Gladstone Maintenance Dredging Hindcast Modelling and Monitoring Tide Island Material Relocation Area

Customer	Gladstone Ports Corporation
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Deliverable	001
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01	14 May 2025	GPC	Revision
02	30 June 2025	GPC	Final Report

Executive Summary

Gladstone Ports Corporation Limited (GPC) is responsible for maintenance dredging of the Port of Gladstone (PoG). This activity is normally undertaken in annual campaigns, or more frequently if required, by the Trailing Suction Hopper Dredger (TSHD) *Brisbane,* to maintain declared depths of channels and berths and ensuring safe navigation for all vessels. Dredge material is placed in the East Banks Offshore Material Relocation Area (MRA) in accordance with related Sea Dumping Permits issued by the Department of Climate Change, Energy, the Environment and Water (DCCEEW), formerly the Department of Agriculture, Water and the Environment (DAWE) and Department of the Environment and Energy (DoEE).

As part of the Sustainable Sediment Management Project (SSM Project), GPC assessed the potential for alternative beneficial reuse of maintenance dredging material. One option involved an alternative in-channel MRA placement at a location near Tide Island, herein referred to as the ‘’Tide Island MRA’’. GPC subsequently obtained a DA to undertake placement of dredged material from the Inner Harbour at this alternative placement site. The activity was conducted by the TSHD *Brisbane* as part of the August-September 2023 annual maintenance dredging campaign, and again during the November-December 2024 campaign.

The present study investigated the properties of sediment plumes created by dredging and placement activities. The specific objectives of this study were to:

- Measure sediment concentrations in plumes created during dredging and sediment placement activities, their extent and their dispersion over time;
- Validate the numerical modelling results presented in the impact assessment study (BMT, 2023) by undertaking hindcast numerical modelling to compare measurements and model outputs; and
- Confirm that the conclusions of the environmental impact assessment are valid including that sediment plumes created by dredging and placement are unlikely to cause impacts to sensitive receptors such as seagrass and reef communities.

Monitoring of plumes generated during these activities was carried out over two three-day measurement campaigns. The key findings of the monitoring program are as follows:

- Analysis of ADCP measurements undertaken during flood and ebb tides show turbid plumes generated by maintenance dredging and placement activities were rapidly advected in the direction of the tidal currents. Plume dispersion and settling was relatively rapid, and plumes generated by dredging were predominantly restricted to the navigation channel, and did not extend to sensitive receptors. These results were consistent with previous monitoring results and modelling predictions;
- Grab sample-based particle size distribution (PSD) results indicate that sediment characteristics at the dredging and placement areas were consistent with previous data used to inform modelling of the activity. There were differences in PSD between field and laboratory based measurements, the former displaying a higher proportion of coarser sediments. The differences between methods was mainly due to the formation of flocs under field conditions which significantly affect the behaviour of turbid plumes. These findings are in line with previous with scientific literature and recent studies undertaken around PoG maintenance and capital dredging activities;
- Turbidity data collected at fixed monitoring stations adjacent to the Tide Island MRA and as part of the GPC maintenance dredging monitoring program show some evidence of elevated turbidity during the dredging campaign relative to pre-dredging baseline measurements during similar

hydrodynamic conditions. This was inconsistent with modelling predictions presented in the impact assessment report (BMT, 2023), and may reflect: (i) higher than predicted erodibility of sediment that has been placed on the seabed, and/or (ii) higher than predicted plume generation rates associated with dredged material placement. The Tide Island MRA was intended to be a dispersive placement site and the measurements are consistent with this expectation;

- Grab samples analysis show that nutrient, metal and metalloids concentrations in dredging and placement plumes were overall within the range of baseline conditions, and in line with previous PoG maintenance dredging plume studies (BMT, 2018).

Hindcast modelling of both maintenance dredging campaigns was also carried out to further validate and confirm the results of the impact assessment. The results from analysis of the measurements and the hindcast modelling results indicate that although the measured plume concentrations were somewhat higher than those assumed in the Tide Island MRA Impact Assessment (BMT, 2023), the plumes generated by dredging at LNG swing basins with placement at the proposed in-channel MRA at Tide Island were ephemeral features and pose a low risk to the environment.

The monitoring activities carried out during the trial placement activity validated the findings of the Tide Island MRA Impact Assessment (BMT, 2023), since measurements of the plume extents confirmed that sensitive receptor habitats (seagrass meadows, reef communities) were not negatively impacted. The bulk of the suspended sediment plume remained within the shipping channels (disturbed footprint), and observed plume dispersion and settling was relatively rapid.

The maintenance dredging impact assessment has been recently revised to reflect the results of this monitoring and modelling report, as part of GPC's commitment to continuous improvement (BMT, 2025). The revised assessment adopted revised dredging-related source terms and modified sediment erosion parameters, consistent with the outcomes of this study, and confirmed that no negative impacts on sensitive receptors are expected as a consequence of the annual maintenance dredging and Tide Island MRA placement activities.

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1 Introduction

1.1 Background

Gladstone Ports Corporation Limited (GPC) is responsible for maintenance dredging of the Port of Gladstone (PoG). This activity is normally undertaken in annual campaigns, or more frequently if required, by the Trailing Suction Hopper Dredger (TSHD) *Brisbane* to maintain declared depths of channels and berths and ensuring safe navigation for all vessels. Dredge material is placed in the East Banks Offshore Material Relocation Area (MRA) in accordance with related Sea Dumping Permits issued by the Department of Climate Change, Energy, the Environment and Water (DCCEEW), previously known as the Department of the Agriculture, Water and the Environment (DAWE) and Department of Environment and Energy (DoEE).

As part of the Sustainable Sediment Management Project (SSM Project), GPC assessed the potential for alternative beneficial reuse of maintenance dredging material. One option involved an alternative in-channel MRA placement at a location near Tide Island, herein referred to as the ''Tide Island MRA''. This location is intended to receive material dredged at Inner Harbour areas which are predominantly composed of fine sediments (Figure 1.2).

In order to assess the feasibility of this option, an impact assessment study was undertaken to identify potential impacts of this activity on the receiving environment and sensitive receptors (BMT, 2023). The study consisted of desktop assessment and hydrodynamic modelling considering two (2) different levels of material placement at the Tide Island MRA, for full details refer to BMT (2023). Impact assessment outputs showed turbid plumes to be short-lived and mostly confined to navigational channels, and therefore unlikely to impact sensitive receptors and the receiving environment. The findings were consistent with previous maintenance dredging monitoring studies such as BMT (2018).

Based on the outcomes of the impact assessment study, GPC obtained a Development Approval (DA) to place material at the Tide Island MRA during the 2023 and 2024 PoG maintenance dredging campaigns. This initial placement at the alternative MRA is intended as a trial, with a monitoring plan in place (BMT, 2022) to validate the modelling outcomes and assess the extent and persistence of dredging-related plumes. Monitoring of the placement trial activities and the impact assessment validation will inform future maintenance dredging campaigns and the implementation of the SSM Project.

1.2 Study Objectives

The aim of this study is to report results and findings of monitoring activities undertaken according to the monitoring plan (BMT, 2022) during the 2023 and 2024 maintenance dredging campaigns and to validate the results of the impact assessment study of trial maintenance dredging material placement at the Tide Island MRA (BMT, 2023). The specific objectives of this study were to:

1. Measure sediment concentrations in plumes created during dredging and sediment placement activities, their extent and their dispersion over time;
2. Validate the numerical modelling results presented in the impact assessment study (BMT, 2023) by undertaking hindcast numerical modelling to compare measurements and model outputs; and
3. Confirm that the conclusions of the environmental impact assessment are valid including that sediment plumes created by dredging and placement are unlikely to cause impacts to sensitive receptors such as seagrass and reef communities.

1.3 Activity Description

The TSHD *Brisbane*

The *Brisbane* is an 85 m long ocean-going TSHD and the largest vessel in the PBPL's (Port of Brisbane Pty Ltd) dredging fleet. The *Brisbane* performs annual maintenance dredging works within the PoG for around one month of the year and contract maintenance dredging services for the Port of Brisbane and Central and North Queensland ports for the remainder of the year.

The *Brisbane* is equipped with two trailing arm suction heads, on the port and starboard sides of the vessel, which are typically lowered and dragged along the seafloor, simultaneously dredging the bed sediments either side of the vessel as it progresses forward. The drag heads are lifted clear of the seabed when moving astern. To efficiently fill the hopper (volume 2,900 m^3) with dredged material, the vessel is usually operated in an overflowing mode whereby the dredged sediments are concentrated within the hopper over time. A telescoping weir within the centre of the hopper can be elevated to maximise the retention of dredged material before discharge from the hopper occurs. Excess water and suspended sediments are ultimately discharged from the hopper *via* the weir to the underside of the keel, approximately 5 m below the water line.

Following cessation of dredging, the *Brisbane* delivers its load of material to a designated placement area, in the PoG instance this is typically the East Banks Offshore MRA. For marine MRA placement, the dredger typically slows to a speed of a few knots on arrival at the MRA and the dredged sediment loaded within the hopper is deposited over the required placement area by opening a series of five valves set within the bottom of the hopper, allowing for gravitational settlement of dredged material from the vessel through the water column to the seafloor. During the 2023 and 2024 maintenance dredging campaigns, some of the fine sediment removed from the Jacobs Channel was placed at the Tide Island MRA in accordance with the DA.

August 2023 Maintenance Dredging Monitoring Campaign

Monitoring of turbid plumes around the *Brisbane* during the 2023 PoG annual maintenance dredging campaign took place daily between the 23rd and 25th (inclusive) of August 2023 whilst the *Brisbane* was performing the following duties:

- Maintenance dredging in the Jacobs Channel swing basins and subsequent placement at the Tide Island MRA on 23rd August from 10:31 – 15:17 during both flooding and ebbing tides;
- Maintenance dredging in the Jacobs Channel swing basins and subsequent placement at the Tide Island MRA on 24th August from 08:42 – 15:15 during flooding tide;
- Maintenance dredging at the South Trees Wharf with subsequent placement at the East Banks Offshore MRA on 25th August from 07:19 – 11:25 from slack-low to flooding tide. Background monitoring was conducted near the Tide Island MRA.

The measured tide at the Maritime Safety Queensland's (MSQ) Auckland Point Tide Station and the respective field monitoring windows are presented in Figure 1.1. Additionally, the field monitoring locality plan is shown in Figure 1.2 and the dredge activity and monitored transecting locations are shown in Figure 1.3.

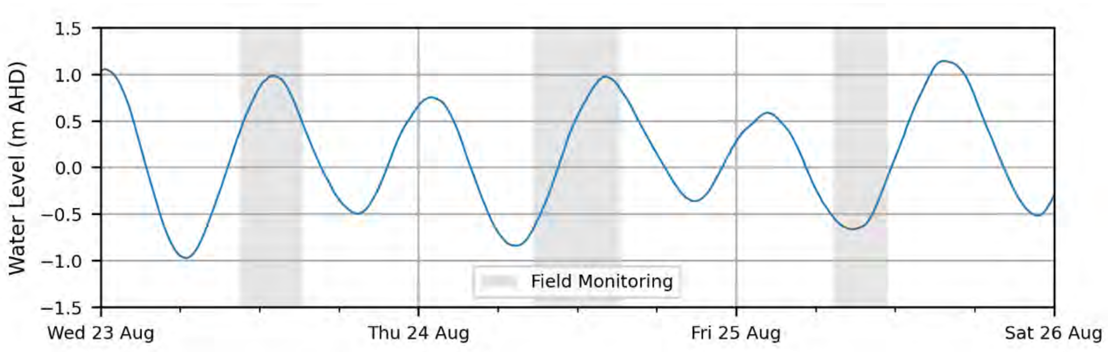

Figure 1.1 Measured water level at the Auckland Point tide gauge over the August 2023 field monitoring campaign (Source: TMR, 2023)

Name	Type	Longitude (°)	Latitude (°)
GPA Tide Measurement Site	Tide	151.25554	-23.83172
Vision Env. Fixed Deployment - T1	Turbidity/LISST	151.21753	-23.79848
Vision Env. Fixed Deployment - T2	Turbidity/LISST	151.24148	-23.80825

Legend

Monitoring Sites
- Dredging Site
- Dredging Placement
- Fixed Monitoring Sites

- Channels
- East Banks MRA

Depth
0 m
-25 m

Title:

Field Monitoring Locality Plan

Figure: 1.2

Rev: A

BMT endeavours to ensure that the information provided in this map is correct at the time of publication. BMT does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

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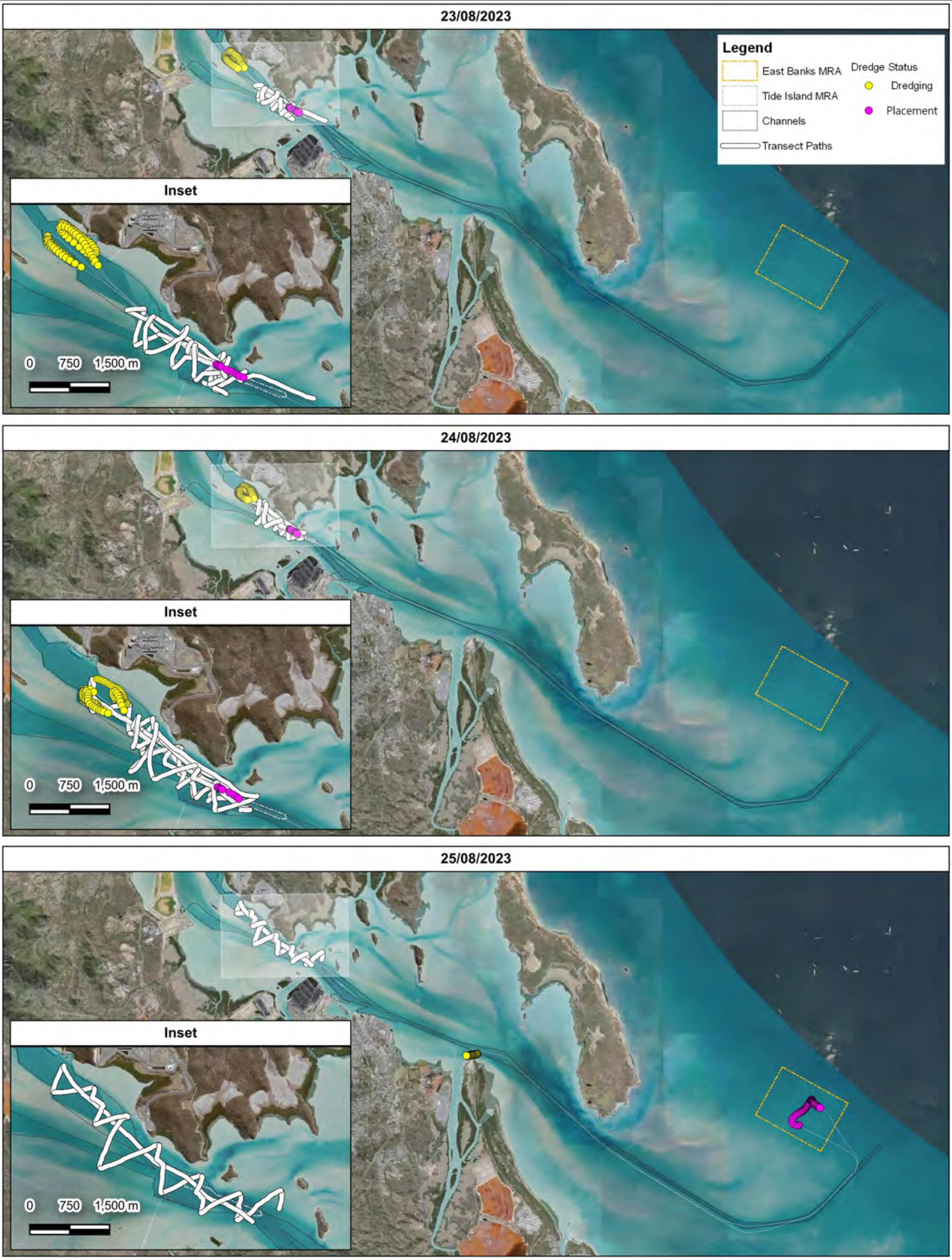

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Dredge Activity and Transecting Locations

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December 2024 Maintenance Dredging Monitoring Campaign

Monitoring of turbid plumes around the *Brisbane* during the 2024 PoG annual maintenance dredging campaign took place daily between the 4th and 6th (inclusive) of December 2024 whilst the *Brisbane* was carrying out the following activities:

- Maintenance dredging in the Jacobs Channel swing basins and subsequent placement at the Tide Island MRA on 4th December from 8:32 – 13:36 during both flooding and ebbing tides;
- Dredging activity paused for crew change between 06:00 and 14:00. Background monitoring was conducted near the Tide Island MRA from 08:46 – 13:36;
- Maintenance dredging in the Jacobs Channel swing basins and subsequent placement at the Tide Island MRA on 6th December from 08:29 – 13:54 during flooding tide to the start of the ebb tide.

The measured tide at the Maritime Safety Queensland's (MSQ) Auckland Point Tide Station is presented in Figure 1.4. The dredge activity and monitored transecting locations are shown in Figure 1.5. Some photos from the transecting activity are provided in Figure 1.6 and Figure 1.7.

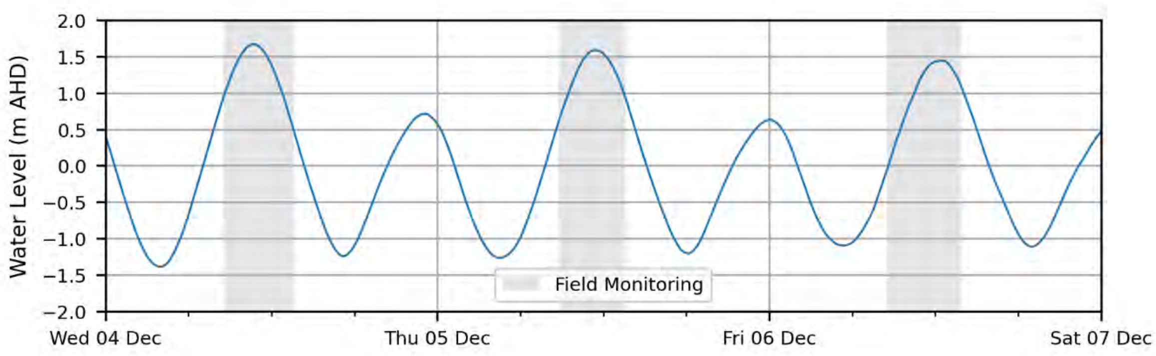

Figure 1.4 Measured water level at the Auckland Point tide gauge over the December 2024 field monitoring campaign (Source: TMR, 2024)

Title:

Dredge Activity and Transecting Locations – December 2024

Figure: **1.5**

Rev: **A**

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www.bmt.org

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Figure 1.6 Bridge view from *Resolution II* of TSHD *Brisbane* whilst steaming in unladen

Figure 1.7 TSHD *Brisbane* whilst steaming out laden. ADCP mounting pole and GNSS in foreground

2 Methodology

2.1 Validation Monitoring Synopsis

A range of field activities were conducted to measure suspended sediment concentrations and assess the longevity and extent of turbid plumes generated during dredging and placement activities in the areas mentioned in Section 1.1. In addition, self-logging instrumentation was deployed at fixed locations to measure time series of turbidity and suspended sediment concentration before and during dredging activities.

- **Timeframes and location:**
    - Fixed turbidity and suspended sediment concentration instrumentation was deployed for two (2) weeks prior to the commencement of dredging and continued for two (2) weeks during dredging;
    - The plume measurement campaign involved three (3) days of boat-based field activities: one (1) day of baseline measurements and two (2) days of dredge monitoring while the dredge was undertaking placement at the Tide Island MRA; and
    - In line with previous plume studies and in order to maximise the capacity for plumes to be detected, sampling was conducted on neap tides when ambient Total Suspended Solids (TSS) concentrations are lowest.
- **Overall methodology:** Boat-based field work involved primarily the indirect measurement of sediment concentrations using an Acoustic Doppler Current Profiler (ADCP) instrument, together with collection of water samples for laboratory analysis of TSS and particle size distribution (PSD) as well as a range of contaminants and *in situ* measurement of water quality profiles using Optical Back Scatter (OBS) and Laser In situ Scattering Transmissometry (LISST) measurement instruments. The ADCP instrument measures acoustic backscatter in the water column, which is converted to an equivalent TSS using a detailed calibration procedure. When applicable, sampling was undertaken in accordance with the Queensland Water Monitoring and Sampling Manual (DES, 2018).

2.2 Fixed Monitoring Stations

Objectives of the fixed monitoring stations were to:

- Quantify temporal patterns in turbidity at two (2) fixed sites located near the Tide Island MRA;
- Determine the frequency/duration of any periods of high turbidity and whether these turbidity spikes coincide with dredging activities; and
- On the basis of the measurements, evaluate whether periods of high turbidity potentially attributable to dredging activities are consistent with the numerical modelling results.

Patterns in turbidity were monitored at two (2) fixed monitoring stations located approximately 500 m to the northwest and 500 m to the southeast of the Tide Island MRA (see Figure 1.2 for approximate locations). The instruments were deployed for two (2) weeks prior to the commencement of dredging and continued measurements for two (2) weeks during the dredging activity.

The fixed instrumentation consisted of a LISST (measuring suspended sediment concentrations) and two (2) Yellow Stone Instruments (YSI) sondes measuring turbidity levels. The instruments measured turbidity and suspended sediment concentrations at 15-minute intervals. The instruments were deployed on benthic frames on the seafloor, outside the shipping channel.

The measured time series data was compared to the hindcast modelling outputs (see Sections 4 and 6) to determine whether the observed change in the turbidity statistics was consistent with the model outputs.

2.3 Plume Transect Monitoring

Data Acquisition

All field measurements were conducted using BMT's six (6) metre research vessel *Resolution II* operating in the vicinity of the dredging operations. During the dredge plume monitoring, BMT communicated and co-ordinated measurement and sampling activities with the dredging plant *via* mobile telephone or VHF marine radio.

The following field measuring instrumentation and techniques were employed during the dredge plume monitoring:

- Acoustic backscatter measurements were collected to infer suspended sediment concentrations within and adjacent to sediment plumes created by dredging and dredged material placement. A vessel mounted downward facing 500 kHz Nortek VM ADCP recorded acoustic backscatter intensity on multiple transects extending through the visible sediment plume. TSS and turbidity measurement data (described below) was collected concurrently, which enabled relationship with acoustic backscatter intensity to be derived. Refer to the section below (Post processing) for data analyses procedures.

- Water quality grab samples were collected on each of the three-day campaigns to assess the water physico-chemical and biological (chlorophyll a) properties of plumes generated by dredging in Jacobs Channel and placement activities at the Tide Island MRA:

    - Samples were collected from the top, mid and bottom of the water column, except in shallow areas, using a peristaltic pumping system mounted on a sampling frame (Figure 2.1). During the 2023 monitoring campaign, a total of 46 samples (n = 46) were collected from 16 sampling locations whilst in the 2024 monitoring campaign, a total of 33 samples (n = 33) were collected from 12 sampling locations (the number of samples collected in each campaign varied according to the available opportunities for monitoring). Samples were analysed by ALS (National Association of Testing Authorities (NATA) accredited). Samples were analysed for:Particle size distribution (PSD) of suspended sediments. This analysis was performed on a subset of samples, 16 in both the 2023 and 2024 monitoring campaigns;

    - total suspended solid (TSS) concentrations. This analysis was performed on all samples and results were used to analyse the TSS-turbidity relationship and calibrate measurements of the dredge plumes; and

    - Total and dissolved nutrients (Total N and P, nitrate + nitrite, ammonia, reactive phosphorus), Total Organic Carbon (TOC), chlorophyll *a* and total and dissolved metal(loid)s (Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Ag, Zn).

    - TSS, nutrients, chlorophyll *a* and metal(loid)s results were screened against Water Quality Objective (WQOs) scheduled under *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (DES 2020) and Default Guideline Values (DGVs) (ANZG 2018) as reported in 0. Note that whilst comparison of single results to DGVs (metal(loid)s) is appropriate, comparisons to WQOs (nutrients) should be based on long-term data rather than individual sample events. Therefore, comparison to WQOs in this report is indicative only and for contextualisation and comparative purposes only. For applicable WQOs expressed as percentiles, the 80th percentile value was adopted (0) as threshold and compared against grab sample results.

  - Note that in in the 2023 monitoring campaign, laboratory LOR for Total N, total and dissolved Cr, Cu, Pb, Ag, and Zn is higher than the corresponding WQOs and/or DGVs in all samples as well as Total P in two samples (Table 3.5, Table 3.6 and Table 3.7). In 2024 this issue was rectified by the laboratory, however, the LOR was raised above related WQOs and DGVs due to matrix interference for Total P in one sample and Total N in three samples on the 04/12/2024 (Table 5.4) and dissolved Hg in 10 samples on the 05/12/2024 (Table 5.5).

  - In 2023, background sampling collection was undertaken near the Tide Island MRA on the 25/08/2023 and thus last day of field campaign in line with the *Brisbane* scheduled activities which were concentrated on South Trees Wharf with subsequent placement at the East Banks Offshore MRA. In 2024, background sampling collection was also carried out near the Tide Island MRA, but on the second day of monitoring, 05/12/2025, as the Brisbane was undertaking crew change activities on that day.

- *In situ* measurements through the water column consisting of:

  - Turbidity profiling, using a YSI turbidity sonde, within and beyond the extents of the dredge plumes for use in the calibration of the ADCP and in assessments of the dredge plumes.

  - *In situ* PSD measurements were conducted using a Sequoia LISST-200X submersible particle size analyser.

Table 2.1 Applicable WQOs and guideline values to the Jacobs Channel and Tide Island

Guideline	Parameter	Units	Water type Wester Basin - Enclosed coastal waters/lower estuary (EC/LE)	Comments
WQOs, EPP Water and Wetland Biodiversity (2009)	DO	%	91–96–100	Wester Basin MD2421 (State of Queensland 2014), baseflow WQOs.
	pH	-	7.2–8.2 (<40mS/cm) 7.4–8.3 (>40mS/cm)	
	Ammonia N	µg/L	3–3–8	
	Oxidised N	µg/L	1–4–16	
	Total N	µg/L	145–170–210	
	Filterable reactive phosphorus (FRP)	µg/L	1–3–7	
	Total P	µg/L	14–18–29	
	Chlorophyll-*a*	µg/L	0.5–1.0–2.0	
	Turbidity	NTU	4–8–17 Dry (May–Oct) 7–13–29 Wet (Nov–Apr)	
ANZG (2018)	Aluminium	µg/L	24	Marine 95% species protection - slightly to moderately disturbed systems (ANZG 2018)
	Arsenic	µg/L	2.3	
	Boron	µg/L	-	
	Cadmium	µg/L	0.7*	
	Chromium	µg/L	4.4	
	Cobalt	µg/L	1	
	Copper	µg/L	1.3	
	Lead	µg/L	4.4	
	Manganese	µg/L	80	
	Mercury (inorganic)	µg/L	0.1*	
	Molybdenum	µg/L	23	
	Nickel	µg/L	70	
	Selenium	µg/L	3	
	Silver	µg/L	1.4	
	Zinc	µg/L	8	

Table notes:
*** To account for the bioaccumulating nature of these toxicants, ANZG (2018) recommends that the 99% species protection level DGV is used for slightly to moderately disturbed systems.**

The co-located YSI, LISST-200X and pump sampling frame, as well as the ADCP mounting pole and GNSS (Global Navigation Satellite System) are shown in Figure 2.1.

Figure 2.1 Plume monitoring equipment setup including the GNSS and ADCP mounting pole, and the profiling array including the co-located LISST, YSI and pump sampler frame.

Post-Processing

Processed ADCP backscatter measurements were used to remotely measure the suspended sediment in the water column with sufficient resolution to provide spatial plots of the suspended sediment associated with dredging throughout the water column across measurement transects. ADCP measurements can be used to estimate suspended sediment concentrations throughout the water column, however an ADCP instrument does not directly measure TSS. The principle of ADCP operation is that a pulse of sound is propagated through the water column and is reflected/ backscattered off suspended particles such as suspended sediments. The Doppler shift of the backscattered acoustic signal is used to directly determine the water currents throughout the water column. The intensity of the backscattered echo can be translated into TSS values through a series of steps as detailed below.

Laboratory measurement of the TSS in water samples spanning a wide range of sediment concentrations provided the means to convert measurements from the YSI turbidity profiling instrument into an equivalent level of TSS. By pairing the measured TSS values with the turbidity in Nephelometric Turbidity Units (NTU) recorded in the field at the same time and location by the YSI sonde, the site and date specific NTU-TSS relationship was determined using linear regression analysis.

The turbidity profiles measured with the YSI, once converted to TSS, were then used to derive a relationship between the ADCP acoustic signal volumetric backscatter intensity and TSS. Model post-processing operations were conducted to derive this relationship for the concurrent YSI turbidity-derived TSS and ADCP bin backscatter at the corresponding sample depth using linear regression analysis. Once this relationship was determined for each monitoring day, the volumetric backscatter transect profiles were then converted to TSS.

ADCP backscatter measurements are prone to occasional spikes/elevated values that are unrelated to TSS in the water column. These spikes may arise due to several sources of interference, including bubbles and turbulence generated near the surface by the dredge, survey vessel, third-party vessel or other objects 'ensonified' in the water-column such as plankton, fish or seaweed. Transect data were visually screened to determine erroneous backscatter signatures, where the corresponding transects were subsequently excluded from the formulation of the backscatter-to-TSS regression analysis.

Presentation of Results

To characterise the turbid plume behaviour in terms of extent, intensity and longevity, spatial plots of the estimated suspended sediment concentration are presented. An example of these plots is provided in Figure 2.2. Due to the complexity of such plots, the layout and interpretation is described in detail below.

The plots are comprised of two (2) components, an upper and a lower component. The upper component depicts the depth averaged plume concentrations in plan-view along the transect. The lower component is a profile-view of the ADCP transect which depicts the TSS concentrations along the transect throughout the water column.

The coloured circles in the lower component depict the YSI TSS (based on turbidity) profile measurements superimposed on the transect. The colour of each circle represents the TSS concentration returned by the YSI which can be compared to those returned by the ADCP to confirm the accuracy of the ADCP backscatter calibration. As the YSI instrument is lowered down through the water column, a process which can take over a minute, the monitoring vessel often drifts with the wind/currents and hence the chainage along the transect increases with depth. Hence the YSI profiles do not appear vertical.

The green '×' plotted in the upper component identifies the start of the ADCP transect which extends from left to right in the lower profile-view component of the plot. All ADCP transects have been presented with a green '×' at the start of the transect (0 m chainage) and a red '×' at the termination of the transect. The timing of the measurement within the tidal cycle is depicted in the upper left-hand corner of the plot (time-of-day shown on x-axis).

The operations of the TSHD *Brisbane* are represented by small, coloured circles in the upper pane. They depict the *Brisbane's* position at the time the transect was conducted and where and how the dredge had been operating for the past 10-minutes prior to the start of the transect and up until the end of the transect.

To capture the hydrodynamics over the period of measurement, the depth-averaged current magnitudes and directions along the sampled transect are superimposed in the form of quiver arrows in the upper panel.

TSS estimates are capped at a maximum value due to the uncertainty surrounding the backscatter-TSS relationship above that value. It should also be noted that due to its mounting location and a measurement "blanking-distance", the ADCP was only able to resolve TSS profiles below approximately 2.5 m depth. Due to "sidelobe" interference, the ADCP was also unable to estimate the TSS within approximately 0.5 m of the bed.

The background (non-plume) TSS concentrations have not been removed from the data. Several of the data sets include a transect conducted before the dredge commenced operations and hence depict the background concentrations at that time. Where possible, the transects extend beyond the extents of the dredge plume and hence can be used to quantify the background concentrations at the time of the transect.

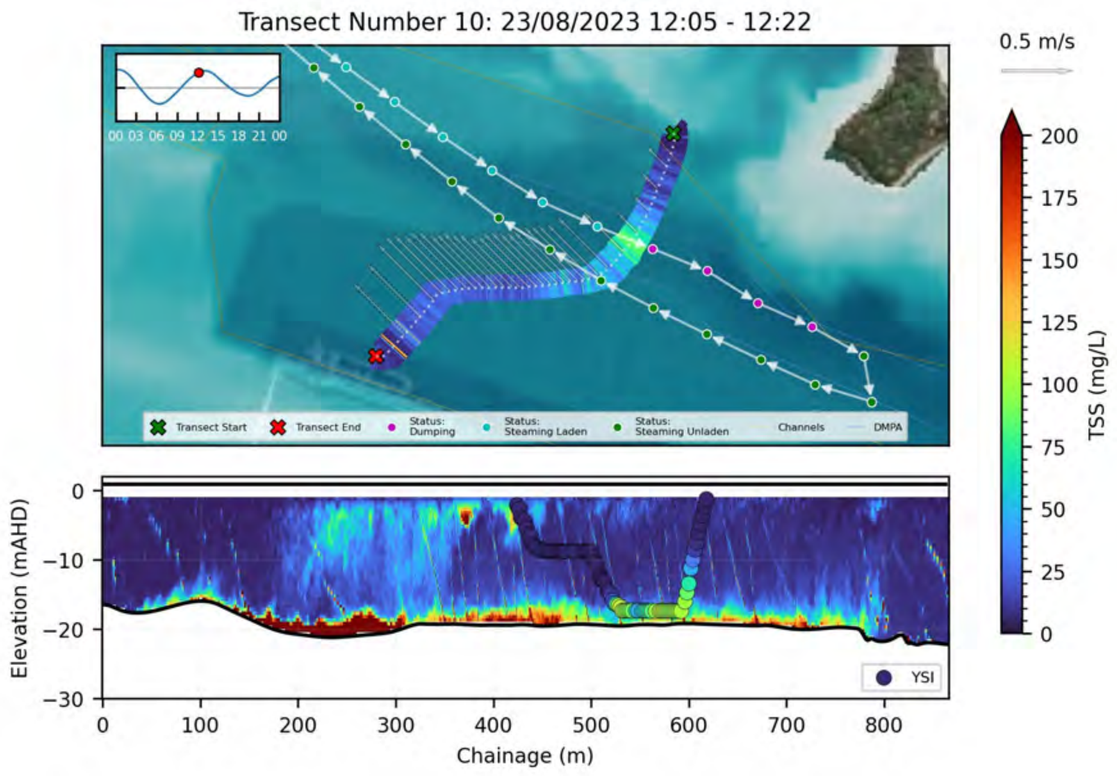


Figure 2.2 Example of turbid plume transecting following a dredge placement event at the Tide Island MRA

3 August 2023 Campaign Monitoring Results

3.1 TSS and Turbidity Relationship

Figure 3.1 shows the relationship between turbidity and TSS from background and plume samples generated by TSHD *Brisbane* collected at the loading sites and the Tide Island MRA across the three-day monitoring campaign. There was a significant (p<0.05) positive linear relationship between turbidity and TSS, with 90% of variation in TSS explained by the linear regression model. The full set of laboratory TSS results is presented in Annex A.

There is a notable amount of scatter in the data compared to typical dredge plume monitoring datasets. The linear slope parameter is higher than, but broadly consistent with, long-term values typically used in Gladstone (y = 1.60 x + 0). The differences here potentially reflect both the broader range (i.e., higher concentrations) of TSS measured and differences in dredged material properties between campaigns (for example, different areas being dredged). Therefore, the correlation model is considered suitable.

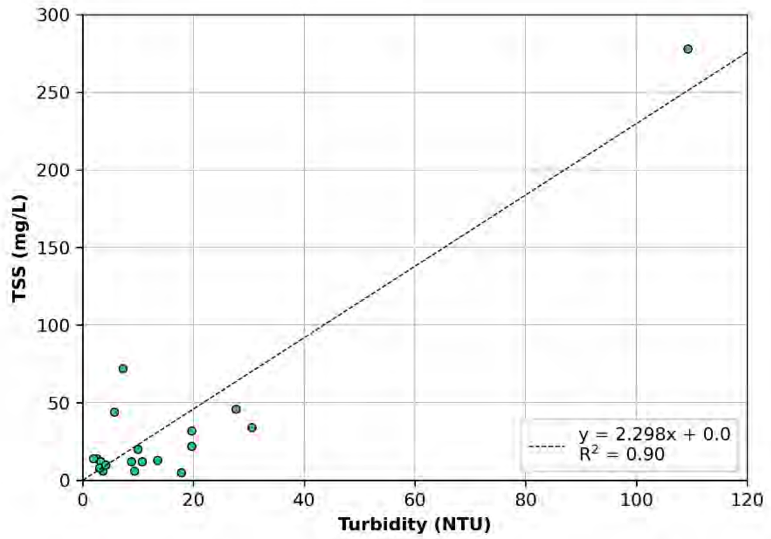


Figure 3.1 Water Sample TSS and Turbidity Correlation Plot

3.2 TSS and Volumetric Backscatter Relationships

As described in Section 2.3, conversion of the Nortek VM ADCP volumetric backscatter to TSS was conducted using a derived relationship linking the inferred YSI TSS measurement (adopting the relationship shown in Figure 3.1) and the concurrent backscatter at the corresponding ADCP bin. Based on acoustic theory, a log-linear model was fitted to produce the ADCP suspended sediment concentration relationship. Due to the varying contextual conditions of each monitoring day (i.e., different site locations, sediment types, etc.), separate relationships were derived for each day. As exception to this, insufficient contrast in backscatter was identified for the background monitoring day on 25/08/2023, whereby the composite of data collected over the full monitoring campaign was used to produce the volumetric backscatter to TSS relationship The full set of volumetric backscatter – TSS relationships are presented in Annex B, with the relationship derived over the full monitoring campaign shown in Figure 3.2.

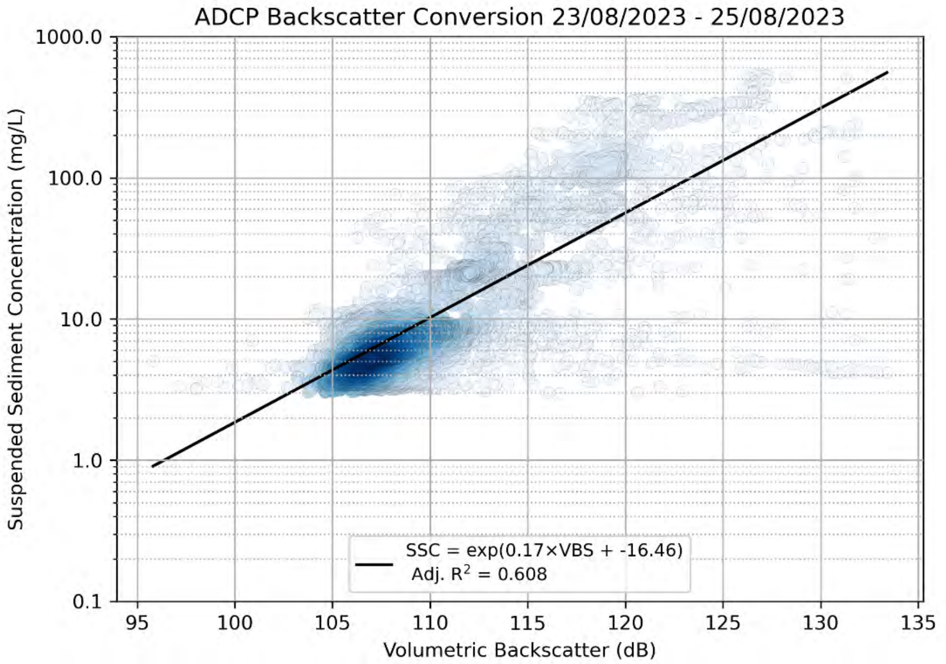


Figure 3.2 ADCP Volumetric Backscatter and Predicted Suspended Sediment Concentration for Sampling Conducted over 23/08/2023 – 25/08/2023. Colour Scale is Based on Sampling Point Density (Darker = More Points)

3.3 Plume Monitoring

23/08/2023 – Tide Island MRA

The TSHD *Brisbane* was monitored whilst disposing at the Tide Island MRA from 10:31 – 15:17 on 23/08/2023 during both flooding and ebbing tides, with high tide occurring at 13:00. Dredging was performed in the Jacobs Channel swing basin off the Queensland Curtis LNG (QCLNG). A summary of the *Brisbane* dredge activity over the course of the monitoring period is shown in Table 3.1.

Table 3.1 Summary of Dredge Cycle Activity During Monitoring on 23/08/2023

Cycle No.	Dredging Site	Dredging Start	Dredging End	Placement Site	Placement Start	Placement End
1	QCLNG Swing Basin	23/08/2023 09:18	23/08/2023 10:12	Tide Island MRA	23/08/2023 10:28	23/08/2023 10:33
2	QCLNG Swing Basin	23/08/2023 10:56	23/08/2023 11:39	Tide Island MRA	23/08/2023 11:54	23/08/2023 12:01
3	QCLNG Swing Basin	23/08/2023 12:26	23/08/2023 13:24	East Banks Offshore MRA	23/08/2023 15:47	23/08/2023 16:01

Weather at the time of monitoring was clear, with winds ranging from 6 km/h SSW at 09:00 to 17 km/h ENE at 15:00.

Figure 3.3 to Figure 3.6 present a sequence of transects observing the placement plume at the Tide Island MRA for the placement event conducted over 11:54 – 12:01 (Cycle No. 2, Table 3.1) approaching high tide. Velocities were generally heading towards the WNW at ~0.2 – 0.6 m/s with the flooding tide, but following high tide, the ebbing currents in Jacobs Channel switch to head SE from ~13:00 at ~0.3 – 0.4 m/s.

With the arrival of the *Brisbane* and the subsequent placement shown in Figure 3.3, the spreading sediment plume was seen in the bottom 5 – 10 m of the water column between chainage 40 – 200 m with suspended sediment concentrations in excess of 200 mg/L. Following the 7-minute placement period, Figure 3.4 shows the spreading sediment plume as it was advected upstream with the flooding tide. By this time, plume concentrations at the placement site had reduced to approximately 50 – 75 mg/L over the depth of the water column, while concentrations near-bed remained in excess of 200 mg/L.

Figure 3.5 shows the plume had advected along the northern bank of Jacobs Channel with the flooding tide approximately 1300 m from the placement site, with concentrations up to 100 – 120 mg/L. The longitudinal transect along Jacobs Channel (Figure 3.6) illustrates the advection of the placement plume (dredging ~2.2 km further upstream), with concentrations in the order of 20 – 60 mg/L, showing increasing concentration on approach to the bed as the plume settled out of the water column.

The full set of ADCP transects for monitoring conducted on 23/08/2023 are presented in Annex A. Depth-averaged suspended sediment concentrations for all ADCP tracks collected over the course of monitoring conducted on 23/08/2023 are presented in Figure 3.7. The plume extents show good agreement with the predicted zone of influence (BMT, 2023). Some higher values are noted beyond the zone of influence at the WICET wharf, although these are likely not dredging-plume related (e.g., vessel traffic, instrumentation artefacts) (Annex A, Transects 20 – 26).

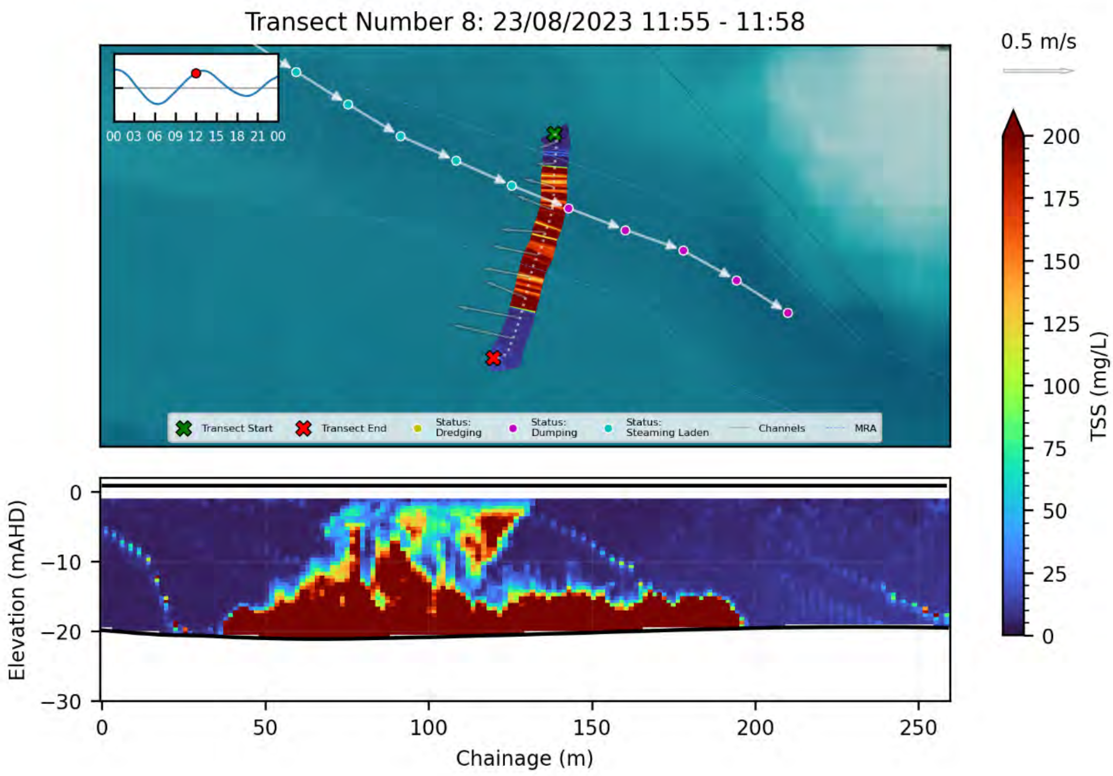


Figure 3.3 Transect at the Tide Island MRA on 23rd August During Dredge Placement

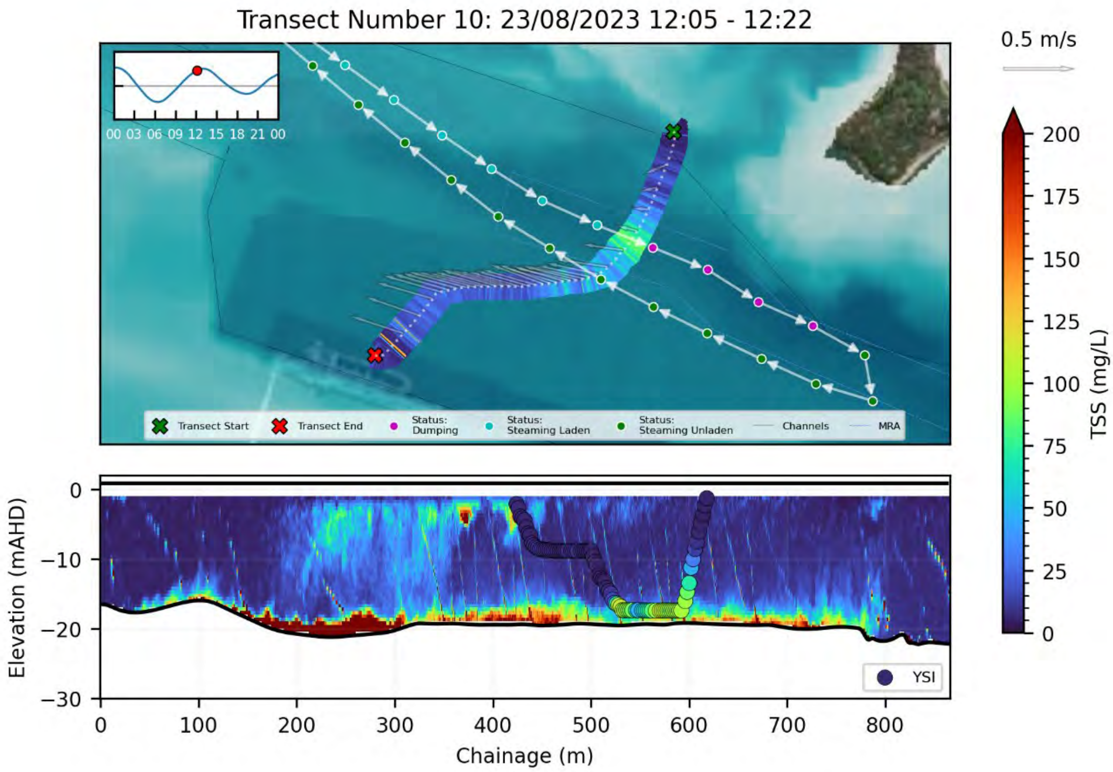


Figure 3.4 Transect at the Tide Island MRA on 23rd August Starting 4 Minutes After Dredge Placement

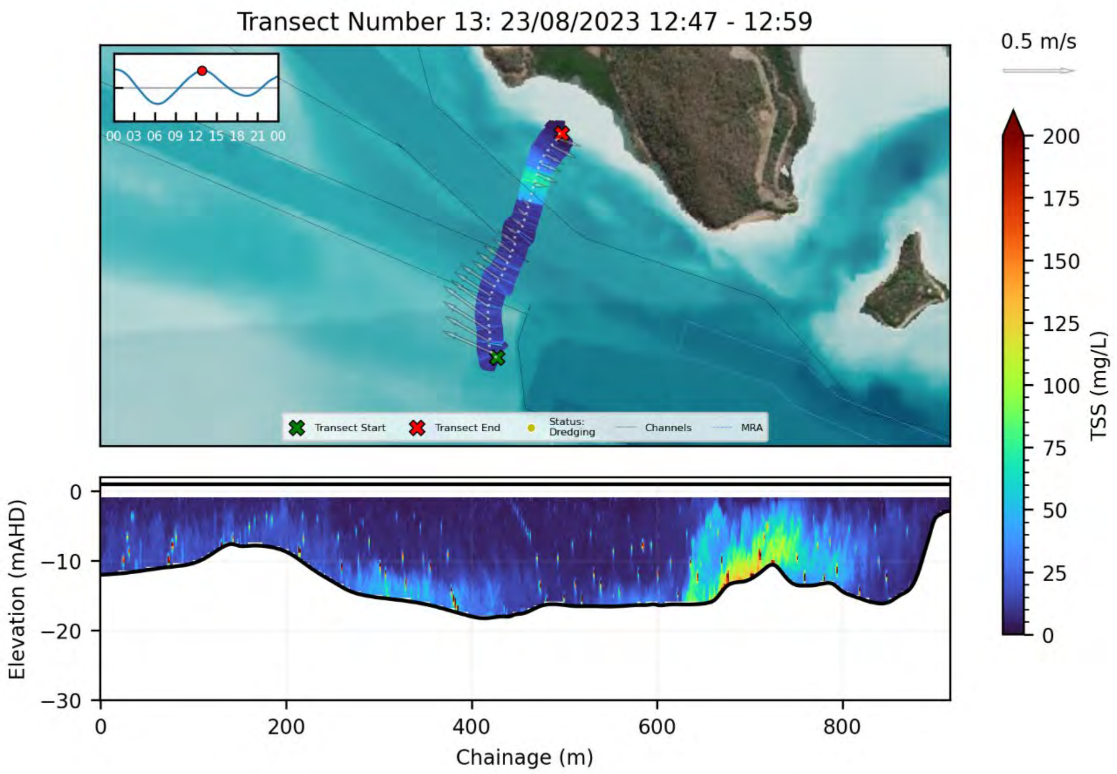


Figure 3.5 Transect Upstream of Tide Island MRA on 23rd August Starting 46 Minutes After Dredge Placement

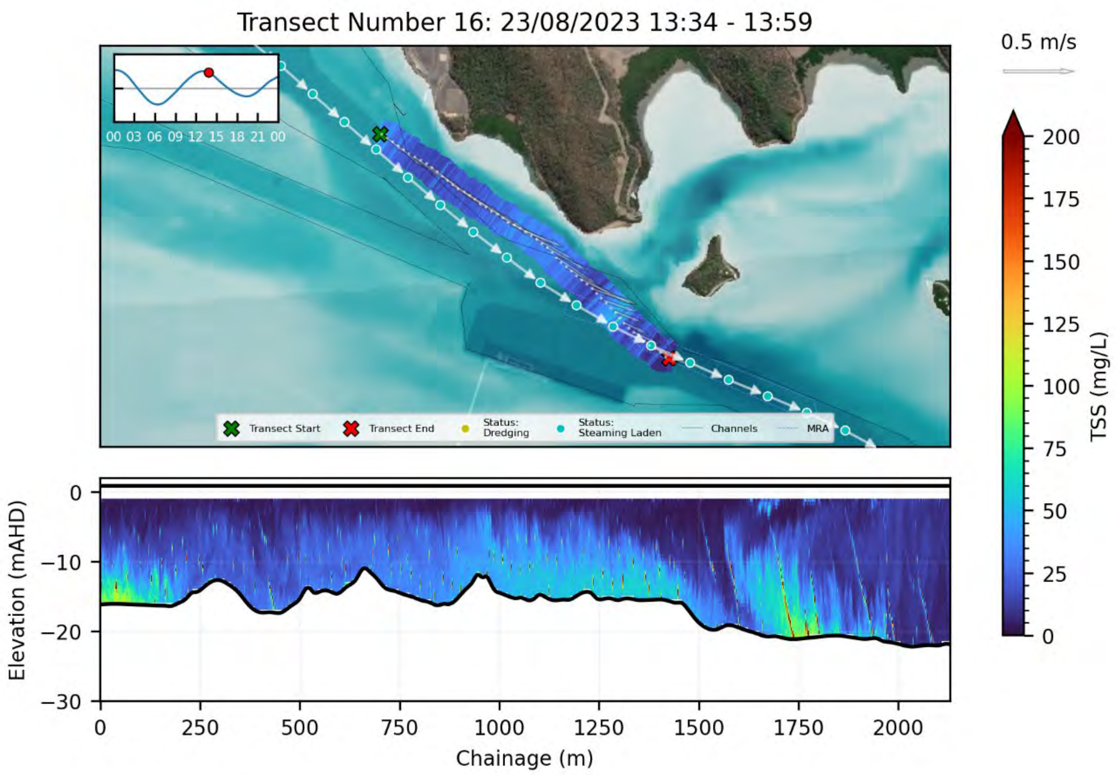
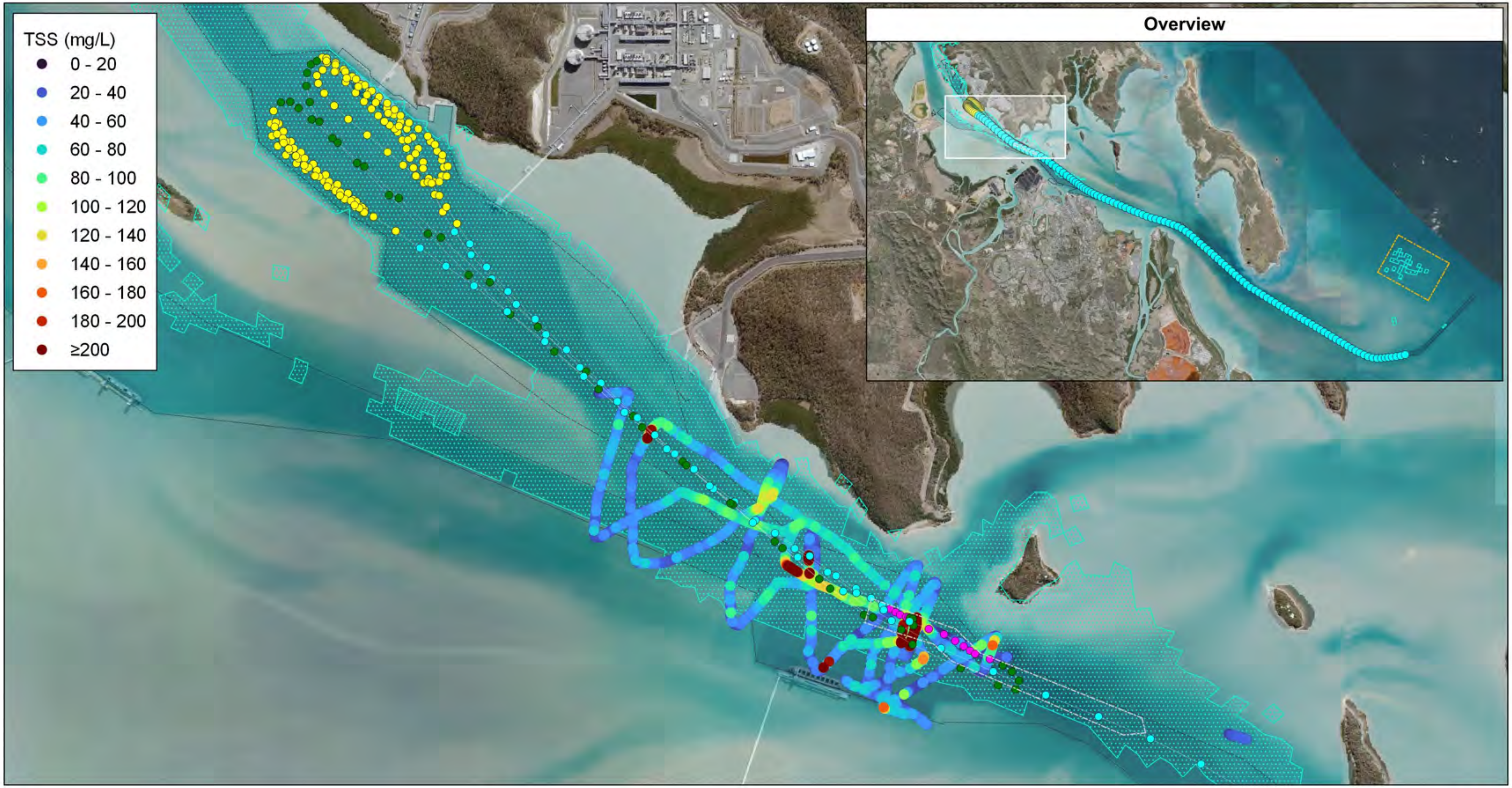


Figure 3.6 Transect Along Jacobs Channel on 23rd August Starting 93 Minutes After Dredge Placement



Legend

East Banks MRA
Tide Island MRA
Channels
Predicted Zone of Influence

Dredge Status

Dredging
Placement
Standby
Steaming Laden
Steaming Unladen

Title:

Depth-Averaged Suspended Sediment Concentration 23/08/2023

Figure: **3.7**

Rev: **A**

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24/08/2023 – Tide Island MRA

The *Brisbane* was monitored whilst placing material at the Tide Island MRA from 08:45 – 15:15 on 24/08/2023 during both flooding and ebbing tides, with high tide occurring at 14:10. Dredging was performed in the Jacobs Channel swing basin near the Gladstone LNG (GLNG) plant. A summary of the *Brisbane* dredge activity over the course of the monitoring period is shown in Table 3.2.

Table 3.2 Summary of Dredge Cycle Activity During Monitoring on 24/08/2023

Cycle No.	Dredging Site	Dredging Start	Dredging End	Placement Site	Placement Start	Placement End
1	GLNG Swing Basin	24/08/2023 10:04	24/08/2023 10:50	Tide Island MRA	24/08/2023 11:03	24/08/2023 11:08
2	GLNG Swing Basin	24/08/2023 11:25	24/08/2023 12:05	Tide Island MRA	24/08/2023 12:20	24/08/2023 12:25
3	GLNG Swing Basin	24/08/2023 12:45	24/08/2023 13:30	East Banks MRA	24/08/2023 16:05	24/08/2023 16:32

Weather over the time of monitoring was clear, with winds ranging from 9 km/h SE at 09:00 to 20 km/h ENE at 15:00.

Figure 3.8 shows a background transect at the Tide Island MRA, with last prior dredging ~6 hours prior to measurement and last prior dredge placement at the Tide Island MRA ~22 hours prior. Background TSS was relatively uniform over the depth of the water column with values in the order of 2 – 12 mg/L. With the flooding tide, velocities generally ranged 0.4 – 0.8 m/s towards the WNW.

With the commencement of the *Brisbane* placement cycle at the Tide Island MRA (Figure 3.9), a plume was evident over the depth of the water column (chainage 450 – 550 m, depth-averaged concentrations up to 1150 mg/L) and advected near-bed with the flooding tide (chainage 550 – 900 m, depth-averaged concentrations ranging 50 – 350 mg/L).

Following the flooding current upstream, Figure 3.10 shows the advected near-bed plume down current of the placement site. A weak (~15 mg/L) plume is noted over the bottom-half of the water column at the Targinnie Channel. A strong plume signature (depth-averaged concentrations 60 – 80 mg/L, 300 – 450 m chainage) was present at the junction of the Targinnie and Jacobs Channels, approximately 750 m down current of the placement site and 26 minutes after the cessation of placement. Plume concentrations on the northern bank of the Jacobs Channel (~900 m chainage) were reduced to background concentrations.

Commencing 51 minutes after the cessation of dredge placement, Figure 3.11 shows suspended sediment concentration across the Targinnie and Jacobs Channels. No plume signature is evident across the Targinnie Channel – rather the signature was induced by passing vessel traffic (chainage 300 – 350 m). The advected plume was detected north of the Targinnie Channel, in Jacobs Channel, with maximum concentrations observed at chainage 650 – 750 m, in the order of 75 mg/L near the bed.

The full set of ADCP transects collected on 24/08/2023 are shown in Annex KAnnex K. Depth-averaged suspended sediment concentrations for all ADCP tracks are presented in Figure 3.12. The detected dredging and placement plume extents again show good agreement with the predicted zone of influence (BMT, 2023).

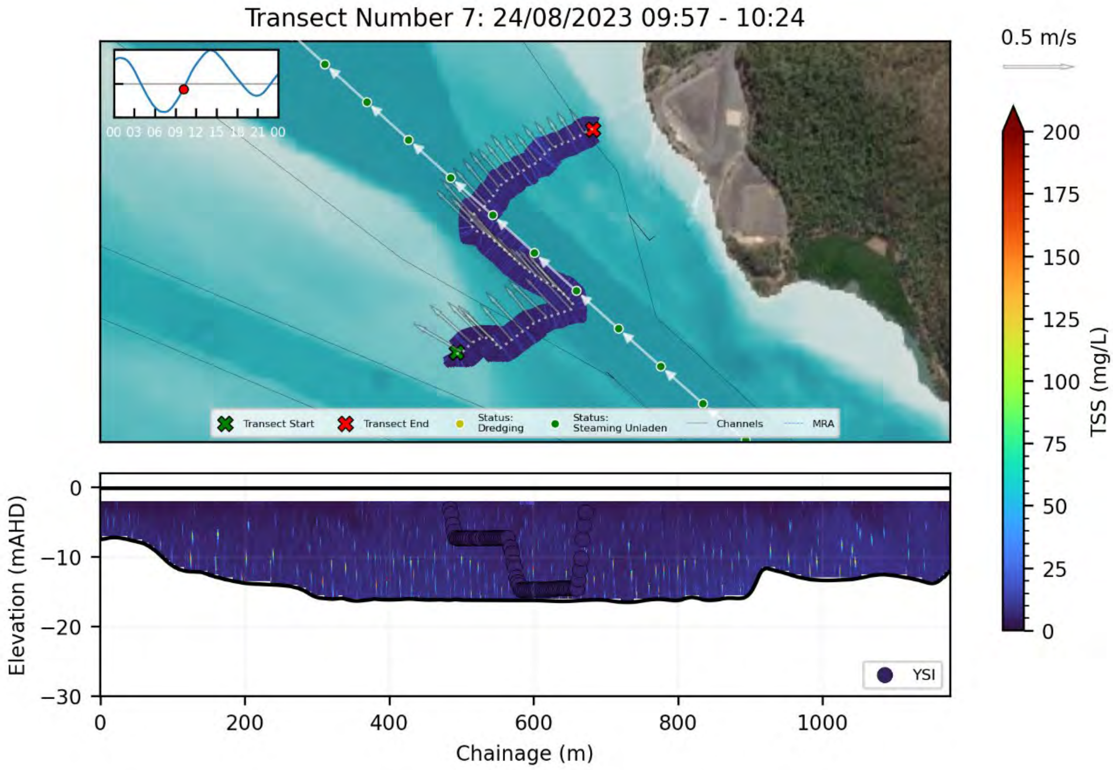


Figure 3.8 Transect across the GLNG Swing Basin on 24/08/2023 Starting ~6 Hours After Dredging and 22 Hours After Last Prior Dredge Placement at Tide Island MRA

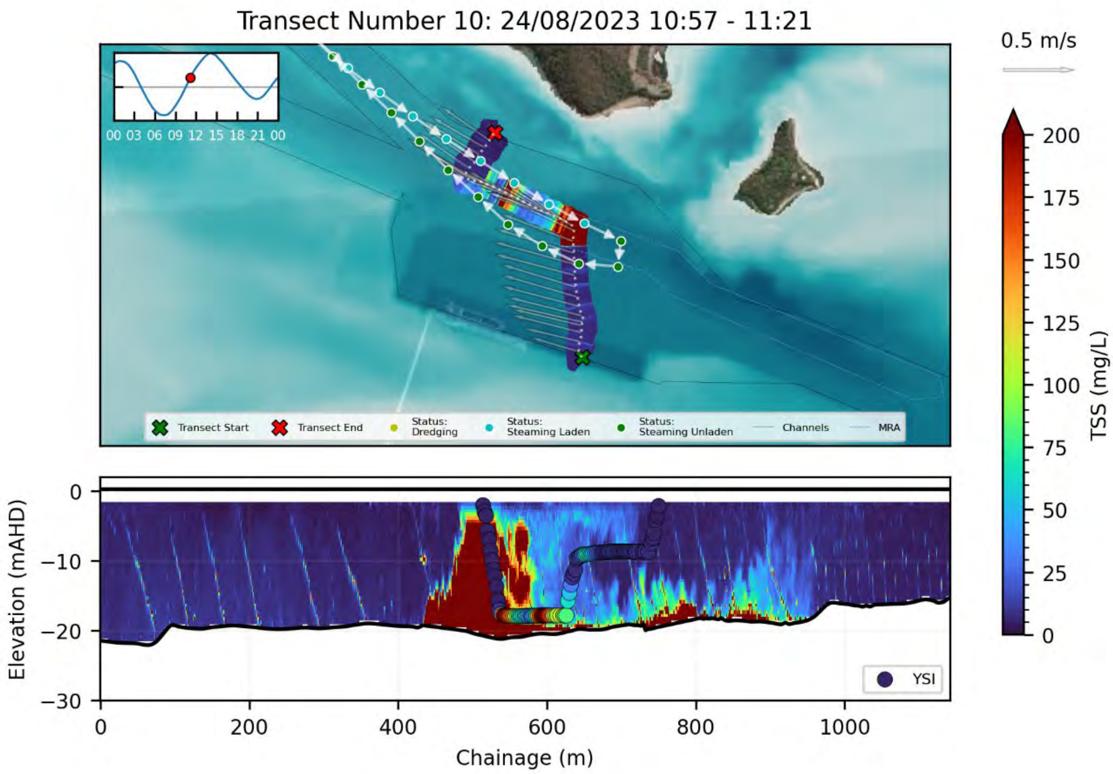


Figure 3.9 Transect at the Tide Island MRA on 24/08/2023. Dredge Placement Commenced 11:03

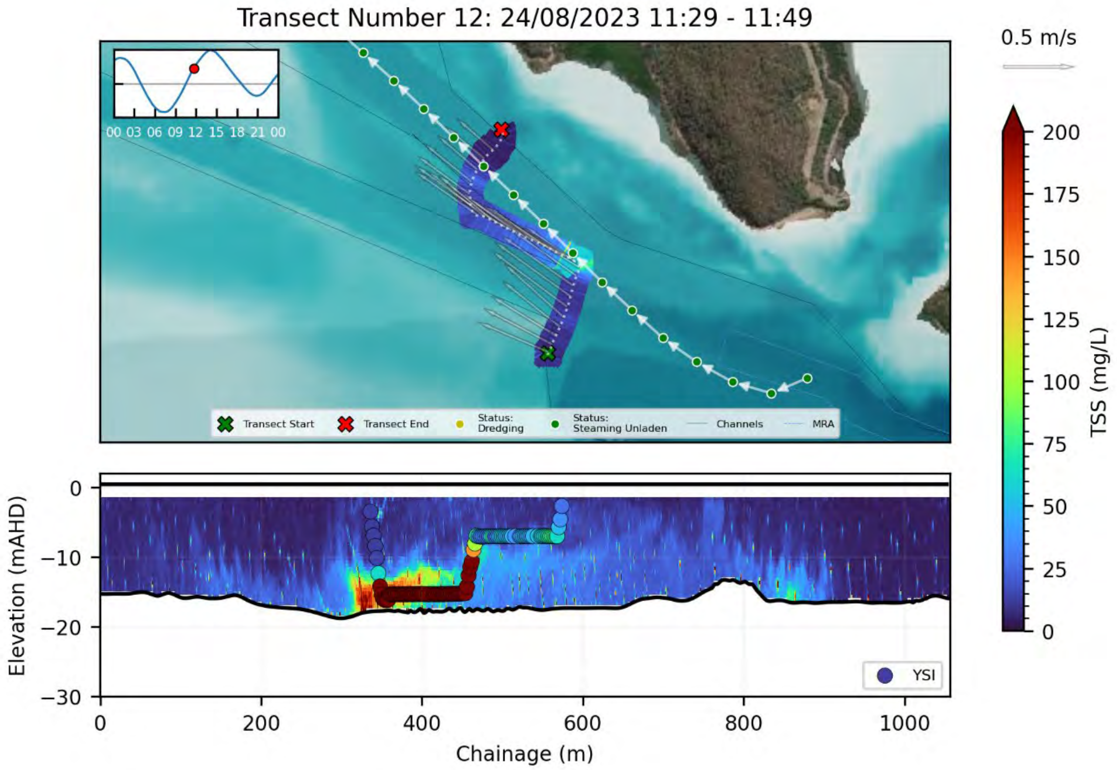


Figure 3.10 Transect Across Targinnie and Jacobs Channels on 24/08/2023 Starting 21 Minutes After Cessation of Dredge Placement

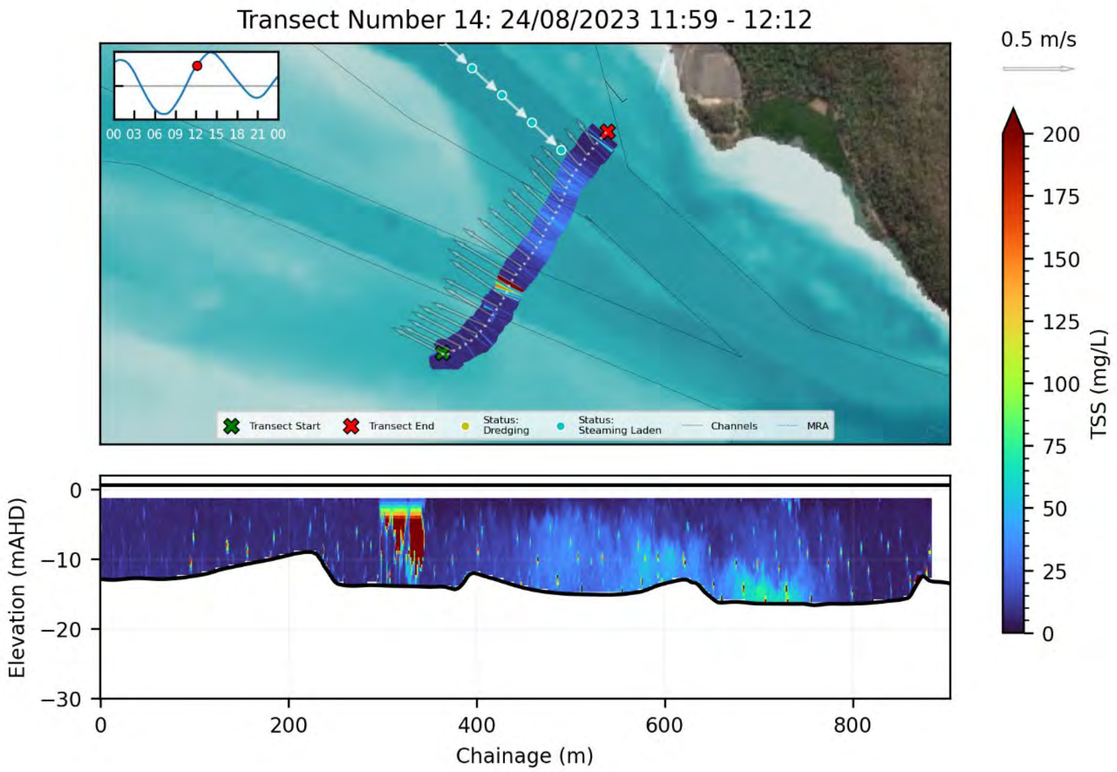
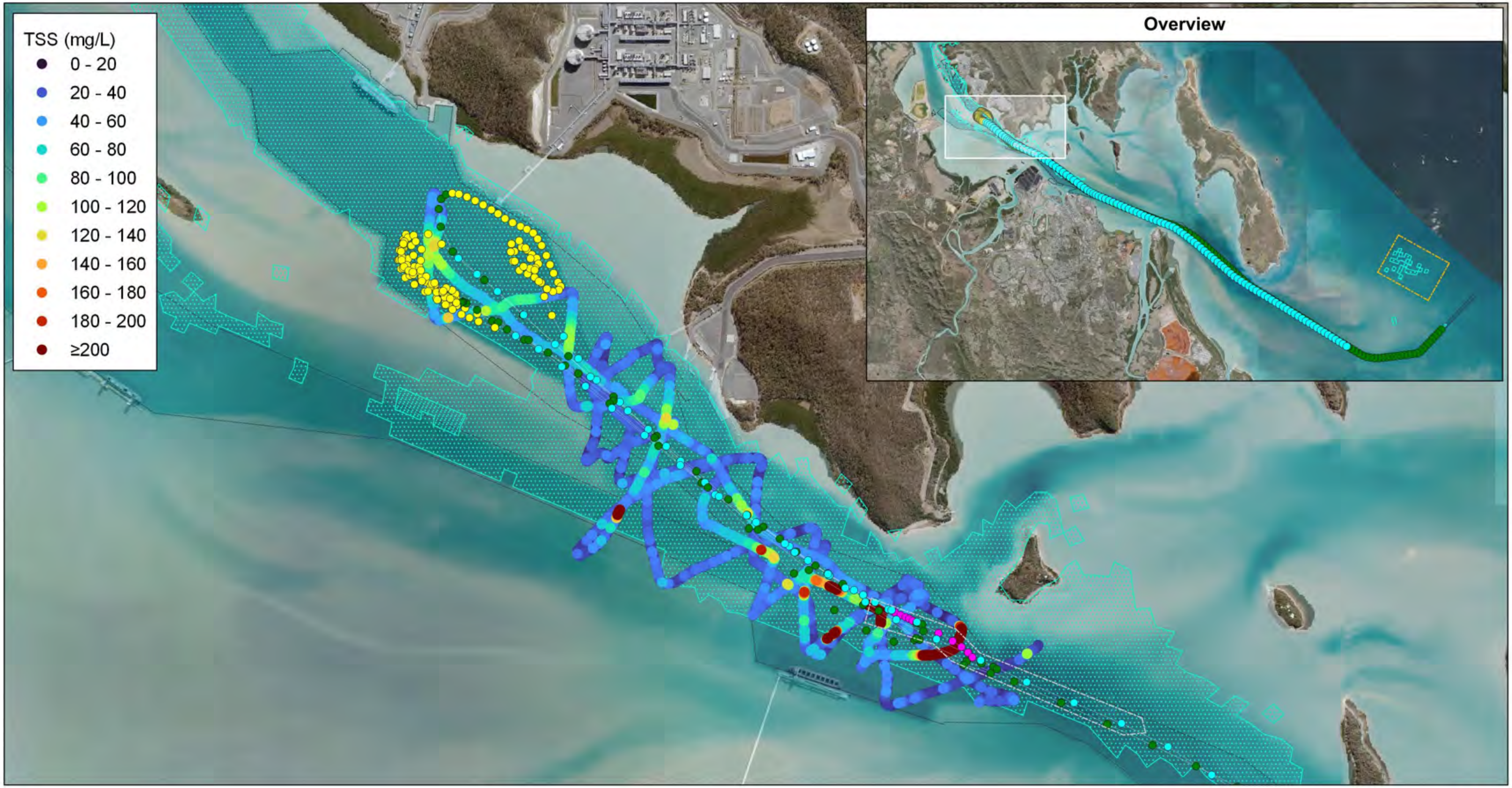


Figure 3.11 Transect Across Targinnie and Jacobs Channels on 24/08/2023 Starting 51 Minutes After Cessation of Dredge Placement. Vessel-Induced Interference Noted in Targinnie Channel



Legend

- East Banks MRA
- Tide Island MRA
- Channels
- Predicted Zone of Influence

Dredge Status

- Dredging
- Placement
- Standby
- Steaming Laden
- Steaming Unladen

Title:

Depth-Averaged Suspended Sediment Concentration 24/08/2023

Figure: **3.12**

Rev: **A**

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25/08/2023 – Tide Island MRA – Background Measurements

Background suspended sediment concentrations were monitored from 07:19 – 11:25 on 25/08/2023, with low tide occurring at 08:50. Over the time of monitoring, the *Brisbane* was dredging at South Trees Wharf, with subsequent placement at the East Banks MRA. A summary of the dredge activity over the period of monitoring is provided in Table 3.3. The last prior dredge placement at the Tide Island MRA took place at 12:24 on 24/08/2023.

Table 3.3 Summary of Dredge Cycle Activity During Monitoring on 25/08/2023

Cycle No.	Dredging Site	Dredging Start	Dredging End	Placement Site	Placement Start	Placement End
1	South Trees Wharf	25/08/2023 05:52	25/08/2023 07:37	East Banks MRA	25/08/2023 09:21	25/08/2023 10:12

Weather over the time of monitoring was clear, with winds ranging from 19 km/h SE at 09:00 to 26 km/h ENE at 15:00.

Figure 3.13 presents measured transect suspended sedimented concentrations starting near Witt Island, across the shipping channel and the Tide Island MRA. With the ebbing tide, velocities ranged 0.2 – 0.5 m/s towards the ESE. Some anomalous backscatter signatures are observed, evident by the “streaky” behaviour over the depth of the water column – potentially attributable to wave-vessel interactions with *Resolution II*. In the shallow region north of the channel (0 – 450 m chainage) TSS values are reasonably uniform with concentrations in the order of 6 – 8 mg/L. Suspended sediment concentrations are slightly higher in the channel with ~11 mg/L observed.

Figure 3.14 shows a longitudinal transect from GLNG Swing Basin to the Tide Island MRA. By this point, the tide had transition to a flooding state, with velocities heading WNW in the order of 0.3 – 0.7 m/s, and with velocities generally increasing along the transect towards the Tide Island MRA. Suspended sediment concentrations were relatively homogenous over the water column, but showed notable variation along the length of the transect, ranging 5 – 16 mg/L, with slight increases coinciding with the GLNG Swing Basin and the Tide Island MRA sites, where the *Brisbane* was operating the day prior.

The full set of ADCP transects measured on 25/08/2023 are presented in Annex LAnnex L. Depth-averaged suspended sediment concentrations for all ADCP tracks sampled on 25/08/2023 are collated in Figure 3.15. Since no dredge activity occurred in proximity of monitoring on this date, localised increases in suspended sediment concentrations are likely anomalous, caused by measurement artefacts, noting also the relatively high measured wind speeds that occurred on the 25/08/2023.

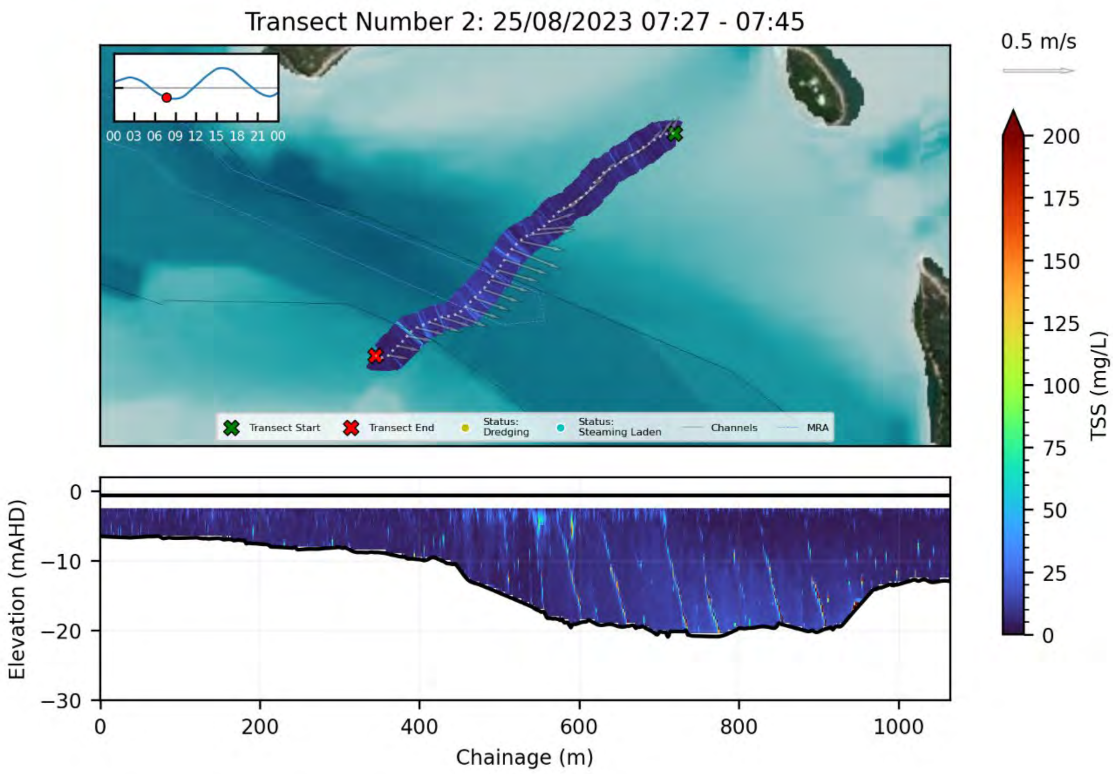

Figure 3.13 Background Transect Across Tide Island MRA on 25/08/2023 ~19 Hours After Prior Placement at Tide Island MRA

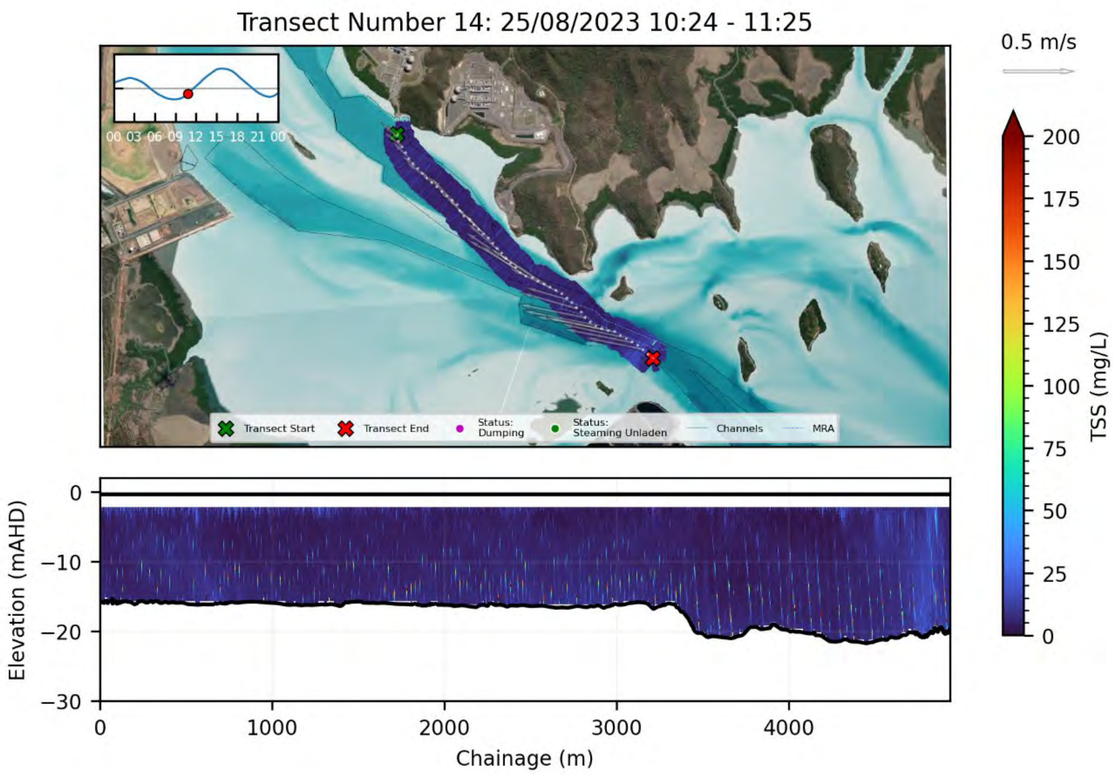

Figure 3.14 Background Transect Along Jacobs Channel and Along the Tide Island MRA on 25/08/2023 ~22 Hours After Prior Placement at Tide Island MRA

Title:

Depth-Averaged Suspended Sediment Concentration 25/08/2023

Figure: **3.15**

Rev: **A**

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3.4 Particle Size Distributions (PSD)

A total of 27 water samples collected on the 23, 24 and 25/08/2023 were analysed for PSD. At the time of sample collection, *in situ* PSD measurements were also obtained using the LISST-200X instrument. The raw laboratory PSD results for each sample are shown in Annex A. A summary of laboratory PSD results including the sample coordinates, depth and dredge status is provided in Annex D.

