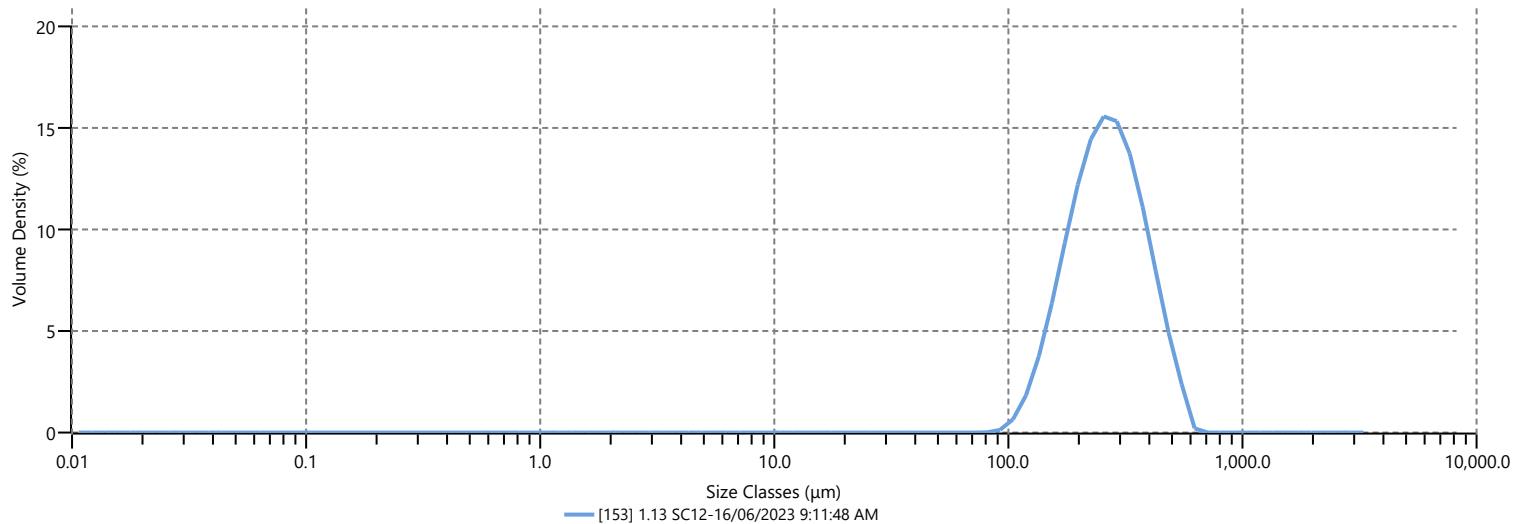
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.26 %
Laser Obscuration 14.51 %

Result

Concentration 0.4965 %
Span 0.984
Uniformity 0.301
Specific Surface Area 24.50 m²/kg
D [3,2] 245 μm
D [4,3] 278 μm
Dv (10) 162 μm
Dv (50) 263 μm
Dv (90) 421 μm
Dv (95) 469 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.01	350	77.61	1410	100.00
0.0600	0.00	15.6	0.00	105	0.34	420	89.92	1680	100.00
0.120	0.00	31.0	0.00	125	1.89	500	97.02	2000	100.00
0.240	0.00	37.0	0.00	149	6.58	590	99.99	2380	100.00
0.490	0.00	44.0	0.00	177	15.27	710	100.00	2830	100.00
0.980	0.00	53.0	0.00	210	28.05	840	100.00	3360	100.00
2.00	0.00	63.0	0.00	250	44.84	1000	100.00		
3.90	0.00	74.0	0.00	300	63.36	1190	100.00		

Measurement Details

Sample Name 1.14 SC13
SOP File Name Sediment.msop
Lab Number 2023133/14
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 9:18:48 AM
Measurement Date Time 16/06/2023 9:18:48 AM
Result Source Measurement

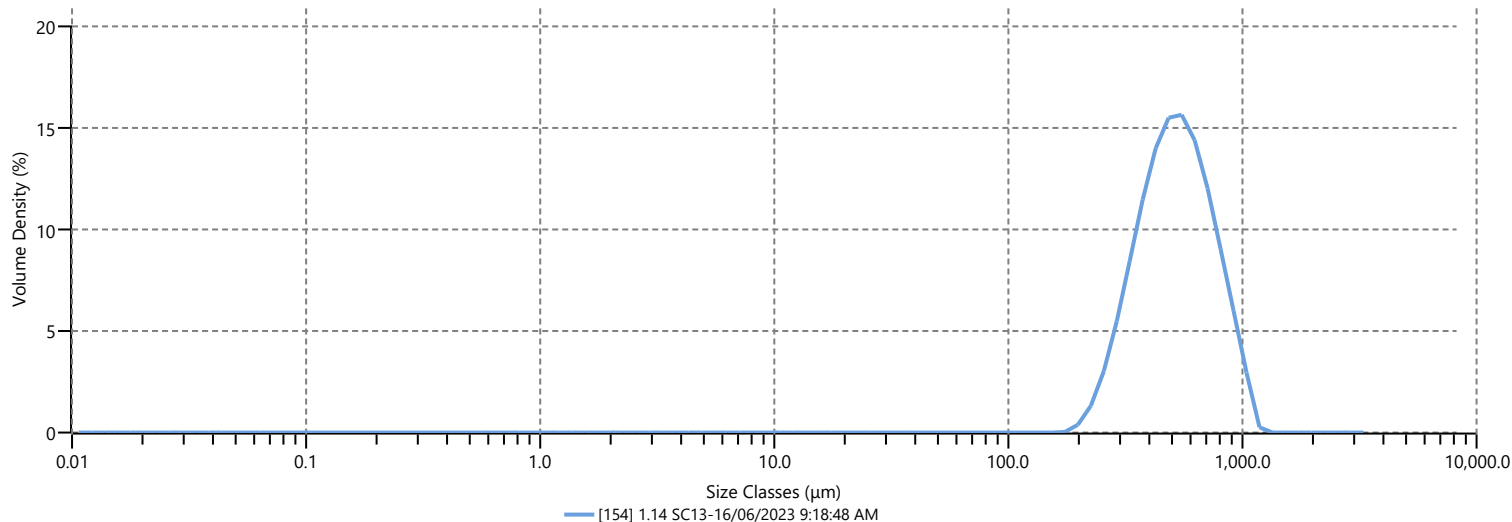
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.48 %
Laser Obscuration 16.36 %

Result

Concentration 1.1084 %
Span 0.975
Uniformity 0.297
Specific Surface Area 12.44 m²/kg
D [3,2] 482 μm
D [4,3] 546 μm
Dv (10) 319 μm
Dv (50) 517 μm
Dv (90) 823 μm
Dv (95) 915 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	15.09	1410	100.00
0.0600	0.00	15.6	0.00	105	0.00	420	29.54	1680	100.00
0.120	0.00	31.0	0.00	125	0.00	500	46.55	2000	100.00
0.240	0.00	37.0	0.00	149	0.00	590	63.50	2380	100.00
0.490	0.00	44.0	0.00	177	0.00	710	80.01	2830	100.00
0.980	0.00	53.0	0.00	210	0.27	840	91.19	3360	100.00
2.00	0.00	63.0	0.00	250	2.13	1000	97.99		
3.90	0.00	74.0	0.00	300	7.20	1190	99.99		

Measurement Details

Sample Name 1.15 M.Heads outer Bar #1
SOP File Name Sediment.msop
Lab Number 2023133/15
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 9:26:18 AM
Measurement Date Time 16/06/2023 9:26:18 AM
Result Source Measurement

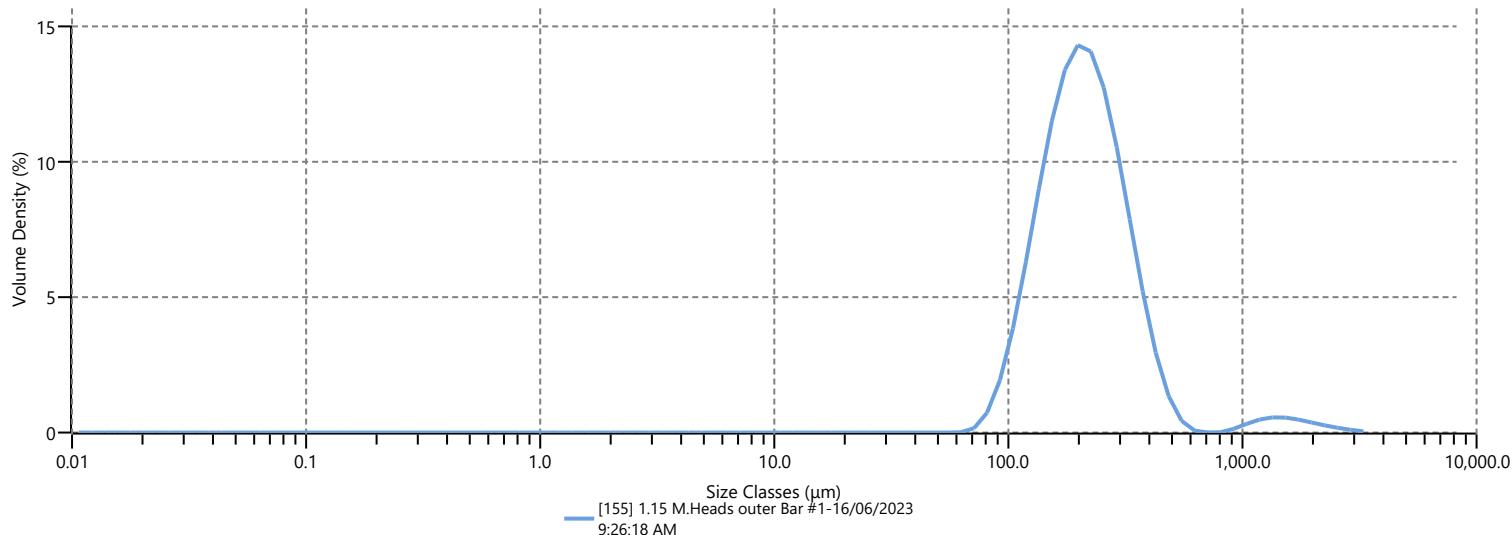
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.26 %
Laser Obscuration 17.87 %

Result

Concentration 0.5002 %
Span 1.143
Uniformity 0.512
Specific Surface Area 30.60 m²/kg
D [3,2] 196 μm
D [4,3] 262 μm
Dv (10) 125 μm
Dv (50) 209 μm
Dv (90) 363 μm
Dv (95) 439 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.90	350	88.67	1410	98.28
0.0600	0.00	15.6	0.00	105	3.92	420	94.17	1680	98.90
0.120	0.00	31.0	0.00	125	10.10	500	96.45	2000	99.39
0.240	0.00	37.0	0.00	149	20.79	590	97.04	2380	99.73
0.490	0.00	44.0	0.00	177	34.79	710	97.07	2830	99.91
0.980	0.00	53.0	0.00	210	50.57	840	97.08	3360	99.99
2.00	0.00	63.0	0.00	250	66.34	1000	97.24		
3.90	0.00	74.0	0.08	300	80.19	1190	97.68		

Measurement Details

Sample Name 1.16 Manukau outer Bar #1
SOP File Name Sediment.msop
Lab Number 2023133/15
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 9:33:34 AM
Measurement Date Time 16/06/2023 9:33:34 AM
Result Source Measurement

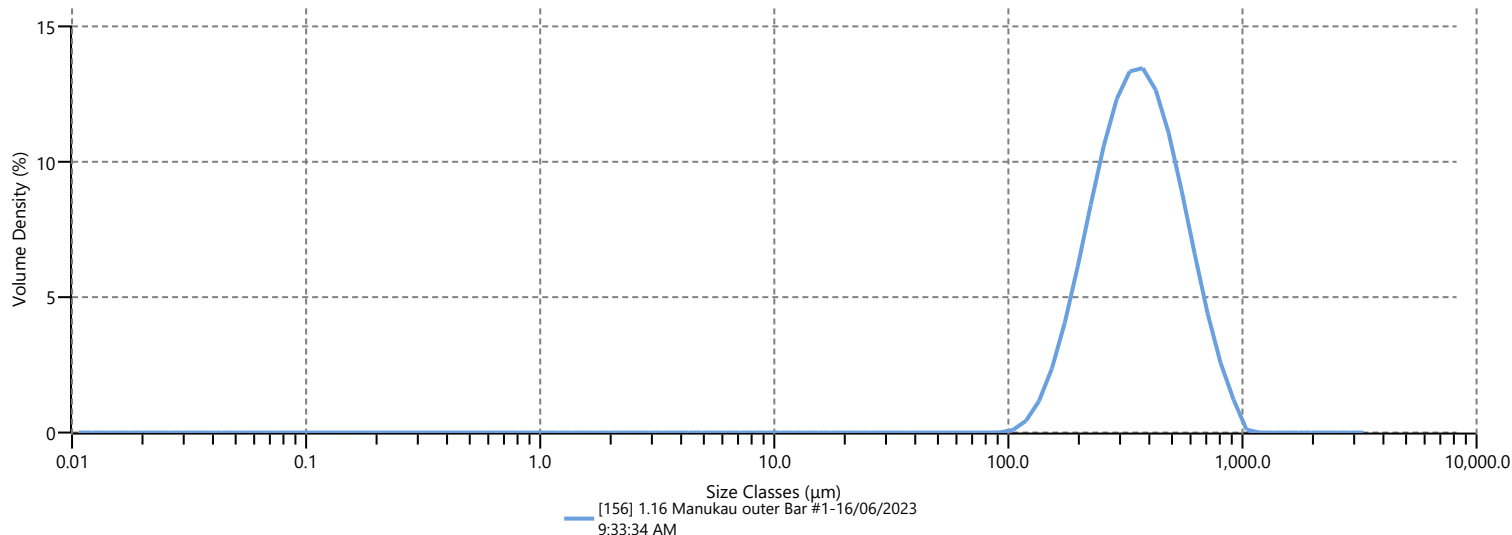
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.36 %
Laser Obscuration 15.30 %

Result

Concentration 0.6943 %
Span 1.170
Uniformity 0.359
Specific Surface Area 18.53 m²/kg
D [3,2] 324 μm
D [4,3] 386 μm
Dv (10) 202 μm
Dv (50) 355 μm
Dv (90) 618 μm
Dv (95) 708 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	48.71	1410	100.00
0.0600	0.00	15.6	0.00	105	0.04	420	64.56	1680	100.00
0.120	0.00	31.0	0.00	125	0.36	500	78.03	2000	100.00
0.240	0.00	37.0	0.00	149	1.86	590	88.04	2380	100.00
0.490	0.00	44.0	0.00	177	5.35	710	95.07	2830	100.00
0.980	0.00	53.0	0.00	210	11.54	840	98.61	3360	100.00
2.00	0.00	63.0	0.00	250	21.66	1000	100.00		
3.90	0.00	74.0	0.00	300	35.42	1190	100.00		

Measurement Details

Sample Name 1.167 M.Heads Inner Bar #3
SOP File Name Sediment.msop
Lab Number 2023133/17
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 9:41:41 AM
Measurement Date Time 16/06/2023 9:41:41 AM
Result Source Measurement

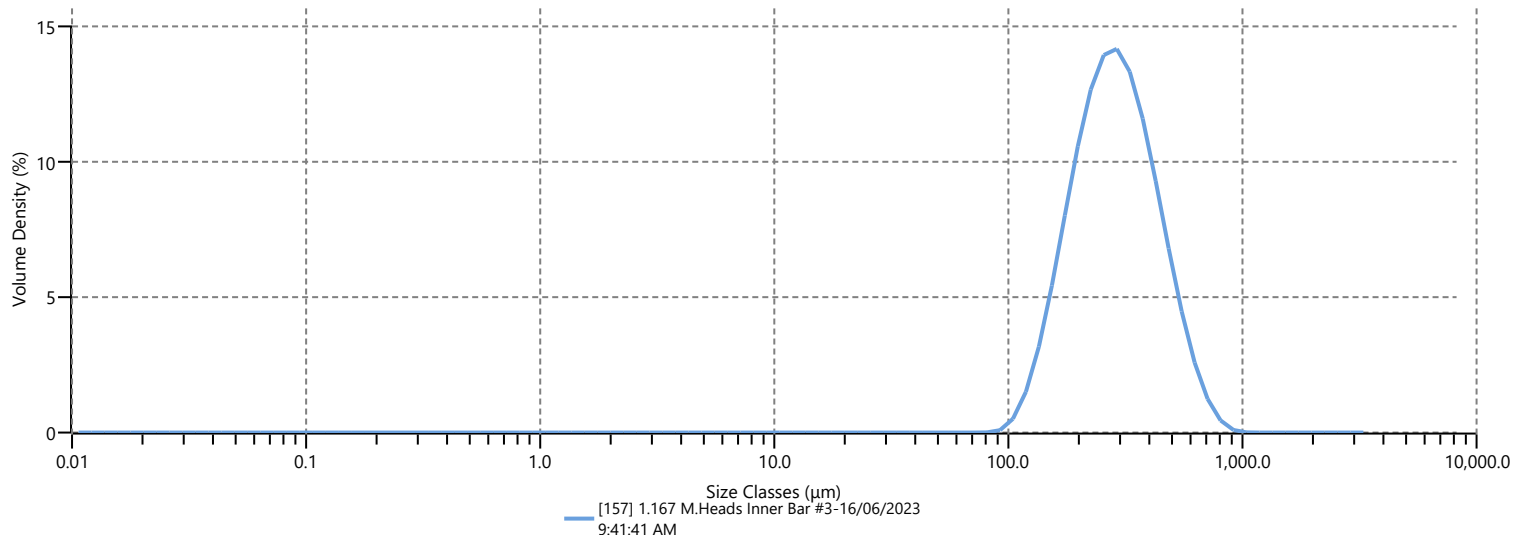
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.28 %
Laser Obscuration 16.95 %

Result

Concentration 0.6293 %
Span 1.122
Uniformity 0.346
Specific Surface Area 22.90 m²/kg
D [3,2] 262 μm
D [4,3] 307 μm
Dv (10) 167 μm
Dv (50) 283 μm
Dv (90) 484 μm
Dv (95) 557 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.01	350	69.25	1410	100.00
0.0600	0.00	15.6	0.00	105	0.25	420	82.40	1680	100.00
0.120	0.00	31.0	0.00	125	1.52	500	91.41	2000	100.00
0.240	0.00	37.0	0.00	149	5.47	590	96.60	2380	100.00
0.490	0.00	44.0	0.00	177	12.91	710	99.10	2830	100.00
0.980	0.00	53.0	0.00	210	23.94	840	99.88	3360	100.00
2.00	0.00	63.0	0.00	250	38.73	1000	100.00		
3.90	0.00	74.0	0.00	300	55.58	1190	100.00		

Measurement Details

Sample Name 1.18 M.Heads Inner Bar #4
SOP File Name Sediment.msop
Lab Number 2023133/18
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 9:48:31 AM
Measurement Date Time 16/06/2023 9:48:31 AM
Result Source Measurement

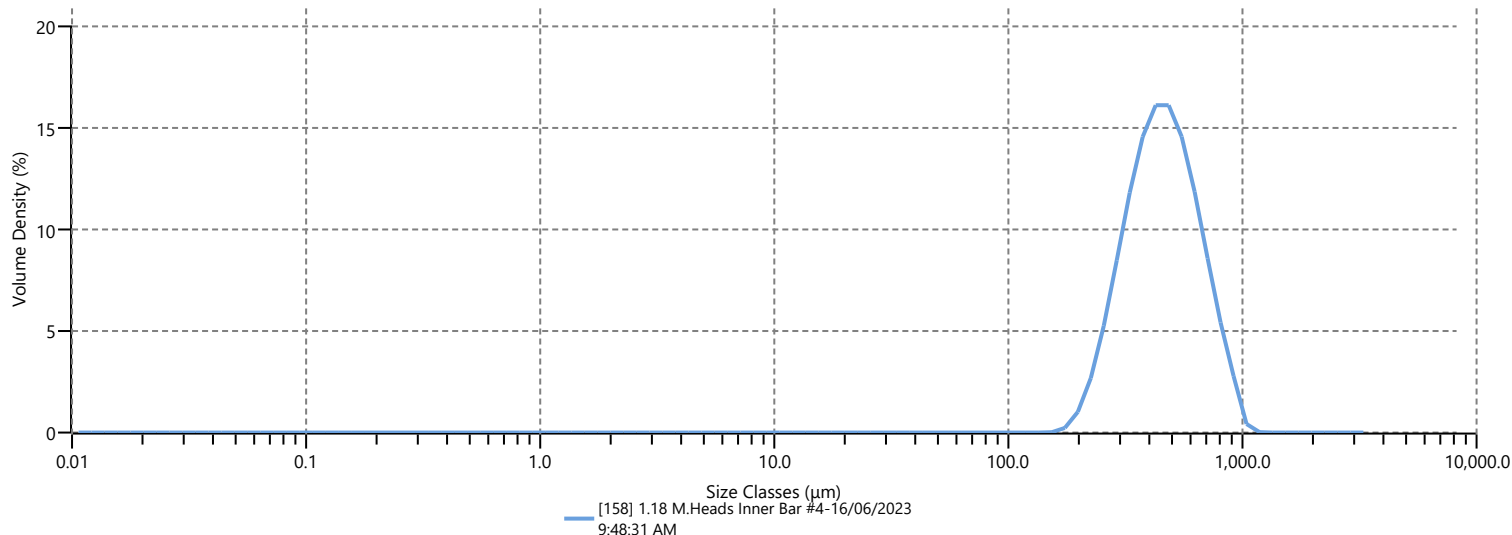
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.42 %
Laser Obscuration 16.85 %

Result

Concentration 1.0125 %
Span 0.952
Uniformity 0.291
Specific Surface Area 14.08 m²/kg
D [3,2] 426 μm
D [4,3] 479 μm
Dv (10) 285 μm
Dv (50) 453 μm
Dv (90) 717 μm
Dv (95) 800 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	24.03	1410	100.00
0.0600	0.00	15.6	0.00	105	0.00	420	41.92	1680	100.00
0.120	0.00	31.0	0.00	125	0.00	500	60.42	2000	100.00
0.240	0.00	37.0	0.00	149	0.00	590	76.48	2380	100.00
0.490	0.00	44.0	0.00	177	0.10	710	89.47	2830	100.00
0.980	0.00	53.0	0.00	210	0.91	840	96.69	3360	100.00
2.00	0.00	63.0	0.00	250	4.52	1000	99.84		
3.90	0.00	74.0	0.00	300	12.78	1190	100.00		