A summary of particle sizes at the different locations for the various phases of the dredge cycle is presented in Figure 3.4. The laboratory-processed particle size distributions for all samples collated for each monitoring day are presented in Figure 3.16, Figure 3.18 and Figure 3.20. Similarly, the *in situ* LISST-200x measurements are shown in Figure 3.17, Figure 3.19 and Figure 3.21.

Table 3.4 Laboratory PSD Result Summary Showing the Particle Sizes (Median Across Samples) at Each Location During the Different Phases of the Dredge Cycle

Location	Description	No. Samples (-)	D10 (µm)	D50 (µm)	D90 (µm)
Jacobs Channel - off GLNG MOF	Background	3	0.4	0.5	0.7
	Residual Dredge Placement Plume	6	0.6	3.4	6.5
Jacobs Channel - off Hamilton Point	Background	6	0.4	0.5	0.7
Tide Island MRA	Background	3	0.4	0.5	0.7
	Dredge Placement	9	0.5	2.3	4.7
Overall	**Background**	12	0.4	0.5	0.7
Overall	**Dredge-Related**	15	0.6	2.9	5.9
Overall	**All**	27	0.4	0.6	2.9

Note that no dispersant was added to the laboratory PSD samples

In general, the lab results for the background samples were characterised by finer particle sizes, predominately clay-sized with a median D50 particle size of 0.5 µm. Background measurements at both Jacobs Channel and the Tide Island MRA yielded similar results. Dredge-related samples were predominately silt-sized particles, with a median D50 particle size of 2.9 µm.

Dredge-related lab sample results showed distinctively bi-modal particle size distributions, with the first peak characteristic of background – centred about 0.5 µm, and the second peak centred about 3 – 8 µm. Dredge-related particle sizes were typically weighted towards this second coarser distribution, indicating that the material from the respective Jacobs Channel maintenance dredging activities is consistently dominated by higher proportions of silts.

Upon inspection of Figure 3.16 to Figure 3.21 it is evident that the *in situ* LISST profiling measurements show a significantly higher proportion of coarser particles, with a rightward shift of the particle size distributions relative to the laboratory measurements. This result indicates that in the field, the particles are in a flocculated state. Here, fine sediment particles (nominally finer than 63 µm) suspended in the marine environment tend to coalesce into "flocs" or aggregations of individual particles that behave physically like a larger-diameter, lower-density single particle. These flocs will settle much faster (by approximately an order of magnitude) than the individual constituent particles. These observations are consistent with other recent observations by Livsey *et al* (2022).

The LISST PSD analysis is likely measuring the characteristics of the flocs, whereas these flocs have been broken up into their finer constituent particles in the laboratory PSD analysis. The discrepancy between the LISST and laboratory PSD estimates is an indication that the fine sediment in suspension in the field tends to be aggregated into flocs and will therefore settle more rapidly than dispersed particles.

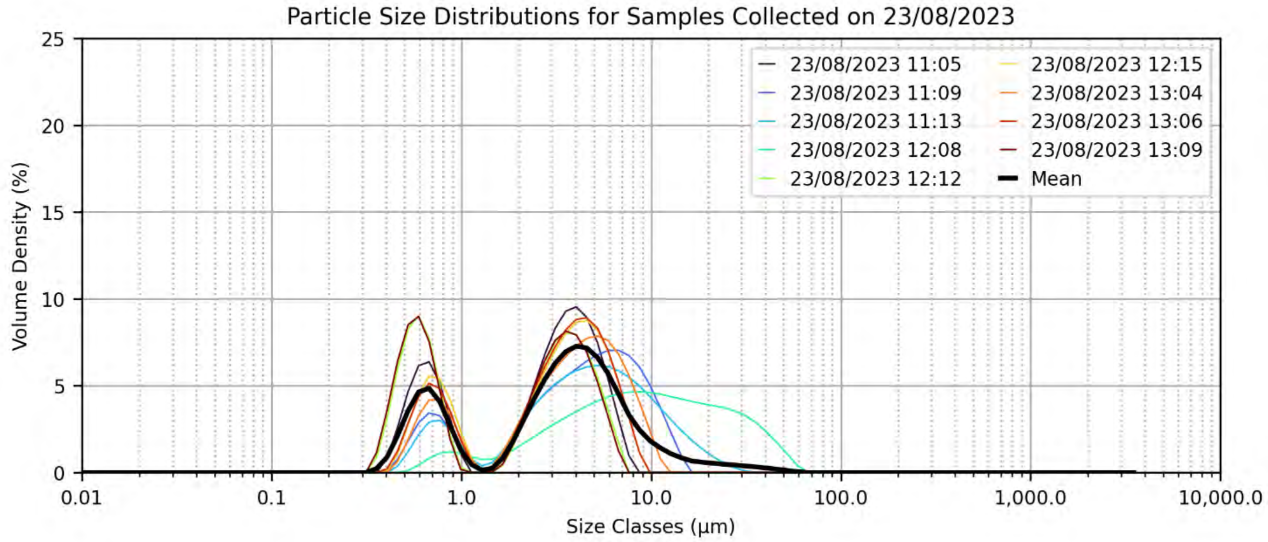


Figure 3.16 Laboratory Particle Size Distributions for all PSD Samples Collected on 23/08/2023

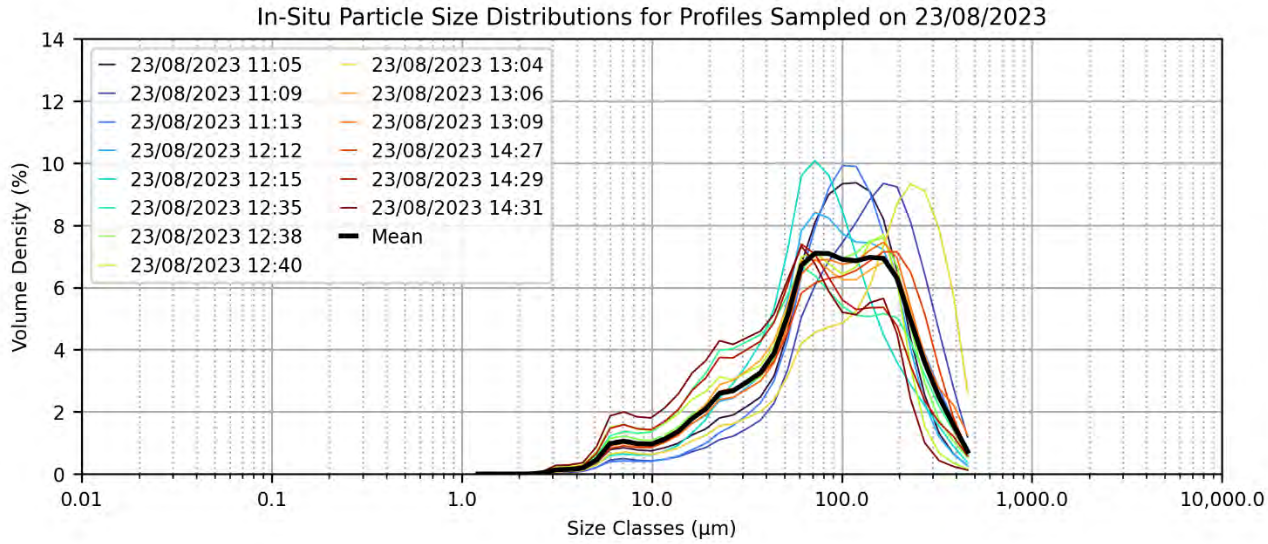


Figure 3.17 *In situ* LISST-200X Particle Size Distributions for all Measured Profiles on 23/08/2023

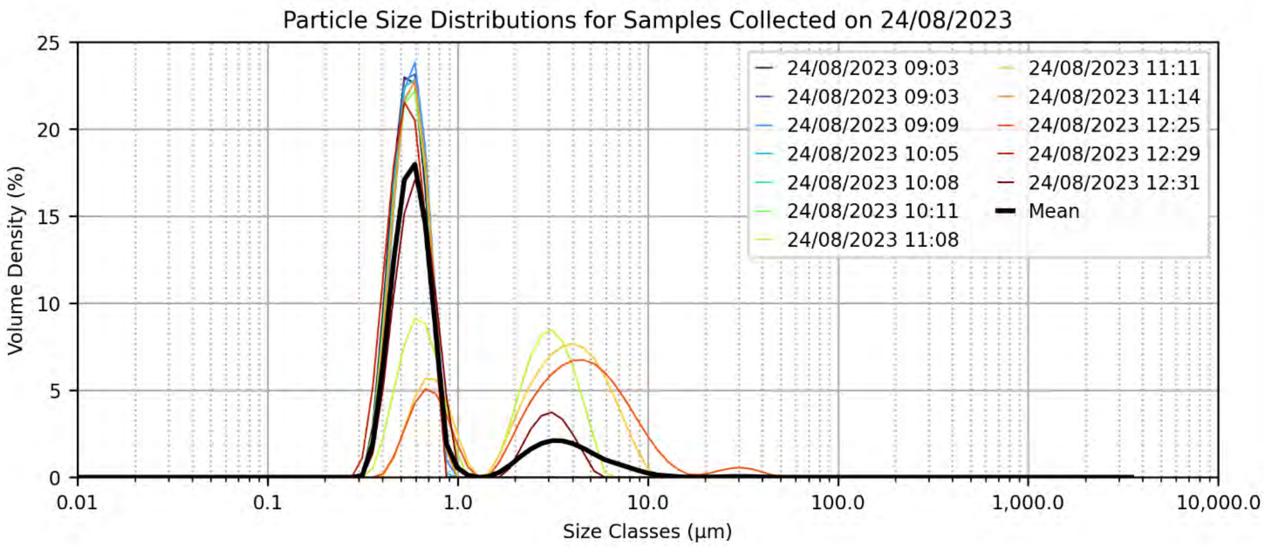


Figure 3.18 Laboratory Particle Size Distributions for all PSD Samples Collected on 24/08/2023

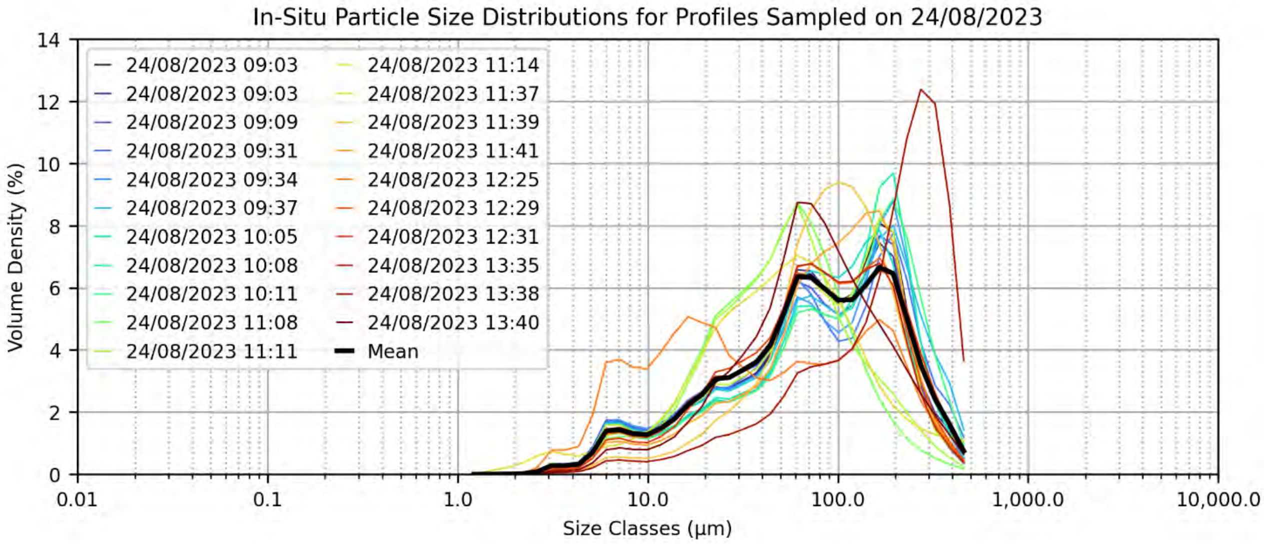


Figure 3.19 *In situ* LISST-200X Particle Size Distributions for all Measured Profiles on 24/08/2023

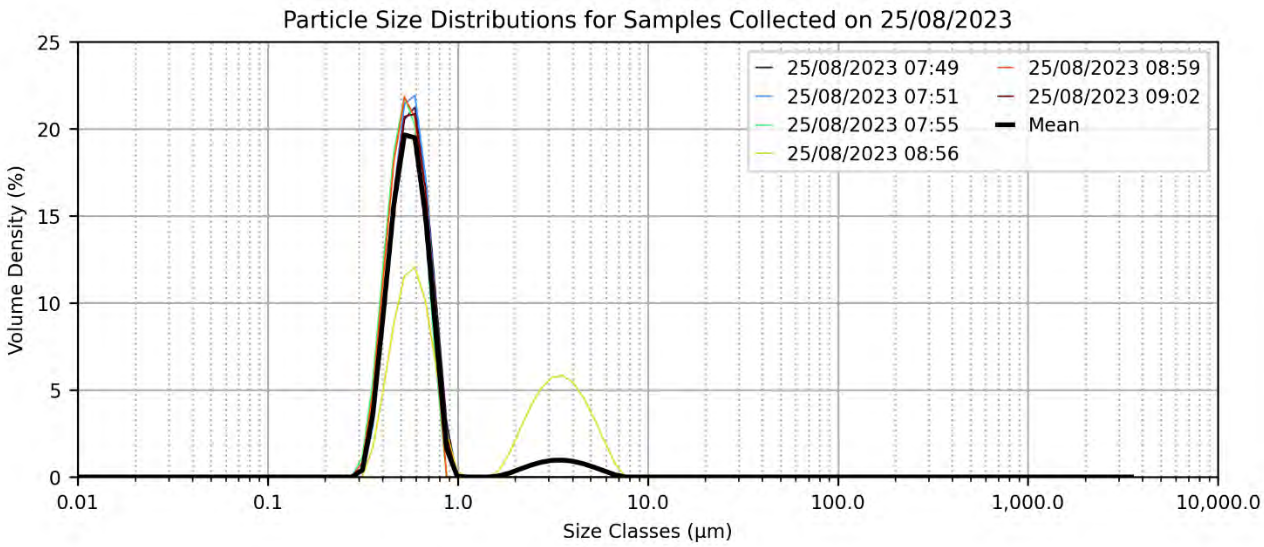


Figure 3.20 Laboratory Particle Size Distributions for all PSD Samples Collected on 25/08/2023

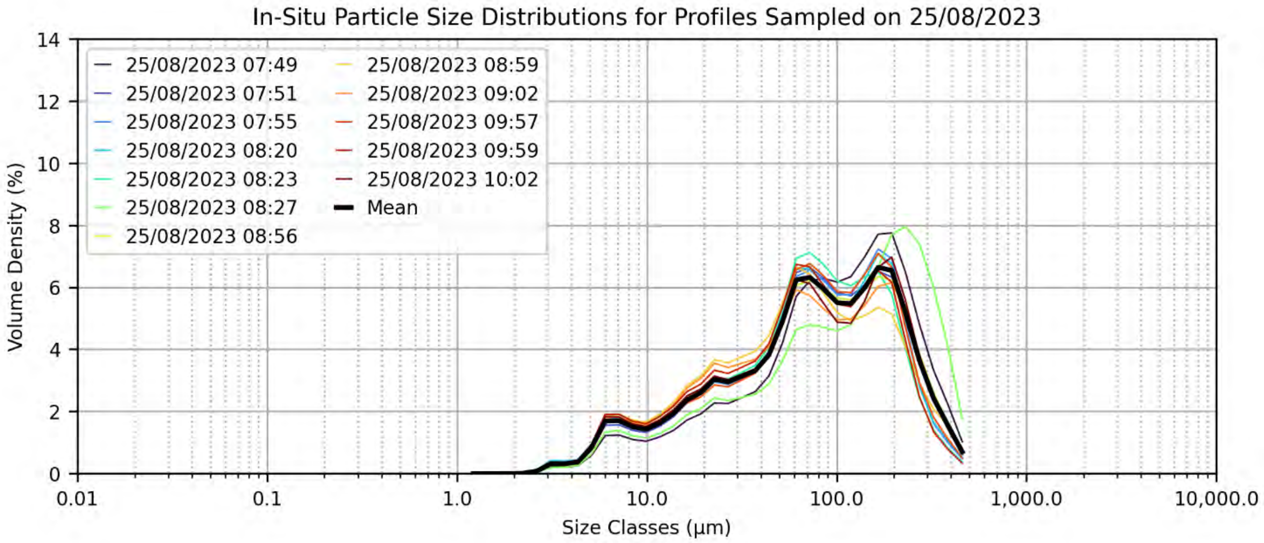


Figure 3.21 *In situ* LISST-200X Particle Size Distributions for all Measured Profiles on 25/08/2023

3.5 Turbidity Time Series

Fixed Deployments

The results of the turbidity measurement at two fixed locations to the north-west of the Tide Island MRA (T1) and to the south-east of the MRA (T2) are shown in Figure 3.22 (for locations, see Figure 1.2). The measurements at both sites do indicate an increase in the turbidity levels during the dredging period (9th August to 11th September) relative to the measured turbidity prior to the commencement of dredging, particularly during the spring tide period around 1st September. The magnitude of the spring tides in the period around 5th August were similar to those around the 1st September, and therefore in the absence of dredging the turbidity levels could be expected to be similar. The modelling results presented in the impact assessment report (BMT, 2023) indicated only a small increase in the 50th percentile of the depth-averaged turbidity (~1 NTU) and a small increase in the 95th percentile of the depth-averaged turbidity (~3 NTU) at those two locations. The TUFLOW FV numerical model of the Port of Gladstone was used to undertake a hindcast of the dredging activity to further investigate the cause of the elevated turbidity. For further analysis and discussion, see Sections 4 and 6.

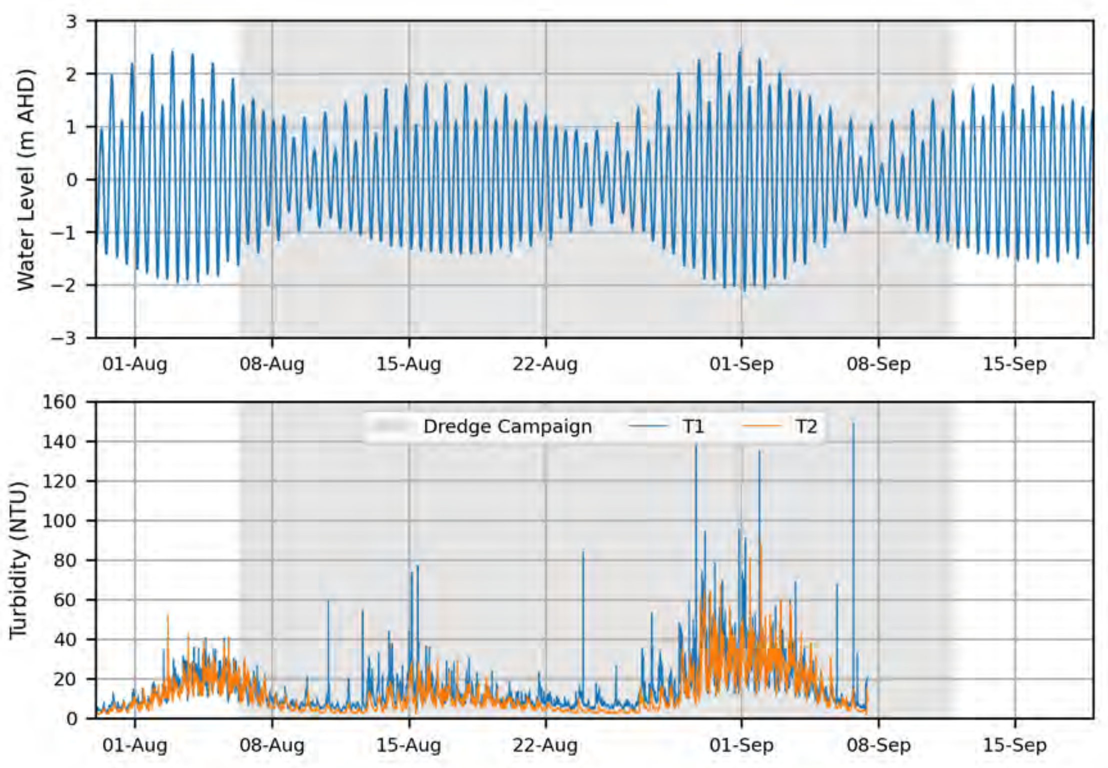


Figure 3.22 Fixed Turbidity Measurements at T1 and T2, near the Tide Island MRA (for locations, see Figure 1.2)

The measured near-surface turbidity at the long-term measurement sites MH10 and WB50 is shown in Figure 3.23 (for locations, see Figure 1.2). The plotted measurements are the mean of the measured values from two co-located turbidity measuring sondes. The measured turbidity at WB50 does appear to be elevated during the dredging activity, however only one of the two measurement sondes was available for most of the period and it was affected by fouling, so the measurement is not considered accurate during this period. The measured turbidity at MH10 was not higher than expected during the dredging activity.

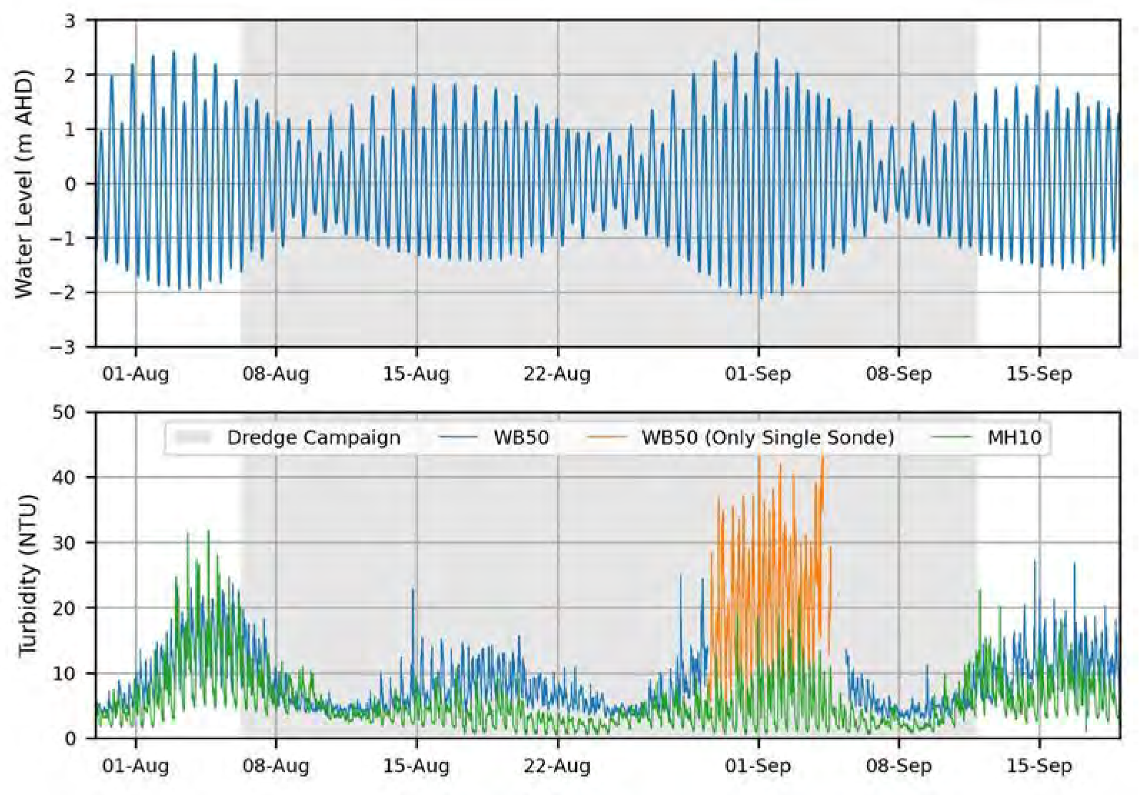


Figure 3.23 Fixed Turbidity Measurements at WB50 and MH10 (for locations, see Figure 1.2)

3.6 Water Quality Grab Samples

Water quality grabs results collected from plumes generated by the loading and placement activities on the 23/08/2023 and 24/08/2023 as described in Table 3.1 and Table 3.2 are summarised in Table 3.5 and Table 3.6 whilst results of background samples collected on the 25/08/2023 are shown in Table 3.7. Key findings include the following:

- Results were in line with findings of previous PoG maintenance dredging plumes studies particularly BMT (2018) and there were minimal differences between background (Table 3.7) and dredge loading and disposal activities samples (Table 3.5 and Table 3.6). BMT (2018) found dredging activities led to temporary (measured in 10's of minutes) increases in the concentrations of several total and dissolved metal(loid)s in the water column, especially at Jacobs Channel, but at all dredge and disposal sites concentrations of total and dissolved metal(loid)s rapidly declined over time (measured in 10s of minutes). Dissolved metal(lloid)s concentrations from plumes were either <LOR of below related DGVs;

- Nutrients: ammonia concentrations were higher than the corresponding WQOs in all samples. It is important to note that the LOR was also higher than guideline value, the same was true for Total N and in some instances Total P. The latter also exceeded the 0.029 mg/L WQO in all samples in particular on the 23rd and 25th August, in line with previous plume studies mentioned above;

- Chlorophyll *a* was equal or below LOR in all samples indicating that phytoplankton biomass achieved the WQO; and

- Metals and metalloids:

- All metals and metalloids were well below relevant guideline values or the LOR in all plume samples.
- Total aluminium, iron and manganese were detected in all samples.
- The dissolved fraction of aluminium, iron and manganese, which represents the most bioavailable component, was less than the LOR in most samples. The exception was dissolved aluminium which was detected in all samples on the 24/04/2023. This was inconsistent with results from this and previous plume studies at the Port of Gladstone, and may indicate laboratory error or sample contamination. The first possibility is supported by the fact that in several instances dissolved fraction results were higher than corresponding total results. In two background samples at the same site, copper levels were 5 µg/L corresponding to LOR and exceeding guideline value of 1.3 µg/L which could be due to laboratory accuracy especially considering that total concentrations were below LOR. However, similar values for this analyte have been recorded by the Port Curtis Integrated Monitoring Program (PCIMP, 2023).

Laboratory QA/QC results were reviewed to assess potential intra-laboratory analyses variation and laboratory contamination as well as methods precision and accuracy. The assessment of the laboratory duplicate report showed all duplicate results to be within acceptable Relative Percent Deviation (RPD). Moreover, method blank and Laboratory Control Samples (LCS) report showed no laboratory contamination with all added reagents <LOR and all spike recovery within acceptable limits respectively. In two samples collected on the 23rd and 25th August spike recovery for NOx and Ammonia respectively was not determined due to high background levels, however this is deemed low concern.

As most QC data was within the acceptable RPD/RSD ranges, the data presented in this report are of reliable quality. The likely exception was anomolous dissolved aluminium recorded on the 24/04/2023, as described aboove.

Table 3.5 Water quality grabs results from samples collected on the 23/08/2023

Parameter	Unit	LOR	GV	Site 1			Site 2			Site 3			Site 4			Site 5		
				Flood Tide			Flood Tide			Flood Tide			Ebb Tide			Ebb Tide		
		Depth interval		Top	Mid	Near-Bed	Top	Mid	Near-Bed	Top	Mid	Near-Bed	-*	-*	-*	Top	Mid	Near-Bed
TSS, Nutrients, Chlorophyll[1]																		
Total Suspended Solids (TSS)	mg/L	5	-	5	12	32	12	14	46	12	<5	44	13	15	8	8	6	20
Total Organic Carbon (TOC)	mg/L	1	-	1	2	2	2	2	2	2	1	1	2	2	1	1	1	2
Chlorophyll-a	µg/L	1	2	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Ammonia	mg/L	0.01	0.008	0.02	0.02	0.02	0.07	0.02	0.03	0.01	0.03	0.04	0.04	0.02	0.02	0.02	0.02	0.03
Nitrate	mg/L	0.01	-	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite	mg/L	0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NOx	mg/L	0.01	0.016	<0.01	<0.01	<0.01	<0.01	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Kjeldahl Nitrogen	mg/L	0.1	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Nitrogen	µg/L	0.1	0.21	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Phosphorus	mg/L	0.01	0.029	0.09	0.08	0.06	0.08	<0.05	0.10	0.08	0.09	0.11	0.08	0.07	0.09	0.06	<0.05	0.06
Reactive Phosphorus	mg/L	0.01	0.007	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Metals and Metalloids[2]																		
Aluminium	µg/L	10	-	190	----	430	1590	300	150	200	2450	3360	340	470	410	170	220	360
Arsenic	µg/L	1	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	µg/L	0.1	5.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/L	1	4.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Copper	µg/L	1	1.3	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Iron	µg/L	50	-	250	----	590	2250	310	200	270	1910	3820	450	600	530	240	300	500
Lead	µg/L	1	4.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Manganese	µg/L	1	80	8	----	12	49	8	6	8	32	70	11	13	12	7	8	19
Nickel	µg/L	1	70	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Silver	µg/L	1	1.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zinc	µg/L	5	8	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Mercury	µg/L	0.1	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dissolved Metals and Metalloids[2]																		
Aluminium	µg/L	10	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Arsenic	µg/L	1	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	µg/L	0.1	5.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/L	1	4.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Copper	µg/L	1	1.3	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Iron	µg/L	50	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Lead	µg/L	1	4.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Manganese	µg/L	1	80	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	5
Nickel	µg/L	1	70	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Silver	µg/L	1	1.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zinc	µg/L	5	8	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Mercury	µg/L	0.1	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

1 EPP (Water and Wetland Biodiversity) guideline values / 2 ANZG (2018) guideline values, 95th %tile marine species protection

Orange shading = guideline exceeded / Yellow shading = guideline exceeded due to LOR > GV

*no depth was recorded due to multiparameter sonde malfunction

Table 3.6 Water quality grabs results from samples collected on the 24/08/2023

Parameter	Unit	LOR	GV	Site 1		Site 2			Site 3			Site 4			Site 5			Site 6			Site 7		
				Flood Tide		Flood Tide			Flood Tide			Flood Tide			Flood Tide			Flood Tide			Flood Tide		
			Depth interval	Top	Near-Bed	Top	Mid	Near-Bed	Top	Mid	Near-Bed	Top	Mid	Near-Bed	Top	Mid	Near-Bed	Top	Mid	Near-Bed	Top	Mid	Near-Bed
TSS, Nutrients, Chlorophyll[1]																							
Total Suspended Solids (TSS)	mg/L	5	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	5	34	10	22	278	72	<5	13	<5	6	12
Total Organic Carbon (TOC)	mg/L	1	-	1	1.5	<1	<1	1	2	1	1	<1	1	1	1	1	1	1	<1	1	<1	1	2
Chlorophyll-a	µg/L	1	2	1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<2	<2	<1	<1	<1	<1	<1
Ammonia	mg/L	0.01	0.008	0.01	0.01	0.01	0.01	0.03	0.03	0.01	0.02	0.04	0.02	<0.01	0.02	0.02	0.02	0.01	0.01	0.01	<0.01	<0.01	<0.01
Nitrate	mg/L	0.01	-	0.12	0.035	0.05	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	0.04	<0.01	0.16	0.04	0.08	<0.01	0.10	0.22	0.25	0.18	0.06
Nitrite	mg/L	0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NOx	mg/L	0.01	0.016	0.12	0.035	0.05	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	0.04	<0.01	0.16	0.04	0.08	<0.01	0.10	0.22	0.25	0.18	0.06
Total Kjeldahl Nitrogen	mg/L	0.1	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Nitrogen	µg/L	0.1	0.21	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Phosphorus	mg/L	0.01	0.029	0.07	0.05	<0.05	<0.05	<0.05	<0.05	0.38	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Reactive Phosphorus	mg/L	0.01	0.007	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Metals and Metalloids[2]																							
Aluminium	µg/L	10	-	250	200	160	180	100	170	110	150	130	170	210	1670	560	120	410	90	110	460	230	430
Arsenic	µg/L	1	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	µg/L	0.1	5.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/L	1	4.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Copper	µg/L	1	1.3	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Iron	µg/L	50	-	120	155	90	130	160	150	180	220	200	270	300	2130	860	110	750	140	170	630	230	610
Lead	µg/L	1	4.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Manganese	µg/L	1	80	7	7	7	7	9	8	10	10	9	7	28	49	8	6	14	14	10	18	10	18
Nickel	µg/L	1	70	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Silver	µg/L	1	1.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zinc	µg/L	5	8	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Mercury	µg/L	0.1	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dissolved Metals and Metalloids[2]																							
Aluminium	µg/L	10	-	60	65	50	70	70	100	90	210	170	370	130	170	160	140	140	140	140	130	120	<10
Arsenic	µg/L	1	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	µg/L	0.1	5.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/L	1	4.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Copper	µg/L	1	1.3	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Iron	µg/L	50	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Lead	µg/L	1	4.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Manganese	µg/L	1	80	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Nickel	µg/L	1	70	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Silver	µg/L	1	1.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zinc	µg/L	5	8	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Mercury	µg/L	0.1	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

1 EPP (Water and Wetland Biodiversity) guideline values
2 ANZG (2018) guideline values, 95th %tile marine species protection
Orange shading = guideline exceeded
Yellow shading = guideline exceeded due to LOR > GV

Table 3.7 Water quality grabs results from samples collected on the 25/08/2023

Parameter	Unit	LOR	GV	Site 1		Site 2			Site 3			Site 4		
				Ebb Tide		Ebb Tide			Flood Tide			Flood Tide		
		Depth interval		Top	Near-Bed	Top	Mid	Near-Bed	Top	Mid	Near-Bed	Top	Mid	Near-Bed
TSS, Nutrients, Chlorophyll[1]														
Total Suspended Solids (TSS)	mg/L	5	-	14	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Total Organic Carbon (TOC)	mg/L	1	-	1	1	1	<1	<1	<1	<1	<1	<1	<1	<1
Chlorophyll-a	µg/L	1	2	<1	1	1	<1	<1	1	<1	2	1	2	<1
Ammonia	mg/L	0.01	0.008	0.05	0.03	0.04	0.043	0.04	0.07	0.03	0.03	0.02	0.03	0.03
Nitrate	mg/L	0.01	-	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrite	mg/L	0.01	-	<0.01	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NOx	mg/L	0.01	0.016	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Kjeldahl Nitrogen	mg/L	0.1	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Nitrogen	µg/L	0.1	0.21	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Total Phosphorus	mg/L	0.01	0.029	0.07	0.09	0.06	0.065	0.06	0.07	0.06	0.08	0.09	0.08	0.07
Reactive Phosphorus	mg/L	0.01	0.007	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Metals and Metalloids[2]														
Aluminium	µg/L	10	-	400	400	480	610	620	1020	620	400	410	2800	660
Arsenic	µg/L	1	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	µg/L	0.1	5.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/L	1	4.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Copper	µg/L	1	1.3	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Iron	µg/L	50	-	220	250	80	170	220	140	270	270	100	80	550
Lead	µg/L	1	4.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Manganese	µg/L	1	80	7	7	7	6.6	8	9	9	8	7	7	13
Nickel	µg/L	1	70	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Silver	µg/L	1	1.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zinc	µg/L	5	8	<26	<26	<26	<26	<26	<26	<26	<26	<26	<26	<26
Mercury	µg/L	0.1	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Dissolved Metals and Metalloids[2]														
Aluminium	µg/L	10	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Arsenic	µg/L	1	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Cadmium	µg/L	0.1	5.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Chromium	µg/L	1	4.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Copper	µg/L	1	1.3	5	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Iron	µg/L	50	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Lead	µg/L	1	4.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Manganese	µg/L	1	80	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Nickel	µg/L	1	70	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Silver	µg/L	1	1.4	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zinc	µg/L	5	8	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
Mercury	µg/L	0.1	0.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

1 EPP (Water and Wetland Biodiversity) guideline values
2 ANZG (2018) guideline values, 95^{th} %tile marine species protection
Orange shading = guideline exceeded
Yellow shading = guideline exceeded due to LOR > GV

4 August 2023 Hindcast Modelling

4.1 Model Description and Boundary Conditions

Numerical Model

The TUFLOW FV Port of Gladstone model was used to undertake a hindcast simulation of the three-dimensional hydrodynamics of the Port and the advection and dispersion of suspended sediment (both the ambient sediment and the plumes generated during dredging). The model configuration is the same as that which was used for the impact assessment of the Tide Island MRA placement activity (BMT, 2023). The dredging log from the TSHD Brisbane was analysed to develop boundary conditions for the dredging-related inputs, and the model was used to simulate the dredging campaigns in full so that the modelled turbidity level could be compared to the measured turbidity at the fixed measurement locations (described in Section 3.5).

The coarse regional PoG model mesh and the high-resolution local nested model mesh is presented in Figure 4.1. The model bathymetry reflects the most recent survey data including updates following the completion of the CVIP dredging project.

Model Bathymetry

The model bathymetry is based on a DEM of PoG, which has been derived from the following survey components:

- Detailed hydrographic survey data of the dredged channels, swing basins and berths as provided by Maritime Safety Queensland (MSQ) and GPC, together with the progressive inclusion of ongoing surveys to ensure that the model bed levels match the actual bathymetric configuration at the time of the simulation period.
- Hydrographic survey data and outlines of the edges of the shoreline, mangroves and saltpans used in producing Boating Safety Charts of the area, as provided by MSQ.

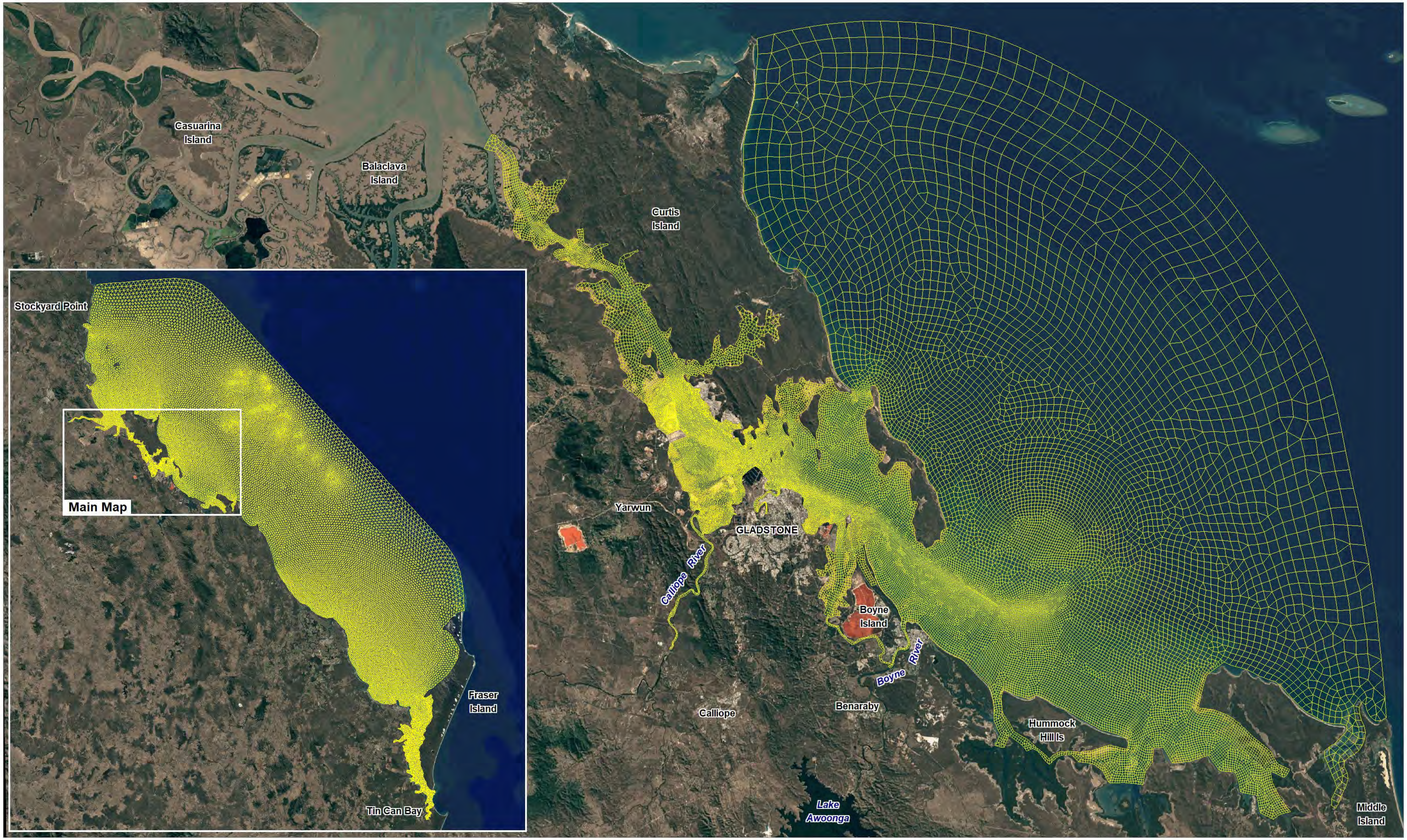
Typical levels were adopted for the edges of the mangroves and saltpan areas for interpolation in those upper inter-tidal zones where no specific survey level data is available. The various data components have been combined and prioritised with respect to date and detail where there is overlap in producing a base DEM. For modelling purposes, all data has been adjusted to a consistent mean sea level datum.

Boundary Conditions

The regional scale model is supplied with external water level boundary conditions from a global tidal model (FES22). The nested high-resolution local model is coupled with the regional model to provide detailed results within the Port.

A SWAN spectral wave model provides the influence of waves on the sediment dynamics (Delft University of Technology 2006). Wave model outputs were input as a boundary condition for the TUFLOW FV model to enable the calculation of total bed shear stresses.

Due to the large scale of the model, regional oceanic effects needed to be incorporated in the offshore open ocean boundary conditions. This was done using HYCOM global ocean circulation model hindcast outputs (www.hycom.org). This model provided 3D current, salinity and temperature data which was applied on the ocean boundary in combination with the tidal water level variation.



LEGEND

Model mesh

Satellite imagery:
Google Earth December 2016
Image Landsat / Copernicus

Title:

Regional Coarse Model Mesh (Inset) and Local Nested Model Mesh

Figure: **4.1**

Rev: **B**

BMT endeavours to ensure that the information provided in this map is correct at the time of publication. BMT does not warrant, guarantee or make representations regarding the currency and accuracy of information contained in this map.

N

0 6 12
Main Map (km)

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Further boundary conditions were also applied to the model to represent atmospheric influences. These boundary conditions were derived from the National Centers for Environmental Predictions (NCEP) Climate Forecast System Reanalysis (CFSR) (www.ncep.noaa.gov) and included wind, temperature, humidity, short and long wave radiation, which were applied on a spatially varying grid throughout the model domain with a temporal resolution of one (1) hour.

Model Validation for Water Levels and Current Velocities

The TUFLOW FV numerical model used for the purposes of this study has evolved from previous PoG models which have been progressively updated, refined and calibrated over many years using a large number of recorded water level, wave and current velocity measurements.

The most recent set of model calibration and validation results are available in the report titled Post-CVIP Port of Gladstone TUFLOW FV Model Validation (BMT 2021b).

4.2 Model Scenarios and Parameterisation

The numerical model was run from 15/07/2023 to 30/09/2023 in order to simulate the hydrodynamics and sediment dynamics during the period, including the effects of the maintenance dredging campaign. In order to include the dredging plume sources in the model, the detailed log of dredging activity for the TSHD *Brisbane* was analysed and a sediment source was added to the model at the dredger location at each timestep depending on the mode of operation of the dredge at that time. The plume release rates that were applied were the same as those used in the impact assessment report for the alternative placement activity (BMT, 2023). The rate of release of sediment of each size class (sand, silt, clay) for the dredging activities in the Jacobs Channel swing basins (GLNG, QCLNG and APLNG) and for the placement activities at Tide Island MRA are provided in Table 4.1.

Table 4.1 Dredging Plume Generation Rates (From BMT, 2023)

Area	Pre-Overflow Dredge Load [kg/s]			Overflow Dredge Load [kg/s]			Placement into Water Column [kg/s]			Placement onto Seabed [kg/s]		
	Sand	Silt	Clay	Sand	Silt	Clay	Sand	Silt	Clay	Sand	Silt	Clay
GLNG	0	8	4	11	49	24	27	93	46	1321	836	418
QCLNG	0	10	5	7	62	31	19	117	59	955	1056	528
APLNG	0	7	3	5	42	21	21	112	56	1033	1007	503

The percentage of the total hopper load that was assumed to be released as a ‘passive plume’ in the water column ranged from 6.1% to 7.1%.

The modelled level of suspended sediment in the water column was compared to the measured turbidity at each of the fixed monitoring locations. The modelled TSS was converted to an equivalent turbidity by dividing by the factor 1.6 (according to an empirical relationship observed in previous studies, see BMT 2019), and adding a small fixed offset factor of 5 NTU to allow for non-sediment sources of turbidity.

Figure 4.2 shows the near-bed modelled and measured turbidity at sites T1 and T2, the measurement locations upstream and downstream of the Tide Island MRA (see Figure 1.2 for locations). The modelled turbidity is significantly lower than the measured turbidity, both in the period before the commencement of dredging and during the dredging campaign itself.

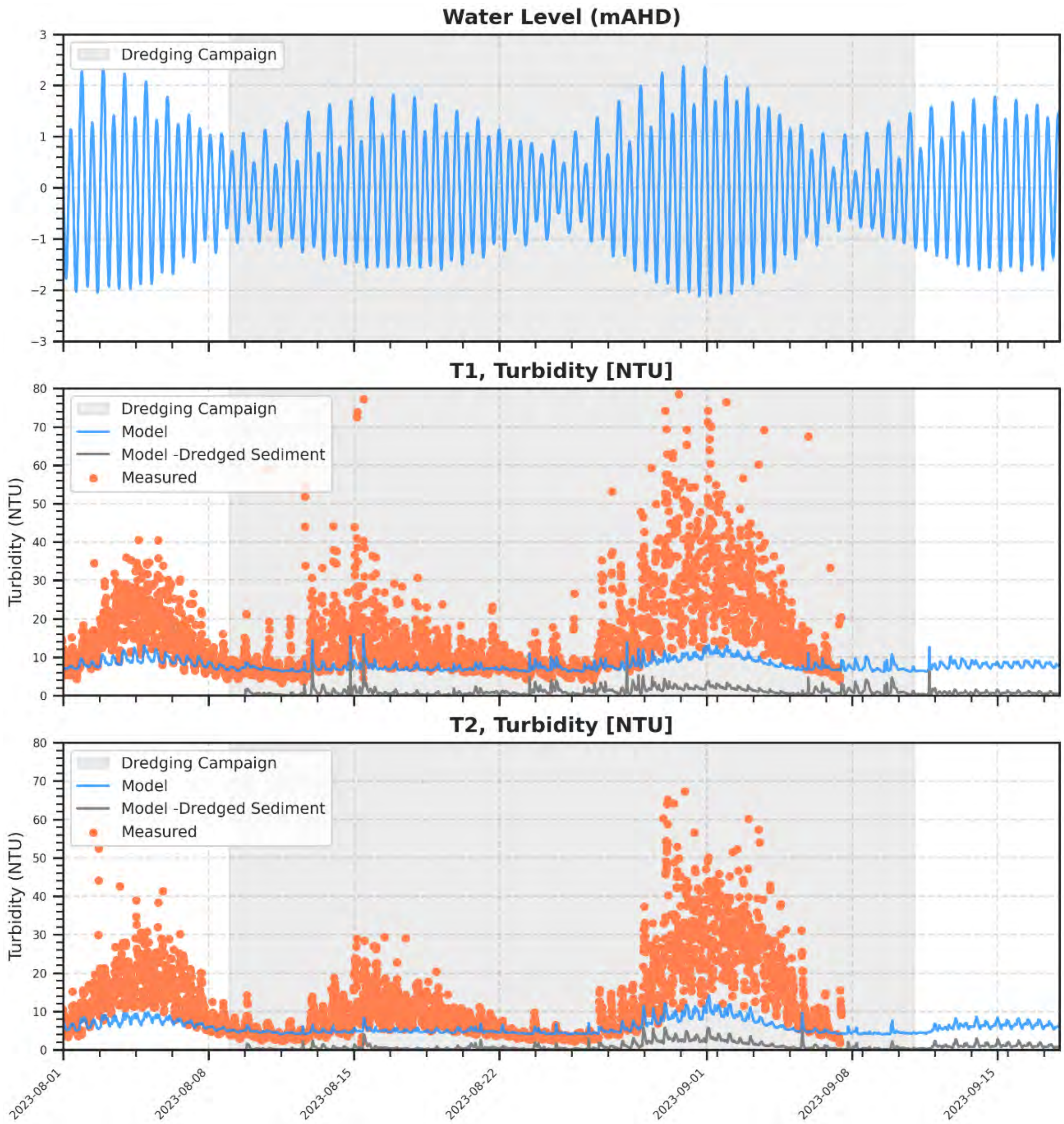

Figure 4.2 Comparison of modelled turbidity with near-bed turbidity measurements from T1 and T2. Instrument locations are shown in Figure 1.2. The top panel shows water levels (mAHD).

Figure 4.3 shows the time series of the near-surface modelled and measured turbidity at the MH10 and WB50 sites (see Figure 1.2 for locations). Again, the modelled turbidity is significantly lower than the measured turbidity, both before the commencement of dredging and during the dredging campaign. Note that at WB50 for part of the dredging campaign (green dots in Figure 4.3) there was only one of the two measurement sondes recording, and there is evidence that it was fouled (and therefore unreliable) since there was a sudden jump in the measured turbidity.

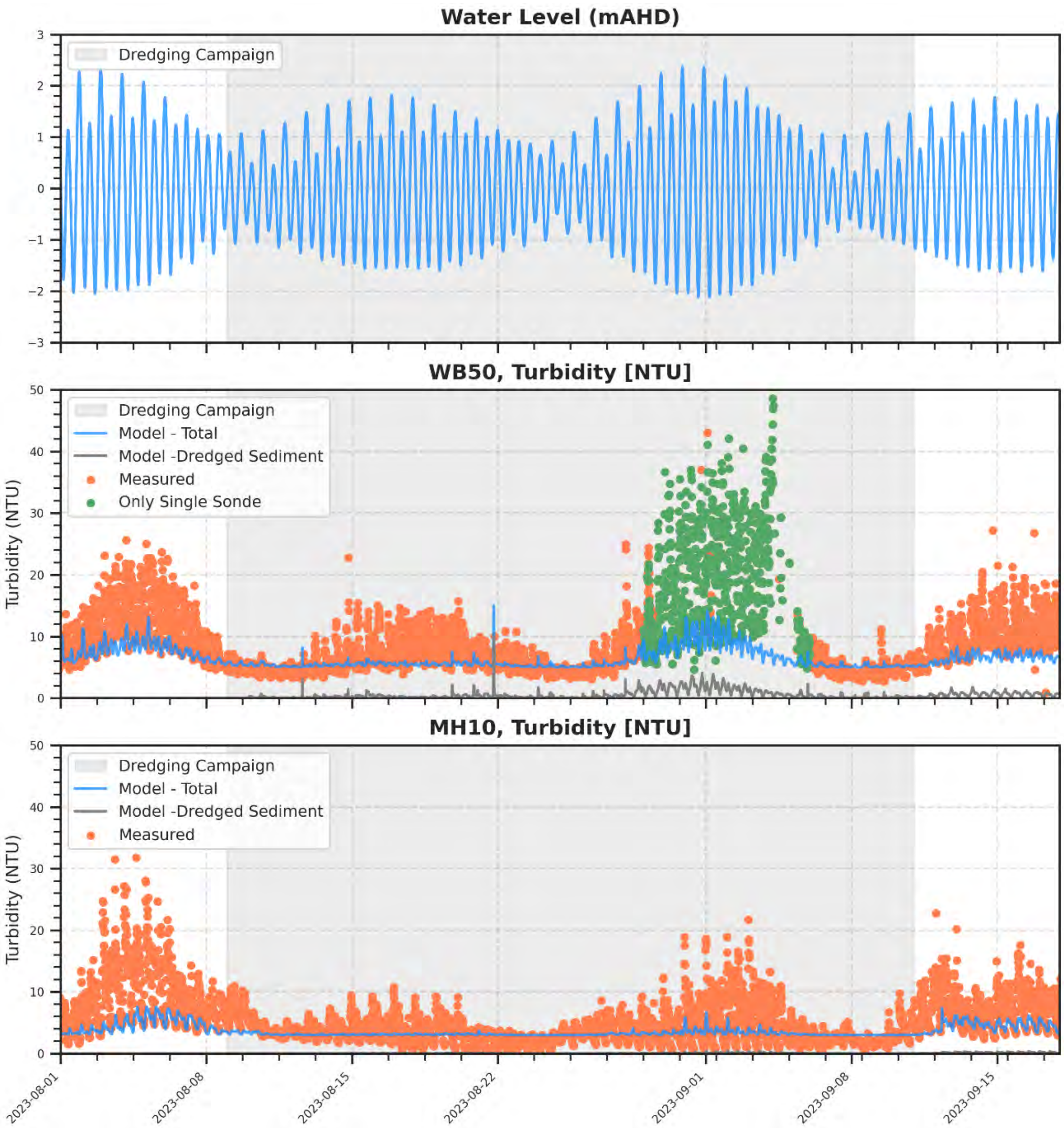

Figure 4.3 Comparison of modelled turbidity with near-surface turbidity measurements from MH10 and WB50. Instrument locations are shown in Figure 1.2. The top panel shows water levels (mAHD).

In order to improve the accuracy of the modelled turbidity, the erosion rate constant *Er* in the formula for sediment pickup in the model was increased from 0.05 to 0.24. The Mehta model (also commonly known as the Partheniades Formula) is a simple shear stress excess formula used to calculate the erosion flux from bed layer to the water column:

$$F_e = Er\ (\tau_{b,cw}/\tau_{ce} - 1)^{\alpha}$$

where: *Er* is the erosion rate constant (g/m^{2}s), $\tau_{b,cw}$ is combined bed shear stress due to currents and waves (N/m^2), τ_{ce} is critical shear stress for erosion (N/m^2) and α is a power coefficient. Table 4.2 shows the parameterisation adopted for the initial 01 simulation (as per the original impact assessment) and the revised 02 simulation. The erosion rate constant was increased for both the ambient sediment fractions and the dredging-related sediment fractions.

Table 4.2 Model Simulations and Parameterisation

ID	Bed Roughness		Sediment Erosion Rate Constant	
	Hydrodynamic	Wave	Ambient	Dredging
01	0.005	0.003	0.05	0.05
02	0.005	0.003	0.24	0.24

Figure 4.4 compares the modelled and observed turbidity levels at the near-bed at measurement locations T1 and T2 for Simulation 02. The modelled turbidity level in this simulation is much closer to the level of measured turbidity, both before dredging and during the dredging campaign. However, the modelled turbidity during the spring tide period in the latter part of the dredging campaign is significantly lower than the measured turbidity. There is no evidence that the turbidity sensors were fouled, so it is likely that these is some underestimation of the dredging-related turbidity sources in the model.

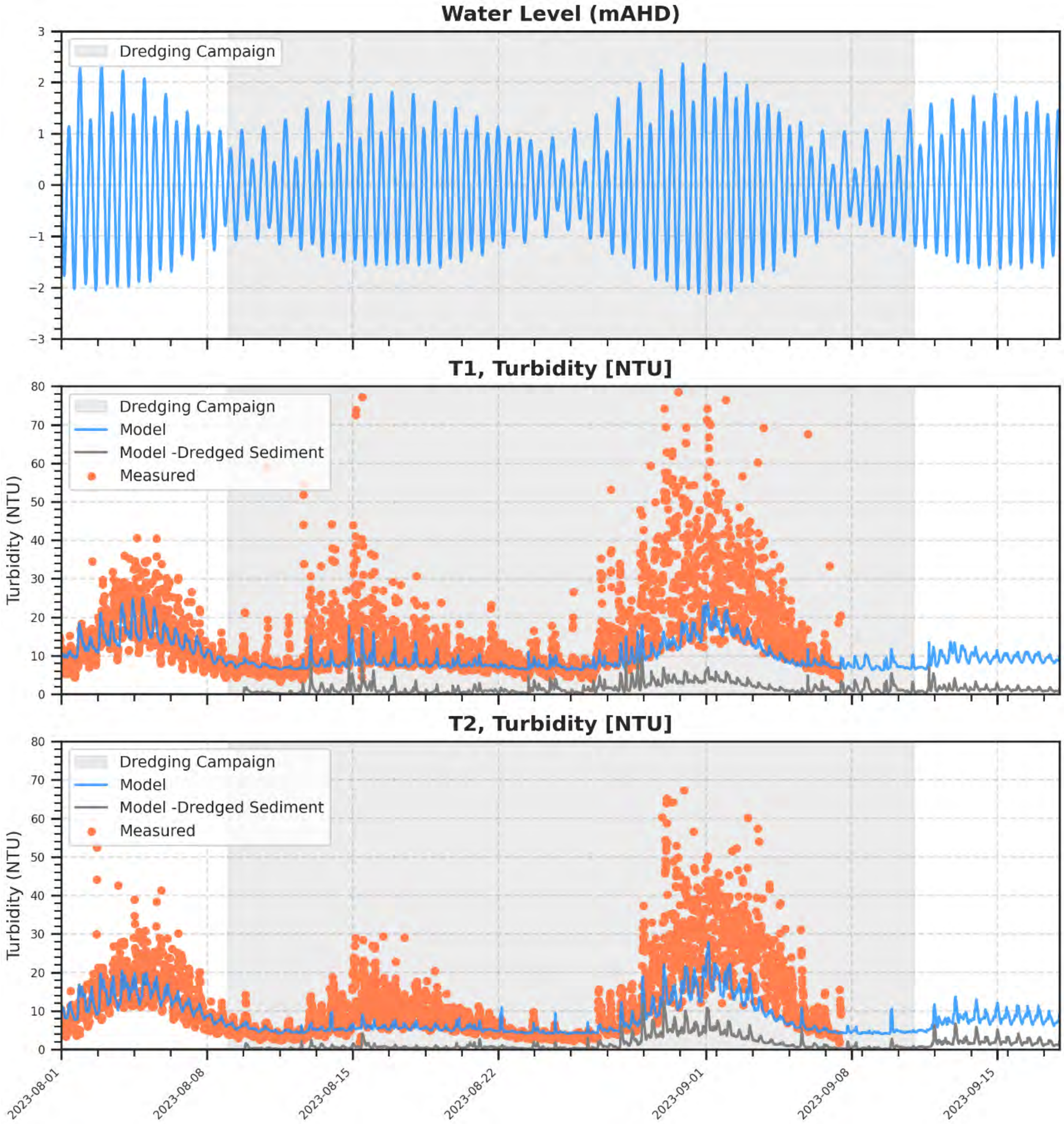

Figure 4.4 Comparison of modelled turbidity with near-bed turbidity measurements from T1 and T2. Instrument locations are indicated in Figure 1.2. The top plot shows water levels (mAHD).

Figure 4.5 shows the modelled and measured turbidity levels at the near-surface at measurement locations WB50 and MH10. WB50 is located approximately 1km from the Tide Island MRA, while MH10 is approximately 7km away (see Figure 1.2 for locations). The agreement between the modelled and measured turbidity is improved relative to the original simulation, both before dredging and during the dredging campaign. The modelled turbidity tends to show less variation in magnitude from tide to tide than the measurements, and underestimates the magnitude overall during the dredging campaign. Note, though, that at the WB50 location some of the data is unreliable since the one remaining measurement sonde was fouled (see Section 3.5).

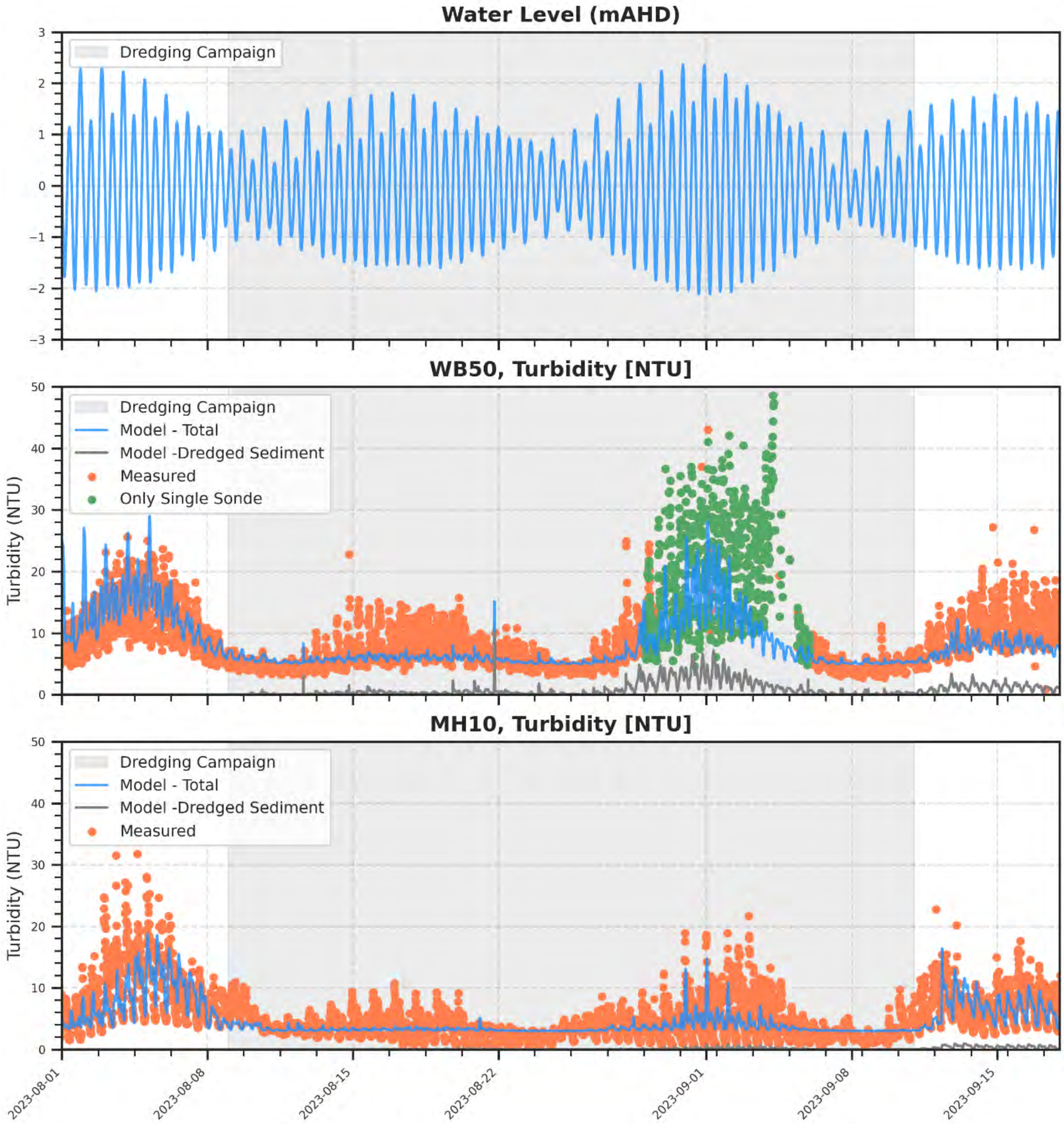

Figure 4.5 Comparison of modelled turbidity with near-surface turbidity measurements from MH10 and WB50. Instrument locations are indicated in Figure 1.2. The top plot shows water levels (mAHD).

The observed underestimation of turbidity levels by the model could be explained by a number of different mechanisms:

- Underestimation of the plume release rate during placement;
- Higher erodibility of dredged sediment after placement relative to ambient sediment, leading to higher rates of resuspension and higher dredging-related turbidity; or
- Fouling of the turbidity measurement sonde at WB50, leading to overestimation of turbidity

It is difficult to estimate the relative contribution of each of these mechanisms to the observed discrepancy. The issues are discussed in more detail in Section 6.

5 December 2024 Campaign Monitoring Results

5.1 TSS and Turbidity Relationship

Figure 5.1 shows the relationship between turbidity and TSS from background and plume samples generated by TSHD *Brisbane* collected at the loading sites and the Tide Island MRA across the three-day monitoring campaign. There was a significant ($p<0.05$) positive linear relationship between turbidity and TSS, with 100% of variation in TSS explained by the linear regression model. The full set of laboratory TSS results is provided in Annex A.

The linear slope parameter is higher than, but broadly consistent with, previous relationships observed in Gladstone ($y = 1.60\ x + 0$). The differences here potentially reflect both the broader range (i.e., higher concentrations) of TSS measured and differences in dredged material properties between campaigns (for example, different areas being dredged).

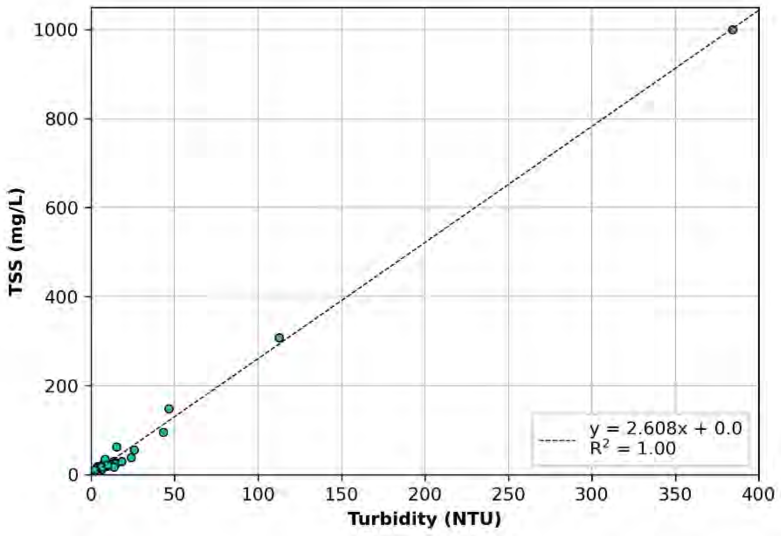

Figure 5.1 Water Sample TSS and Turbidity Correlation Plot

5.2 TSS and Volumetric Backscatter Relationships

As described in Section 2.3, conversion of the Nortek VM ADCP volumetric backscatter to TSS was carried out using a derived relationship linking the inferred YSI TSS measurement (adopting the relationship shown in Figure 3.1) and the concurrent backscatter at the corresponding ADCP bin. Based on acoustic theory, a log-linear model was fitted to produce the ADCP suspended sediment concentration relationship. The relationship derived over the full monitoring campaign shown in Figure 5.2.

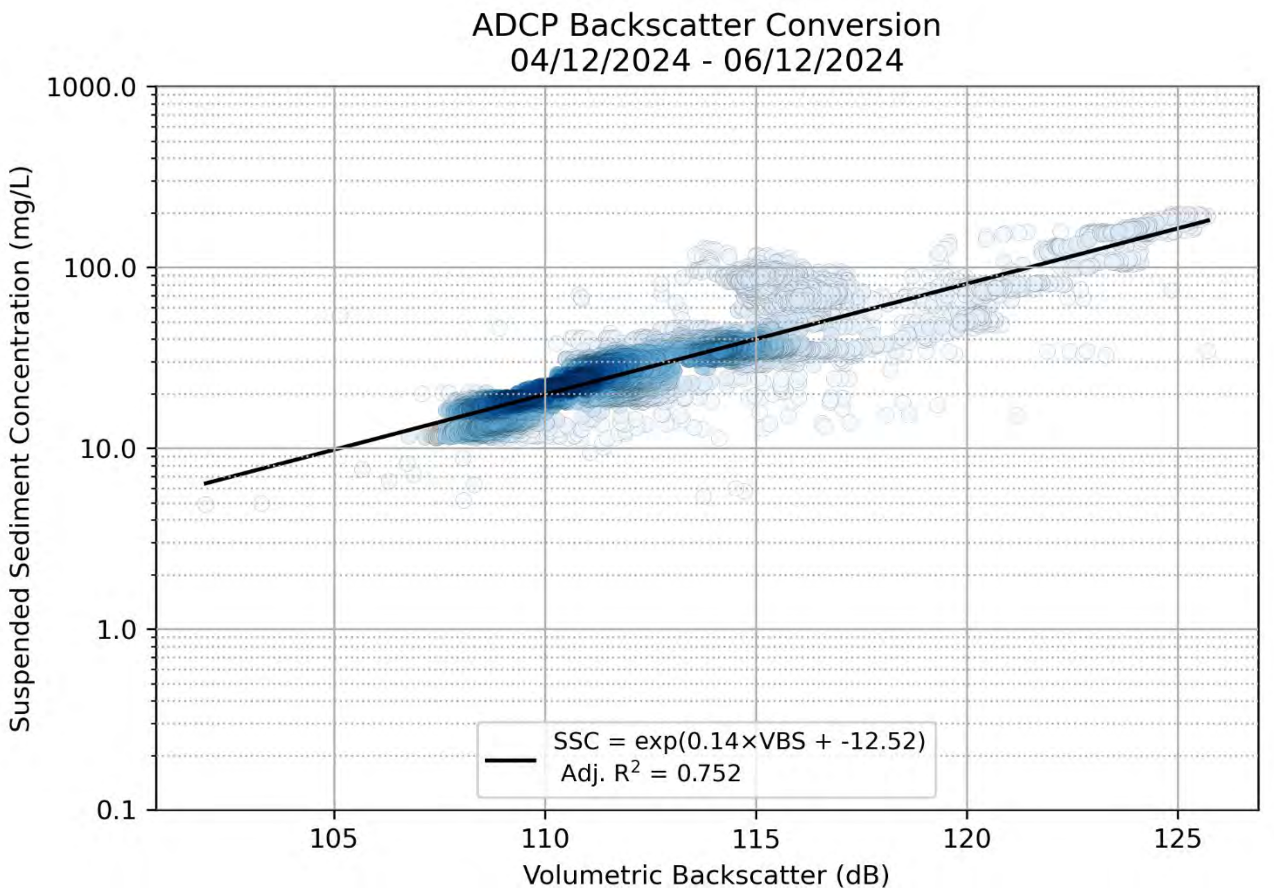

Figure 5.2 ADCP Volumetric Backscatter and Predicted Suspended Sediment Concentration for Sampling Conducted over 04/12/2024 – 06/12/2024. Colour Scale is Based on Sampling Point Density (Darker = More Points)

5.3 Plume Monitoring

04/12/2024 – Tide Island MRA

The TSHD *Brisbane* was monitored whilst placing material at the Tide Island MRA from 8:41 – 13:30 on 04/12/2024 during both flooding and ebbing tides, with high tide occurring at 10:50. Dredging was carried out in the Jacobs Channel APLNG swing basin. A summary of the *Brisbane* dredge activity over the course of the monitoring period is shown in Table 5.1.

Table 5.1 Summary of Dredge Cycle Activity During Monitoring on 04/12/2024

Cycle No.	Dredging Site	Dredging Start	Dredging End	Placement Site	Placement Start	Placement End
1	APLNG Swing Basin	04/12/2024 07:46	04/12/2024 8:39	Tide Island MRA	04/12/2024 09:05	04/12/2024 09:09
2	APLNG Swing Basin	04/12/2024 09:35	04/12/2024 10:15	Tide Island MRA	04/12/2024 10:40	04/12/2024 10:45

Weather at the time of monitoring was overcast, with winds 15 km/h from ENE at 09:00 and 15 km/h from NE at 15:00.

Figure 5.3 to Figure 5.5 present a sequence of transects measuring the placement plume at the Tide Island MRA for the placement event conducted over 10:33 – 11:01 (Cycle No. 2, Table 5.1) approaching high tide. Velocities were generally heading towards the WNW at ~0.1 – 0.4 m/s with the flooding tide.

With the arrival of the *Brisbane* and the subsequent placement shown in Figure 5.3, the sediment plume occupied the whole water column with suspended sediment concentrations in excess of 200 mg/L (chainage 1200-1400m). Following the 5-minute placement period, Figure 5.4 shows the spreading sediment plume as it was advected upstream with the flooding tide. Plume concentrations within the bulk of the plume remained in excess of 200 mg/L.

Figure 5.5 shows the remnants of the plume at around 15 minutes after the start of placement, with concentrations in a few areas reaching 200 mg/L, showing higher concentrations at the bed as the plume settled out of the water column.

The full set of ADCP transects for monitoring conducted on 04/12/2024 are presented in Annex M. Depth-averaged suspended sediment concentrations for all ADCP tracks collected over the course of monitoring conducted on 04/12/2024 are presented in Figure 5.6. The plume extents show good agreement with the predicted zone of influence (BMT, 2023).

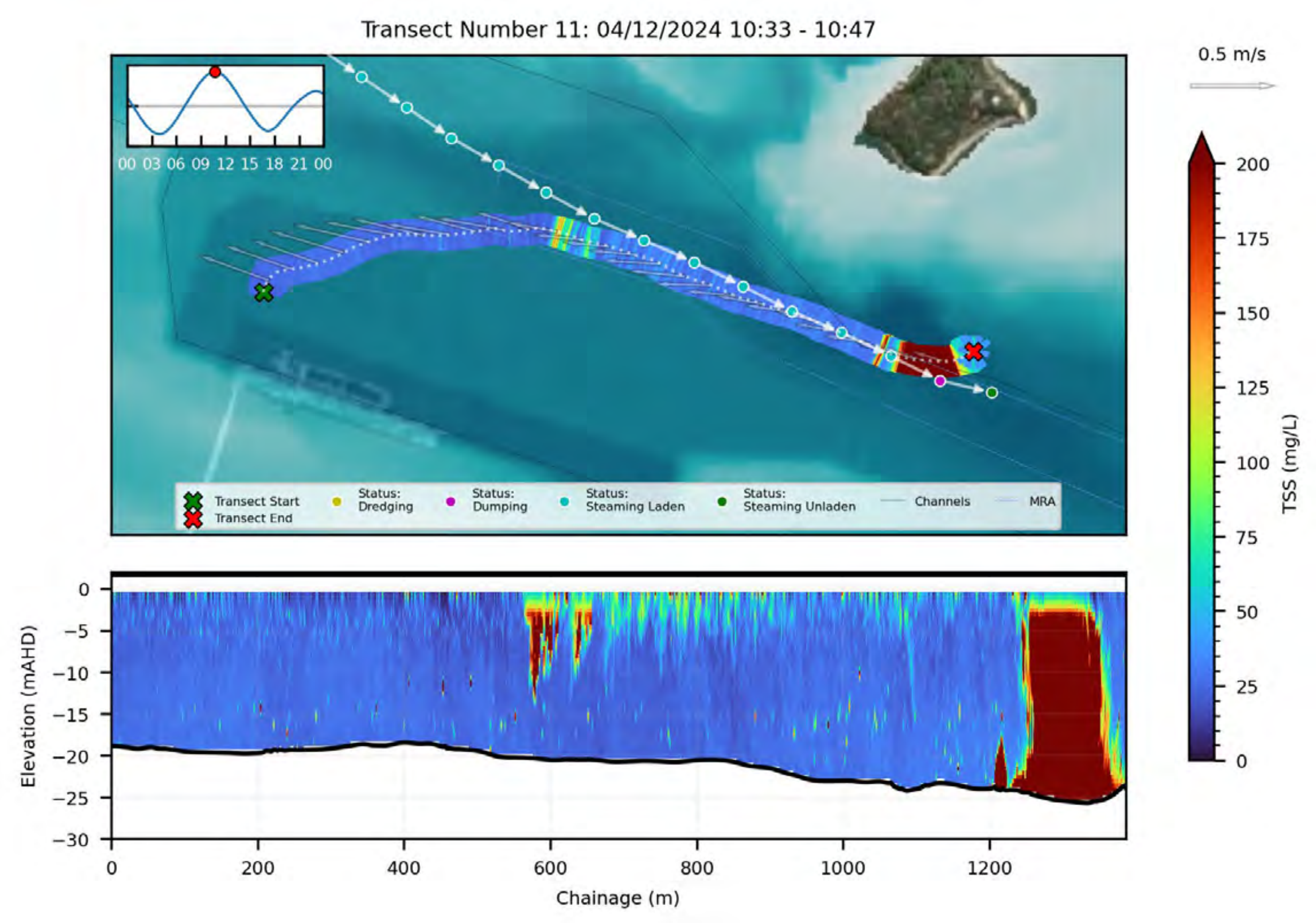

Figure 5.3 Transect at the Tide Island MRA on 4th December 2024 During Dredge Placement (Placement Started at 10:40)

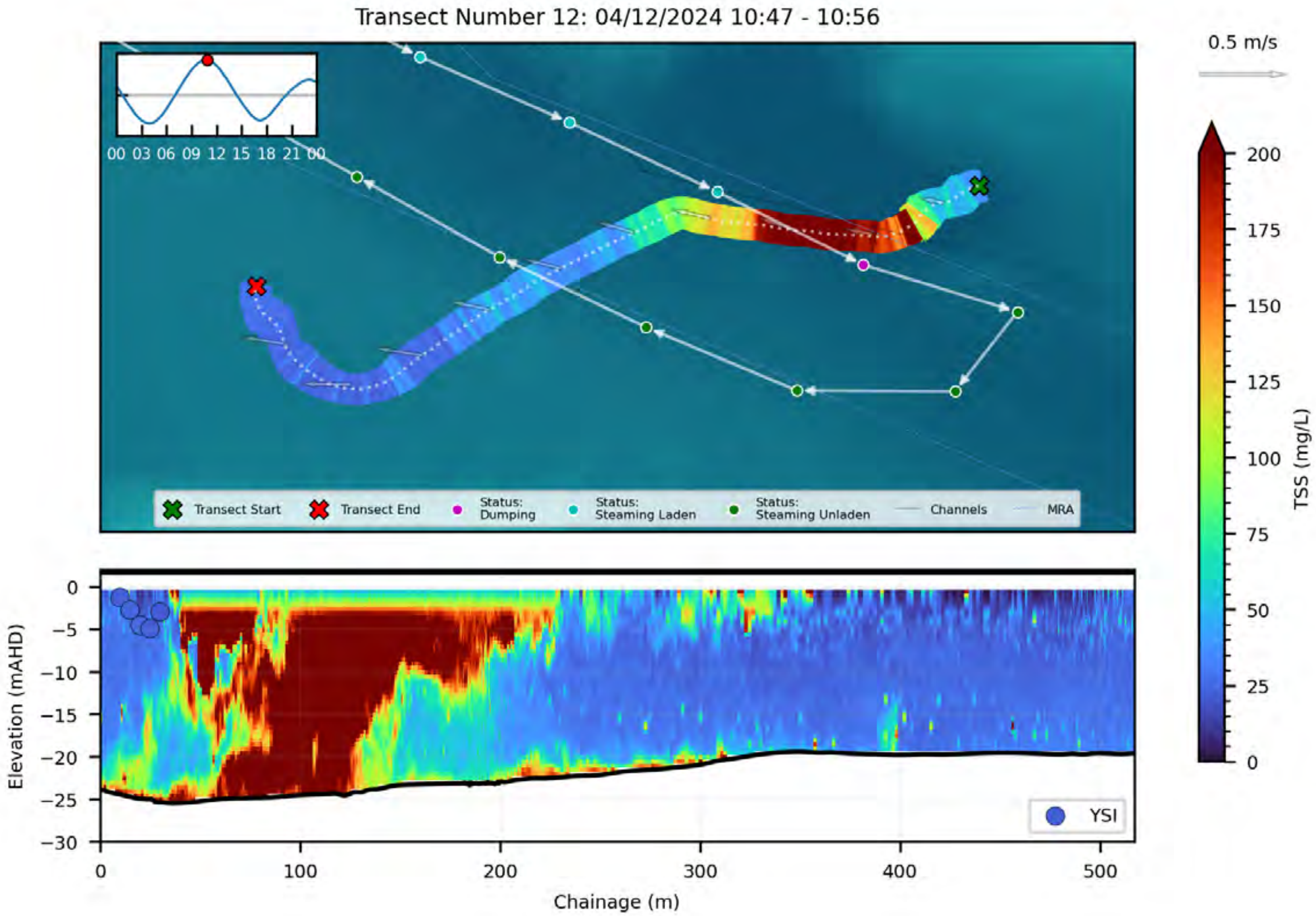

Figure 5.4 Transect at the Tide Island MRA on 4th December Starting 7 Minutes After Dredge Placement

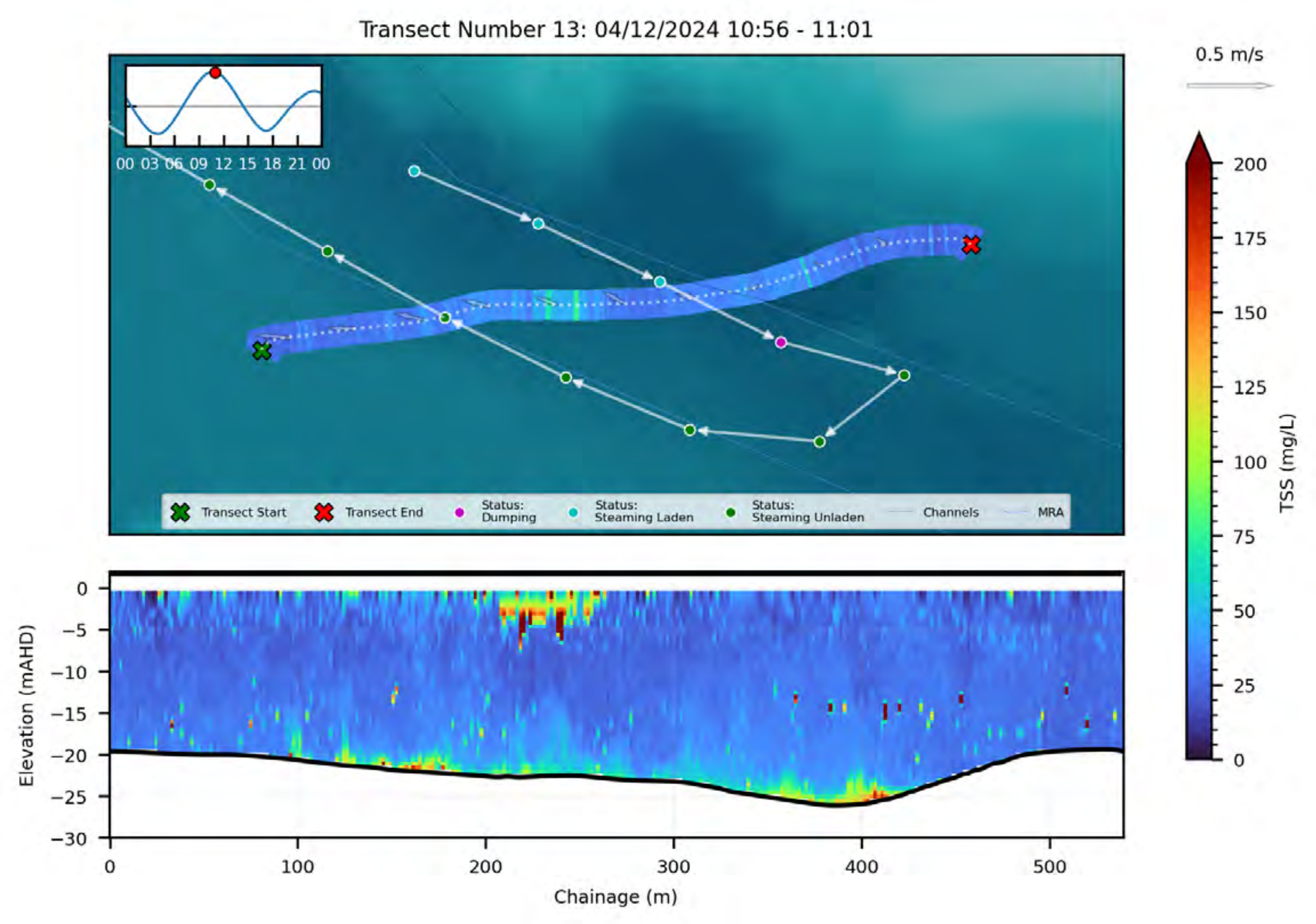

Figure 5.5 Transect at Tide Island MRA on 4th December Starting 16 Minutes After Dredge Placement

Legend

- East Banks MRA
- Tide Island MRA
- Channels
- Predicted Zone of Influence

Dredge Status

- Dredging
- Dumping
- Standby
- Steaming Laden
- Steaming Unladen

Title:

Depth-Averaged Suspended Sediment Concentration 04/12/2024

Figure: 5.6

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05/12/2024 – Tide Island MRA – Background Measurements

Background suspended sediment concentrations were monitored from 09:09 – 13:26 on 05/12/2024, with high tide at 11:35. Over the time of monitoring, the *Brisbane* was undergoing a crew change so no dredging took place. The last prior dredge placement at the Tide Island MRA took place at 10:45 on 04/12/2024.