Measurement Details

Sample Name 2.01 S2
SOP File Name Sediment.msop
Lab Number 2023133/19
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 9:55:36 AM
Measurement Date Time 16/06/2023 9:55:36 AM
Result Source Measurement

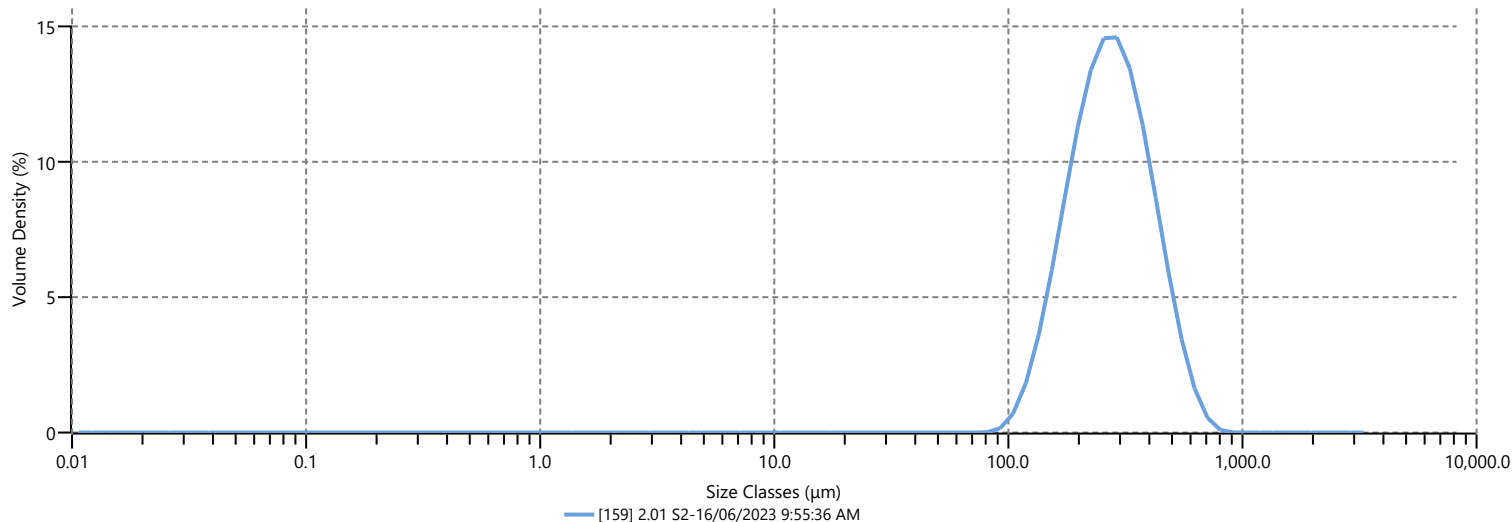
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.33 %
Laser Obscuration 13.54 %

Result

Concentration 0.4737 %
Span 1.055
Uniformity 0.329
Specific Surface Area 23.83 m²/kg
D [3,2] 252 μm
D [4,3] 292 μm
Dv (10) 163 μm
Dv (50) 272 μm
Dv (90) 450 μm
Dv (95) 510 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.02	350	73.38	1410	100.00
0.0600	0.00	15.6	0.00	105	0.39	420	86.13	1680	100.00
0.120	0.00	31.0	0.00	125	1.97	500	94.23	2000	100.00
0.240	0.00	37.0	0.00	149	6.47	590	98.31	2380	100.00
0.490	0.00	44.0	0.00	177	14.62	710	99.75	2830	100.00
0.980	0.00	53.0	0.00	210	26.45	840	99.99	3360	100.00
2.00	0.00	63.0	0.00	250	42.04	1000	100.00		
3.90	0.00	74.0	0.00	300	59.51	1190	100.00		

Measurement Details

Sample Name 2.02 2-300E
SOP File Name Sediment.msop
Lab Number 2023133/20
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 10:02:44 AM
Measurement Date Time 16/06/2023 10:02:44 AM
Result Source Measurement

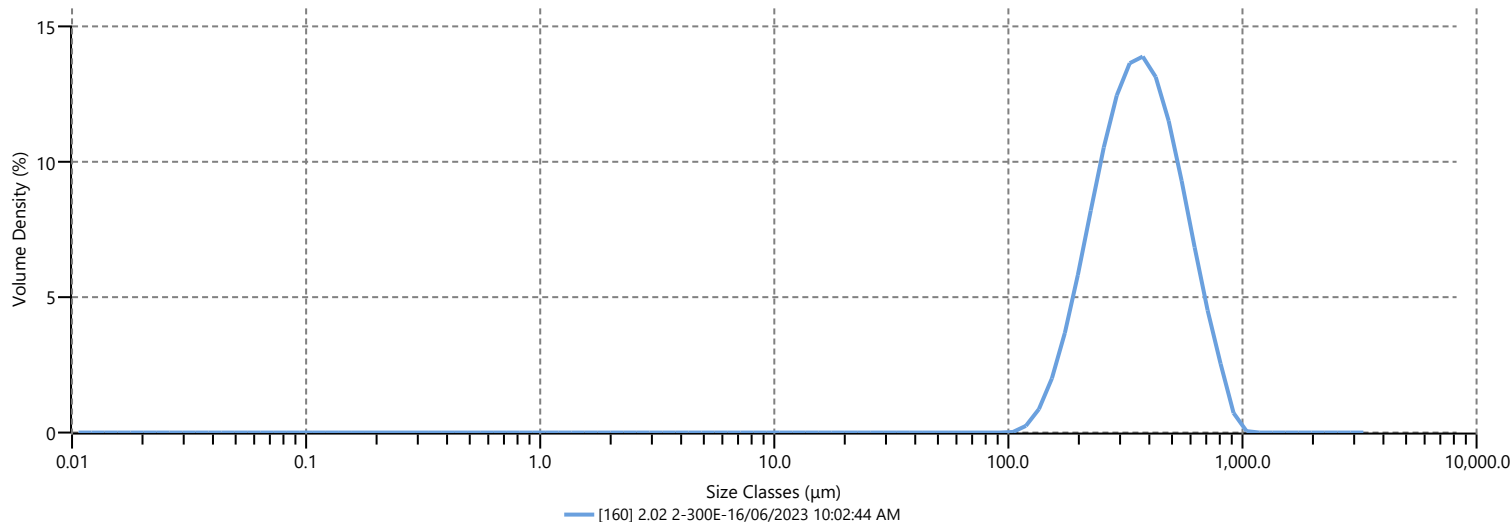
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.39 %
Laser Obscuration 13.40 %

Result

Concentration 0.6126 %
Span 1.124
Uniformity 0.345
Specific Surface Area 18.18 m²/kg
D [3,2] 330 μm
D [4,3] 388 μm
Dv (10) 209 μm
Dv (50) 360 μm
Dv (90) 614 μm
Dv (95) 698 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	47.45	1410	100.00
0.0600	0.00	15.6	0.00	105	0.00	420	63.83	1680	100.00
0.120	0.00	31.0	0.00	125	0.16	500	77.83	2000	100.00
0.240	0.00	37.0	0.00	149	1.31	590	88.24	2380	100.00
0.490	0.00	44.0	0.00	177	4.38	710	95.52	2830	100.00
0.980	0.00	53.0	0.00	210	10.17	840	99.11	3360	100.00
2.00	0.00	63.0	0.00	250	20.08	1000	100.00		
3.90	0.00	74.0	0.00	300	33.89	1190	100.00		

Measurement Details

Sample Name 2.03 2-300W
SOP File Name Sediment.msop
Lab Number 2023133/21
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 10:09:31 AM
Measurement Date Time 16/06/2023 10:09:31 AM
Result Source Measurement

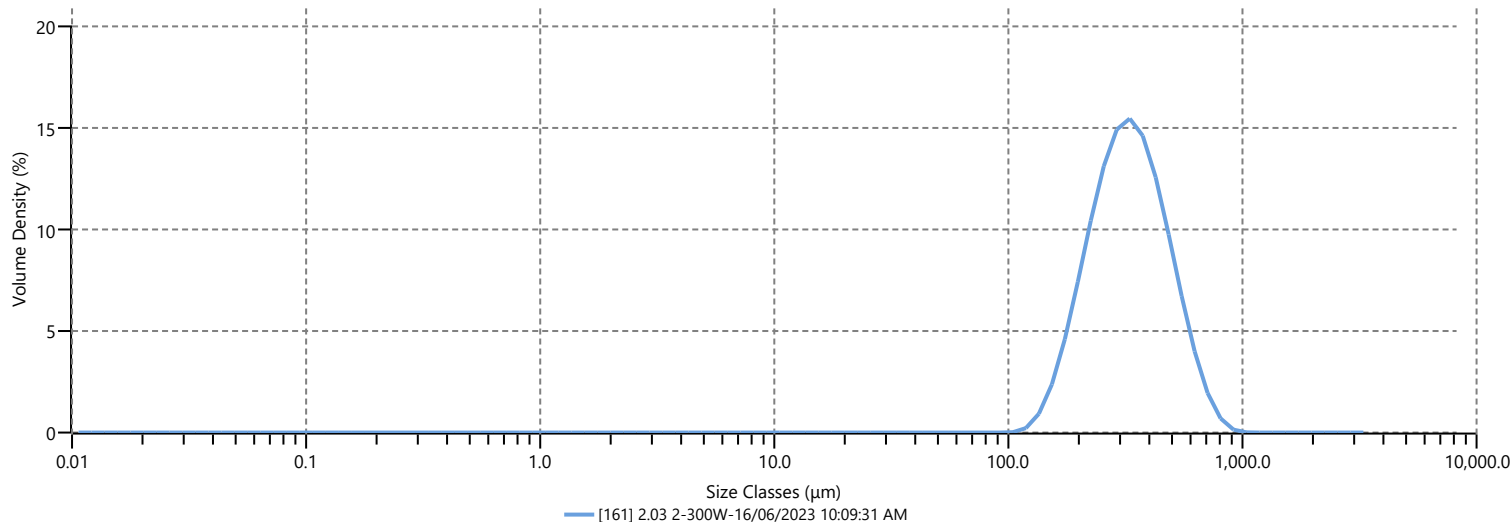
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.35 %
Laser Obscuration 17.24 %

Result

Concentration 0.7421 %
Span 1.012
Uniformity 0.311
Specific Surface Area 19.74 m²/kg
D [3,2] 304 μm
D [4,3] 348 μm
Dv (10) 199 μm
Dv (50) 325 μm
Dv (90) 528 μm
Dv (95) 597 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	57.51	1410	100.00
0.0600	0.00	15.6	0.00	105	0.00	420	74.38	1680	100.00
0.120	0.00	31.0	0.00	125	0.14	500	86.96	2000	100.00
0.240	0.00	37.0	0.00	149	1.40	590	94.70	2380	100.00
0.490	0.00	44.0	0.00	177	5.15	710	98.60	2830	100.00
0.980	0.00	53.0	0.00	210	12.52	840	99.81	3360	100.00
2.00	0.00	63.0	0.00	250	25.08	1000	100.00		
3.90	0.00	74.0	0.00	300	41.94	1190	100.00		

Measurement Details

Sample Name 2.04 2-600S
SOP File Name Sediment.msop
Lab Number 2023133/21
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 10:35:00 AM
Measurement Date Time 16/06/2023 10:35:00 AM
Result Source Measurement

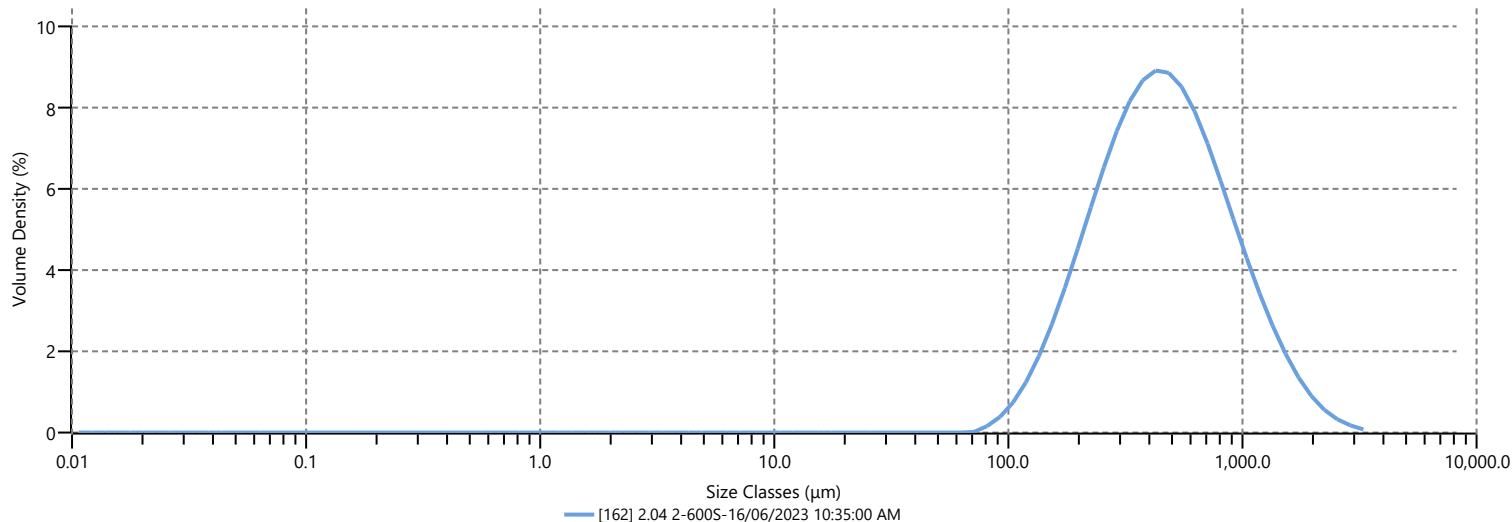
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.39 %
Laser Obscuration 13.67 %

Result

Concentration 0.7015 %
Span 1.983
Uniformity 0.624
Specific Surface Area 16.23 m²/kg
D [3,2] 370 μm
D [4,3] 567 μm
Dv (10) 193 μm
Dv (50) 451 μm
Dv (90) 1090 μm
Dv (95) 1380 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

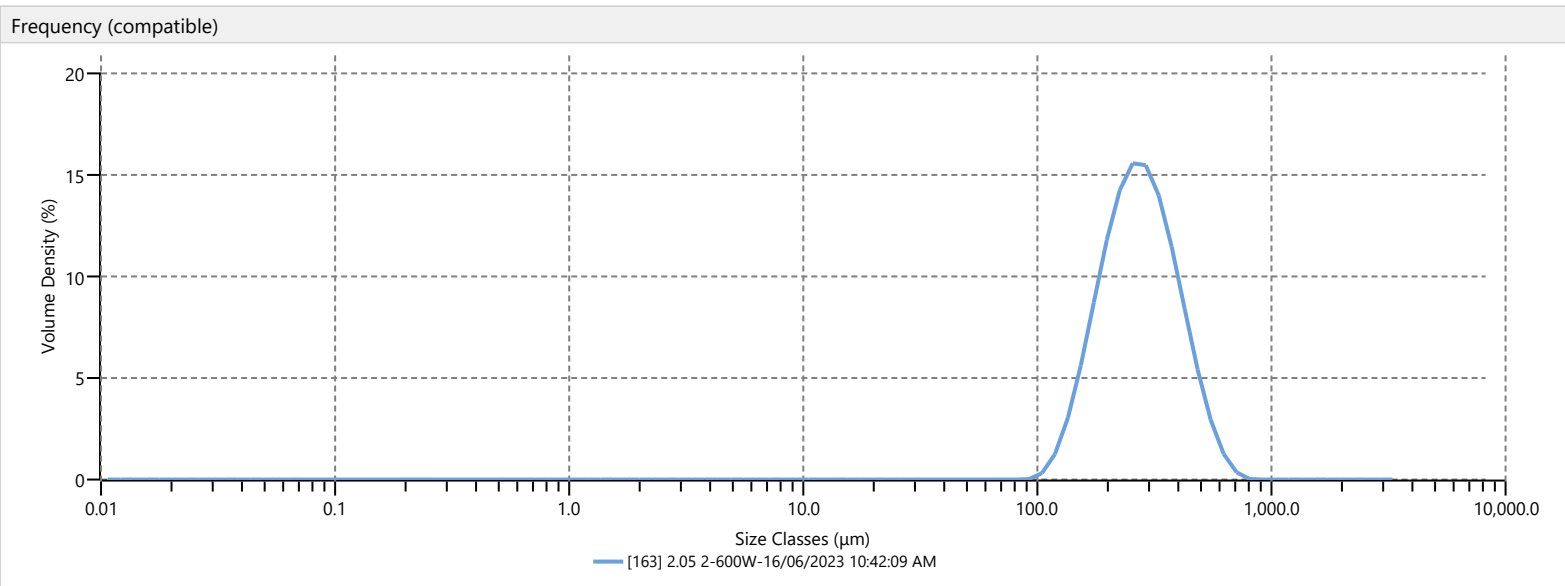
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.18	350	35.41	1410	95.32
0.0600	0.00	15.6	0.00	105	0.76	420	45.82	1680	97.49
0.120	0.00	31.0	0.00	125	1.96	500	55.96	2000	98.79
0.240	0.00	37.0	0.00	149	4.23	590	65.23	2380	99.52
0.490	0.00	44.0	0.00	177	7.68	710	74.48	2830	99.84
0.980	0.00	53.0	0.00	210	12.43	840	81.67	3360	99.98
2.00	0.00	63.0	0.00	250	18.98	1000	87.63		
3.90	0.00	74.0	0.00	300	27.33	1190	92.11		

Measurement Details	
Sample Name	2.05 2-600W
SOP File Name	Sediment.msop
Lab Number	2023133/23
Operator Name	rodgers

Measurement Details	
Analysis Date Time	16/06/2023 10:42:09 AM
Measurement Date Time	16/06/2023 10:42:09 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.35 %
Laser Obscuration	14.65 %

Result	
Concentration	0.5214 %
Span	0.998
Uniformity	0.309
Specific Surface Area	23.58 m ² /kg
D [3,2]	254 μm
D [4,3]	290 μm
Dv (10)	168 μm
Dv (50)	271 μm
Dv (90)	439 μm
Dv (95)	496 μm
Volume Below (31) μm	0.00 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	74.84	1410	100.00
0.0600	0.00	15.6	0.00	105	0.12	420	87.60	1680	100.00
0.120	0.00	31.0	0.00	125	1.10	500	95.25	2000	100.00
0.240	0.00	37.0	0.00	149	4.95	590	98.80	2380	100.00
0.490	0.00	44.0	0.00	177	12.86	710	99.87	2830	100.00
0.980	0.00	53.0	0.00	210	25.11	840	100.00	3360	100.00
2.00	0.00	63.0	0.00	250	41.73	1000	100.00		
3.90	0.00	74.0	0.00	300	60.36	1190	100.00		

Measurement Details

Sample Name 2.06 S2-300S
SOP File Name Sediment.msop
Lab Number 2023133/24
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 10:50:47 AM
Measurement Date Time 16/06/2023 10:50:47 AM
Result Source Measurement

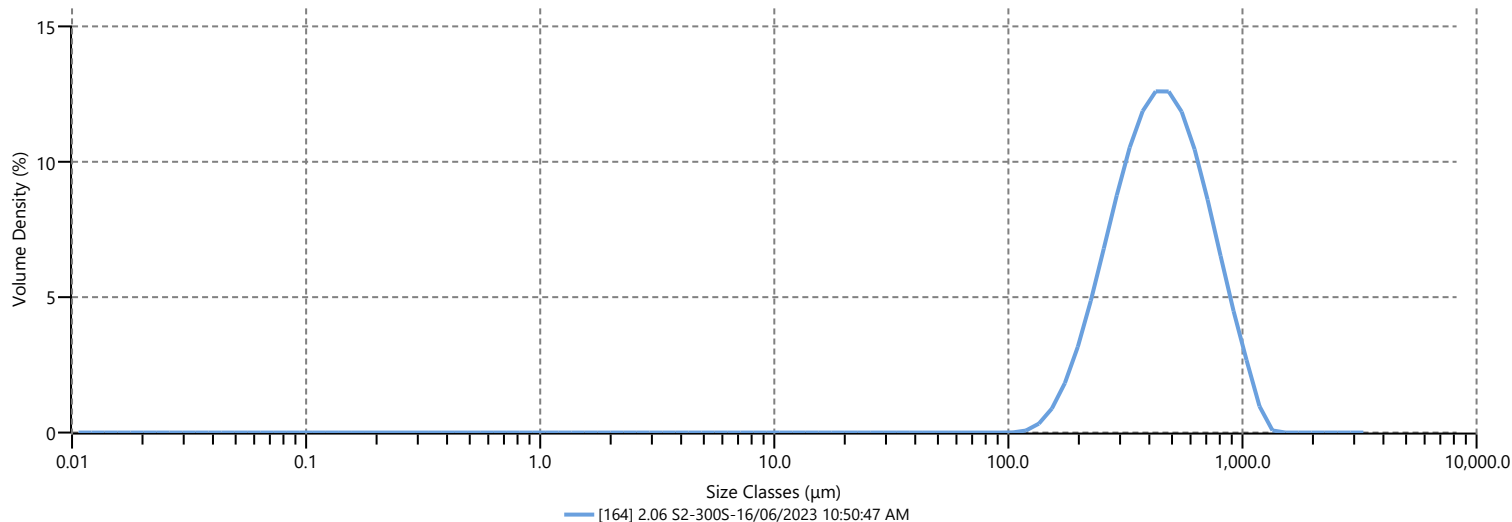
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.35 %
Laser Obscuration 8.32 %

Result

Concentration 0.4484 %
Span 1.235
Uniformity 0.379
Specific Surface Area 14.98 m²/kg
D [3,2] 401 μm
D [4,3] 487 μm
Dv (10) 244 μm
Dv (50) 446 μm
Dv (90) 795 μm
Dv (95) 911 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	30.62	1410	100.00
0.0600	0.00	15.6	0.00	105	0.00	420	45.02	1680	100.00
0.120	0.00	31.0	0.00	125	0.04	500	59.44	2000	100.00
0.240	0.00	37.0	0.00	149	0.50	590	72.40	2380	100.00
0.490	0.00	44.0	0.00	177	1.94	710	84.30	2830	100.00
0.980	0.00	53.0	0.00	210	5.02	840	92.33	3360	100.00
2.00	0.00	63.0	0.00	250	11.02	1000	97.44		
3.90	0.00	74.0	0.00	300	20.35	1190	99.66		