Weather over the time of monitoring was overcast with rain showers, with winds ranging from 20 km/h ENE at 09:00 to 30 km/h ENE at 15:00.

Figure 5.7 presents measured transect suspended sedimented concentrations starting near Tide Island, across the shipping channel and the Tide Island MRA. With the flooding tide, the flow velocity was approximately 0.7 m/s towards the WNW. Some anomalous backscatter signatures are observed as small patches of colour which are not likely to be suspended sediment. TSS values were generally low, around 15 mg/L.

Figure 5.8 shows a longitudinal transect along and across the Tide Island MRA. The water level was approaching high tide with the velocity up to 0.3m/s towards the WNW. Suspended sediment concentrations were relatively homogenous over the water column at approximately 15 mg/L.

The full set of ADCP transects measured on 05/12/2024 are presented in Annex N. Depth-averaged suspended sediment concentrations for all ADCP tracks sampled on 05/12/2024 are collated in Figure 5.9. Since no dredge activity occurred in proximity of monitoring on this date, localised increases in suspended sediment concentrations are likely due to ambient TSS associated with tidal currents and wave activity, or propwash from the monitoring vessel.

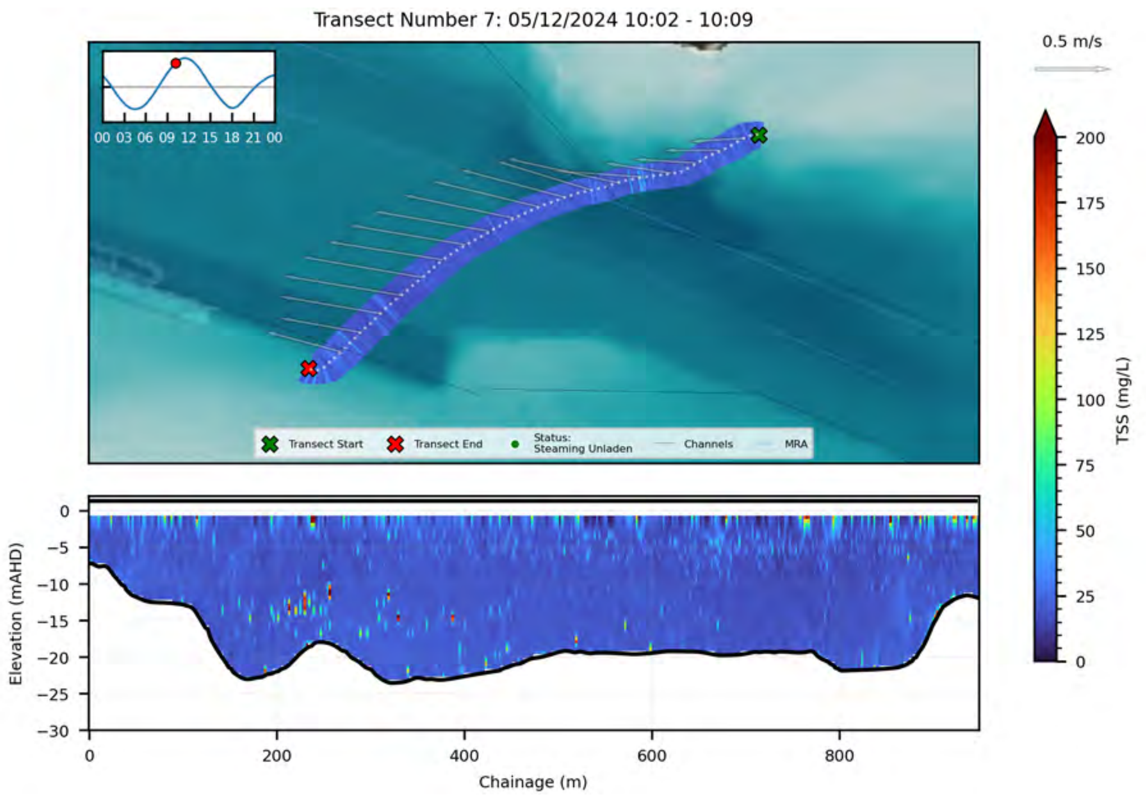

Figure 5.7 Background Transect at the Tide Island MRA on 05/12/2024 approximately 23 hours after the last previous placement activity

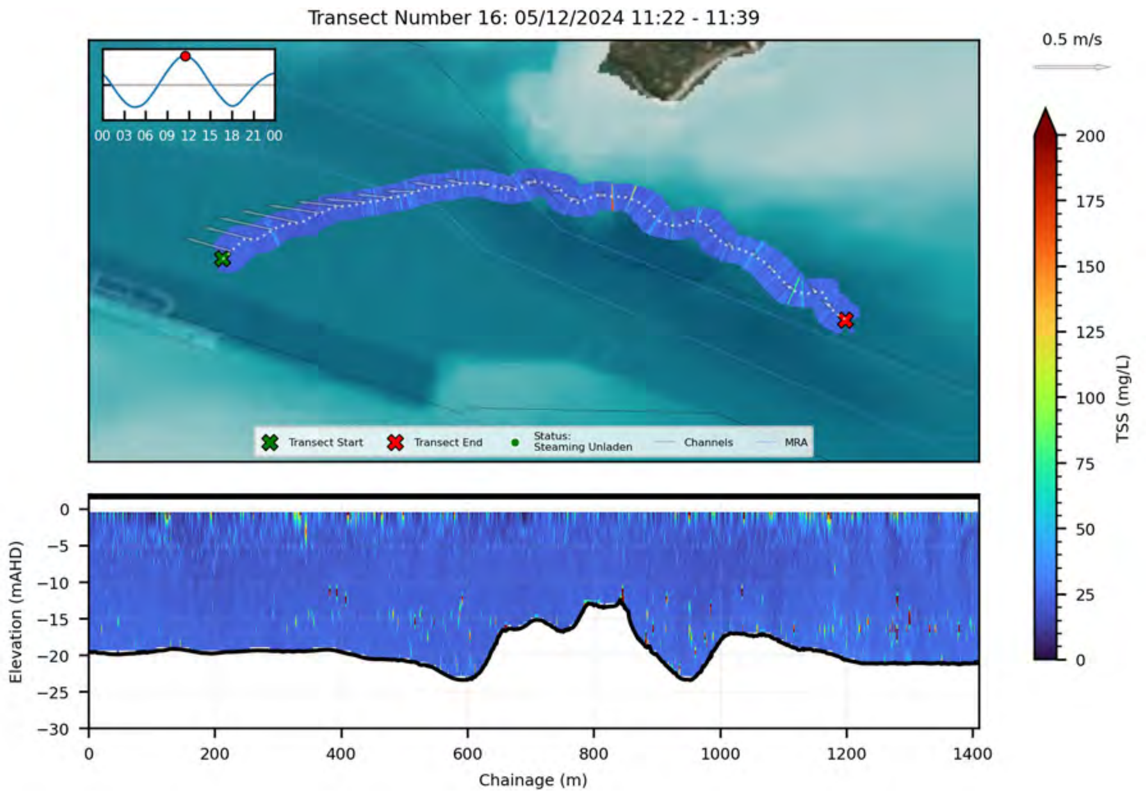

Figure 5.8 Background Transect at the Tide Island MRA on 05/12/2024

Legend

- East Banks MRA
- Tide Island MRA
- Channels
- Predicted Zone of Influence

Dredge Status

- Dredging
- Dumping
- Standby
- Steaming Laden
- Steaming Unladen

Title:

Depth-Averaged Suspended Sediment Concentration 05/12/2024

Figure: 5.9

Rev: A

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06/12/2024 – Tide Island MRA and GLNG Swing Basin

The TSHD *Brisbane* was monitored whilst placing material at the Tide Island MRA from 08:45 – 13:14 on 06/12/2024 mostly on the flooding tide, with high tide occurring at 12:27. Dredging was performed in the Jacobs Channel GLNG swing basin. A summary of the *Brisbane* dredge activity over the course of the monitoring period is shown in Table 5.2.

Table 5.2 Summary of Dredge Cycle Activity During Monitoring on 06/12/2024

Cycle No.	Dredging Site	Dredging Start	Dredging End	Placement Site	Placement Start	Placement End
1	GLNG Swing Basin	06/12/2024 08:52	06/12/2024 09:27	Tide Island MRA	06/12/2024 09:28	06/12/2024 09:35
2	GLNG Swing Basin	06/12/2024 09:58	06/12/2024 10:55	Tide Island MRA	06/12/2024 11:14	06/12/2024 11:17

Weather over the time of monitoring was overcast, with winds ranging from 20 km/h E at 09:00 to 28 km/h ENE at 15:00.

Figure 5.10 shows the measured plume shortly after the commencement of the *Brisbane* placement cycle at the Tide Island MRA, indicating a spreading plume over the full height of the water column with high TSS concentrations well over 200 mg/L. Figure 5.11 shows the plume approximately 4 minutes later, spreading wider and with high concentrations over the full depth.

Following the flooding current, Figure 5.12 shows the advected near-bed plume down-current of the placement site approximately 13 minutes after the commencement of placement. The plume has spread considerably but significant portions of the plume remain above 200 mg/L.

Figure 5.13 shows the suspended sediment concentration near the southern end of Jacobs Channel approximately 33 minutes after placement commenced. The plume was then concentrated towards the bottom of the water column with depth-averaged concentrations up to 100 mg/L and concentrations of up to 200 mg/L near the bed.

The full set of ADCP transects collected on 06/12/2024 are shown in Annex A. Depth-averaged suspended sediment concentrations for all ADCP tracks are presented in Figure 5.14. The measured placement plume extents are consistent with the zone of influence from the impact assessment study (BMT, 2023).

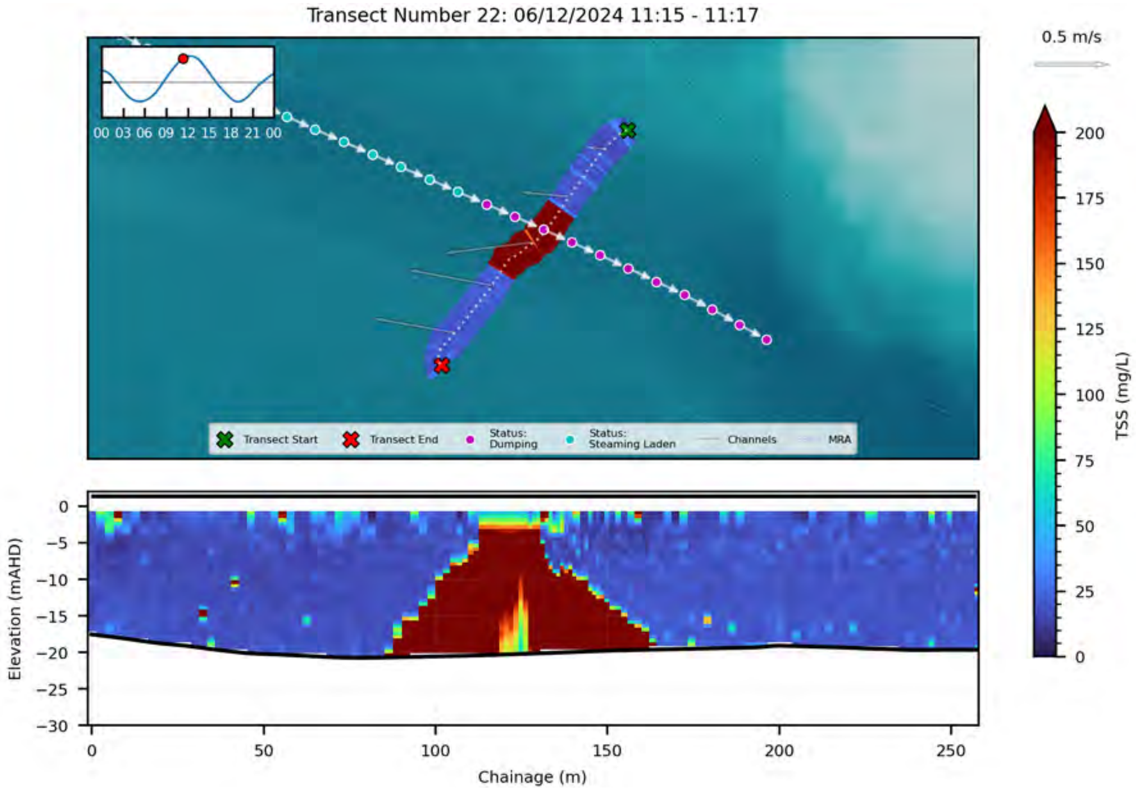


Figure 5.10 Transect at the Tide Island MRA on 06/12/2024. Dredge Placement Commenced 11:14

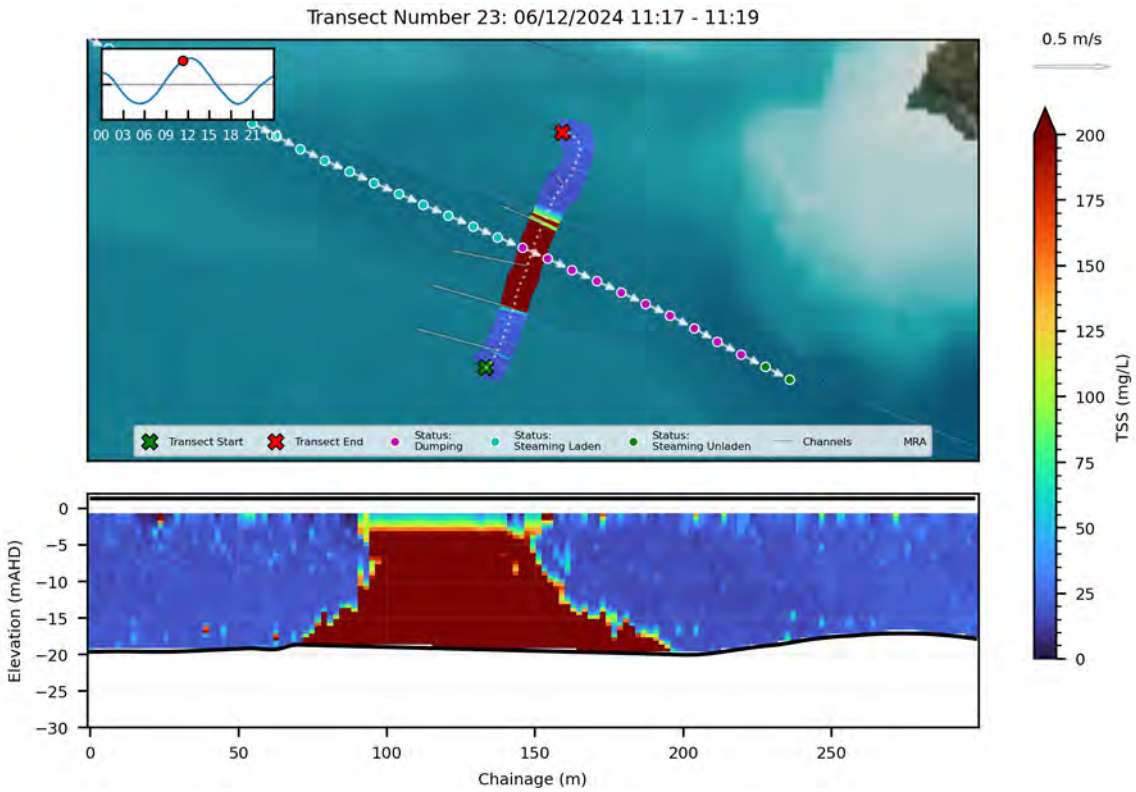


Figure 5.11 Transect at the Tide Island MRA on 06/12/2024 Approximately 4 Minutes after Placement Commenced

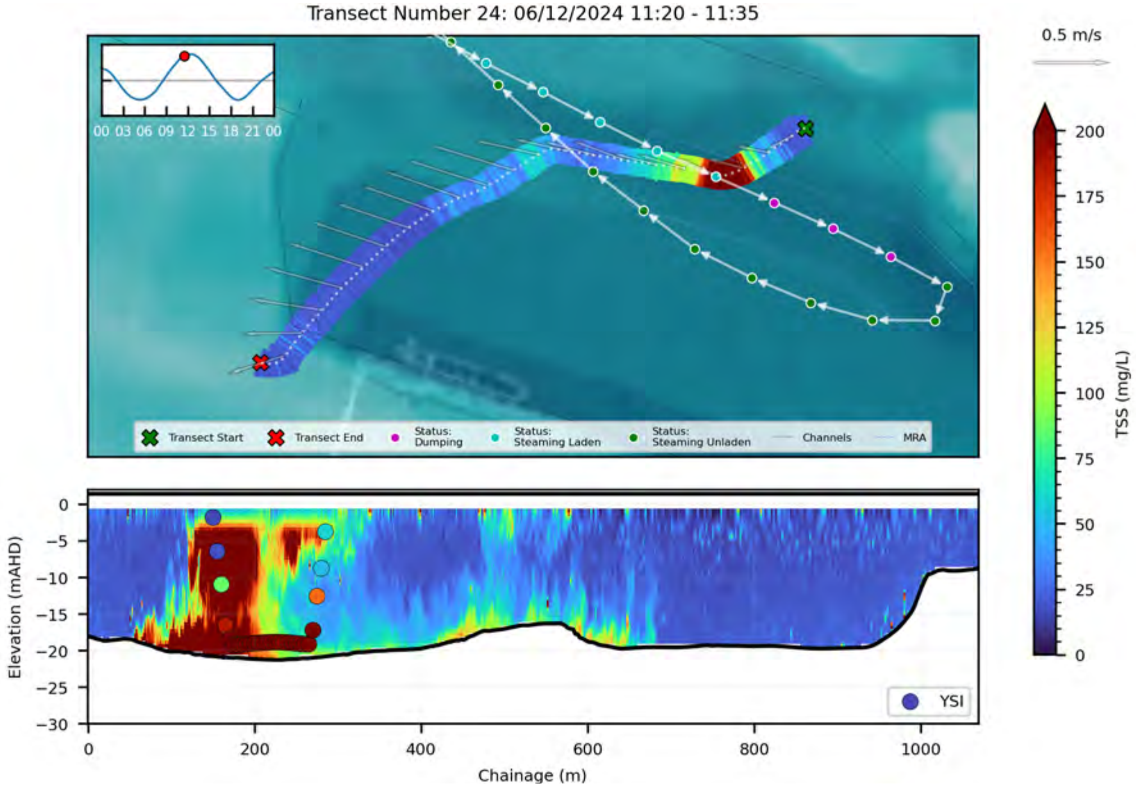


Figure 5.12 Transect at the Tide Island MRA on 06/12/2024 Approximately 13 Minutes after Placement Commenced

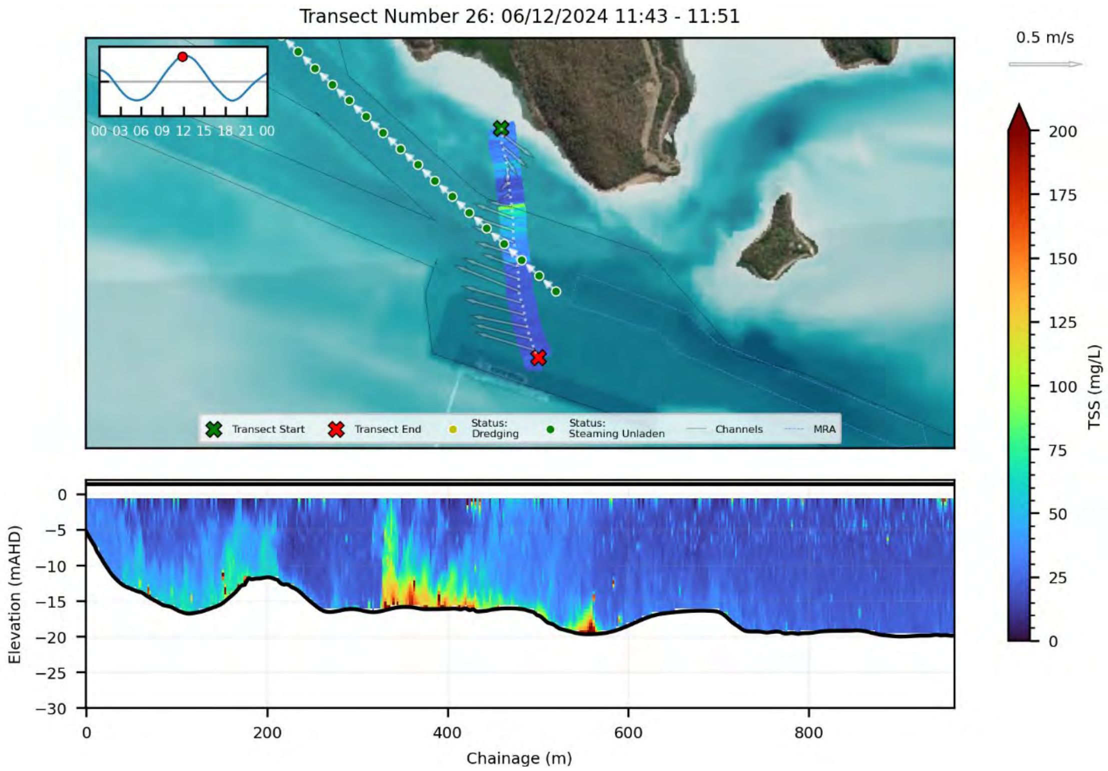
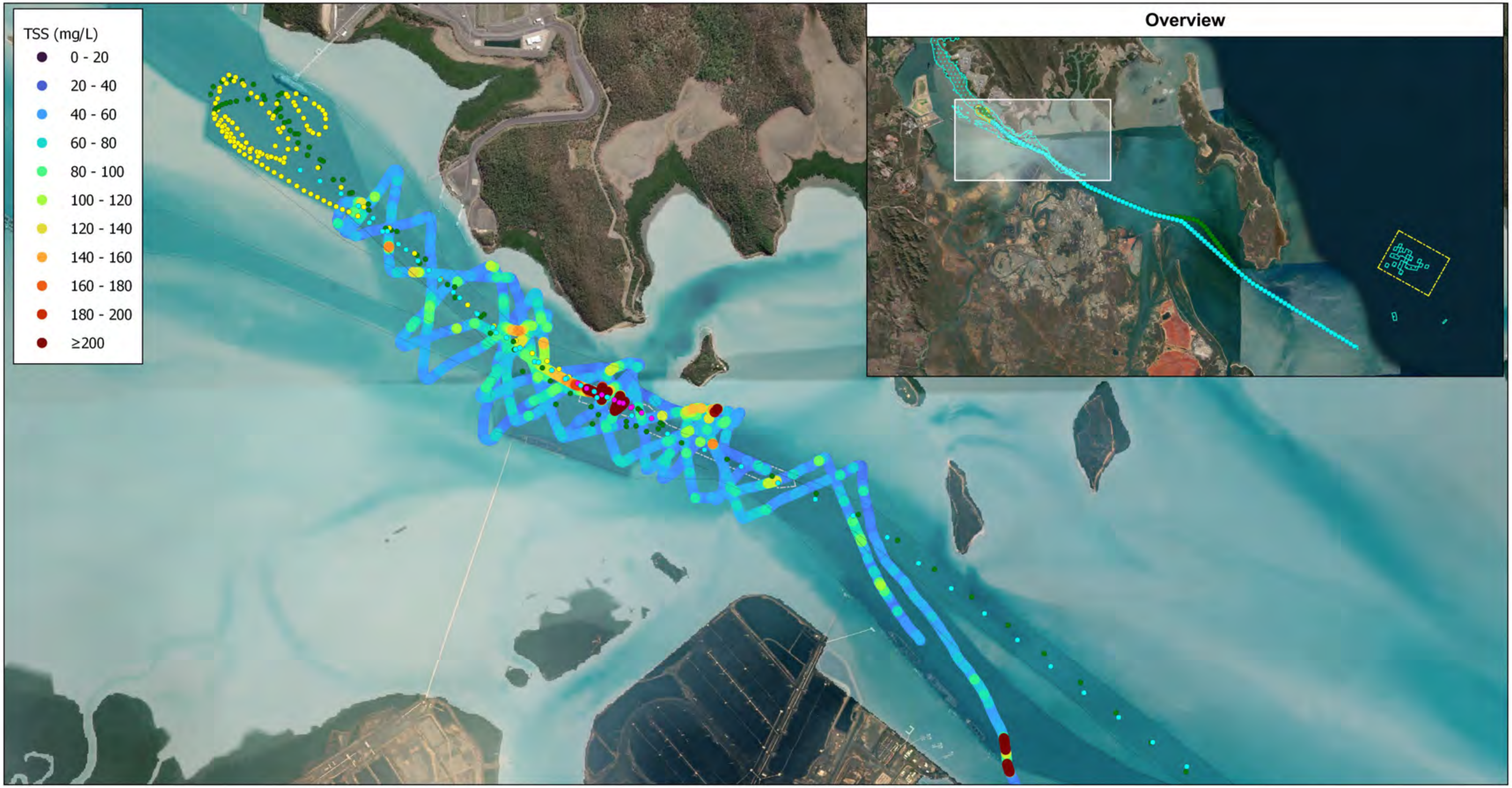


Figure 5.13 Transect at Tide Island MRA on 06/12/2024 Approximately 33 Minutes after Placement Commenced



Legend

- East Banks MRA
- Tide Island MRA
- Channels
- Predicted Zone of Influence

Dredge Status

- Dredging
- Dumping
- Standby
- Steaming Laden
- Steaming Unladen

Title:

Depth-Averaged Suspended Sediment Concentration 06/12/2024

Figure: **5.14**

Rev: **A**

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5.4 Particle Size Distributions (PSD)

A total of 16 water samples collected on the 04, 05 and 06/12/2024 were analysed for PSD. At the time of sample collection, *in situ* PSD measurements were also obtained using the LISST-200X instrument. The raw laboratory PSD results for each sample are shown in Annex A. A summary of laboratory PSD results including the sample coordinates, depth and dredge status is provided in Annex H.

A summary of particle sizes at the different locations for the various phases of the dredge cycle is presented in Table 5.3. The laboratory-processed particle size distributions for all samples collated for each monitoring day are presented in Figure 5.15, Figure 5.17 and Figure 5.19. *In situ* LISST-200x measurements are shown in Figure 5.16 , Figure 5.19 and Figure 5.20

Table 5.3 Laboratory PSD Result Summary Showing the Particle Sizes (Median Across Samples) at Each Location During the Different Phases of the Dredge Cycle

Location	Description	No. Samples (-)	D10 (µm)	D50 (µm)	D90 (µm)
Jacobs Channel - off GLNG MOF	Residual Dredge Placement Plume	2	2.3	8.6	41.3
Jacobs Channel - off Hamilton Point	Background	4	2.1	7.0	23.3
Tide Island MRA	Dredge Placement	10	2.2	8.3	49.0
Overall	**Background**	4	2.1	7.0	23.3
Overall	**Dredge-Related**	12	2.2	8.4	47.7
Overall	**All**	16	2.1	8.0	41.6

Note that no dispersant was added to the laboratory PSD samples

In general, the lab results for the background samples were characterised by finer particle sizes, predominately silt-sized with a median D50 particle size of 7.0 µm. Background measurements at both Jacobs Channel and the Tide Island MRA yielded similar results. Dredge-related samples were predominately silt-sized particles, with a median D50 particle size of 8.4 µm.

Dredge-related lab sample results across all three days showed a consistent uni-modal distribution centred around 7-9µm. This indicates that during this monitoring period, both the ambient suspended sediment and the material from the Jacobs Channel maintenance dredging activities is consistently dominated by a high proportions of silts.

Upon inspection of Figure 5.16 to Figure 5.20 it is evident that the *in situ* LISST profiling measurements show a significantly higher proportion of coarser particles, with a rightward shift of the particle size distributions relative to the laboratory measurements. This result indicates that in the field, the particles are in a flocculated state. Here, fine sediment particles (nominally finer than 63 µm) suspended in the marine environment tend to coalesce into "flocs" or aggregations of individual particles that behave physically like a larger-diameter, lower-density single particle. These flocs will settle much faster (by approximately an order of magnitude) than the individual constituent particles. These observations are consistent with other recent observations by Livsey *et al.* (2022).

The LISST PSD analysis is likely measuring the characteristics of the flocs, whereas these flocs have been broken up into their finer constituent particles in the laboratory PSD analysis. The discrepancy between the LISST and laboratory PSD estimates is an indication that the fine sediment in suspension in the field tends to be aggregated into flocs and will therefore settle more rapidly than dispersed particles.

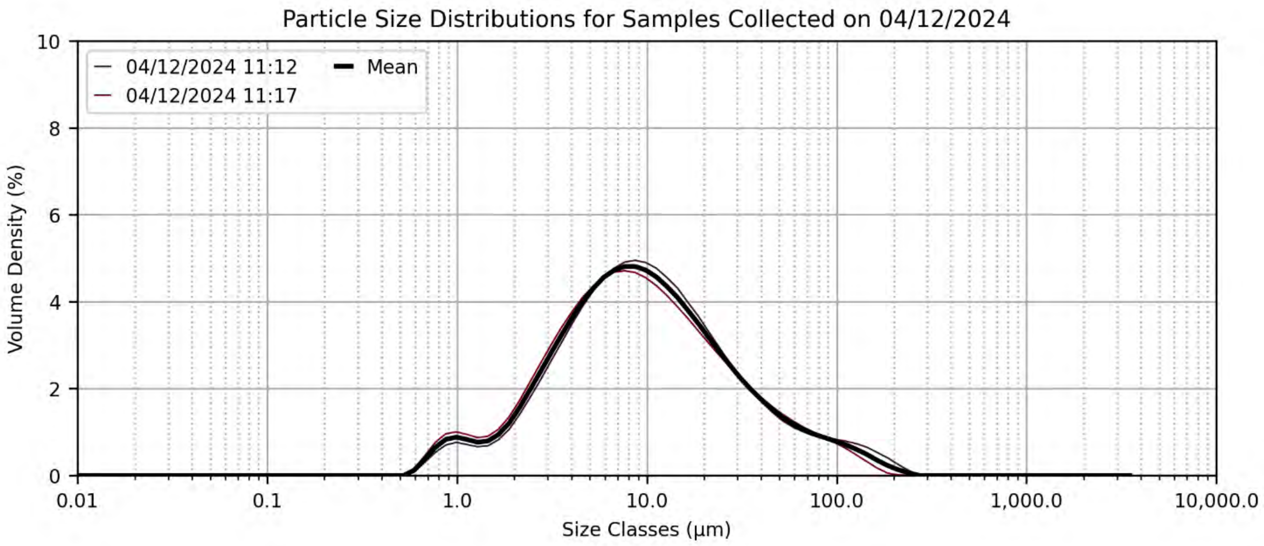

Figure 5.15 Laboratory Particle Size Distributions for all PSD Samples Collected on 04/12/2024

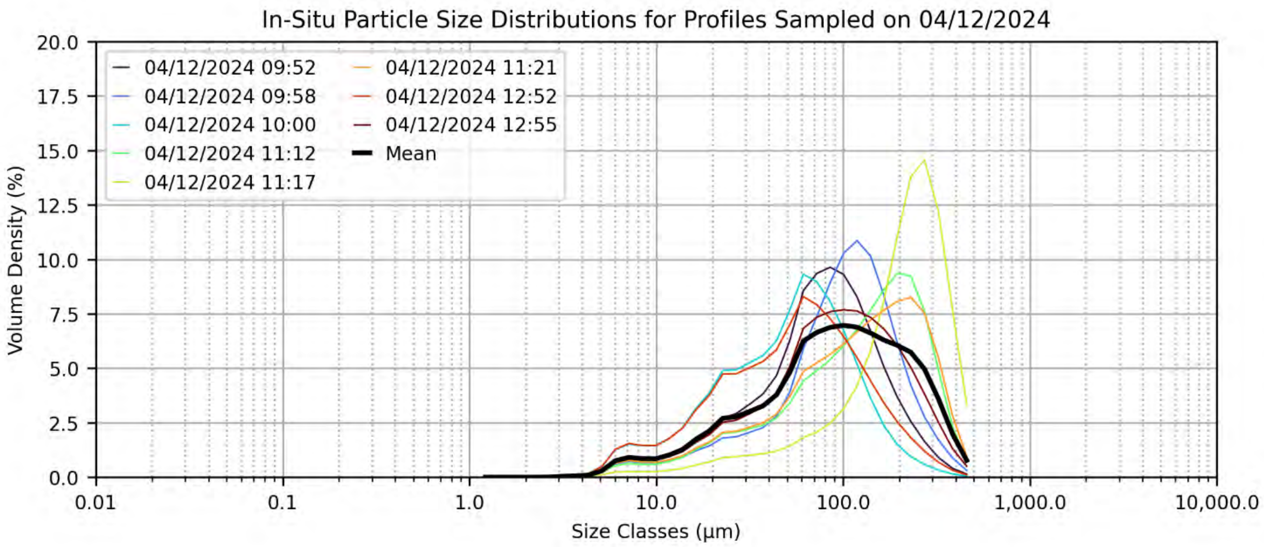

Figure 5.16 *In situ* LISST-200X Particle Size Distributions for all Measured Profiles on 04/12/2024

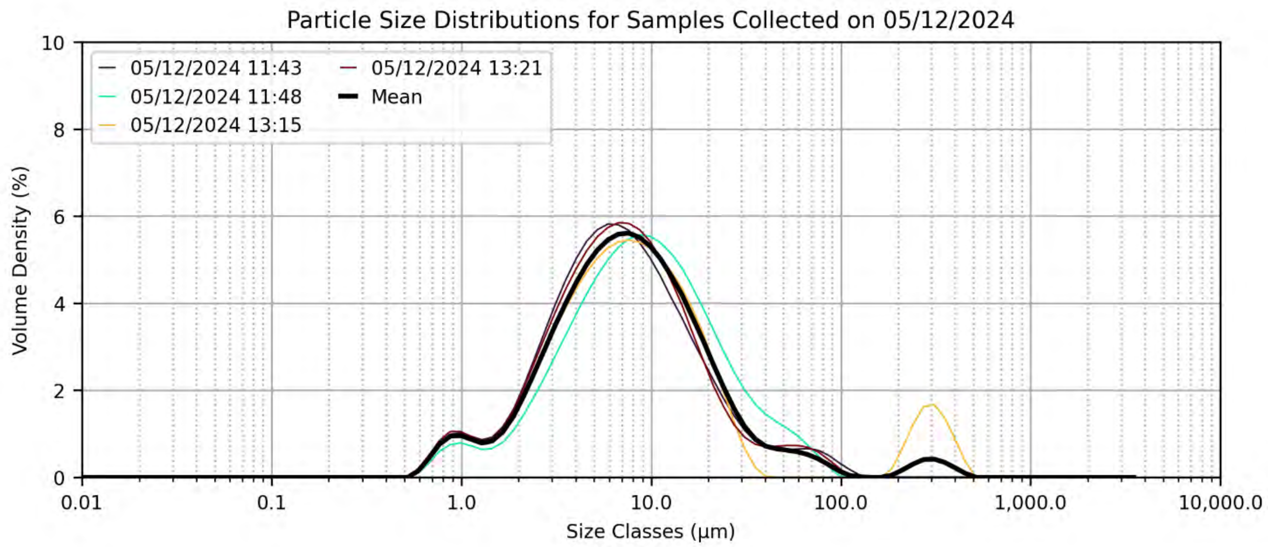

Figure 5.17 Laboratory Particle Size Distributions for all PSD Samples Collected on 05/12/2024

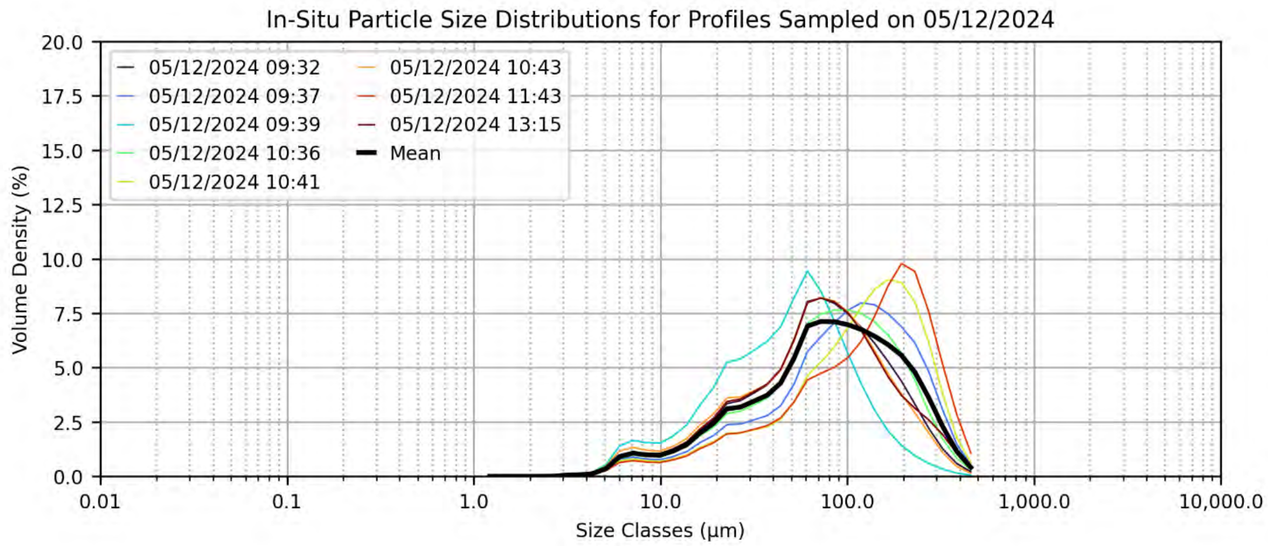

Figure 5.18 *In situ* LISST-200X Particle Size Distributions for all Measured Profiles on 06/12/2024

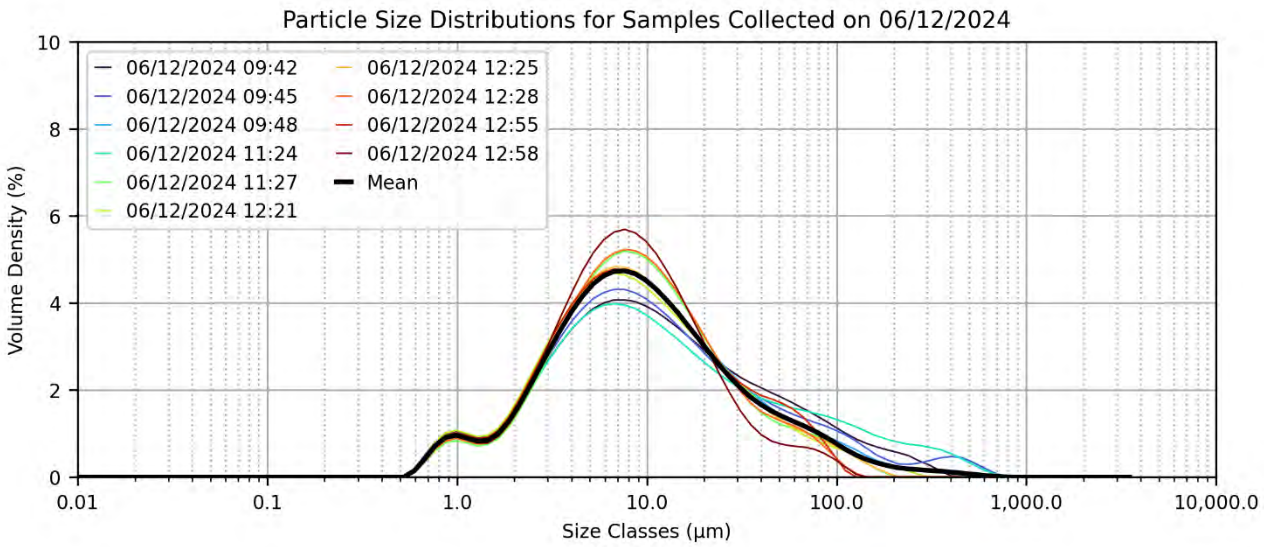

Figure 5.19 Laboratory Particle Size Distributions for all PSD Samples Collected on 06/12/2024

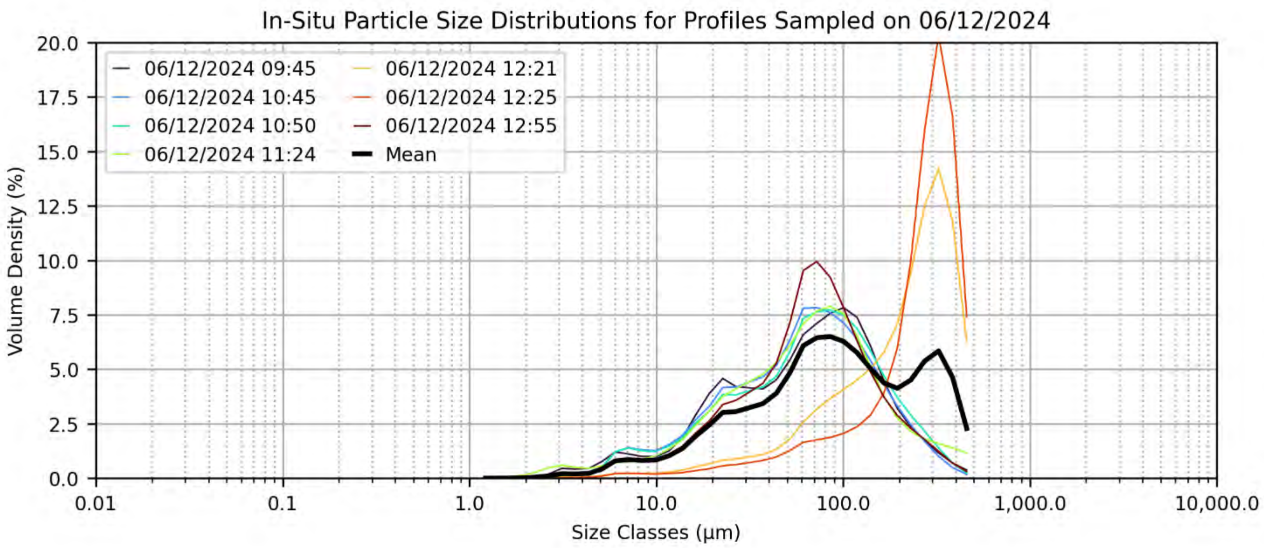

Figure 5.20 *In situ* LISST-200X Particle Size Distributions for all Measured Profiles on 06/12/2024

5.5 Turbidity Time Series

Fixed Deployments

The results of the turbidity measurement at two fixed locations to the north-west of the Tide Island MRA (T1) and to the south-east of the MRA (T2) are shown in Figure 5.21 (for locations, see Figure 1.2). The measurements at both sites do indicate an increase in the turbidity levels during the dredging period (10^{th} November to 13^{th} December 2024) relative to the measured turbidity prior to the commencement of dredging, particularly during the spring tide period around 17^{st} November. The modelling results presented in the impact assessment report (BMT, 2023) indicated only a small increase in the 50^{th} percentile of the depth-averaged turbidity (~1 NTU) and a small increase in the 95^{th} percentile of the depth-averaged turbidity (~3 NTU) at those two locations. The TUFLOW FV numerical model of the Port of Gladstone was used to undertake a hindcast of the dredging activity to further investigate the cause of the elevated turbidity. For further analysis and discussion, see Sections 4 and 6

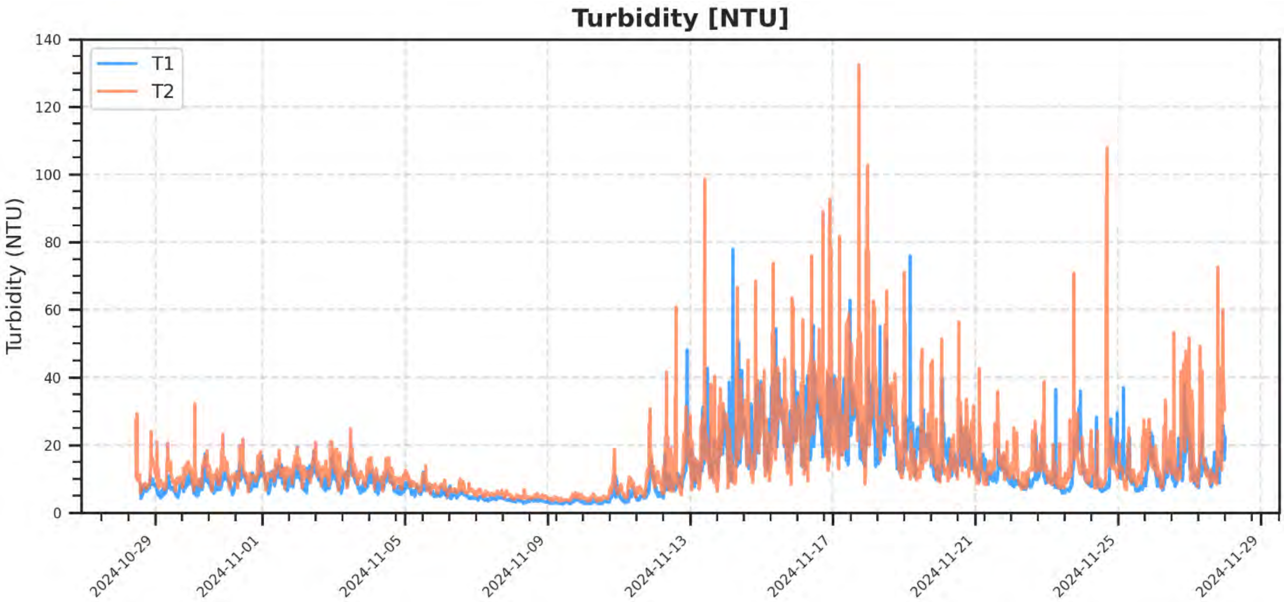

Figure 5.21 Fixed Turbidity Measurements at T1 and T2, near the Tide Island MRA (for locations, see Figure 1.2)

Figure 5.22Figure 5.22 illustrates the near-surface turbidity at the long-term measurement sites MH10 and WB50 (for locations, see Figure 1.2). The plotted values represent the mean turbidity from two co-located sondes. During the dredging activity, turbidity at WB50 appears to be elevated in comparison to MH10.

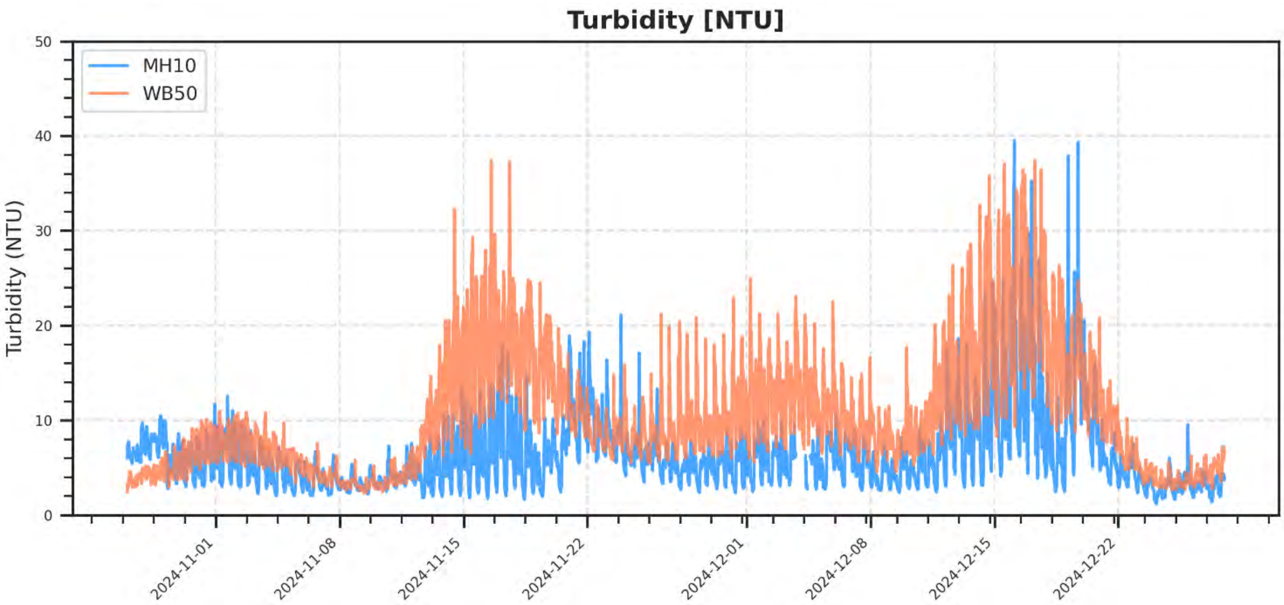

Figure 5.22 Fixed Turbidity Measurements at WB50 and MH10 (for locations, see Figure 1.2)

5.6 Water Quality Grab Samples

Water quality grabs results collected from plumes generated by the loading and placement activities on the 04/12/2024 and 06/12/2024 are summarised in Table 5.4 and Table 5.6 whilst results of background samples collected on the 05/12/2024 are shown in Table 5.5.

Key findings are as follows:

- **General observations:**
  - Generally, results showed that there were minimal differences between loading and disposal activities and background samples. These results are in line with previous PoG maintenance dredging plumes studies (BMT 2018) (refer to 3.6 for more details on this study) and the sampling campaign undertaken in 2023 as part of the present study (Section 3.6). Results were also in general agreement with data on the Port Curtis Integrated Monitoring Program website (PCIMP 2024) and trends described in the Gladstone Healthy Harbour Partnership annual technical reports (GHHP 2024);

- **Nutrients, TSS and chlorophyll *a*:**
  - Ammonia was detected (>LOR) in all samples, including background sites, with concentrations ranging between 13 µg/L to 144 µg/L and thus above the WQO of 8 µg/L. Ammonia concentrations were well below the toxicity DGV of 910 µg/L (ANZG 2018);
  - Total N was detected in all samples except for three (3) samples where the LOR was raised to 500 µg/L due to matrix interference. Total N ranged from 107 µg/L to 800 µg/L. Excluding the two samples where the LOR was raised, total N exceeded the related WQO of 210 µg/L only in one near-bed sample collected during loading activities on the 06/12/2024 (800 µg/L). It is possible that this high total N value was due to sampling error resulting from the sampling device disturbing the bed and releasing nitrogen into the water column. Similarly, TSS, aluminium and arsenic concentrations in this near bed sample were also highly elevated;

  - Total P was detected in most samples. Total P concentrations were above the WQO of 29 µg/L in three (3) samples. All of these were from samples collected within plumes at the bottom or mid of the water column. Therefore these elevated results could be due to localised resuspension from the bed as well as equipment potentially touching the bottom in one instance as highlighted above;
  - FRP was above LOR and the WQO of 7 µg/L in most samples. On the first day of sampling, 04/12/2024, all but one (1) results were <LOR;
  - Chlorophyll *a* was <LOR in most samples, and below the WQO of 2 µg/L in all samples;
  - TSS ranged from 6 mg/L to 1,000 mg/L. The highest TSS concentration was recorded in the sample suspected to have been a result of sampling error (see total N). There are no WQOs for this parameter in the applicable water area to this study.
- **Metals and metalloids:**
  - Most metal(loid)s, particularly their dissolved fraction, were typically below LOR and/or the DGV.
  - Most dissolved metal(loid)s had concentrations below the DGV, except silver in one sample (which was considered spurious - see below for details). Whilst metal(loid)s total and dissolved concentrations can be compared to DGVs, the dissolved concentration is more relevant for assessing the potential bioavailable fraction causing toxicity (ANZG 2018). Notable results are highlighted in the points below;
  - Total aluminium was detected in all samples at concentrations above the DGV of 24 µg/L. Concentrations ranged from 276 µg/L to 14,400 µg/L, with the highest value potentially erroneous (i.e. sampling error due to sampling equipment resuspending sediments from the bed). Aluminium is ubiquitous in the environment, it is the most abundant metal in the lithosphere, comprising about 8% of the Earth’s crust (Ščančar and Milačič 2006). Due to its reactive nature aluminium never occurs as a free metal, but it is present in a variety of minerals, primarily aluminosilicate, most commonly feldspars in metamorphic and igneous rocks and as clay minerals in well weathered soils (Hendershot et al. 1996; Driscoll and Postek, 1996; Gensemer and Playle, 1999; Ščančar and Milačič 2006). Through weathering and geochemistry processes, alumimum is present in high abundance in coastal waters mainly in its particulate form as it is highly insoluble (under ‘’normal’’ marine pH conditions >8.0) and generally unavailable to participate in biogeochemical reactions (Driscoll and Schecher, 1990; Ščančar and Milačič 2006).
  - Total and dissolved arsenic were detected in all samples. The DGV of 2.3 µg/L for arsenic (III) was conservatively applied, but note this GV has low reliability and should be used as an interim working level (ANZG 2018). Dissolved arsenic, which represents the most bioavailabkle fraction, had concentrations below this DGV in all samples. Total arsenic was above the DGV in seven (7) samples in concentration ranging from 2.7 µg/L to 13.3 µg/L. Arsenic is abundant in the Earth's crust and seawater, representing the 14^{th} most abundant element (Wang et al. 2022). Total arsenic concentrations in global clean open coastal waters typically range from 0.5 to 3 µg/L, with a mean of 1.7 µg/L (Neff 2002). As the study was conducted in a coastal/estuarine environment, the reported concentrations are within range reported in the literature;

- Total and dissolved cadmium and mercury were all <LOR. However, for some samples mercury LOR was raised to 0.5 µg/L and thus above the applicable DGV of 0.1 µg/L due to matrix interference.
- Total chromium, copper, lead and zinc were detected in several samples and exceeded the related DGVs in a few samples (n = 3, 16, 2 and 3 respectively) collected within activity plumes. Dissolved concentrations were <LOR with the exception of two (2) samples where copper concentrations were equal to the LOR of 1 µg/L;
- Total manganese and nickel were detected in all samples, in two (2) instances total manganese concentrations were above the DGV of 80 µg/L. However, the dissolved fractions of both metals were mostly <LOR or well below DGVs; and
- Total and dissolved silver concentrations were typically <LOR or well below the DVG of 1.4 µg/L. One (1) sample collected during the background sample collection day had a total concentration of <0.1 and a dissolved fraction of 15.7 µg/L. This sample is considered spurious.

QA/QC

Laboratory QA/QC results were reviewed to assess potential intra-laboratory analyses variation and laboratory contamination as well as methods precision and accuracy. The assessment of the laboratory duplicate report showed all duplicate results to be within acceptable Relative Percent Deviation (RPD) with no outliers. Moreover, method blank and Laboratory Control Samples (LCS) report showed no laboratory contamination with all added reagents <LOR and all spike recovery within acceptable limits respectively.

The only laboratory QA/QC non-compliance was that chlorophyll *a* samples were analysed outside their holding time. As QC data was within the acceptable RPD/RSD ranges, the data presented in this report can be considered to be of reliable quality.

Assumptions and Limitations

Grab water samples were collected on three occasions corresponding to: (i) periods when the dredger was overflowing and disturbing the seafloor; (ii) during the disposal of dredged sediments at the MRA. These water samples were representative of periods of high plume intensity (i.e. acute exposure). Dredging and placement plumes rapidly degrade as a result of advection, dilution and settlement. The samples are not representative of periods of plume degradation, nor do they capture sediment resuspension following placement. Previous dredge plume studies indicate that the physico-chemical and biological properties of the dredge site rapidly return to background at time scales measured in hours (BMT, 2018).

Table 5.4 Water quality grabs results from samples collected on the 04/12/2024

Parameter	Unit	LOR	GV	Site 1			Site 2				Site 3		
Depth interval				Near-Bed	Mid	Top	Near-Bed	Near-Bed	Mid	Top	Near-Bed	Mid	Top
Nutrients, Chlorophyll a, TSS (EPP WQOs) and TOC													
Total Organic Carbon (TOC)	mg/L	1	-	3	3	2	4	2	2	1	1	1	1
Chlorophyll a	µg/L	1	2	<1	<1	<1	<1	<1	<1	1	<1	<1	<1
Total P	µg/L	5	29	6	8	<5	5	22	<5	<5	6	13	<5
Nitrite + Nitrate as N	µg/L	2	-	8	5	86	22	12	52	5	108	6	5
Ammonia as N	µg/L	5	8	13	15	40	17	28	14	12	38	18	18
Kjeldahl Nitrogen Total	µg/L	25	-	170	168	96	160	169	132	154	67	137	165
Nitrate (as N)	µg/L	2	-	4	2	83	20	4	52	5	106	3	3
Nitrite (as N)	µg/L	2	-	4	3	3	2	8	<2	<2	2	3	2
Nitrogen (Total)	µg/L	25	210	178	173	182	182	181	184	159	175	143	170
Reactive Phosphorus (FRP)	µg/L	1	7	<1	<1	<1	<1	9	<1	<1	<1	<1	<1
Total Suspended Solids (TSS)	mg/L	1	-	30	26	25	17	56	20	18	19	26	17
Metal(loid)s (ANZG 2018)													
Aluminium	µg/L	5	24	746	728	688	464	1470	483	532	525	665	602
Aluminium (dissolved)	µg/L	5	24	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Arsenic	µg/L	0.5	2.3	2.3	2.2	2.2	2	2.7	2	2	1.8	2	1.7
Arsenic (dissolved)	µg/L	0.5	2.3	1.2	1.2	1.2	1.2	1.2	1.1	1.1	1.2	1.1	1.1
Cadmium	µg/L	0.2	0.7	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cadmium (dissolved)	µg/L	0.2	0.7	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium (III + VI)	µg/L	0.5	4.4	1.1	1.2	1.2	0.9	2.2	0.8	0.9	0.8	1.1	0.9
Chromium (III + VI) (dissolved)	µg/L	0.5	4.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper	µg/L	1	1.3	2	2	2	2	3	2	1	2	1	2
Copper (dissolved)	µg/L	1	1.3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Iron	µg/L	5	-	1,100	1,000	972	648	2,010	697	714	735	950	742
Iron (dissolved)	µg/L	5	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Lead	µg/L	0.2	4.4	0.4	0.3	0.3	0.2	0.6	0.2	0.2	0.2	0.3	0.2
Lead (dissolved)	µg/L	0.2	4.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	µg/L	0.5	80	24	22	20.8	14.2	32.8	16.6	15.9	16	20.8	16
Manganese (dissolved)	µg/L	0.5	80	<0.5	<0.5	<0.5	0.7	1.8	<0.5	<0.5	<0.5	<0.5	<0.5
Mercury	µg/L	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Mercury (dissolved)	µg/L	0.1	0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Nickel	µg/L	0.5	70	1.1	1	1	0.8	1.6	0.9	0.9	0.8	0.9	0.9
Nickel (dissolved)	µg/L	0.5	70	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Silver	µg/L	0.1	1.4	0.4	0.2	0.2	0.2	0.1	<0.1	0.1	<0.1	<0.1	<0.1
Silver (dissolved)	µg/L	0.1	1.4	0.2	0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1
Zinc	µg/L	5	8	6	<5	<5	<5	5	<5	<5	<5	<5	<5
Zinc (dissolved)	µg/L	5	8	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

1 EPP (Water and Wetland Biodiversity) guideline values

2 ANZG (2018) guideline values, 95 %tile marine species protection, 99% percentile applied to cadmium and mercury due to their bioaccumulation potential

Orange shading = guideline exceeded

Yellow shading = guideline exceeded due to LOR > GV

Table 5.5 Water quality grab results from samples collected on the 05/12/2024

Parameter	Unit	LOR	GV	Site 1			Site 2			Site 3		Site 4	
Depth interval				Near-Bed	Mid	Top	Near-Bed	Mid	Top	Near-Bed	Top	Near-Bed	Top
Nutrients, Chlorophyll a, TSS (EPP WQOs) and TOC													
Total Organic Carbon (TOC)	mg/L	1	-	3	2	2	2	3	2	2	2	2	<1
Chlorophyll a	µg/L	1	2	1	2	2	1	1	1	<1	1	1	1
Total P	µg/L	5	29	7	9	11	9	12	8	5	<5	16	<5
Nitrite + Nitrate as N	µg/L	2	-	9	8	8	7	7	6	7	7	7	6
Ammonia as N	µg/L	5	8	42	44	40	40	37	38	40	39	46	37
Kjeldahl Nitrogen Total	µg/L	25	-	120	120	121	115	128	115	120	100	138	113
Nitrate (as N)	µg/L	2	-	7	6	6	7	7	6	7	7	4	6
Nitrite (as N)	µg/L	2	-	2	2	2	<2	<2	<2	<2	<2	3	<2
Nitrogen (Total)	µg/L	25	210	129	128	129	122	135	121	127	107	145	119
Reactive Phosphorus (FRP)	µg/L	1	7	10	9	6	10	10	8	8	5	12	4
Total Suspended Solids (TSS)	mg/L	1	-	20	18	20	23	35	16	12	11	27	9
Metal(loid)s (ANZG 2018)													
Aluminium	µg/L	5	24	588	537	558	648	638	476	539	359	754	301
Aluminium (dissolved)	µg/L	5	24	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Arsenic	µg/L	0.5	2.3	1.6	1.7	1.7	1.9	1.8	1.7	1.8	1.6	1.9	1.6
Arsenic (dissolved)	µg/L	0.5	2.3	1.2	1.2	1.4	1.3	1.3	1.3	1.2	1.3	1.3	1.3
Cadmium	µg/L	0.2	0.7	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cadmium (dissolved)	µg/L	0.2	0.7	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium (III + VI)	µg/L	0.5	4.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5	<0.5
Chromium (III + VI) (dissolved)	µg/L	0.5	4.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper	µg/L	1	1.3	1	<1	1	1	1	<1	<1	<1	1	<1
Copper (dissolved)	µg/L	1	1.3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Iron	µg/L	5	-	758	704	715	863	811	604	693	467	1,020	380
Iron (dissolved)	µg/L	5	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Lead	µg/L	0.2	4.4	0.3	0.2	0.3	0.3	0.2	0.2	0.2	<0.2	0.3	<0.2
Lead (dissolved)	µg/L	0.2	4.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	µg/L	0.5	80	16.3	15.8	16.4	19.6	18.5	14.5	16.4	10.8	22.4	10.1
Manganese (dissolved)	µg/L	0.5	80	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Mercury	µg/L	0.1	0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Mercury (dissolved)	µg/L	0.1	0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel	µg/L	0.5	70	0.8	0.7	1	0.9	0.8	0.8	0.8	1.5	0.9	0.6
Nickel (dissolved)	µg/L	0.5	70	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.6	<0.5
Silver	µg/L	0.1	1.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Silver (dissolved)	µg/L	0.1	1.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	15.7	<0.1	<0.1	<0.1
Zinc	µg/L	5	8	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Zinc (dissolved)	µg/L	5	8	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

1 EPP (Water and Wetland Biodiversity) guideline values
2 ANZG (2018) guideline values, 95 %tile marine species protection, 99% percentile applied to cadmium and mercury due to their bioaccumulation potential
Orange shading = guideline exceeded
Yellow shading = guideline exceeded due to LOR > GV

Table 5.6 Water quality grab results from samples collected on the 06/12/2024

Parameter	Unit	LOR	GV	Site 1			Site 2		Site 3			Site 4			Site 5	
Depth interval				Near-Bed	Mid	Top	Near-Bed	Top	Near-Bed	Mid	Top	Near-Bed	Mid	Top	Near-Bed	Top
Nutrients, Chlorophyll a, TSS (EPP WQOs) and TOC																
Total Organic Carbon (TOC)	mg/L	1	-	20	5	3	3	3	3	5	2	4	3	3	2	2
Chlorophyll a	µg/L	1	2	<2	<2	<1	2	2	2	<2	2	1	1	2	1	2
Total P	µg/L	5	29	350	<50	6	28	6	<5	830	8	290	16	16	20	<5
Nitrite + Nitrate as N	µg/L	2	-	9	7	8	8	8	7	8	6	7	5	5	5	4
Ammonia as N	µg/L	5	8	144	71	38	59	36	33	106	39	83	43	36	52	24
Kjeldahl Nitrogen Total	µg/L	25	-	800	<500	142	162	142	134	<500	141	<500	133	132	143	110
Nitrate (as N)	µg/L	2	-	3	4	8	5	8	7	5	6	4	5	5	3	4
Nitrite (as N)	µg/L	2	-	6	3	<2	3	<2	<2	3	<2	3	<2	<2	2	<2
Nitrogen (Total)	µg/L	25	210	800	<500	150	170	150	141	<500	147	<500	138	137	148	114
Reactive Phosphorus (FRP)	µg/L	1	7	80	41	8	24	5	4	60	8	44	10	9	2	3
Total Suspended Solids (TSS)	mg/L	1	-	1,000	95	30	19	15	15	308	17	148	63	22	39	10
Metal(loid)s (ANZG 2018)																
Aluminium	µg/L	5	24	14400	3780	1370	486	498	359	7020	606	3070	1240	859	1520	276
Aluminium (dissolved)	µg/L	5	24	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Arsenic	µg/L	0.5	2.3	13.3	4.7	2.5	1.7	1.7	1.6	7.7	1.9	3.7	2.3	2.1	2.6	1.7
Arsenic (dissolved)	µg/L	0.5	2.3	1.3	1.2	1.2	1.2	1.3	1.2	1.3	1.2	1.2	1.2	1.3	1.3	1.3
Cadmium	µg/L	0.2	0.7	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Cadmium (dissolved)	µg/L	0.2	0.7	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Chromium (III + VI)	µg/L	0.5	4.4	20.6	4.8	1.2	<0.5	<0.5	<0.5	9.9	1.1	3.6	1	0.5	1.3	<0.5
Chromium (III + VI) (dissolved)	µg/L	0.5	4.4	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Copper	µg/L	1	1.3	24	6	2	<1	<1	<1	10	1	4	2	2	2	1
Copper (dissolved)	µg/L	1	1.3	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	1
Iron	µg/L	5	-	21,600	5,600	1,970	624	638	465	10,500	806	4,130	1,610	1,150	2,060	361
Iron (dissolved)	µg/L	5	-	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Lead	µg/L	0.2	4.4	7.4	2	0.6	0.2	<0.2	<0.2	3.3	0.2	1.3	0.5	0.4	0.6	<0.2
Lead (dissolved)	µg/L	0.2	4.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	µg/L	0.5	80	370	99.3	37.8	14.6	14.1	11.6	172	18.1	68.2	31.5	23.9	38.7	10.5
Manganese (dissolved)	µg/L	0.5	80	1.8	0.9	<0.5	<0.5	<0.5	<0.5	1.3	<0.5	0.7	0.7	<0.5	1.1	<0.5
Mercury	µg/L	0.1	0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Mercury (dissolved)	µg/L	0.1	0.1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nickel	µg/L	0.5	70	13.2	3.7	1.5	0.9	0.7	0.8	6.6	0.8	2.9	1.2	1	1.6	0.7
Nickel (dissolved)	µg/L	0.5	70	0.8	<0.5	<0.5	0.9	<0.5	<0.5	0.6	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Silver	µg/L	0.1	1.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Silver (dissolved)	µg/L	0.1	1.4	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	µg/L	5	8	44	13	<5	<5	<5	<5	20	<5	7	<5	<5	<5	<5
Zinc (dissolved)	µg/L	5	8	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

1 EPP (Water and Wetland Biodiversity) guideline values

2 ANZG (2018) guideline values, 95 %tile marine species protection, 99% percentile applied to cadmium and mercury due to their bioaccumulation potential

Orange shading = guideline exceeded

Yellow shading = guideline exceeded due to LOR > GV

6 December 2024 Hindcast Modelling Results

The numerical model described in Section 4 was used to undertake hindcast modelling of the maintenance dredging activity and placement of material at Tide Island MRA during the 2024 campaign.

6.1 Model Scenarios and Parameterisation

The numerical model was run from 20/10/2024 to 20/12/2024 in order to simulate the hydrodynamics and sediment dynamics, including the effects of the maintenance dredging campaign. In order to include the dredging plume sources in the model, the detailed log of dredging activity for the TSHD *Brisbane* was analysed and a sediment source was added to the model at the dredger location at each timestep depending on the mode of operation of the dredge at that time. The plume release rates that were applied were the same as those applied in Section 4.

The modelled TSS was converted to an equivalent turbidity using the same empirical relationship adopted in Section 4.

The model parameters for the initial 2024 simulation were set to the same values as simulation 02 in the 2023 model hindcast (see Table 4.2). The erosion rate constant for all sediment fractions was set to 0.24.

Figure 6.1 shows the near-bed modelled and measured turbidity at sites T1 and T2, the measurement locations upstream and downstream of the Tide Island MRA (see Figure 1.2 for locations). The modelled turbidity is significantly lower than the measured turbidity, both in the period before the commencement of dredging and during the dredging campaign itself. In addition, the range of the modelled turbidity from one tide to the next is significantly smaller than the measured range.

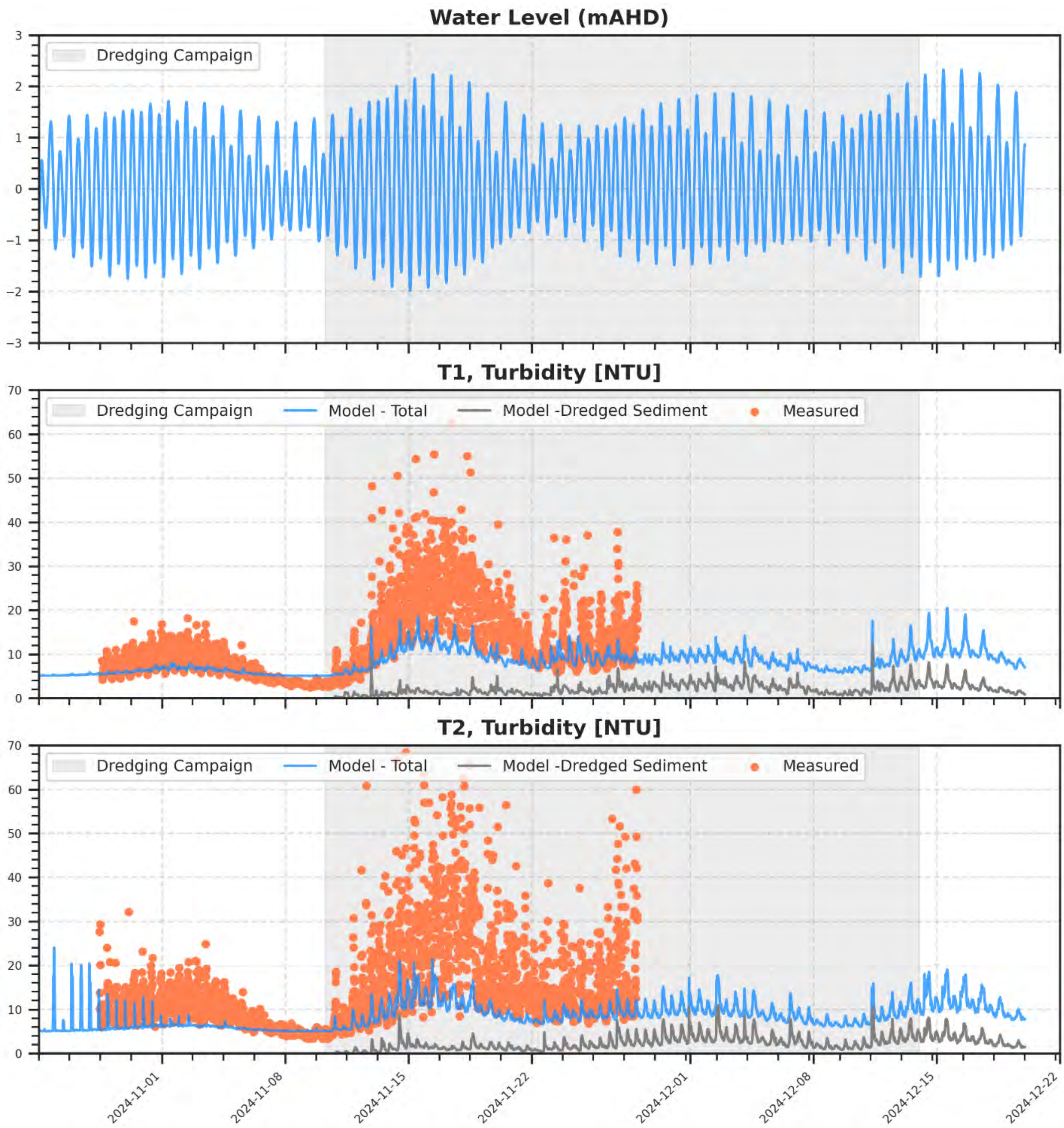

Figure 6.1 Comparison of modelled turbidity (ID = 01) with near-bed turbidity measurements from T1 and T2. Instrument locations are indicated in Figure 1.2. The top plot shows water levels (mAHD).

Figure 6.2 shows the time series of the near-surface modelled and measured turbidity at the MH10 and WB50 sites (see Figure 1.2 for locations). Again, the modelled turbidity is significantly lower than the measured turbidity, both before the commencement of dredging and during the dredging campaign. The discrepancy is highest during the spring tide period around 15th December 2024, after the completion of dredging. This indicates that the resuspension rate of dredged sediment after placement may be higher than that of ambient sediment.

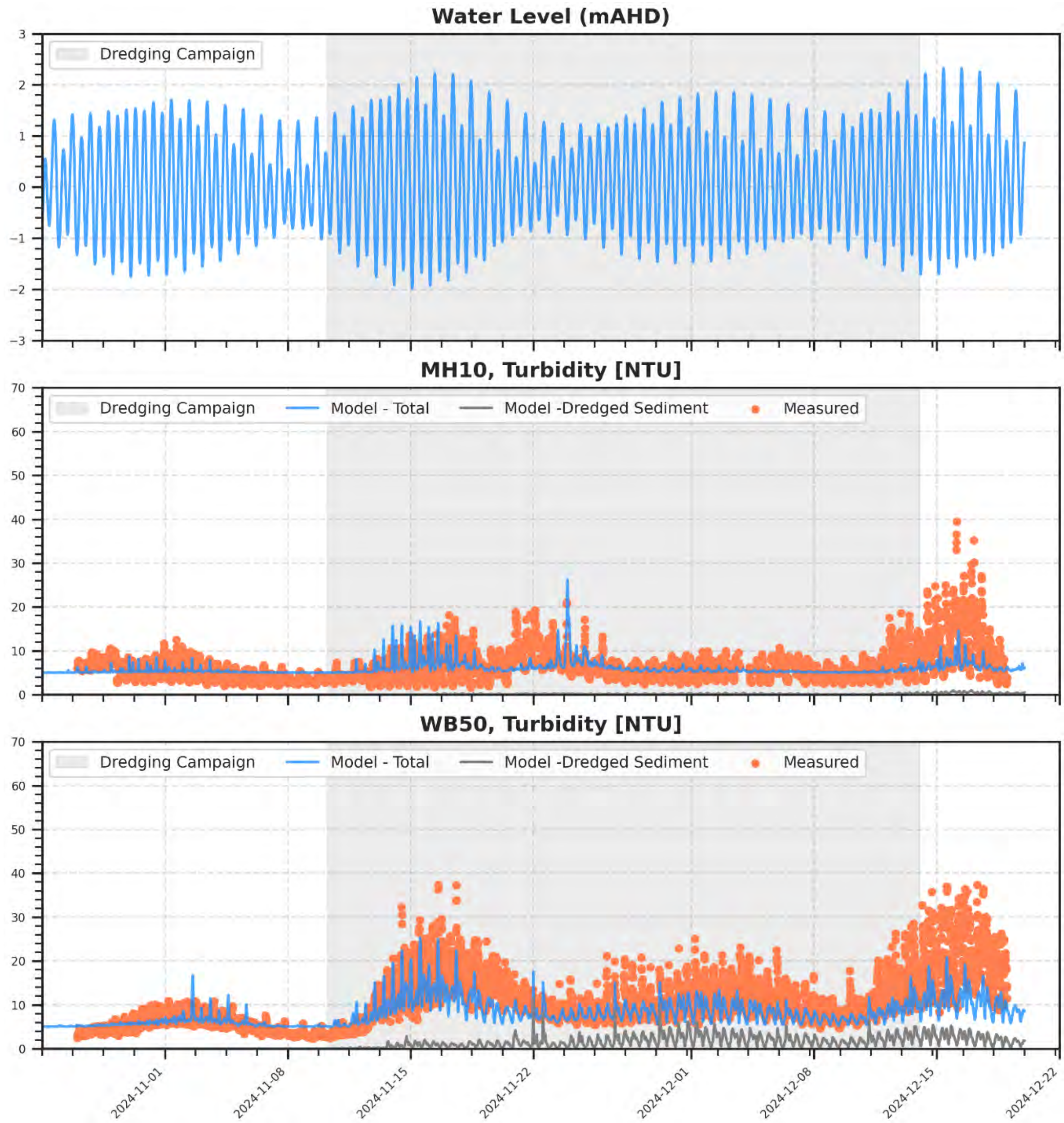

Figure 6.2 Comparison of modelled turbidity (ID = 01) with near-surface turbidity measurements from MH10 and WB50. Instrument locations are indicated in Figure 1.2. The top plot shows water levels (mAHD).

As discussed in Section 4, the observed underestimation of turbidity levels by the model could be explained by at least three different mechanisms:

- Underestimation of the plume release rate during placement;
- Higher erodibility of dredged sediment after placement relative to ambient sediment, leading to higher rates of resuspension and higher dredging-related turbidity; or
- Fouling of instruments, however no fouling of turbidity sensors was noted during the 2024 campaign.

In order to further investigate the possible magnitude of each of these mechanisms, a series of model simulations were undertaken, as shown in Table 6.1.

Table 6.1 Model scenarios and parametrisation

ID	Source rate	Bed Roughness		Sediment Erosion Rate	
		Hydrodynamic	Wave	Ambient	Dredging
01	x 1	0.005	0.003	0.24	0.24
02	x 1	0.005	0.003	0.24	0.72
03	x 1	0.02	0.003	0.12	0.24
04	x 1	0.02	0.003	0.12	0.12
05	x 2	0.05	0.03	0.24	0.48
06	x 2	0.03	0.003	0.12	0.40
07	x 2	0.03	0.003	0.16	0.40

The results from each of the simulations were analysed and the modelled turbidity at each of the fixed monitoring locations was compared to the measurements. Simulation 07 yielded the best agreement between the modelled and measured turbidity. In that simulation, the plume generation rate during placement was doubled relative to the rates in Table 4.1. In addition, the hydrodynamic roughness (used in the calculation of the bed shear stress) was increased to 0.03, and the erosion rate constant for the dredged sediment fractions was increased to 0.4. The erosion rate constant for the ambient sediment fractions was set to 0.16.

Figure 6.3 shows the comparison between the modelled and measured near-bed turbidity at sites T1 and T2 for Simulation 07 (see Figure 1.2 for locations). While the overall magnitude of the modelled turbidity matches the measurements reasonably well, the range measured from tide to tide is underestimated by the model. The proportion of the total turbidity in the model attributed to dredged sediment is also shown in the figure.

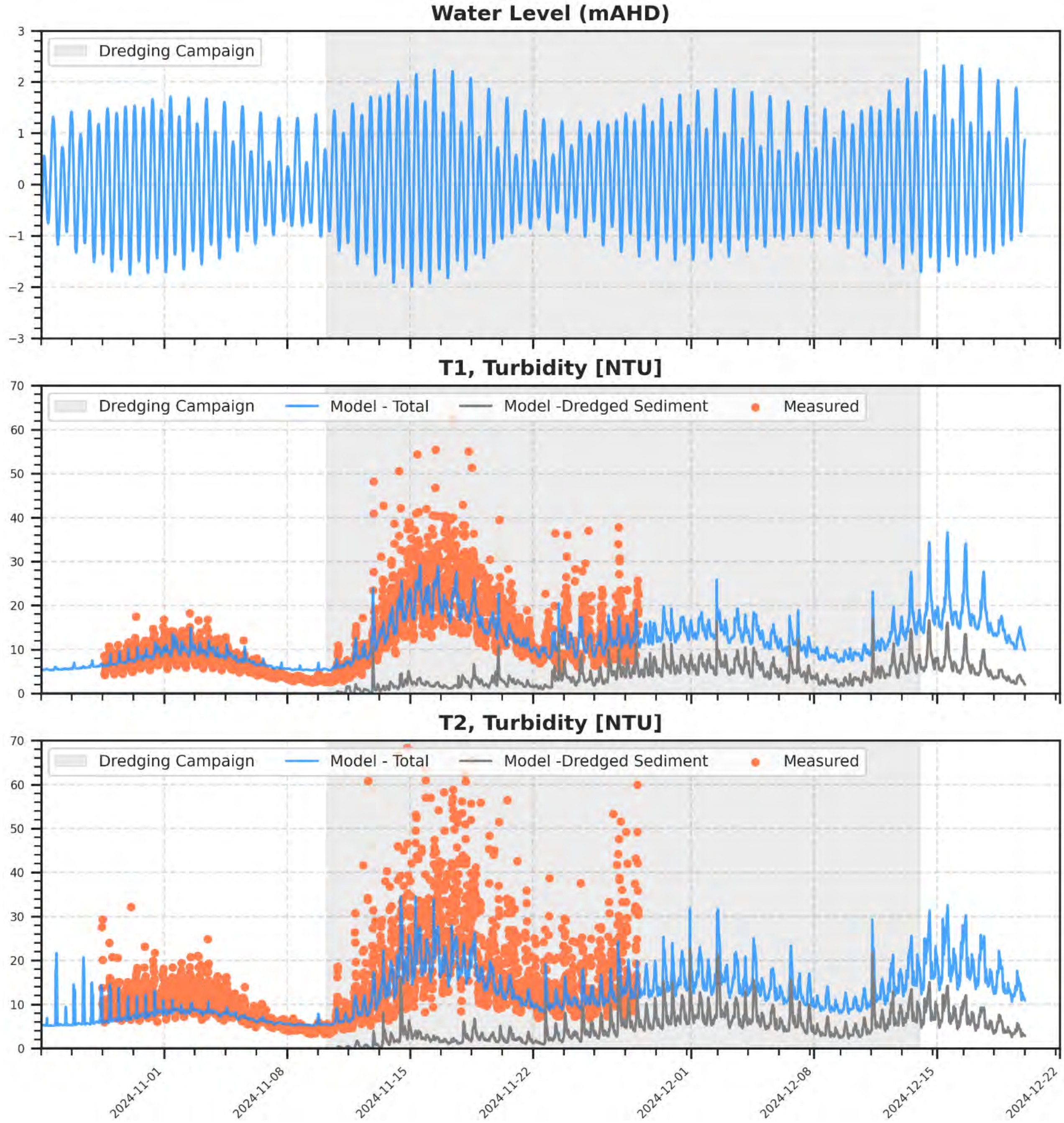

Figure 6.3 Comparison of modelled turbidity with near-bed turbidity measurements from T1 and T2. Instrument locations are indicated in Figure 1.2. The top panel shows water levels (mAHD).

Figure 6.4 shows modelled and measured near-surface turbidity at the MH10 and WB50 sites for Simulation 07 (see Figure 1.2 for locations). The modelled turbidity at MH10 is higher than the measurements during the spring tide period around 15 November 2024, but lower than that measured during the spring tide period around 15 December 2024. The modelled and measured turbidity at WB50 is in good agreement throughout, except for some underestimation of turbidity towards the end of the simulation.

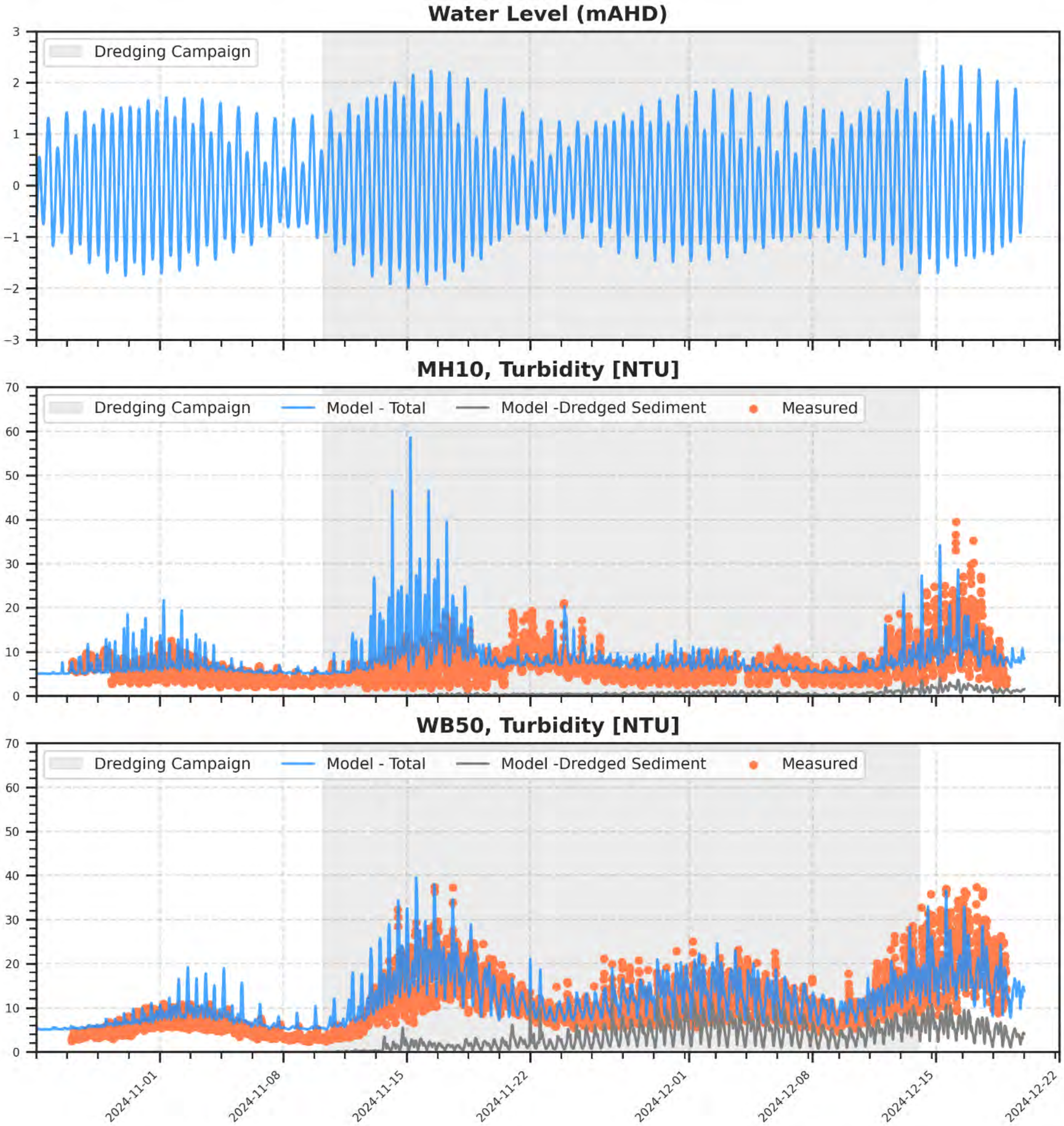

Figure 6.4 Comparison of modelled turbidity with near-surface turbidity measurements from MH10 and WB50. Instrument locations are indicated in Figure 1.2. The top panel shows water levels (mAHD).

7 ADCP Transect Validation Results – December 2024 Campaign

The measured TSS concentrations for each of the ADCP transects presented in Section 5.3 were compared to the modelled TSS in order to further assess the validity of the plume source rate assumptions. The results of Simulation 07 from Section 6 were used for this purpose, since that simulation provided the best agreement with the measured turbidity at the fixed monitoring locations.

Examples of the comparisons between the measured and modelled TSS concentrations are provided in Figure 7.1 to Figure 7.6. Overall, the agreement between the modelled and measured plume extent and concentration magnitude is quite good, although there are times when the plume concentration is underestimated and other times when it is overestimated. Given the complexity of the plume dynamics, the model performance indicates that the plume source release rate is reasonably accurate.

Additional comparison plots are provided in Annex P.

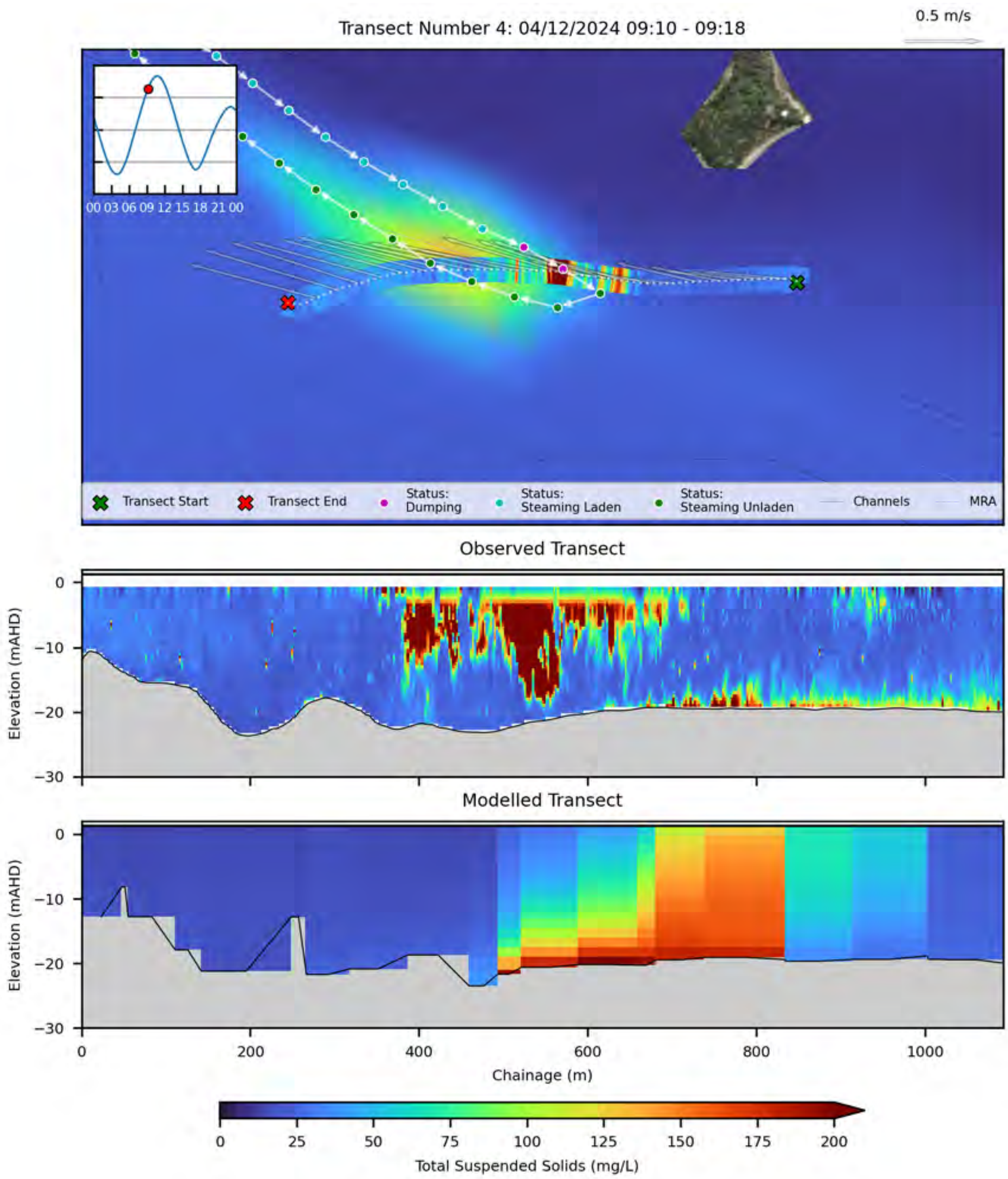

Figure 7.1 Example Comparison Between Measured (Top) and Modelled (Bottom) TSS Concentration in the Placement Plume

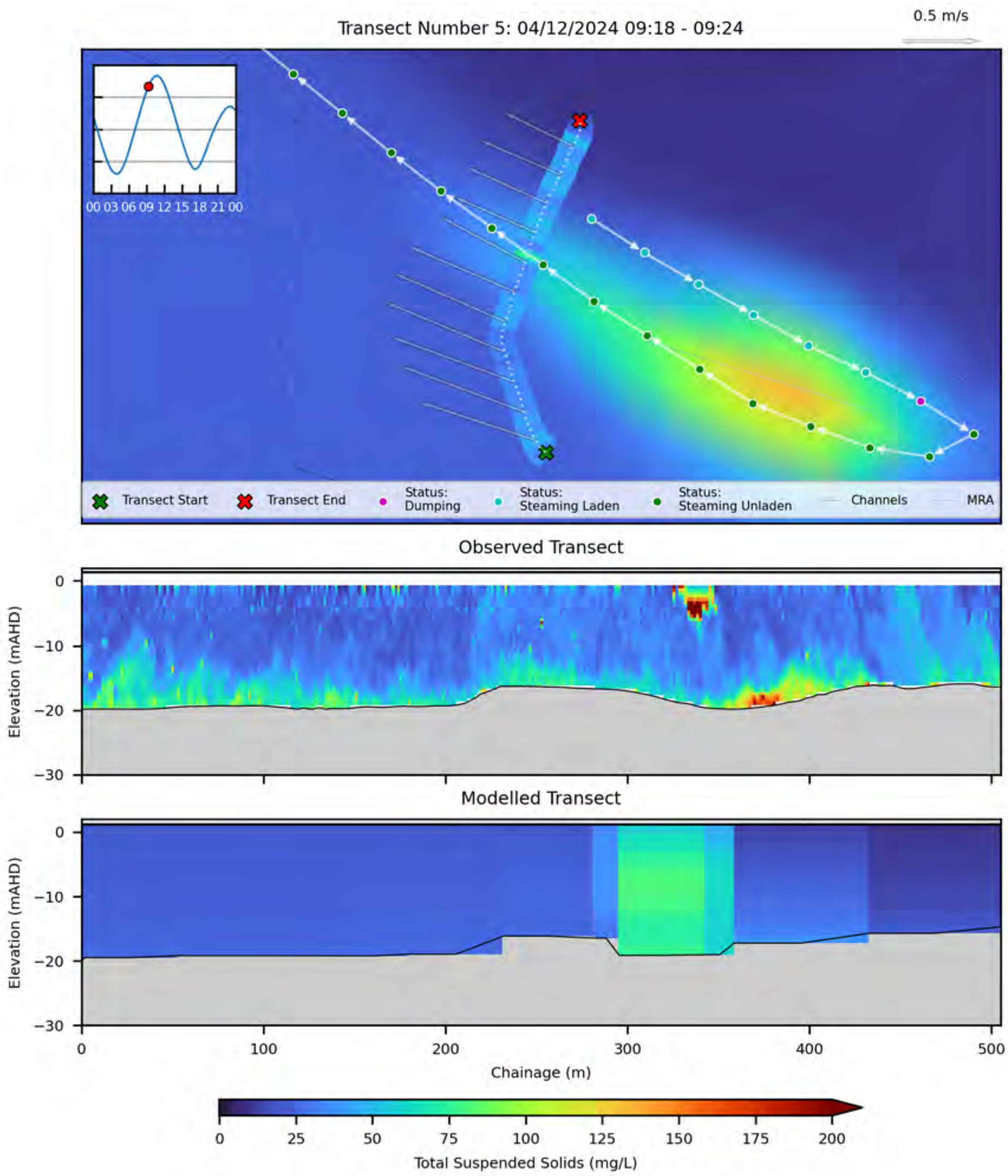

Figure 7.2 Example Comparison Between Measured (Top) and Modelled (Bottom) TSS Concentration in the Placement Plume

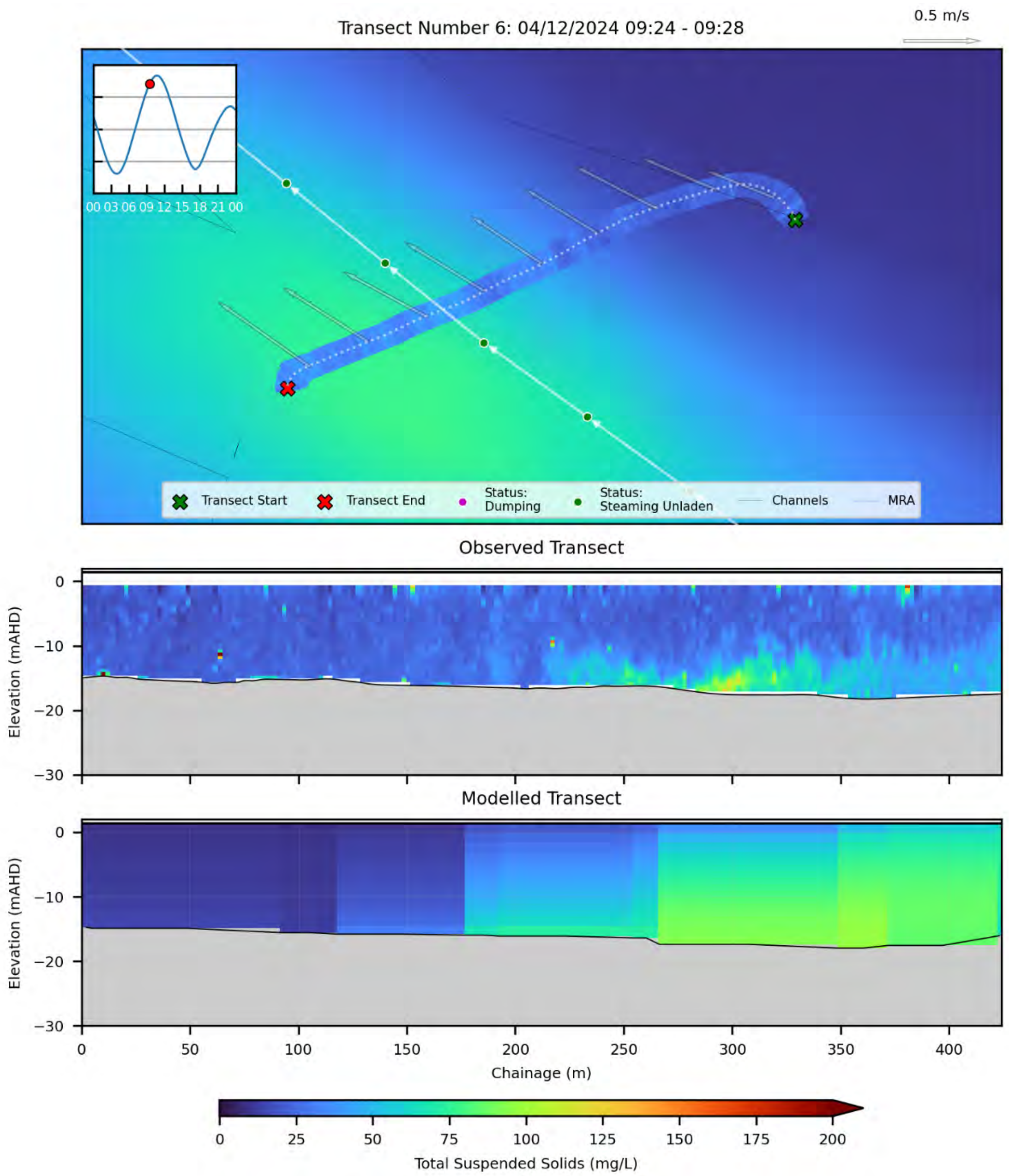

Figure 7.3 Example Comparison Between Measured (Top) and Modelled (Bottom) TSS Concentration in the Placement Plume

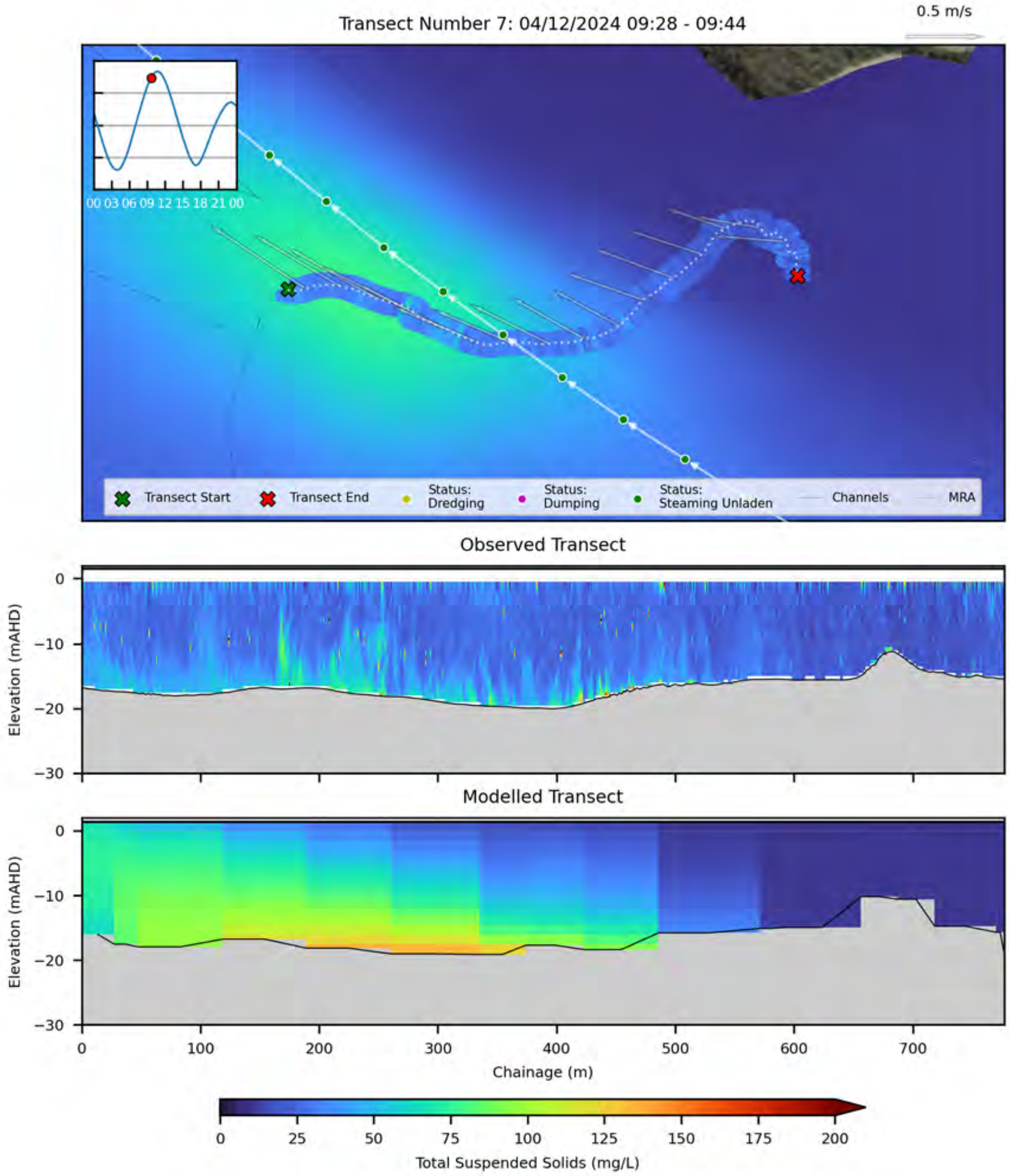

Figure 7.4 Example Comparison Between Measured (Top) and Modelled (Bottom) TSS Concentration in the Placement Plume

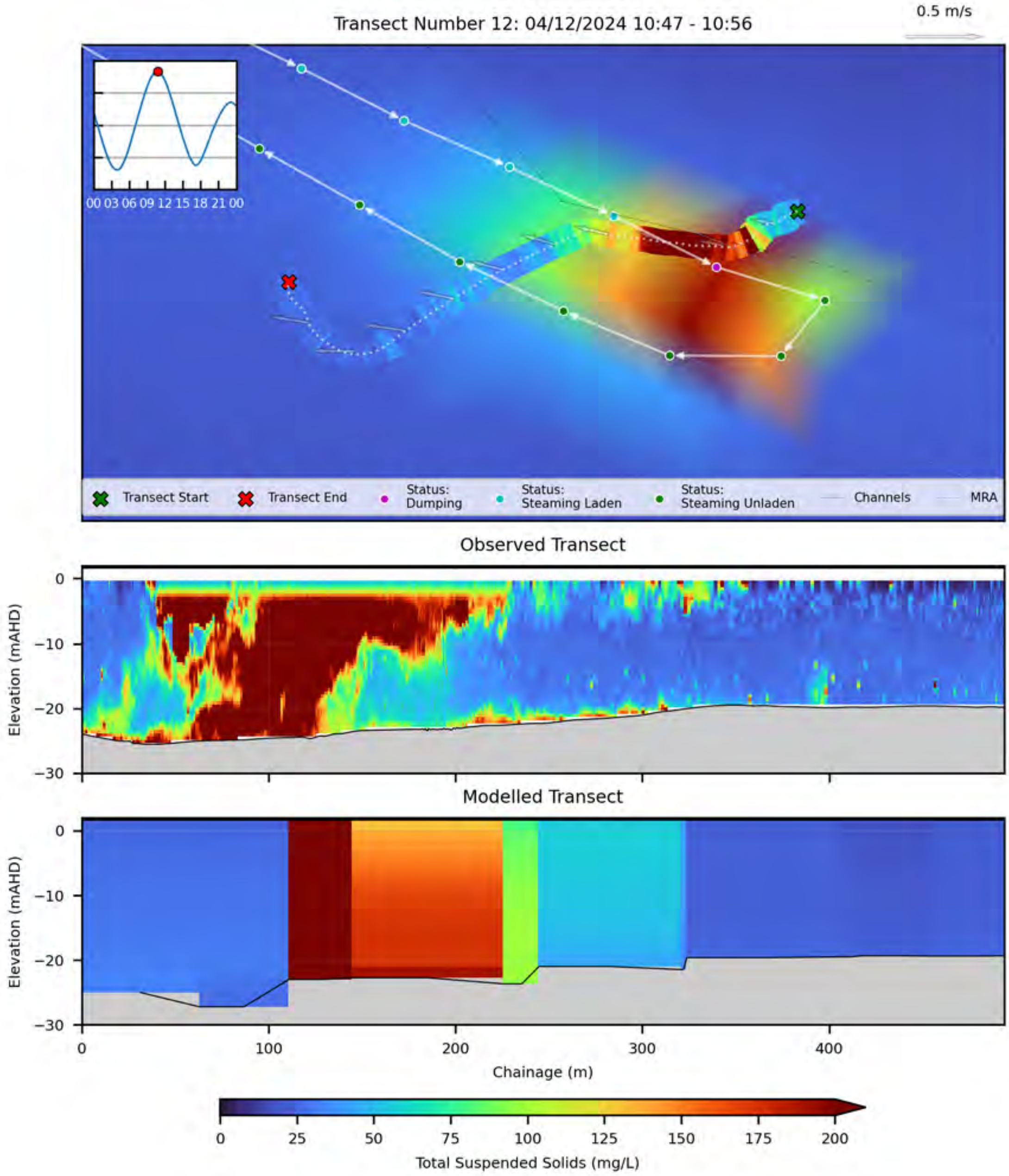

Figure 7.5 Example Comparison Between Measured (Top) and Modelled (Bottom) TSS Concentration in the Placement Plume

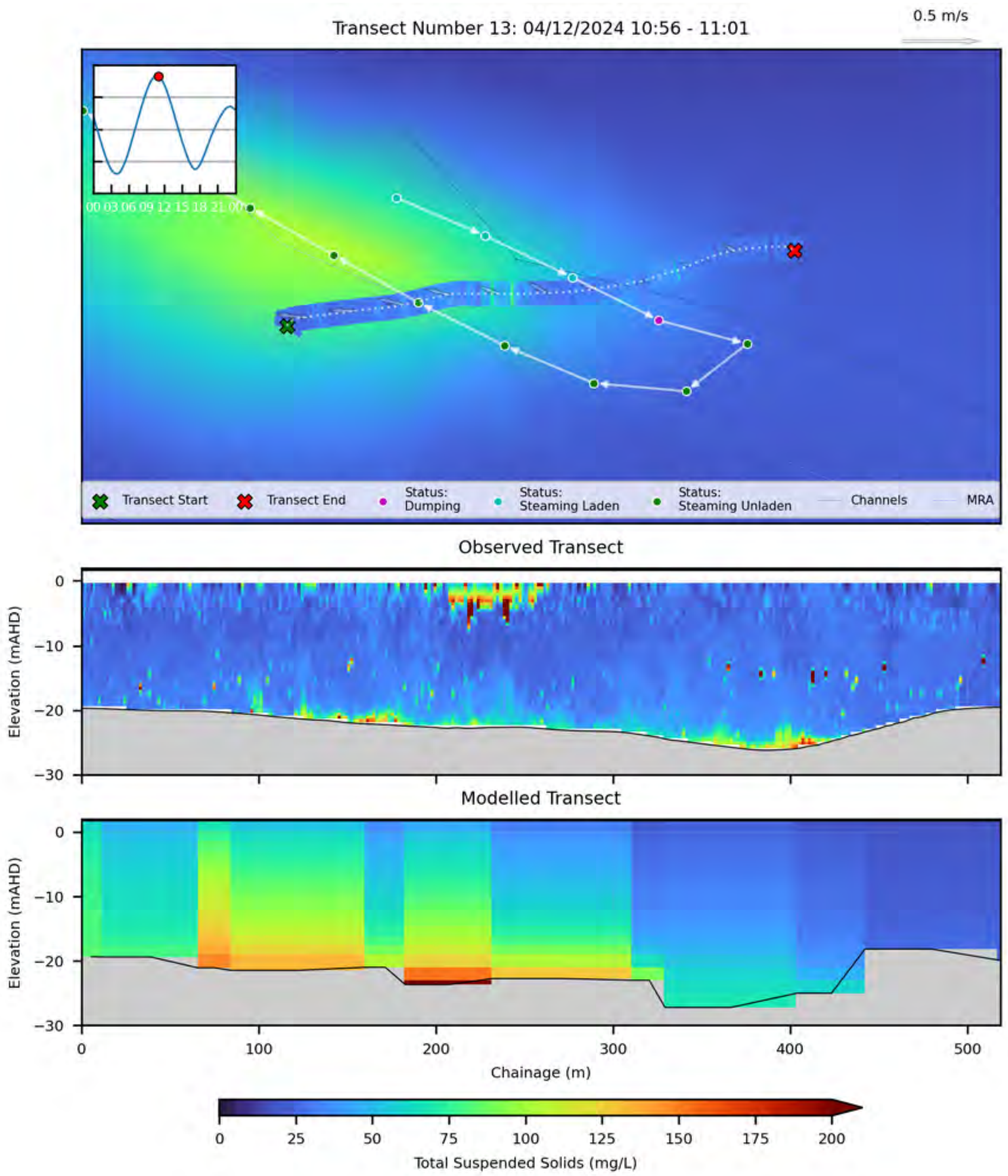

Figure 7.6 Example Comparison Between Measured (Top) and Modelled (Bottom) TSS Concentration in the Placement Plume

8 Discussion

A range of parameters were measured to characterise behaviour and contaminant loads of sediment plumes generated by the TSHD *Brisbane* conducting maintenance dredging activities during the 2023 campaign conducted in August-September. In particular activities assessed were dredging at LNG swing basins with placement of material at the alternative in-channel Tide Island MRA.

Overall, sediment plumes behaviour as well as contaminant loads were consistent with previous plume studies and modelling-based predictions carried out by BMT (2023) as part of the impact assessment for this activity with no expected impacts to sensitive receptors or receiving environment including water quality.

8.1 Turbid Plumes Extent, Longevity and Intensities

The collected ADCP transects and water grabs for TSS and PSD were analysed as per Section 2.3 and utilised to characterise extent, longevity and intensity of turbid plumes generated during LNG swing basins loading activities with placement at the alternative in-channel Tide Island MRA.

The Tide Island MRA impact assessment (BMT, 2023) showed that apart from the area of direct impact corresponding to loading and placement footprint, no Zone of Impact was expected from the activity. Only a Zone of Influence was present which is the area where plumes are expected to be identified above background and measured by turbidity instruments, but are not expected to cause any ecological impact. This was limited to areas near LNG facilities and Jacobs Channel, the Tide Island MRA, a small area near the Clinton Channel and Bypass. Within this overall area and the modelled Zone of Influence, the only sensitive receptors that were identified and mapped were the Passage Island seagrass meadows, adjacent to Jacobs Channel. Therefore, these meadows were the only sensitive receptor that was expected to potentially be reached by activity-generated turbid plumes but without any expected ecological impact.

Transect measurements showed the turbid plume characteristics to be consistent with modelling predictions, i.e. transient features mainly limited in extent to within the navigation channel where the dredging and placement activities took place. On 23rd and 24th August 2023 and 4th and 6th December 2024, plumes measured around dredging and placement activities showed good agreement with modelled Zone of Influence and thus no impact to seagrass meadows adjacent to activities was expected.

8.2 Turbid Plumes PSD

Particle Size Distribution analysis of turbid plumes is important in the context of plumes behaviour discussed in the previous section. In fact, PSD of surface sediments in dredged areas are used to inform modelling inputs, including in the Tide Island MRA Impact Assessment (BMT, 2023).

As described in Section 2, water grabs were collected and subsequently analysed for PSD whilst concurrently with grabs collection, *in situ* PSD measurements were obtained using the LISST-200x instrument. In general the results for the background samples were consistent with previous information used in the modelling with sediments dominated by clays at both Jacobs Channel and Tide Island MRA.

The *in situ* LISST profiling measurements showed a significantly higher proportion of coarser particles than the laboratory PSD results. (Section 3.4 and Section 5.4). This suggests that fine sediments resuspended by dredging activities within plumes are flocculated, and so tend to behave like larger-diameter, lower-density single particles.

These flocs settle much faster (by approximately an order of magnitude) than the individual constituent particles and thus significantly affect the behaviour of dredging plumes. The discrepancies between laboratory and LISST PSD are likely due to the sampling and laboratory analysis process breaking the flocs. The difference can provide an indication on the proportion of fine sediment that is aggregated into flocs, an approach that has been adopted in other dredging studies (Beecroft *et al.* 2019). Moreover, these patterns and findings are in line with literature and other recent studies undertaken around dredging activities at the PoG (Symonds *et al.* 2022 and Symonds *et al.* 2023).

8.3 Turbidity Time Series

Turbidity data from fixed monitoring locations adjacent to the Tide Island MRA deployed specifically for this study was analysed to determine whether the magnitude and frequency of the potential dredging-related signal was consistent with the model outputs. Moreover, turbidity data from water quality buoys deployed as part of the maintenance dredging monitoring program were also used for the same purpose. These included a compliance site within the predicted maintenance dredging Zone of Influence (WB50) and one support site (MH10) well away from the predicted Zone of Influence as per latest Port of Gladstone Maintenance Dredging Impact Assessment (BMT, 2021).

Turbidity data from both monitoring stations adjacent to the Tide Island MRA showed some increase in turbidity levels during a spring tide period during dredging compared to a similar spring tide period prior to dredging. This is in contrast to the modelling results presented in the impact assessment (BMT, 2023) which indicated only small increases in the 50th and 95th percentiles of the turbidity at those locations. The reasons for this discrepancy were investigated by undertaking hindcast modelling.

8.4 Water Quality Parameters

Maintenance dredging and placement activities can temporarily increase nutrient and metal/metalloid concentrations in the water column through several processes. These include resuspension of particulate-bound contaminants, release of dissolved constituents following seafloor disturbance and release of particulate-bound constituents in dredged sediments and waters from the dredge hopper at placements sites.

Analysis of grab samples collected as part of this study, 2023 and 2024 campaign, show that nutrient concentrations in dredging and placement plumes were typically within the range of baseline conditions and in line with previous PoG maintenance dredging plume studies (BMT 2018).

Exceptions were:

2023 sampling:

- An increase in NOx concentrations in samples collected on the 24/08/2023. BMT (2018) also recorded elevated NOx in maintenance dredging plumes at another site in PoG, but also in background samples. This suggests NOx above the WQO occurs naturally in the PoG. Nutrient concentrations can vary over time in response to flood events, natural sediment resuspension processes, as well as the maintenance dredging history of the site.
- On the day of the NoX WQO exceedance, total phosphorous levels were lower than on the 23/08/2023 and the 25/08/2023 when background sampling was conducted. The higher levels of total phosphorous recorded in the background samples possibly reflects the high energy environment of the PoG highlighting the significance of natural background processes such as natural resuspension occurring in the harbour; and
- Total and dissolved metal and metalloids concentrations were typically below default guideline values. The exception was dissolved copper on the 25/08/2023 in background samples. Previous investigations and long-term monitoring programs (BMT, 2018 and PCIMP, 2023 respectively) have

also recorded copper concentrations above the DGV, which may be due to natural processes or sampling/analysis error.

2024 sampling:

- Total P in three (3) samples collected on the 06/12/2024 had concentrations well above the WQO. These samples were collected within plumes at the bottom or mid of the water column. These elevated levels may be due to sampling error or natural resuspension of the bed;

- Concentrations of total copper on the 04 and 06/12/2024 and total arsenic, chromium, lead and zinc in some samples collected on the 06/12/2024 were above DGVs. The dissolved concentrations of these metals were all <LOR and/or below DGVs, as also reported in previous studies (BMT 2018) showing that sediments and sediments bound contaminants will rapidly disperse and reach background levels within hours. Moreover, whilst metal(loid)s total and dissolved concentrations can both be compared to DGVs, the dissolved concentration is more relevant for assessing the potential bioavailable fraction causing toxicity (ANZG 2018).

Grab water sample results from the present study were in agreement with previous studies conducted on PoG maintenance dredging plumes (BMT 2018) and trends summarised in the Tide Island Impact Assessment (BMT 2023). These studies indicate that nutrients, metals and metalloids in maintenance dredging and disposal plumes pose a low risk to the environment.

8.5 Hindcast Modelling Results

Numerical modelling of periods encompassing both the 2023 and 2024 dredging campaigns was carried out to further investigate the reason for the higher levels of turbidity measured during the dredging campaigns. The model parameters were adjusted to obtain a good agreement between the modelled and measured turbidity at four fixed monitoring sites. It was necessary to increase the plume generation rate and the erosion rate constant for the dredged sediment in order to achieve a good agreement. This indicates that the assumptions that were adopted in the original impact assessment (BMT, 2023) were likely to have underestimated the extent and magnitude of dredging-related TSS, mainly due to enhanced resuspension of dredging-related sediment during spring tide periods. It is also possible that fouling of the turbidity measurement sondes affected some of the measurements, but two independent sensors were deployed at each site and the measurements were mostly consistent between the two sondes.

The maintenance dredging impact assessment has been recently revised to reflect the results of this monitoring and modelling report, as part of GPC’s commitment to continuous improvement (BMT, 2025). The revised assessment adopted revised dredging-related source terms and modified sediment erosion parameters, consistent with the outcomes of this study, and confirmed that no negative impacts on sensitive receptors are expected as a consequence of the annual maintenance dredging and Tide Island MRA placement activities.

9 Conclusions

As part of the SSM Project investigating the potential for alternative beneficial reuse of maintenance dredging material, GPC obtained a DA to undertake alternative placement of dredged material from LNG swing basins at the in-channel Tide Island MRA.

The TSHD *Brisbane* carried out the alternative placement activity as part of the 2023 and 2024 annual maintenance dredging campaigns (August-September 2023 and November-December 2024). Monitoring of plumes generated during this activity was undertaken during both campaigns to measure the extent and magnitude of dredging-related plumes, validate the Tide Island MRA Impact Assessment modelling outputs and inform future maintenance dredging campaigns. Specific aims of the monitoring campaign were to:

- Characterise the behaviour of dredge plumes and their constituents such as sediments, metals, metalloids and nutrients during flood and ebb tides; and
- Assess the potential exposure of sensitive receptors to dredge plumes generated by the activity in these conditions.

Analysis of the monitoring data shows that plumes generated by dredging at LNG swing basins with placement at the proposed in-channel MRA at Tide Island are ephemeral features and pose a low risk to the environment. However, some evidence of elevated turbidity measured at the fixed turbidity monitoring sites during dredging indicated that the plume-related signal may have been higher than expected. Hindcast modelling of both the 2023 and 2024 dredging campaigns was undertaken in order to investigate this observation and to validate the findings of the Tide Island MRA Impact Assessment (BMT, 2023).

Summary of study findings include:

- Analysis of ADCP measurements undertaken during flood and ebb tides show turbid plumes generated by maintenance dredging and placement activities are rapidly advected in the direction of the tidal currents. In turn plume dispersion and settling is relatively rapid and they remain predominantly isolated to the navigation channel and did not affect sensitive receptors, consistent with related impact assessment results and previous modelling;
- Grab sample PSD analysis showed that sediment characteristics at the dredging and placement areas are consistent with previous data used to inform modelling of the activity. Moreover, a significant difference was found between field measured and laboratory measured PSD with the former displaying a higher proportion of coarser sediments. The difference is due to the formation of flocs under field conditions which significantly affect the behaviour of turbid plumes. These findings are in line with previous with scientific literature and recent studies undertaken around PoG maintenance and capital dredging activities;
- Turbidity data collected from fixed monitoring stations adjacent to the Tide Island MRA and as part of the GPC maintenance dredging monitoring program show some evidence of elevated turbidity during the dredging campaign relative to measurements during similar hydrodynamic conditions prior to dredging.
- Hindcast modelling results indicate that elevated turbidity measurements at the fixed measurement locations could be caused by resuspension of previously placed sediment being resuspended at a higher rate than ambient sediment, or that the plume generation rate during placement was higher than expected. Overall, though, the measured extent and intensity of dredging-related plumes are consistent with the results of the Tide Island MRA Impact Assessment (BMT, 2023).

- Grab samples analysis show that nutrient, metal and metalloids concentrations in dredging and placement plumes were typically within the range of baseline conditions and in line with previous PoG maintenance dredging plume studies (BMT 2018).

The observed extents and intensity of the dredging-related plumes are consistent with the findings of the Tide Island MRA Impact Assessment (BMT, 2023) and the revised Gladstone Maintenance Dredging Impact Assessment (BMT, 2025) which included revised plume source release rates and sediment transport parameterisation consistent with the validated modelling results presented in this report. The measurements of the plume extents confirmed that sensitive receptor habitats (seagrass meadows, reef communities) were not negatively impacted. The bulk of the suspended sediment plume remained within the shipping channels (disturbed footprint), and observed plume dispersion and settling was relatively rapid.

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Annex A Sample TSS Results – August 2023 Campaign

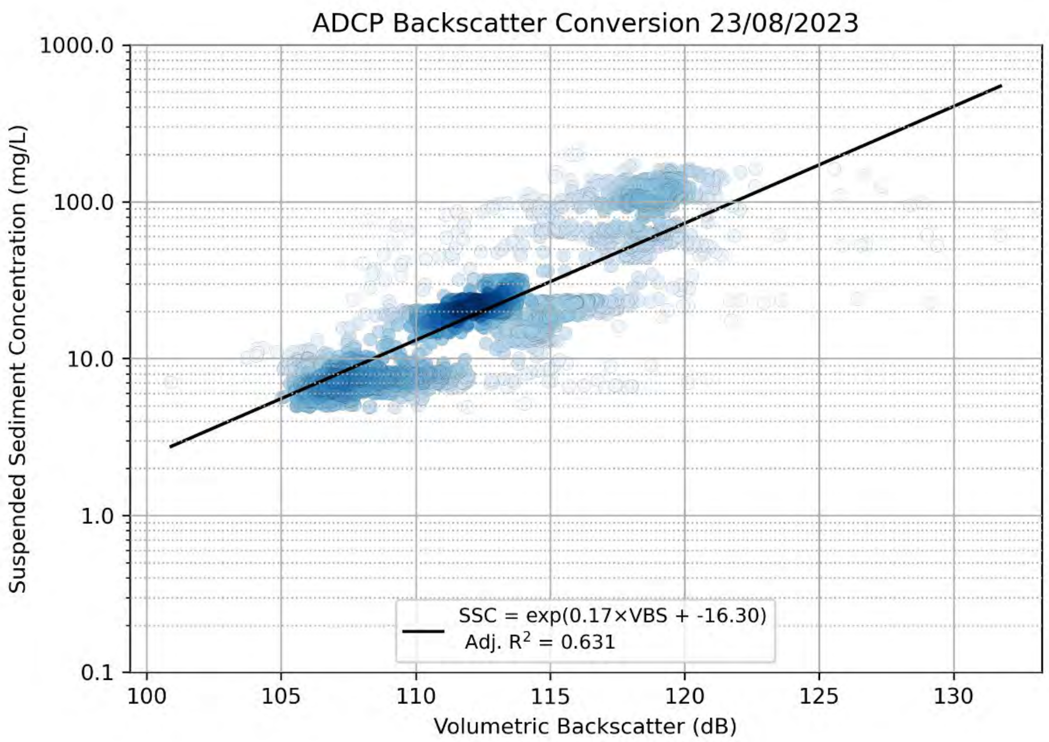
Table A.1. Summary of all TSS results Collected Over the August 2023 Monitoring Campaign

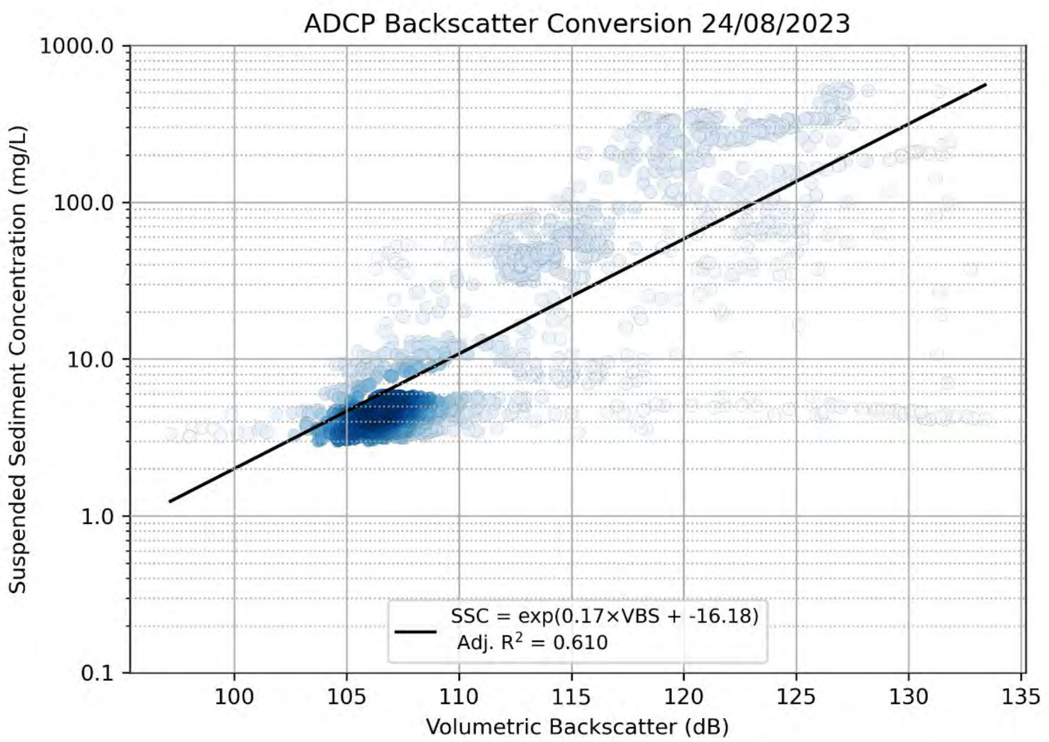
Date	Location	Latitude (°)	Longitude (°)	Depth (m)	TSS (mg/L)	Description
23/08/2023 11:05	Jacobs Channel - off GLNG MOF	-23.79891	151.21539	–	5	Residual Dredge Placement Plume
23/08/2023 11:09	Jacobs Channel - off GLNG MOF	-23.79851	151.21430	8.2	12	Residual Dredge Placement Plume
23/08/2023 11:13	Jacobs Channel - off GLNG MOF	-23.79797	151.21314	14.0	32	Residual Dredge Placement Plume
23/08/2023 12:08	Tide Island MRA	-23.80386	151.22319	–	12	Dredge Placement
23/08/2023 12:12	Tide Island MRA	-23.80444	151.22178	8.3	14	Dredge Placement
23/08/2023 12:15	Tide Island MRA	-23.80448	151.22094	17.3	46	Dredge Placement
23/08/2023 12:35	Jacobs Channel - off Hamilton Point	-23.80173	151.21777	16.2	44	Residual Dredge Placement Plume
23/08/2023 12:38	Jacobs Channel - off Hamilton Point	-23.80162	151.21727	10.1	<5	Residual Dredge Placement Plume
23/08/2023 12:40	Jacobs Channel - off Hamilton Point	-23.80158	151.21694	1.5	12	Residual Dredge Placement Plume
23/08/2023 13:04	Jacobs Channel - off GLNG MOF	-23.79749	151.21598	–	13	Residual Dredge Placement Plume
23/08/2023 13:06	Jacobs Channel - off GLNG MOF	-23.79754	151.21599	–	15	Residual Dredge Placement Plume
23/08/2023 13:09	Jacobs Channel - off GLNG MOF	-23.79762	151.21587	–	8	Residual Dredge Placement Plume
23/08/2023 14:27	Tide Island MRA	-23.80351	151.22284	16.2	20	Residual Dredge Placement Plume
23/08/2023 14:29	Tide Island MRA	-23.80384	151.22301	9.1	6	Residual Dredge Placement Plume
23/08/2023 14:31	Tide Island MRA	-23.80423	151.22319	2.5	8	Residual Dredge Placement Plume
24/08/2023 09:03	Jacobs Channel - off Hamilton Point	-23.80154	151.21659	8.8	<5	Background
24/08/2023 09:03	Jacobs Channel - off Hamilton Point	-23.80154	151.21657	8.0	<5	Background
24/08/2023 09:09	Jacobs Channel - off Hamilton Point	-23.80078	151.21544	1.5	<5	Background
24/08/2023 09:31	Jacobs Channel - off GLNG MOF	-23.79408	151.20881	1.8	<5	Background
24/08/2023 09:34	Jacobs Channel - off GLNG MOF	-23.79351	151.20825	7.6	<5	Background
24/08/2023 09:37	Jacobs Channel - off GLNG MOF	-23.79296	151.20769	14.4	<5	Background
24/08/2023 10:05	Jacobs Channel - off GLNG MOF	-23.79450	151.20958	1.4	<5	Background
24/08/2023 10:08	Jacobs Channel - off GLNG MOF	-23.79395	151.20876	7.2	<5	Background

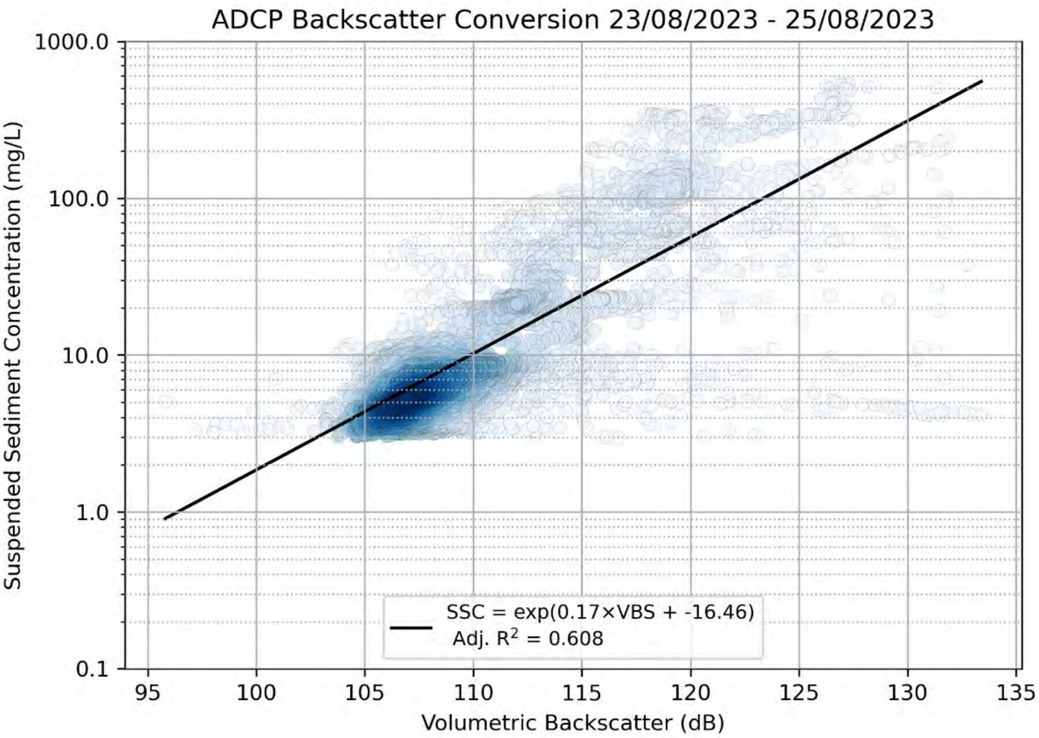
Date	Location	Latitude (°)	Longitude (°)	Depth (m)	TSS (mg/L)	Description
24/08/2023 10:11	Jacobs Channel - off GLNG MOF	-23.79341	151.20804	14.6	<5	Background
24/08/2023 11:08	Tide Island MRA	-23.80270	151.22094	18.2	34	Dredge Placement
24/08/2023 11:11	Tide Island MRA	-23.80230	151.22004	9.2	5	Dredge Placement
24/08/2023 11:14	Tide Island MRA	-23.80182	151.21902	1.5	<5	Dredge Placement
24/08/2023 11:37	Jacobs Channel - off Hamilton Point	-23.80000	151.21538	15.8	278	Residual Dredge Placement Plume
24/08/2023 11:39	Jacobs Channel - off Hamilton Point	-23.79961	151.21456	7.5	22	Residual Dredge Placement Plume
24/08/2023 11:41	Jacobs Channel - off Hamilton Point	-23.79924	151.21372	1.2	10	Residual Dredge Placement Plume
24/08/2023 12:25	Tide Island MRA	-23.80487	151.22498	1.4	13	Dredge Placement
24/08/2023 12:29	Tide Island MRA	-23.80506	151.22293	9.6	<5	Dredge Placement
24/08/2023 12:31	Tide Island MRA	-23.80504	151.22251	16.1	72	Dredge Placement
24/08/2023 13:35	Jacobs Channel - off GLNG MOF	-23.79289	151.20916	1.5	<5	Residual Dredge Placement Plume
24/08/2023 13:38	Jacobs Channel - off GLNG MOF	-23.79298	151.20882	8.2	6	Residual Dredge Placement Plume
24/08/2023 13:40	Jacobs Channel - off GLNG MOF	-23.79297	151.20838	14.3	12	Residual Dredge Placement Plume
25/08/2023 07:49	Tide Island MRA	-23.80817	151.23070	13.9	<5	Background
25/08/2023 07:51	Tide Island MRA	-23.80793	151.23077	12.1	<5	Background
25/08/2023 07:55	Tide Island MRA	-23.80745	151.23078	1.4	14	Background
25/08/2023 08:20	Tide Island MRA	-23.80573	151.22404	1.6	<5	Background
25/08/2023 08:23	Tide Island MRA	-23.80539	151.22366	8.9	<5	Background
25/08/2023 08:23	Tide Island MRA	-23.80539	151.22366	8.9	<5	Background
25/08/2023 08:23	Tide Island MRA	-23.80539	151.22366	8.9	<5	Background
25/08/2023 08:27	Tide Island MRA	-23.80489	151.22327	13.9	<5	Background
25/08/2023 08:56	Jacobs Channel - off Hamilton Point	-23.79949	151.21671	2.1	<5	Background
25/08/2023 08:59	Jacobs Channel - off Hamilton Point	-23.79918	151.21639	6.6	<5	Background
25/08/2023 09:02	Jacobs Channel - off Hamilton Point	-23.79889	151.21611	14.3	<5	Background
25/08/2023 09:57	Jacobs Channel - GLNG Swing Basin	-23.78830	151.20548	14.0	<5	Background
25/08/2023 09:59	Jacobs Channel - GLNG Swing Basin	-23.78787	151.20487	6.8	<5	Background
25/08/2023 10:02	Jacobs Channel - GLNG Swing Basin	-23.78753	151.20439	1.5	<5	Background

Measurements with no depths recorded due to YSI not recording at time of sampling

Annex B TSS and Volumetric Backscatter Relationships – August 2023 Campaign

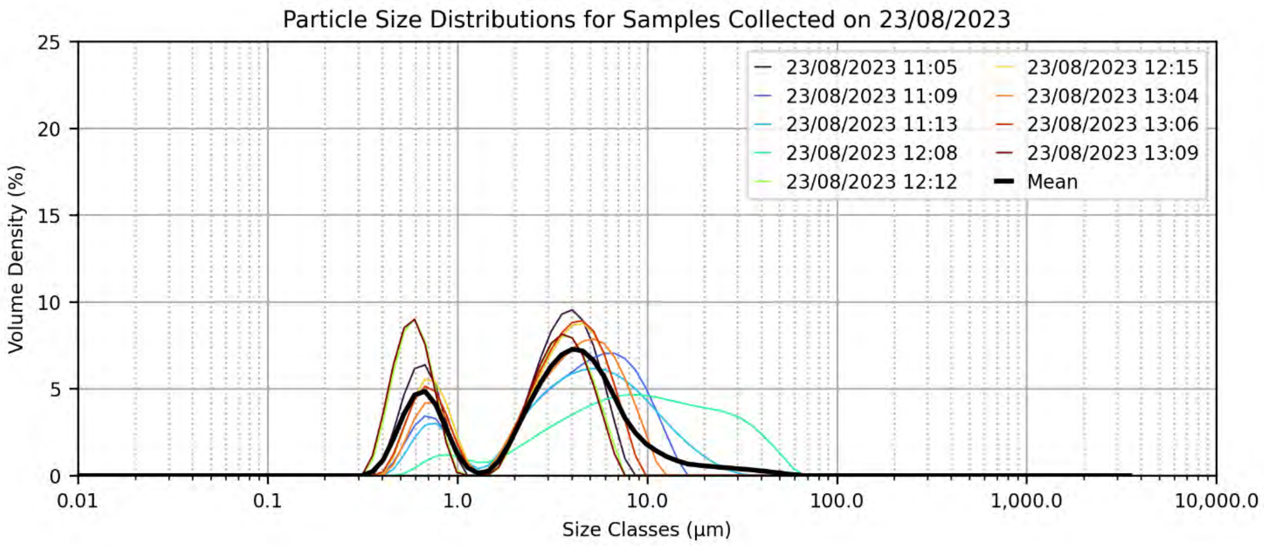


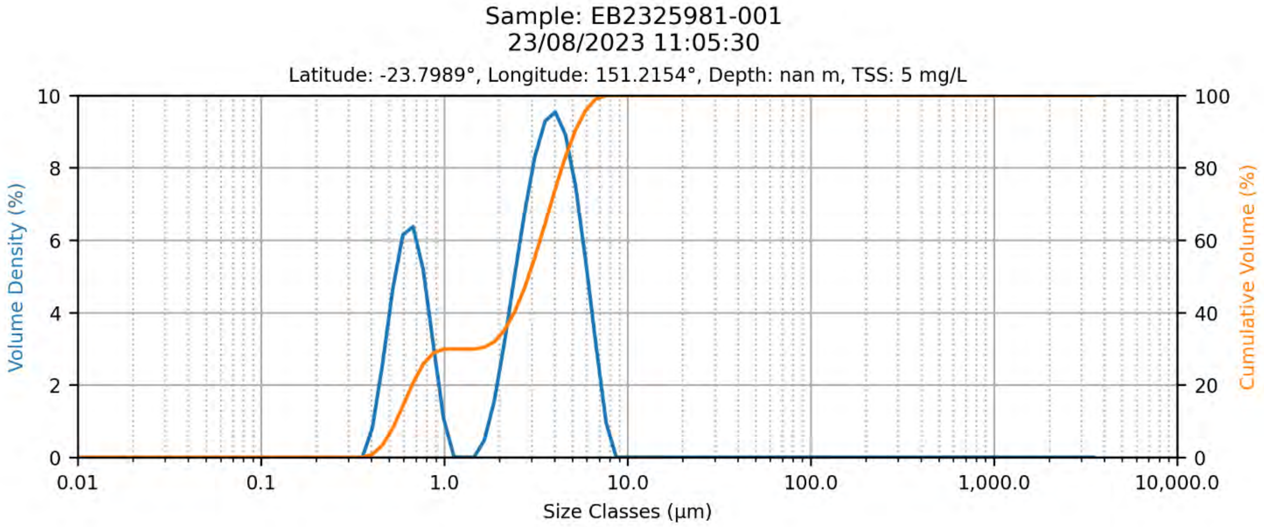



ADCP Backscatter Conversion 23/08/2023 - 25/08/2023
Suspended Sediment Concentration (mg/L)
1000.0
100.0
10.0
1.0
0.1
95
100
105
110
115
120
125
130
135
Volumetric Backscatter (dB)
SSC = exp(0.17×VBS + -16.46)
Adj. R2 = 0.608

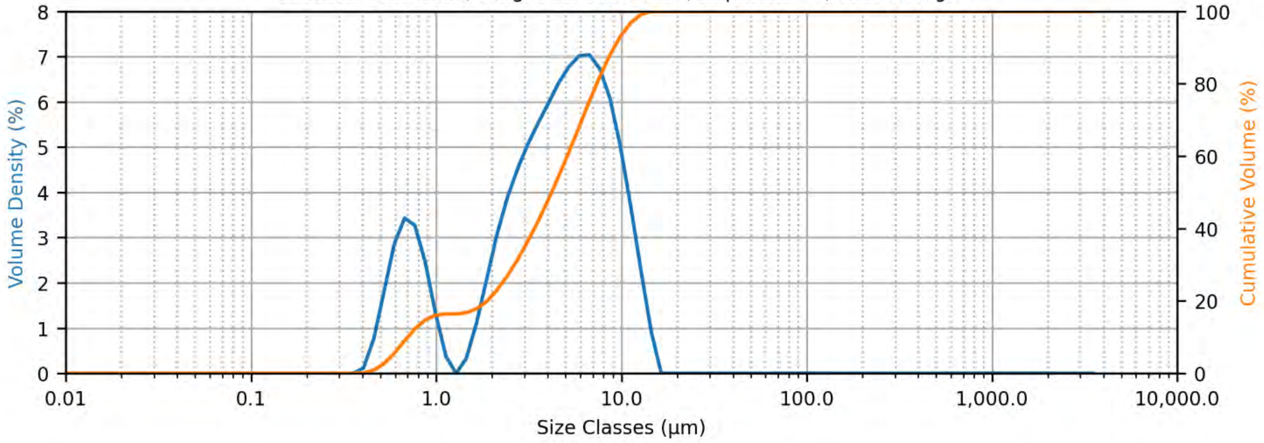
Annex C Sample PSD Results – August 2023 Campaign

C.1 23rd August 2023

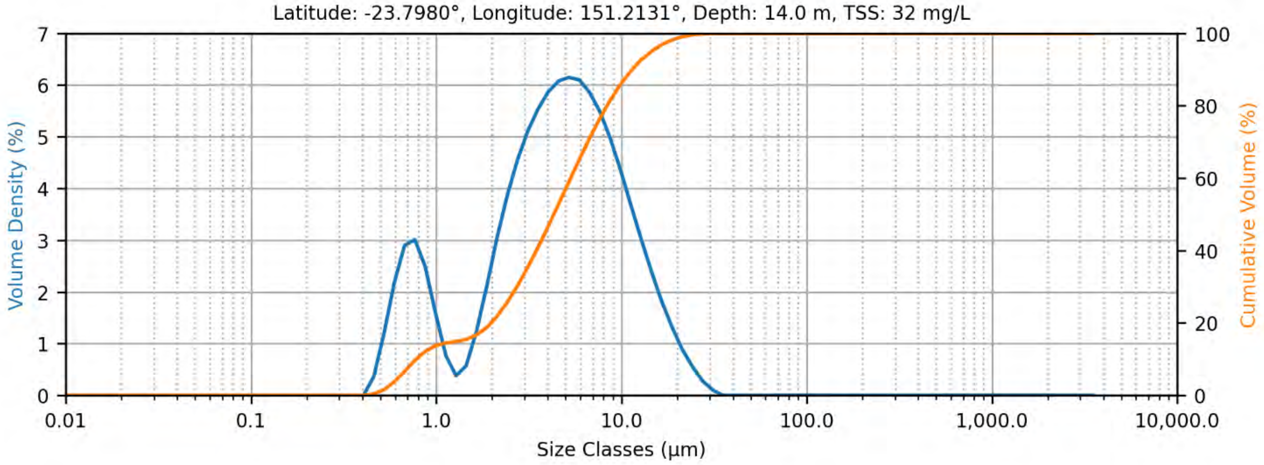




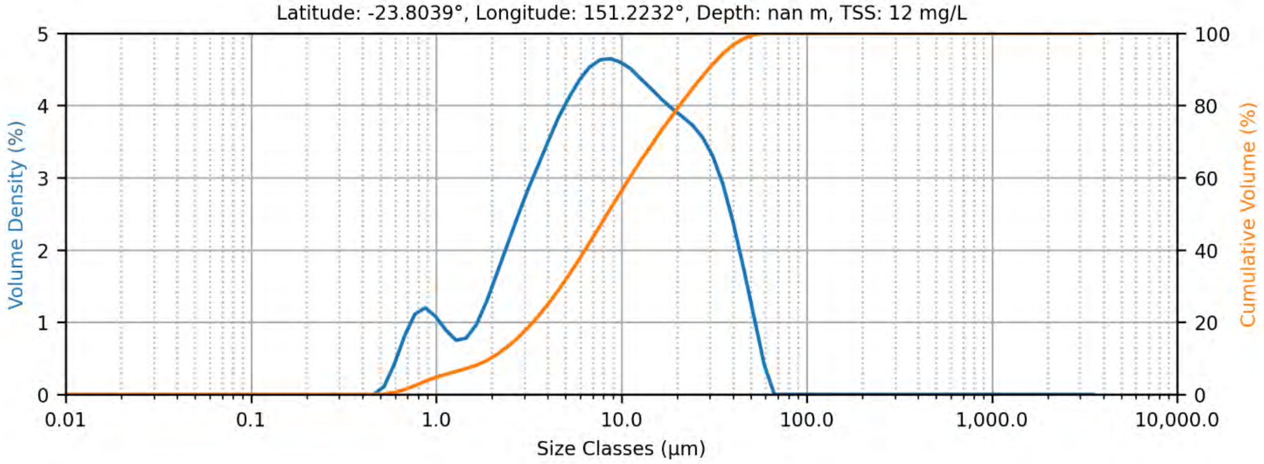
Sample: EB2325981-002
23/08/2023 11:09:04
Latitude: -23.7985°, Longitude: 151.2143°, Depth: 8.2 m, TSS: 12 mg/L



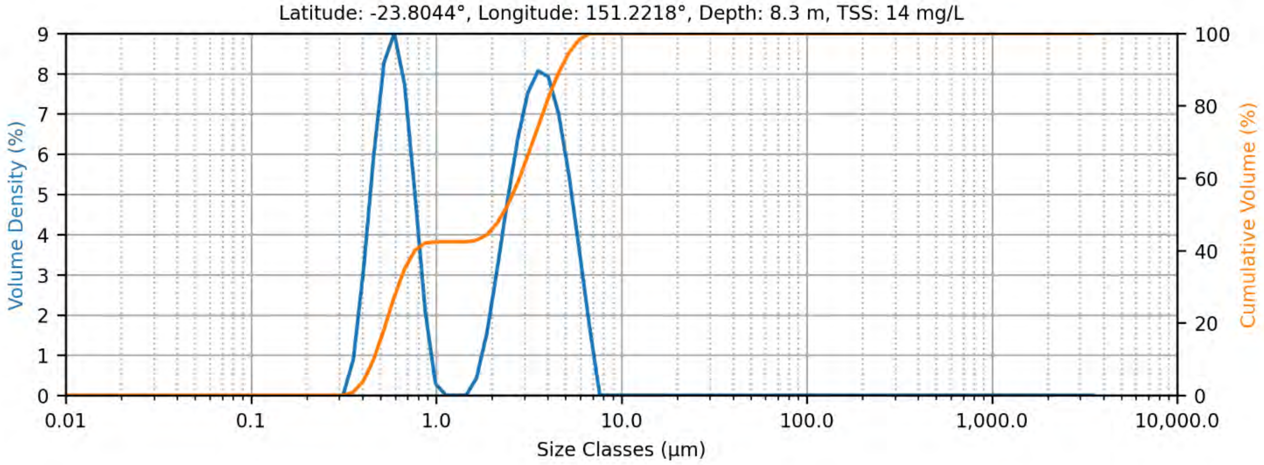
Sample: EB2325981-003
23/08/2023 11:13:08
Latitude: -23.7980°, Longitude: 151.2131°, Depth: 14.0 m, TSS: 32 mg/L



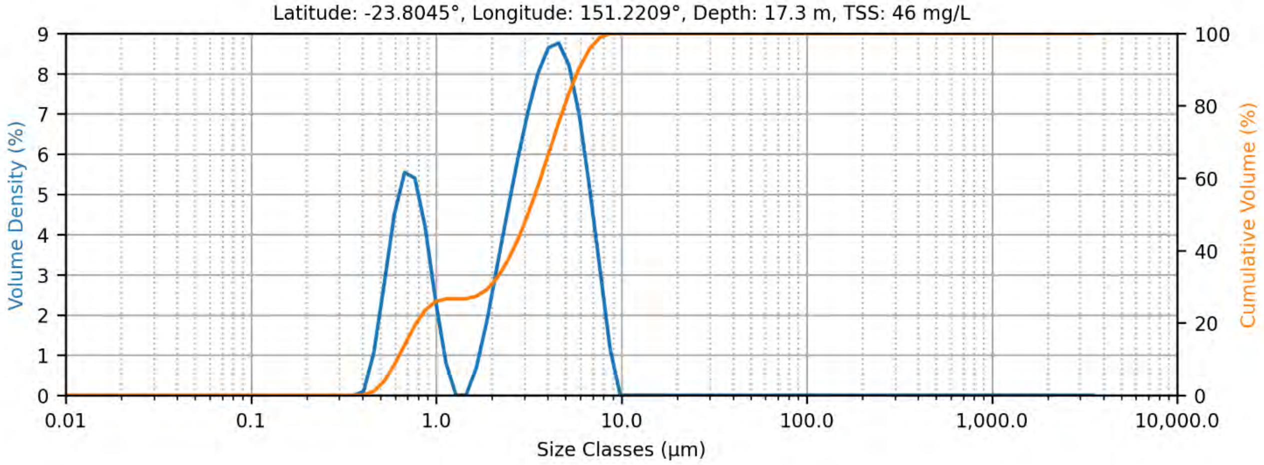
Sample: EB2325981-004
23/08/2023 12:08:03
Latitude: -23.8039°, Longitude: 151.2232°, Depth: nan m, TSS: 12 mg/L



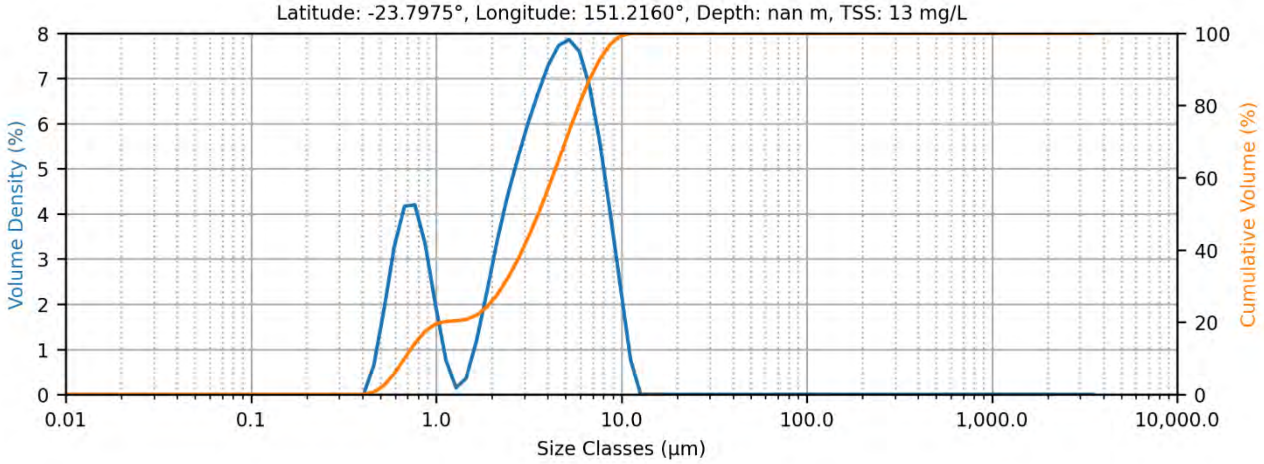
Sample: EB2325981-005
23/08/2023 12:12:33
Latitude: -23.8044°, Longitude: 151.2218°, Depth: 8.3 m, TSS: 14 mg/L

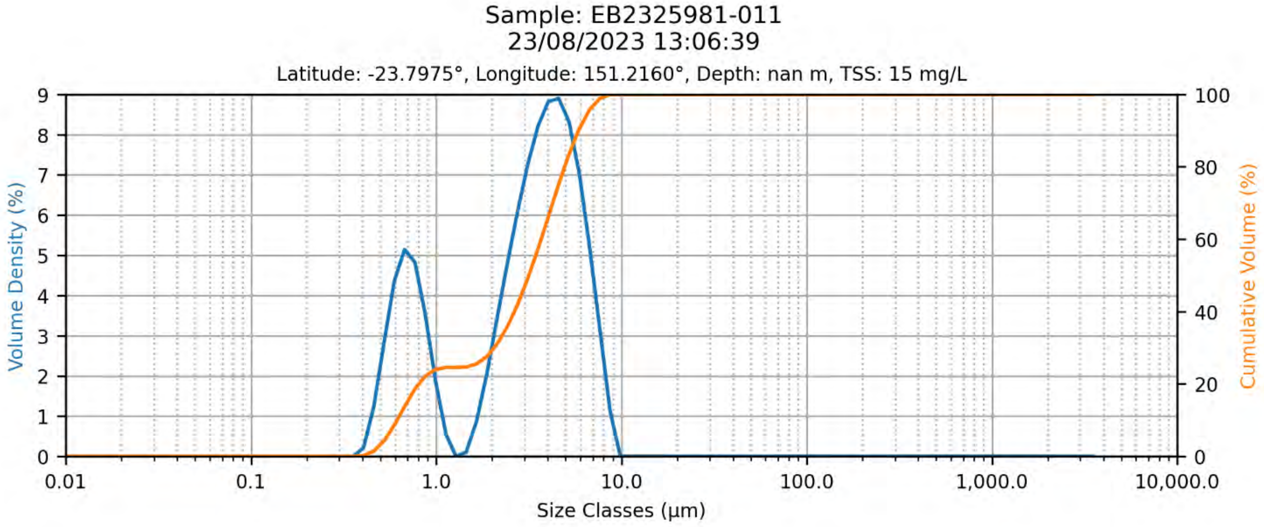


Sample: EB2325981-006
23/08/2023 12:15:20
Latitude: -23.8045°, Longitude: 151.2209°, Depth: 17.3 m, TSS: 46 mg/L

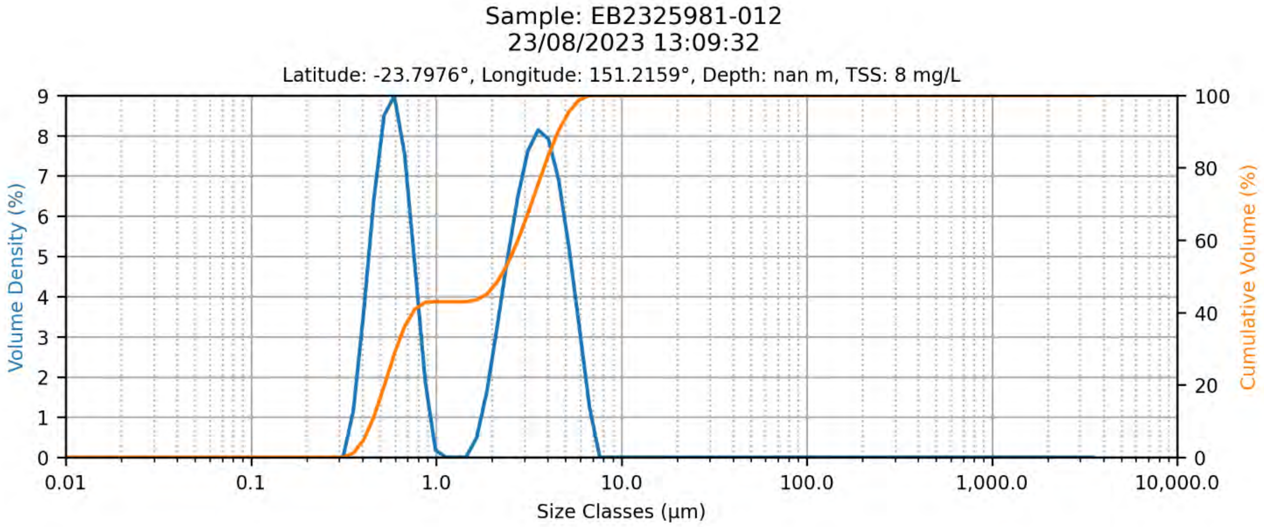


Sample: EB2325981-010
23/08/2023 13:04:04
Latitude: -23.7975°, Longitude: 151.2160°, Depth: nan m, TSS: 13 mg/L



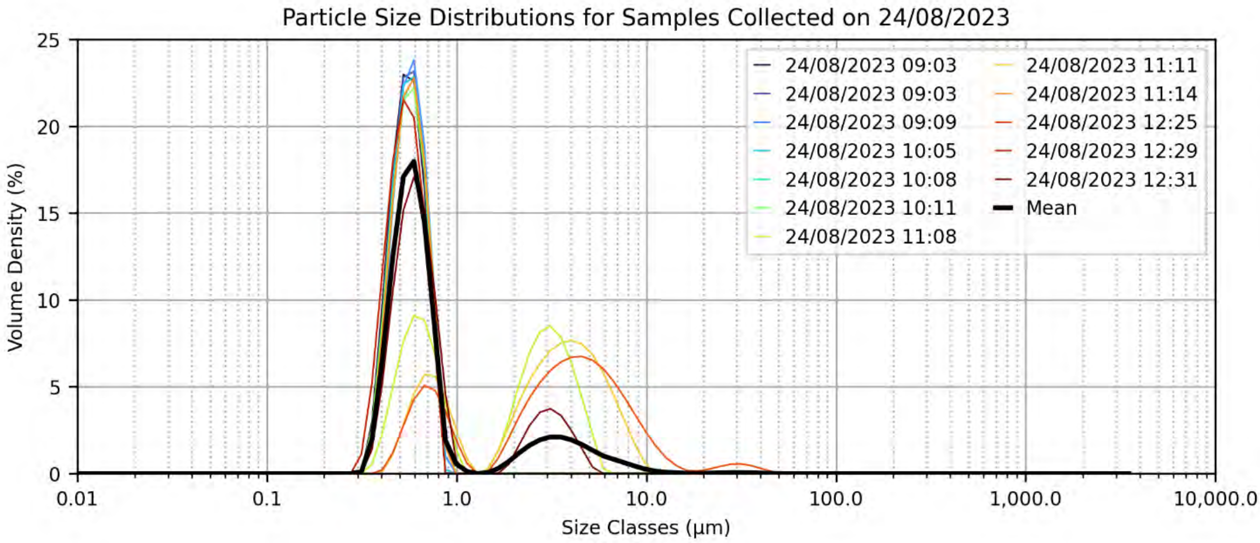


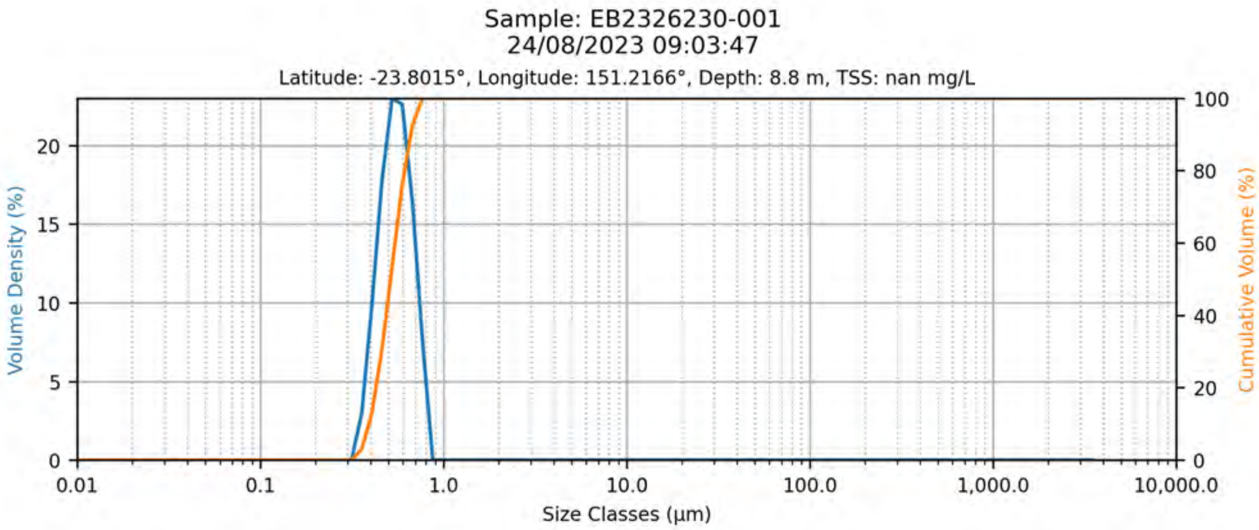
Sample: EB2325981-011
23/08/2023 13:06:39
Latitude: -23.7975°, Longitude: 151.2160°, Depth: nan m, TSS: 15 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

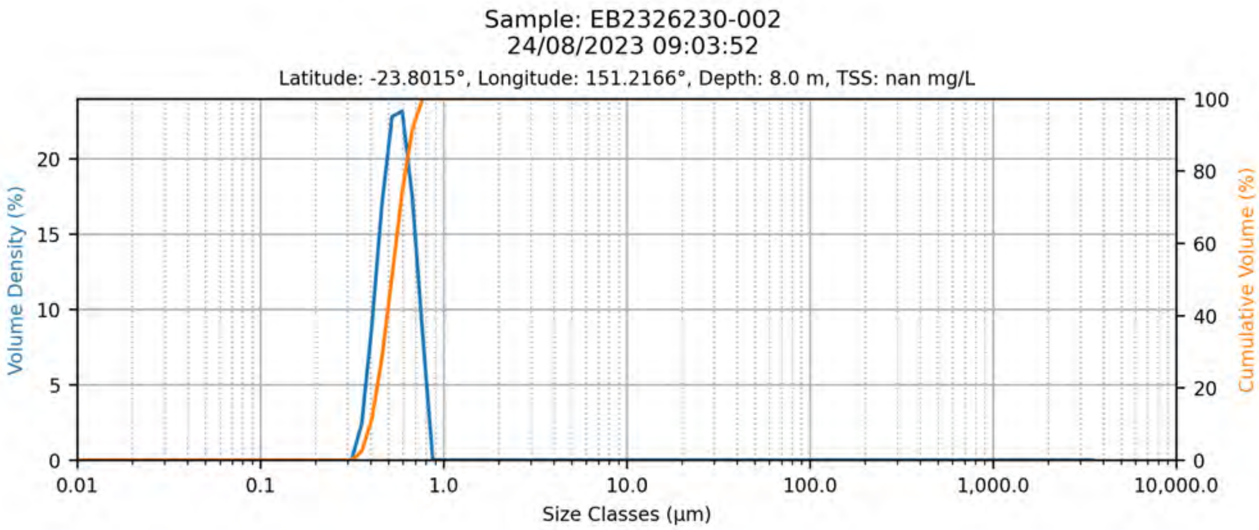


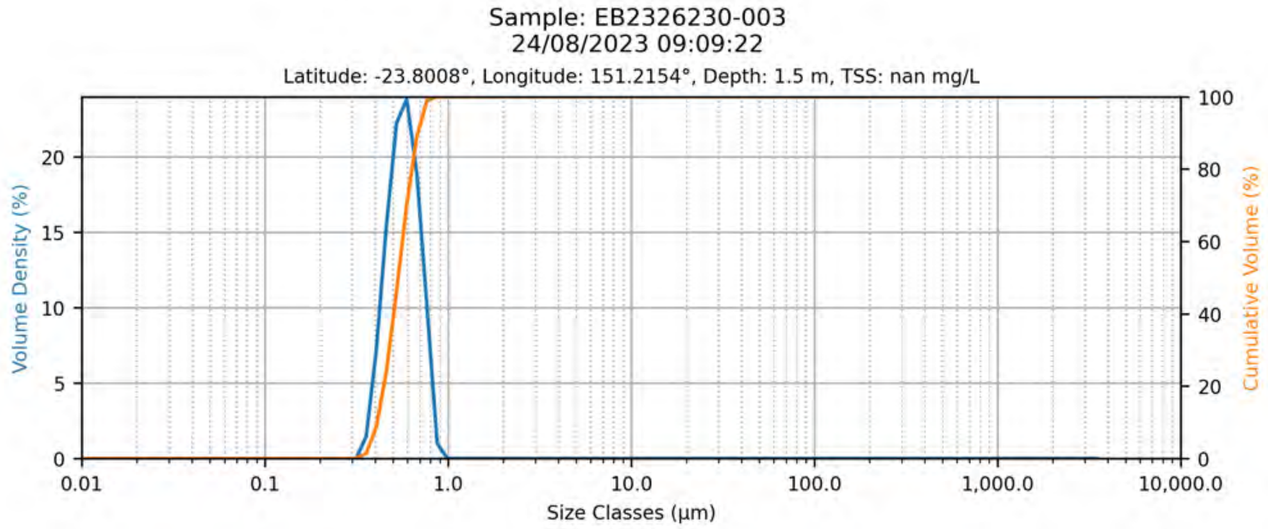
Sample: EB2325981-012
23/08/2023 13:09:32
Latitude: -23.7976°, Longitude: 151.2159°, Depth: nan m, TSS: 8 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