Measurement Details

Sample Name 2.07 SS14
SOP File Name Sediment.msop
Lab Number 2023133/25
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 10:57:43 AM
Measurement Date Time 16/06/2023 10:57:43 AM
Result Source Measurement

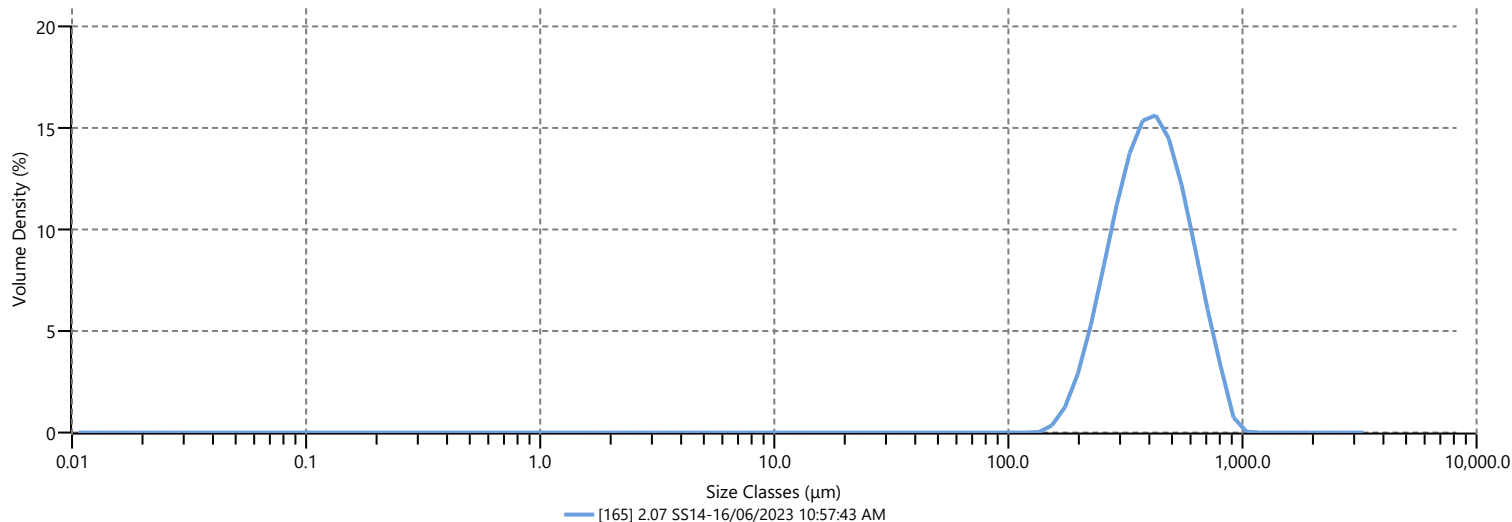
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.35 %
Laser Obscuration 13.36 %

Result

Concentration 0.6978 %
Span 0.981
Uniformity 0.301
Specific Surface Area 15.89 m²/kg
D [3,2] 378 μm
D [4,3] 428 μm
Dv (10) 249 μm
Dv (50) 405 μm
Dv (90) 646 μm
Dv (95) 723 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

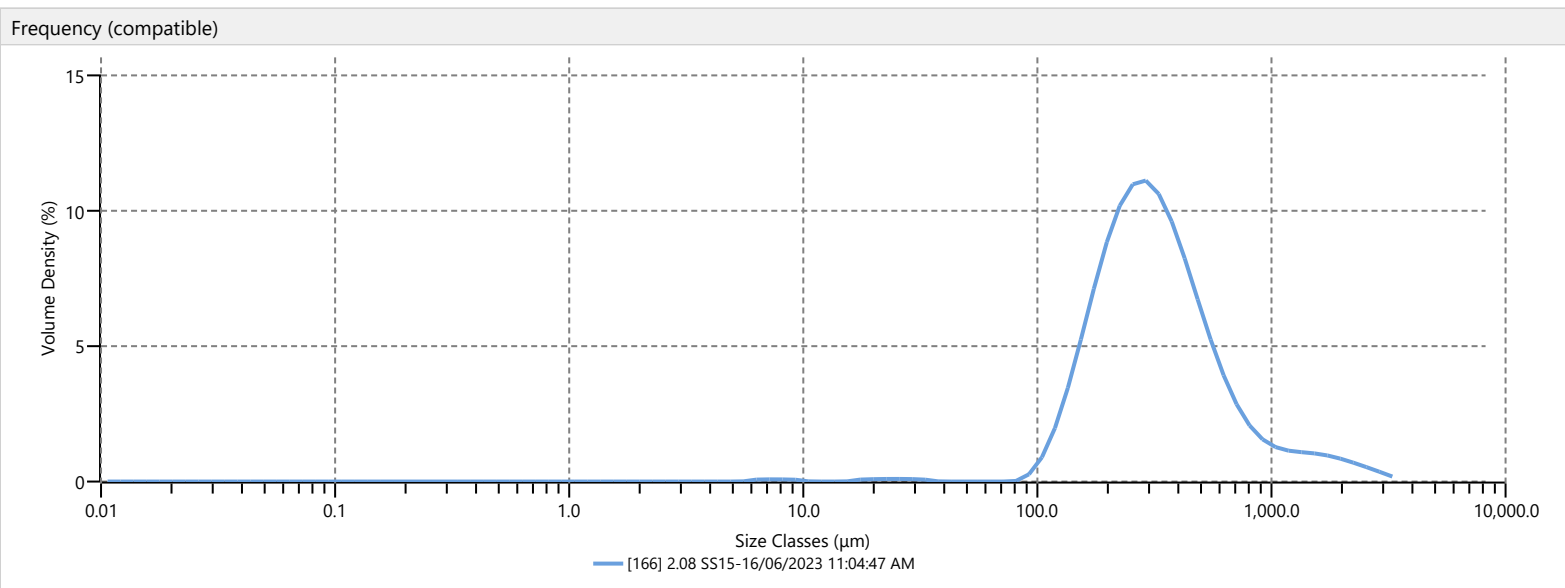
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	35.31	1410	100.00
0.0600	0.00	15.6	0.00	105	0.00	420	53.76	1680	100.00
0.120	0.00	31.0	0.00	125	0.00	500	70.96	2000	100.00
0.240	0.00	37.0	0.00	149	0.07	590	84.54	2380	100.00
0.490	0.00	44.0	0.00	177	0.87	710	94.31	2830	100.00
0.980	0.00	53.0	0.00	210	3.50	840	99.05	3360	100.00
2.00	0.00	63.0	0.00	250	10.20	1000	100.00		
3.90	0.00	74.0	0.00	300	21.89	1190	100.00		

Measurement Details	
Sample Name	2.08 SS15
SOP File Name	Sediment.msop
Lab Number	2023133/26
Operator Name	rodgers

Measurement Details	
Analysis Date Time	16/06/2023 11:04:47 AM
Measurement Date Time	16/06/2023 11:04:47 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.33 %
Laser Obscuration	21.34 %

Result	
Concentration	0.7649 %
Span	1.913
Uniformity	0.696
Specific Surface Area	24.23 m ² /kg
D [3,2]	248 μm
D [4,3]	424 μm
Dv (10)	161 μm
Dv (50)	306 μm
Dv (90)	747 μm
Dv (95)	1220 μm
Volume Below (31)	0.64 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.14	88.0	0.73	350	59.42	1410	96.02
0.0600	0.00	15.6	0.26	105	1.28	420	70.47	1680	97.20
0.120	0.00	31.0	0.64	125	3.07	500	78.90	2000	98.24
0.240	0.00	37.0	0.70	149	7.29	590	84.80	2380	99.09
0.490	0.00	44.0	0.70	177	14.17	710	89.07	2830	99.64
0.980	0.00	53.0	0.70	210	23.53	840	91.64	3360	99.95
2.00	0.00	63.0	0.70	250	35.35	1000	93.43		
3.90	0.00	74.0	0.70	300	48.58	1190	94.80		

Measurement Details

Sample Name 2.09 SS16
SOP File Name Sediment.msop
Lab Number 2023133/27
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 11:11:50 AM
Measurement Date Time 16/06/2023 11:11:50 AM
Result Source Measurement

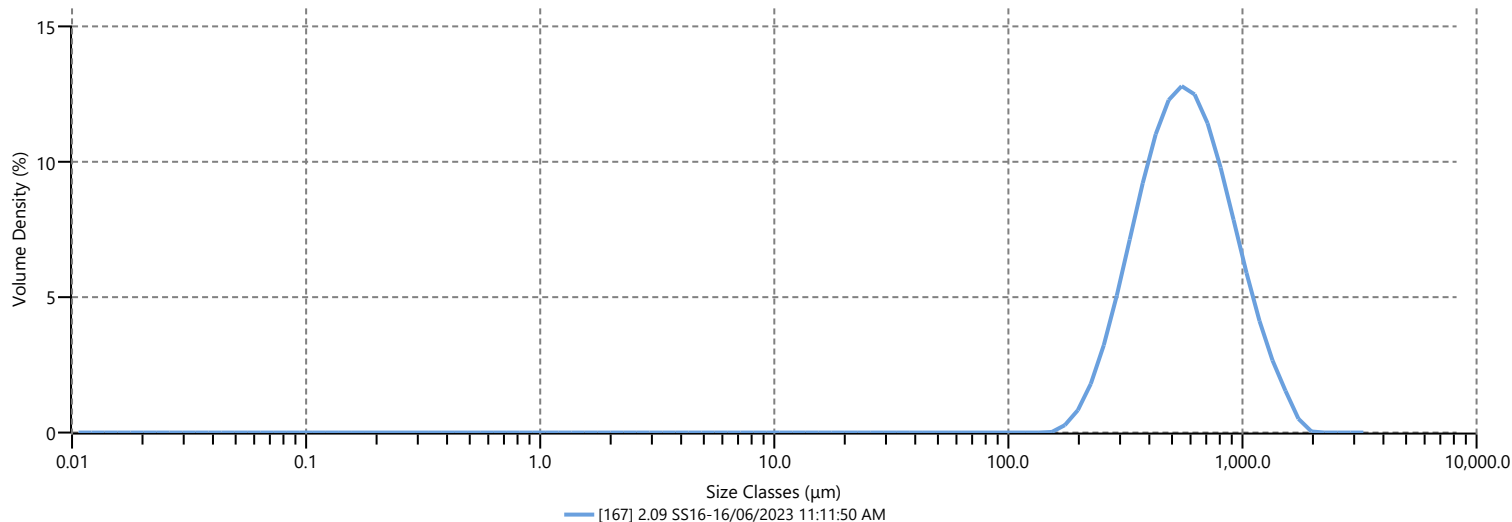
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.49 %
Laser Obscuration 9.49 %

Result

Concentration 0.6581 %
Span 1.272
Uniformity 0.390
Specific Surface Area 11.68 m²/kg
D [3,2] 514 μm
D [4,3] 627 μm
Dv (10) 315 μm
Dv (50) 565 μm
Dv (90) 1030 μm
Dv (95) 1210 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

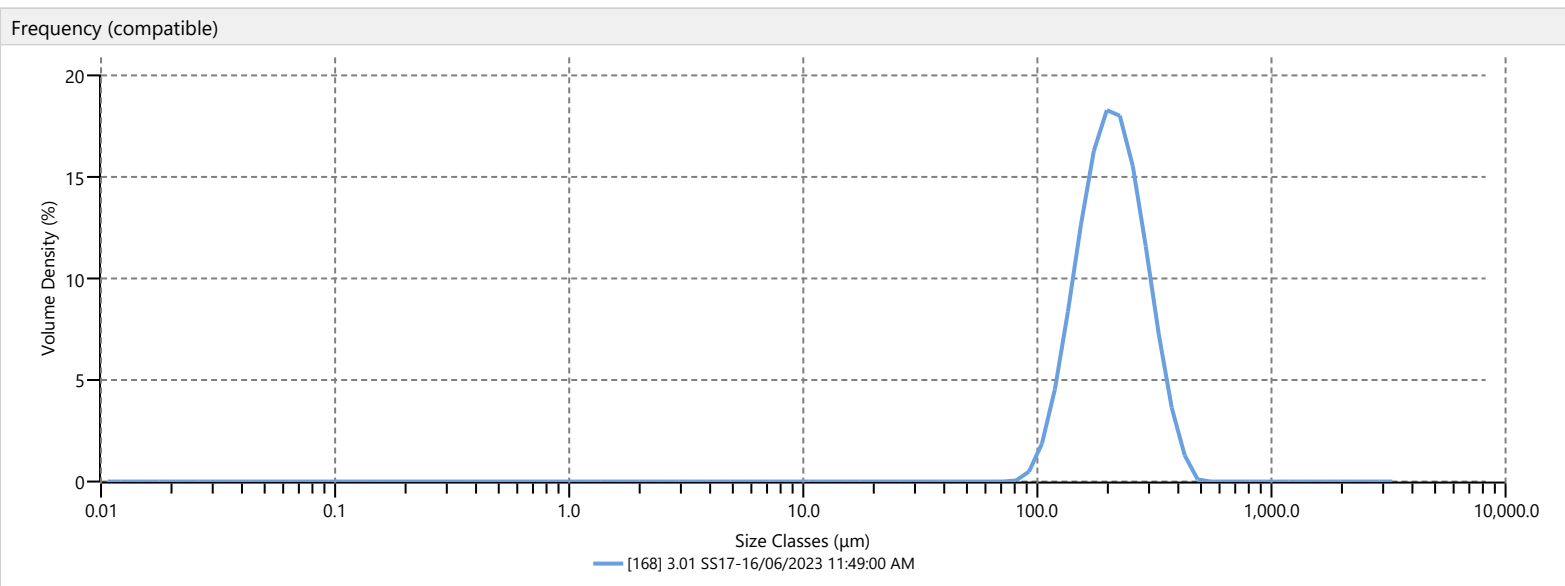
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.00	350	14.92	1410	98.07
0.0600	0.00	15.6	0.00	105	0.00	420	26.44	1680	99.71
0.120	0.00	31.0	0.00	125	0.00	500	39.84	2000	100.00
0.240	0.00	37.0	0.00	149	0.00	590	53.63	2380	100.00
0.490	0.00	44.0	0.00	177	0.13	710	68.35	2830	100.00
0.980	0.00	53.0	0.00	210	0.84	840	79.81	3360	100.00
2.00	0.00	63.0	0.00	250	3.21	1000	88.74		
3.90	0.00	74.0	0.00	300	8.17	1190	94.60		

Measurement Details	
Sample Name	3.01 SS17
SOP File Name	Sediment.msop
Lab Number	2023133/28
Operator Name	rodgers

Measurement Details	
Analysis Date Time	16/06/2023 11:49:00 AM
Measurement Date Time	16/06/2023 11:49:00 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.43 %
Laser Obscuration	14.91 %

Result	
Concentration	0.4138 %
Span	0.829
Uniformity	0.257
Specific Surface Area	30.37 m ² /kg
D [3,2]	198 μm
D [4,3]	217 μm
Dv (10)	138 μm
Dv (50)	207 μm
Dv (90)	309 μm
Dv (95)	344 μm
Volume Below (31)	0.00 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.07	350	95.84	1410	100.00
0.0600	0.00	15.6	0.00	105	1.14	420	99.39	1680	100.00
0.120	0.00	31.0	0.00	125	5.15	500	100.00	2000	100.00
0.240	0.00	37.0	0.00	149	15.36	590	100.00	2380	100.00
0.490	0.00	44.0	0.00	177	31.56	710	100.00	2830	100.00
0.980	0.00	53.0	0.00	210	51.54	840	100.00	3360	100.00
2.00	0.00	63.0	0.00	250	71.59	1000	100.00		
3.90	0.00	74.0	0.00	300	87.68	1190	100.00		

Measurement Details

Sample Name 3.02 SS18
SOP File Name Sediment.msop
Lab Number 2023133/29
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 11:56:06 AM
Measurement Date Time 16/06/2023 11:56:06 AM
Result Source Measurement

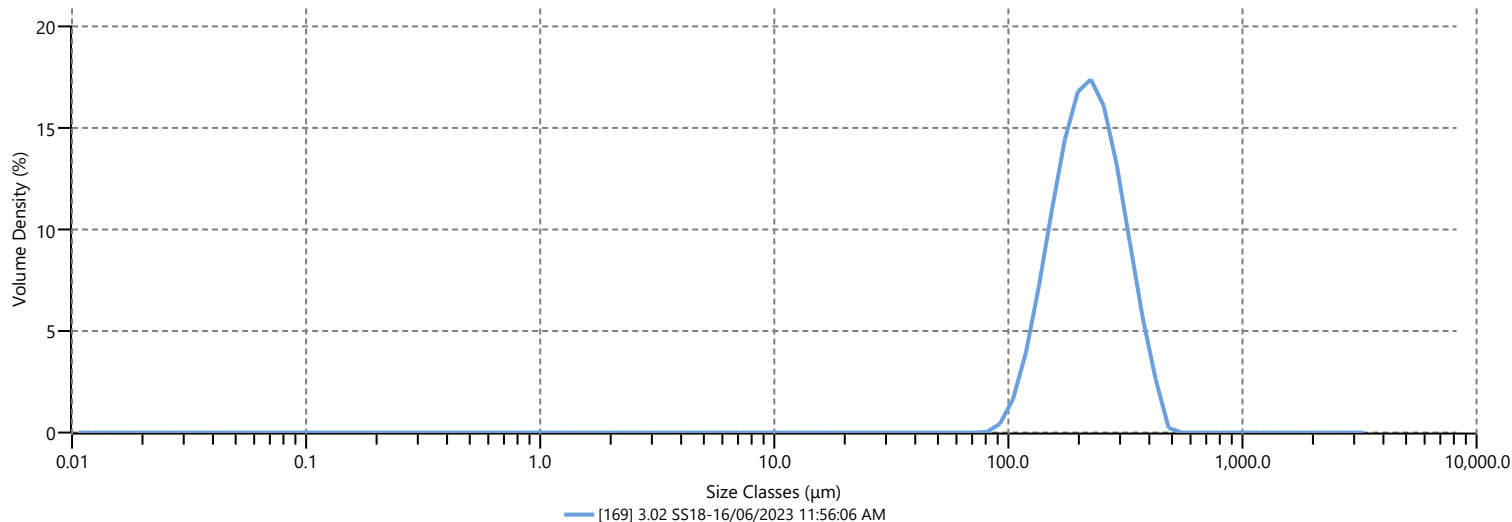
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.53 %
Laser Obscuration 18.16 %

Result

Concentration 0.5360 %
Span 0.881
Uniformity 0.269
Specific Surface Area 29.07 m²/kg
D [3,2] 206 μm
D [4,3] 229 μm
Dv (10) 142 μm
Dv (50) 218 μm
Dv (90) 334 μm
Dv (95) 370 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.05	350	92.89	1410	100.00
0.0600	0.00	15.6	0.00	105	0.99	420	98.68	1680	100.00
0.120	0.00	31.0	0.00	125	4.48	500	100.00	2000	100.00
0.240	0.00	37.0	0.00	149	13.28	590	100.00	2380	100.00
0.490	0.00	44.0	0.00	177	27.46	710	100.00	2830	100.00
0.980	0.00	53.0	0.00	210	45.60	840	100.00	3360	100.00
2.00	0.00	63.0	0.00	250	65.21	1000	100.00		
3.90	0.00	74.0	0.00	300	82.65	1190	100.00		

Measurement Details

Sample Name 3.03 SS19
SOP File Name Sediment.msop
Lab Number 2023133/30
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 12:02:42 PM
Measurement Date Time 16/06/2023 12:02:42 PM
Result Source Measurement

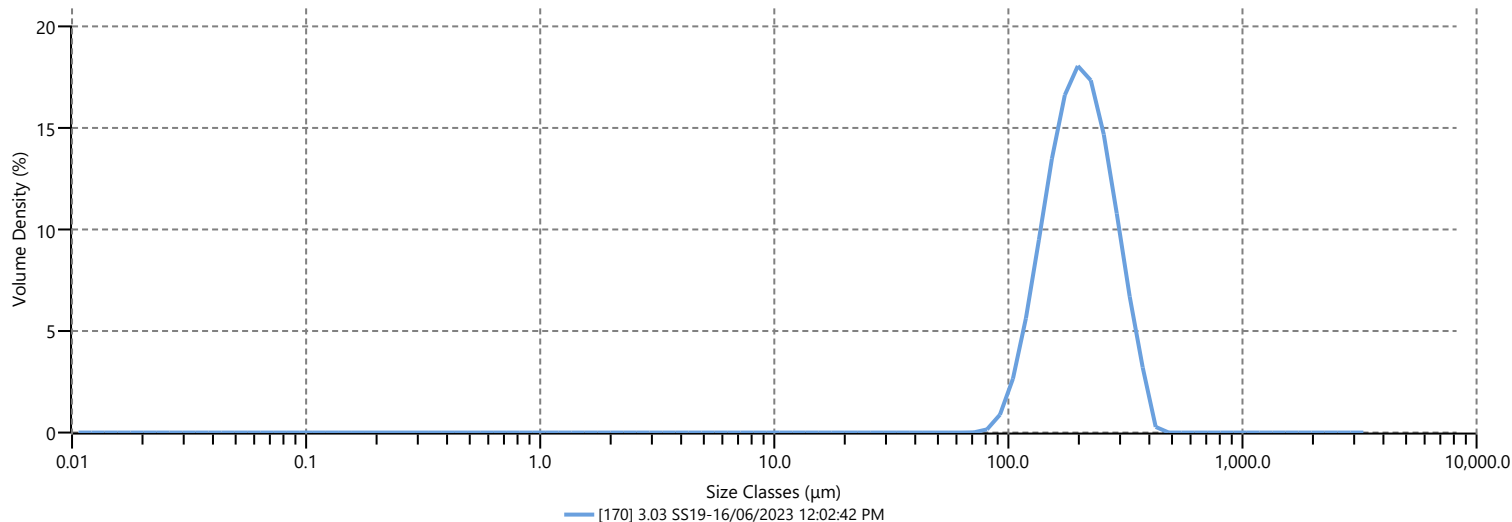
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.46 %
Laser Obscuration 18.42 %

Result

Concentration 0.5033 %
Span 0.845
Uniformity 0.256
Specific Surface Area 31.48 m²/kg
D [3,2] 191 μm
D [4,3] 210 μm
Dv (10) 132 μm
Dv (50) 201 μm
Dv (90) 302 μm
Dv (95) 333 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