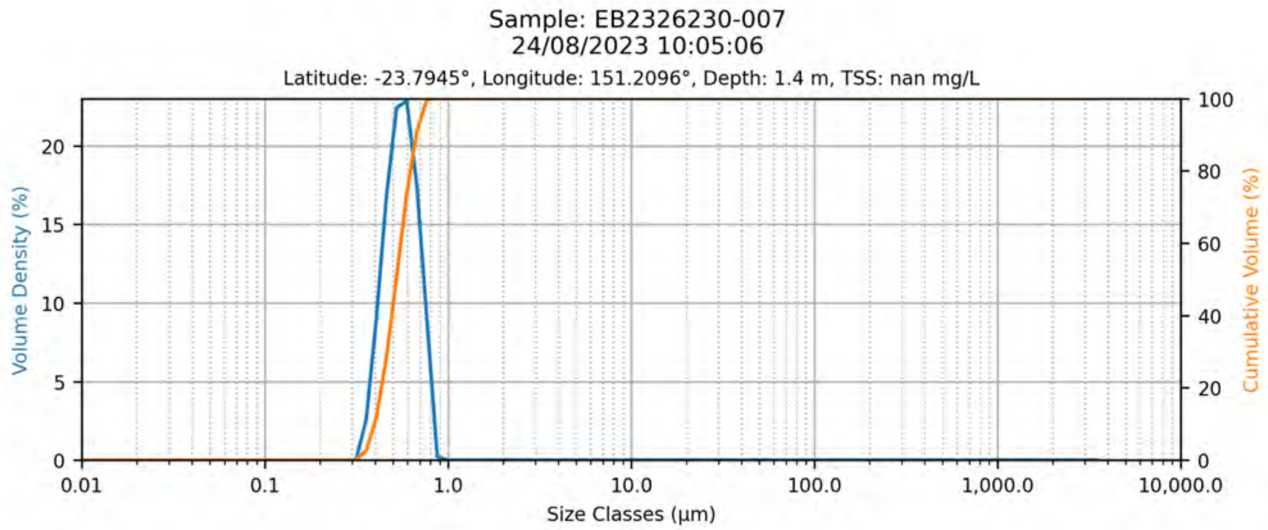
C.2 24th August 2023

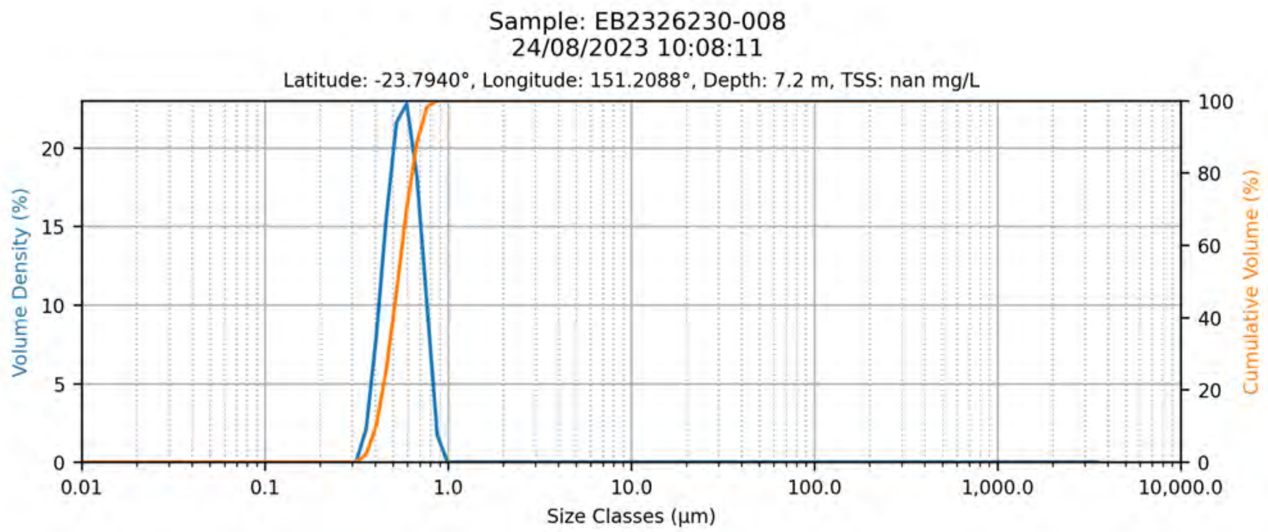




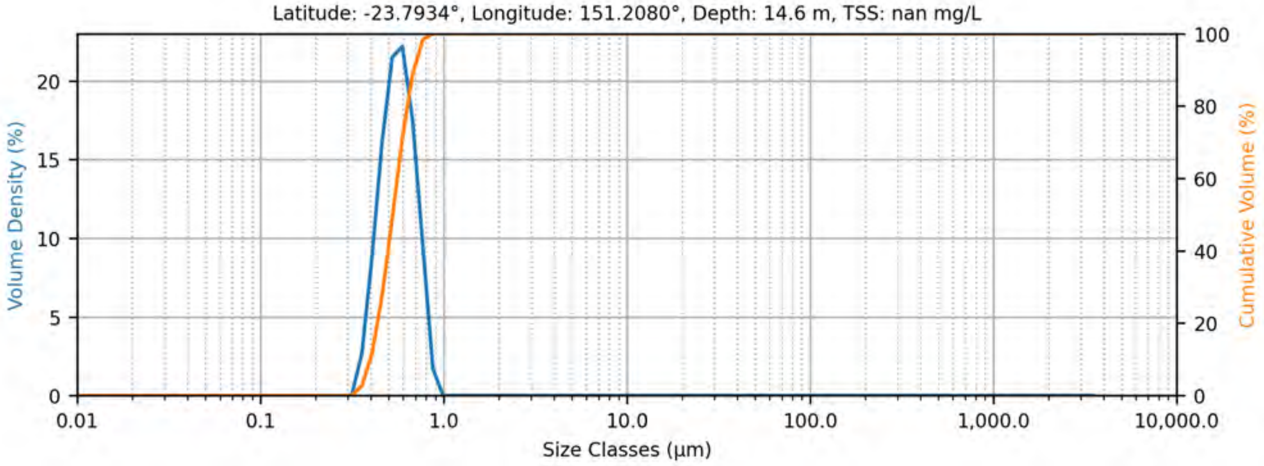



Sample: EB2326230-003
24/08/2023 09:09:22
Latitude: -23.8008°, Longitude: 151.2154°, Depth: 1.5 m, TSS: nan mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

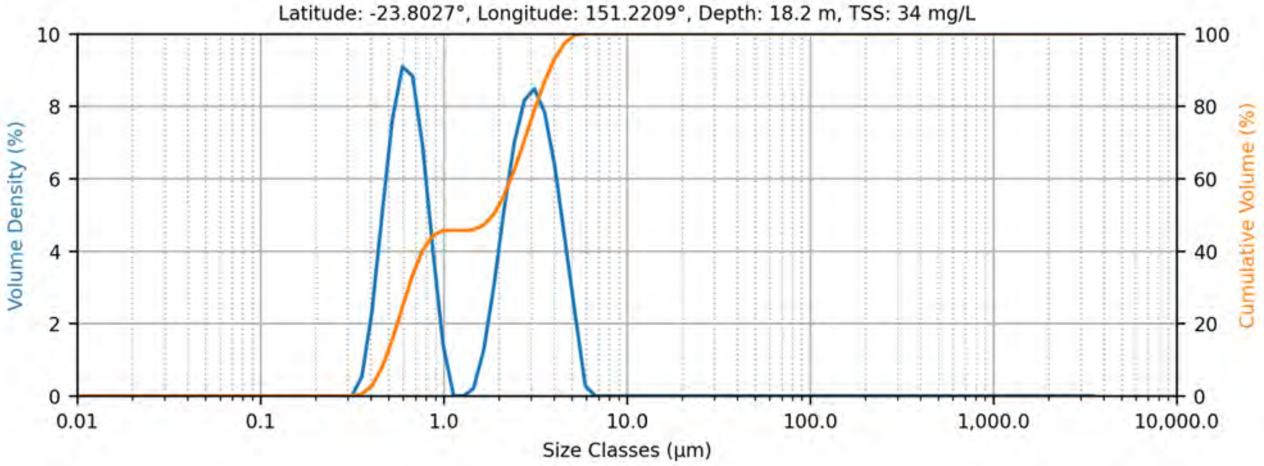

Sample: EB2326230-007
24/08/2023 10:05:06
Latitude: -23.7945°, Longitude: 151.2096°, Depth: 1.4 m, TSS: nan mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


Sample: EB2326230-008
24/08/2023 10:08:11
Latitude: -23.7940°, Longitude: 151.2088°, Depth: 7.2 m, TSS: nan mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

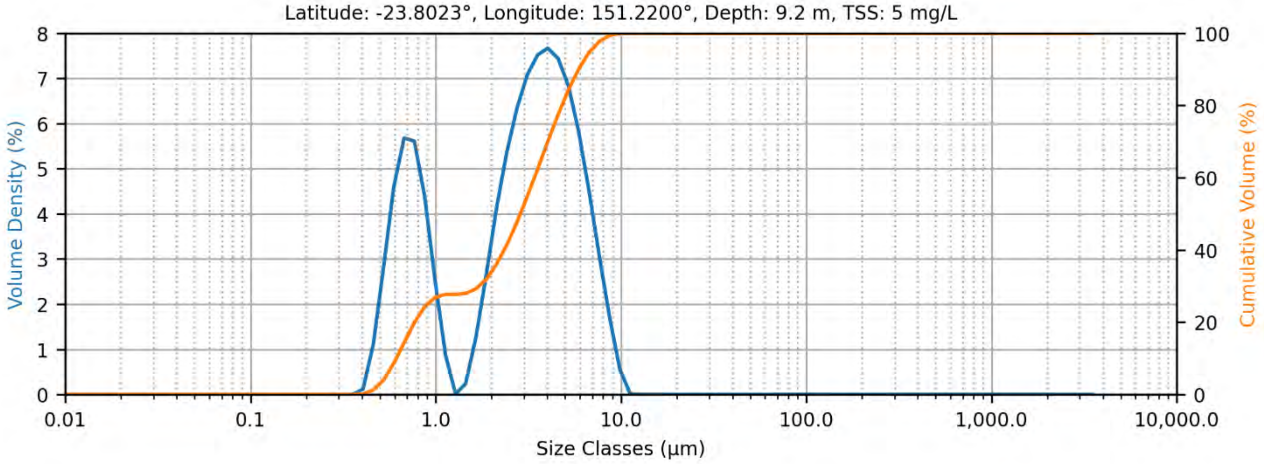
Sample: EB2326230-009
24/08/2023 10:11:10
Latitude: -23.7934°, Longitude: 151.2080°, Depth: 14.6 m, TSS: nan mg/L

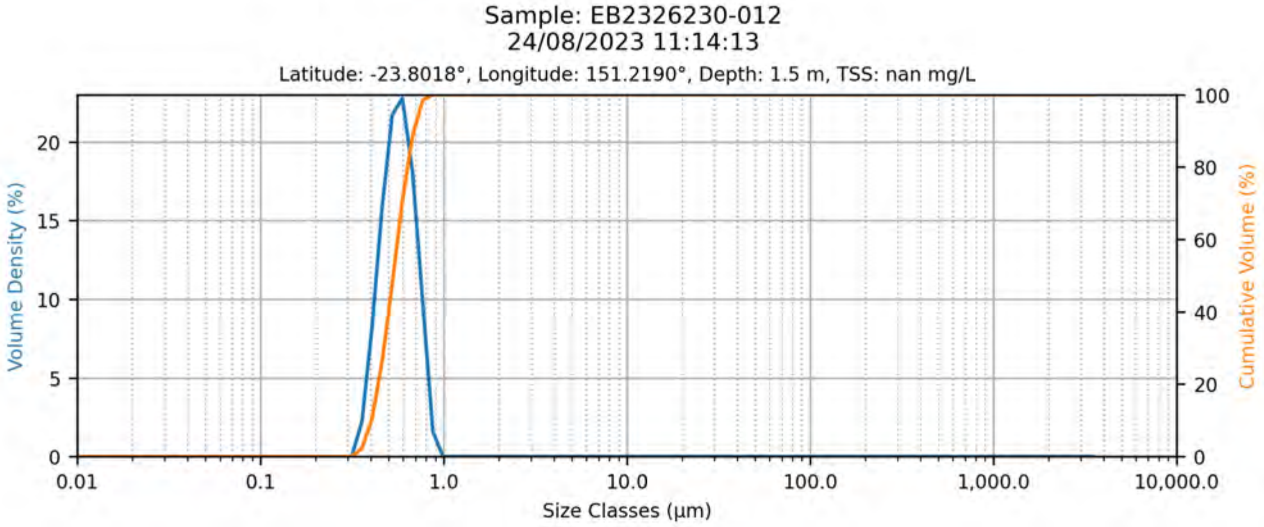


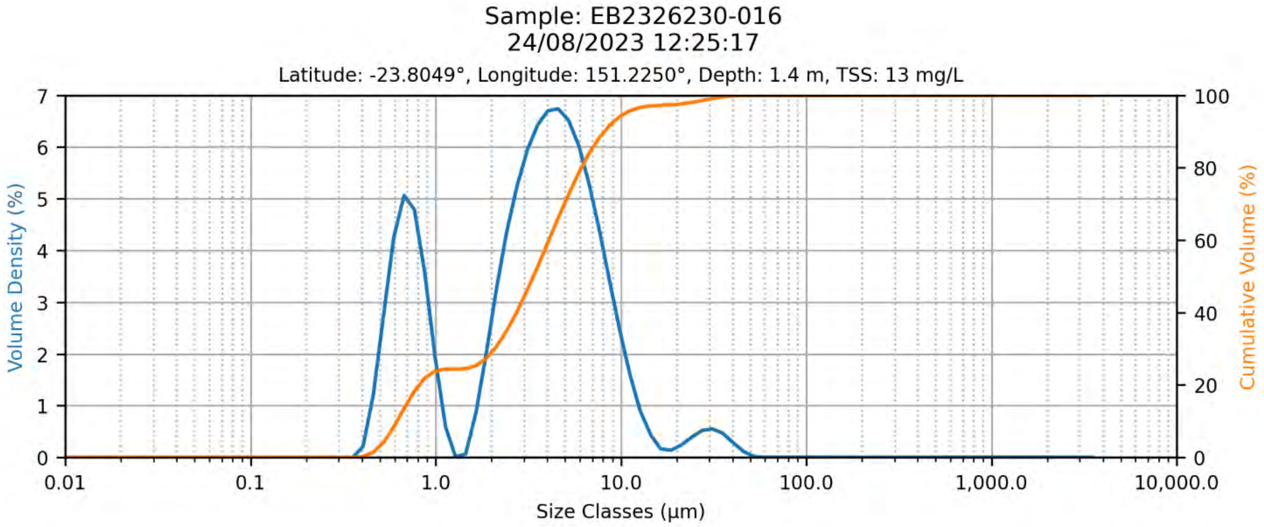
Sample: EB2326230-010
24/08/2023 11:08:09
Latitude: -23.8027°, Longitude: 151.2209°, Depth: 18.2 m, TSS: 34 mg/L

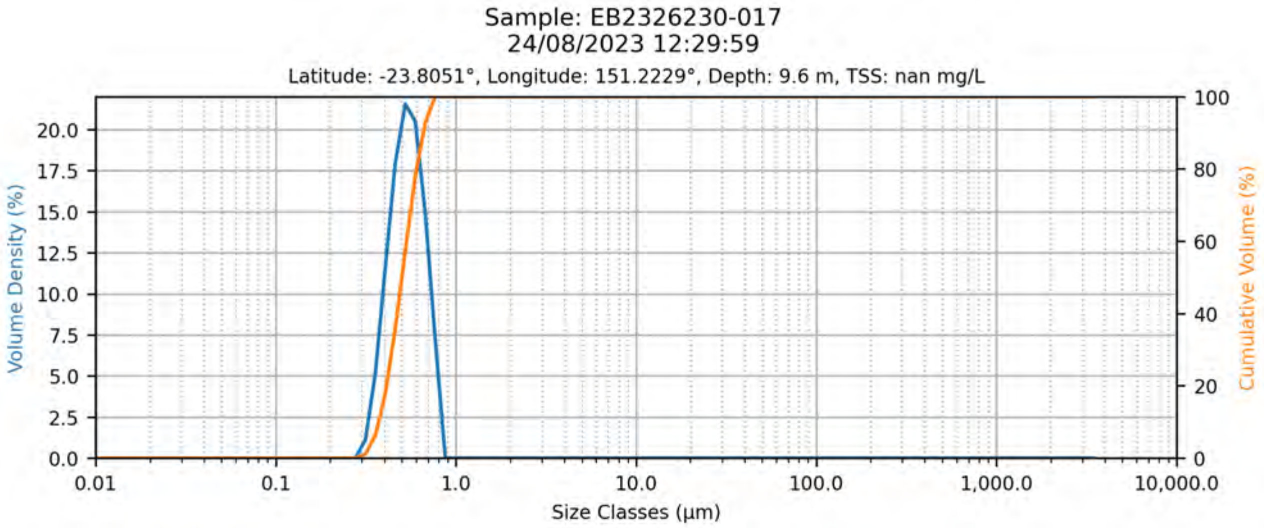


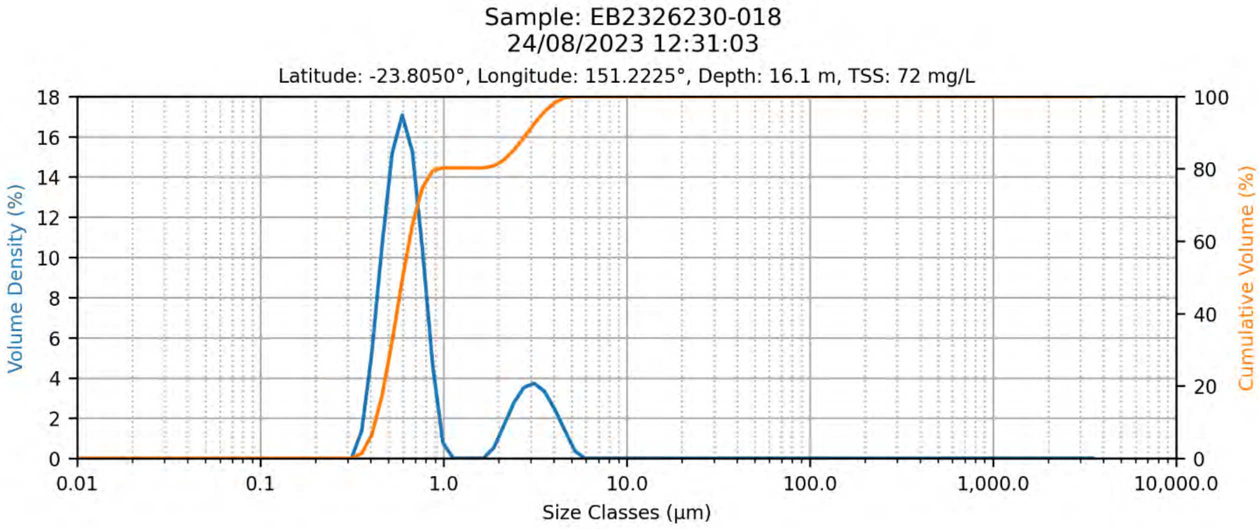
Sample: EB2326230-011
24/08/2023 11:11:16
Latitude: -23.8023°, Longitude: 151.2200°, Depth: 9.2 m, TSS: 5 mg/L



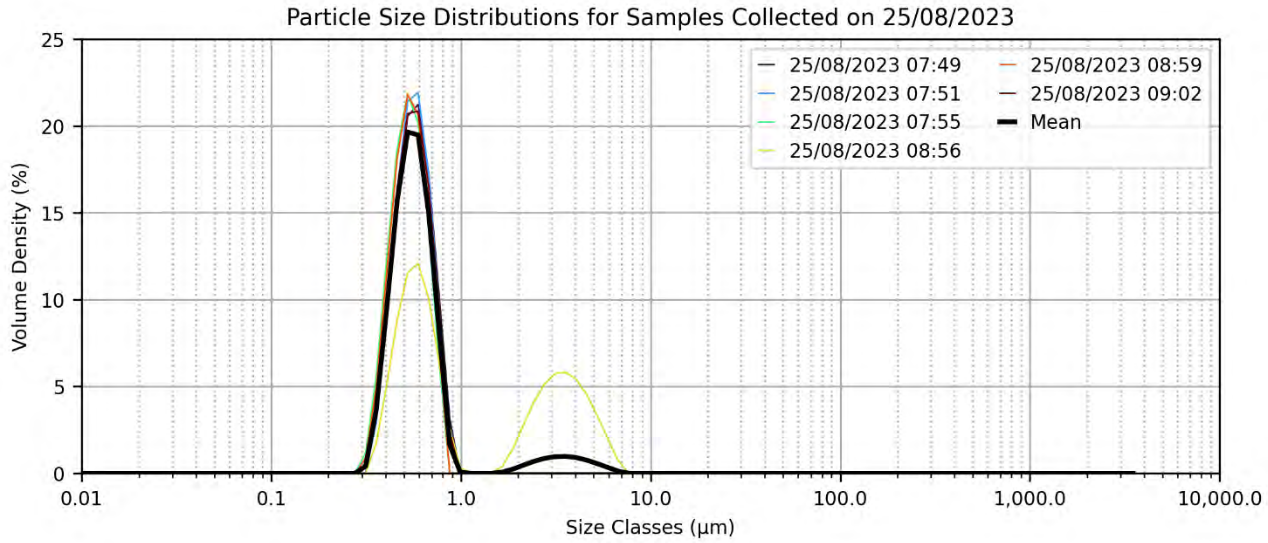

Sample: EB2326230-012
24/08/2023 11:14:13
Latitude: -23.8018°, Longitude: 151.2190°, Depth: 1.5 m, TSS: nan mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

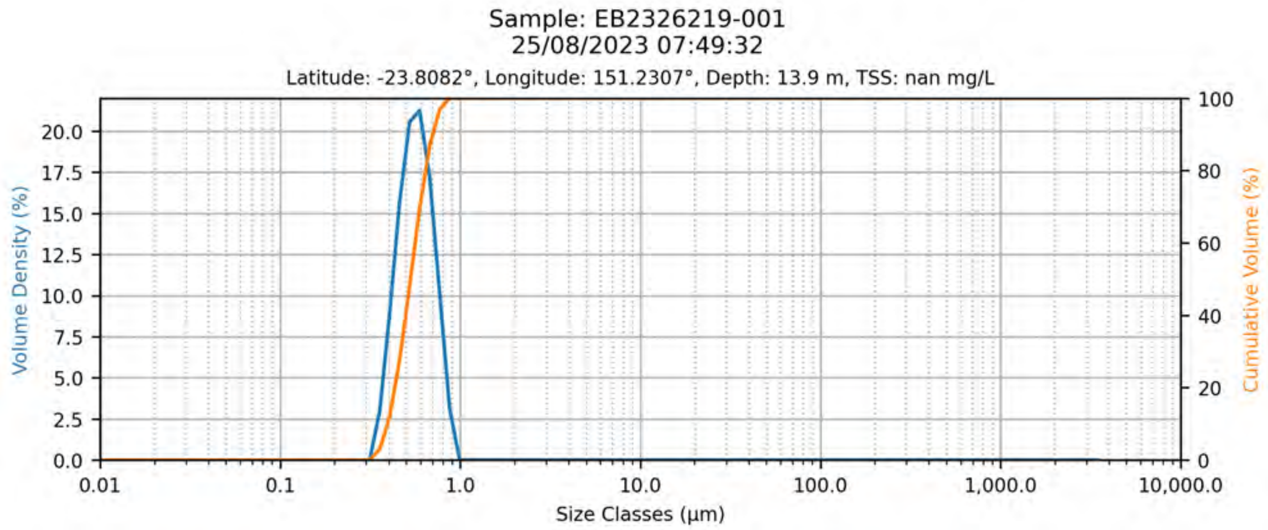

Sample: EB2326230-016
24/08/2023 12:25:17
Latitude: -23.8049°, Longitude: 151.2250°, Depth: 1.4 m, TSS: 13 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

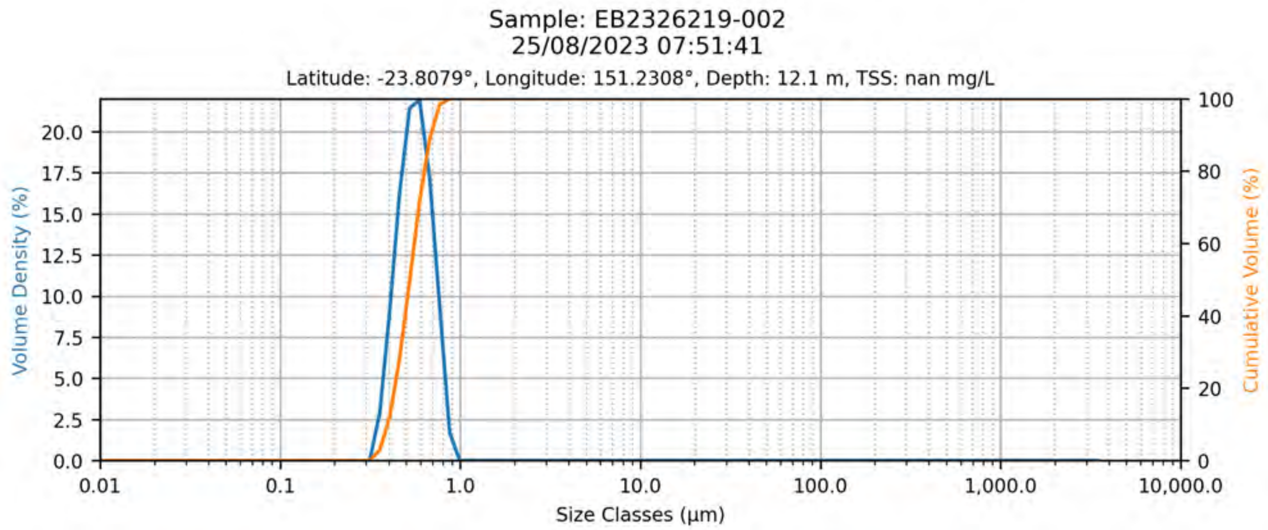

Sample: EB2326230-017
24/08/2023 12:29:59
Latitude: -23.8051°, Longitude: 151.2229°, Depth: 9.6 m, TSS: nan mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

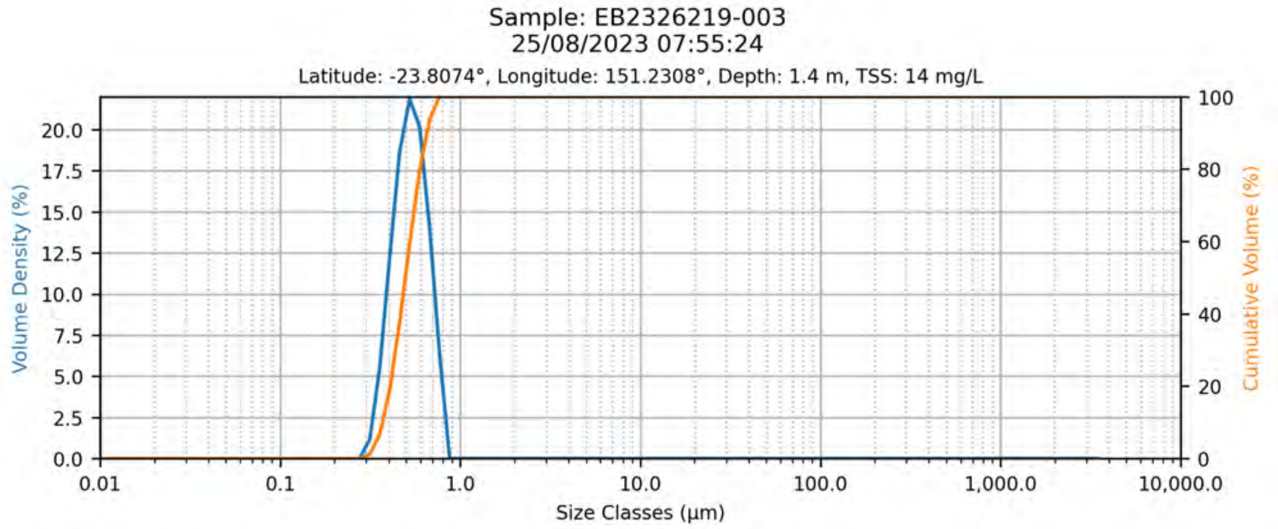

Sample: EB2326230-018
24/08/2023 12:31:03
Latitude: -23.8050°, Longitude: 151.2225°, Depth: 16.1 m, TSS: 72 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

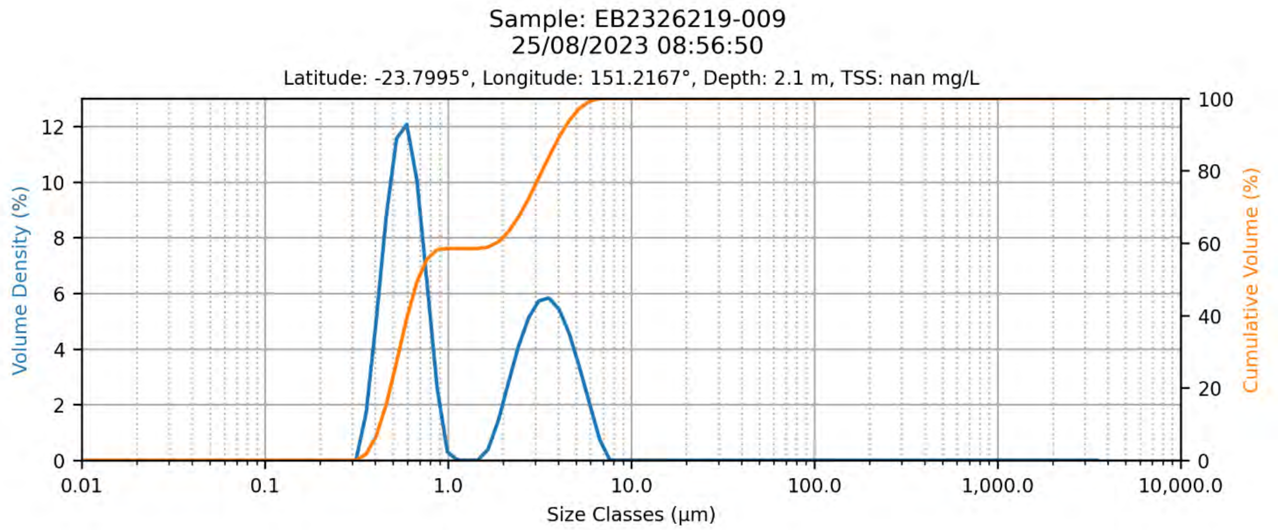
C.3 25th August 2023

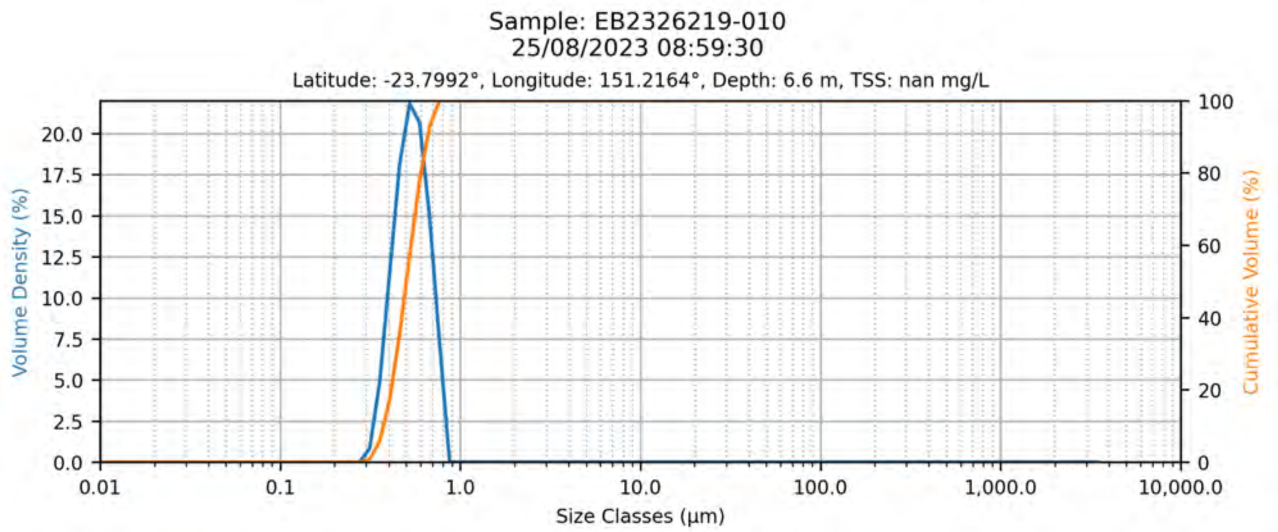


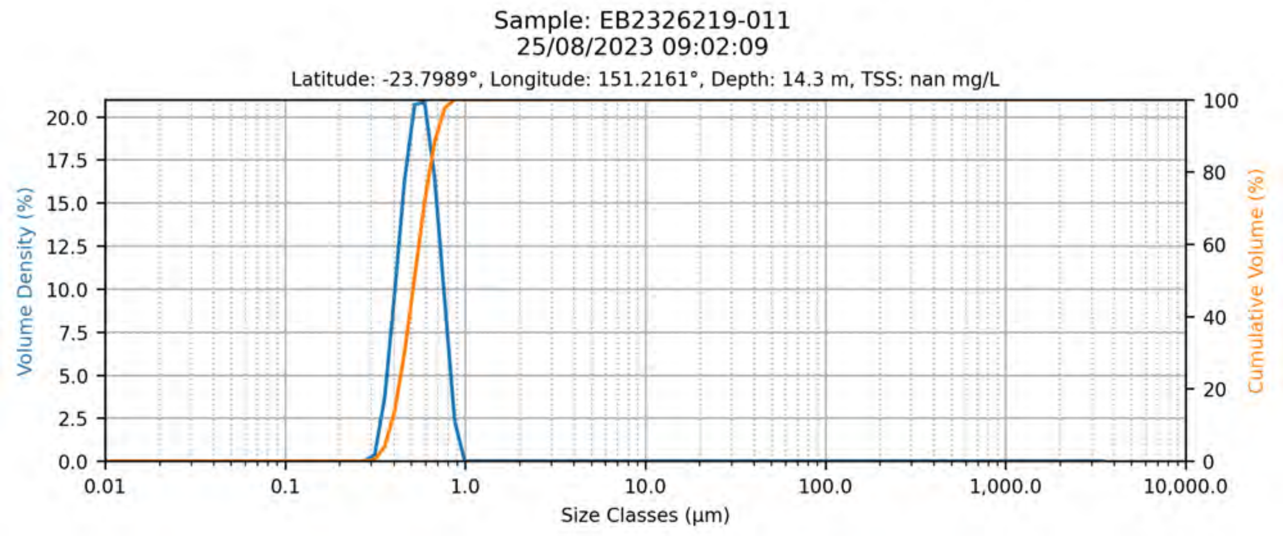





Sample: EB2326219-003
25/08/2023 07:55:24
Latitude: -23.8074°, Longitude: 151.2308°, Depth: 1.4 m, TSS: 14 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


Sample: EB2326219-009
25/08/2023 08:56:50
Latitude: -23.7995°, Longitude: 151.2167°, Depth: 2.1 m, TSS: nan mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


Sample: EB2326219-010
25/08/2023 08:59:30
Latitude: -23.7992°, Longitude: 151.2164°, Depth: 6.6 m, TSS: nan mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


Sample: EB2326219-011
25/08/2023 09:02:09
Latitude: -23.7989°, Longitude: 151.2161°, Depth: 14.3 m, TSS: nan mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0
0.0
2.5
5.0
7.5
10.0
12.5
15.0
17.5
20.0
0
20
40
60
80
100

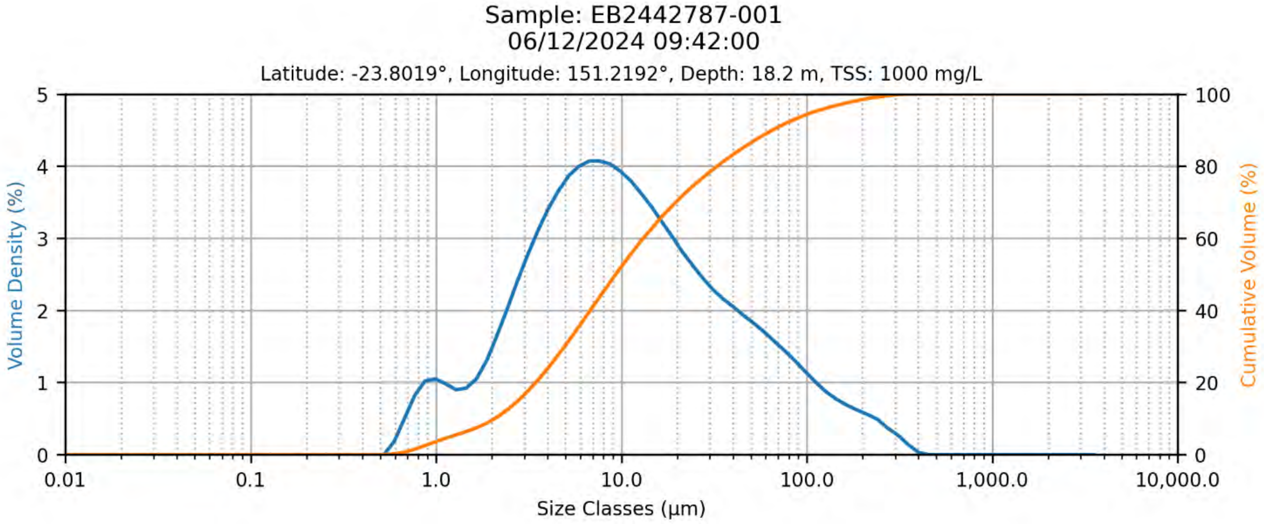
Annex D Sample PSD Summary – August 2023 Campaign

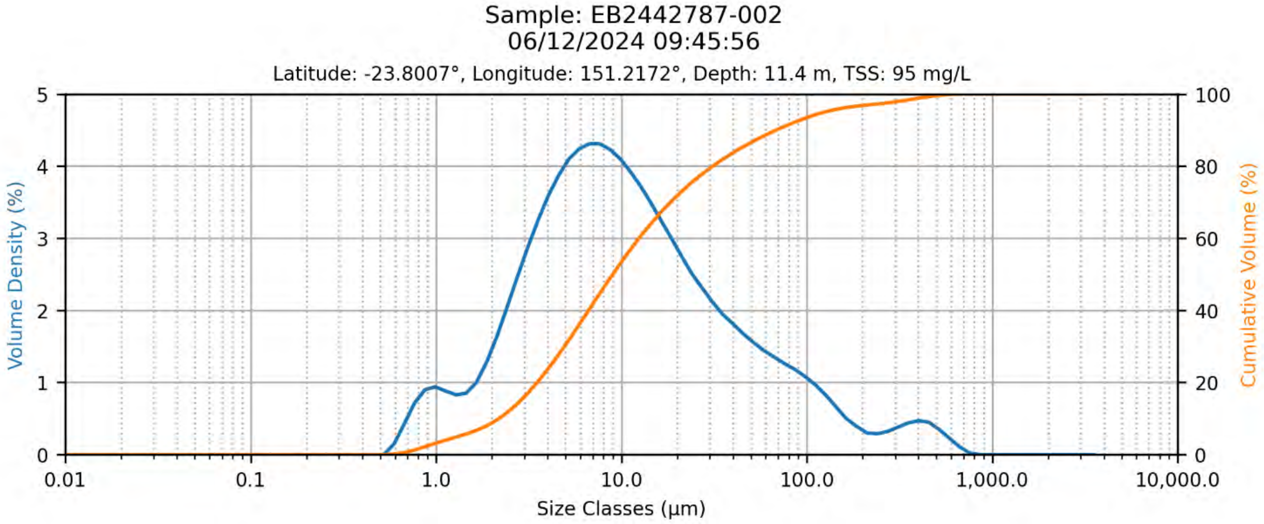
Table D.1. Particle Size Summary Statistics for all PSD Results Collected over the August 2023 Monitoring Campaign

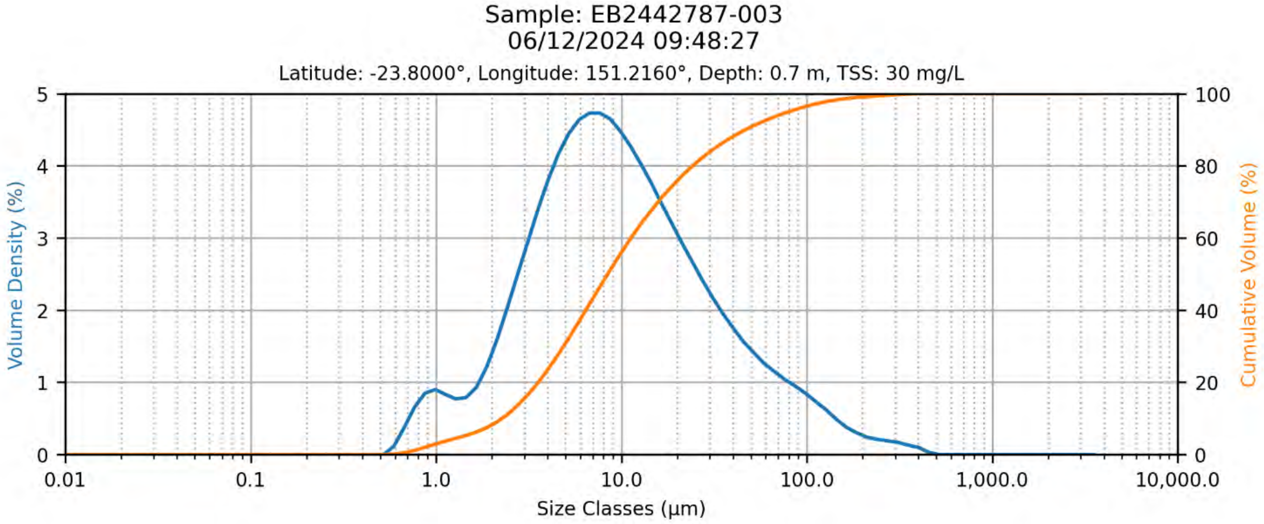
Date	Location	Latitude (°)	Longitude (°)	Depth (m)	D10 (µm)	D50 (µm)	D90 (µm)	Description
23/08/2023 11:05	Jacobs Channel - off GLNG MOF	-23.79891	151.21539	–	0.5	2.9	5.2	Residual Dredge Placement Plume
23/08/2023 11:09	Jacobs Channel - off GLNG MOF	-23.79851	151.21430	8.2	0.7	4.2	9.1	Residual Dredge Placement Plume
23/08/2023 11:13	Jacobs Channel - off GLNG MOF	-23.79797	151.21314	14.0	0.8	4.3	11.4	Residual Dredge Placement Plume
23/08/2023 12:08	Tide Island MRA	-23.80386	151.22319	–	2.0	8.4	29.5	Dredge Placement
23/08/2023 12:12	Tide Island MRA	-23.80444	151.22178	8.3	0.5	2.3	4.7	Dredge Placement
23/08/2023 12:15	Tide Island MRA	-23.80448	151.22094	17.3	0.6	3.1	5.9	Dredge Placement
23/08/2023 13:04	Jacobs Channel - off GLNG MOF	-23.79749	151.21598	–	0.7	3.6	7.2	Residual Dredge Placement Plume
23/08/2023 13:06	Jacobs Channel - off GLNG MOF	-23.79754	151.21599	–	0.6	3.2	5.9	Residual Dredge Placement Plume
23/08/2023 13:09	Jacobs Channel - off GLNG MOF	-23.79762	151.21587	–	0.5	2.2	4.6	Residual Dredge Placement Plume
24/08/2023 09:03	Jacobs Channel - off Hamilton Point	-23.80154	151.21659	8.8	0.4	0.5	0.7	Background
24/08/2023 09:03	Jacobs Channel - off Hamilton Point	-23.80154	151.21657	8.0	0.4	0.5	0.7	Background
24/08/2023 09:09	Jacobs Channel - off Hamilton Point	-23.80078	151.21544	1.5	0.4	0.5	0.7	Background
24/08/2023 10:05	Jacobs Channel - off GLNG MOF	-23.79450	151.20958	1.4	0.4	0.5	0.7	Background
24/08/2023 10:08	Jacobs Channel - off GLNG MOF	-23.79395	151.20876	7.2	0.4	0.5	0.7	Background
24/08/2023 10:11	Jacobs Channel - off GLNG MOF	-23.79341	151.20804	14.6	0.4	0.5	0.7	Background
24/08/2023 11:08	Tide Island MRA	-23.80270	151.22094	18.2	0.5	1.9	3.8	Dredge Placement
24/08/2023 11:11	Tide Island MRA	-23.80230	151.22004	9.2	0.6	2.9	5.9	Dredge Placement
24/08/2023 11:14	Tide Island MRA	-23.80182	151.21902	1.5	0.4	0.5	0.7	Dredge Placement
24/08/2023 12:25	Tide Island MRA	-23.80487	151.22498	1.4	0.6	3.4	8.2	Dredge Placement
24/08/2023 12:29	Tide Island MRA	-23.80506	151.22293	9.6	0.4	0.5	0.7	Dredge Placement
24/08/2023 12:31	Tide Island MRA	-23.80504	151.22251	16.1	0.4	0.6	2.9	Dredge Placement
25/08/2023 07:49	Tide Island MRA	-23.80817	151.23070	13.9	0.4	0.5	0.7	Background

Date	Location	Latitude (°)	Longitude (°)	Depth (m)	D10 (µm)	D50 (µm)	D90 (µm)	Description
25/08/2023 07:51	Tide Island MRA	-23.80793	151.23077	12.1	0.4	0.5	0.7	Background
25/08/2023 07:55	Tide Island MRA	-23.80745	151.23078	1.4	0.4	0.5	0.7	Background
25/08/2023 08:56	Jacobs Channel - off Hamilton Point	-23.79949	151.21671	2.1	0.4	0.7	4.1	Background
25/08/2023 08:59	Jacobs Channel - off Hamilton Point	-23.79918	151.21639	6.6	0.4	0.5	0.7	Background
25/08/2023 09:02	Jacobs Channel - off Hamilton Point	-23.79889	151.21611	14.3	0.4	0.5	0.7	Background

Measurements with no depths recorded due to YSI not recording at time of sampling

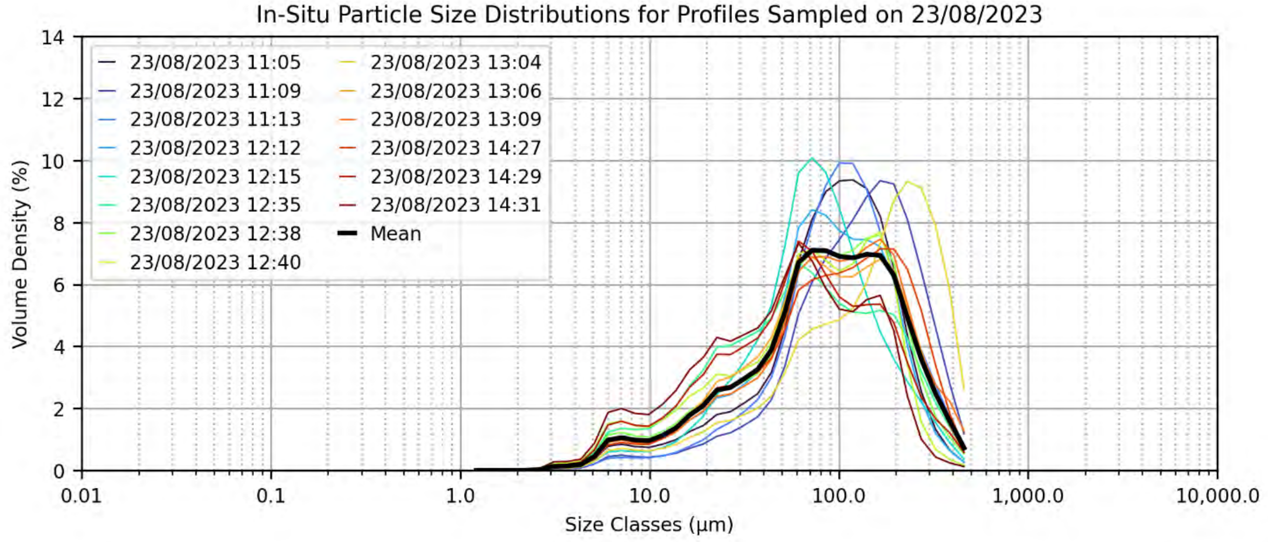

Sample: EB2442787-001
06/12/2024 09:42:00
Latitude: -23.8019°, Longitude: 151.2192°, Depth: 18.2 m, TSS: 1000 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

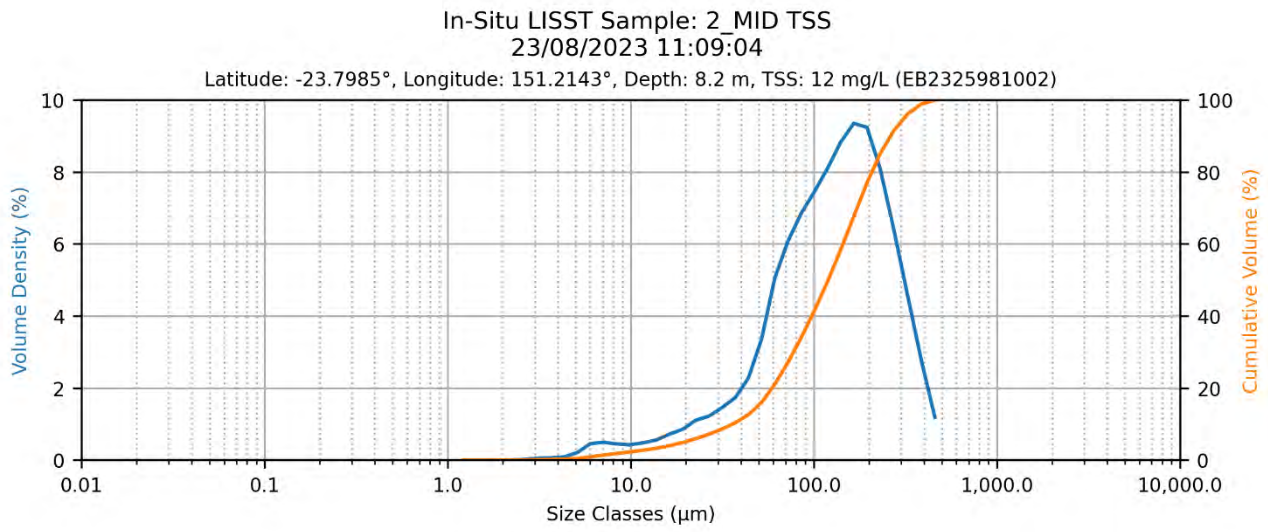

Sample: EB2442787-002
06/12/2024 09:45:56
Latitude: -23.8007°, Longitude: 151.2172°, Depth: 11.4 m, TSS: 95 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

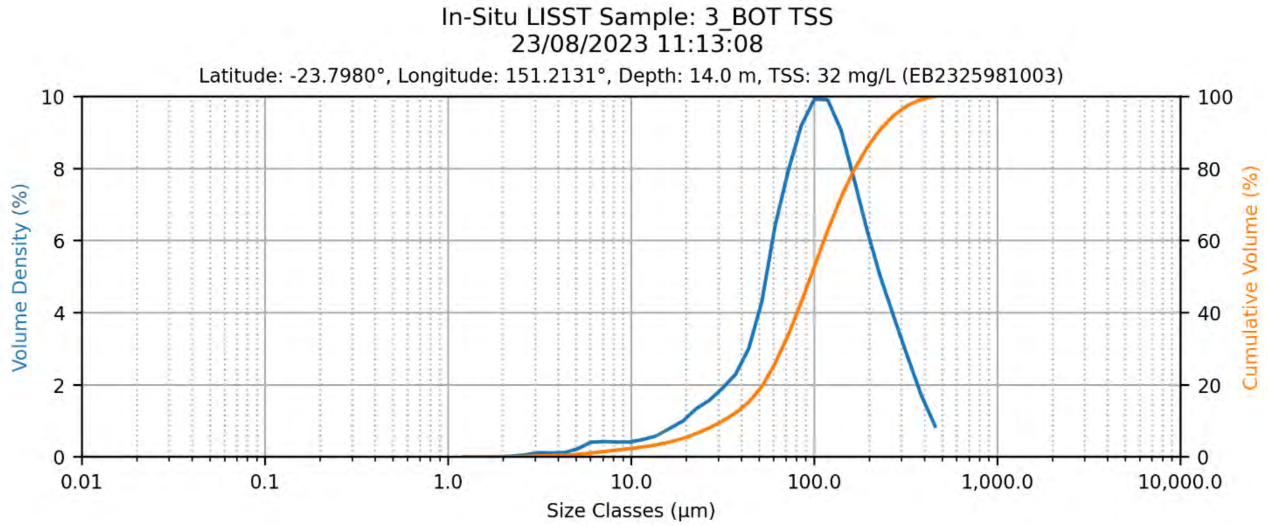

Sample: EB2442787-003
06/12/2024 09:48:27
Latitude: -23.8000°, Longitude: 151.2160°, Depth: 0.7 m, TSS: 30 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

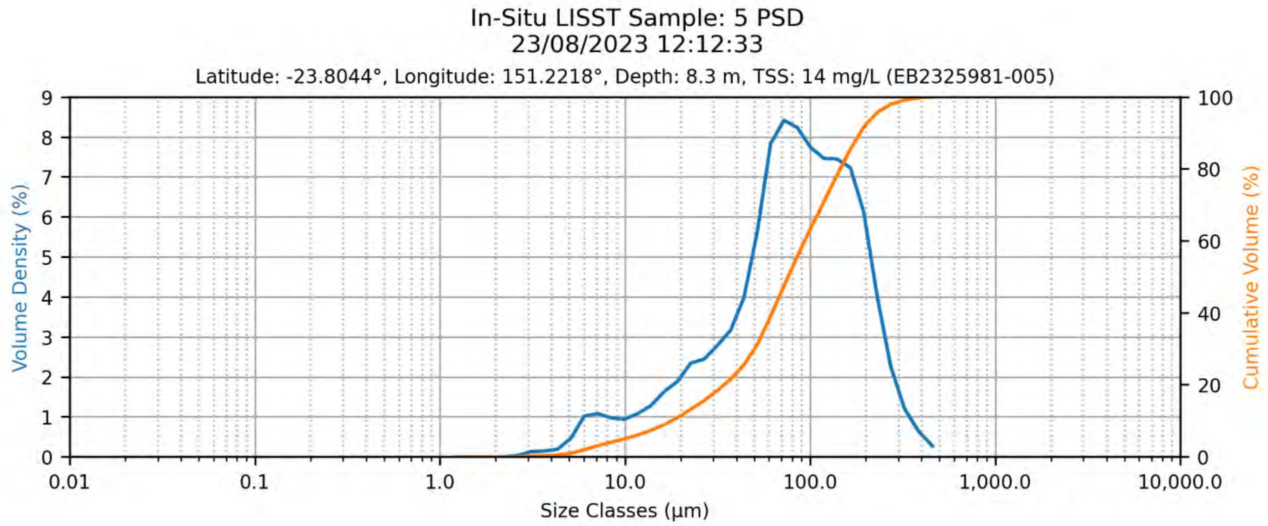
Annex E In situ LISST-200x PSD Results – August 2023 Campaign

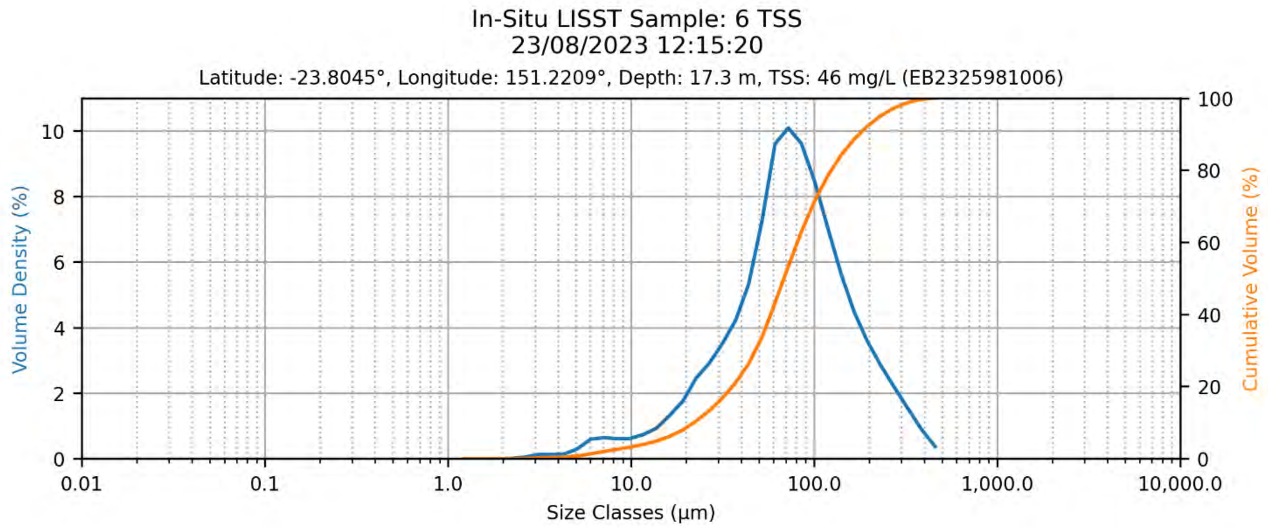
E.1 23rd August 2023

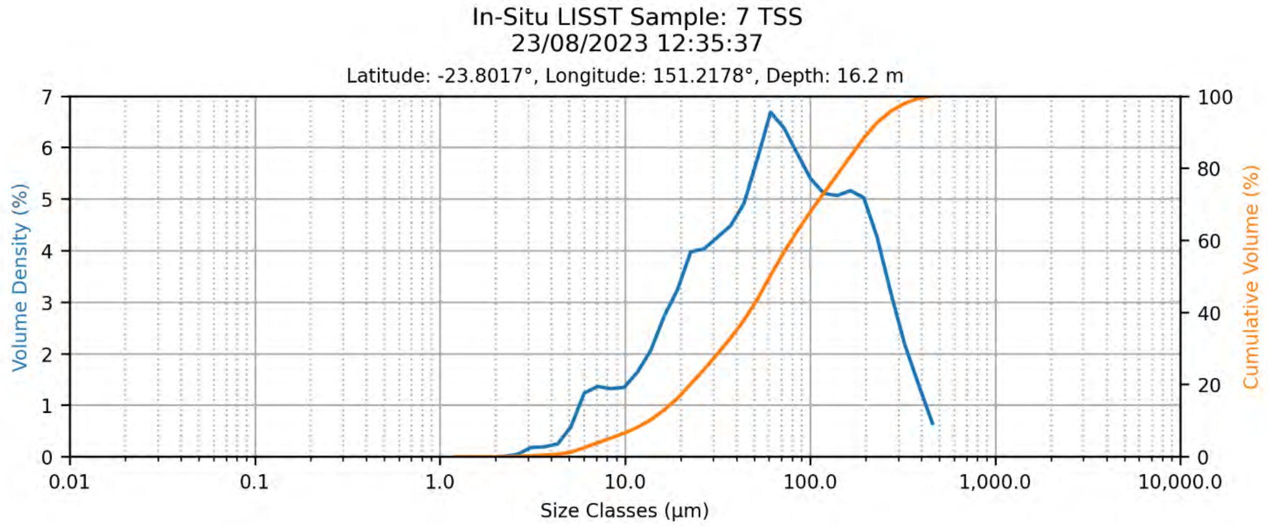


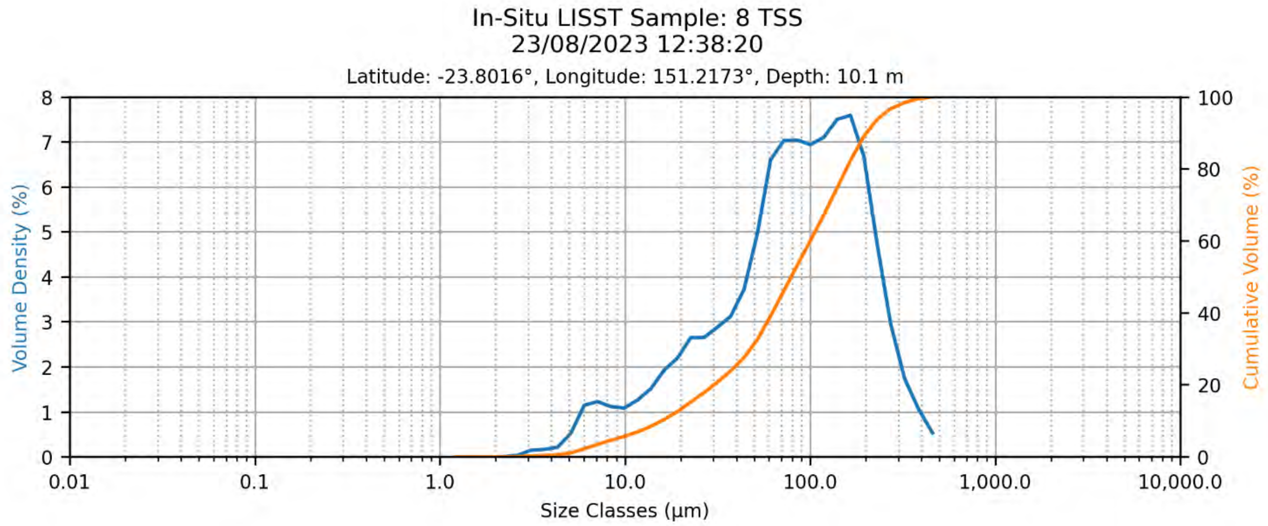


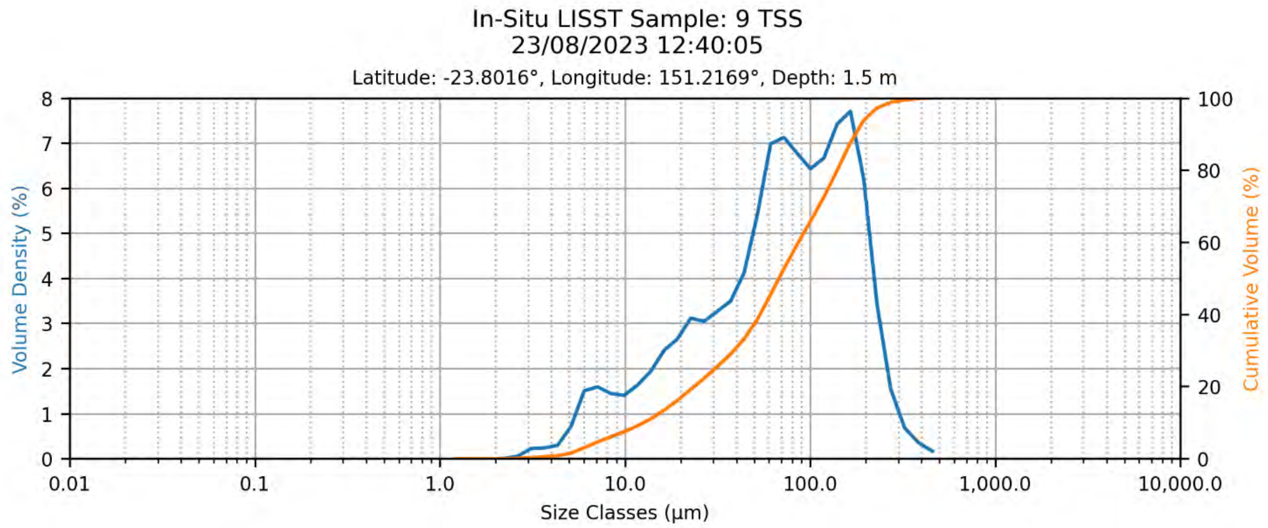

In-Situ LISST Sample: 3_BOT TSS
23/08/2023 11:13:08
Latitude: -23.7980°, Longitude: 151.2131°, Depth: 14.0 m, TSS: 32 mg/L (EB2325981003)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

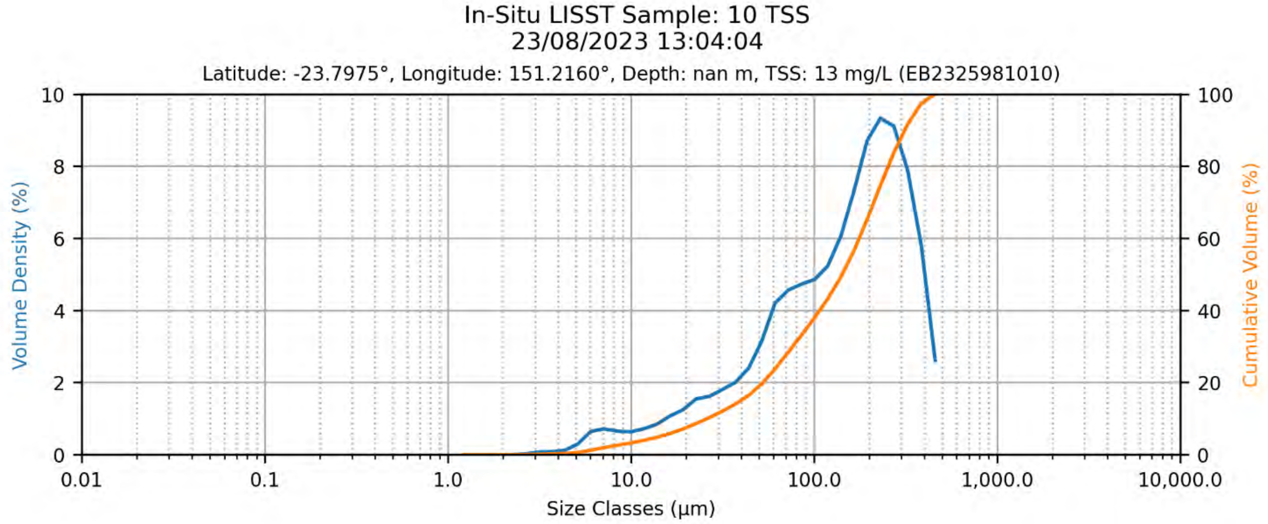

In-Situ LISST Sample: 5 PSD
23/08/2023 12:12:33
Latitude: -23.8044°, Longitude: 151.2218°, Depth: 8.3 m, TSS: 14 mg/L (EB2325981-005)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

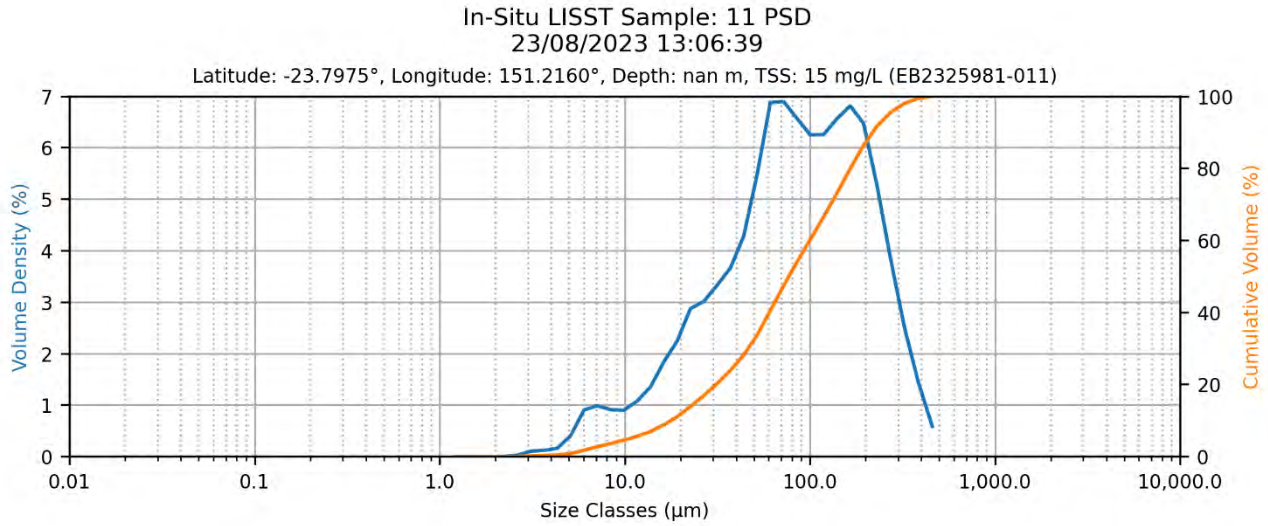

In-Situ LISST Sample: 6 TSS
23/08/2023 12:15:20
Latitude: -23.8045°, Longitude: 151.2209°, Depth: 17.3 m, TSS: 46 mg/L (EB2325981006)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

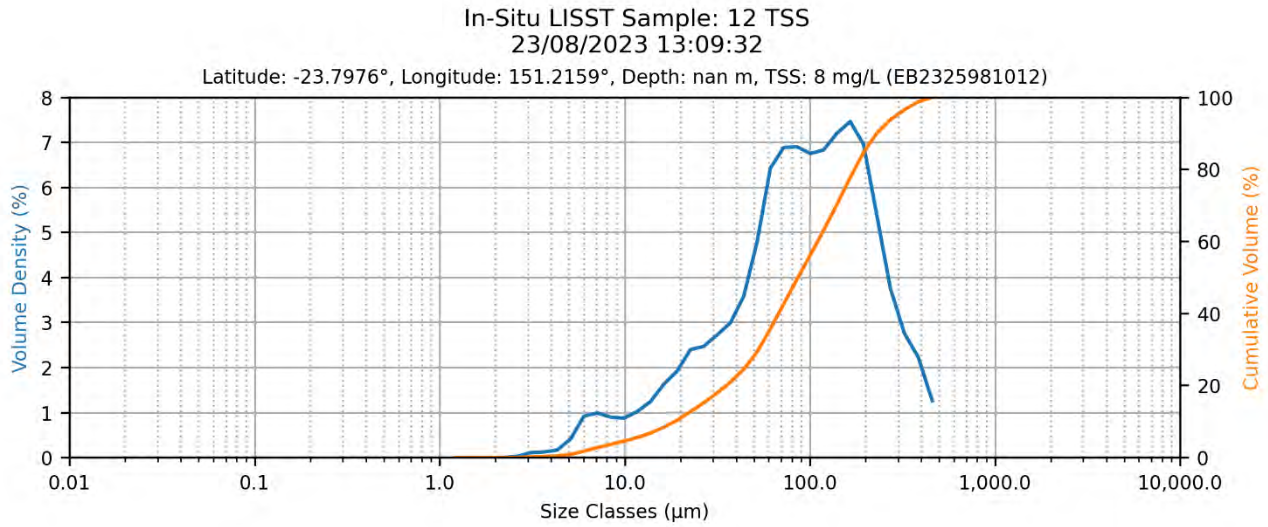

In-Situ LISST Sample: 7 TSS
23/08/2023 12:35:37
Latitude: -23.8017°, Longitude: 151.2178°, Depth: 16.2 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

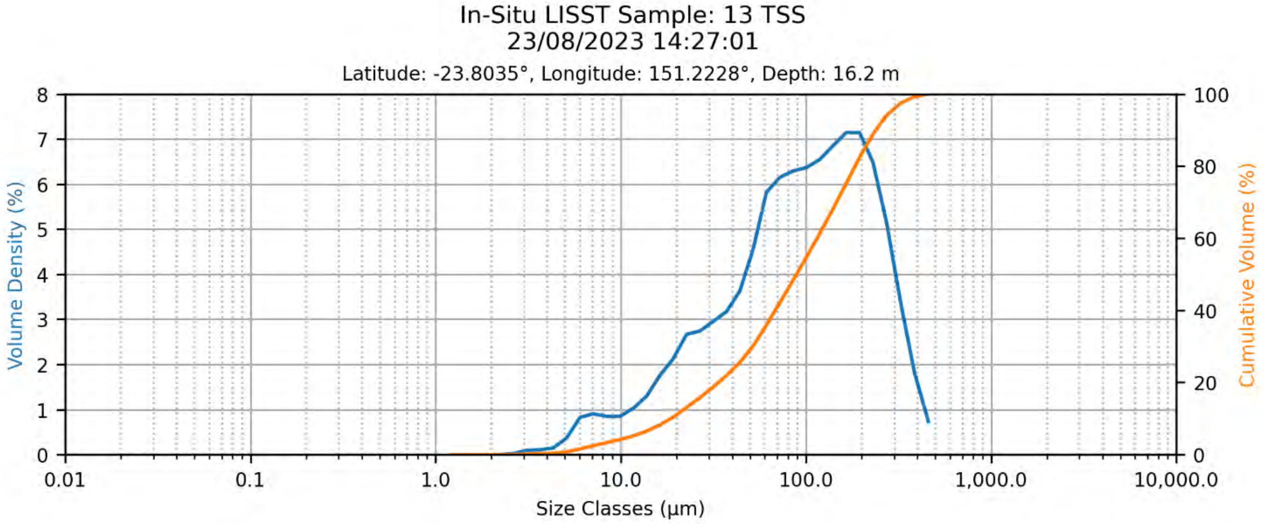

In-Situ LISST Sample: 8 TSS
23/08/2023 12:38:20
Latitude: -23.8016°, Longitude: 151.2173°, Depth: 10.1 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

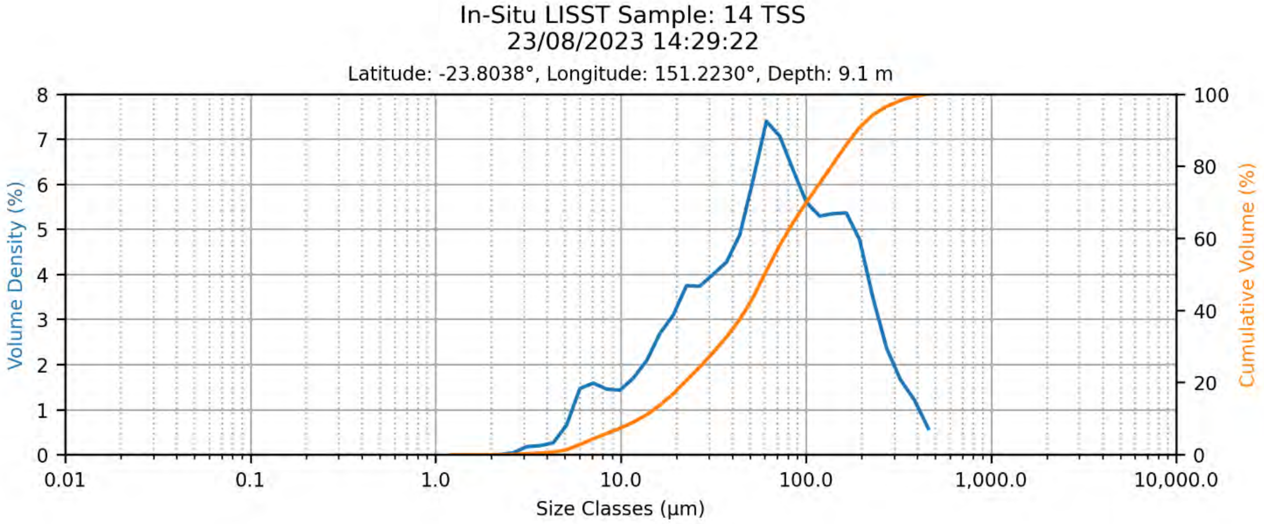

In-Situ LISST Sample: 9 TSS
23/08/2023 12:40:05
Latitude: -23.8016°, Longitude: 151.2169°, Depth: 1.5 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

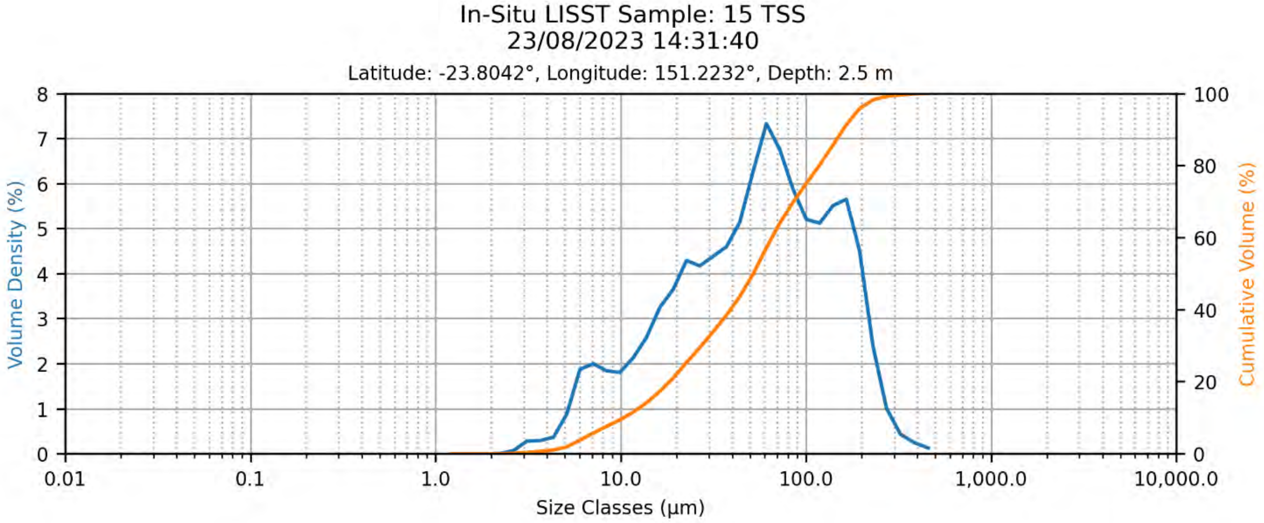

In-Situ LISST Sample: 10 TSS
23/08/2023 13:04:04
Latitude: -23.7975°, Longitude: 151.2160°, Depth: nan m, TSS: 13 mg/L (EB2325981010)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

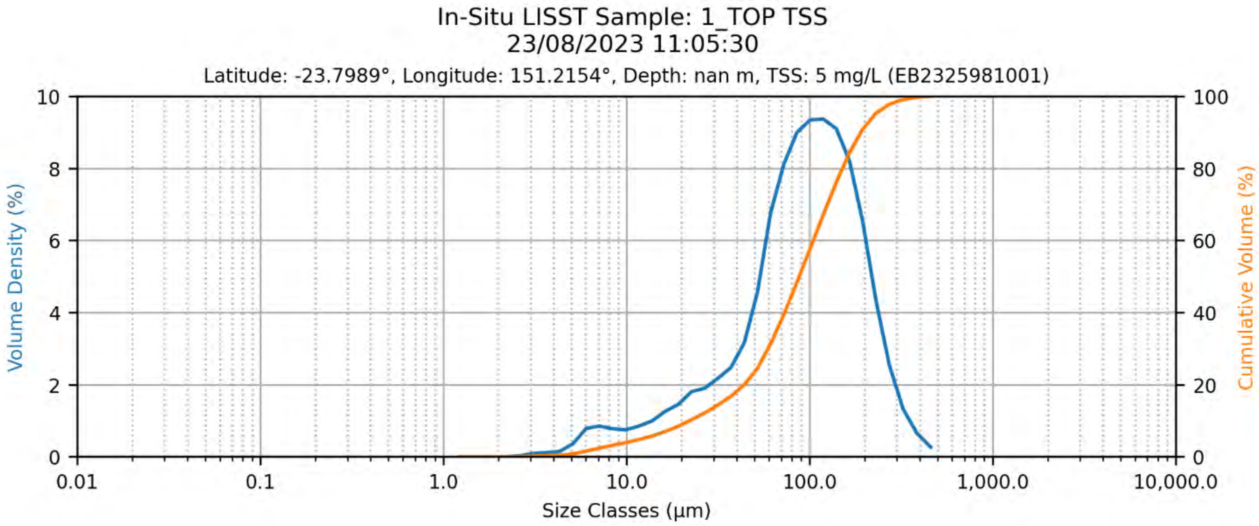

In-Situ LISST Sample: 11 PSD
23/08/2023 13:06:39
Latitude: -23.7975°, Longitude: 151.2160°, Depth: nan m, TSS: 15 mg/L (EB2325981-011)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


In-Situ LISST Sample: 12 TSS
23/08/2023 13:09:32
Latitude: -23.7976°, Longitude: 151.2159°, Depth: nan m, TSS: 8 mg/L (EB2325981012)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

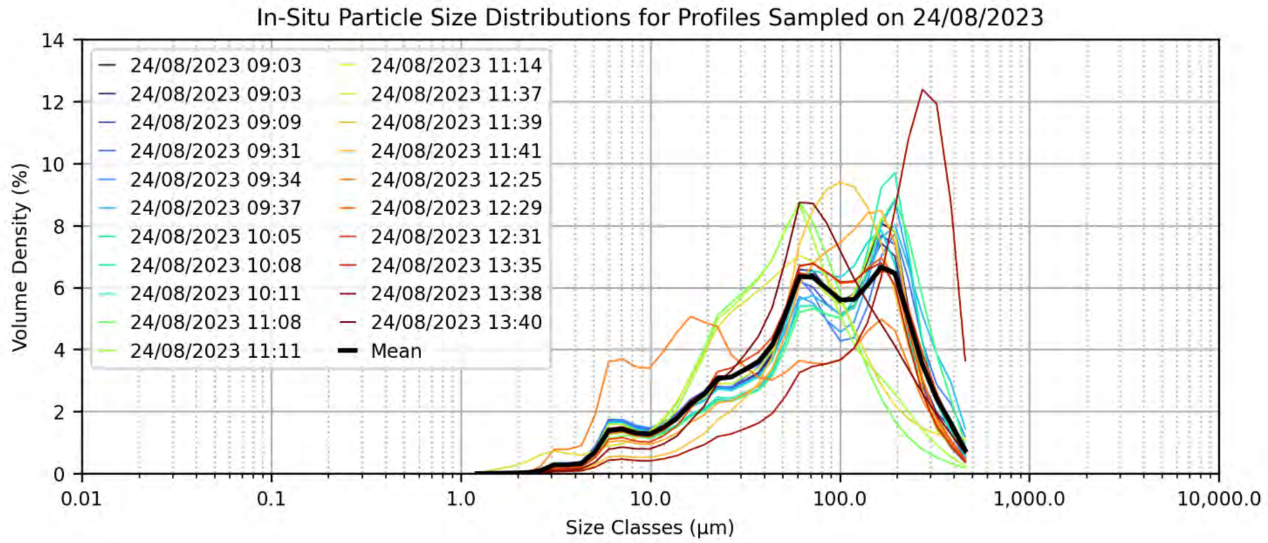

In-Situ LISST Sample: 13 TSS
23/08/2023 14:27:01
Latitude: -23.8035°, Longitude: 151.2228°, Depth: 16.2 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

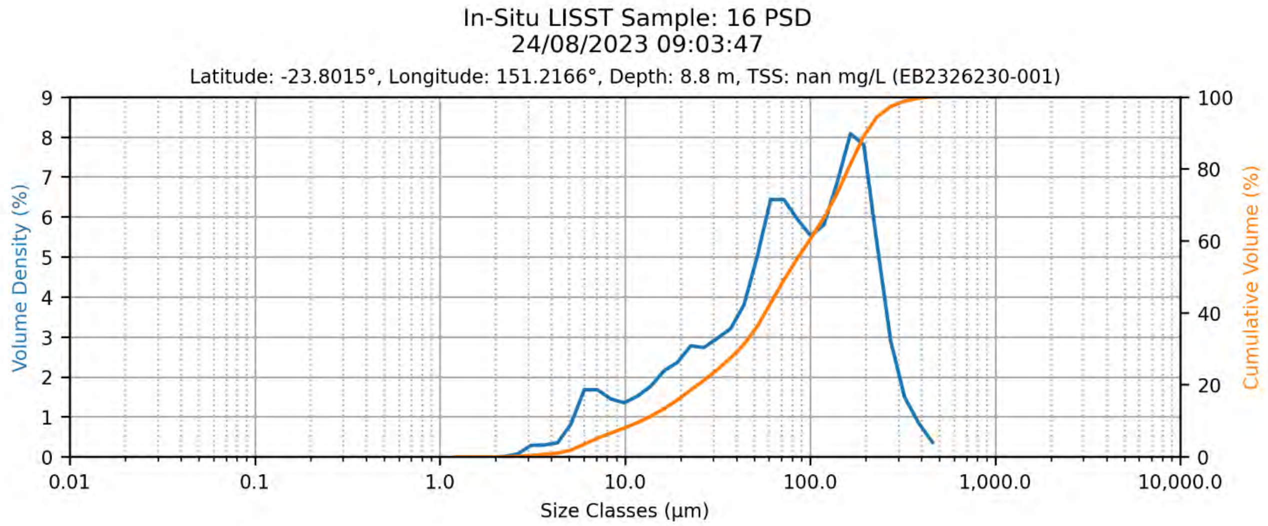

In-Situ LISST Sample: 14 TSS
23/08/2023 14:29:22
Latitude: -23.8038°, Longitude: 151.2230°, Depth: 9.1 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

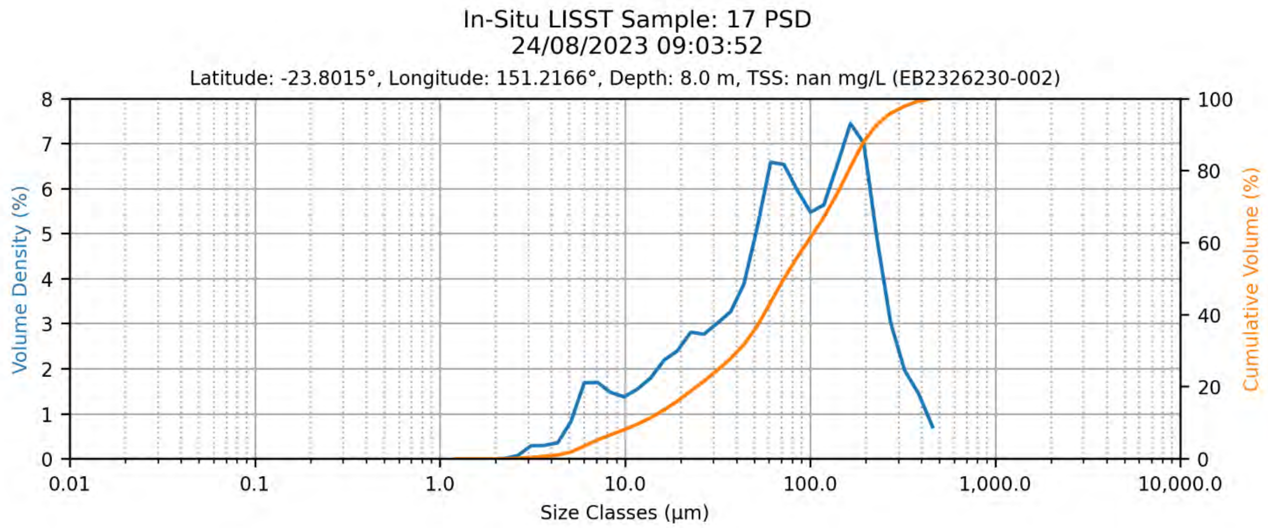

In-Situ LISST Sample: 15 TSS
23/08/2023 14:31:40
Latitude: -23.8042°, Longitude: 151.2232°, Depth: 2.5 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

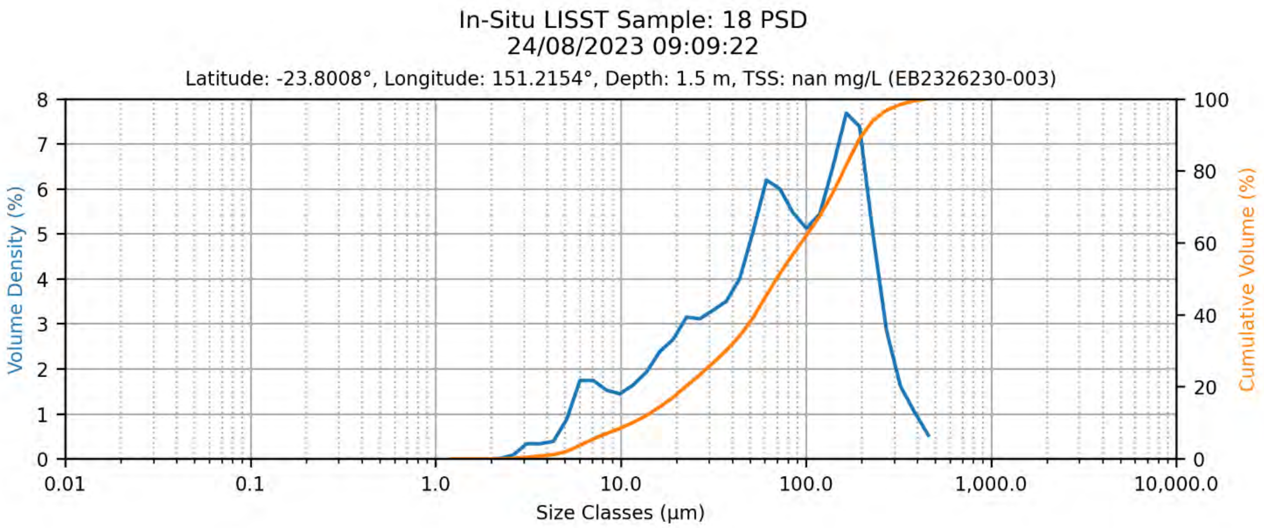

In-Situ LISST Sample: 1_TOP TSS
23/08/2023 11:05:30
Latitude: -23.7989°, Longitude: 151.2154°, Depth: nan m, TSS: 5 mg/L (EB2325981001)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

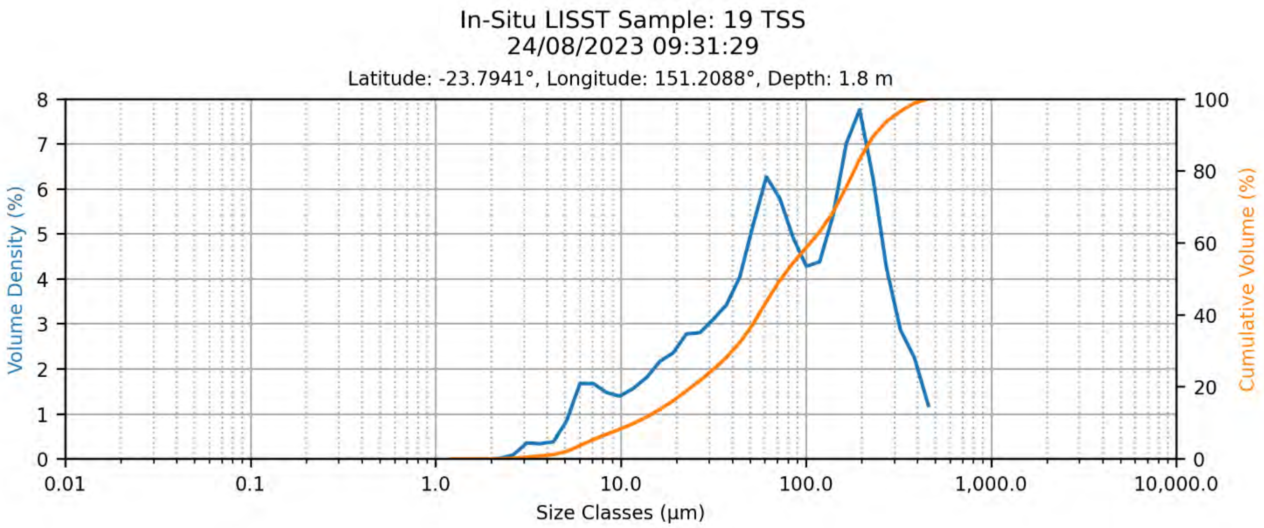
E.2 24th August 2023

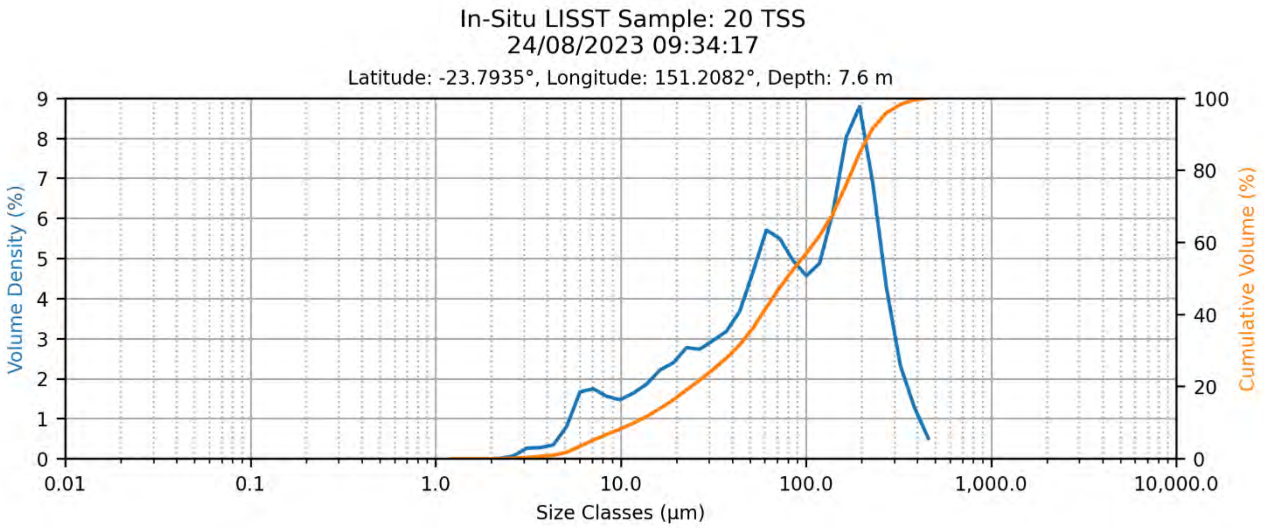


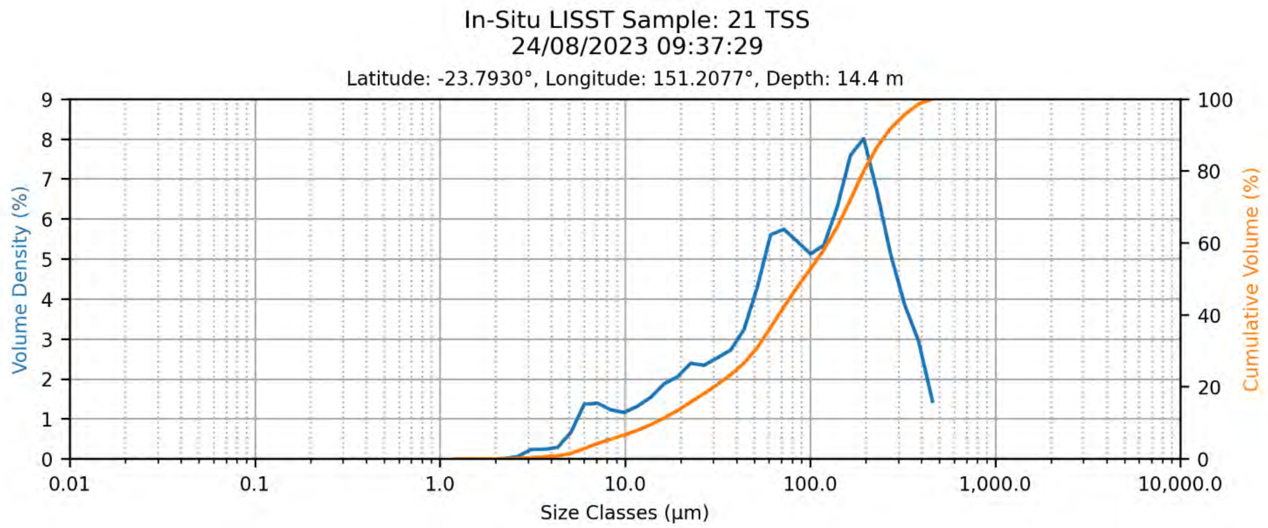


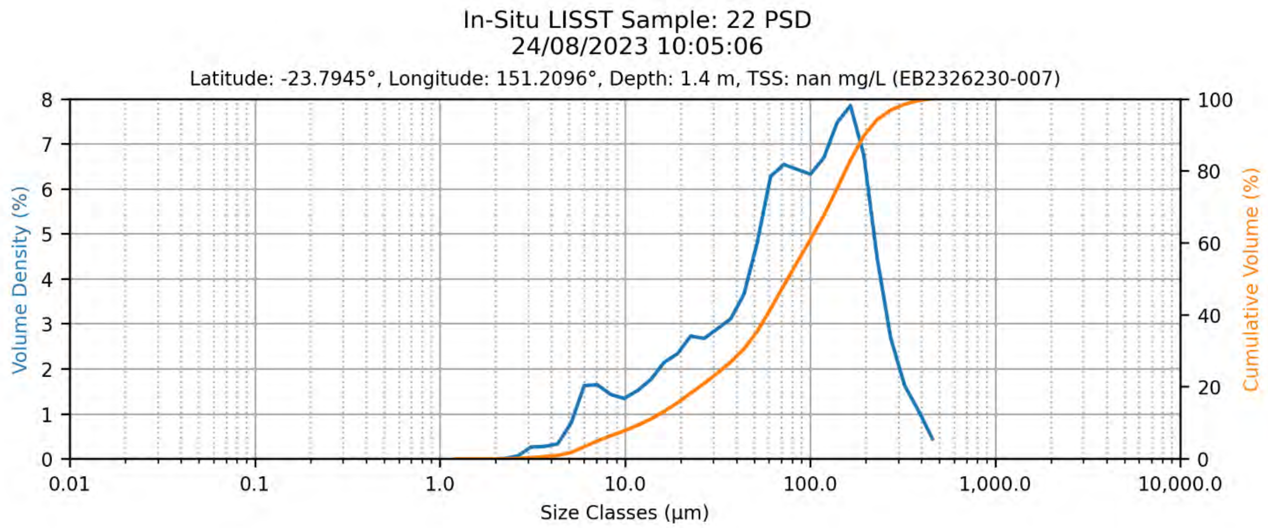


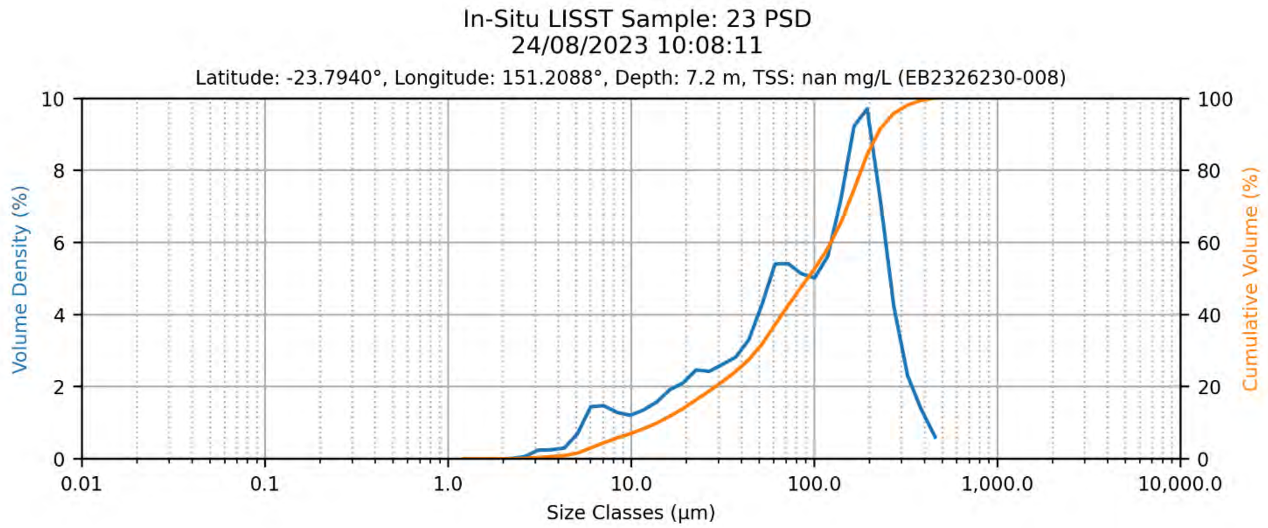

In-Situ LISST Sample: 18 PSD
24/08/2023 09:09:22
Latitude: -23.8008°, Longitude: 151.2154°, Depth: 1.5 m, TSS: nan mg/L (EB2326230-003)
Volume Density (%)
Cumulative Volume (%)
Size Classes (μm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

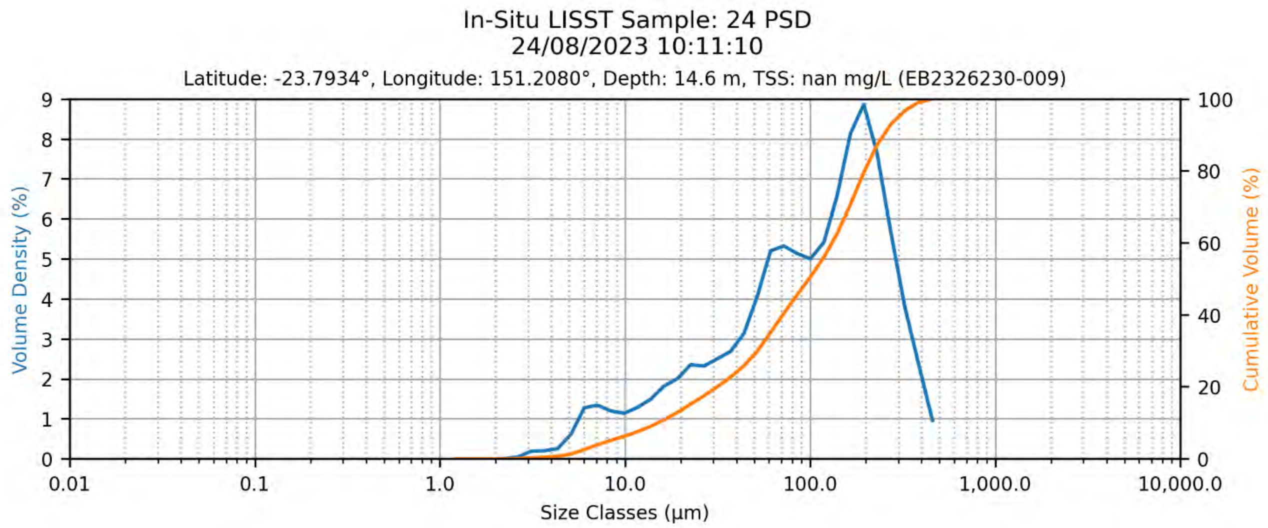

In-Situ LISST Sample: 19 TSS
24/08/2023 09:31:29
Latitude: -23.7941°, Longitude: 151.2088°, Depth: 1.8 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (μm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

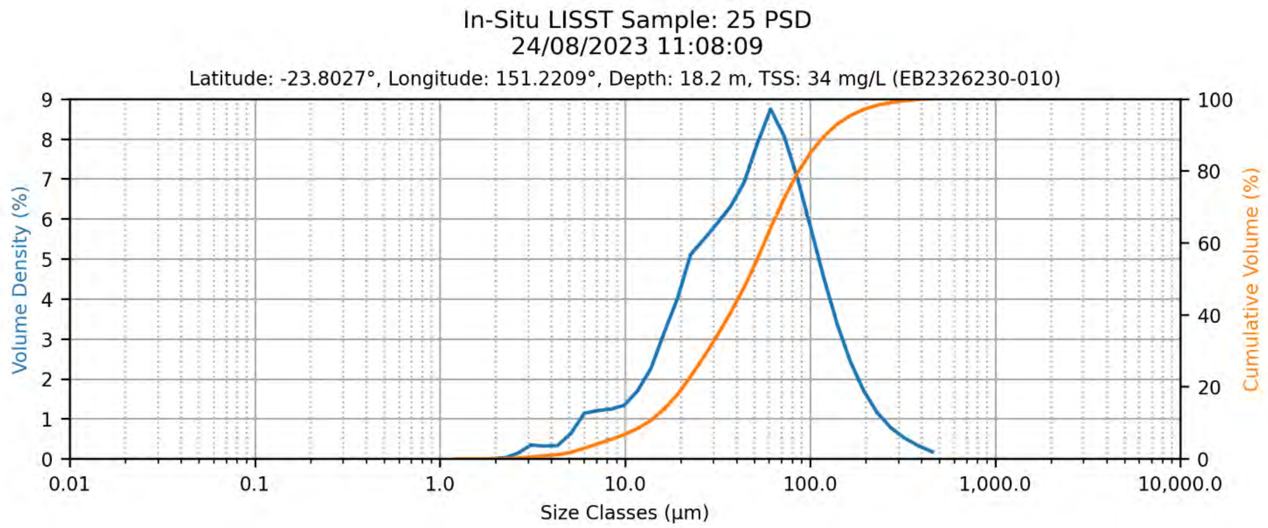

In-Situ LISST Sample: 20 TSS
24/08/2023 09:34:17
Latitude: -23.7935°, Longitude: 151.2082°, Depth: 7.6 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (μm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

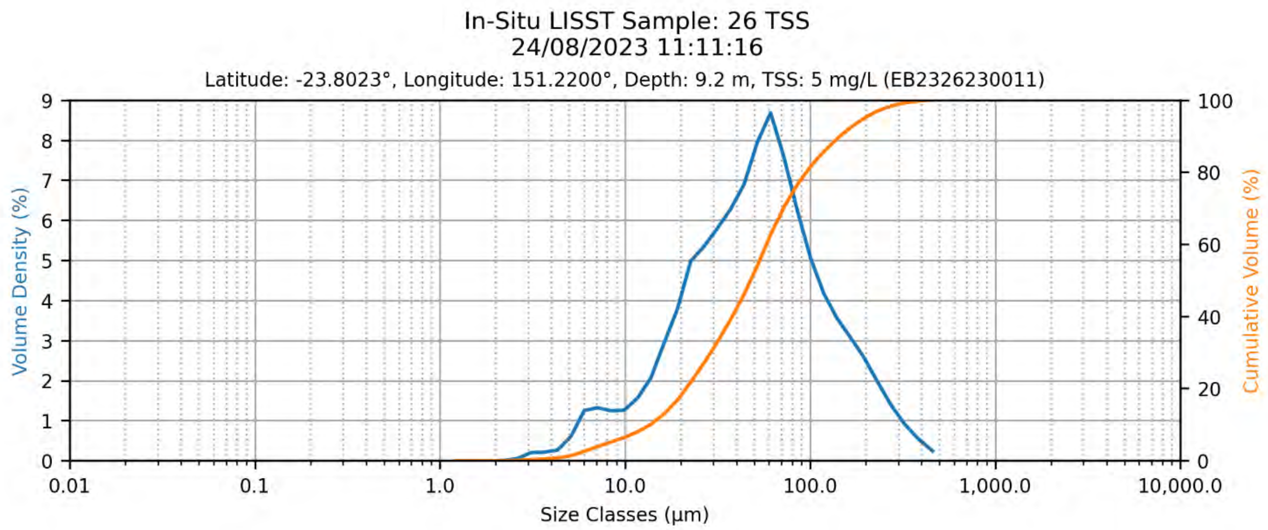

In-Situ LISST Sample: 21 TSS
24/08/2023 09:37:29
Latitude: -23.7930°, Longitude: 151.2077°, Depth: 14.4 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0


In-Situ LISST Sample: 22 PSD
24/08/2023 10:05:06
Latitude: -23.7945°, Longitude: 151.2096°, Depth: 1.4 m, TSS: nan mg/L (EB2326230-007)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

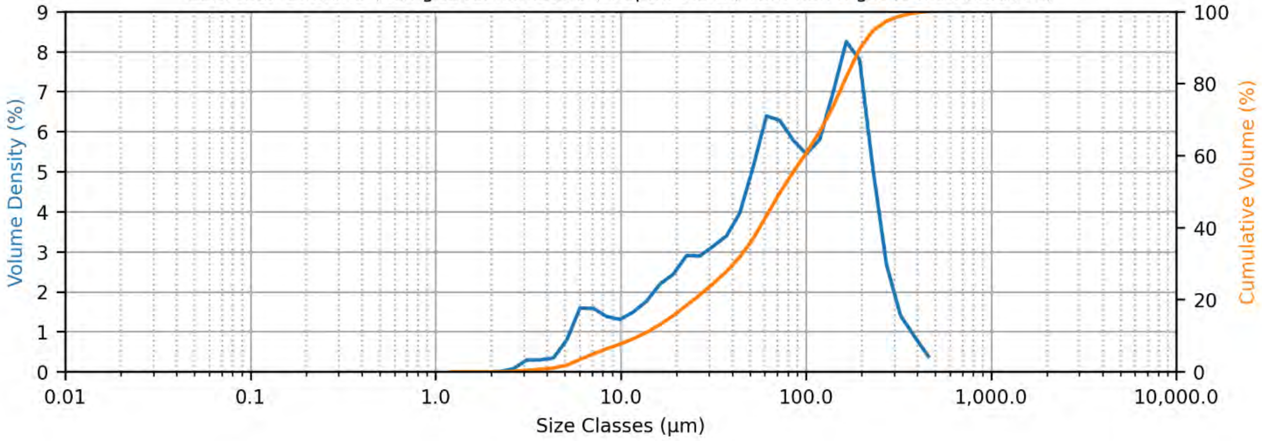

In-Situ LISST Sample: 23 PSD
24/08/2023 10:08:11
Latitude: -23.7940°, Longitude: 151.2088°, Depth: 7.2 m, TSS: nan mg/L (EB2326230-008)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0


In-Situ LISST Sample: 24 PSD
24/08/2023 10:11:10
Latitude: -23.7934°, Longitude: 151.2080°, Depth: 14.6 m, TSS: nan mg/L (EB2326230-009)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

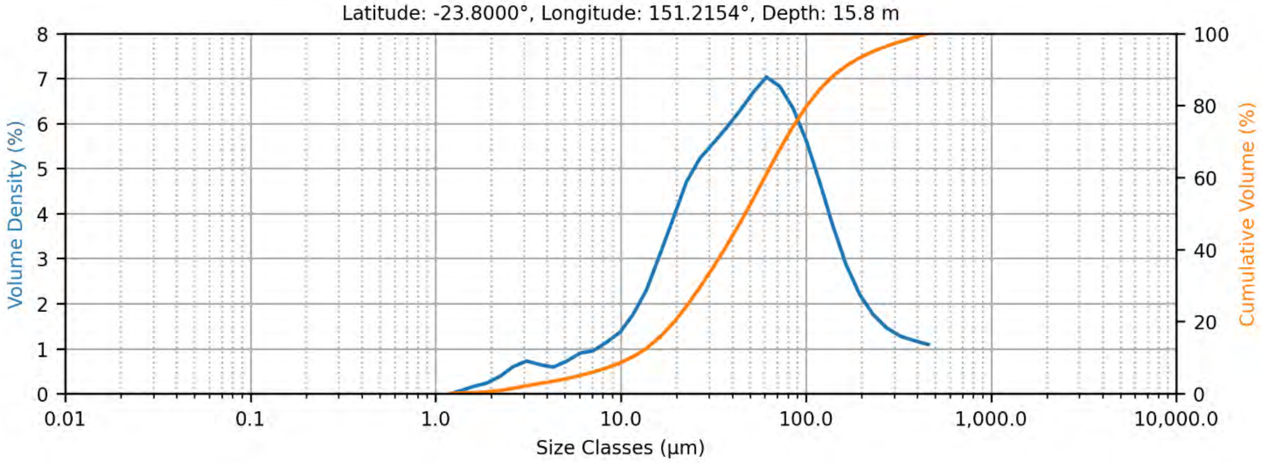

In-Situ LISST Sample: 25 PSD
24/08/2023 11:08:09
Latitude: -23.8027°, Longitude: 151.2209°, Depth: 18.2 m, TSS: 34 mg/L (EB2326230-010)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


In-Situ LISST Sample: 26 TSS
24/08/2023 11:11:16
Latitude: -23.8023°, Longitude: 151.2200°, Depth: 9.2 m, TSS: 5 mg/L (EB2326230011)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

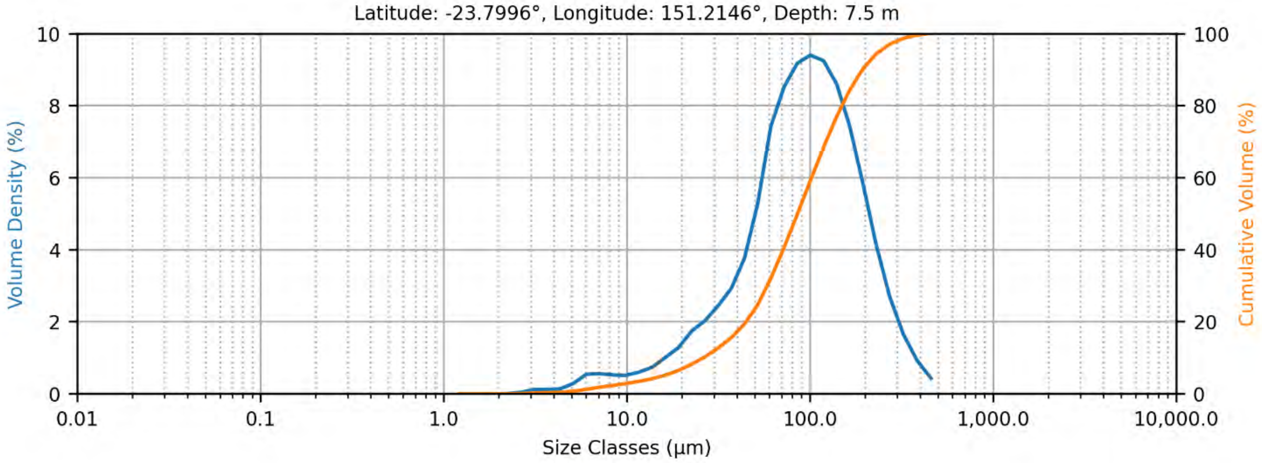
In-Situ LISST Sample: 27 TSS
24/08/2023 11:14:13
Latitude: -23.8018°, Longitude: 151.2190°, Depth: 1.5 m, TSS: nan mg/L (EB2326230012)

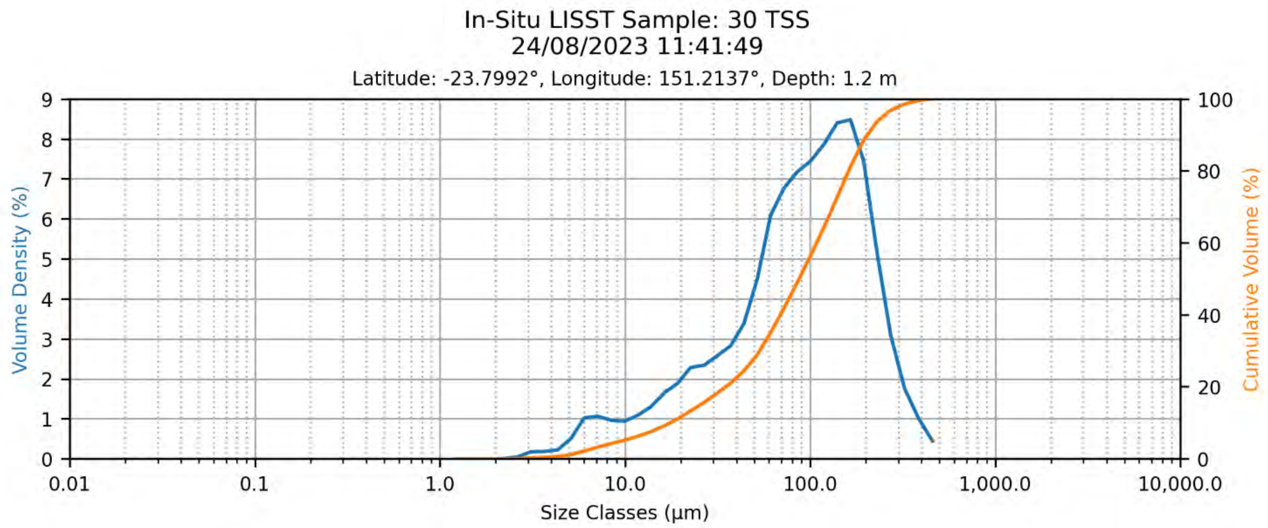


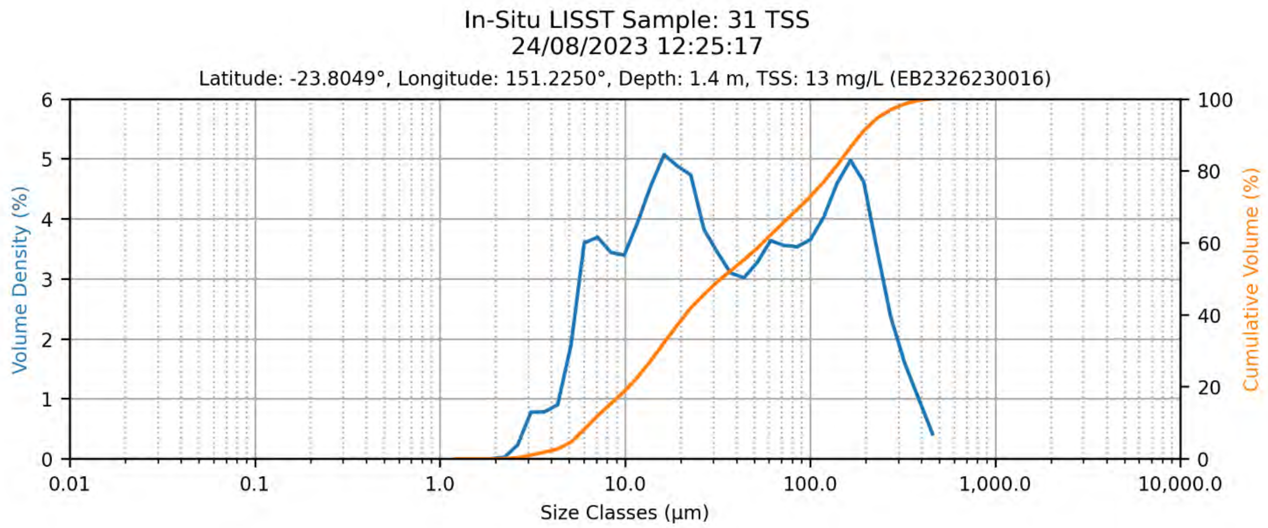
In-Situ LISST Sample: 28 TSS
24/08/2023 11:37:04
Latitude: -23.8000°, Longitude: 151.2154°, Depth: 15.8 m

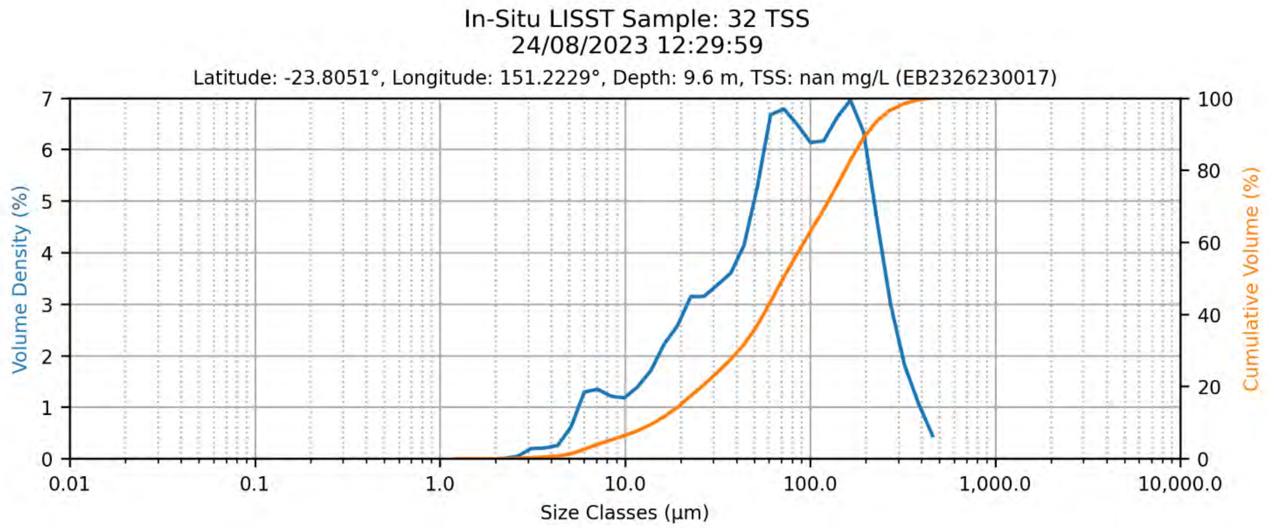


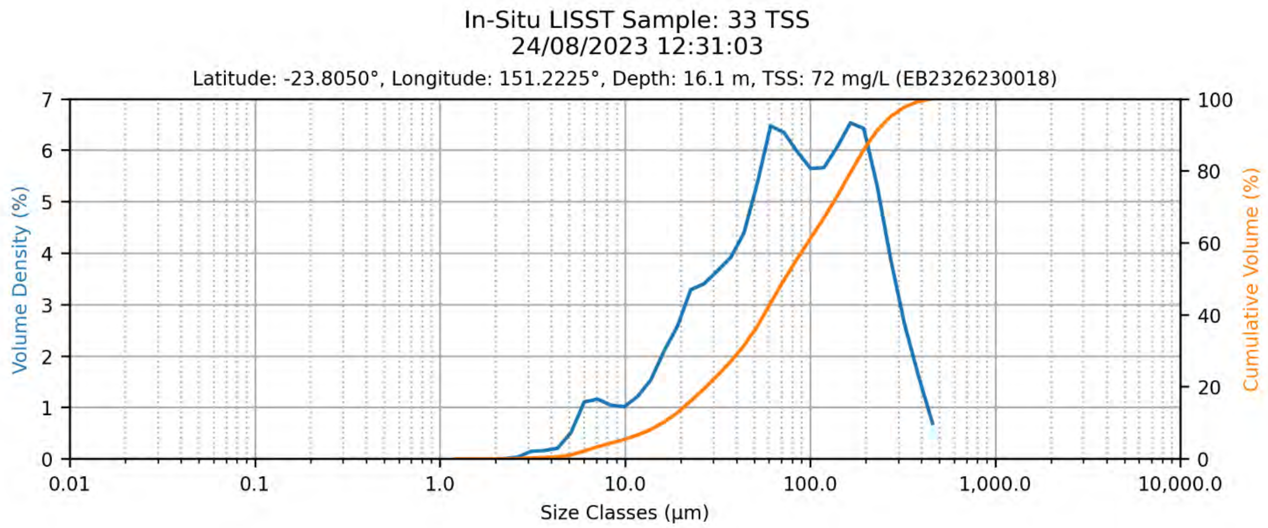
In-Situ LISST Sample: 29 TSS
24/08/2023 11:39:31
Latitude: -23.7996°, Longitude: 151.2146°, Depth: 7.5 m

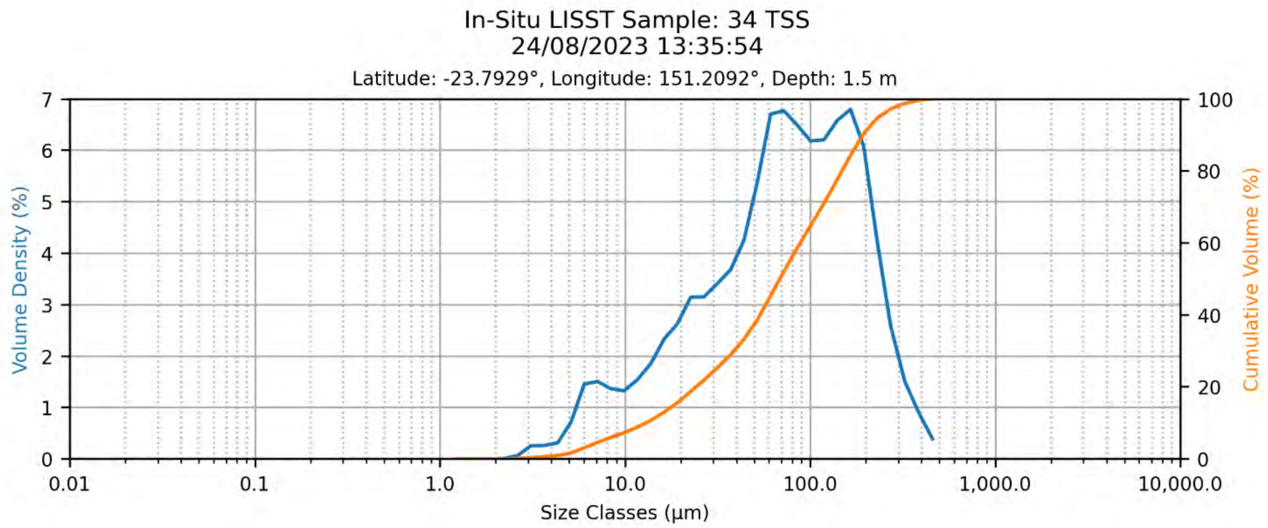


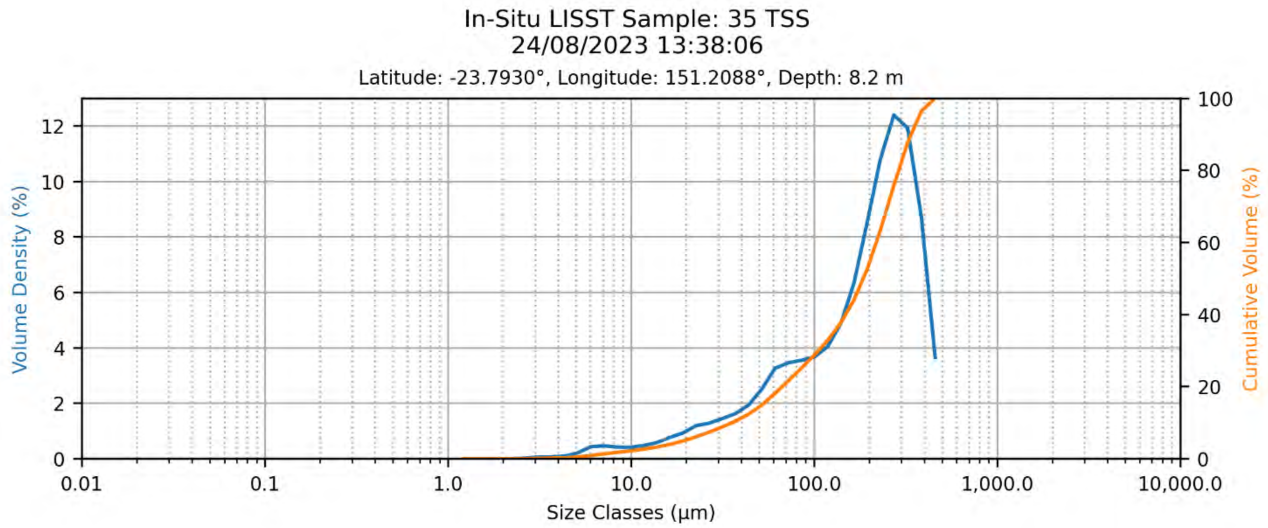

In-Situ LISST Sample: 30 TSS
24/08/2023 11:41:49
Latitude: -23.7992°, Longitude: 151.2137°, Depth: 1.2 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (μm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

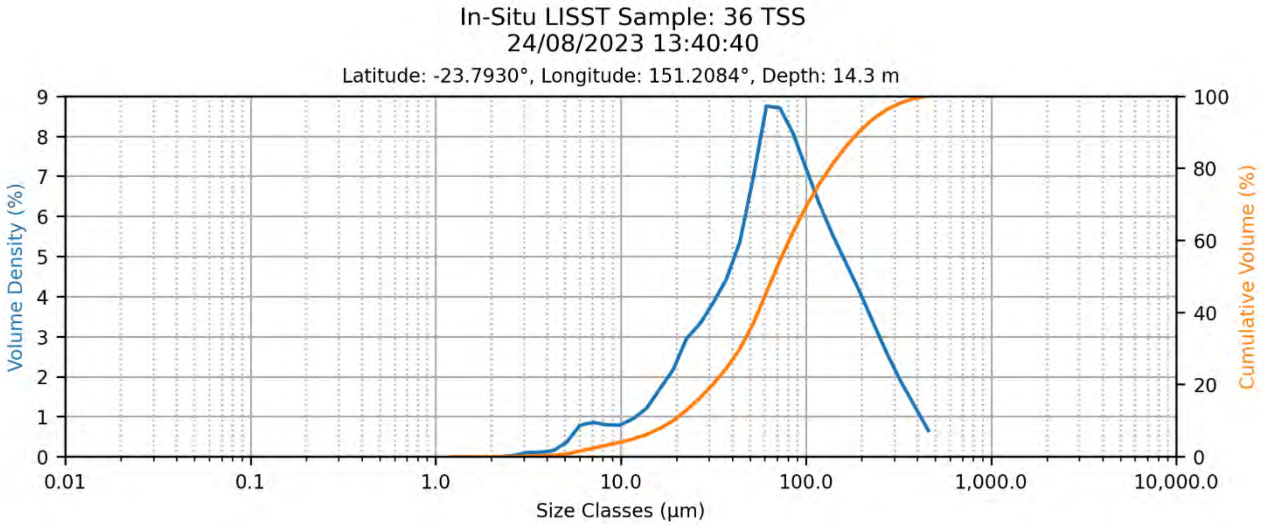

In-Situ LISST Sample: 31 TSS
24/08/2023 12:25:17
Latitude: -23.8049°, Longitude: 151.2250°, Depth: 1.4 m, TSS: 13 mg/L (EB2326230016)
Volume Density (%)
Cumulative Volume (%)
Size Classes (μm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0


In-Situ LISST Sample: 32 TSS
24/08/2023 12:29:59
Latitude: -23.8051°, Longitude: 151.2229°, Depth: 9.6 m, TSS: nan mg/L (EB2326230017)
Volume Density (%)
Cumulative Volume (%)
Size Classes (μm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

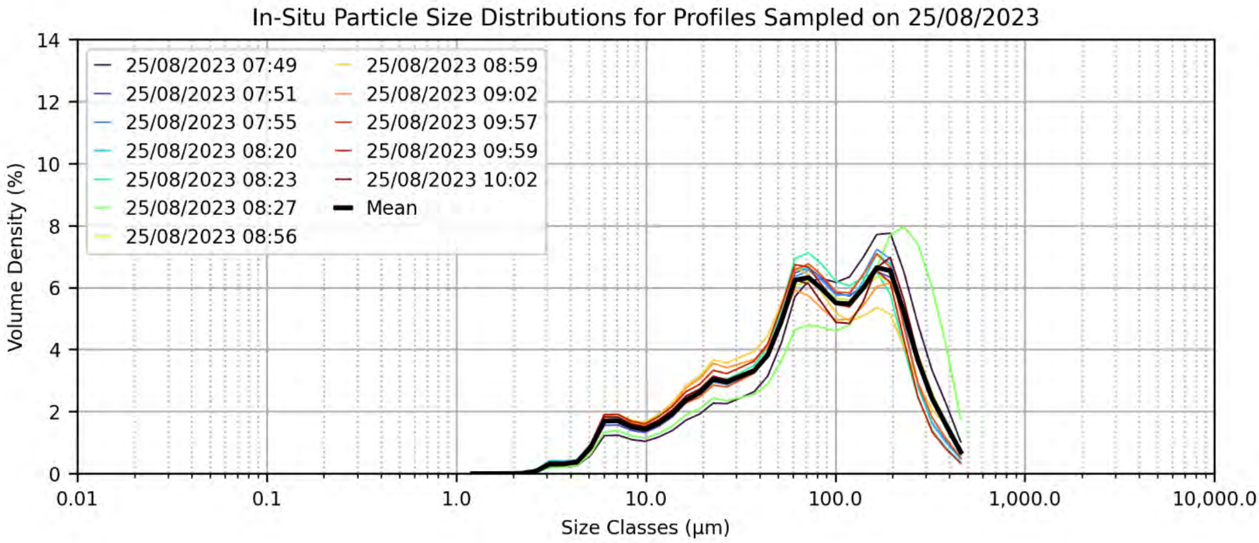

In-Situ LISST Sample: 33 TSS
24/08/2023 12:31:03
Latitude: -23.8050°, Longitude: 151.2225°, Depth: 16.1 m, TSS: 72 mg/L (EB2326230018)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

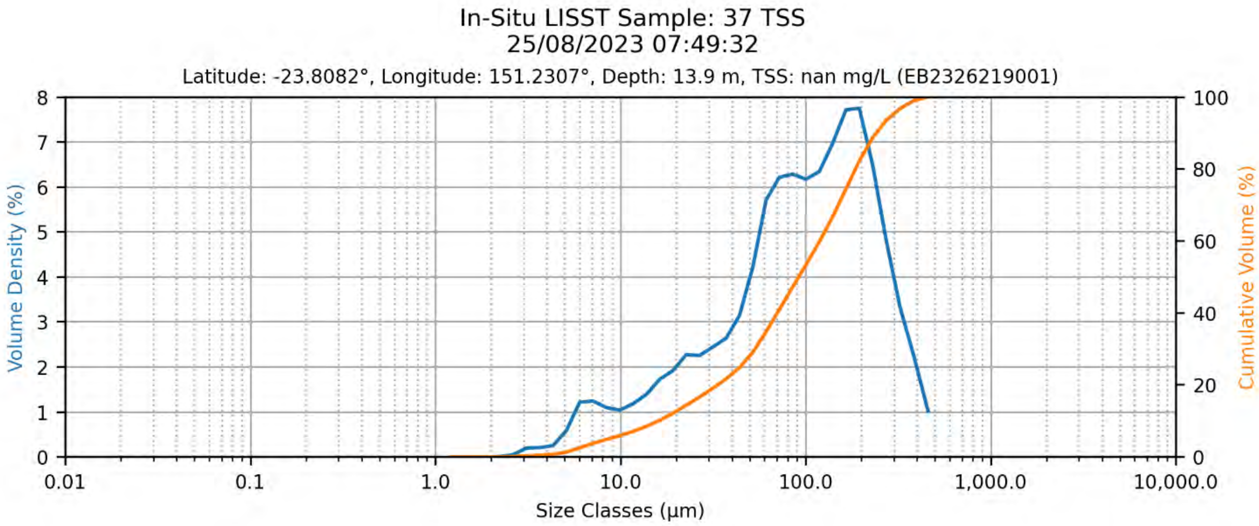

In-Situ LISST Sample: 34 TSS
24/08/2023 13:35:54
Latitude: -23.7929°, Longitude: 151.2092°, Depth: 1.5 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

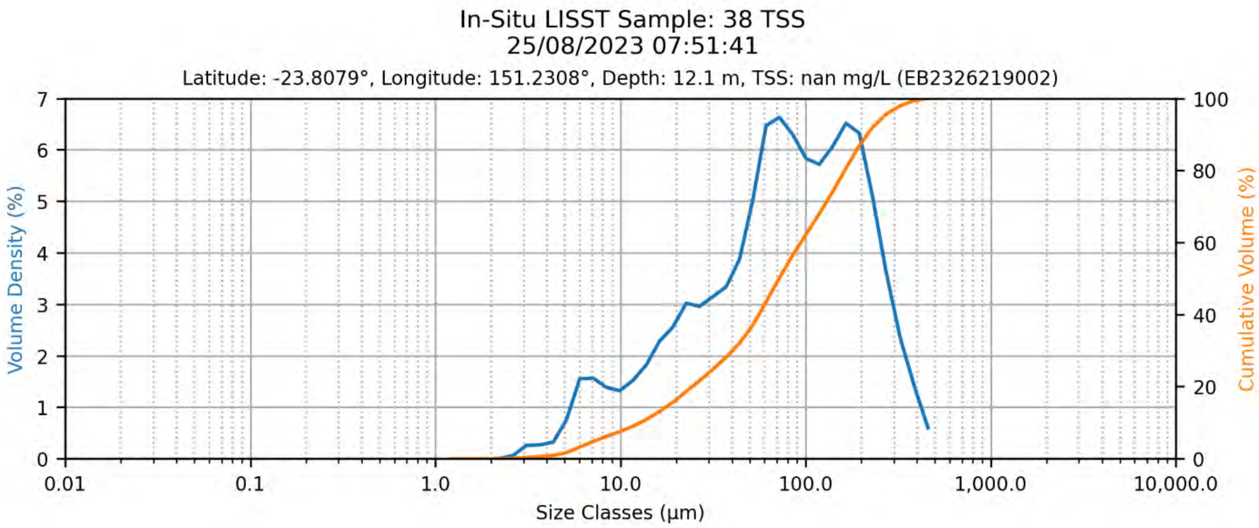

In-Situ LISST Sample: 35 TSS
24/08/2023 13:38:06
Latitude: -23.7930°, Longitude: 151.2088°, Depth: 8.2 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

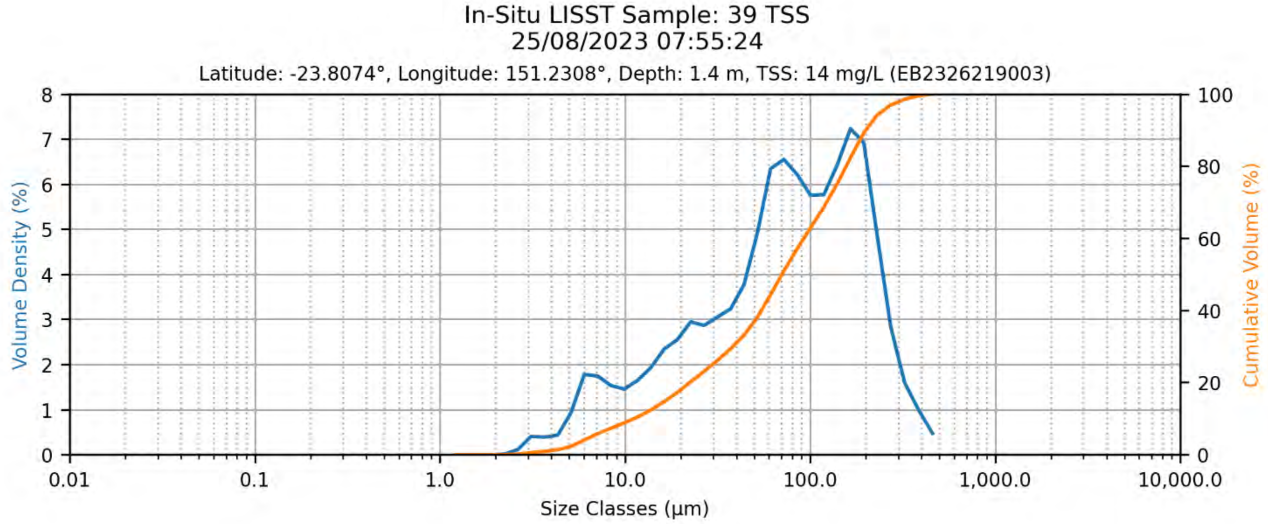

In-Situ LISST Sample: 36 TSS
24/08/2023 13:40:40
Latitude: -23.7930°, Longitude: 151.2084°, Depth: 14.3 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (μm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

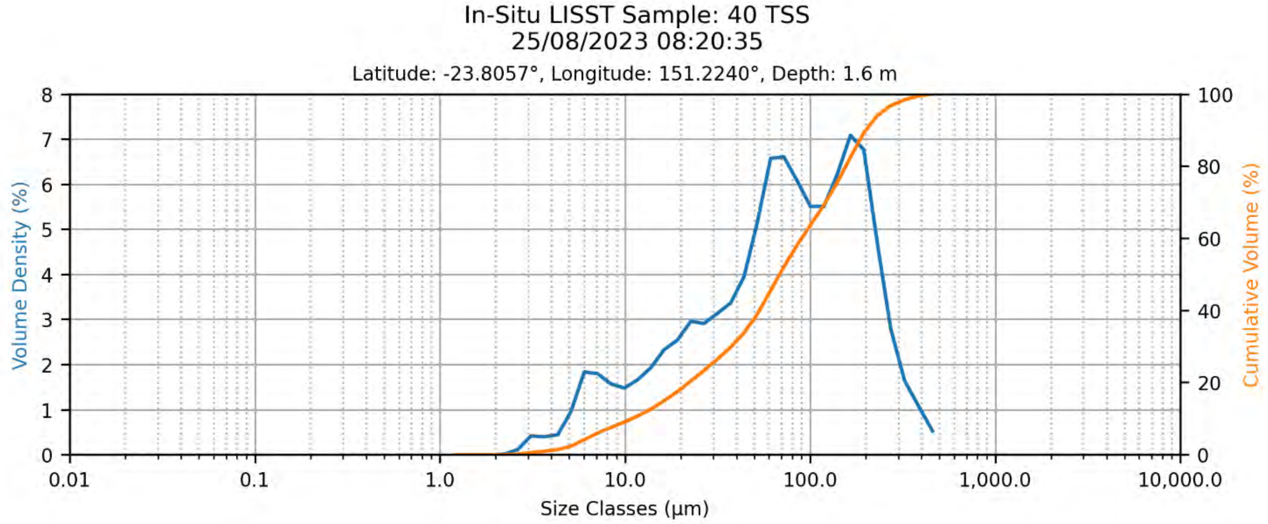
E.3 25th August 2023

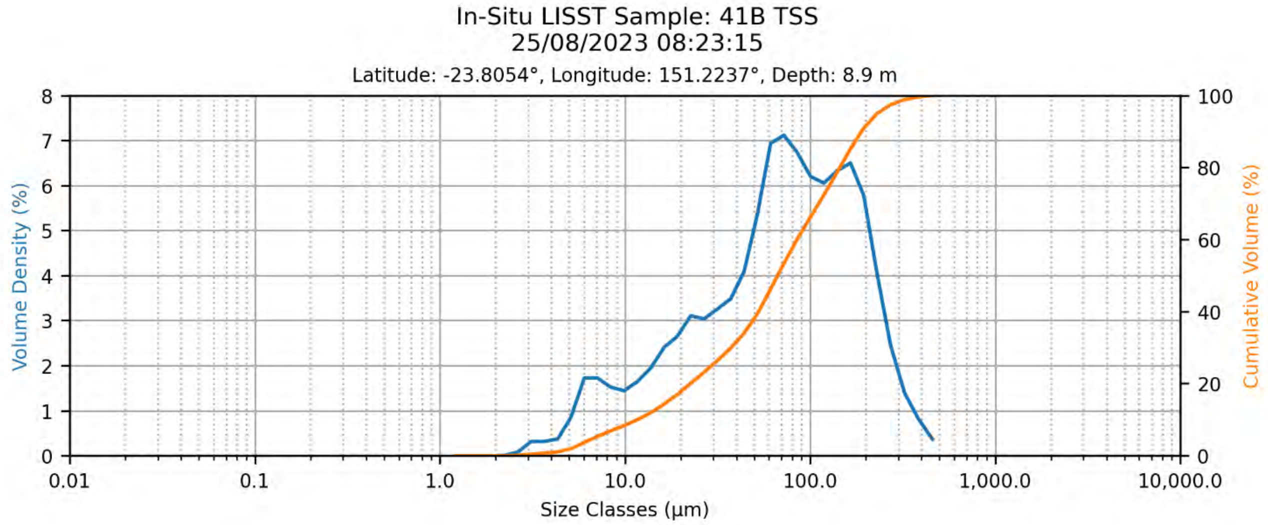


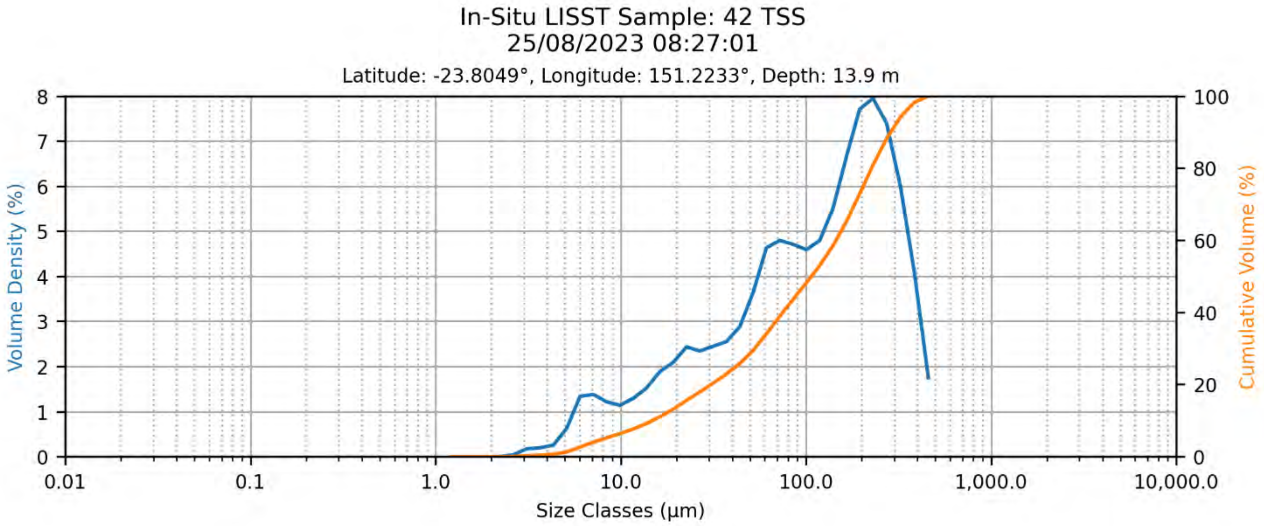


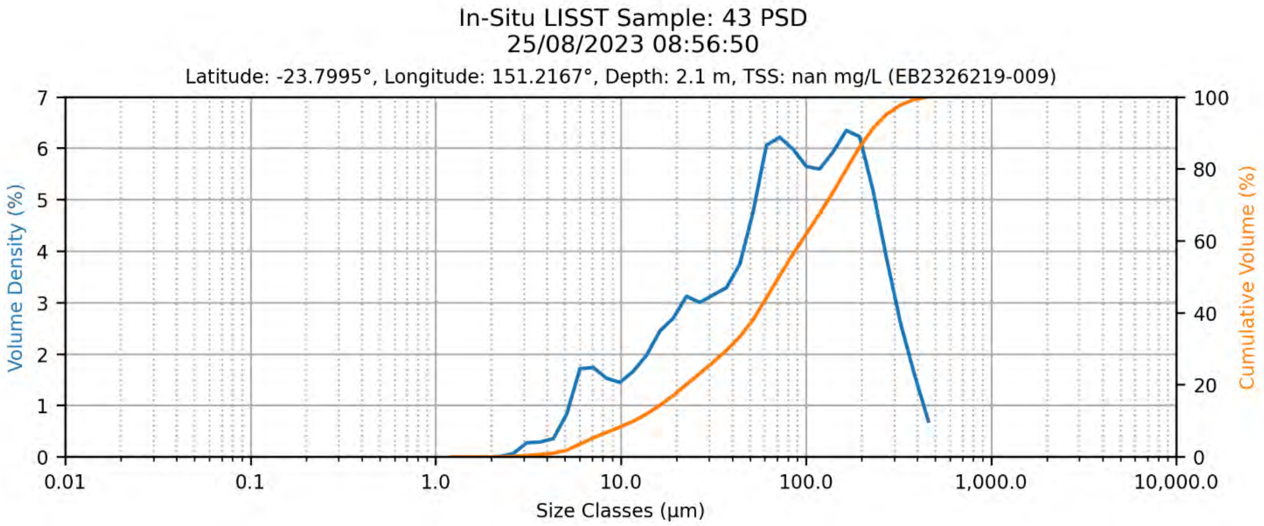


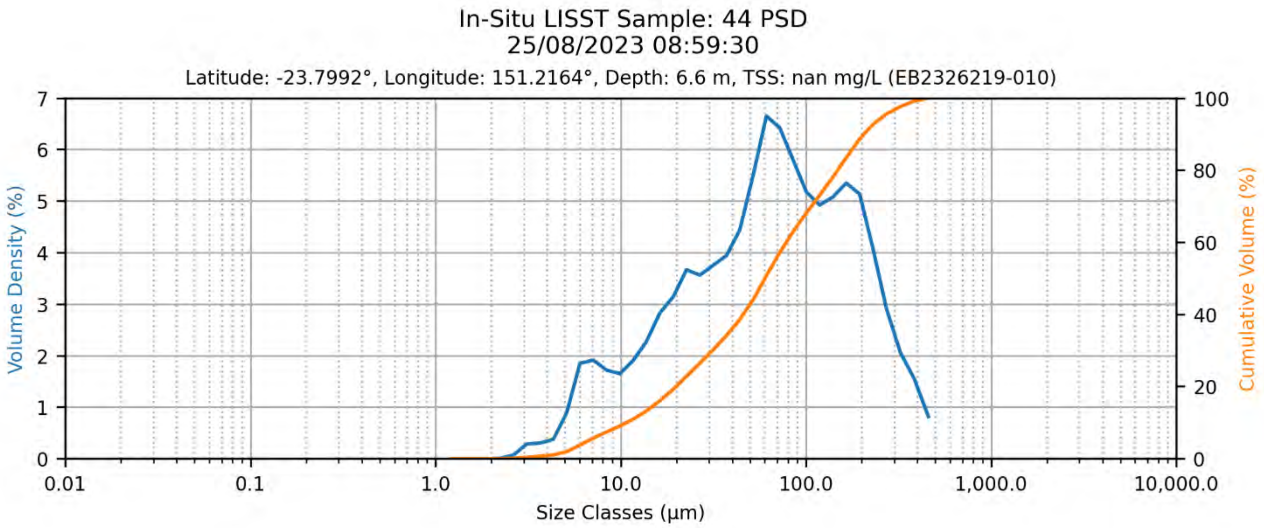

In-Situ LISST Sample: 39 TSS
25/08/2023 07:55:24
Latitude: -23.8074°, Longitude: 151.2308°, Depth: 1.4 m, TSS: 14 mg/L (EB2326219003)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

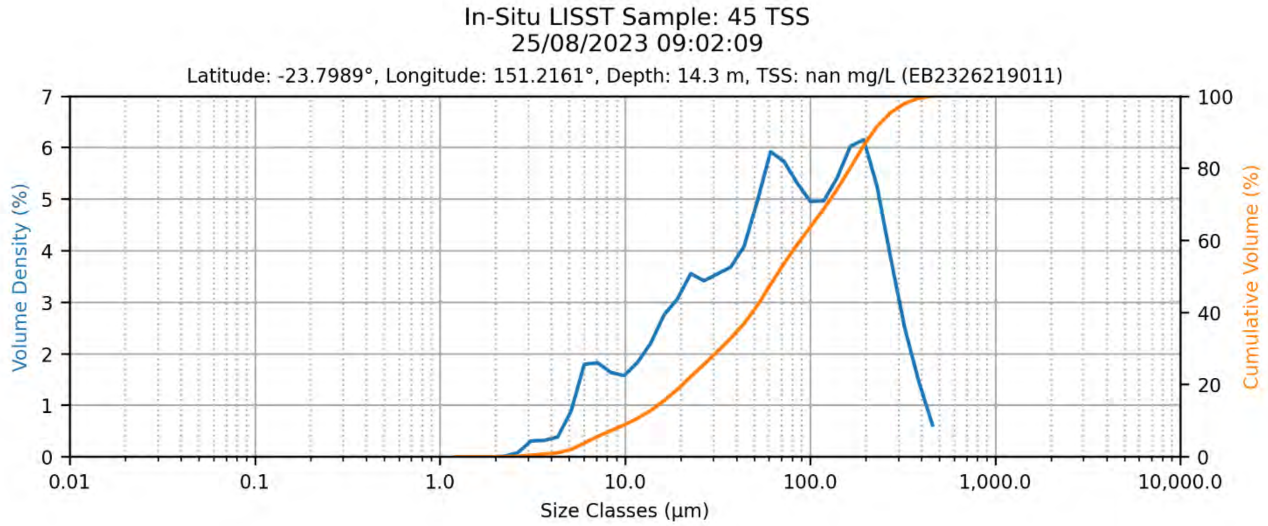

In-Situ LISST Sample: 40 TSS
25/08/2023 08:20:35
Latitude: -23.8057°, Longitude: 151.2240°, Depth: 1.6 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

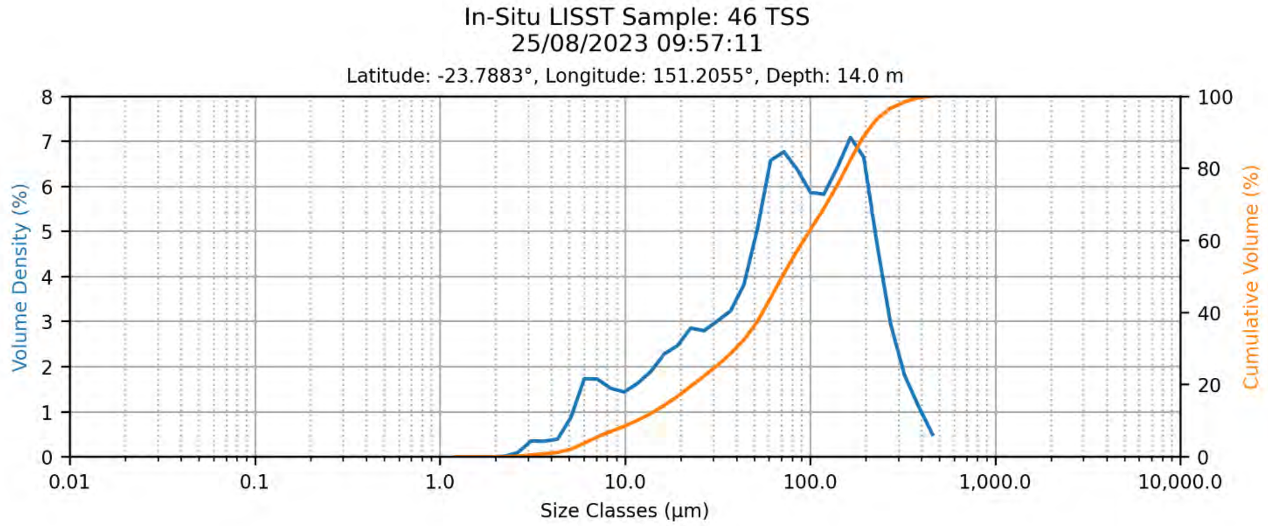

In-Situ LISST Sample: 41B TSS
25/08/2023 08:23:15
Latitude: -23.8054°, Longitude: 151.2237°, Depth: 8.9 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

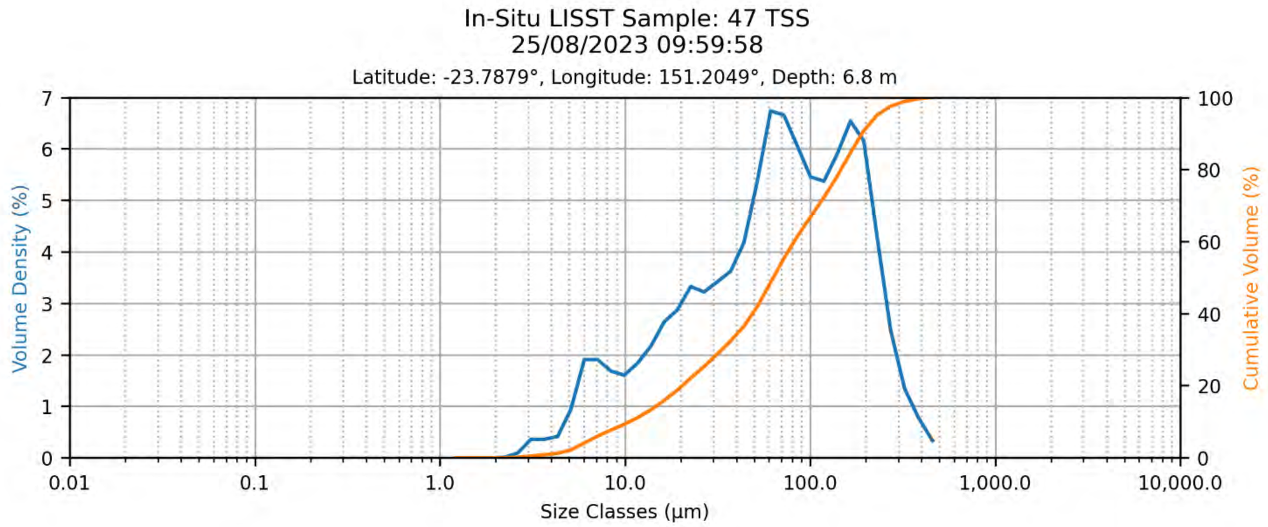

In-Situ LISST Sample: 42 TSS
25/08/2023 08:27:01
Latitude: -23.8049°, Longitude: 151.2233°, Depth: 13.9 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


In-Situ LISST Sample: 43 PSD
25/08/2023 08:56:50
Latitude: -23.7995°, Longitude: 151.2167°, Depth: 2.1 m, TSS: nan mg/L (EB2326219-009)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


In-Situ LISST Sample: 44 PSD
25/08/2023 08:59:30
Latitude: -23.7992°, Longitude: 151.2164°, Depth: 6.6 m, TSS: nan mg/L (EB2326219-010)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


In-Situ LISST Sample: 45 TSS
25/08/2023 09:02:09
Latitude: -23.7989°, Longitude: 151.2161°, Depth: 14.3 m, TSS: nan mg/L (EB2326219011)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


In-Situ LISST Sample: 46 TSS
25/08/2023 09:57:11
Latitude: -23.7883°, Longitude: 151.2055°, Depth: 14.0 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


In-Situ LISST Sample: 47 TSS
25/08/2023 09:59:58
Latitude: -23.7879°, Longitude: 151.2049°, Depth: 6.8 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

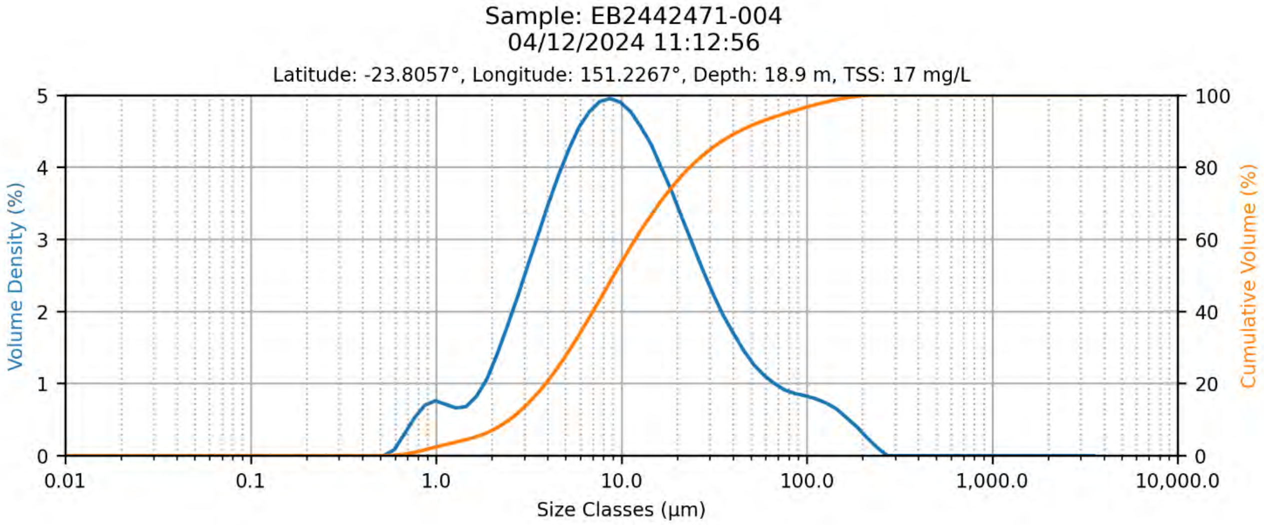
Annex F Sample TSS Results – December 2024 Campaign

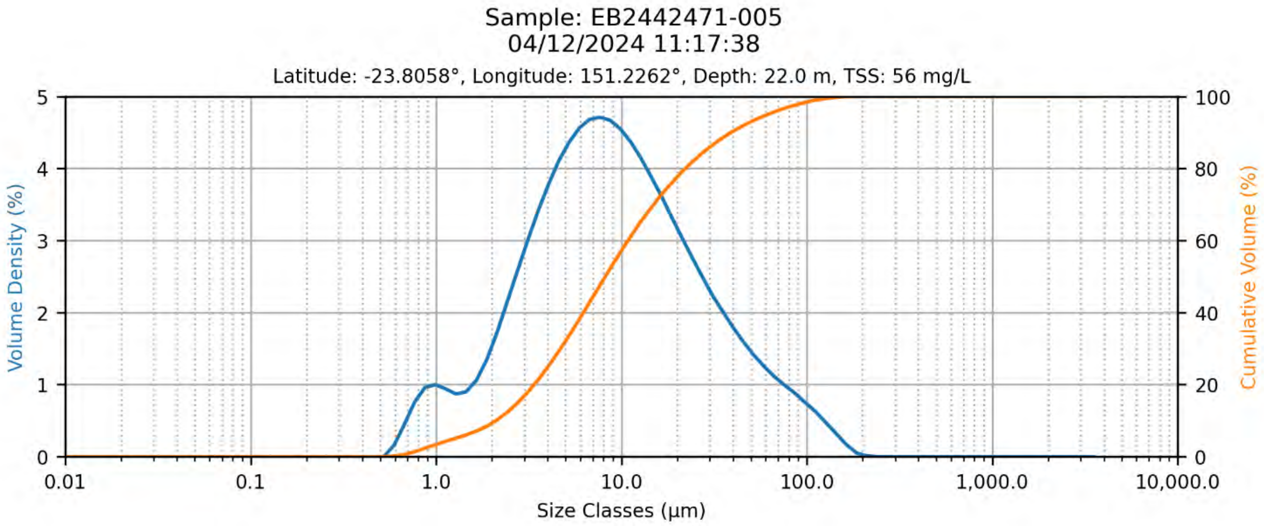
Table F.1. Summary of all TSS results Collected Over the December 2024 Monitoring Campaign

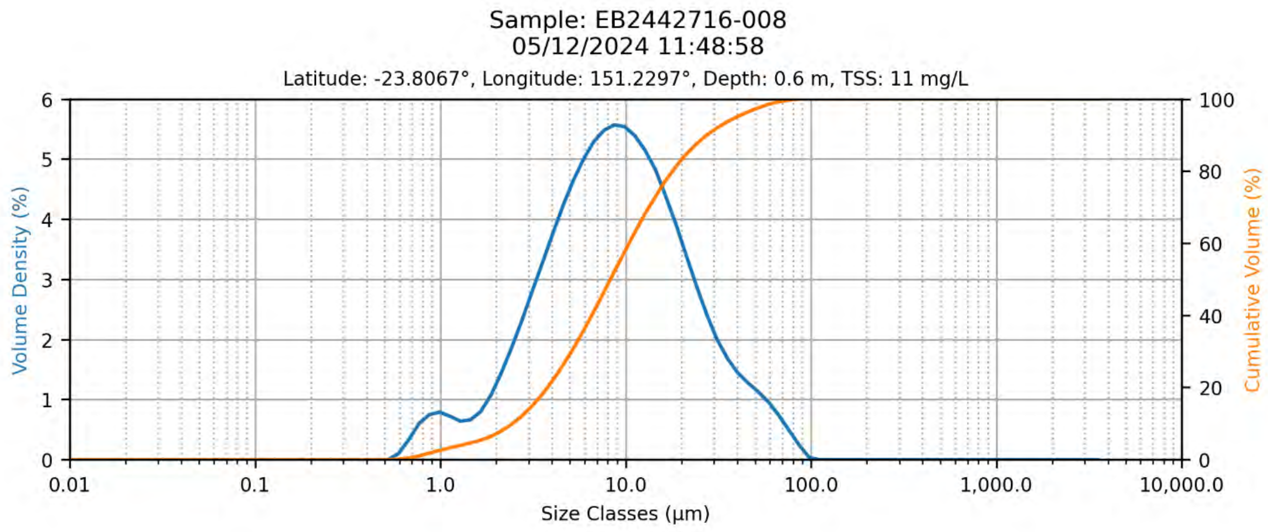
Date	Location	Latitude (°)	Longitude (°)	Depth (m)	TSS (mg/L)	Description
4/12/2024 9:53	Jacobs Channel - off GLNG MOF	-23.80021	151.216	17	30	Residual Dredge Placement Plume
4/12/2024 9:59	Jacobs Channel - off GLNG MOF	-23.79909	151.214	10	26	Residual Dredge Placement Plume
4/12/2024 10:01	Jacobs Channel - off GLNG MOF	-23.79871	151.2134	1	25	Residual Dredge Placement Plume
4/12/2024 11:13	Tide Island MRA	-23.80574	151.2264	19	17	Dredge Placement
4/12/2024 11:18	Tide Island MRA	-23.80582	151.2259	22	56	Dredge Placement
4/12/2024 11:21	Tide Island MRA	-23.806	151.2256	10	20	Residual Dredge Placement Plume
4/12/2024 11:23	Tide Island MRA	-23.8061	151.2253	1	18	Residual Dredge Placement Plume
4/12/2024 12:53	Tide Island MRA	-23.80647	151.2302	21	19	Residual Dredge Placement Plume
4/12/2024 12:55	Tide Island MRA	-23.80701	151.2315	10	26	Residual Dredge Placement Plume
4/12/2024 12:58	Tide Island MRA	-23.80766	151.233	1	17	Residual Dredge Placement Plume
5/12/2024 9:33	Tide Island MRA	-23.8095	151.2369	19	20	Background
5/12/2024 9:38	Tide Island MRA	-23.80862	151.2346	10	18	Background
5/12/2024 9:40	Tide Island MRA	-23.80821	151.2334	1	20	Background
5/12/2024 10:36	Jacobs Channel - off GLNG MOF	-23.79724	151.2123	16	23	Background
5/12/2024 10:41	Jacobs Channel - off GLNG MOF	-23.79724	151.2123	8	35	Background
5/12/2024 10:43	Jacobs Channel - off GLNG MOF	-23.79642	151.2107	1	16	Background
5/12/2024 11:43	Tide Island MRA	-23.79642	151.2107	18	12	Background
5/12/2024 11:49	Tide Island MRA	-23.79605	151.2099	1	11	Background
5/12/2024 13:16	Tide Island MRA	-23.8067	151.231	18	27	Background
5/12/2024 13:21	Tide Island MRA	-23.8067	151.2296	2	9	Background

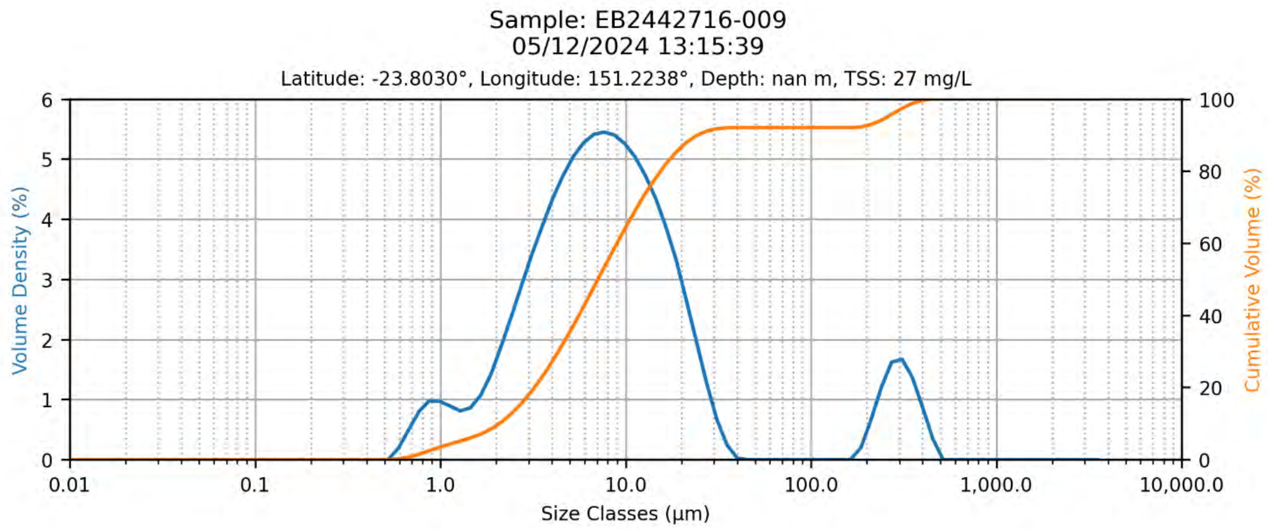
Date	Location	Latitude (°)	Longitude (°)	Depth (m)	TSS (mg/L)	Description
6/12/2024 9:42	Jacobs Channel - off GLNG MOF	-23.80177	151.2191	19	1000	Residual Dredge Placement Plume
6/12/2024 9:46	Jacobs Channel - off GLNG MOF	-23.79984	151.2159	10	95	Residual Dredge Placement Plume
6/12/2024 9:48	Jacobs Channel - off GLNG MOF	-23.80733	151.232	2	30	Residual Dredge Placement Plume
6/12/2024 10:45	Tide Island MRA	-23.80636	151.2295	20	19	Residual Dredge Placement Plume
6/12/2024 10:51	Tide Island MRA	-23.80592	151.2281	10	15	Residual Dredge Placement Plume
6/12/2024 10:53	Tide Island MRA	-23.80293	151.2215	2	15	Residual Dredge Placement Plume
6/12/2024 11:24	Tide Island MRA	-23.80279	151.2205	20	308	Dredge Placement
6/12/2024 11:28	Tide Island MRA	-23.79917	151.2167	2	17	Residual Dredge Placement Plume
6/12/2024 12:22	Jacobs Channel - off GLNG MOF	-23.79911	151.2164	17	148	Residual Dredge Placement Plume
6/12/2024 12:25	Jacobs Channel - off GLNG MOF	-23.799	151.2161	8	63	Residual Dredge Placement Plume
6/12/2024 12:28	Jacobs Channel - off GLNG MOF	-23.79121	151.2063	2	22	Residual Dredge Placement Plume
6/12/2024 12:55	Jacobs Channel - off GLNG MOF	-23.79122	151.2059	16	39	Residual Dredge Placement Plume
6/12/2024 12:59	Jacobs Channel - off GLNG MOF	-23.7912	151.206	2	10	Residual Dredge Placement Plume