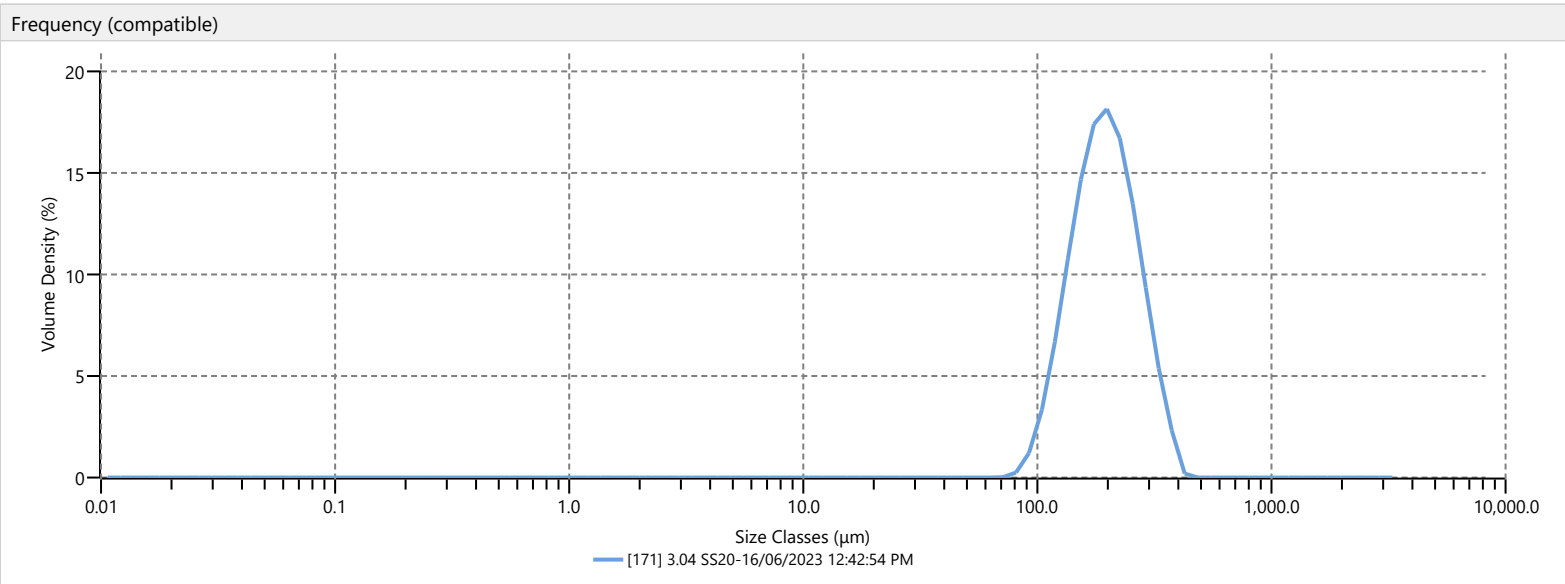
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.19	350	97.13	1410	100.00
0.0600	0.00	15.6	0.00	105	1.88	420	99.99	1680	100.00
0.120	0.00	31.0	0.00	125	7.03	500	100.00	2000	100.00
0.240	0.00	37.0	0.00	149	18.49	590	100.00	2380	100.00
0.490	0.00	44.0	0.00	177	35.39	710	100.00	2830	100.00
0.980	0.00	53.0	0.00	210	55.29	840	100.00	3360	100.00
2.00	0.00	63.0	0.00	250	74.51	1000	100.00		
3.90	0.00	74.0	0.00	300	89.61	1190	100.00		

Measurement Details	
Sample Name	3.04 SS20
SOP File Name	Sediment.msop
Lab Number	2023133/31
Operator Name	rodgers

Measurement Details	
Analysis Date Time	16/06/2023 12:42:54 PM
Measurement Date Time	16/06/2023 12:42:54 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.55 %
Laser Obscuration	18.81 %

Result	
Concentration	0.4969 %
Span	0.846
Uniformity	0.258
Specific Surface Area	32.66 m ² /kg
D [3,2]	184 μm
D [4,3]	202 μm
Dv (10)	128 μm
Dv (50)	193 μm
Dv (90)	291 μm
Dv (95)	321 μm
Volume Below (31)	0.00 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.29	350	97.94	1410	100.00
0.0600	0.00	15.6	0.00	105	2.51	420	99.99	1680	100.00
0.120	0.00	31.0	0.00	125	8.74	500	100.00	2000	100.00
0.240	0.00	37.0	0.00	149	21.66	590	100.00	2380	100.00
0.490	0.00	44.0	0.00	177	39.72	710	100.00	2830	100.00
0.980	0.00	53.0	0.00	210	59.95	840	100.00	3360	100.00
2.00	0.00	63.0	0.00	250	78.30	1000	100.00		
3.90	0.00	74.0	0.00	300	91.78	1190	100.00		

Measurement Details

Sample Name 3.05 SS21
SOP File Name Sediment.msop
Lab Number 2023133/32
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 12:49:47 PM
Measurement Date Time 16/06/2023 12:49:47 PM
Result Source Measurement

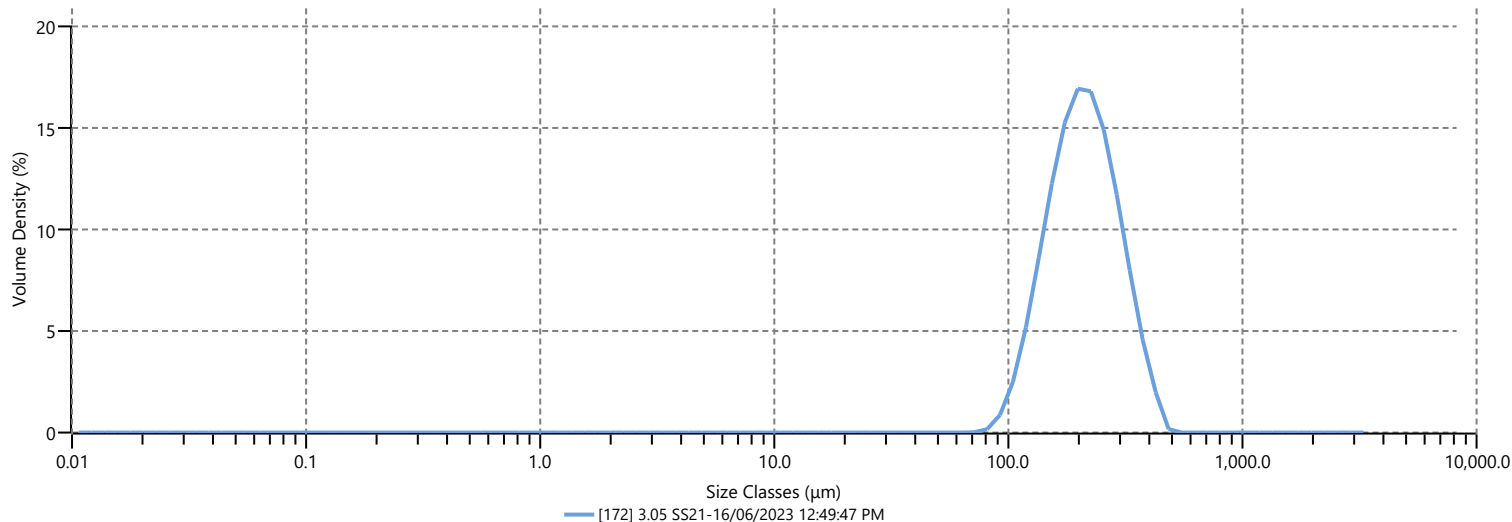
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.46 %
Laser Obscuration 15.58 %

Result

Concentration 0.4318 %
Span 0.904
Uniformity 0.277
Specific Surface Area 30.51 m²/kg
D [3,2] 197 μm
D [4,3] 219 μm
Dv (10) 134 μm
Dv (50) 208 μm
Dv (90) 322 μm
Dv (95) 356 μm
Volume Below (31) μm 0.00 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.19	350	94.40	1410	100.00
0.0600	0.00	15.6	0.00	105	1.82	420	99.01	1680	100.00
0.120	0.00	31.0	0.00	125	6.58	500	100.00	2000	100.00
0.240	0.00	37.0	0.00	149	17.01	590	100.00	2380	100.00
0.490	0.00	44.0	0.00	177	32.45	710	100.00	2830	100.00
0.980	0.00	53.0	0.00	210	50.99	840	100.00	3360	100.00
2.00	0.00	63.0	0.00	250	69.77	1000	100.00		
3.90	0.00	74.0	0.00	300	85.60	1190	100.00		

Measurement Details

Sample Name 3.06 SS22
SOP File Name Sediment.msop
Lab Number 2023133/33
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 12:56:40 PM
Measurement Date Time 16/06/2023 12:56:40 PM
Result Source Measurement

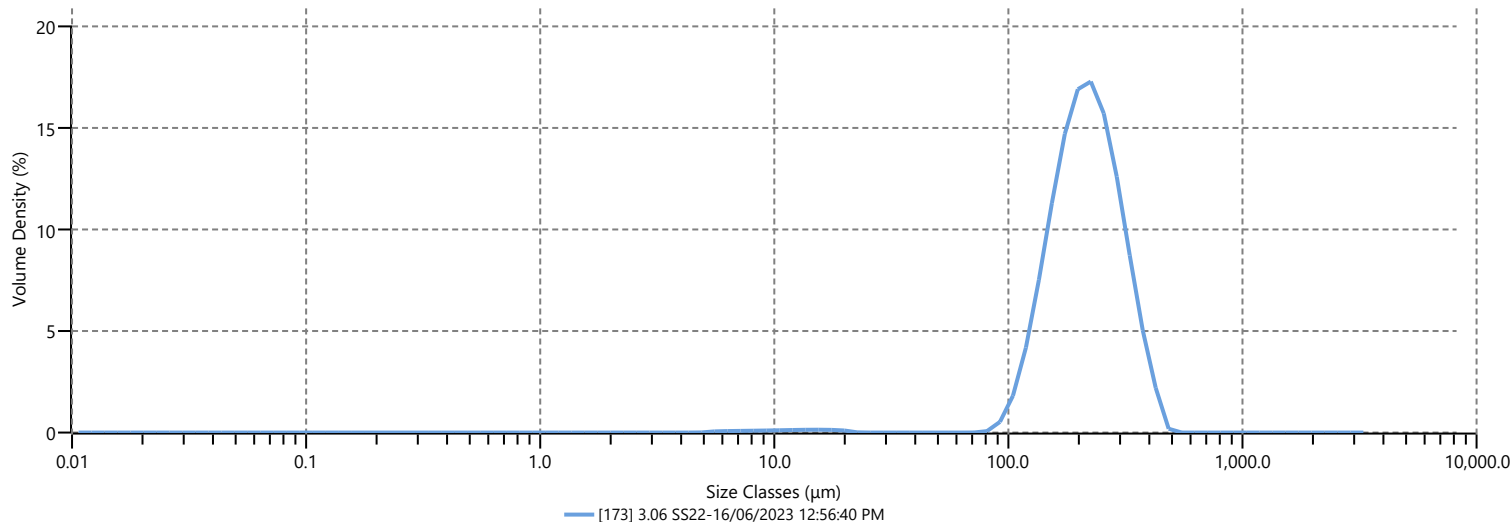
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.28 %
Laser Obscuration 14.34 %

Result

Concentration 0.3448 %
Span 0.891
Uniformity 0.277
Specific Surface Area 34.72 m²/kg
D [3,2] 173 μm
D [4,3] 223 μm
Dv (10) 137 μm
Dv (50) 214 μm
Dv (90) 327 μm
Dv (95) 362 μm
Volume Below (31) μm 0.97 %

Frequency (compatible)



Result

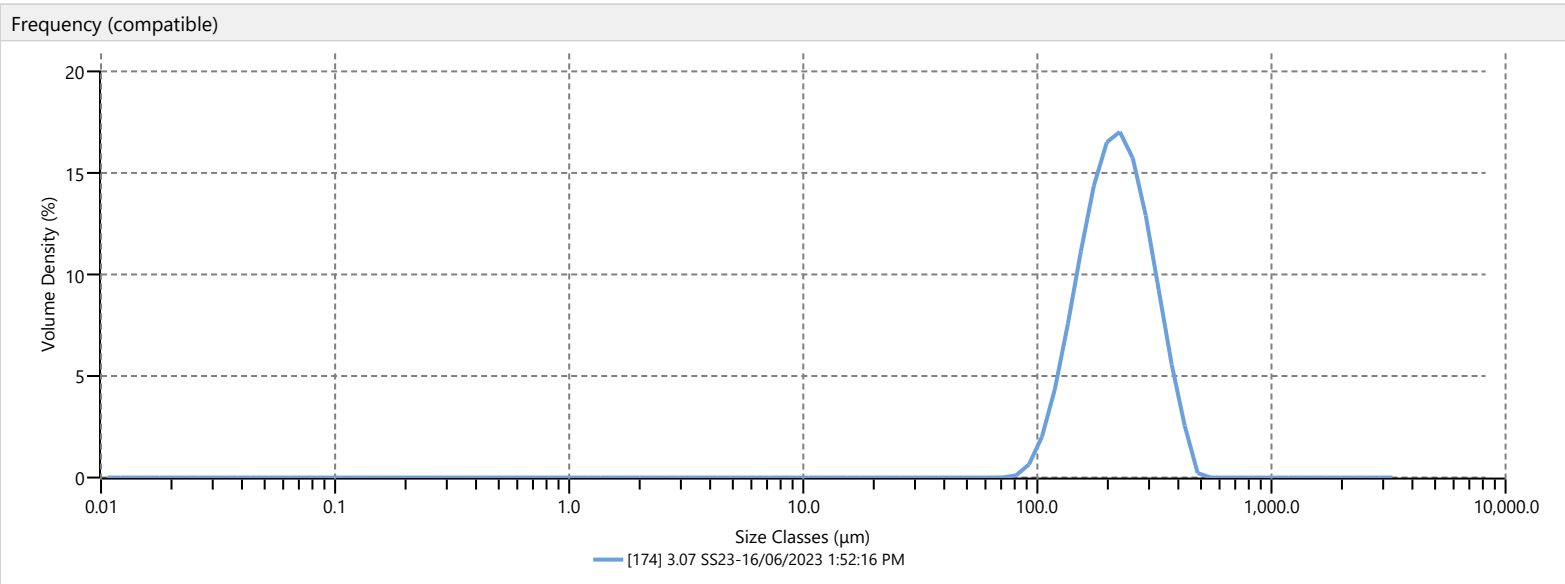
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.19	88.0	1.06	350	93.79	1410	100.00
0.0600	0.00	15.6	0.72	105	2.15	420	98.90	1680	100.00
0.120	0.00	31.0	0.97	125	5.88	500	100.00	2000	100.00
0.240	0.00	37.0	0.97	149	15.05	590	100.00	2380	100.00
0.490	0.00	44.0	0.97	177	29.60	710	100.00	2830	100.00
0.980	0.00	53.0	0.97	210	47.93	840	100.00	3360	100.00
2.00	0.00	63.0	0.97	250	67.35	1000	100.00		
3.90	0.00	74.0	0.97	300	84.22	1190	100.00		

Measurement Details	
Sample Name	3.07 SS23
SOP File Name	Sediment.msop
Lab Number	2023133/34
Operator Name	rodgers

Measurement Details	
Analysis Date Time	16/06/2023 1:52:16 PM
Measurement Date Time	16/06/2023 1:52:16 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.37 %
Laser Obscuration	15.74 %

Result	
Concentration	0.4520 %
Span	0.900
Uniformity	0.275
Specific Surface Area	29.46 m ² /kg
D [3,2]	204 μm
D [4,3]	227 μm
Dv (10)	138 μm
Dv (50)	216 μm
Dv (90)	333 μm
Dv (95)	369 μm
Volume Below (31)	0.00 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.13	350	93.02	1410	100.00
0.0600	0.00	15.6	0.00	105	1.39	420	98.71	1680	100.00
0.120	0.00	31.0	0.00	125	5.35	500	100.00	2000	100.00
0.240	0.00	37.0	0.00	149	14.55	590	100.00	2380	100.00
0.490	0.00	44.0	0.00	177	28.81	710	100.00	2830	100.00
0.980	0.00	53.0	0.00	210	46.71	840	100.00	3360	100.00
2.00	0.00	63.0	0.00	250	65.89	1000	100.00		
3.90	0.00	74.0	0.00	300	82.96	1190	100.00		

Measurement Details

Sample Name 3.08 SS24
SOP File Name Sediment.msop
Lab Number 2023133/35
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 2:01:27 PM
Measurement Date Time 16/06/2023 2:01:27 PM
Result Source Measurement

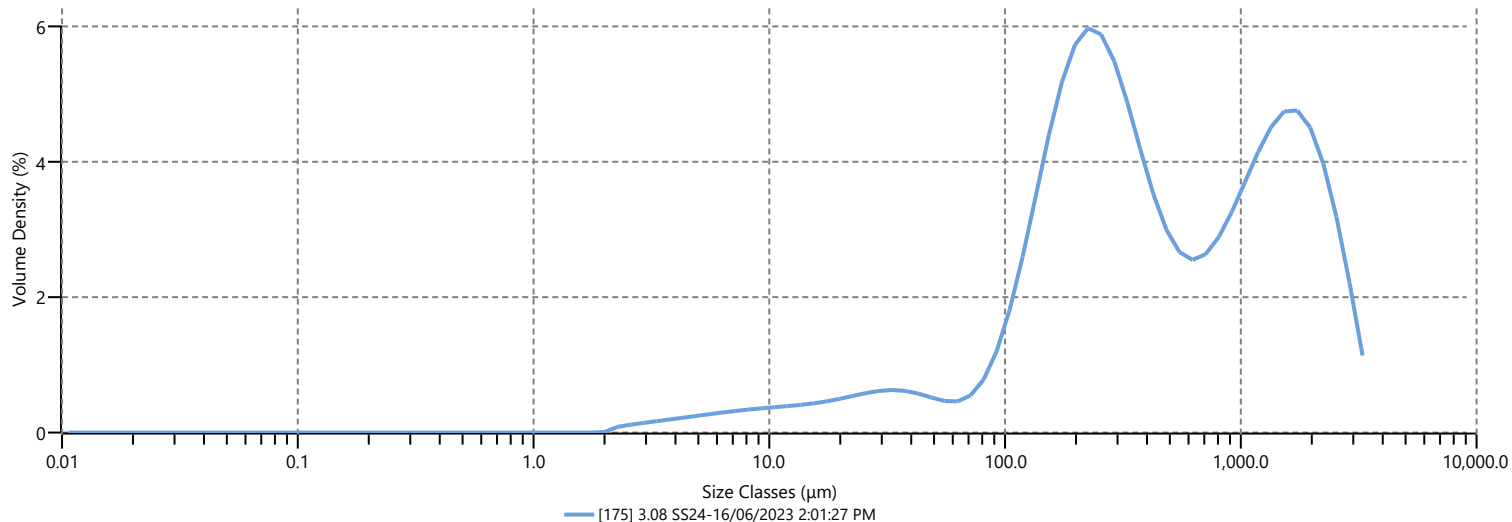
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.48 %
Laser Obscuration 6.19 %

Result

Concentration 0.0796 %
Span 5.215
Uniformity 1.576
Specific Surface Area 60.61 m²/kg
D [3,2] 99.0 μm
D [4,3] 763 μm
Dv (10) 89.9 μm
Dv (50) 370 μm
Dv (90) 2020 μm
Dv (95) 2440 μm
Volume Below (31) μm 5.87 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	1.76	88.0	9.83	350	48.49	1410	79.00
0.0600	0.00	15.6	3.49	105	11.47	420	53.27	1680	84.43
0.120	0.00	31.0	5.87	125	14.11	500	56.93	2000	89.74
0.240	0.00	37.0	6.60	149	18.25	590	59.85	2380	94.45
0.490	0.00	44.0	7.27	177	23.61	710	62.95	2830	97.81
0.980	0.00	53.0	7.91	210	29.86	840	66.01	3360	99.69
2.00	0.00	63.0	8.43	250	36.66	1000	69.73		
3.90	0.55	74.0	8.96	300	43.44	1190	74.13		

Measurement Details

Sample Name 3.09 SS25
SOP File Name Sediment.msop
Lab Number 2023133/36
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 2:08:35 PM
Measurement Date Time 16/06/2023 2:08:35 PM
Result Source Measurement

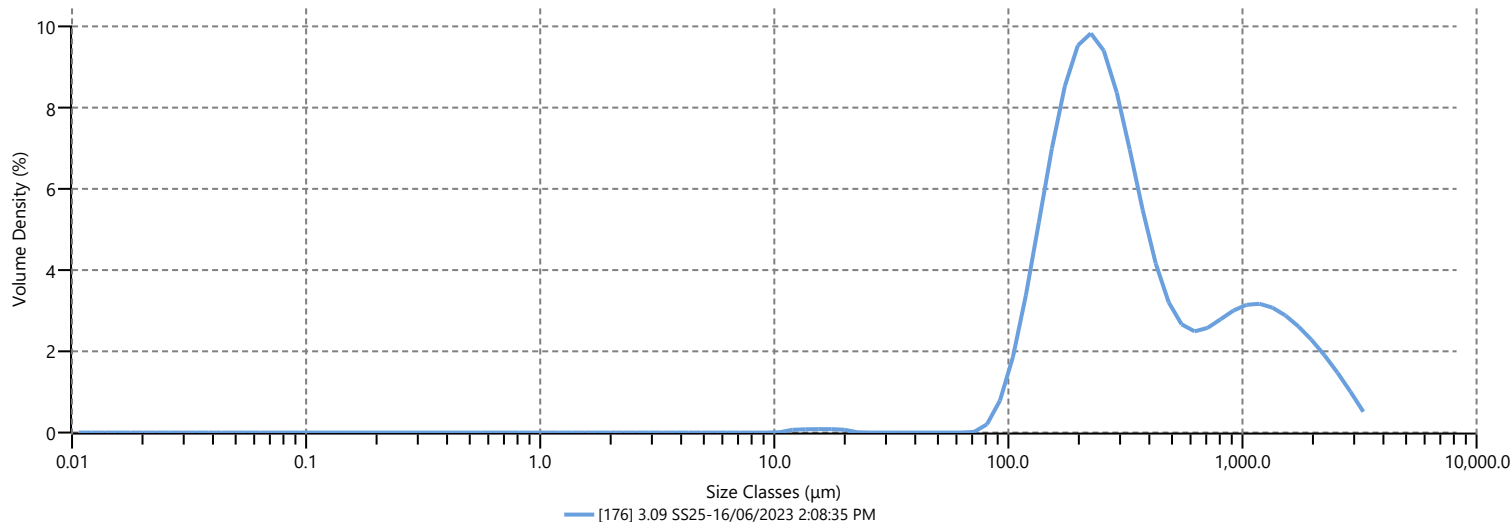
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.47 %
Laser Obscuration 10.87 %