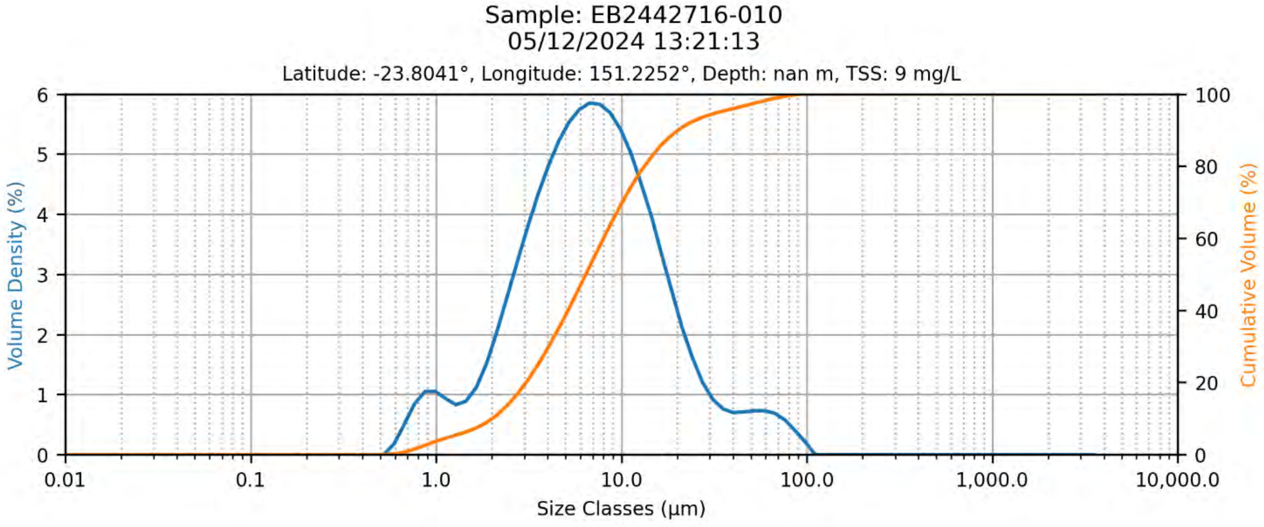
Annex G Sample PSD Results – December 2024 Campaign

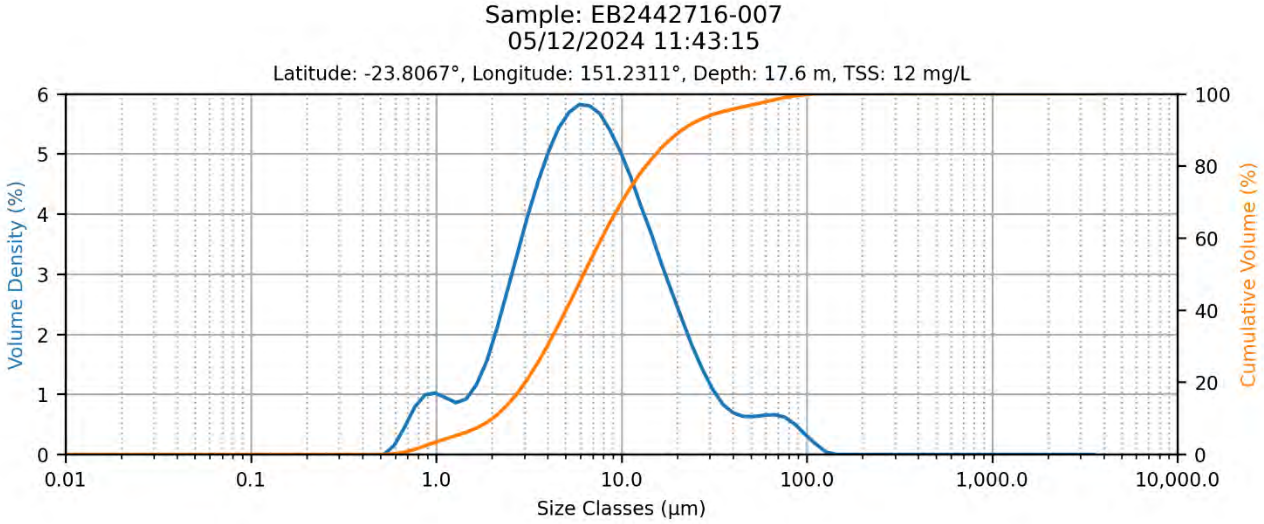


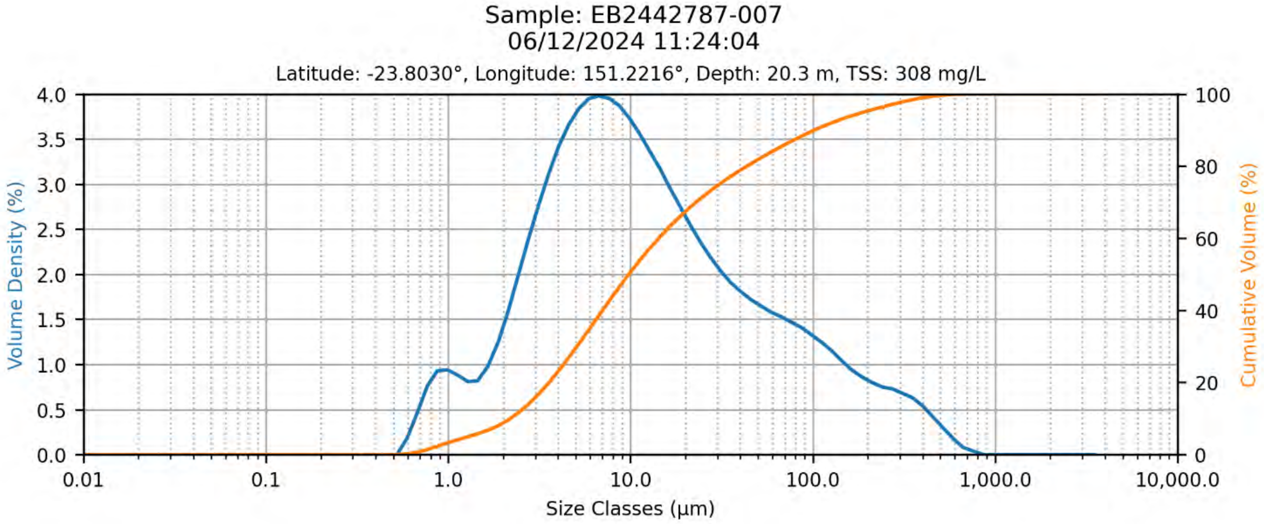


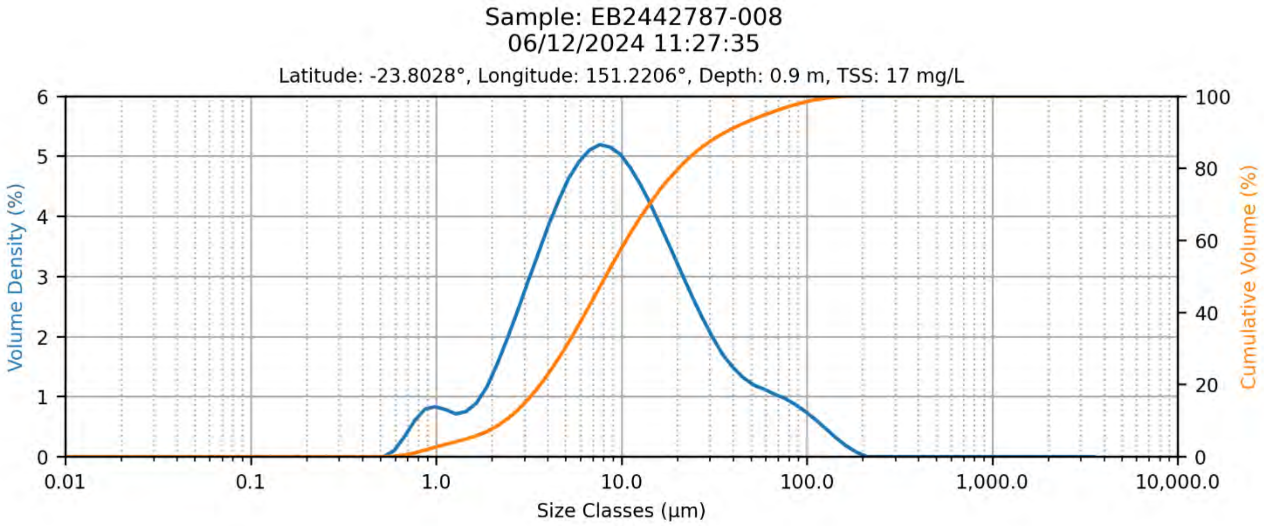

Sample: EB2442716-008
05/12/2024 11:48:58
Latitude: -23.8067°, Longitude: 151.2297°, Depth: 0.6 m, TSS: 11 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

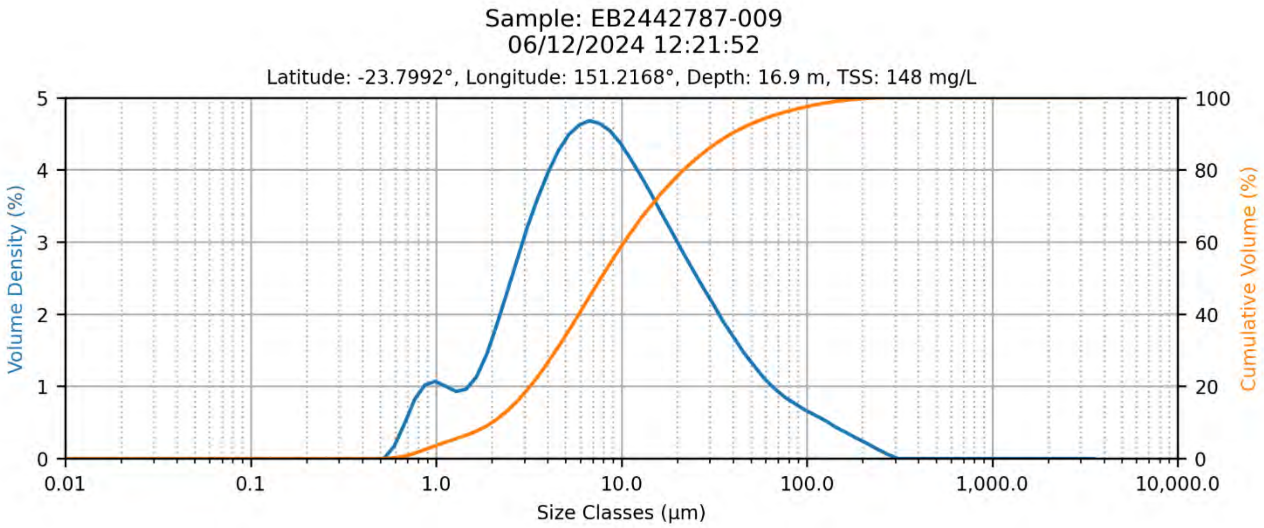

Sample: EB2442716-009
05/12/2024 13:15:39
Latitude: -23.8030°, Longitude: 151.2238°, Depth: nan m, TSS: 27 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

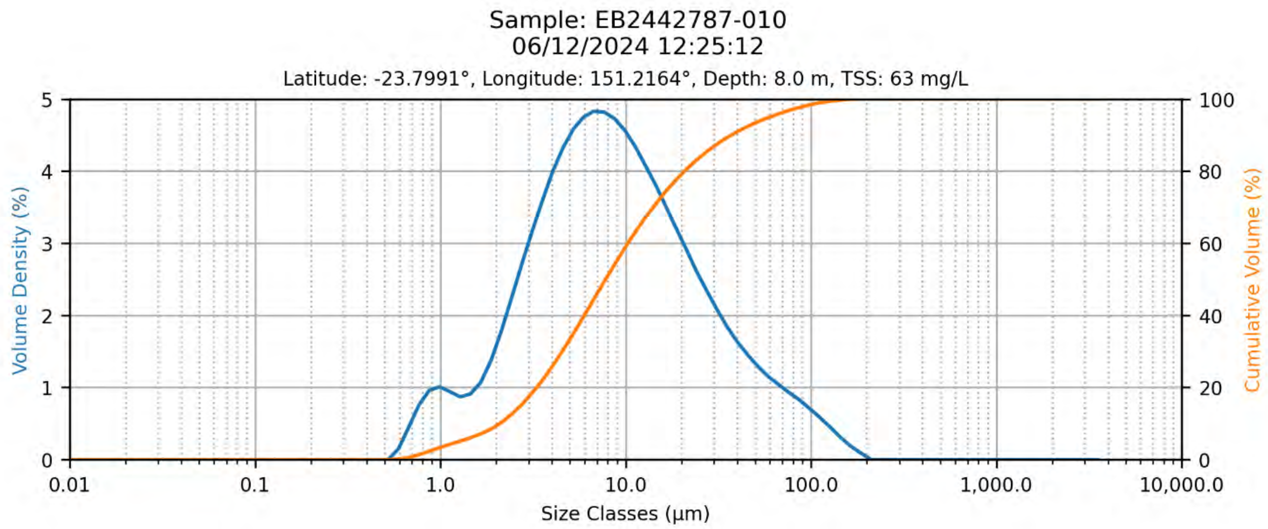

Sample: EB2442716-010
05/12/2024 13:21:13
Latitude: -23.8041°, Longitude: 151.2252°, Depth: nan m, TSS: 9 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

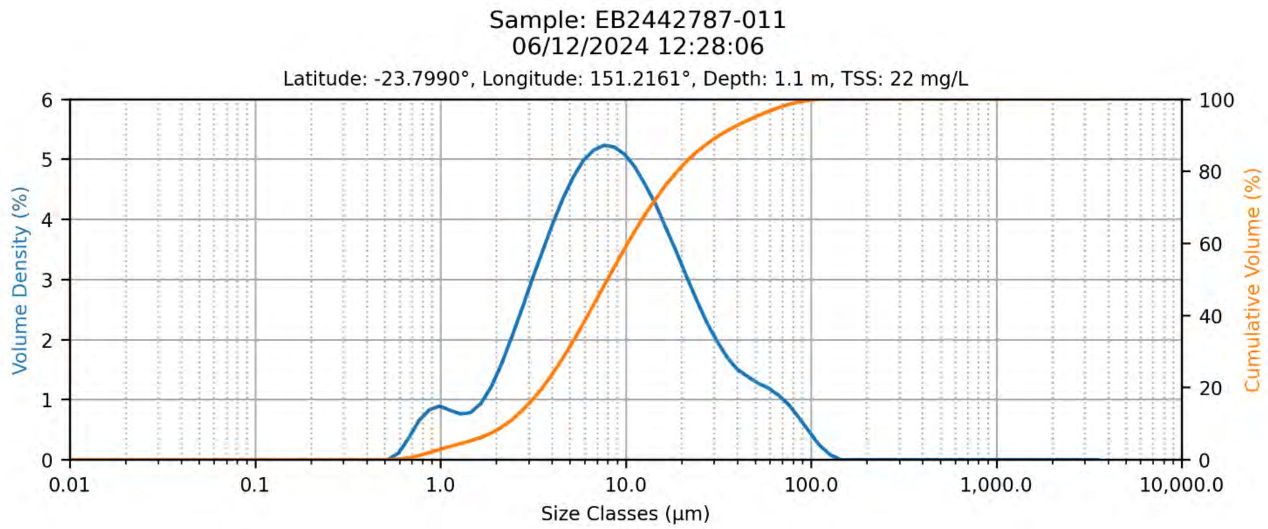

Sample: EB2442716-007
05/12/2024 11:43:15
Latitude: -23.8067°, Longitude: 151.2311°, Depth: 17.6 m, TSS: 12 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

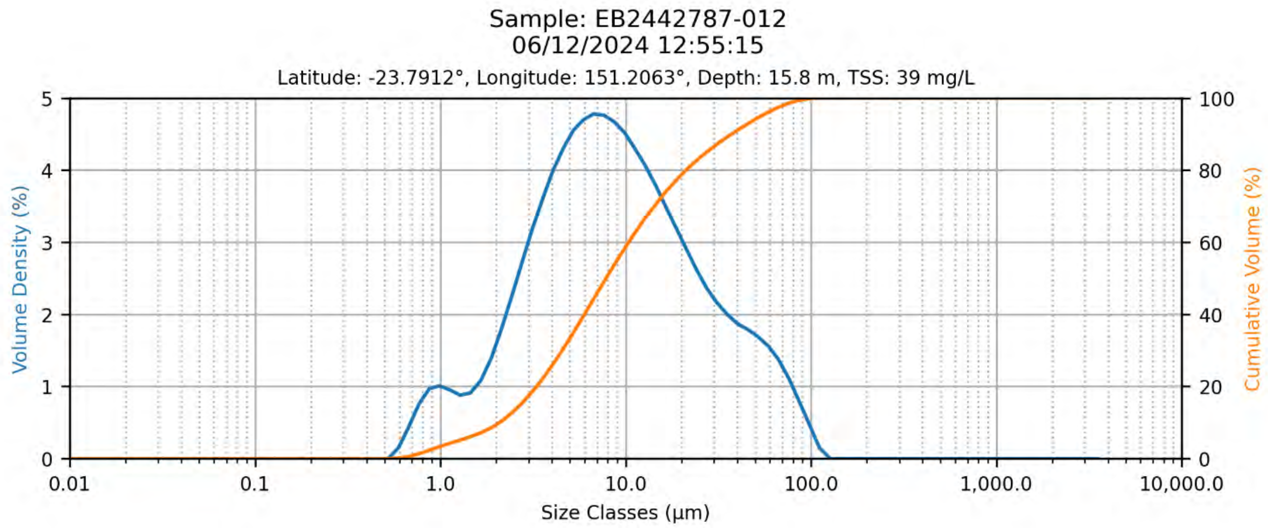

Sample: EB2442787-007
06/12/2024 11:24:04
Latitude: -23.8030°, Longitude: 151.2216°, Depth: 20.3 m, TSS: 308 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

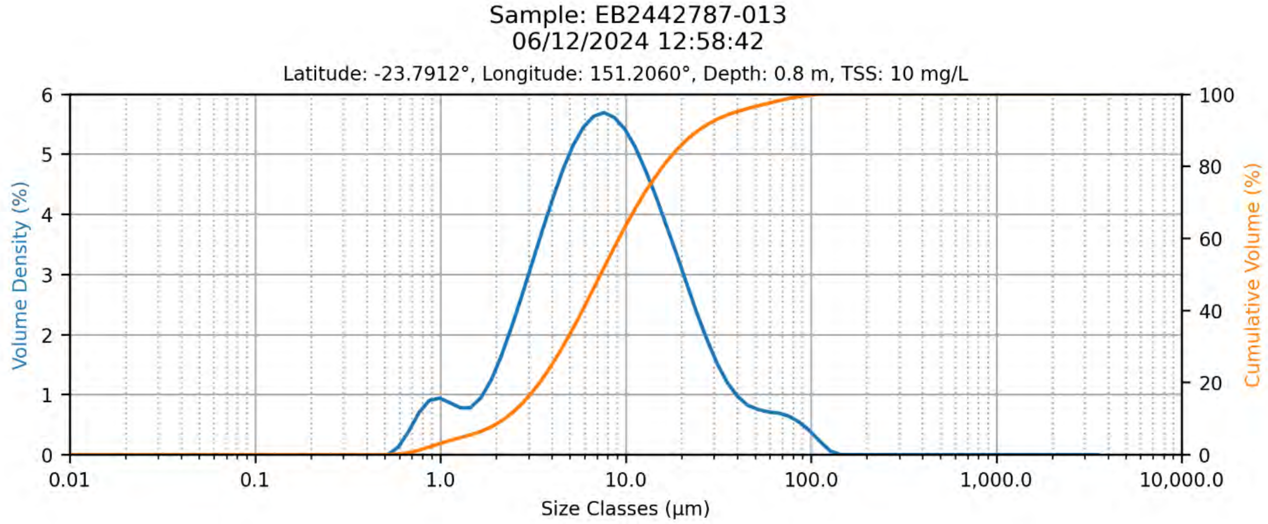

Sample: EB2442787-008
06/12/2024 11:27:35
Latitude: -23.8028°, Longitude: 151.2206°, Depth: 0.9 m, TSS: 17 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

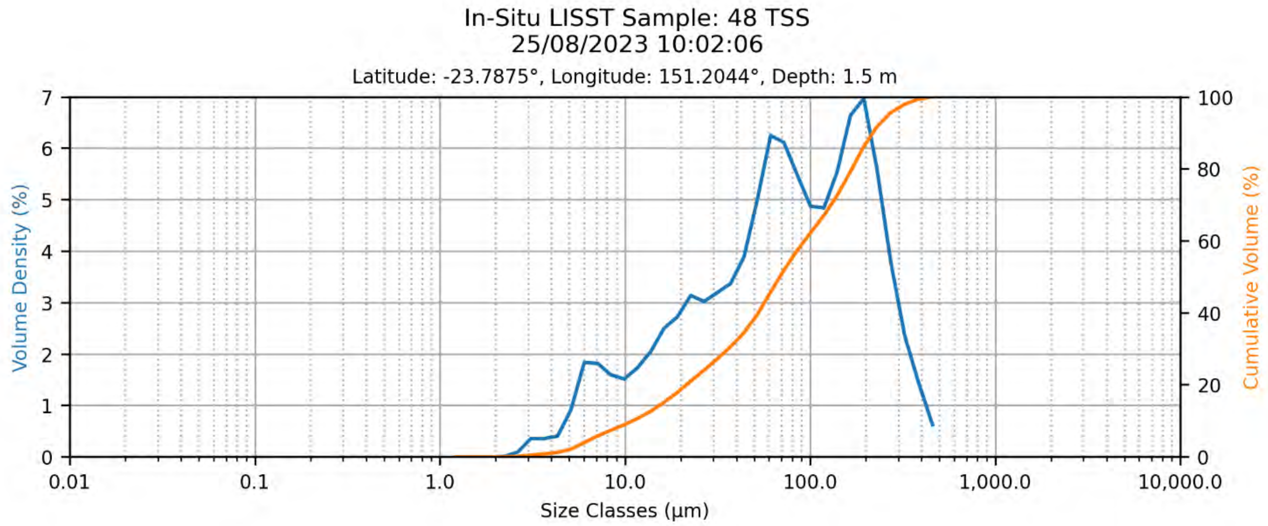

Sample: EB2442787-009
06/12/2024 12:21:52
Latitude: -23.7992°, Longitude: 151.2168°, Depth: 16.9 m, TSS: 148 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


Sample: EB2442787-010
06/12/2024 12:25:12
Latitude: -23.7991°, Longitude: 151.2164°, Depth: 8.0 m, TSS: 63 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


Sample: EB2442787-011
06/12/2024 12:28:06
Latitude: -23.7990°, Longitude: 151.2161°, Depth: 1.1 m, TSS: 22 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


Sample: EB2442787-012
06/12/2024 12:55:15
Latitude: -23.7912°, Longitude: 151.2063°, Depth: 15.8 m, TSS: 39 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


Sample: EB2442787-013
06/12/2024 12:58:42
Latitude: -23.7912°, Longitude: 151.2060°, Depth: 0.8 m, TSS: 10 mg/L
Volume Density (%)
Cumulative Volume (%)
Size Classes (μm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

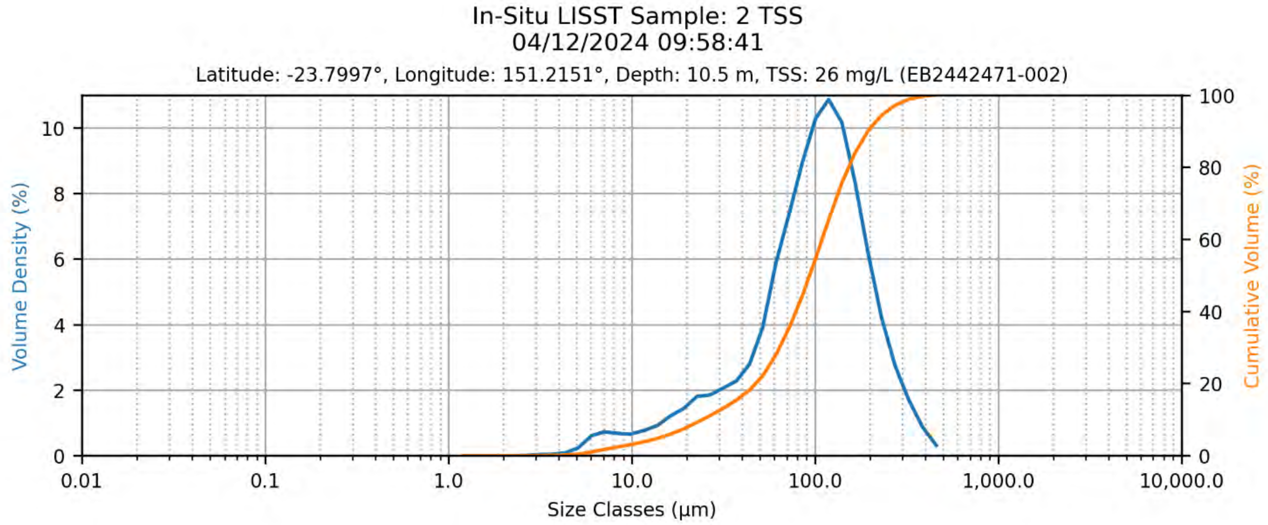

In-Situ LISST Sample: 48 TSS
25/08/2023 10:02:06
Latitude: -23.7875°, Longitude: 151.2044°, Depth: 1.5 m
Volume Density (%)
Cumulative Volume (%)
Size Classes (μm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

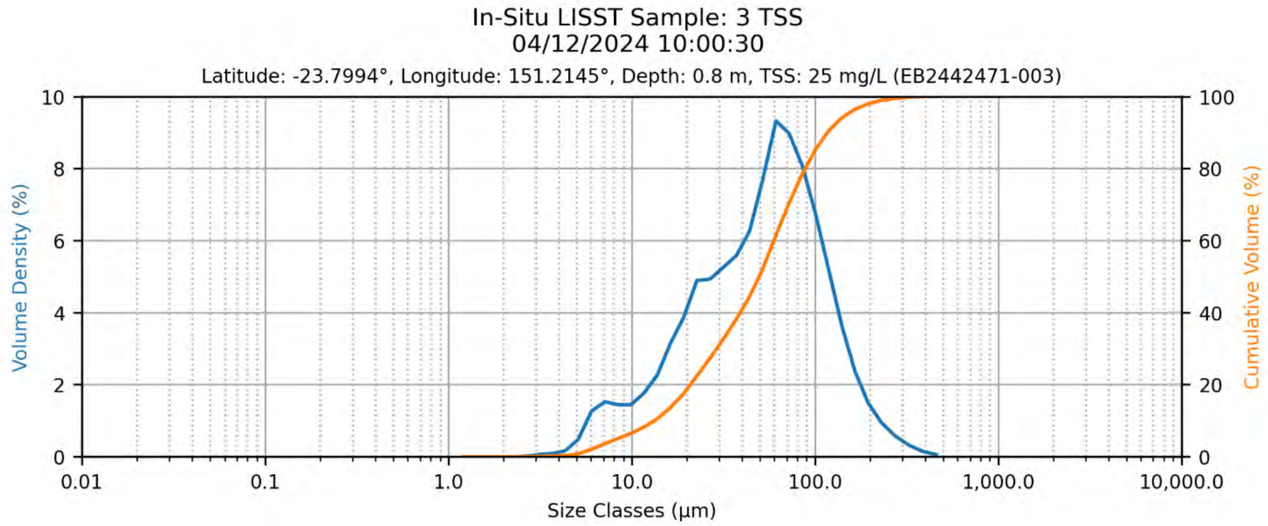
Annex H Sample PSD Summary – December 2024 Campaign

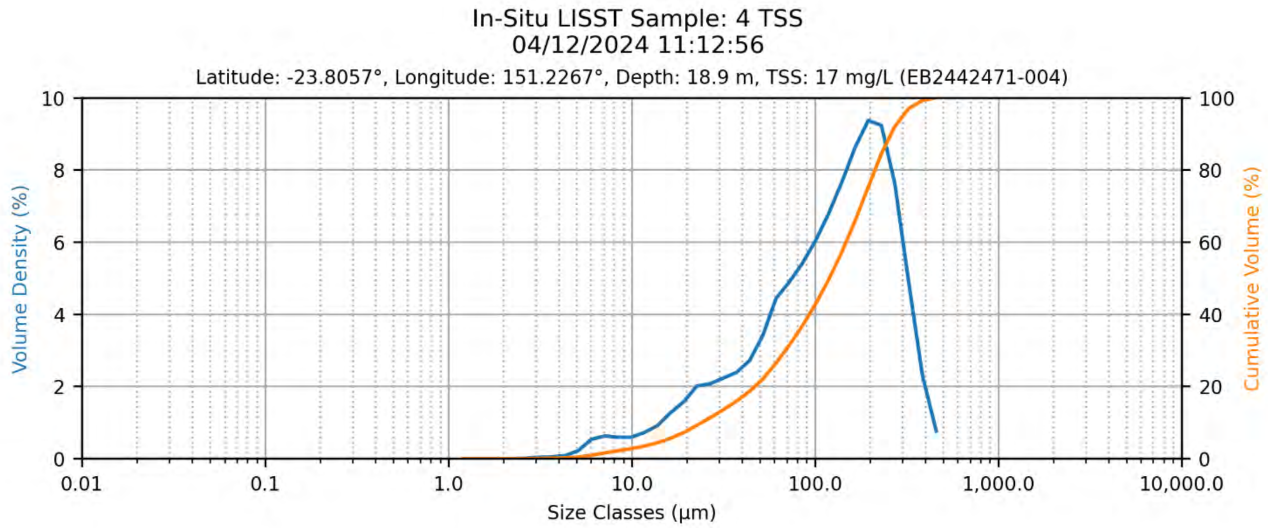
Table H.1. Particle Size Summary Statistics for all PSD Results Collected over the December 2024 Monitoring Campaign

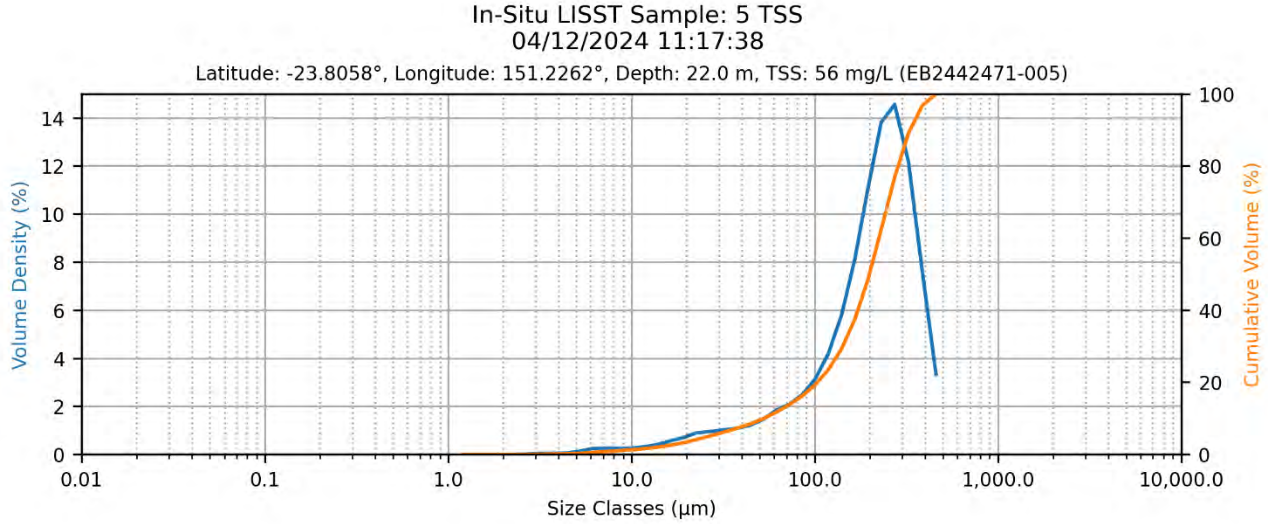
Date	Location	Latitude (°)	Longitude (°)	Depth (m)	D10 (µm)	D50 (µm)	D90 (µm)	Description
4/12/2024 11:13	Tide Island MRA	-23.80574	151.2264	19	2.5	9.1	43.5	Dredge Placement
4/12/2024 11:18	Tide Island MRA	-23.80582	151.2259	22	2.1	8.2	39.1	Dredge Placement
5/12/2024 11:43	Tide Island MRA	-23.79642	151.2107	18	2.0	6.3	21.3	Background
5/12/2024 11:49	Tide Island MRA	-23.79605	151.2099	1	2.5	8.3	27.4	Background
5/12/2024 13:16	Tide Island MRA	-23.8067	151.231	18	2.1	7.1	24.5	Background
5/12/2024 13:21	Tide Island MRA	-23.8067	151.2296	2	2	6.4	20.3	Background
6/12/2024 9:42	Jacobs Channel - off GLNG MOF	-23.80177	151.2191	19	2.07	9.3	65.4	Residual Dredge Placement Plume
6/12/2024 9:46	Jacobs Channel - off GLNG MOF	-23.79984	151.2159	10	2.2	9	68.5	Residual Dredge Placement Plume
6/12/2024 9:48	Jacobs Channel - off GLNG MOF	-23.80733	151.232	2	2.3	8.4	46.8	Residual Dredge Placement Plume
6/12/2024 11:24	Tide Island MRA	-23.80279	151.2205	20	2.2	9.8	102.1	Dredge Placement
6/12/2024 11:28	Tide Island MRA	-23.79917	151.2167	2	2.3	8.2	36.5	Residual Dredge Placement Plume
6/12/2024 12:22	Jacobs Channel - off GLNG MOF	-23.79911	151.2164	17	2.0	7.8	39.3	Residual Dredge Placement Plume
6/12/2024 12:25	Jacobs Channel - off GLNG MOF	-23.799	151.2161	8	2.1	7.8	37.2	Residual Dredge Placement Plume
6/12/2024 12:28	Jacobs Channel - off GLNG MOF	-23.79121	151.2063	2	2.3	8.0	32.3	Residual Dredge Placement Plume
6/12/2024 12:55	Jacobs Channel - off GLNG MOF	-23.79122	151.2059	16	2.1	7.9	37.3	Residual Dredge Placement Plume
6/12/2024 12:59	Jacobs Channel - off GLNG MOF	-23.7912	151.206	2	2.2	7.3	24.9	Residual Dredge Placement Plume

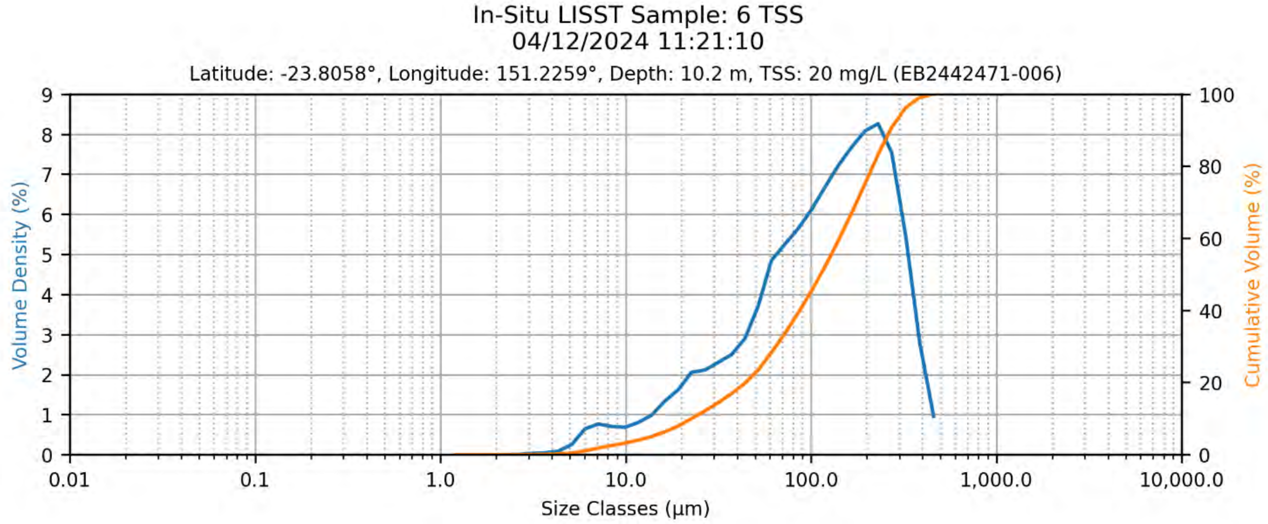
Annex I In situ LISST-200x PSD Results – December 2024 Campaign

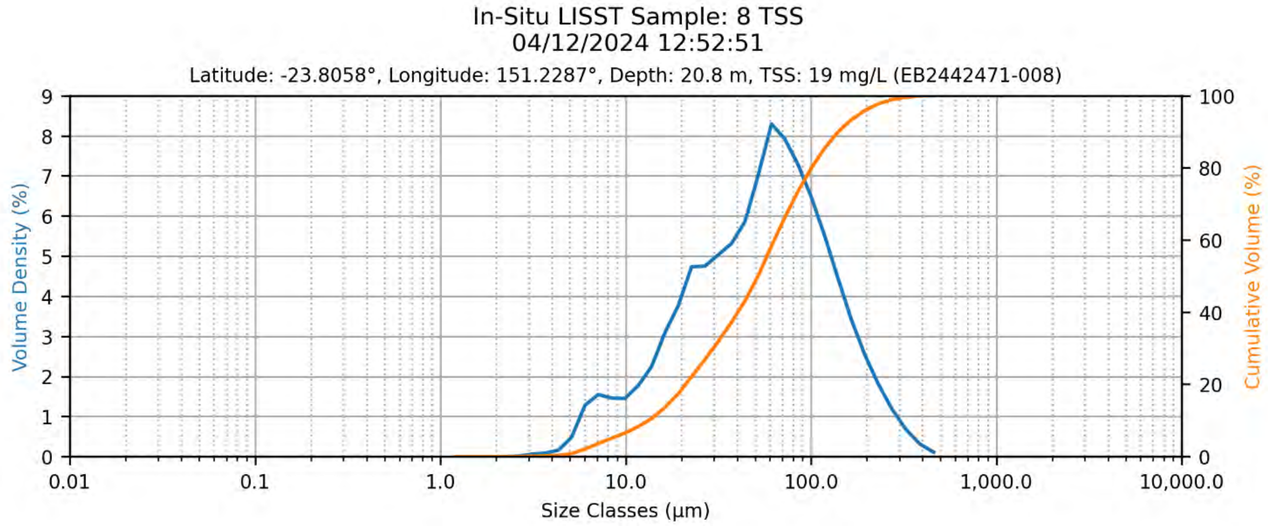




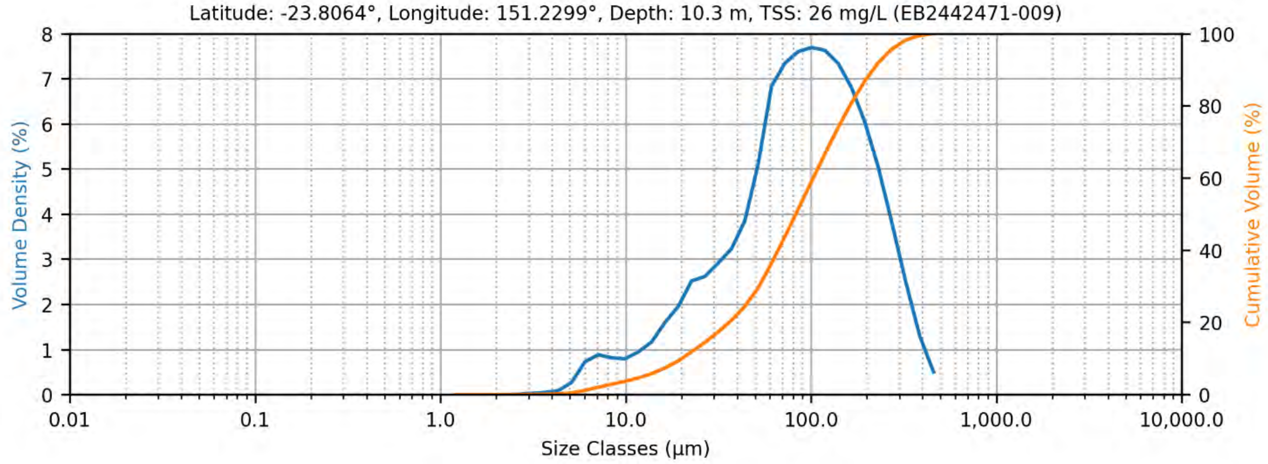



In-Situ LISST Sample: 5 TSS
04/12/2024 11:17:38
Latitude: -23.8058°, Longitude: 151.2262°, Depth: 22.0 m, TSS: 56 mg/L (EB2442471-005)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

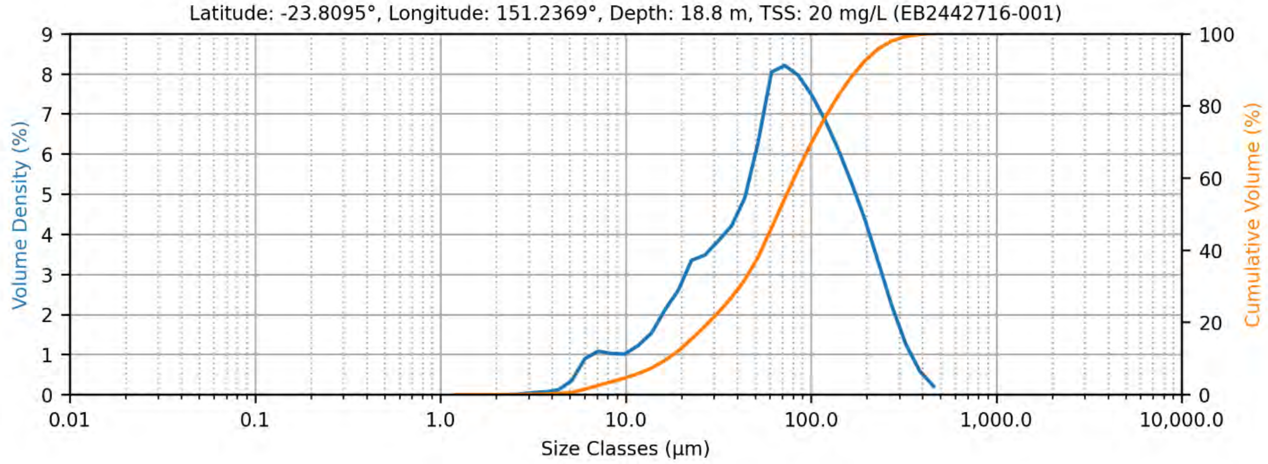

In-Situ LISST Sample: 6 TSS
04/12/2024 11:21:10
Latitude: -23.8058°, Longitude: 151.2259°, Depth: 10.2 m, TSS: 20 mg/L (EB2442471-006)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


In-Situ LISST Sample: 8 TSS
04/12/2024 12:52:51
Latitude: -23.8058°, Longitude: 151.2287°, Depth: 20.8 m, TSS: 19 mg/L (EB2442471-008)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

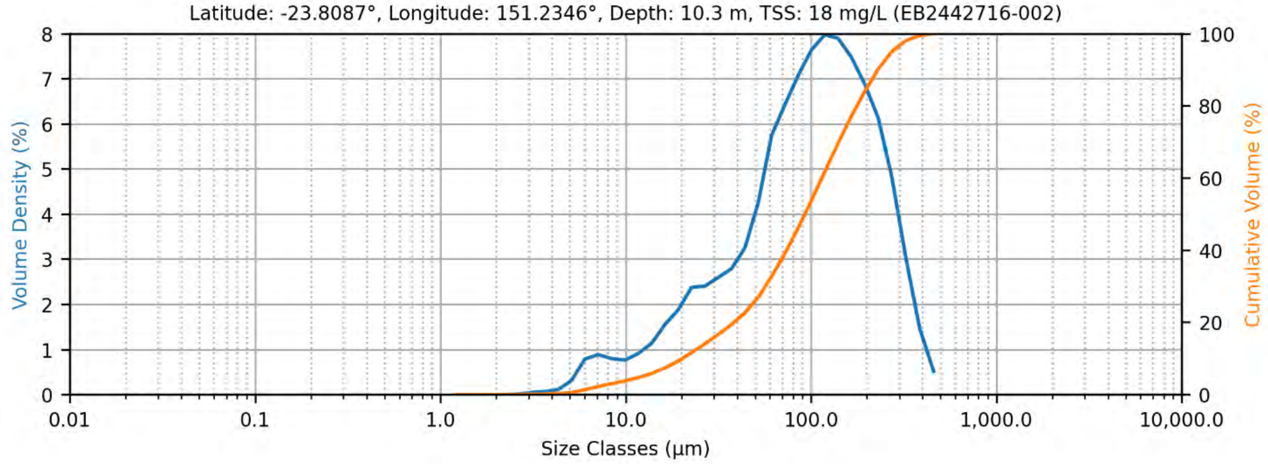
In-Situ LISST Sample: 9 TSS
04/12/2024 12:55:25
Latitude: -23.8064°, Longitude: 151.2299°, Depth: 10.3 m, TSS: 26 mg/L (EB2442471-009)

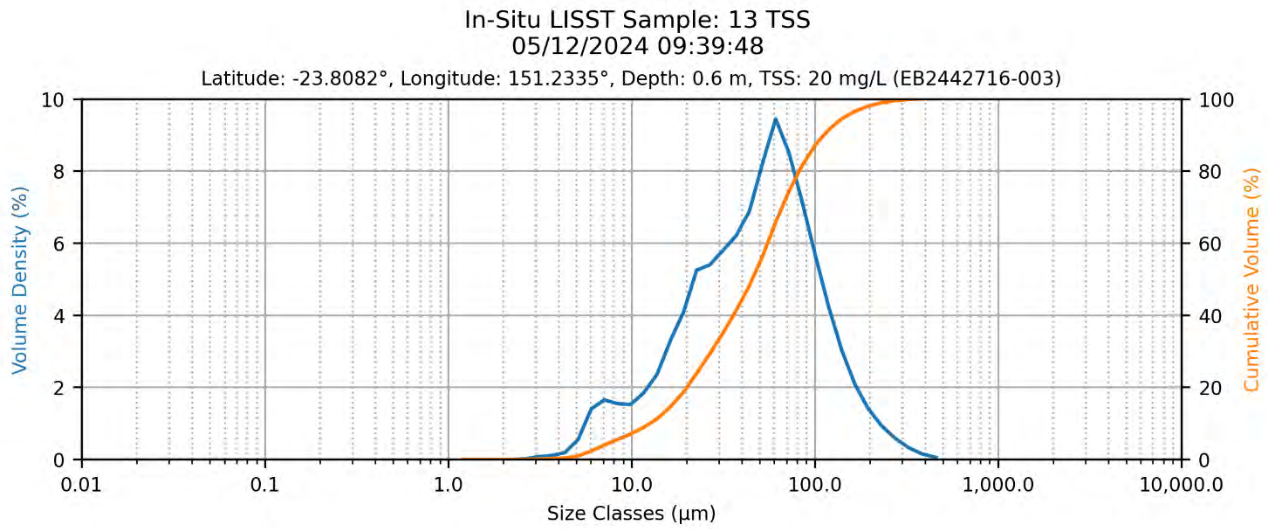


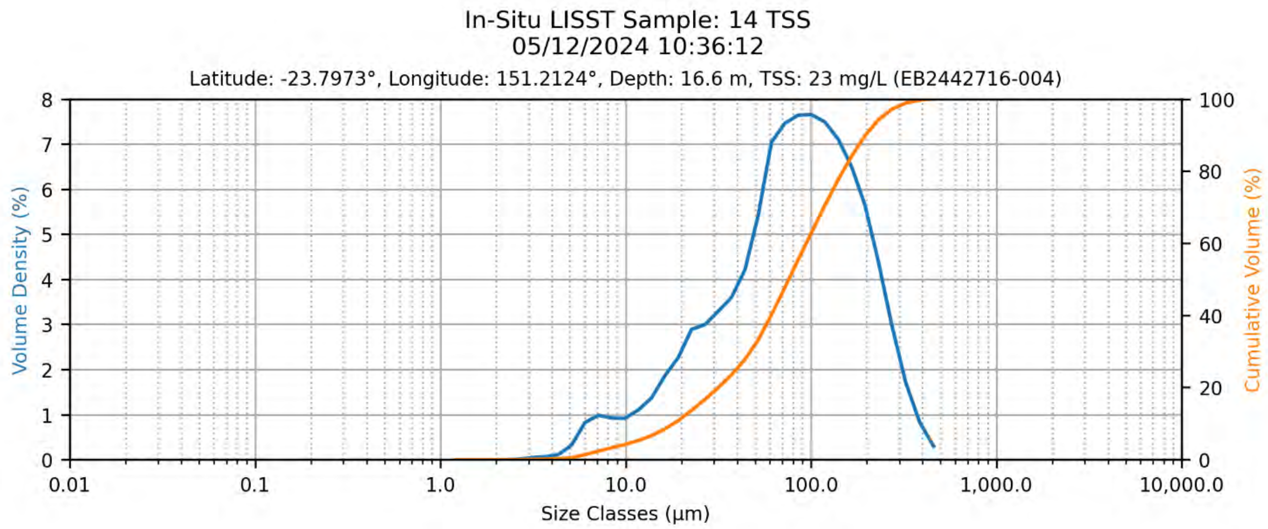
In-Situ LISST Sample: 11 TSS
05/12/2024 09:32:43
Latitude: -23.8095°, Longitude: 151.2369°, Depth: 18.8 m, TSS: 20 mg/L (EB2442716-001)

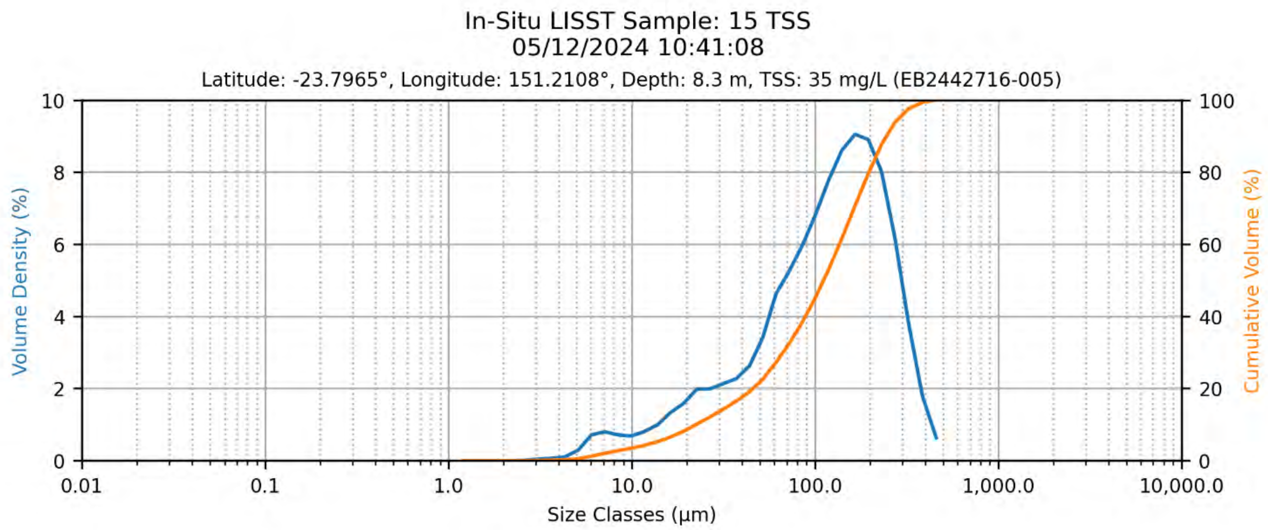


In-Situ LISST Sample: 12 TSS
05/12/2024 09:37:36
Latitude: -23.8087°, Longitude: 151.2346°, Depth: 10.3 m, TSS: 18 mg/L (EB2442716-002)



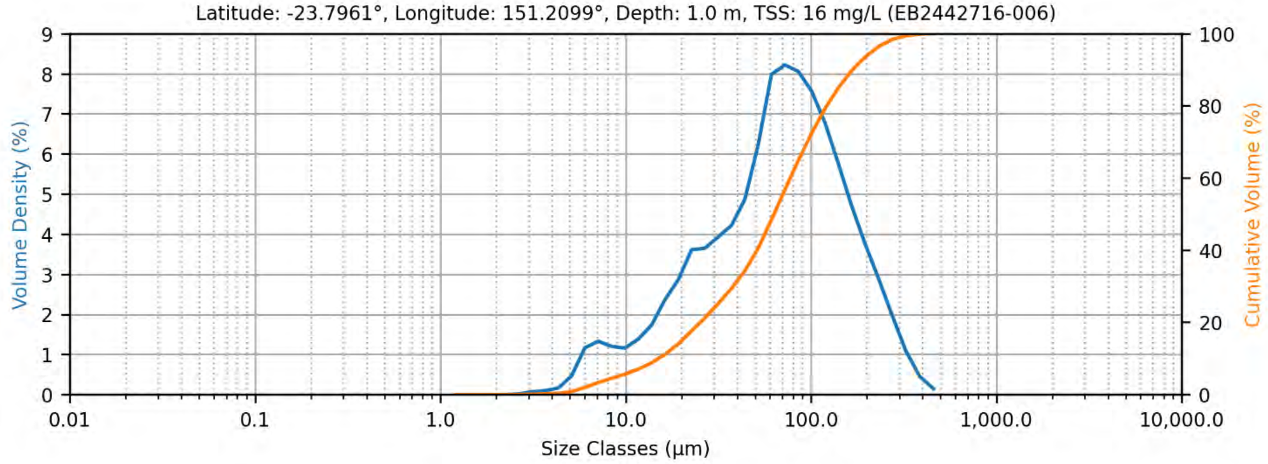

In-Situ LISST Sample: 13 TSS
05/12/2024 09:39:48
Latitude: -23.8082°, Longitude: 151.2335°, Depth: 0.6 m, TSS: 20 mg/L (EB2442716-003)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


In-Situ LISST Sample: 14 TSS
05/12/2024 10:36:12
Latitude: -23.7973°, Longitude: 151.2124°, Depth: 16.6 m, TSS: 23 mg/L (EB2442716-004)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)


In-Situ LISST Sample: 15 TSS
05/12/2024 10:41:08
Latitude: -23.7965°, Longitude: 151.2108°, Depth: 8.3 m, TSS: 35 mg/L (EB2442716-005)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

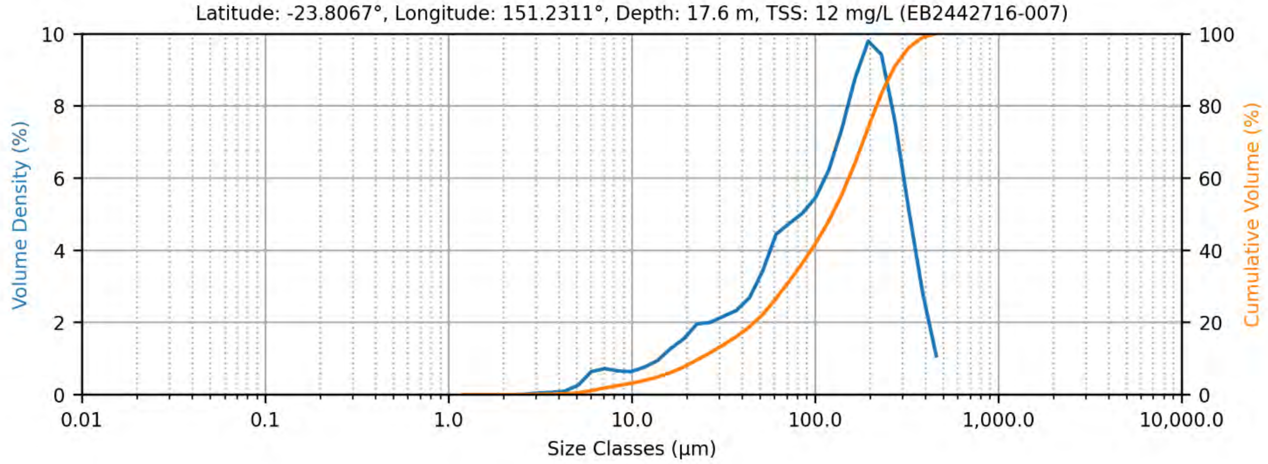
In-Situ LISST Sample: 16 TSS
05/12/2024 10:43:12

Latitude: -23.7961°, Longitude: 151.2099°, Depth: 1.0 m, TSS: 16 mg/L (EB2442716-006)



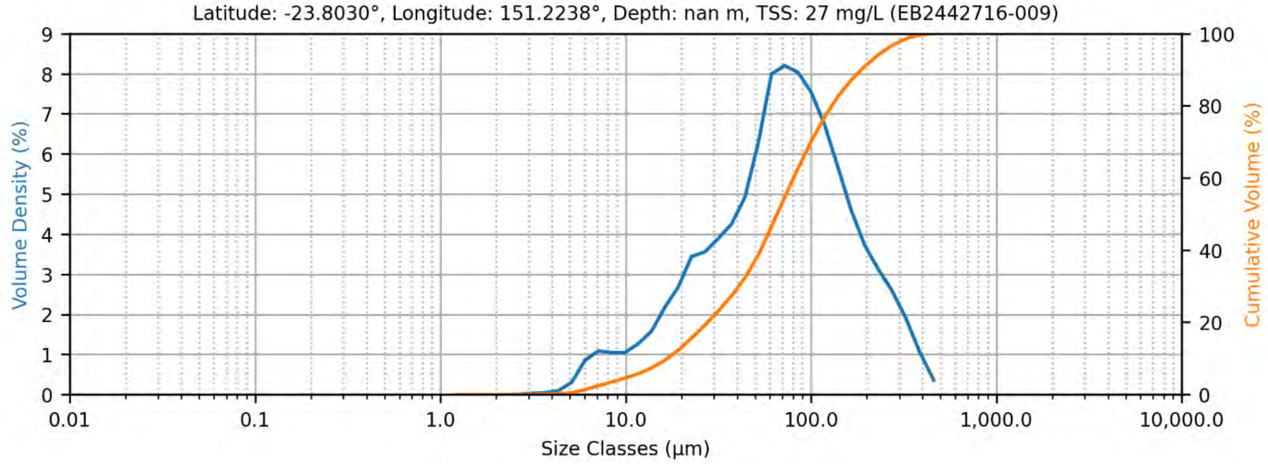
In-Situ LISST Sample: 17 TSS
05/12/2024 11:43:15

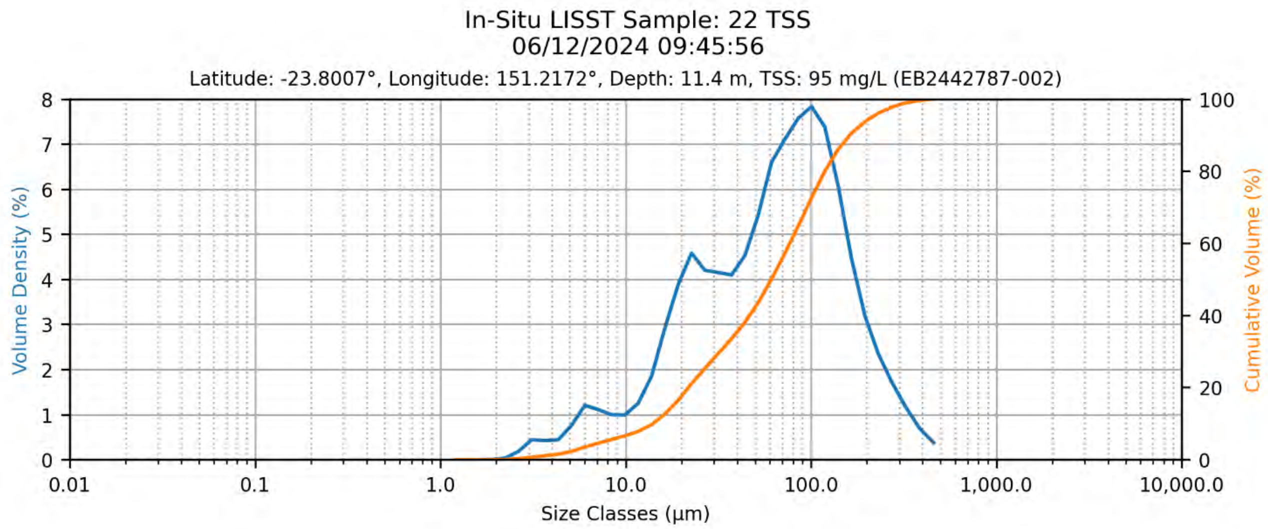
Latitude: -23.8067°, Longitude: 151.2311°, Depth: 17.6 m, TSS: 12 mg/L (EB2442716-007)

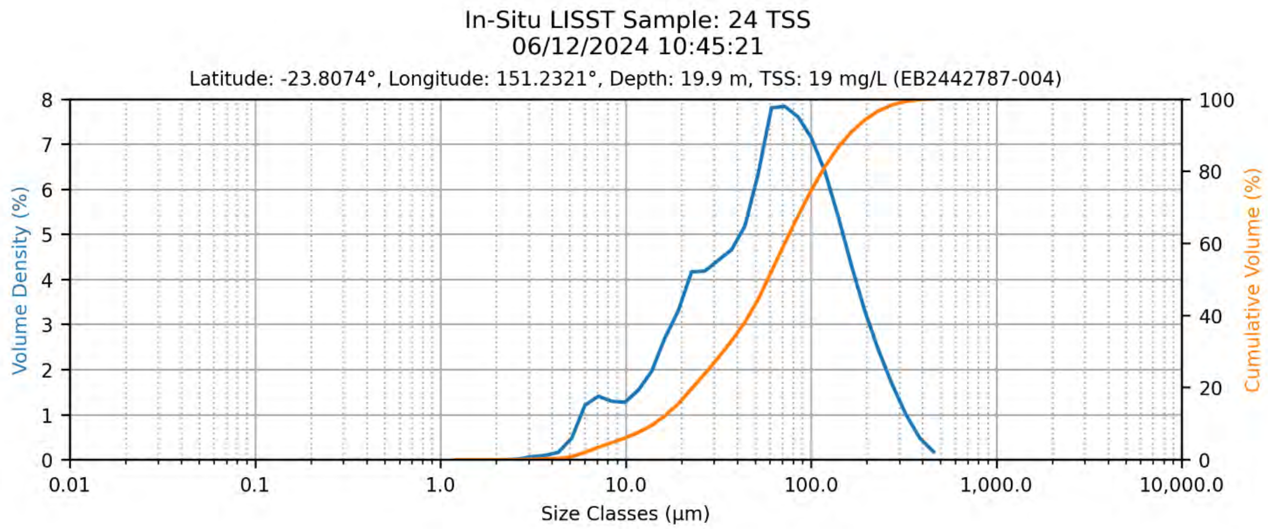


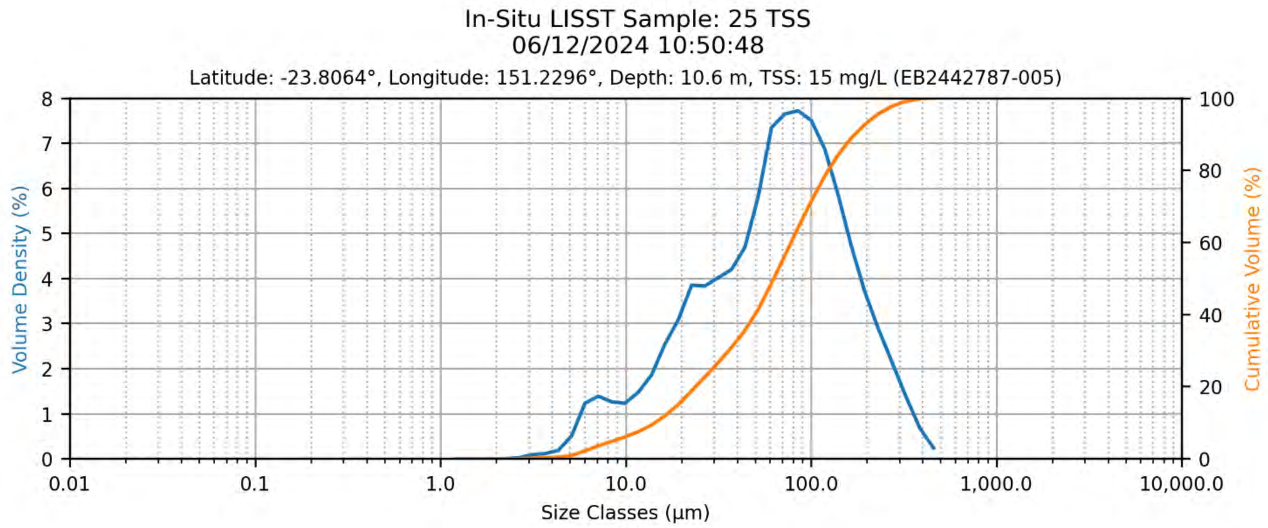
In-Situ LISST Sample: 19 TSS
05/12/2024 13:15:39

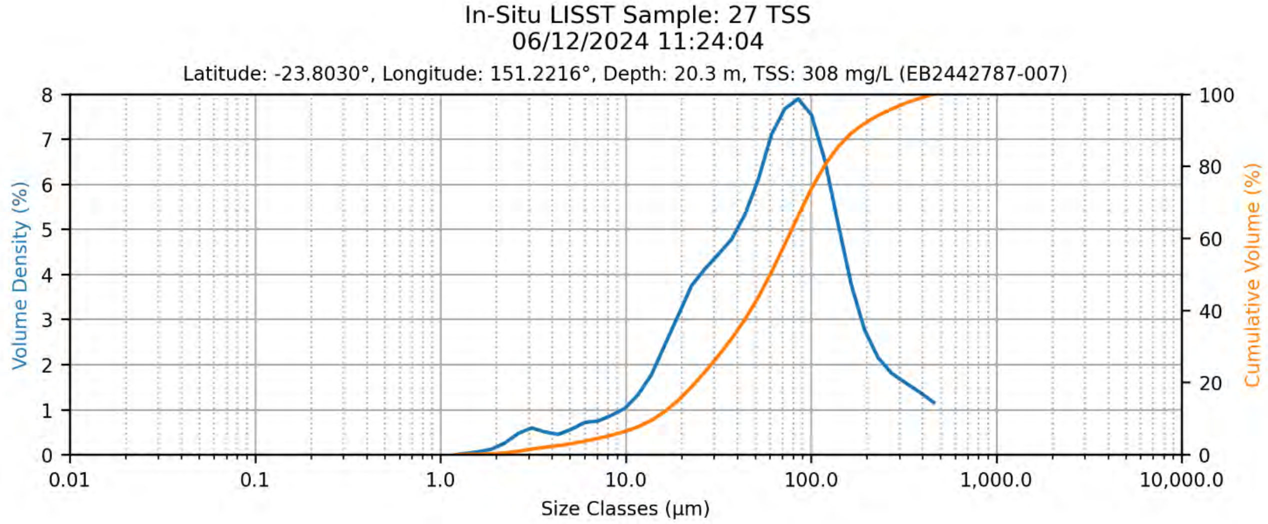
Latitude: -23.8030°, Longitude: 151.2238°, Depth: nan m, TSS: 27 mg/L (EB2442716-009)

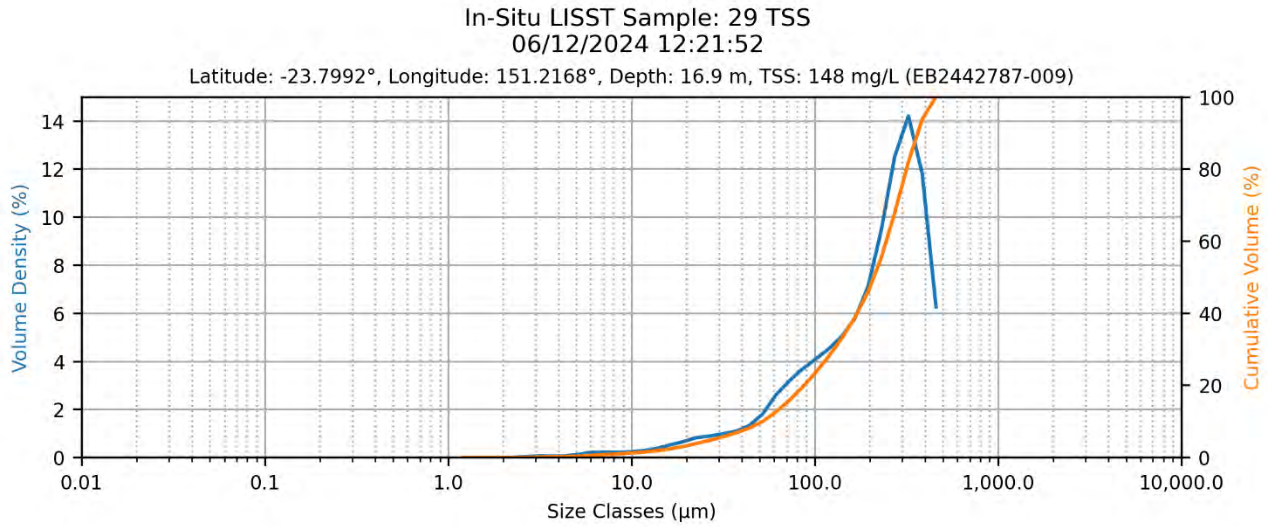


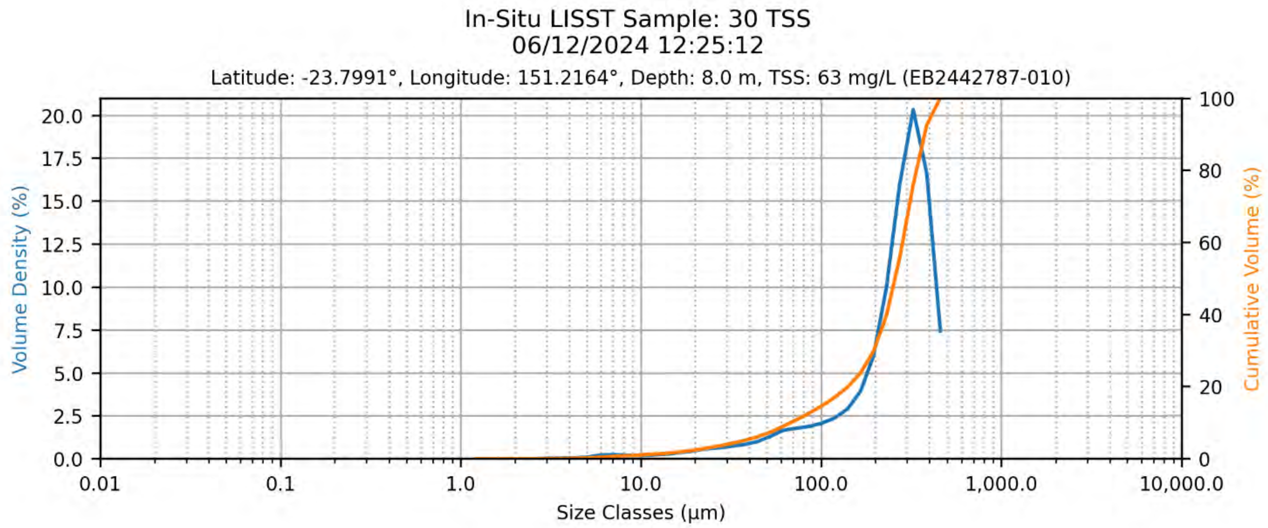

In-Situ LISST Sample: 22 TSS
06/12/2024 09:45:56
Latitude: -23.8007°, Longitude: 151.2172°, Depth: 11.4 m, TSS: 95 mg/L (EB2442787-002)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

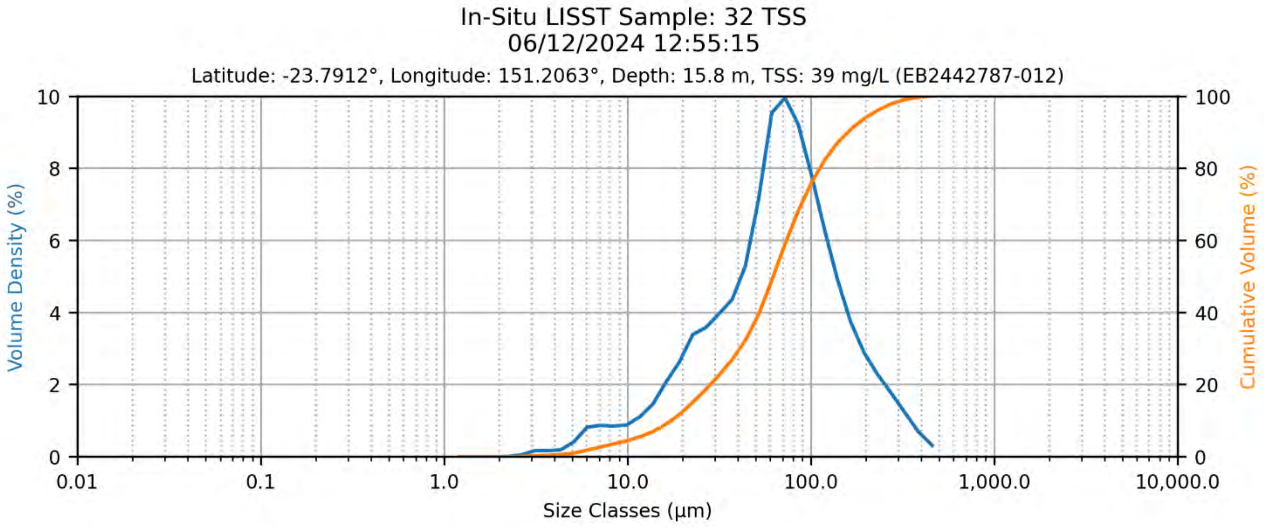

In-Situ LISST Sample: 24 TSS
06/12/2024 10:45:21
Latitude: -23.8074°, Longitude: 151.2321°, Depth: 19.9 m, TSS: 19 mg/L (EB2442787-004)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

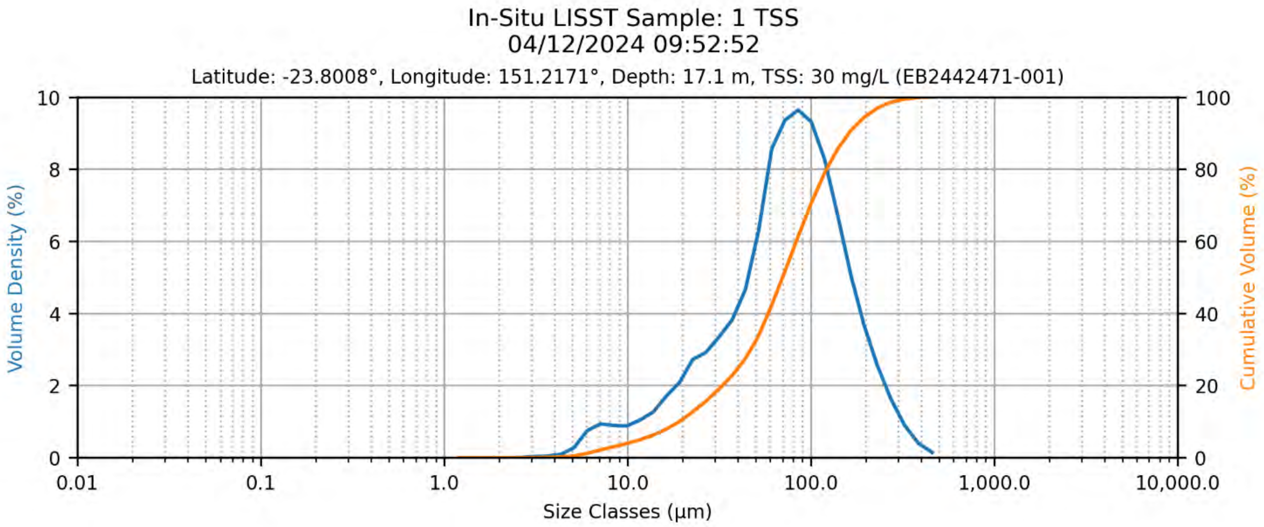

In-Situ LISST Sample: 25 TSS
06/12/2024 10:50:48
Latitude: -23.8064°, Longitude: 151.2296°, Depth: 10.6 m, TSS: 15 mg/L (EB2442787-005)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0


In-Situ LISST Sample: 27 TSS
06/12/2024 11:24:04
Latitude: -23.8030°, Longitude: 151.2216°, Depth: 20.3 m, TSS: 308 mg/L (EB2442787-007)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

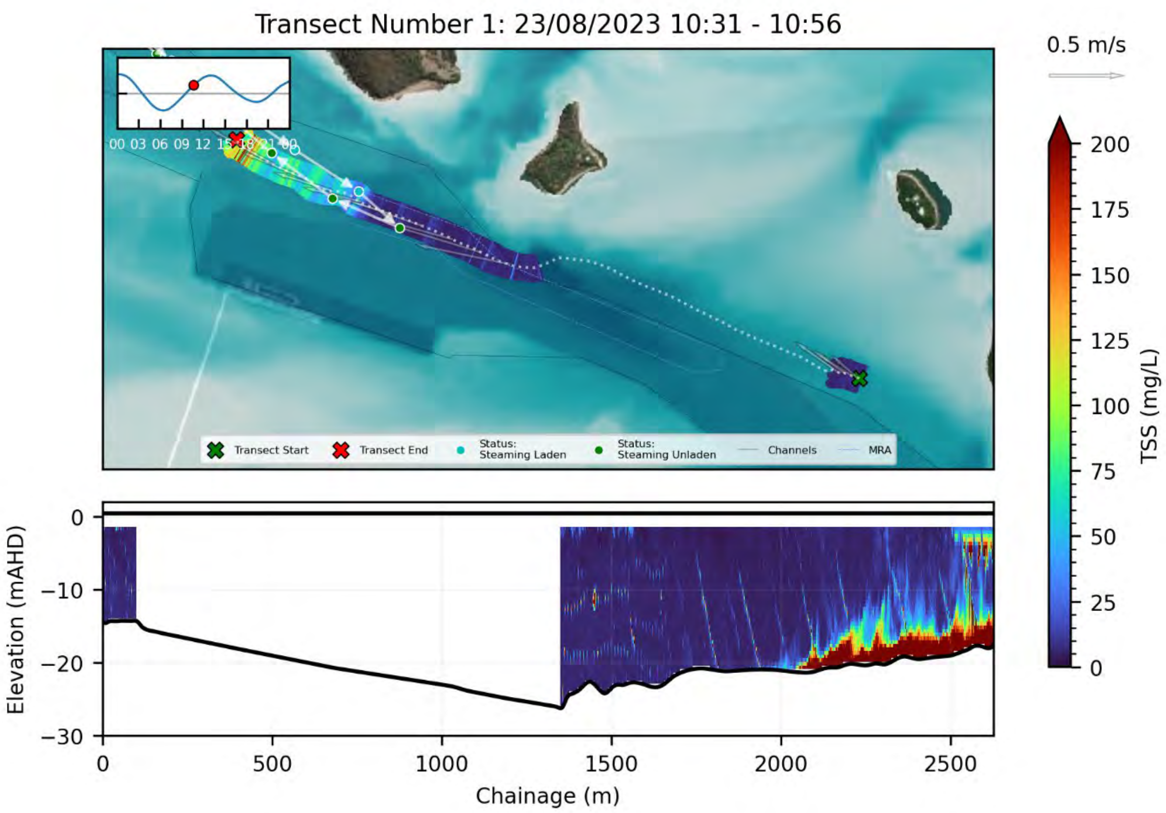

In-Situ LISST Sample: 29 TSS
06/12/2024 12:21:52
Latitude: -23.7992°, Longitude: 151.2168°, Depth: 16.9 m, TSS: 148 mg/L (EB2442787-009)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

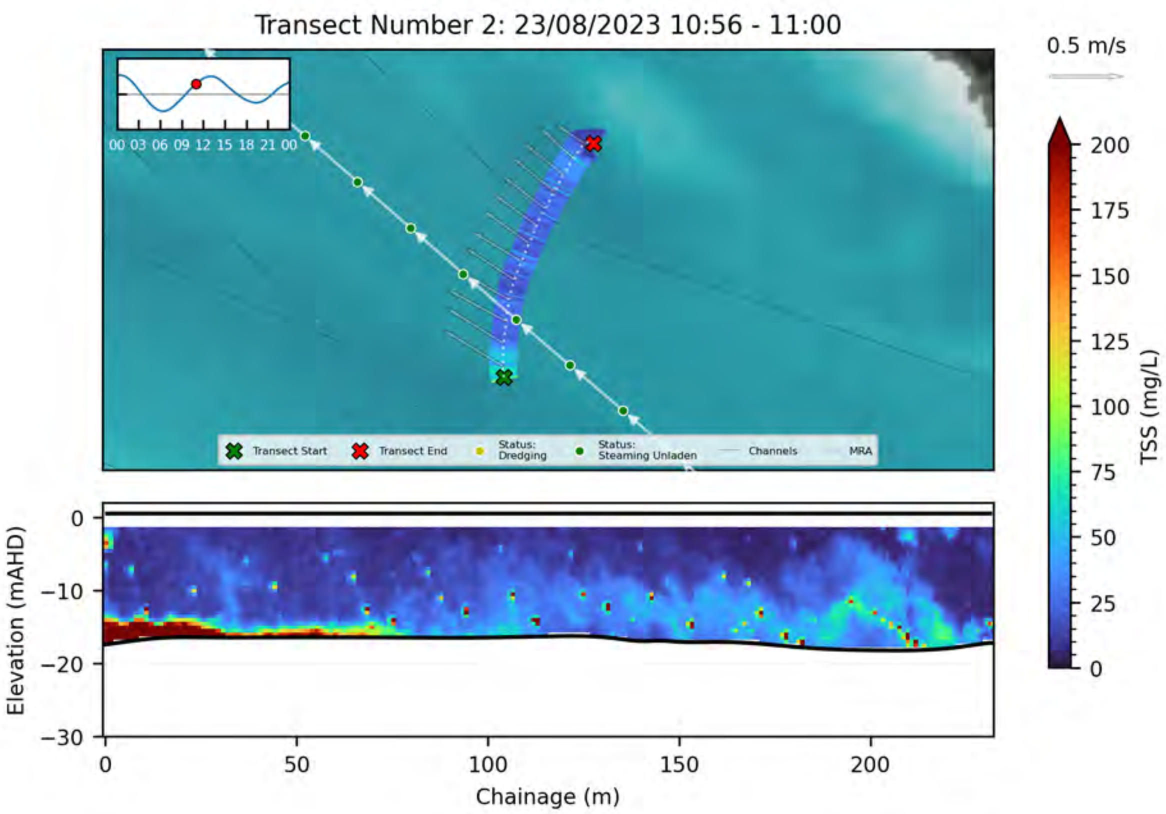

In-Situ LISST Sample: 30 TSS
06/12/2024 12:25:12
Latitude: -23.7991°, Longitude: 151.2164°, Depth: 8.0 m, TSS: 63 mg/L (EB2442787-010)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)

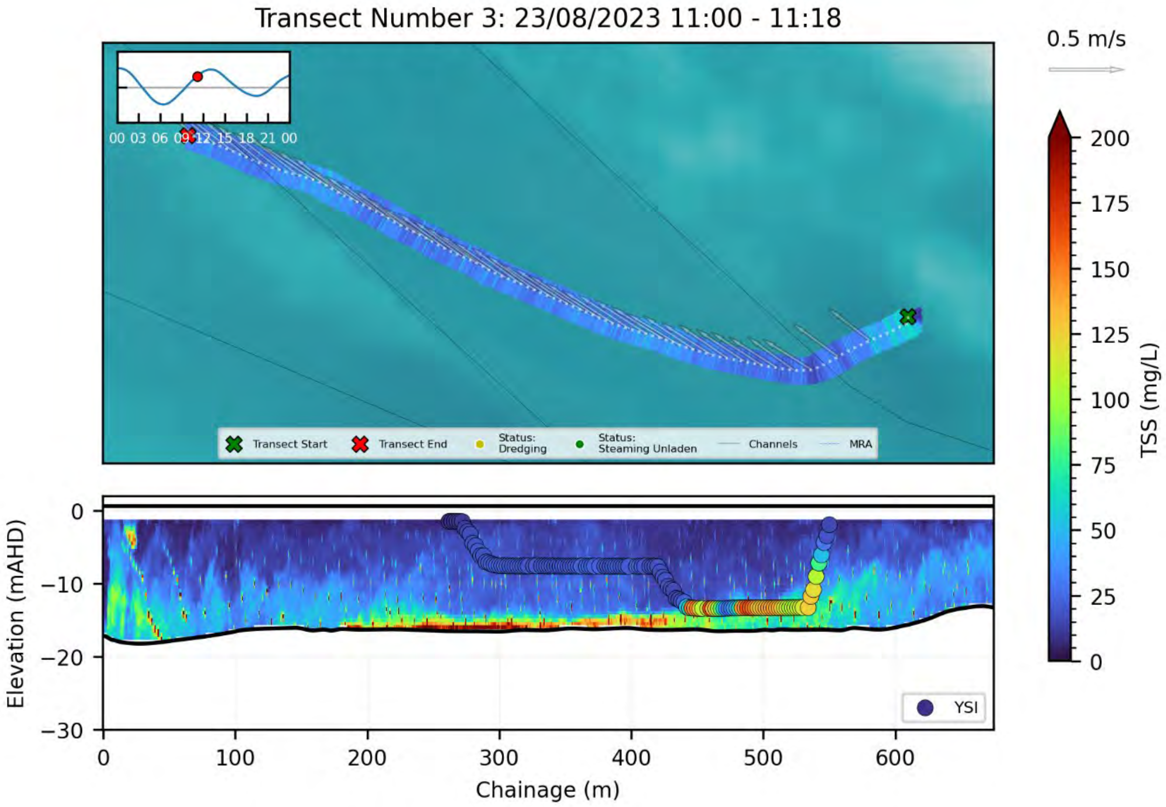

In-Situ LISST Sample: 32 TSS
06/12/2024 12:55:15
Latitude: -23.7912°, Longitude: 151.2063°, Depth: 15.8 m, TSS: 39 mg/L (EB2442787-012)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