Result

Concentration 0.3881 %
Span 4.622
Uniformity 1.287
Specific Surface Area 22.98 m²/kg
D [3,2] 261 μm
D [4,3] 564 μm
Dv (10) 145 μm
Dv (50) 288 μm
Dv (90) 1480 μm
Dv (95) 1980 μm
Volume Below (31) μm 0.33 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	0.00	88.0	0.57	350	59.46	1410	89.09
0.0600	0.00	15.6	0.17	105	1.91	420	65.58	1680	92.36
0.120	0.00	31.0	0.33	125	5.13	500	69.68	2000	95.17
0.240	0.00	37.0	0.33	149	11.34	590	72.63	2380	97.46
0.490	0.00	44.0	0.33	177	20.04	710	75.65	2830	99.01
0.980	0.00	53.0	0.33	210	30.42	840	78.62	3360	99.86
2.00	0.00	63.0	0.33	250	41.55	1000	82.04		
3.90	0.00	74.0	0.33	300	52.15	1190	85.64		

Measurement Details

Sample Name 4.01 1A
SOP File Name Sediment.msop
Lab Number 2023133/36
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 2:15:35 PM
Measurement Date Time 16/06/2023 2:15:35 PM
Result Source Measurement

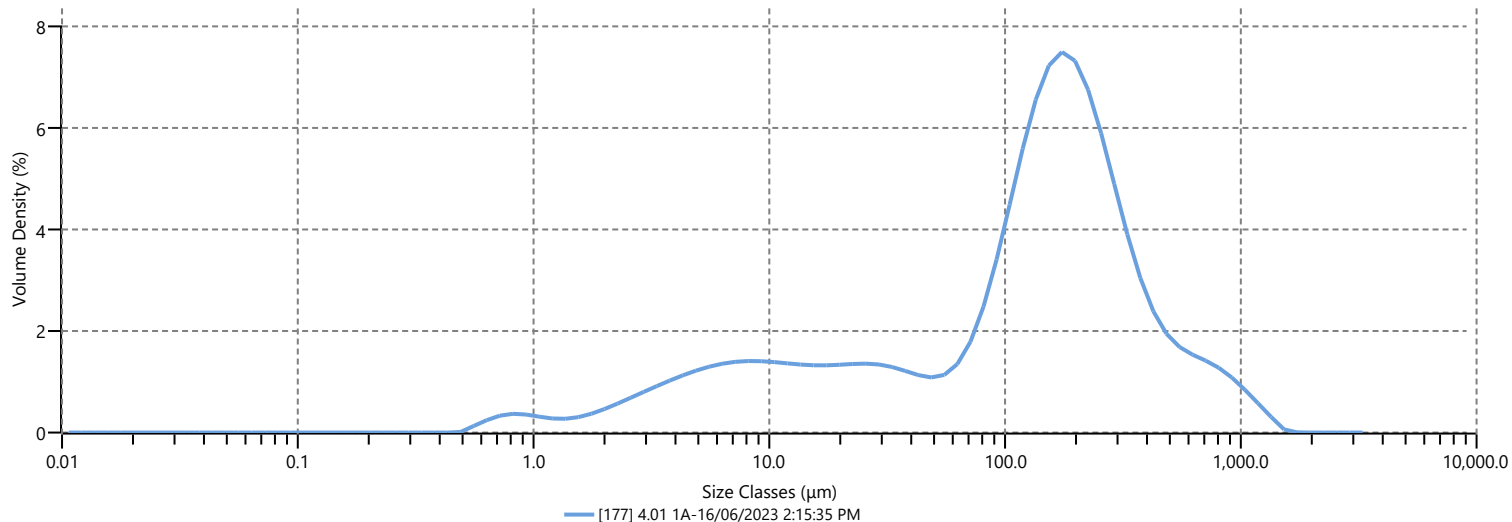
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.31 %
Laser Obscuration 25.71 %

Result

Concentration 0.0642 %
Span 2.911
Uniformity 0.957
Specific Surface Area 373.8 m²/kg
D [3,2] 16.1 μm
D [4,3] 191 μm
Dv (10) 6.45 μm
Dv (50) 143 μm
Dv (90) 423 μm
Dv (95) 642 μm
Volume Below (31) μm 23.96 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	11.72	88.0	33.90	350	86.46	1410	99.93
0.0600	0.00	15.6	17.94	105	38.30	420	89.88	1680	100.00
0.120	0.00	31.0	23.96	125	44.25	500	92.30	2000	100.00
0.240	0.00	37.0	25.43	149	51.87	590	94.16	2380	100.00
0.490	0.00	44.0	26.75	177	60.18	710	95.96	2830	100.00
0.980	1.18	53.0	28.08	210	68.44	840	97.42	3360	100.00
2.00	2.67	63.0	29.44	250	75.94	1000	98.65		
3.90	5.97	74.0	31.13	300	82.34	1190	99.49		

Measurement Details

Sample Name 4.02 1B
SOP File Name Sediment.msop
Lab Number 2023133/38
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 2:23:08 PM
Measurement Date Time 16/06/2023 2:23:08 PM
Result Source Measurement

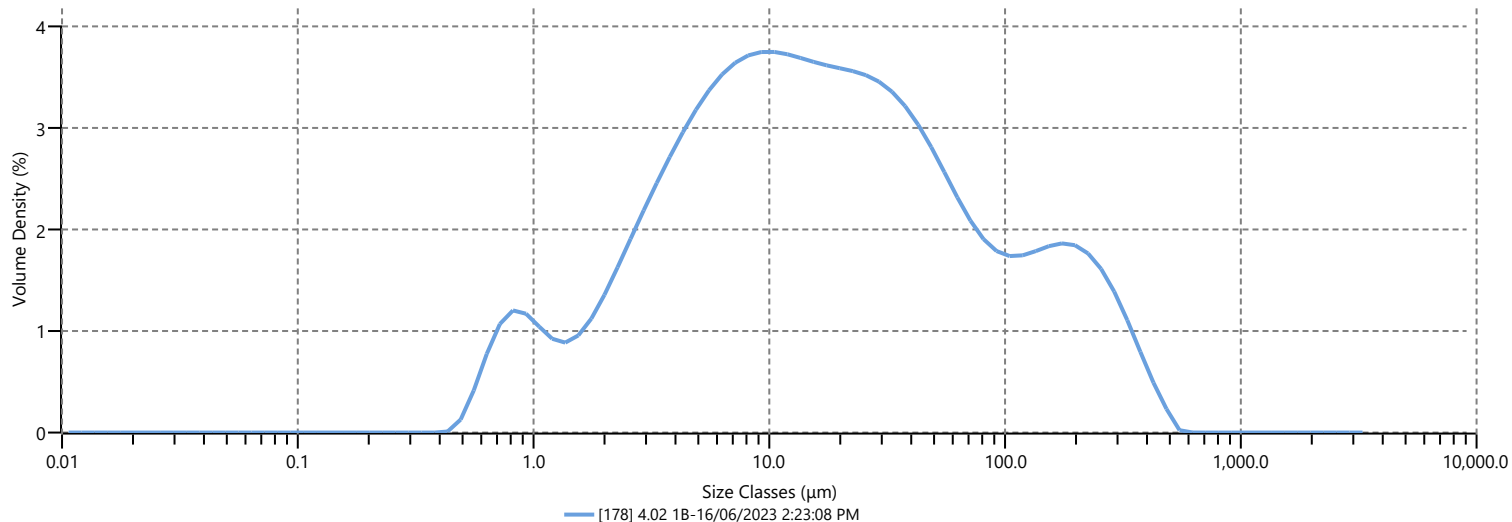
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.69 %
Laser Obscuration 15.22 %

Result

Concentration 0.0130 %
Span 9.535
Uniformity 2.672
Specific Surface Area 1044 m²/kg
D [3,2] 5.75 μm
D [4,3] 48.9 μm
Dv (10) 2.30 μm
Dv (50) 15.9 μm
Dv (90) 154 μm
Dv (95) 234 μm
Volume Below (31) μm 65.50 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	32.71	88.0	83.54	350	98.70	1410	100.00
0.0600	0.00	15.6	49.55	105	85.57	420	99.56	1680	100.00
0.120	0.00	31.0	65.50	125	87.56	500	99.95	2000	100.00
0.240	0.00	37.0	69.34	149	89.61	590	100.00	2380	100.00
0.490	0.05	44.0	72.87	177	91.69	710	100.00	2830	100.00
0.980	3.90	53.0	76.31	210	93.76	840	100.00	3360	100.00
2.00	8.64	63.0	79.09	250	95.74	1000	100.00		
3.90	17.69	74.0	81.37	300	97.53	1190	100.00		

Measurement Details

Sample Name 4.03 1C
SOP File Name Sediment.msop
Lab Number 2023133/39
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 2:30:07 PM
Measurement Date Time 16/06/2023 2:30:07 PM
Result Source Measurement

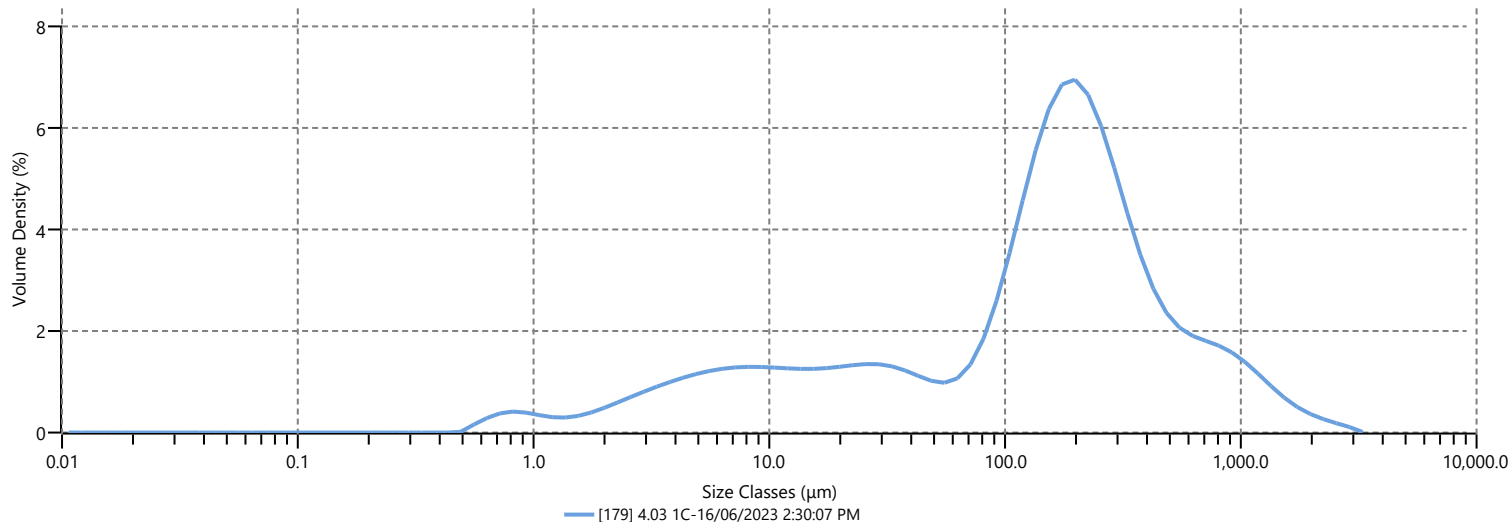
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.32 %
Laser Obscuration 24.52 %

Result

Concentration 0.0597 %
Span 3.730
Uniformity 1.194
Specific Surface Area 383.7 m²/kg
D [3,2] 15.6 μm
D [4,3] 254 μm
Dv (10) 6.40 μm
Dv (50) 162 μm
Dv (90) 610 μm
Dv (95) 944 μm
Volume Below (31) μm 23.31 %

Frequency (compatible)



Result

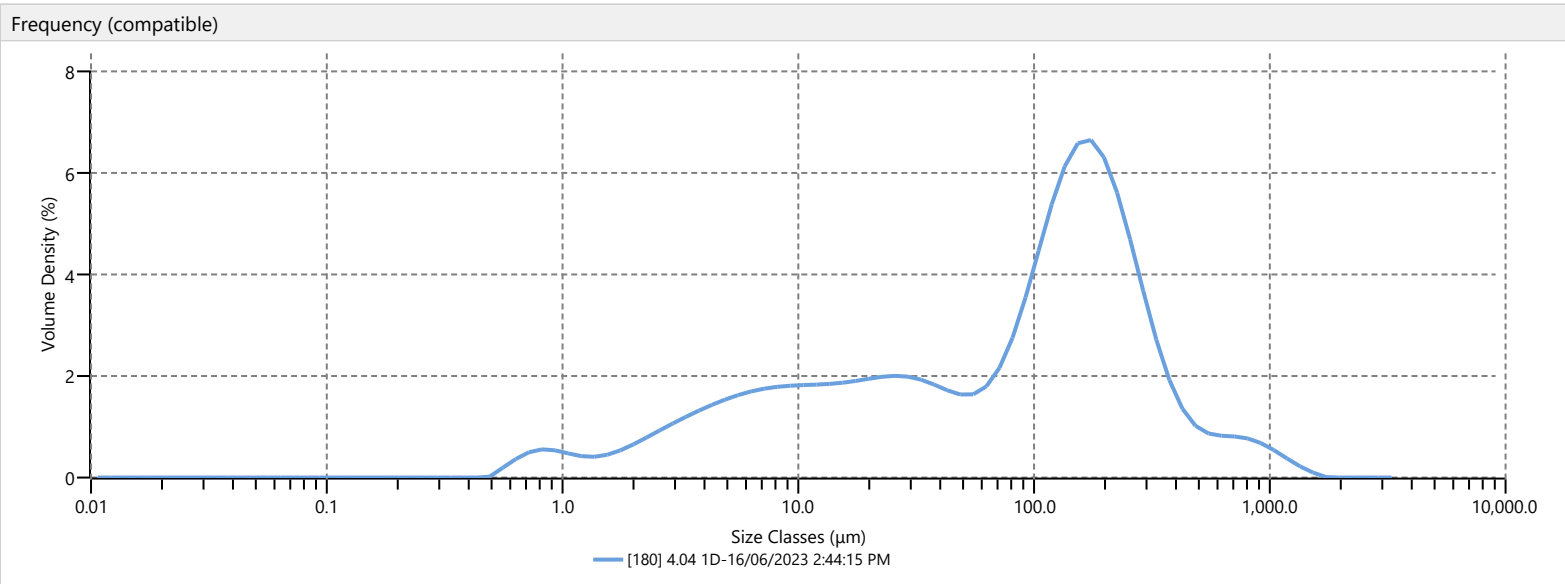
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	11.66	88.0	31.86	350	80.46	1410	98.15
0.0600	0.00	15.6	17.42	105	35.26	420	84.42	1680	98.92
0.120	0.00	31.0	23.31	125	40.06	500	87.32	2000	99.42
0.240	0.00	37.0	24.80	149	46.57	590	89.59	2380	99.75
0.490	0.00	44.0	26.12	177	54.02	710	91.85	2830	99.94
0.980	1.34	53.0	27.37	210	61.79	840	93.77	3360	100.00
2.00	2.95	63.0	28.50	250	69.24	1000	95.56		
3.90	6.27	74.0	29.78	300	75.92	1190	97.04		

Measurement Details	
Sample Name	4.04 1D
SOP File Name	Sediment.msop
Lab Number	2023133/40
Operator Name	rodgers

Measurement Details	
Analysis Date Time	16/06/2023 2:44:15 PM
Measurement Date Time	16/06/2023 2:44:15 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.36 %
Laser Obscuration	22.11 %

Result	
Concentration	0.0396 %
Span	2.970
Uniformity	1.117
Specific Surface Area	513.0 m ² /kg
D [3,2]	11.7 μm
D [4,3]	145 μm
Dv (10)	4.65 μm
Dv (50)	103 μm
Dv (90)	312 μm
Dv (95)	465 μm
Volume Below (31)	32.66 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	15.62	88.0	45.97	350	92.06	1410	99.90
0.0600	0.00	15.6	23.88	105	50.47	420	94.16	1680	100.00
0.120	0.00	31.0	32.66	125	56.25	500	95.48	2000	100.00
0.240	0.00	37.0	34.87	149	63.35	590	96.43	2380	100.00
0.490	0.00	44.0	36.87	177	70.82	710	97.42	2830	100.00
0.980	1.77	53.0	38.87	210	78.01	840	98.29	3360	100.00
2.00	3.98	63.0	40.77	250	84.19	1000	99.06		
3.90	8.38	74.0	42.88	300	89.14	1190	99.60		

Measurement Details

Sample Name 4.06 1F
SOP File Name Sediment.msop
Lab Number 2023133/41
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 2:52:18 PM
Measurement Date Time 16/06/2023 2:52:18 PM
Result Source Measurement

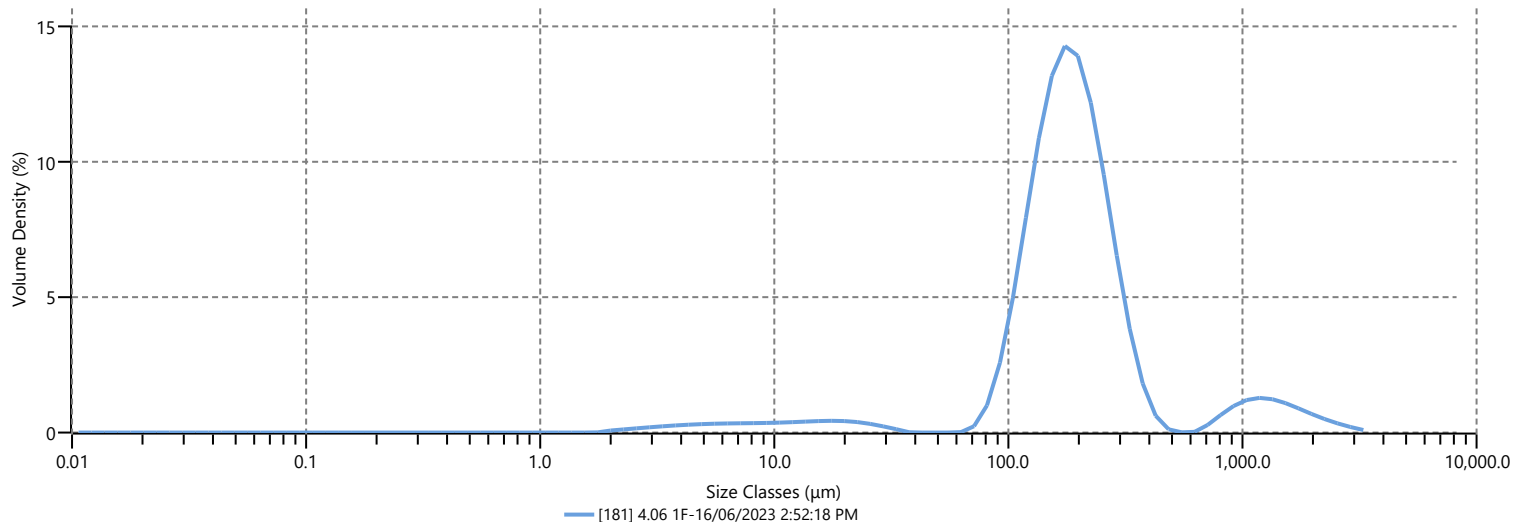
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.38 %
Laser Obscuration 12.94 %

Result

Concentration 0.1347 %
Span 1.359
Uniformity 0.841
Specific Surface Area 77.89 m²/kg
D [3,2] 77.0 μm
D [4,3] 279 μm
Dv (10) 102 μm
Dv (50) 182 μm
Dv (90) 350 μm
Dv (95) 1150 μm
Volume Below (31) 5.61 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	2.26	88.0	6.97	350	90.00	1410	96.70
0.0600	0.00	15.6	3.97	105	10.94	420	91.75	1680	97.92
0.120	0.00	31.0	5.61	125	18.80	500	92.09	2000	98.84
0.240	0.00	37.0	5.72	149	31.62	590	92.11	2380	99.46
0.490	0.00	44.0	5.72	177	47.13	710	92.23	2830	99.81
0.980	0.00	53.0	5.72	210	62.91	840	92.79	3360	99.98
2.00	0.03	63.0	5.72	250	76.19	1000	93.90		
3.90	0.81	74.0	5.85	300	85.65	1190	95.31		

Measurement Details

Sample Name 4.07 1G
SOP File Name Sediment.msop
Lab Number 2023133/42
Operator Name rodgers

Measurement Details

Analysis Date Time 16/06/2023 3:00:26 PM
Measurement Date Time 16/06/2023 3:00:26 PM
Result Source Measurement

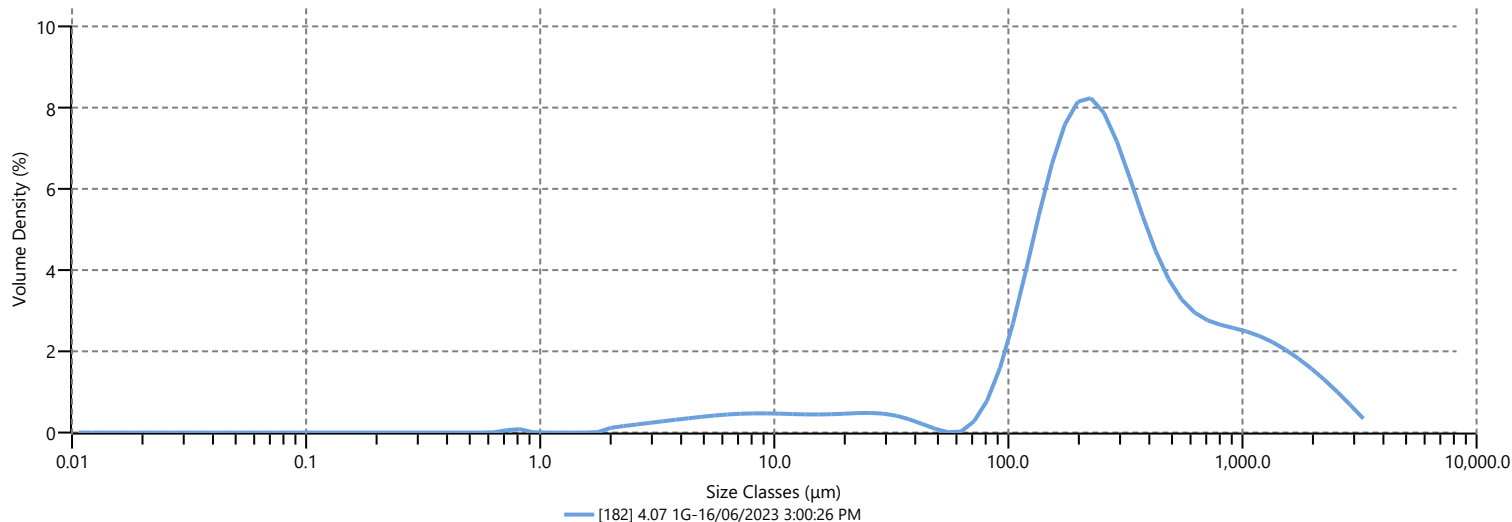
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.30 %
Laser Obscuration 22.21 %

Result

Concentration 0.2095 %
Span 4.229
Uniformity 1.223
Specific Surface Area 92.44 m²/kg
D [3,2] 64.9 μm
D [4,3] 467 μm
Dv (10) 95.9 μm
Dv (50) 260 μm
Dv (90) 1190 μm
Dv (95) 1710 μm
Volume Below (31) μm 7.20 %

Frequency (compatible)



Result

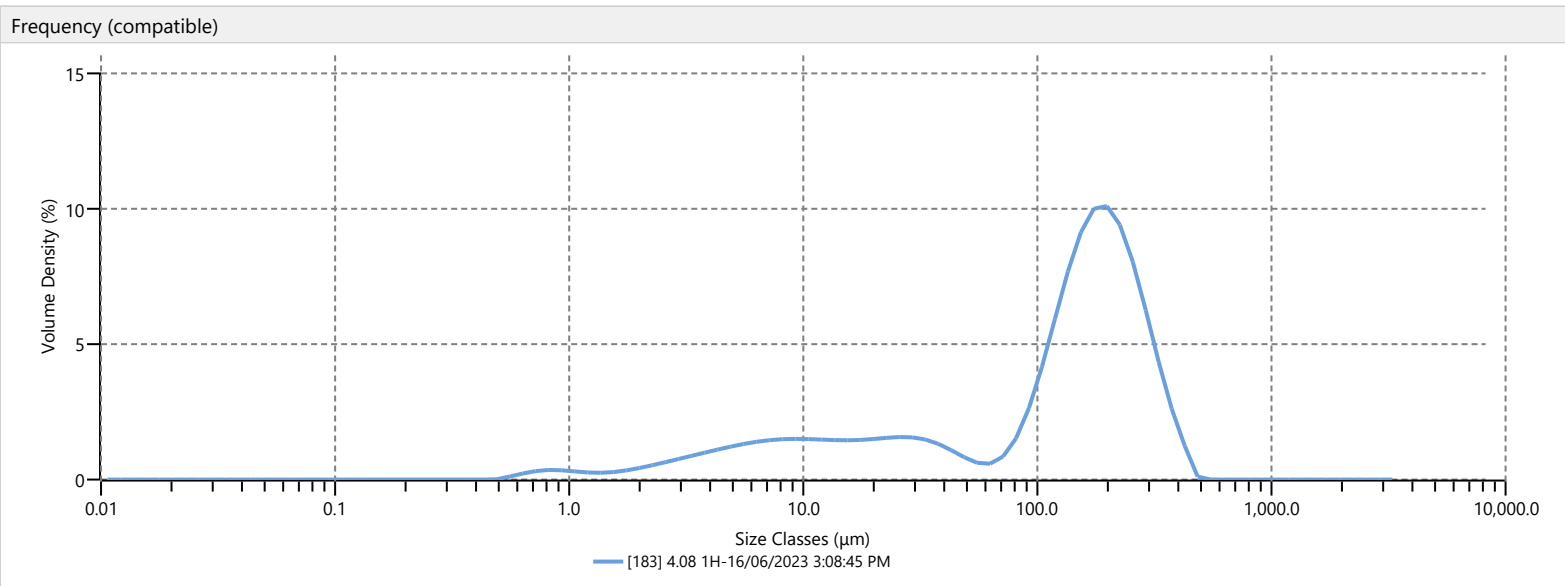
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	3.01	88.0	9.12	350	63.47	1410	92.46
0.0600	0.00	15.6	5.10	105	11.41	420	69.55	1680	94.77
0.120	0.00	31.0	7.20	125	15.43	500	74.18	2000	96.72
0.240	0.00	37.0	7.65	149	21.76	590	77.80	2380	98.29
0.490	0.00	44.0	7.96	177	29.73	710	81.28	2830	99.34
0.980	0.13	53.0	8.08	210	38.69	840	84.23	3360	99.91
2.00	0.18	63.0	8.08	250	48.01	1000	87.16		
3.90	1.15	74.0	8.25	300	56.97	1190	89.94		

Measurement Details	
Sample Name	4.08 1H
SOP File Name	Sediment.msop
Lab Number	2023133/43
Operator Name	rodgers

Measurement Details	
Analysis Date Time	16/06/2023 3:08:45 PM
Measurement Date Time	16/06/2023 3:08:45 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.40 %
Laser Obscuration	17.15 %

Result	
Concentration	0.0415 %
Span	1.905
Uniformity	0.598
Specific Surface Area	365.0 m ² /kg
D [3,2]	16.4 μm
D [4,3]	144 μm
Dv (10)	6.70 μm
Dv (50)	147 μm
Dv (90)	286 μm
Dv (95)	330 μm
Volume Below (31) μm	24.98 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	11.45	88.0	32.16	350	96.68	1410	100.00
0.0600	0.00	15.6	18.16	105	35.85	420	99.37	1680	100.00
0.120	0.00	31.0	24.98	125	41.90	500	100.00	2000	100.00
0.240	0.00	37.0	26.65	149	50.93	590	100.00	2380	100.00
0.490	0.00	44.0	28.01	177	61.71	710	100.00	2830	100.00
0.980	1.11	53.0	29.04	210	73.03	840	100.00	3360	100.00
2.00	2.49	63.0	29.70	250	83.45	1000	100.00		
3.90	5.62	74.0	30.46	300	91.93	1190	100.00		

Measurement Details

Sample Name 5.01 2A
SOP File Name Sediment.msop
Lab Number 2023133/44
Operator Name rodgers

Measurement Details

Analysis Date Time 19/06/2023 3:44:19 PM
Measurement Date Time 19/06/2023 3:44:19 PM
Result Source Measurement

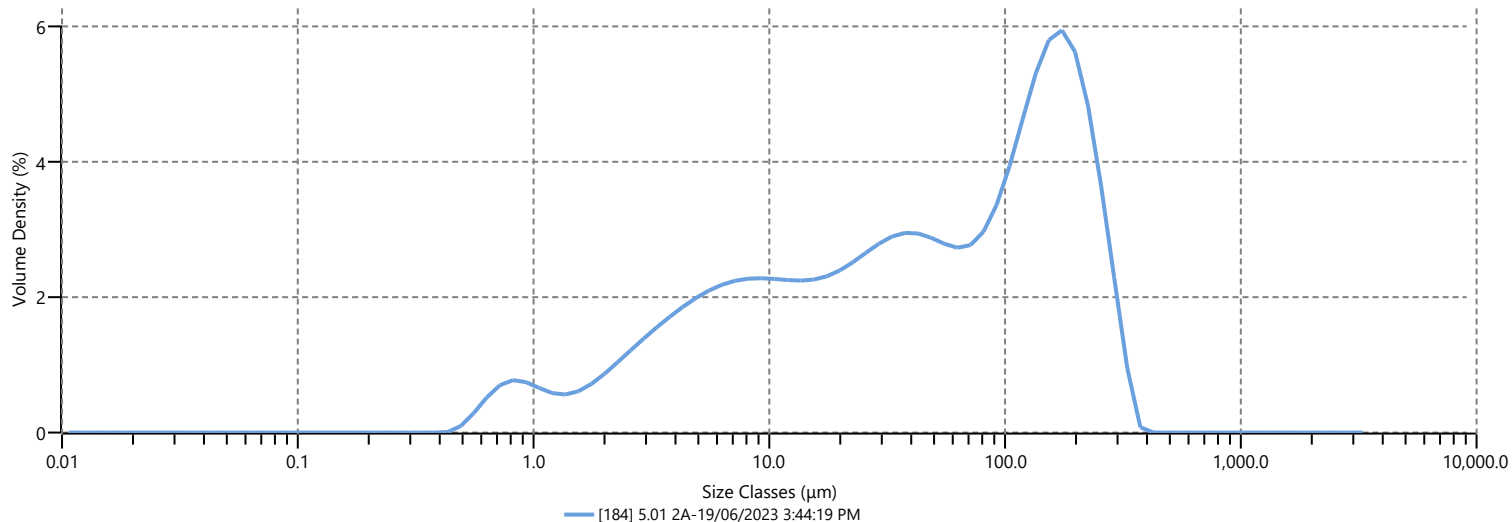
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 1.36 %
Laser Obscuration 20.22 %

Result

Concentration 0.0269 %
Span 4.414
Uniformity 1.430
Specific Surface Area 688.8 m²/kg
D [3,2] 8.71 μm
D [4,3] 81.8 μm
Dv (10) 3.46 μm
Dv (50) 46.7 μm
Dv (90) 210 μm
Dv (95) 247 μm
Volume Below (31) μm 42.15 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	20.65	88.0	61.71	350	99.97	1410	100.00
0.0600	0.00	15.6	30.90	105	65.83	420	100.00	1680	100.00
0.120	0.00	31.0	42.15	125	70.83	500	100.00	2000	100.00
0.240	0.00	37.0	45.52	149	76.99	590	100.00	2380	100.00
0.490	0.04	44.0	48.85	177	83.62	710	100.00	2830	100.00
0.980	2.56	53.0	52.36	210	90.05	840	100.00	3360	100.00
2.00	5.57	63.0	55.47	250	95.28	1000	100.00		
3.90	11.31	74.0	58.36	300	98.77	1190	100.00		

Measurement Details

Sample Name 5.02 2B
SOP File Name Sediment.msop
Lab Number 2023133/45
Operator Name rodgers

Measurement Details

Analysis Date Time 19/06/2023 3:52:11 PM
Measurement Date Time 19/06/2023 3:52:11 PM
Result Source Measurement

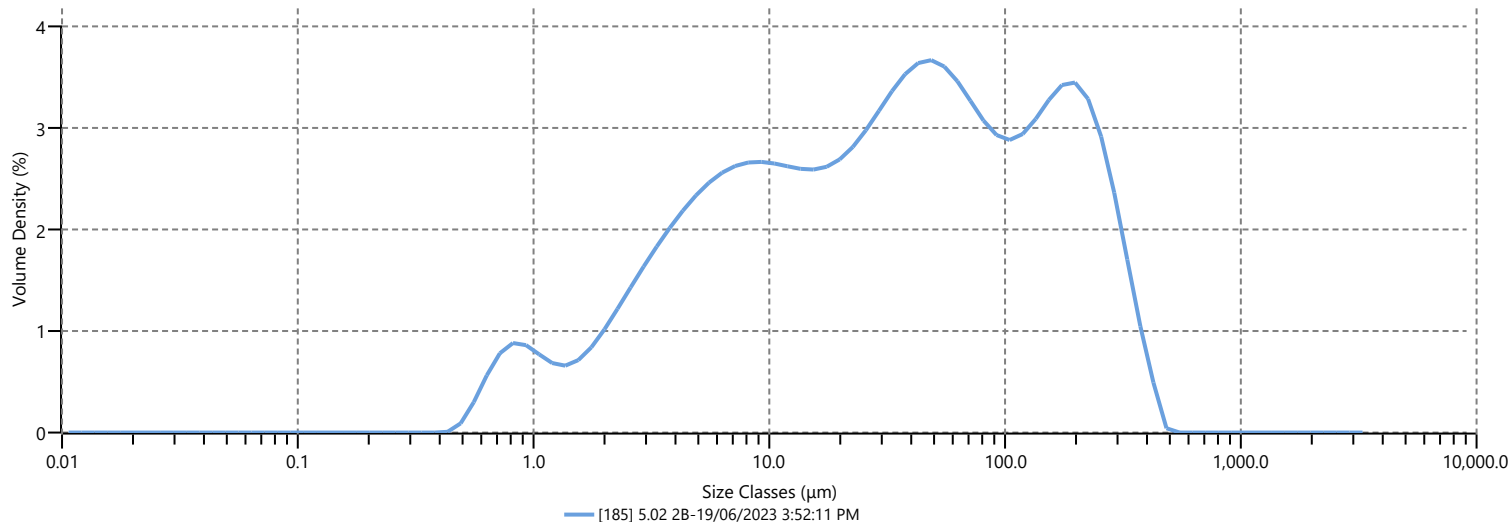
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.52 %
Laser Obscuration 17.79 %

Result

Concentration 0.0204 %
Span 6.287
Uniformity 1.831
Specific Surface Area 785.7 m²/kg
D [3,2] 7.64 μm
D [4,3] 71.3 μm
Dv (10) 3.02 μm
Dv (50) 32.9 μm
Dv (90) 210 μm
Dv (95) 268 μm
Volume Below (31) μm 48.70 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	24.10	88.0	72.16	350	98.67	1410	100.00
0.0600	0.00	15.6	36.01	105	75.51	420	99.75	1680	100.00
0.120	0.00	31.0	48.70	125	78.83	500	100.00	2000	100.00
0.240	0.00	37.0	52.64	149	82.40	590	100.00	2380	100.00
0.490	0.03	44.0	56.70	177	86.16	710	100.00	2830	100.00
0.980	2.85	53.0	61.15	210	90.02	840	100.00	3360	100.00
2.00	6.38	63.0	65.16	250	93.69	1000	100.00		
3.90	13.13	74.0	68.67	300	96.82	1190	100.00		

Measurement Details

Sample Name 5.03 2C
SOP File Name Sediment.msop
Lab Number 2023133/46
Operator Name rodgers

Measurement Details

Analysis Date Time 19/06/2023 3:59:25 PM
Measurement Date Time 19/06/2023 3:59:25 PM
Result Source Measurement

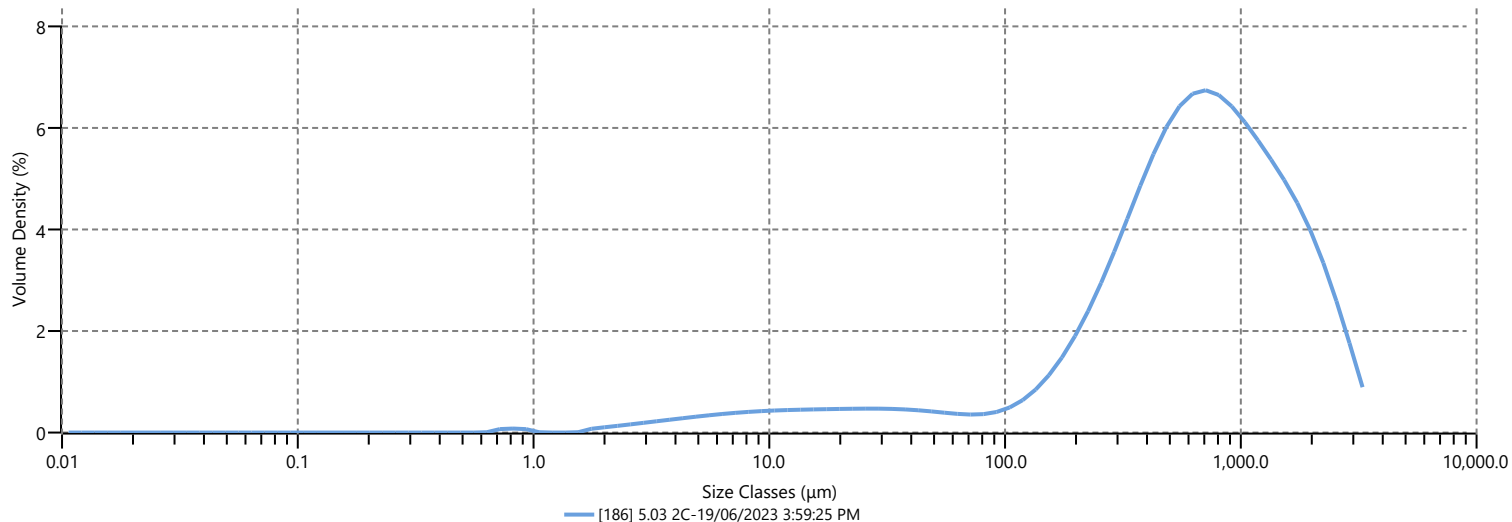
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.45 %
Laser Obscuration 25.05 %

Result

Concentration 0.2777 %
Span 2.710
Uniformity 0.801
Specific Surface Area 80.77 m²/kg
D [3,2] 74.3 μm
D [4,3] 849 μm
Dv (10) 107 μm
Dv (50) 656 μm
Dv (90) 1890 μm
Dv (95) 2320 μm
Volume Below (31) 6.67 %

Frequency (compatible)



Result

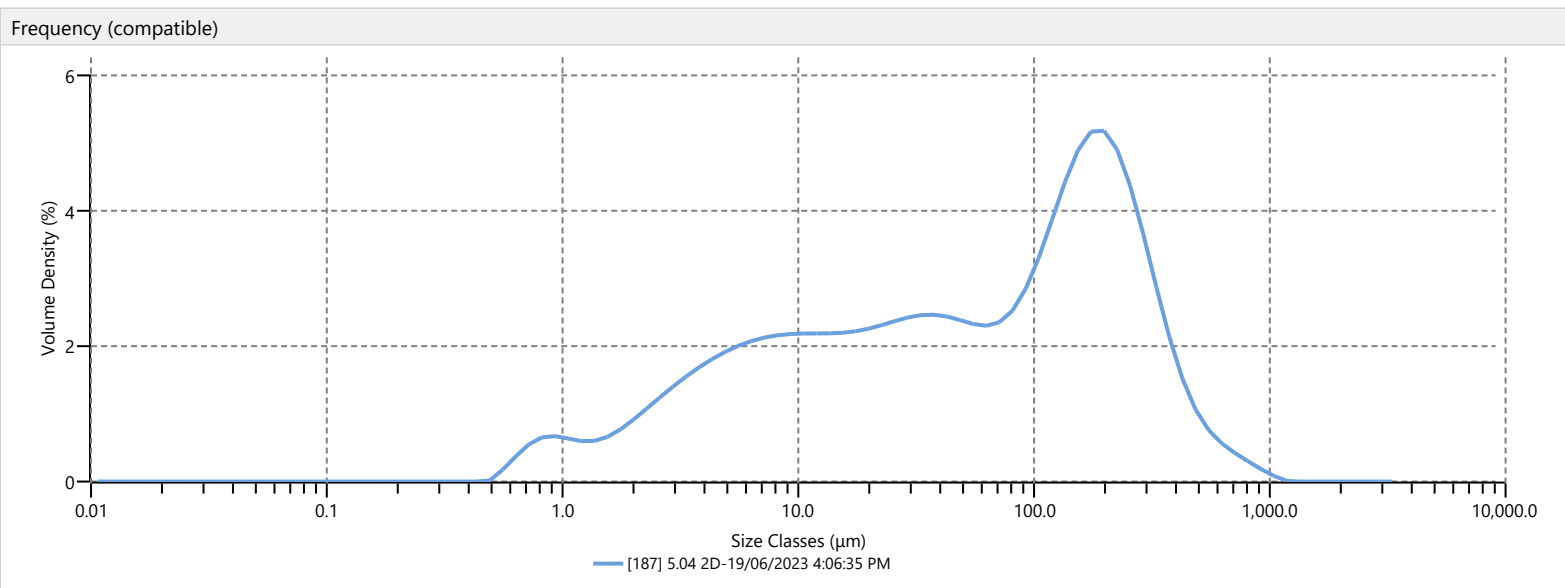
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	2.61	88.0	9.44	350	25.89	1410	81.01
0.0600	0.00	15.6	4.58	105	9.94	420	31.87	1680	86.66
0.120	0.00	31.0	6.67	125	10.61	500	38.46	2000	91.54
0.240	0.00	37.0	7.21	149	11.62	590	45.35	2380	95.56
0.490	0.00	44.0	7.71	177	13.06	710	53.47	2830	98.27
0.980	0.18	53.0	8.22	210	15.05	840	60.82	3360	99.76
2.00	0.30	63.0	8.65	250	17.90	1000	68.13		
3.90	1.09	74.0	9.03	300	21.79	1190	74.91		

Measurement Details	
Sample Name	5.04 2D
SOP File Name	Sediment.msop
Lab Number	2023133/47
Operator Name	rodgers

Measurement Details	
Analysis Date Time	19/06/2023 4:06:35 PM
Measurement Date Time	19/06/2023 4:06:35 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.43 %
Laser Obscuration	28.75 %

Result	
Concentration	0.0433 %
Span	4.892
Uniformity	1.670
Specific Surface Area	630.2 m ² /kg
D [3,2]	9.52 μm
D [4,3]	114 μm
Dv (10)	3.59 μm
Dv (50)	58.0 μm
Dv (90)	287 μm
Dv (95)	373 μm
Volume Below (31) μm	40.11 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	19.88	88.0	56.54	350	94.08	1410	100.00
0.0600	0.00	15.6	29.76	105	60.01	420	96.44	1680	100.00
0.120	0.00	31.0	40.11	125	64.18	500	97.86	2000	100.00
0.240	0.00	37.0	42.95	149	69.32	590	98.73	2380	100.00
0.490	0.00	44.0	45.73	177	74.98	710	99.35	2830	100.00
0.980	1.99	53.0	48.63	210	80.79	840	99.73	3360	100.00
2.00	5.13	63.0	51.24	250	86.26	1000	99.94		
3.90	10.93	74.0	53.69	300	91.03	1190	100.00		

Measurement Details

Sample Name 5.05 2E
SOP File Name Sediment.msop
Lab Number 2023133/48
Operator Name rodgers

Measurement Details

Analysis Date Time 19/06/2023 4:13:52 PM
Measurement Date Time 19/06/2023 4:13:52 PM
Result Source Measurement

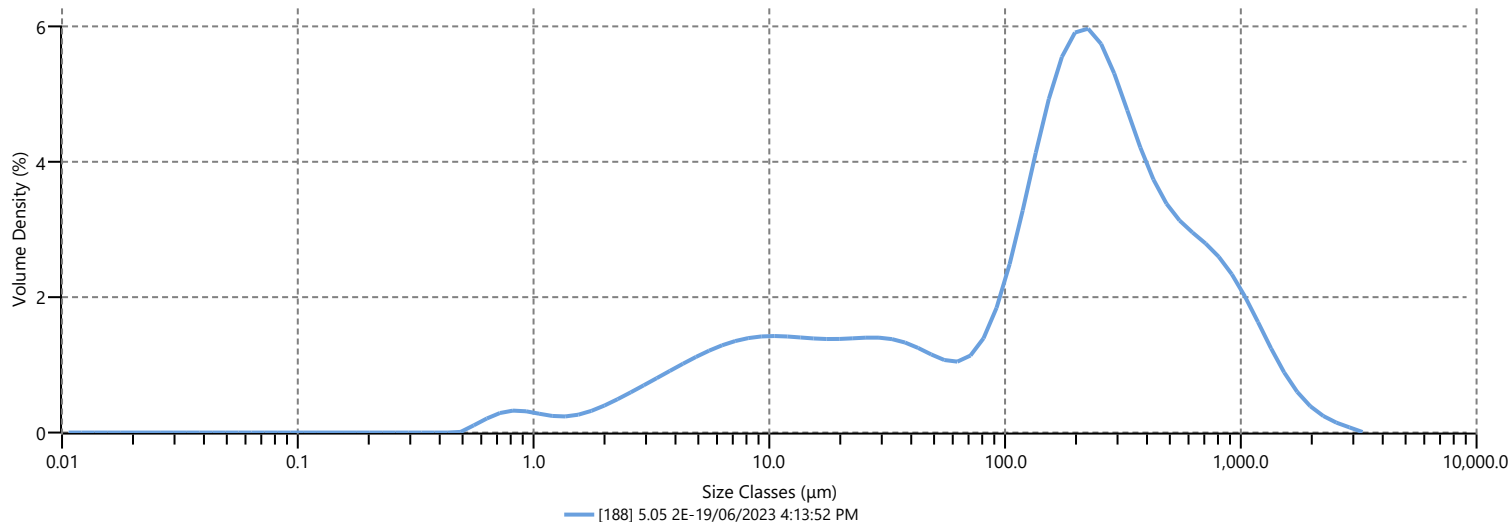
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.31 %
Laser Obscuration 24.67 %

Result

Concentration 0.0678 %
Span 4.056
Uniformity 1.239
Specific Surface Area 336.0 m²/kg
D [3,2] 17.9 μm
D [4,3] 297 μm
Dv (10) 7.30 μm
Dv (50) 186 μm
Dv (90) 763 μm
Dv (95) 1050 μm
Volume Below (31) μm 23.22 %

Frequency (compatible)



Result

Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	10.59	88.0	31.59	350	72.89	1410	97.94
0.0600	0.00	15.6	16.98	105	33.98	420	77.76	1680	98.92
0.120	0.00	31.0	23.22	125	37.40	500	81.78	2000	99.49
0.240	0.00	37.0	24.81	149	42.25	590	85.20	2380	99.81
0.490	0.00	44.0	26.27	177	48.14	710	88.70	2830	99.96
0.980	1.02	53.0	27.68	210	54.65	840	91.64	3360	100.00
2.00	2.33	63.0	28.87	250	61.41	1000	94.30		
3.90	5.21	74.0	30.02	300	67.98	1190	96.41		

Measurement Details

Sample Name 5.06 2F
SOP File Name Sediment.msop
Lab Number 2023133/48
Operator Name rodgers

Measurement Details

Analysis Date Time 19/06/2023 4:20:58 PM
Measurement Date Time 19/06/2023 4:20:58 PM
Result Source Measurement

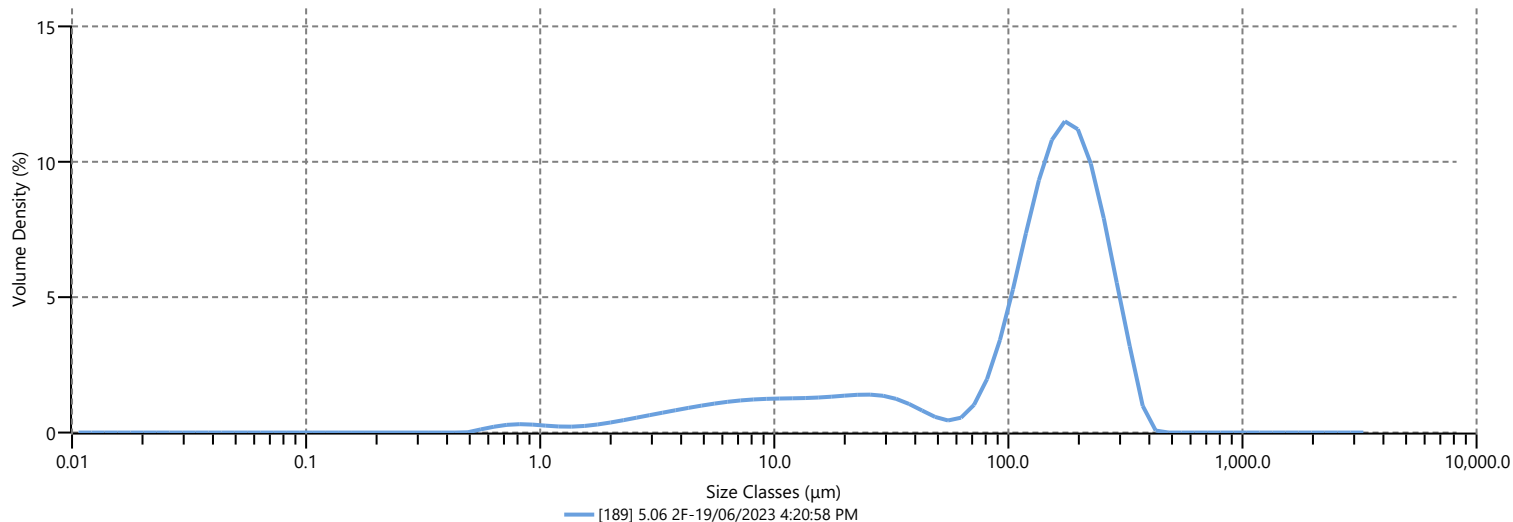
Analysis

Particle Name Sediment
Particle Refractive Index 1.500
Particle Absorption Index 0.200
Dispersant Name Water
Dispersant Refractive Index 1.330
Scattering Model Mie
Analysis Model General Purpose
Weighted Residual 0.48 %
Laser Obscuration 21.65 %

Result

Concentration 0.0611 %
Span 1.738
Uniformity 0.519
Specific Surface Area 322.4 m²/kg
D [3,2] 18.6 μm
D [4,3] 141 μm
Dv (10) 8.17 μm
Dv (50) 146 μm
Dv (90) 262 μm
Dv (95) 296 μm
Volume Below (31) μm 21.44 %

Frequency (compatible)



Result

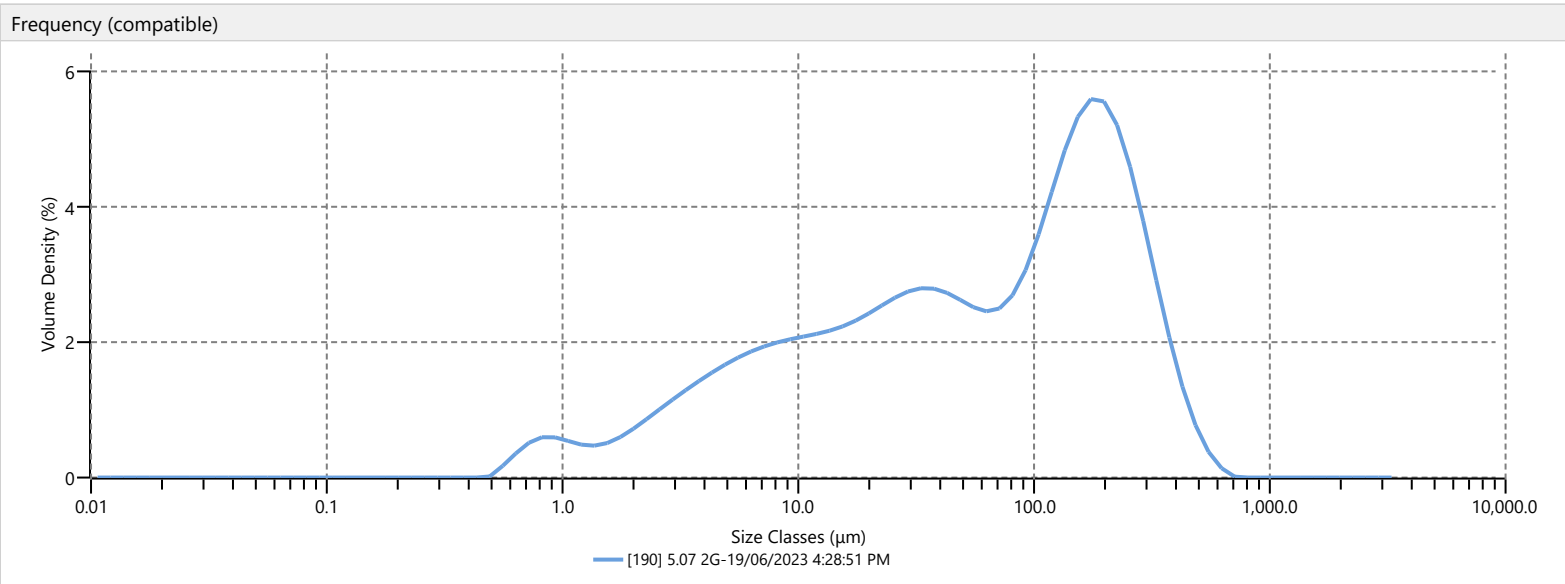
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	9.63	88.0	28.18	350	99.18	1410	100.00
0.0600	0.00	15.6	15.32	105	32.92	420	100.00	1680	100.00
0.120	0.00	31.0	21.44	125	40.49	500	100.00	2000	100.00
0.240	0.00	37.0	22.83	149	51.41	590	100.00	2380	100.00
0.490	0.00	44.0	23.88	177	64.00	710	100.00	2830	100.00
0.980	1.01	53.0	24.61	210	76.69	840	100.00	3360	100.00
2.00	2.21	63.0	25.13	250	87.56	1000	100.00		
3.90	4.86	74.0	25.98	300	95.49	1190	100.00		

Measurement Details	
Sample Name	5.07 2G
SOP File Name	Sediment.msop
Lab Number	2023133/49
Operator Name	rodgers

Measurement Details	
Analysis Date Time	19/06/2023 4:28:51 PM
Measurement Date Time	19/06/2023 4:28:51 PM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.42 %
Laser Obscuration	18.03 %

Result	
Concentration	0.0286 %
Span	4.229
Uniformity	1.398
Specific Surface Area	561.6 m ² /kg
D [3,2]	10.7 μm
D [4,3]	106 μm
Dv (10)	4.27 μm
Dv (50)	62.3 μm
Dv (90)	268 μm
Dv (95)	331 μm
Volume Below (31) μm	37.82 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	17.03	88.0	55.82	350	96.03	1410	100.00
0.0600	0.00	15.6	26.54	105	59.58	420	98.28	1680	100.00
0.120	0.00	31.0	37.82	125	64.14	500	99.43	2000	100.00
0.240	0.00	37.0	41.05	149	69.75	590	99.90	2380	100.00
0.490	0.00	44.0	44.18	177	75.91	710	100.00	2830	100.00
0.980	1.84	53.0	47.38	210	82.15	840	100.00	3360	100.00
2.00	4.34	63.0	50.18	250	87.95	1000	100.00		
3.90	9.11	74.0	52.78	300	92.92	1190	100.00		



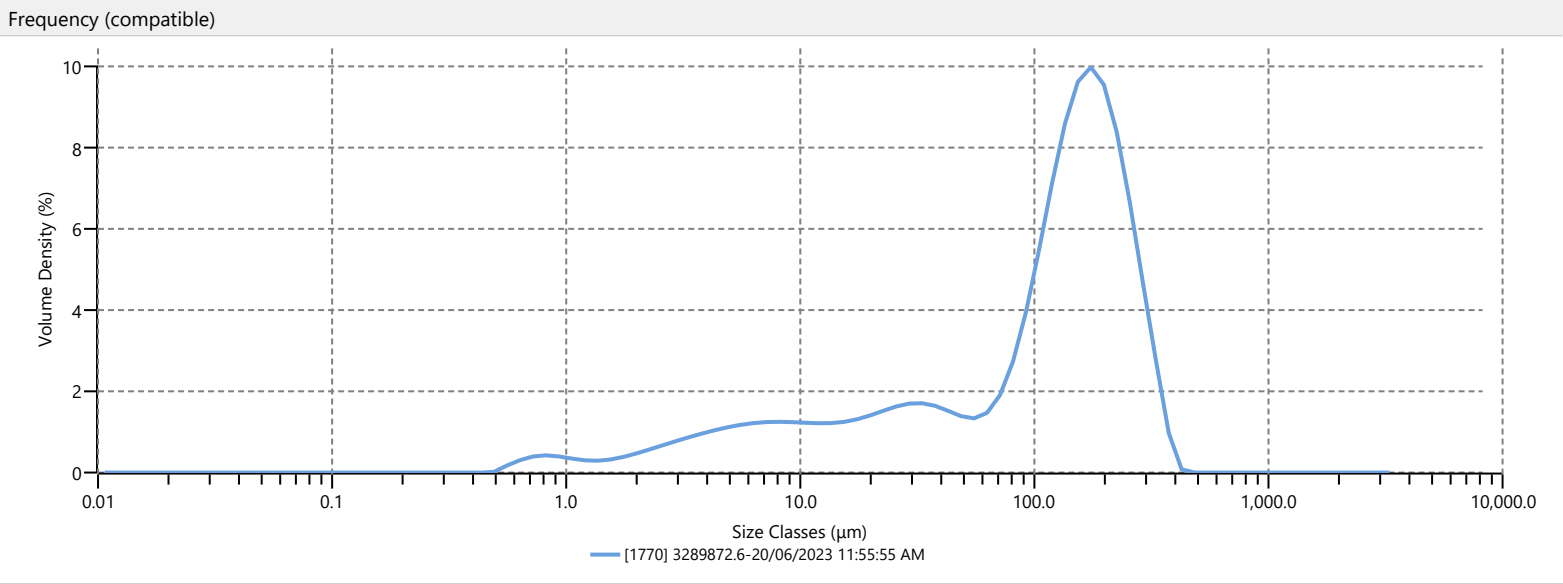
Analysis - Under

Measurement Details	
Sample Name	5.08 3289872.6
SOP File Name	Sediment.msop
Lab Number	2023139/6
Operator Name	rodgers

Measurement Details	
Analysis Date Time	20/06/2023 11:55:55 AM
Measurement Date Time	20/06/2023 11:55:55 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.38 %
Laser Obscuration	24.36 %

Result	
Concentration	0.0581 %
Span	1.913
Uniformity	0.598
Specific Surface Area	392.7 m ² /kg
D [3,2]	15.3 μm
D [4,3]	128 μm
Dv (10)	6.58 μm
Dv (50)	129 μm
Dv (90)	254 μm
Dv (95)	291 μm
Volume Below (31) μm	23.65 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	11.38	88.0	35.51	350	99.16	1410	100.00
0.0600	0.00	15.6	16.96	105	40.71	420	100.00	1680	100.00
0.120	0.00	31.0	23.65	125	48.17	500	100.00	2000	100.00
0.240	0.00	37.0	25.61	149	58.17	590	100.00	2380	100.00
0.490	0.00	44.0	27.40	177	69.25	710	100.00	2830	100.00
0.980	1.40	53.0	29.10	210	80.12	840	100.00	3360	100.00
2.00	2.99	63.0	30.64	250	89.27	1000	100.00		
3.90	6.17	74.0	32.45	300	95.97	1190	100.00		





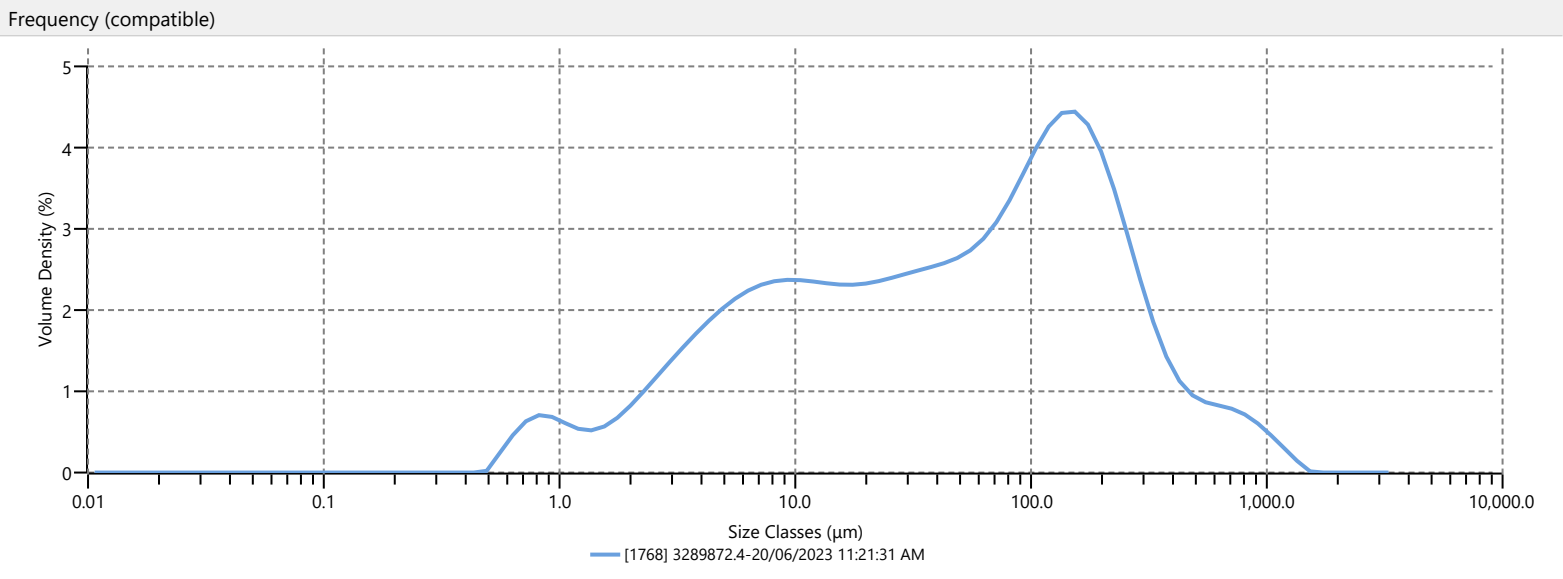
Analysis - Under

Measurement Details	
Sample Name	5.09 3289872.4
SOP File Name	Sediment.msop
Lab Number	2023139/4
Operator Name	rodgers

Measurement Details	
Analysis Date Time	20/06/2023 11:21:31 AM
Measurement Date Time	20/06/2023 11:21:31 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.41 %
Laser Obscuration	21.88 %

Result	
Concentration	0.0310 %
Span	5.308
Uniformity	1.929
Specific Surface Area	647.7 m ² /kg
D [3,2]	9.26 μm
D [4,3]	116 μm
Dv (10)	3.67 μm
Dv (50)	51.8 μm
Dv (90)	279 μm
Dv (95)	437 μm
Volume Below (31) μm	41.43 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	20.19	88.0	60.49	350	93.12	1410	99.98
0.0600	0.00	15.6	30.84	105	64.86	420	94.72	1680	100.00
0.120	0.00	31.0	41.43	125	69.62	500	95.88	2000	100.00
0.240	0.00	37.0	44.32	149	74.70	590	96.83	2380	100.00
0.490	0.00	44.0	47.21	177	79.63	710	97.81	2830	100.00
0.980	2.25	53.0	50.41	210	84.16	840	98.63	3360	100.00
2.00	5.05	63.0	53.56	250	88.01	1000	99.31		
3.90	10.67	74.0	56.71	300	91.15	1190	99.76		



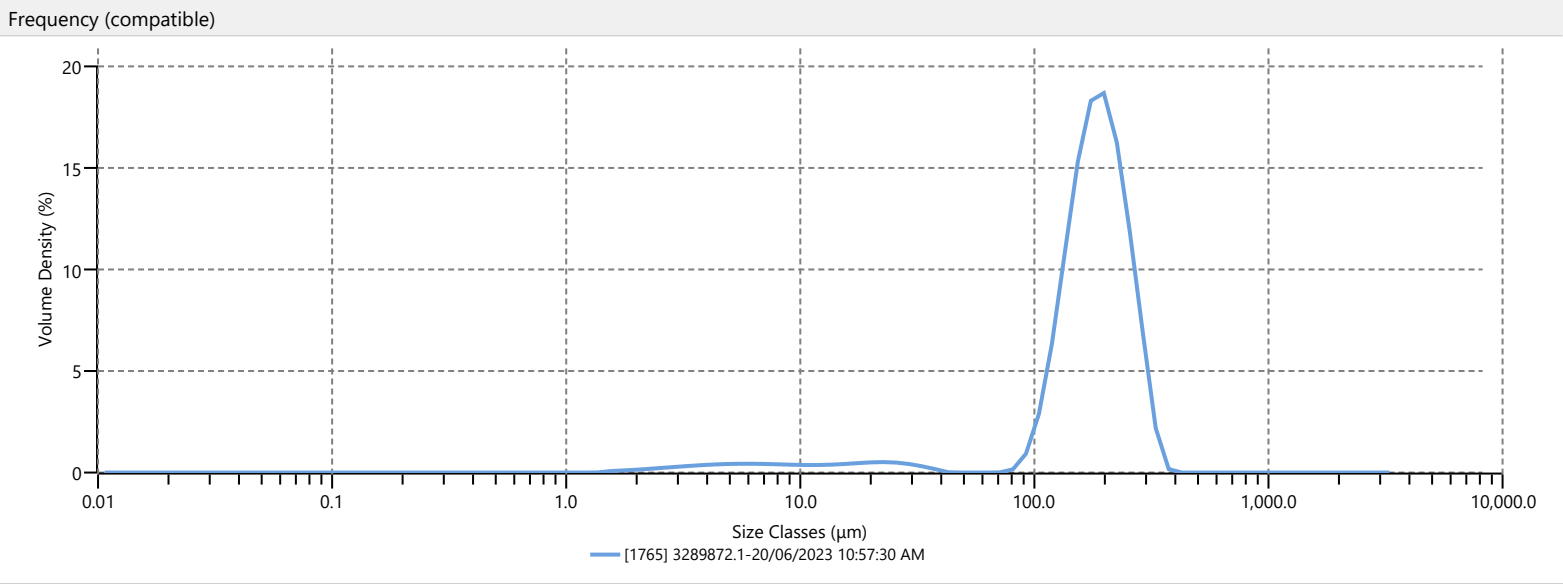
Analysis - Under

Measurement Details	
Sample Name	5.10 3289872.1
SOP File Name	Sediment.msop
Lab Number	2023139/1
Operator Name	rodgers

Measurement Details	
Analysis Date Time	20/06/2023 10:57:30 AM
Measurement Date Time	20/06/2023 10:57:30 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.63 %
Laser Obscuration	13.66 %

Result	
Concentration	0.1119 %
Span	0.861
Uniformity	0.287
Specific Surface Area	99.19 m ² /kg
D [3,2]	60.5 μm
D [4,3]	179 μm
Dv (10)	108 μm
Dv (50)	181 μm
Dv (90)	263 μm
Dv (95)	287 μm
Volume Below (31)	7.13 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	3.24	88.0	7.74	350	99.93	1410	100.00
0.0600	0.00	15.6	4.99	105	9.55	420	100.00	1680	100.00
0.120	0.00	31.0	7.13	125	15.30	500	100.00	2000	100.00
0.240	0.00	37.0	7.45	149	28.41	590	100.00	2380	100.00
0.490	0.00	44.0	7.54	177	47.38	710	100.00	2830	100.00
0.980	0.00	53.0	7.54	210	68.39	840	100.00	3360	100.00
2.00	0.21	63.0	7.54	250	85.94	1000	100.00		
3.90	1.34	74.0	7.54	300	96.97	1190	100.00		





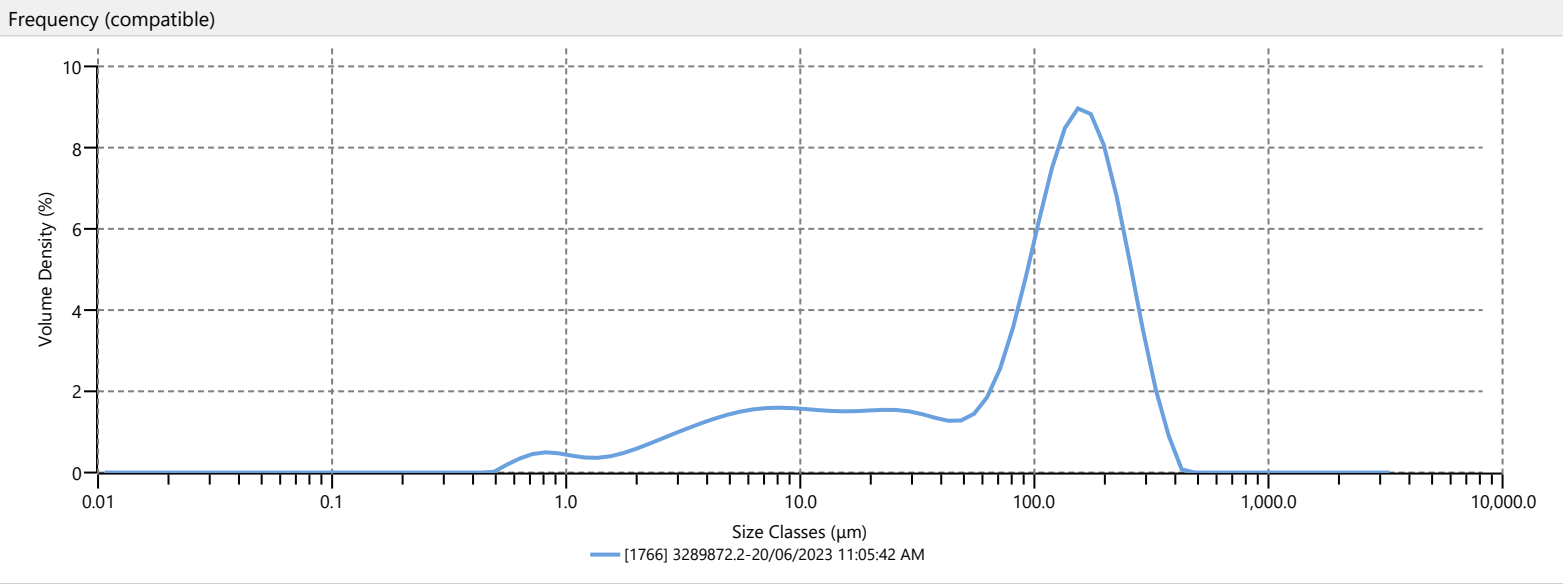
Analysis - Under

Measurement Details	
Sample Name	5.11 3289872.2
SOP File Name	Sediment.msop
Lab Number	2023139/2
Operator Name	rodgers

Measurement Details	
Analysis Date Time	20/06/2023 11:05:42 AM
Measurement Date Time	20/06/2023 11:05:42 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.36 %
Laser Obscuration	28.67 %

Result	
Concentration	0.0588 %
Span	2.072
Uniformity	0.670
Specific Surface Area	468.3 m ² /kg
D [3,2]	12.8 μm
D [4,3]	115 μm
Dv (10)	5.11 μm
Dv (50)	112 μm
Dv (90)	238 μm
Dv (95)	277 μm
Volume Below (31) μm	28.14 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	14.27	88.0	40.98	350	99.20	1410	100.00
0.0600	0.00	15.6	21.30	105	47.16	420	100.00	1680	100.00
0.120	0.00	31.0	28.14	125	55.21	500	100.00	2000	100.00
0.240	0.00	37.0	29.78	149	65.01	590	100.00	2380	100.00
0.490	0.00	44.0	31.26	177	75.08	710	100.00	2830	100.00
0.980	1.63	53.0	32.82	210	84.37	840	100.00	3360	100.00
2.00	3.59	63.0	34.61	250	91.73	1000	100.00		
3.90	7.60	74.0	36.99	300	96.86	1190	100.00		



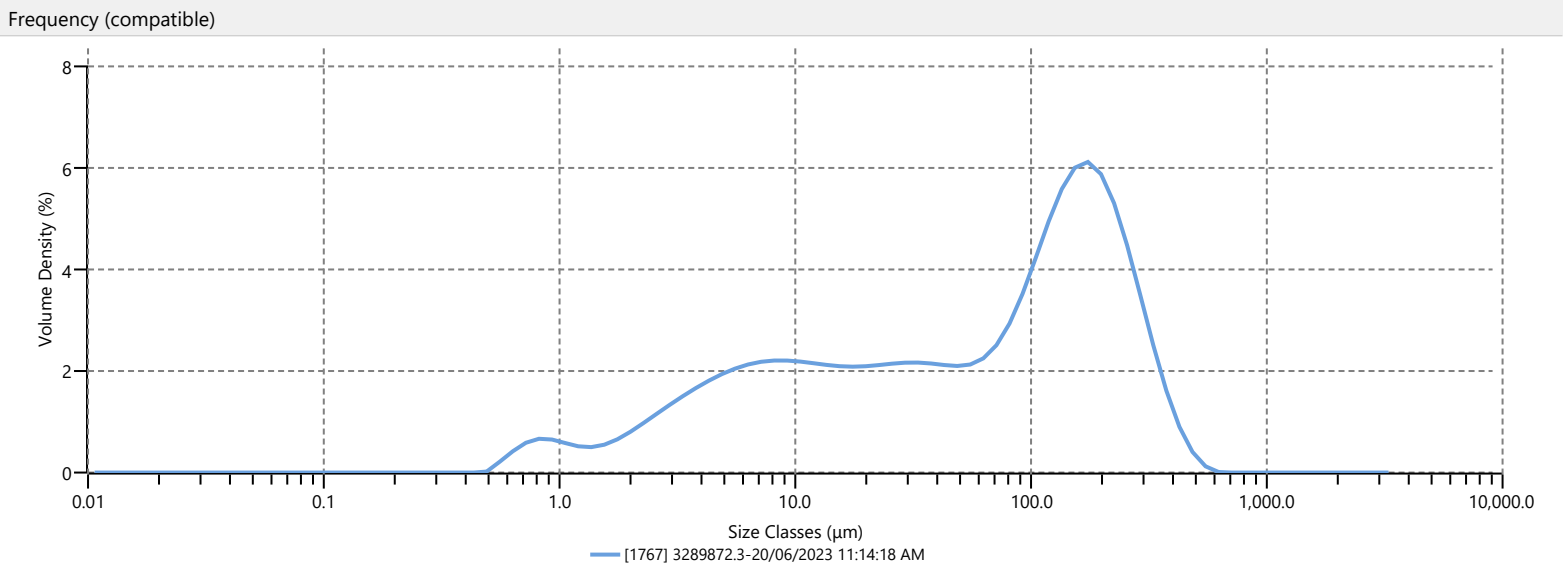
Analysis - Under

Measurement Details	
Sample Name	5.12 3289872.3
SOP File Name	Sediment.msop
Lab Number	2023139/3
Operator Name	rodgers

Measurement Details	
Analysis Date Time	20/06/2023 11:14:18 AM
Measurement Date Time	20/06/2023 11:14:18 AM
Result Source	Measurement

Analysis	
Particle Name	Sediment
Particle Refractive Index	1.500
Particle Absorption Index	0.200
Dispersant Name	Water
Dispersant Refractive Index	1.330
Scattering Model	Mie
Analysis Model	General Purpose
Weighted Residual	0.46 %
Laser Obscuration	17.26 %

Result	
Concentration	0.0250 %
Span	3.567
Uniformity	1.200
Specific Surface Area	614.7 m ² /kg
D [3,2]	9.76 μm
D [4,3]	102 μm
Dv (10)	3.80 μm
Dv (50)	69.0 μm
Dv (90)	250 μm
Dv (95)	304 μm
Volume Below (31) μm	38.70 %



Result									
Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under	Size (μm)	% Volume Under
0.0500	0.00	7.80	19.40	88.0	54.44	350	97.44	1410	100.00
0.0600	0.00	15.6	29.20	105	58.80	420	99.14	1680	100.00
0.120	0.00	31.0	38.70	125	64.16	500	99.83	2000	100.00
0.240	0.00	37.0	41.20	149	70.63	590	100.00	2380	100.00
0.490	0.00	44.0	43.61	177	77.47	710	100.00	2830	100.00
0.980	2.09	53.0	46.17	210	84.14	840	100.00	3360	100.00
2.00	4.79	63.0	48.61	250	89.99	1000	100.00		
3.90	10.29	74.0	51.13	300	94.72	1190	100.00		

Density test results

Density Test result register

Sample Name	Particle Density g/cm ³
	1.01 3.55
	1.09 3.02
	1.14 2.77
	1.18 2.82
	2.03 2.94
	3.03 2.94
	4.01 2.71
	4.04 2.72
	5.02 2.64
	5.03 2.69
	5.09 1.49
	5.10 1.89
	5.11 1.59
	5.12 1.45
	5.13 1.64

Particle density measured using the Density Bottle (Small pyknometer) Method

Environmental test results

Certificate of Analysis

Page 1 of 4

Client: Tonkin & Taylor	Lab No: 3289872	SPV5
Contact: Hayley Jones	Date Received: 30-May-2023	
C/- Tonkin & Taylor	Date Reported: 23-Jun-2023	
PO Box 317	Quote No: 124087	
Tauranga 3140	Order No: Manukau Port	
	Client Reference: Manukau Port	
	Submitted By: Hayley Jones	

Sample Type: Sediment

Sample Name:	5.10 - Site 1 25-May-2023 12:45 pm	5.11 - Site 2 25-May-2023 1:45 pm	5.12 - Site 3 25-May-2023 1:00 pm	5.09 - Site 4 25-May-2023 1:05 pm	5.13 - Site 5 25-May-2023 1:15 pm
Lab Number:	3289872.1	3289872.2	3289872.3	3289872.4	3289872.5
Individual Tests					
Dry Matter g/100g as rcvd	76	64	58	63	67
Particle size analysis**	See attached report	See attached report	See attached report	See attached report	See attached report
Density* g/mL at 20°C	1.89	1.59	1.45	1.49	1.64
Total Recoverable Mercury mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Organic Carbon* g/100g dry wt	0.11	0.42	0.65	0.45	0.35
Heavy metals screen level As,Cd,Cr,Cu,Ni,Pb,Zn					
Total Recoverable Arsenic mg/kg dry wt	< 2	8	10	12	11
Total Recoverable Cadmium mg/kg dry wt	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10
Total Recoverable Chromium mg/kg dry wt	3	12	13	14	15
Total Recoverable Copper mg/kg dry wt	< 2	4	4	4	5
Total Recoverable Lead mg/kg dry wt	1.6	6.0	7.6	8.0	8.8
Total Recoverable Nickel mg/kg dry wt	< 2	6	6	7	7
Total Recoverable Zinc mg/kg dry wt	13	40	45	51	48
Organochlorine Pesticides UltraTrace in Soil					
Aldrin mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
alpha-BHC mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
beta-BHC mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
delta-BHC mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
gamma-BHC (Lindane) mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
cis-Chlordane mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
trans-Chlordane mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
2,4'-DDD mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
4,4'-DDD mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
2,4'-DDE mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
4,4'-DDE mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
2,4'-DDT mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
4,4'-DDT mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Total DDT Isomers mg/kg dry wt	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003
Dieldrin mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Endosulfan I mg/kg dry wt	< 0.0007	< 0.0007	< 0.0007	< 0.0007	< 0.0007
Endosulfan II mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Endosulfan sulphate mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Endrin mg/kg dry wt	< 0.0007	< 0.0007	< 0.0007	< 0.0007	< 0.0007
Endrin aldehyde mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Endrin ketone mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Heptachlor mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004

Sample Type: Sediment

Sample Name:	Site 1 25-May-2023 12:45 pm	Site 2 25-May-2023 1:45 pm	Site 3 25-May-2023 1:00 pm	Site 4 25-May-2023 1:05 pm	Site 5 25-May-2023 1:15 pm
Lab Number:	3289872.1	3289872.2	3289872.3	3289872.4	3289872.5

Organochlorine Pesticides UltraTrace in Soil

Heptachlor epoxide	mg/kg dry wt	< 0.0004	< 0.0004	< 0.0004	< 0.0004	< 0.0004
Hexachlorobenzene	mg/kg dry wt	< 0.0007	< 0.0007	< 0.0007	< 0.0007	< 0.0007
Methoxychlor	mg/kg dry wt	< 0.0007	< 0.0007	< 0.0007	< 0.0007	< 0.0007

Polycyclic Aromatic Hydrocarbons Screening in Solids*

Total of Reported PAHs in Soil	mg/kg dry wt	< 0.4	< 0.4	< 0.5	< 0.4	< 0.4
1-Methylnaphthalene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
2-Methylnaphthalene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Acenaphthylene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Acenaphthene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Anthracene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Benzo[a]anthracene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Benzo[a]pyrene Potency Equivalency Factor (PEF) NES*	mg/kg dry wt	< 0.031	< 0.037	< 0.041	< 0.038	< 0.036
Benzo[a]pyrene Toxic Equivalence (TEF)*	mg/kg dry wt	< 0.031	< 0.036	< 0.041	< 0.038	< 0.035
Benzo[b]fluoranthene + Benzo[j] fluoranthene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Benzo[e]pyrene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Benzo[k]fluoranthene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Chrysene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Fluoranthene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Fluorene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Naphthalene	mg/kg dry wt	< 0.07	< 0.08	< 0.09	< 0.08	< 0.08
Perylene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Phenanthrene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015
Pyrene	mg/kg dry wt	< 0.013	< 0.015	< 0.017	< 0.016	< 0.015

Sample Name:	Site 6 25-May-2023 1:25 pm
Lab Number:	3289872.6

Individual Tests

Dry Matter	g/100g as rcvd	74
Particle size analysis**		See attached report
Density*	g/mL at 20°C	1.82
Total Recoverable Mercury	mg/kg dry wt	< 0.10
Total Organic Carbon*	g/100g dry wt	0.30

Heavy metals screen level As,Cd,Cr,Cu,Ni,Pb,Zn

Total Recoverable Arsenic	mg/kg dry wt	8
Total Recoverable Cadmium	mg/kg dry wt	< 0.10
Total Recoverable Chromium	mg/kg dry wt	13
Total Recoverable Copper	mg/kg dry wt	3
Total Recoverable Lead	mg/kg dry wt	4.7
Total Recoverable Nickel	mg/kg dry wt	6
Total Recoverable Zinc	mg/kg dry wt	38

Organochlorine Pesticides UltraTrace in Soil

Aldrin	mg/kg dry wt	< 0.0004
alpha-BHC	mg/kg dry wt	< 0.0004
beta-BHC	mg/kg dry wt	< 0.0004
delta-BHC	mg/kg dry wt	< 0.0004
gamma-BHC (Lindane)	mg/kg dry wt	< 0.0004
cis-Chlordane	mg/kg dry wt	< 0.0004
trans-Chlordane	mg/kg dry wt	< 0.0004

Sample Type: Sediment

Sample Name:		Site 6 25-May-2023 1:25 pm
Lab Number:		3289872.6
Organochlorine Pesticides UltraTrace in Soil		
2,4'-DDD	mg/kg dry wt	< 0.0004
4,4'-DDD	mg/kg dry wt	< 0.0004
2,4'-DDE	mg/kg dry wt	< 0.0004
4,4'-DDE	mg/kg dry wt	< 0.0004
2,4'-DDT	mg/kg dry wt	< 0.0004
4,4'-DDT	mg/kg dry wt	< 0.0004
Total DDT Isomers	mg/kg dry wt	< 0.003
Dieldrin	mg/kg dry wt	< 0.0004
Endosulfan I	mg/kg dry wt	< 0.0007
Endosulfan II	mg/kg dry wt	< 0.0004
Endosulfan sulphate	mg/kg dry wt	< 0.0004
Endrin	mg/kg dry wt	< 0.0007
Endrin aldehyde	mg/kg dry wt	< 0.0004
Endrin ketone	mg/kg dry wt	< 0.0004
Heptachlor	mg/kg dry wt	< 0.0004
Heptachlor epoxide	mg/kg dry wt	< 0.0004
Hexachlorobenzene	mg/kg dry wt	< 0.0007
Methoxychlor	mg/kg dry wt	< 0.0007
Polycyclic Aromatic Hydrocarbons Screening in Solids*		
Total of Reported PAHs in Soil	mg/kg dry wt	< 0.4
1-Methylnaphthalene	mg/kg dry wt	< 0.013
2-Methylnaphthalene	mg/kg dry wt	< 0.013
Acenaphthylene	mg/kg dry wt	< 0.013
Acenaphthene	mg/kg dry wt	< 0.013
Anthracene	mg/kg dry wt	< 0.013
Benzo[a]anthracene	mg/kg dry wt	< 0.013
Benzo[a]pyrene (BAP)	mg/kg dry wt	< 0.013
Benzo[a]pyrene Potency Equivalency Factor (PEF) NES*	mg/kg dry wt	< 0.032
Benzo[a]pyrene Toxic Equivalence (TEF)*	mg/kg dry wt	< 0.032
Benzo[b]fluoranthene + Benzo[j]fluoranthene	mg/kg dry wt	< 0.013
Benzo[e]pyrene	mg/kg dry wt	< 0.013
Benzo[g,h,i]perylene	mg/kg dry wt	< 0.013
Benzo[k]fluoranthene	mg/kg dry wt	< 0.013
Chrysene	mg/kg dry wt	< 0.013
Dibenzo[a,h]anthracene	mg/kg dry wt	< 0.013
Fluoranthene	mg/kg dry wt	< 0.013
Fluorene	mg/kg dry wt	< 0.013
Indeno(1,2,3-c,d)pyrene	mg/kg dry wt	< 0.013
Naphthalene	mg/kg dry wt	< 0.07
Perylene	mg/kg dry wt	< 0.013
Phenanthrene	mg/kg dry wt	< 0.013
Pyrene	mg/kg dry wt	< 0.013

Analyst's Comments

‡ Analysis subcontracted to an external provider. Refer to the Summary of Methods section for more details.

Appendix No.1 - Waikato University Report

Appendix No.2 - Density sample photos for 3289872

Summary of Methods

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively simple matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis. A detection limit range indicates the lowest and highest detection limits in the associated suite of analytes. A full listing of compounds and detection limits are available from the laboratory upon request. Unless otherwise indicated, analyses were performed at Hill Labs, 28 Duke Street, Frankton, Hamilton 3204.

Sample Type: Sediment			
Test	Method Description	Default Detection Limit	Sample No
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-6
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation May contain a residual moisture content of 2-5%.	-	1-6
Sample preparation by Non Routine section*	Sample preparation as per test requirement.	-	1-6
Soil Prep Dry for Organics, Trace*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-6
Heavy metals screen level As, Cd, Cr, Cu, Ni, Pb, Zn	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, screen level.	0.10 - 4 mg/kg dry wt	1-6
Organochlorine Pesticides UltraTrace in Soil	Sonication extraction, GC-ECD analysis. Tested on as received sample. In-house based on US EPA 8081.	0.0002 - 0.003 mg/kg dry wt	1-6
Polycyclic Aromatic Hydrocarbons Screening in Solids*	Sonication extraction, GC-MS/MS analysis. Tested on as received sample. In-house based on US EPA 8270.	0.010 - 0.05 mg/kg dry wt	1-6
Dry Matter	Dried at 103°C for 4-22hr (removes 3-5% more water than air dry) , gravimetry. (Free water removed before analysis, non-soil objects such as sticks, leaves, grass and stones also removed). US EPA 3550.	0.10 g/100g as rcvd	1-6
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	1-6
Particle size analysis*	Malvern Laser Sizer particle size analysis from 0.05 microns to 3.4 mm. Samples are measured in volume %. Subcontracted to Earth Sciences Department, Waikato University, Hamilton.	-	1-6
Density*	Calculation: weight of sample / volume of sample at 20°C. Gravimetric determination.	0.02 g/mL at 20°C	1-6
Total Recoverable Mercury	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion, ICP-MS, screen level. US EPA 200.2.	0.10 mg/kg dry wt	1-6
Total Organic Carbon*	Acid pretreatment to remove carbonates present followed by Catalytic Combustion (O2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g dry wt	1-6

These samples were collected by yourselves (or your agent) and analysed as received at the laboratory.

Testing was completed between 30-May-2023 and 23-Jun-2023. For completion dates of individual analyses please contact the laboratory.

Samples are held at the laboratory after reporting for a length of time based on the stability of the samples and analytes being tested (considering any preservation used), and the storage space available. Once the storage period is completed, the samples are discarded unless otherwise agreed with the customer. Extended storage times may incur additional charges.

This certificate of analysis must not be reproduced, except in full, without the written consent of the signatory.

Kim Harrison MSc
Client Services Manager - Environmental

www.tonkintaylor.co.nz