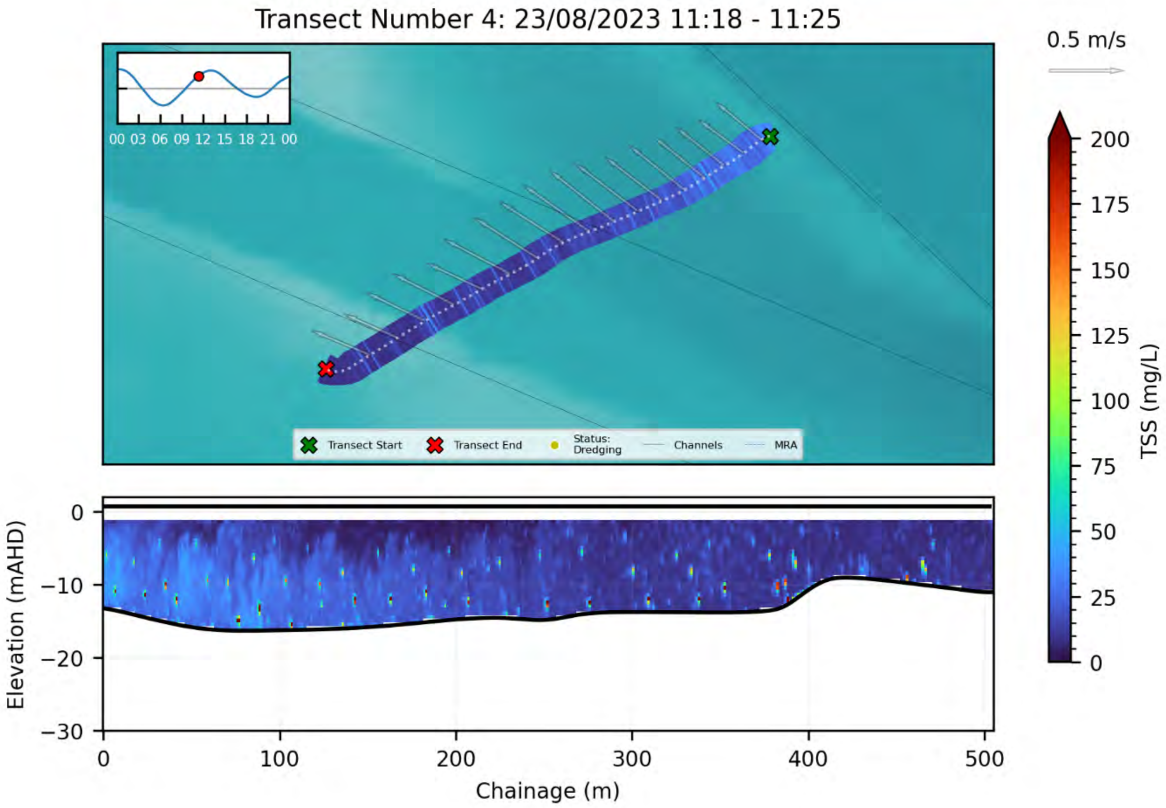

In-Situ LISST Sample: 1 TSS
04/12/2024 09:52:52
Latitude: -23.8008°, Longitude: 151.2171°, Depth: 17.1 m, TSS: 30 mg/L (EB2442471-001)
Volume Density (%)
Cumulative Volume (%)
Size Classes (µm)
0.01
0.1
1.0
10.0
100.0
1,000.0
10,000.0

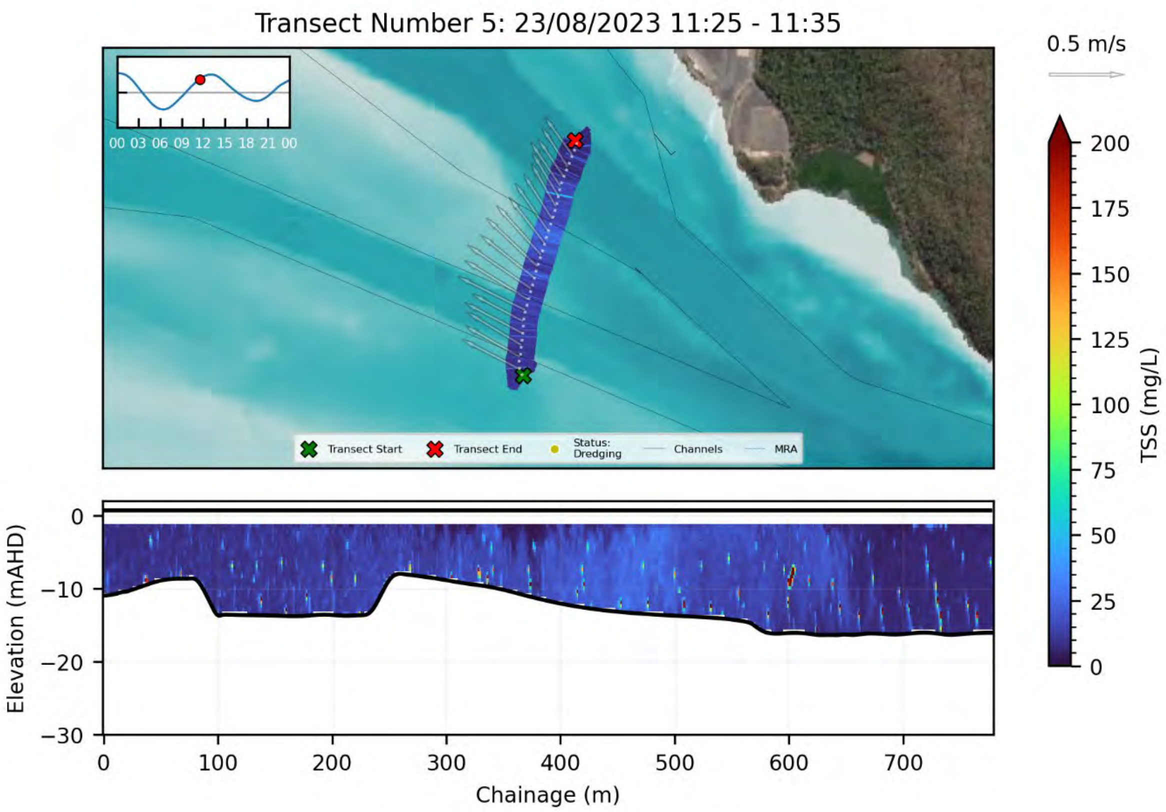
Annex J ADCP Derived TSS Transects 23rd August 2023

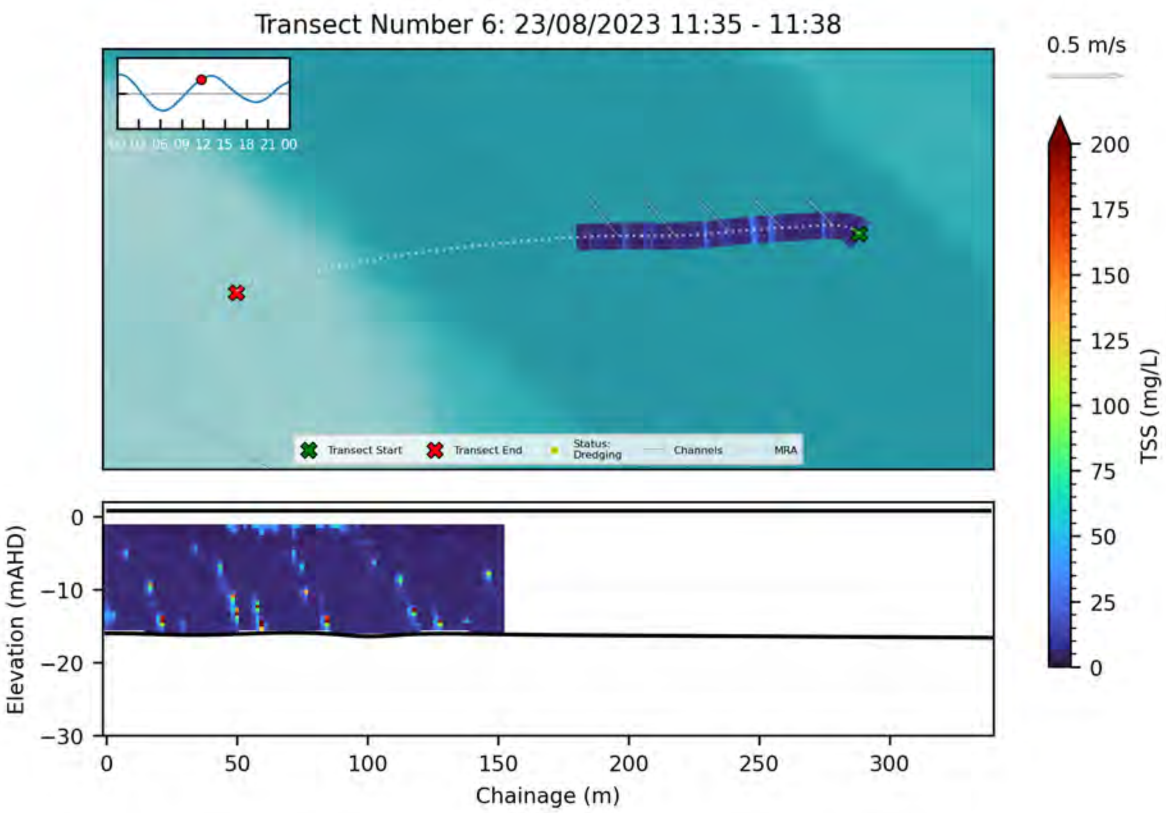


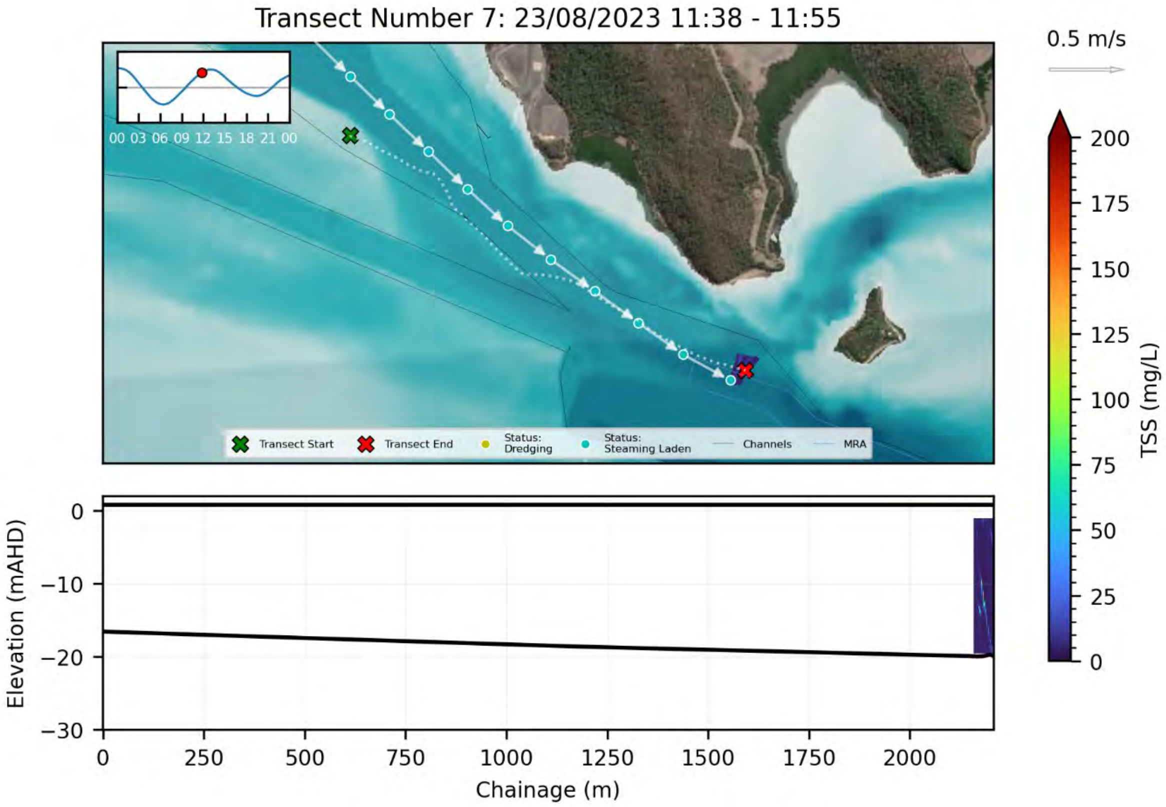


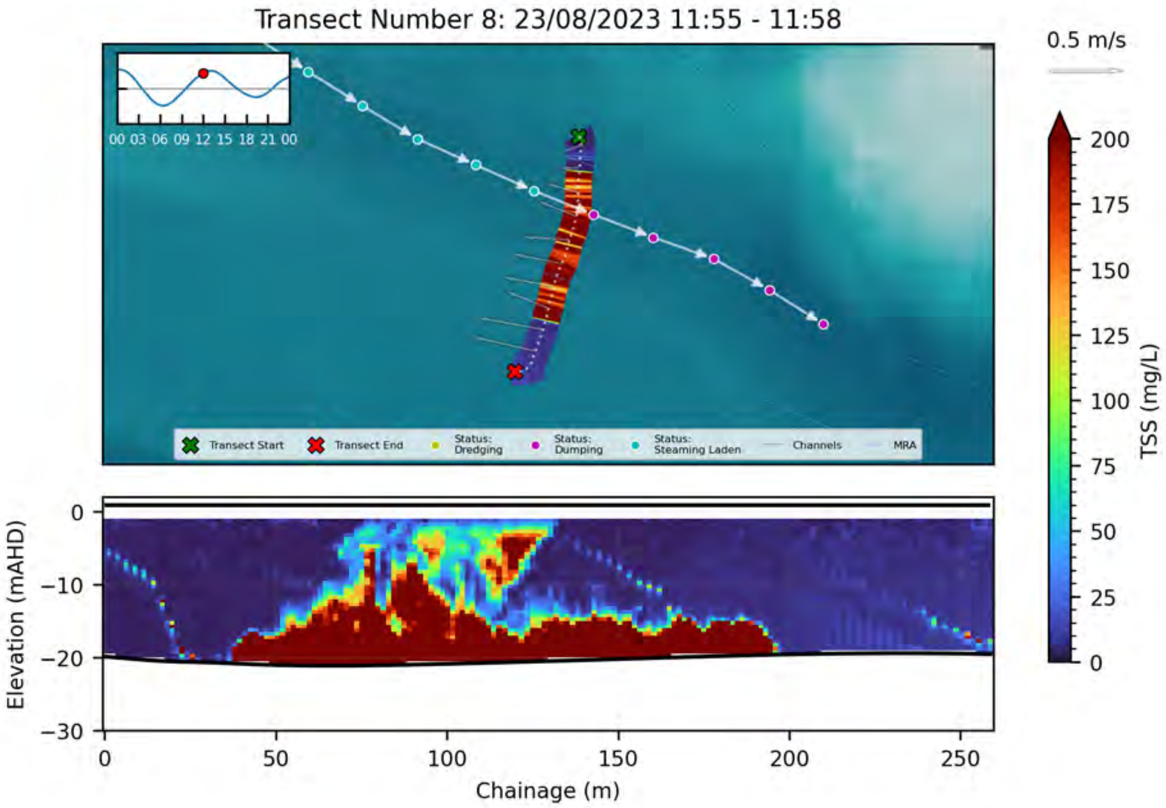

Transect Number 3: 23/08/2023 11:00 - 11:18
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
Elevation (mAHD)
Chainage (m)
YSI
TSS (mg/L)

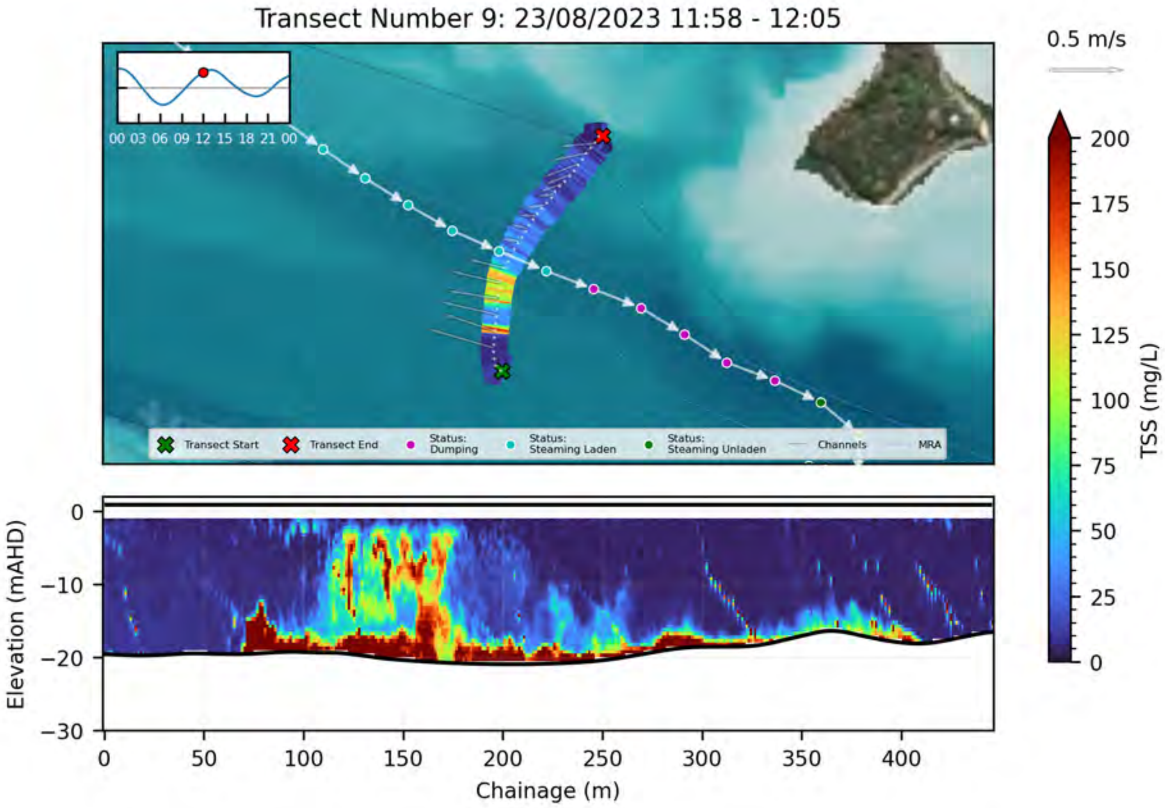

Transect Number 4: 23/08/2023 11:18 - 11:25
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Channels
MRA
Elevation (mAHD)
Chainage (m)
TSS (mg/L)

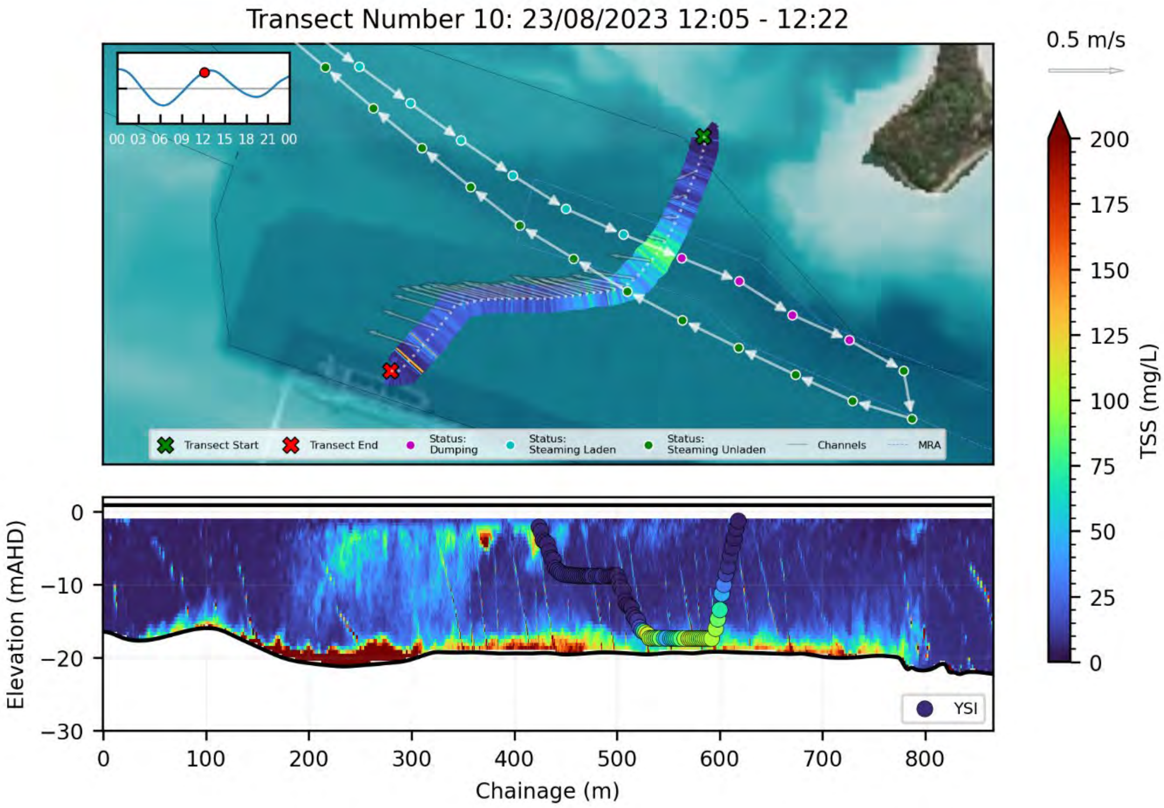

Transect Number 5: 23/08/2023 11:25 - 11:35
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Channels
MRA
0.5 m/s
TSS (mg/L)
200
175
150
125
100
75
50
25
0
Elevation (mAHD)
0
−10
−20
−30
0
100
200
300
400
500
600
700
Chainage (m)

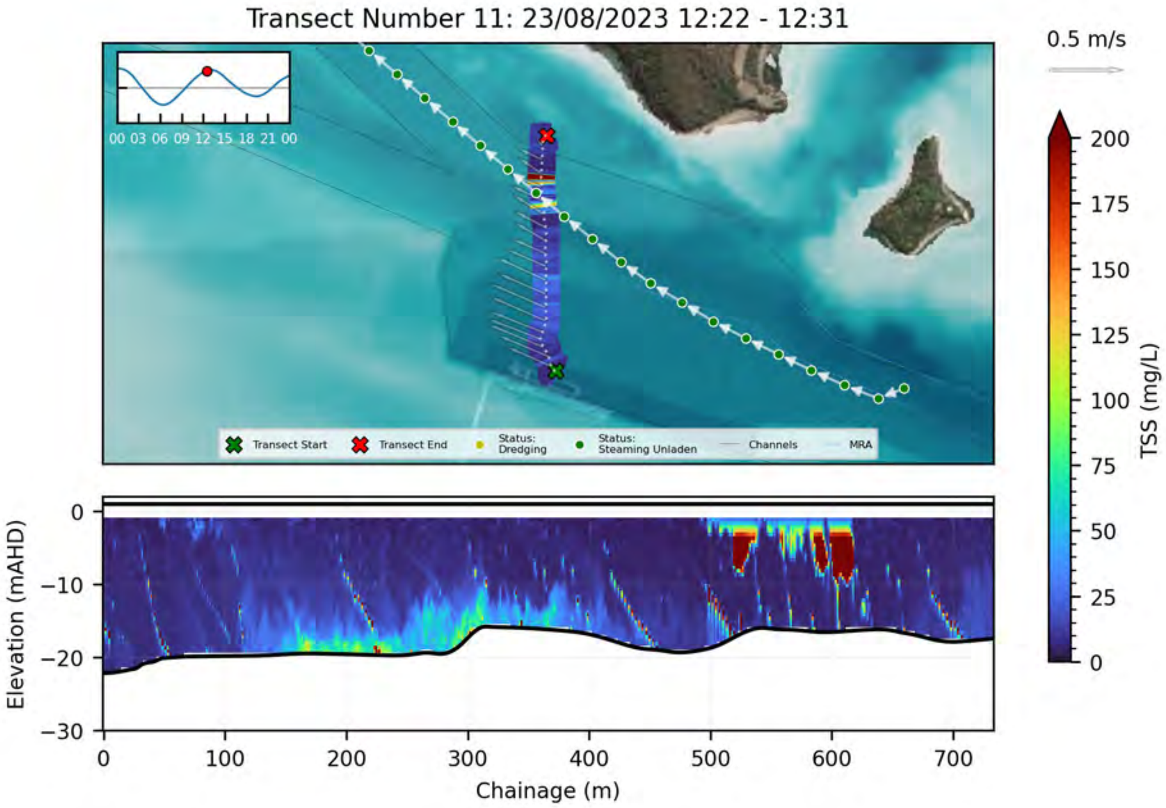

Transect Number 6: 23/08/2023 11:35 - 11:38
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Channels
MRA
0.5 m/s
TSS (mg/L)
200
175
150
125
100
75
50
25
0
Elevation (mAHD)
0
−10
−20
−30
0
50
100
150
200
250
300
Chainage (m)

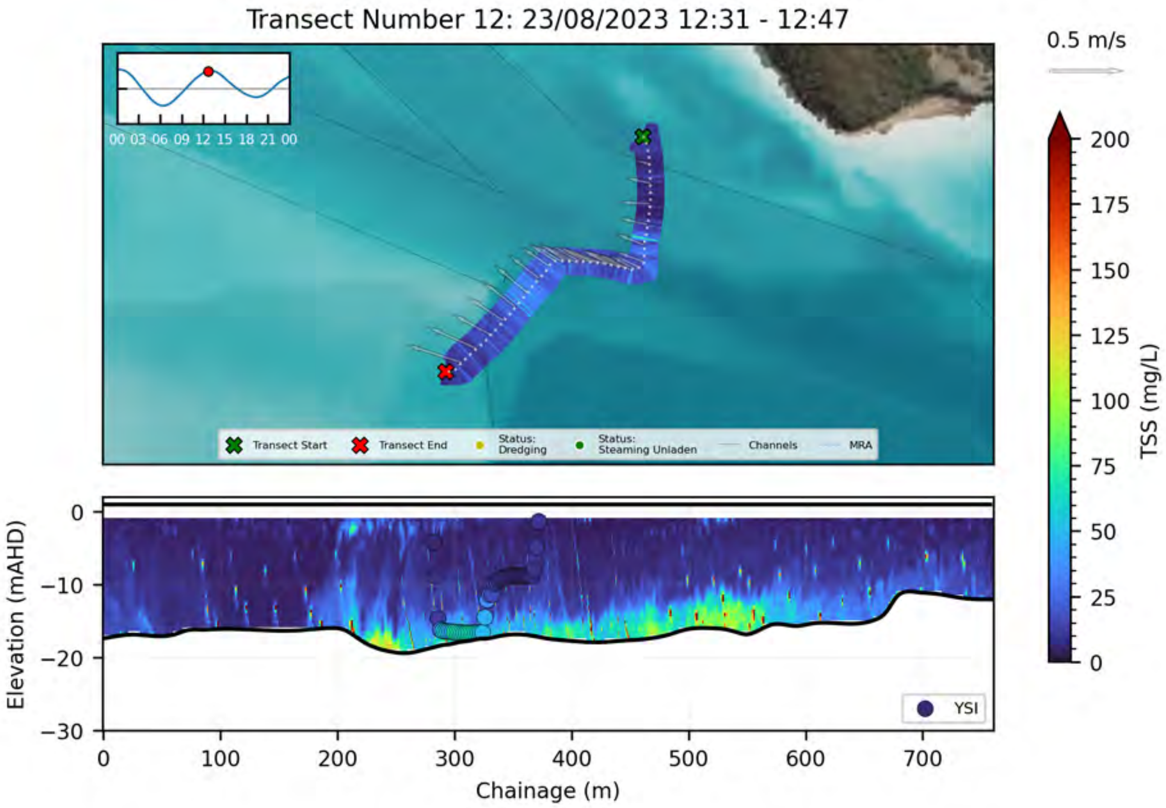

Transect Number 7: 23/08/2023 11:38 - 11:55
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

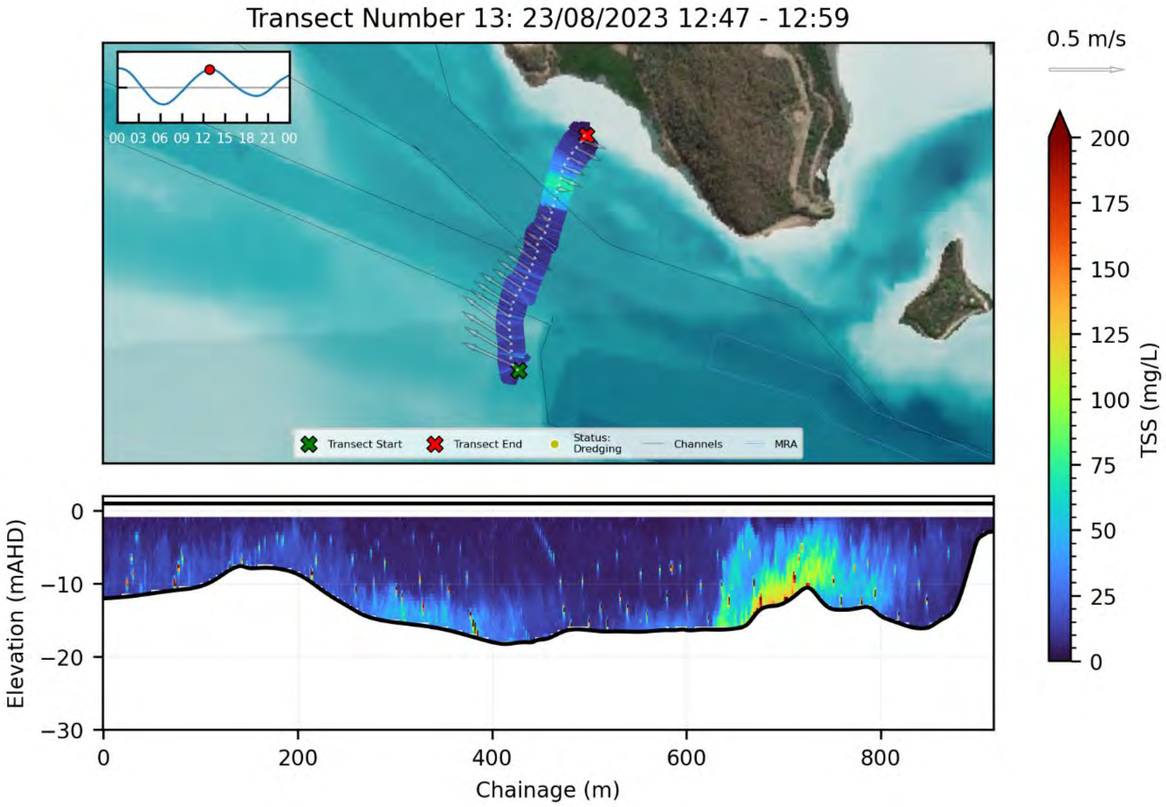

Transect Number 8: 23/08/2023 11:55 - 11:58
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Dumping
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

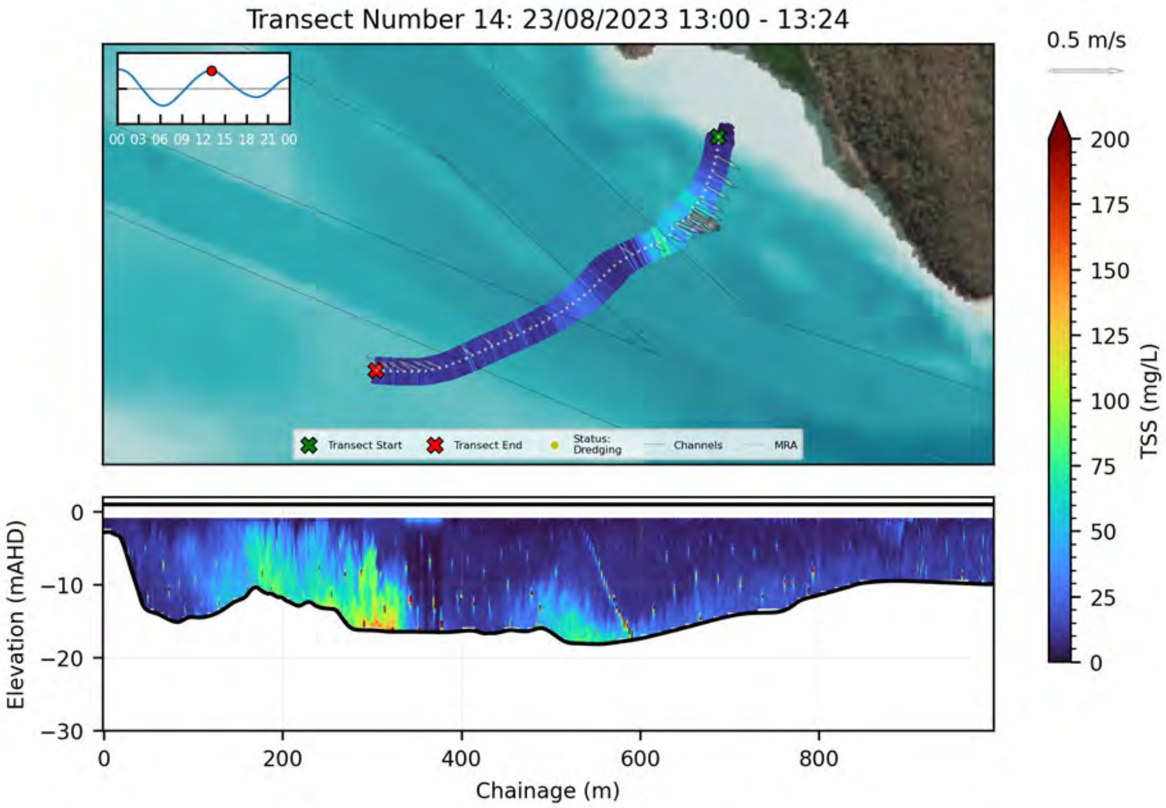

Transect Number 9: 23/08/2023 11:58 - 12:05
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Laden
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
Chainage (m)
0
50
100
150
200
250
300
350
400

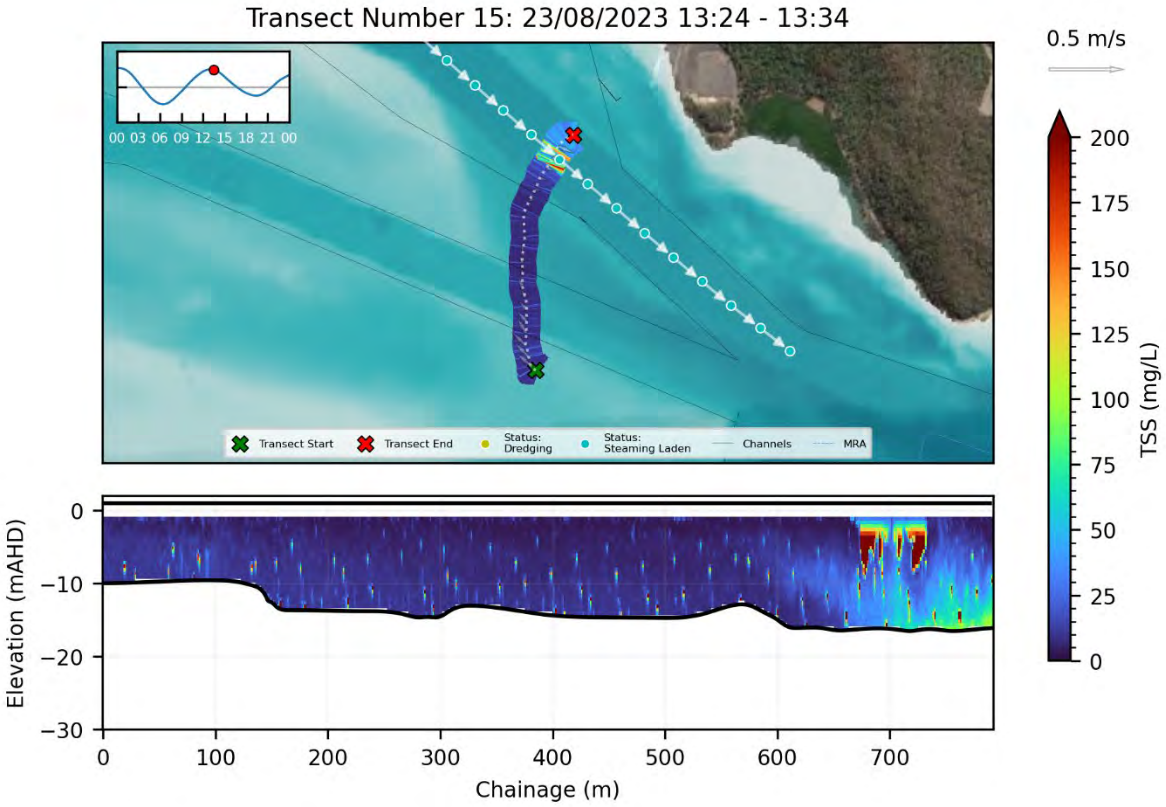

Transect Number 10: 23/08/2023 12:05 - 12:22
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Laden
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
YSI
Chainage (m)
0
100
200
300
400
500
600
700
800

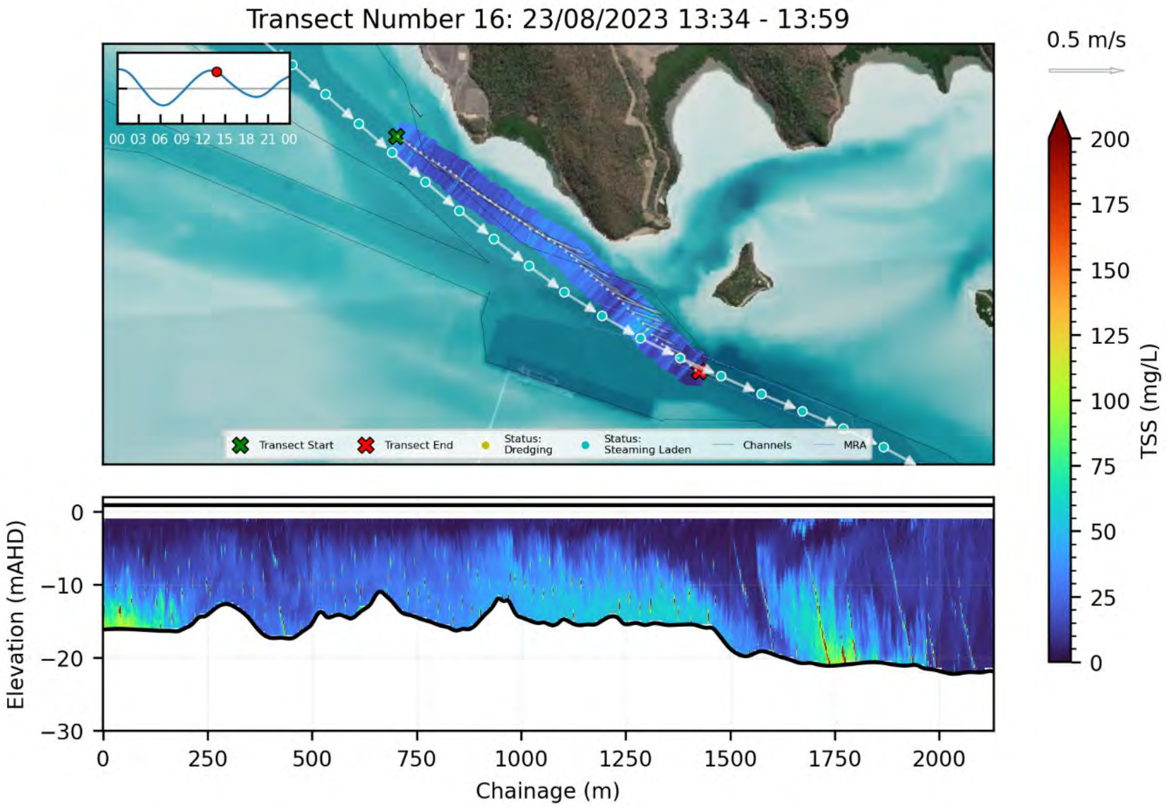

Transect Number 11: 23/08/2023 12:22 - 12:31
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
200
175
150
125
100
75
50
25
0
Elevation (mAHD)
0
−10
−20
−30
0
100
200
300
400
500
600
700
Chainage (m)

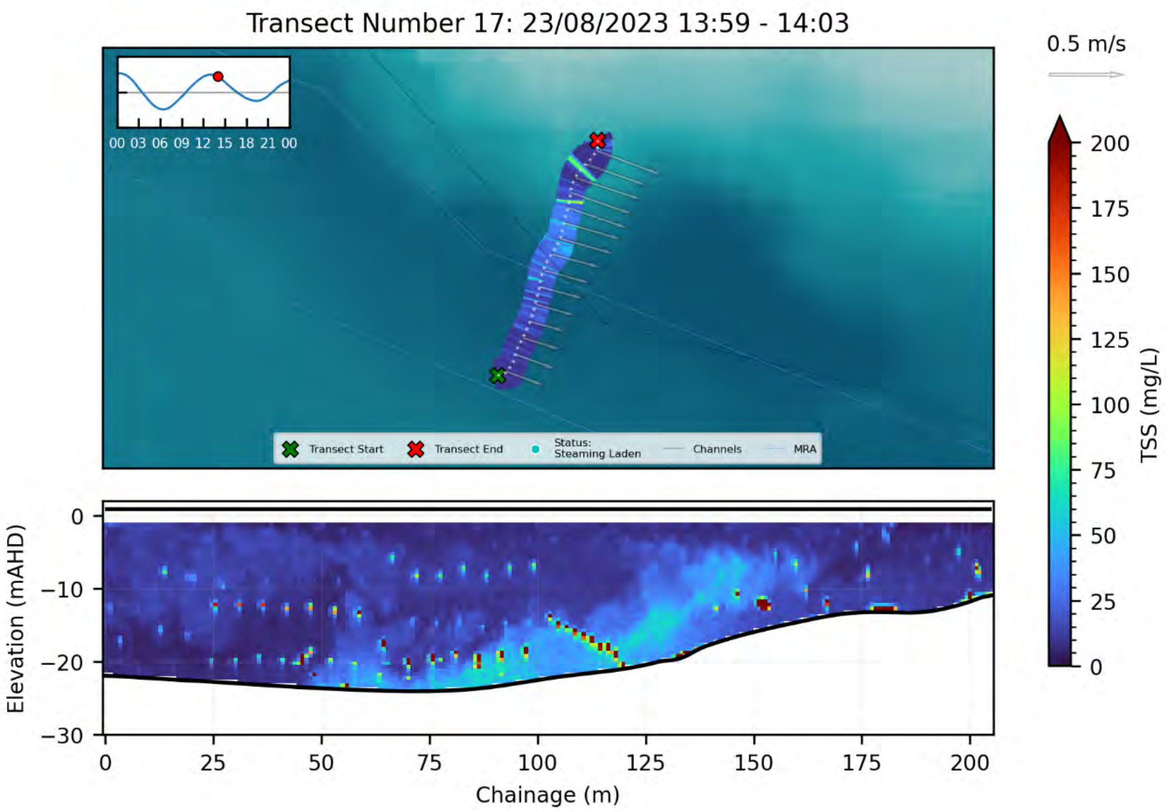

Transect Number 12: 23/08/2023 12:31 - 12:47
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
200
175
150
125
100
75
50
25
0
Elevation (mAHD)
0
−10
−20
−30
YSI
0
100
200
300
400
500
600
700
Chainage (m)


Transect Number 13: 23/08/2023 12:47 - 12:59
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
Chainage (m)
0
200
400
600
800

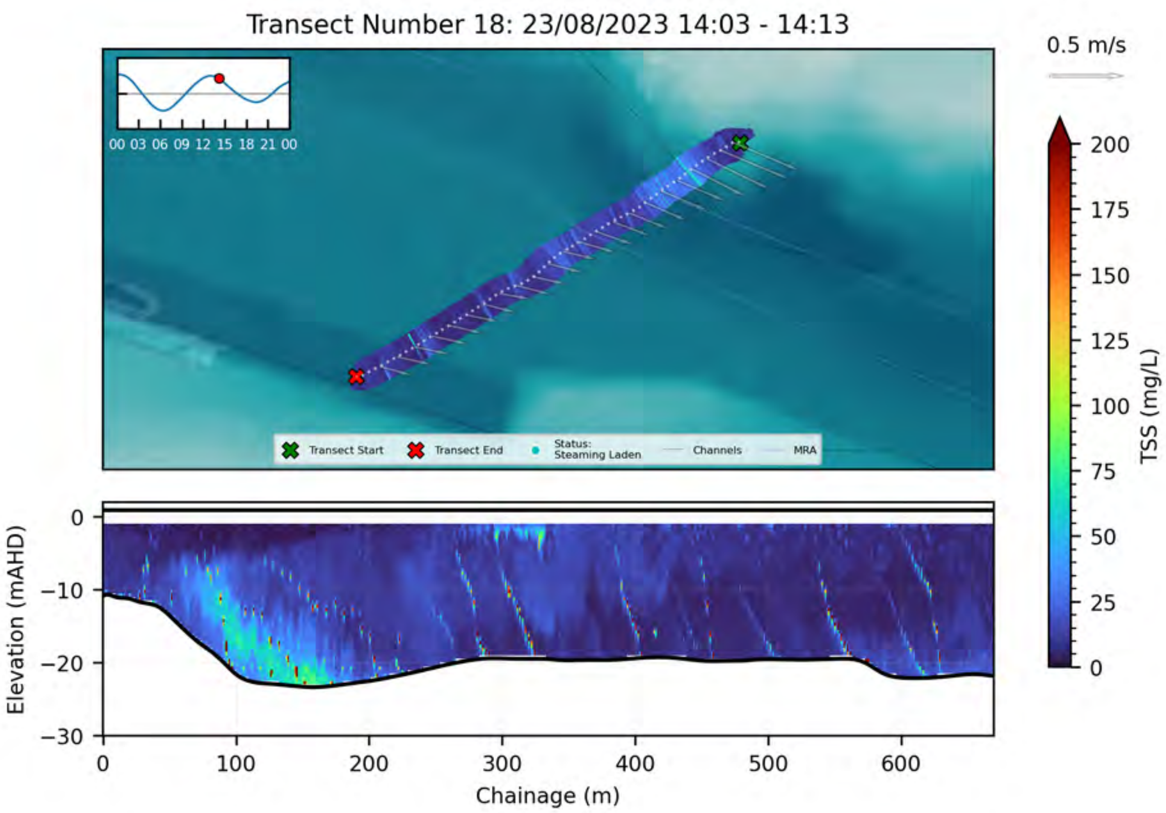

Transect Number 14: 23/08/2023 13:00 - 13:24
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
Chainage (m)
0
200
400
600
800


Transect Number 15: 23/08/2023 13:24 - 13:34
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
Chainage (m)
0
100
200
300
400
500
600
700

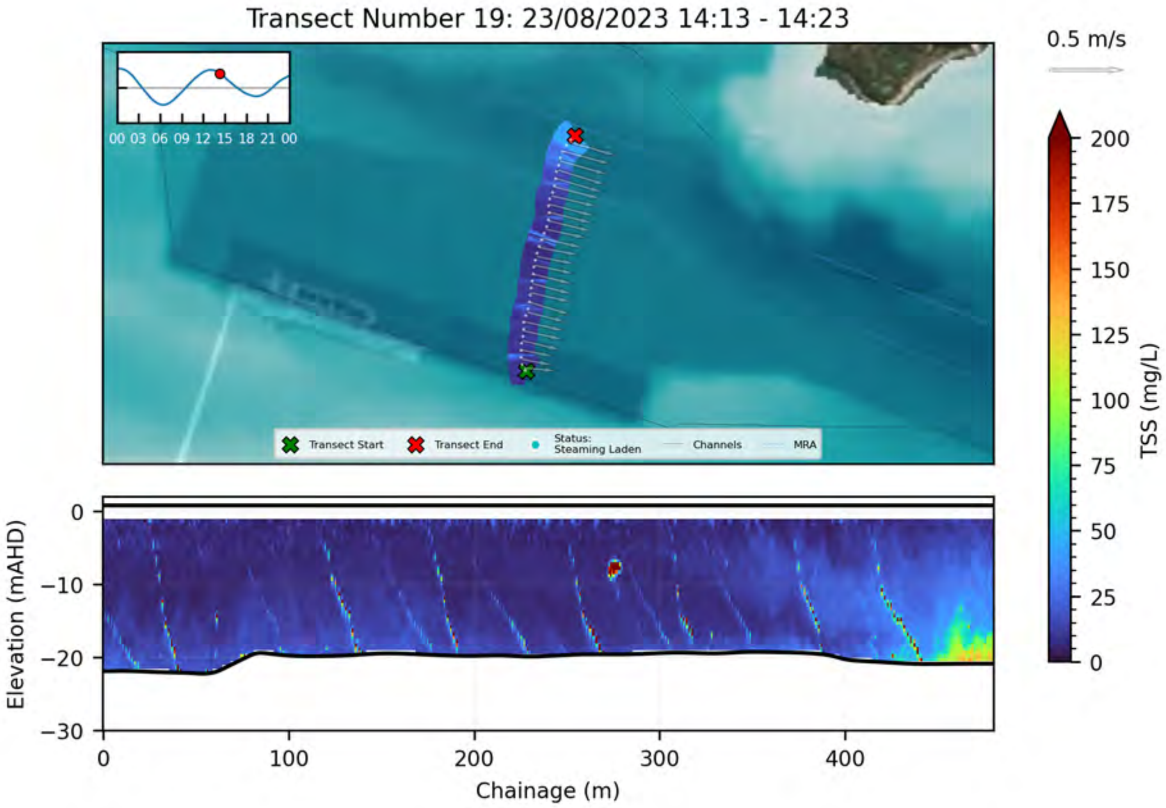

Transect Number 16: 23/08/2023 13:34 - 13:59
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
Chainage (m)
0
250
500
750
1000
1250
1500
1750
2000

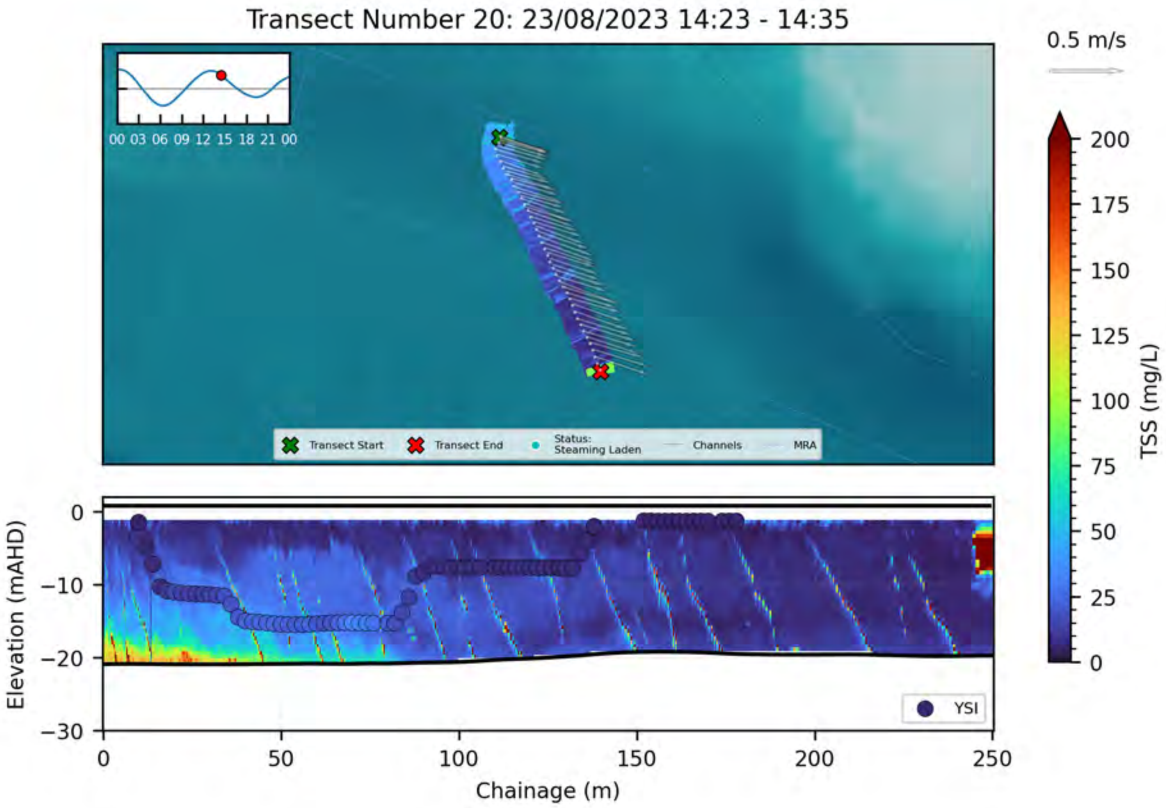


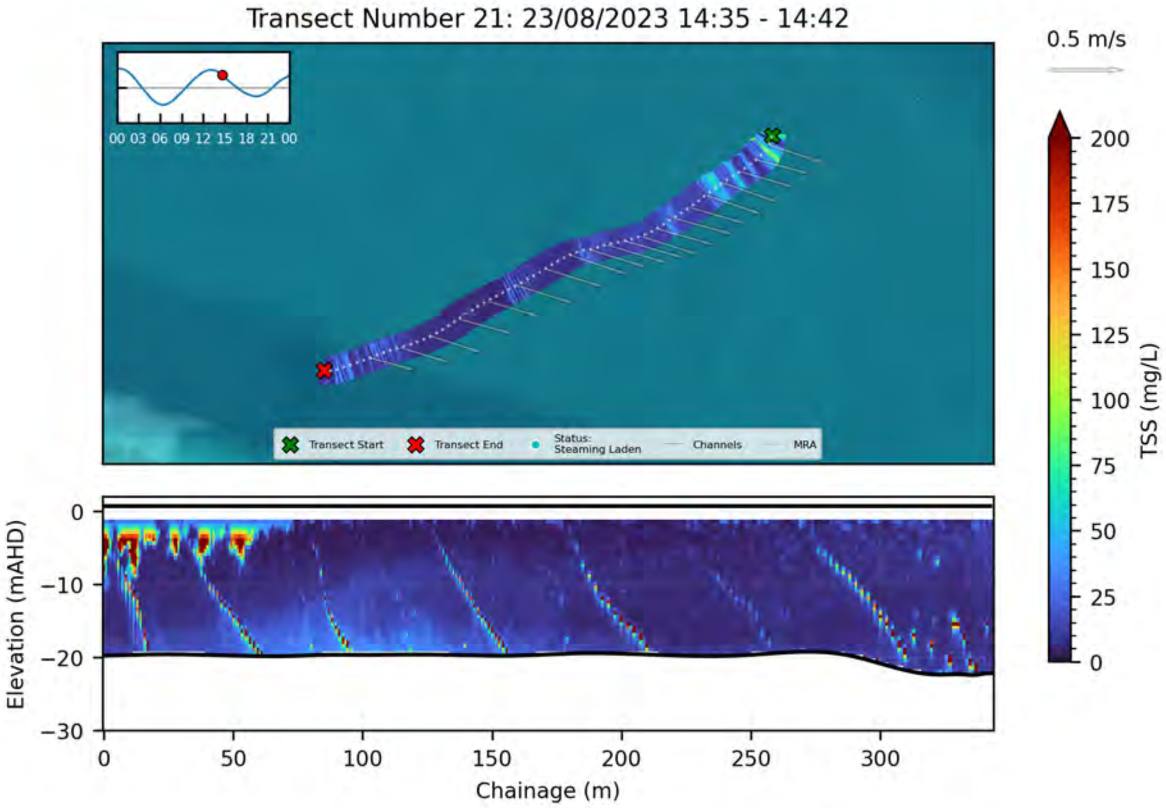
Transect Number 17: 23/08/2023 13:59 - 14:03
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
0
25
50
75
100
125
150
175
200
Chainage (m)

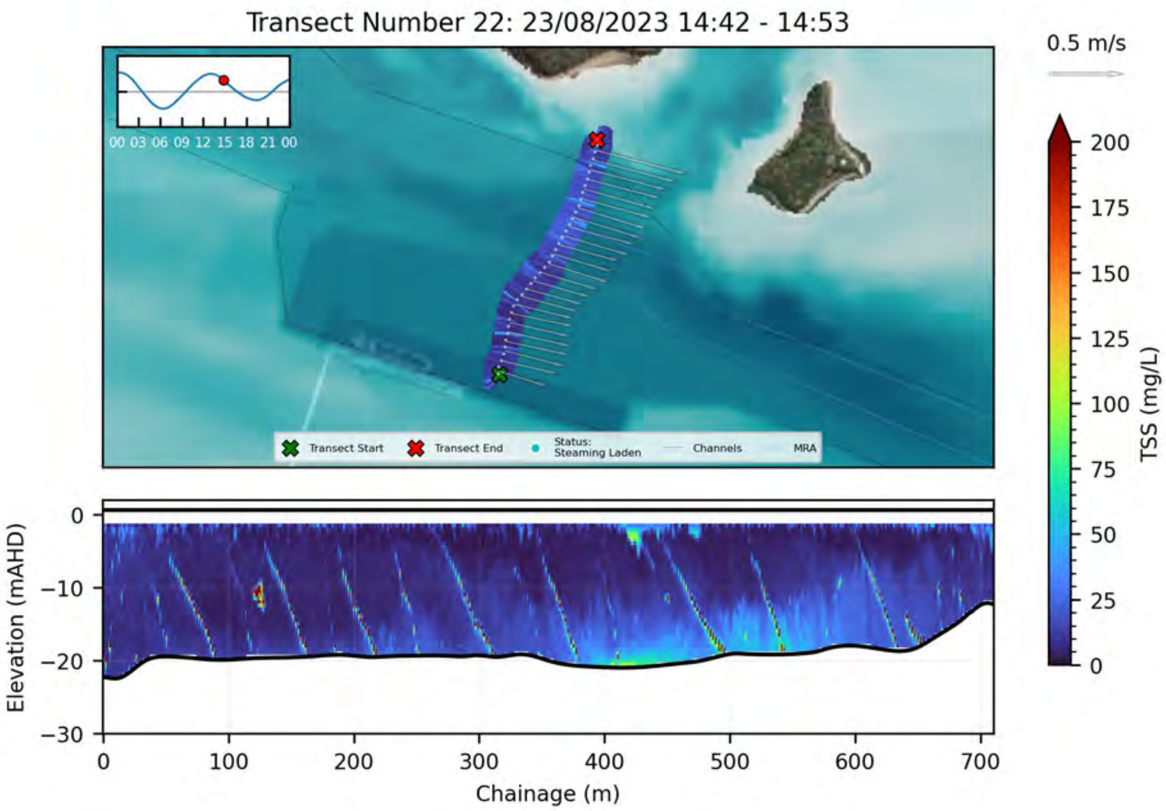


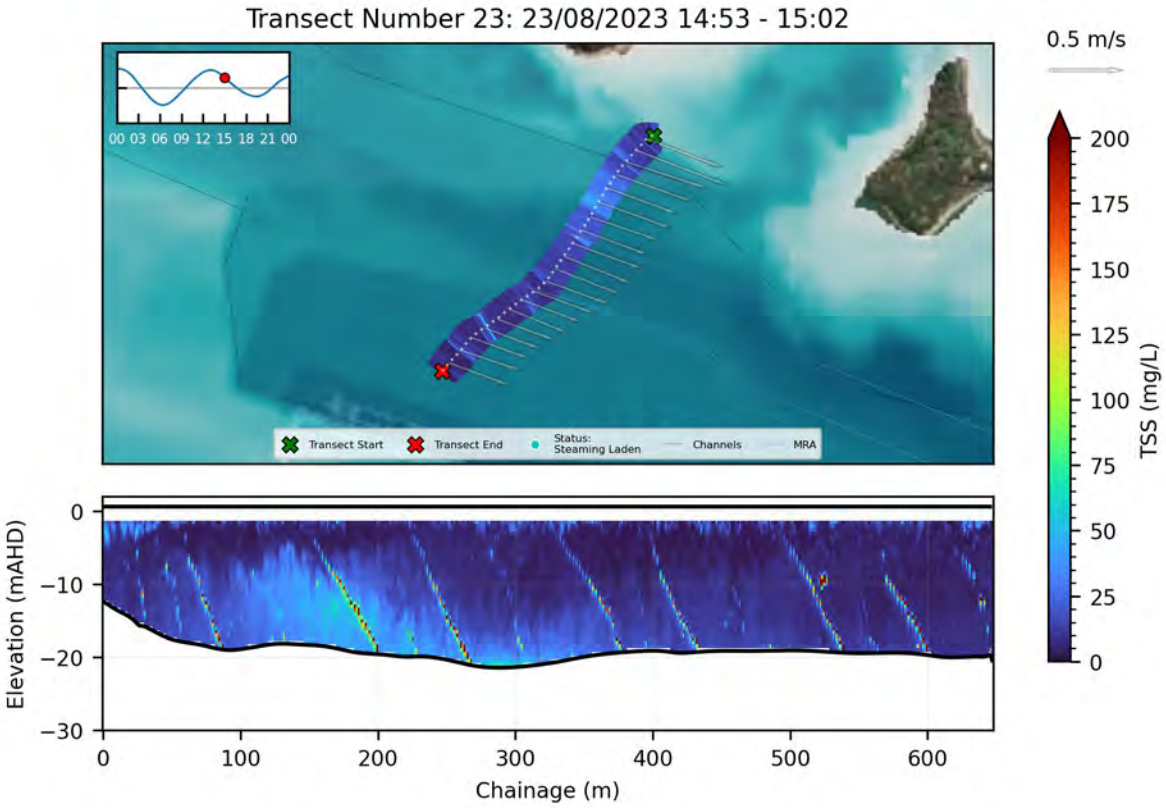
Transect Number 18: 23/08/2023 14:03 - 14:13
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
0
100
200
300
400
500
600
Chainage (m)

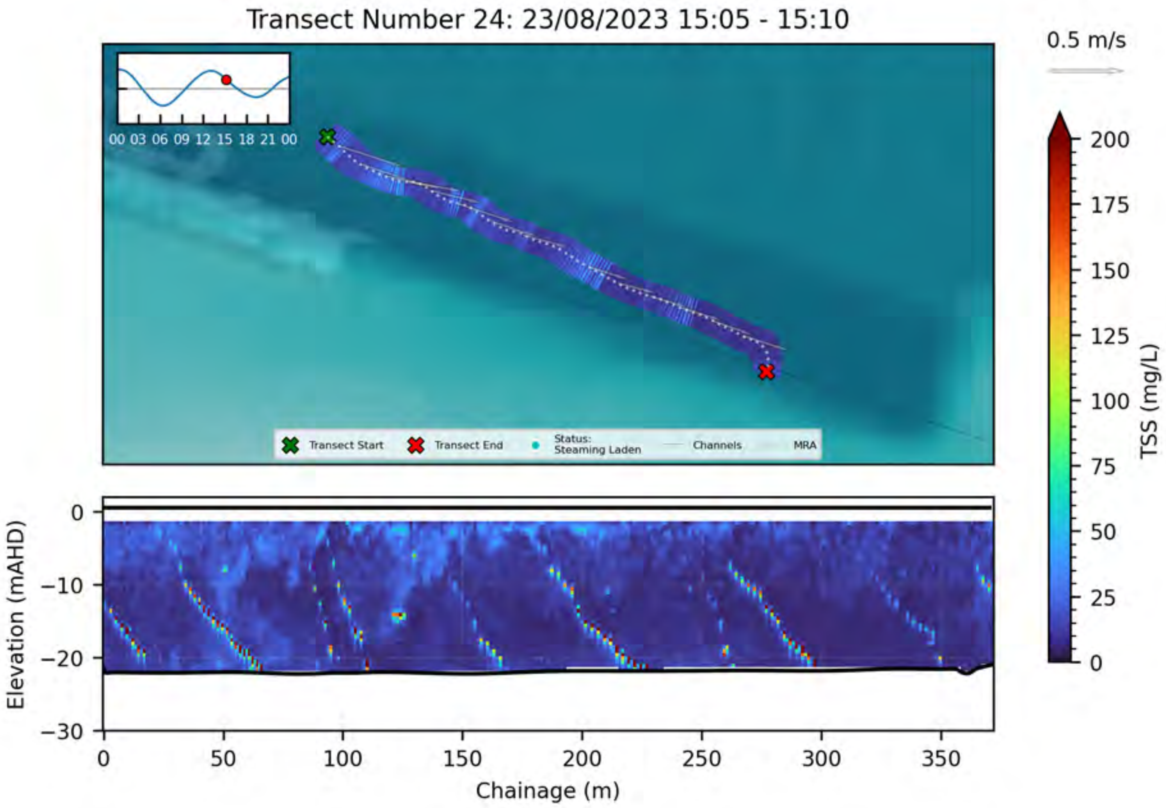

Transect Number 19: 23/08/2023 14:13 - 14:23
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
Elevation (mAHD)
Chainage (m)
TSS (mg/L)

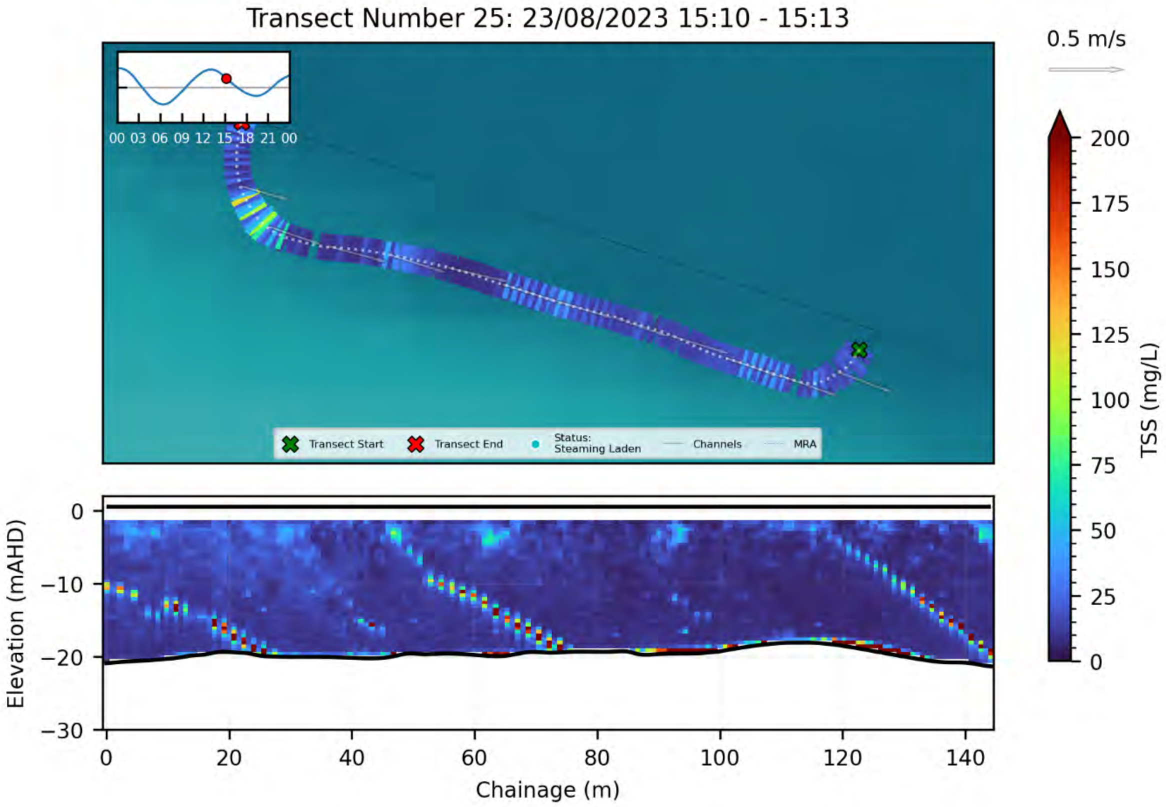

Transect Number 20: 23/08/2023 14:23 - 14:35
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
Elevation (mAHD)
Chainage (m)
YSI
TSS (mg/L)

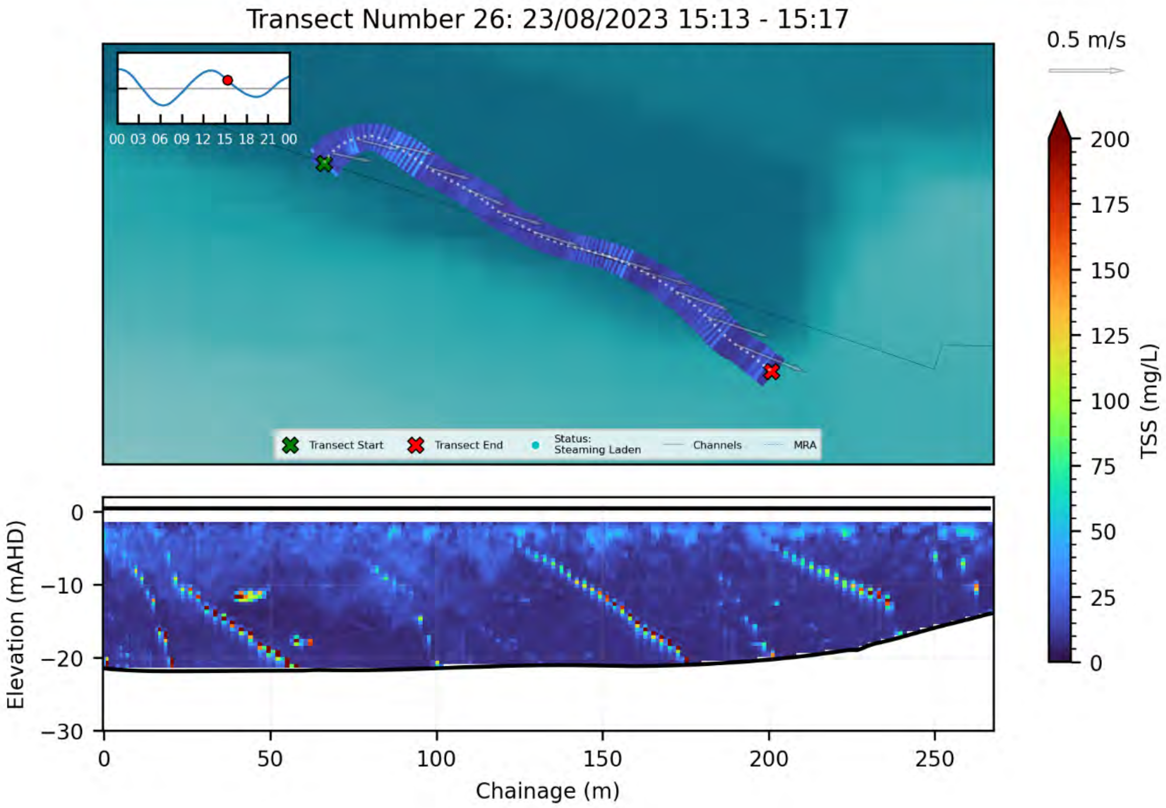

Transect Number 21: 23/08/2023 14:35 - 14:42
00 03 06 09 12 15 18 21 00
0.5 m/s
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)


Transect Number 22: 23/08/2023 14:42 - 14:53
00 03 06 09 12 15 18 21 00
0.5 m/s
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

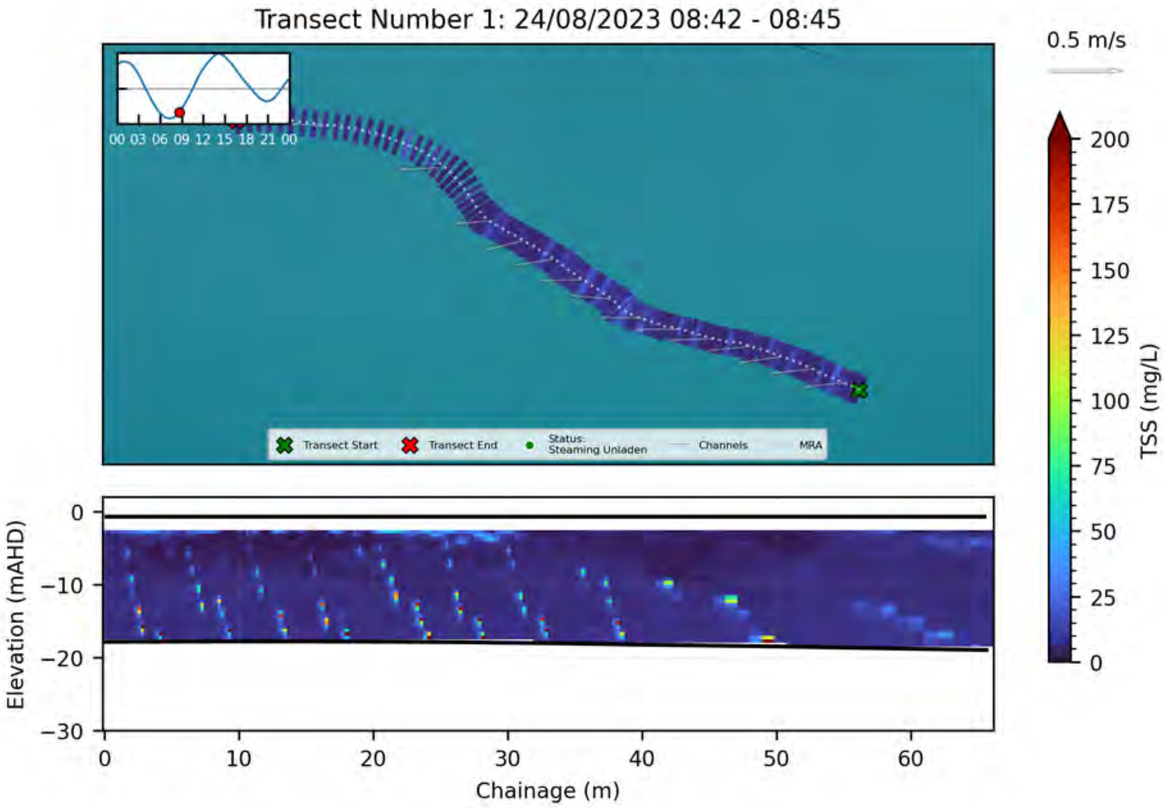

Transect Number 23: 23/08/2023 14:53 - 15:02
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
200
175
150
125
100
75
50
25
0
Elevation (mAHD)
0
−10
−20
−30
0
100
200
300
400
500
600
Chainage (m)

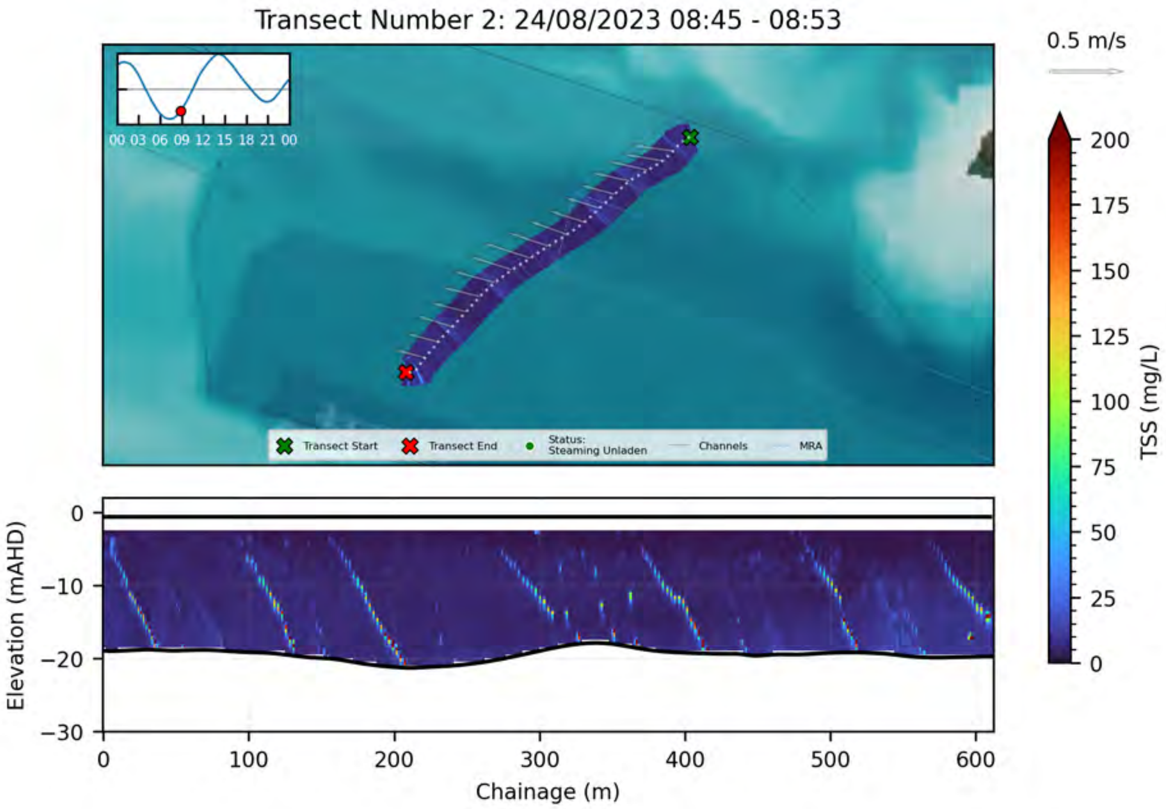

Transect Number 24: 23/08/2023 15:05 - 15:10
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
200
175
150
125
100
75
50
25
0
Elevation (mAHD)
0
−10
−20
−30
0
50
100
150
200
250
300
350
Chainage (m)

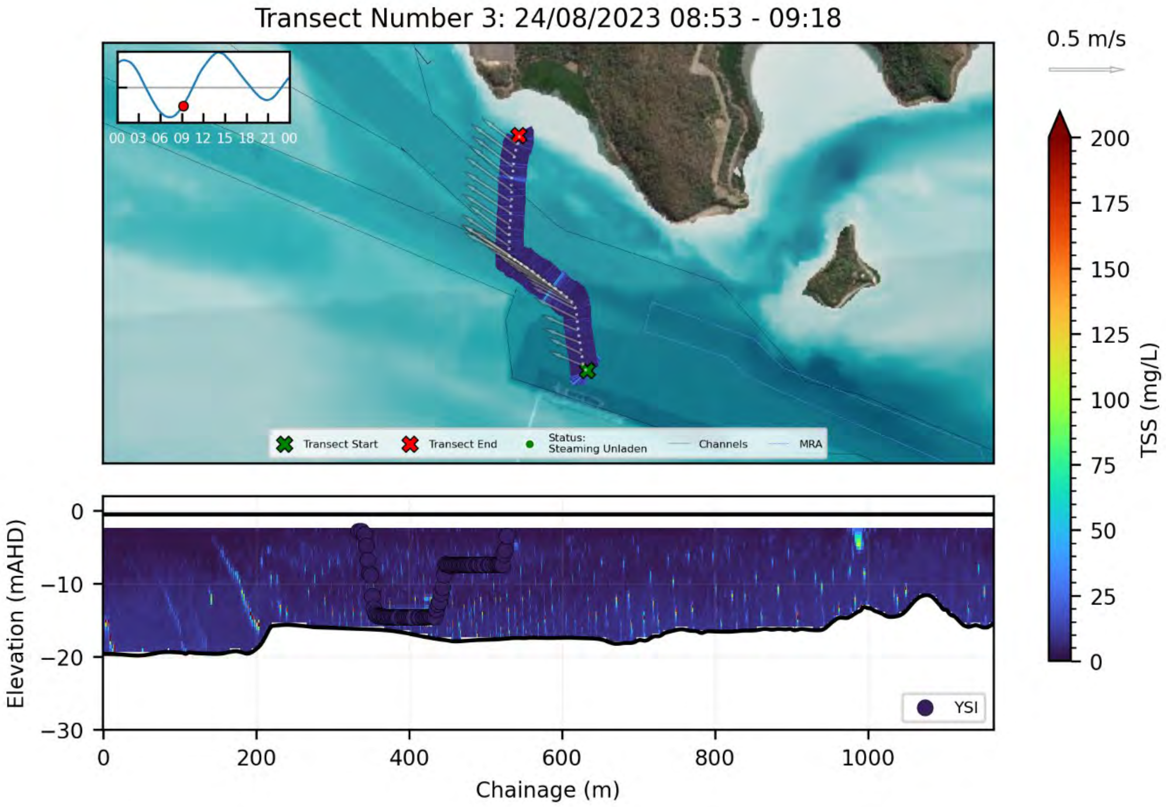

Transect Number 25: 23/08/2023 15:10 - 15:13
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)


Transect Number 26: 23/08/2023 15:13 - 15:17
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

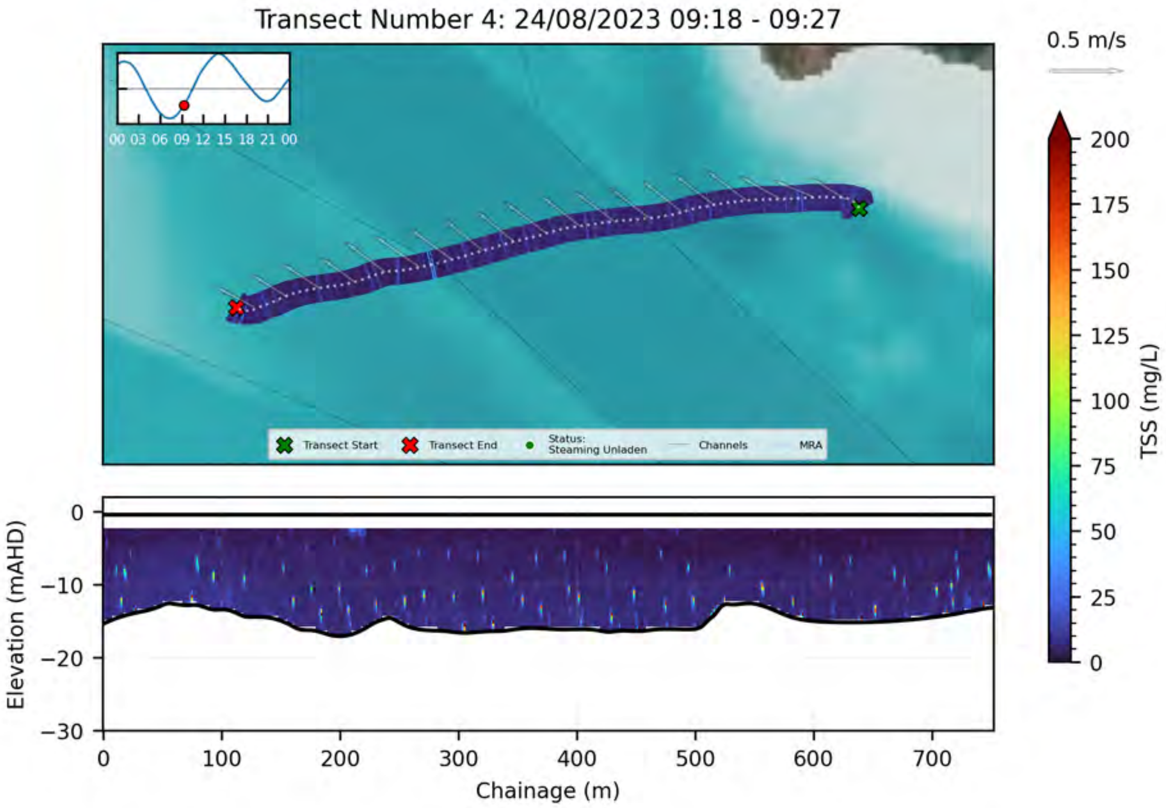
Annex K ADCP Derived TSS Transects 24th August 2023



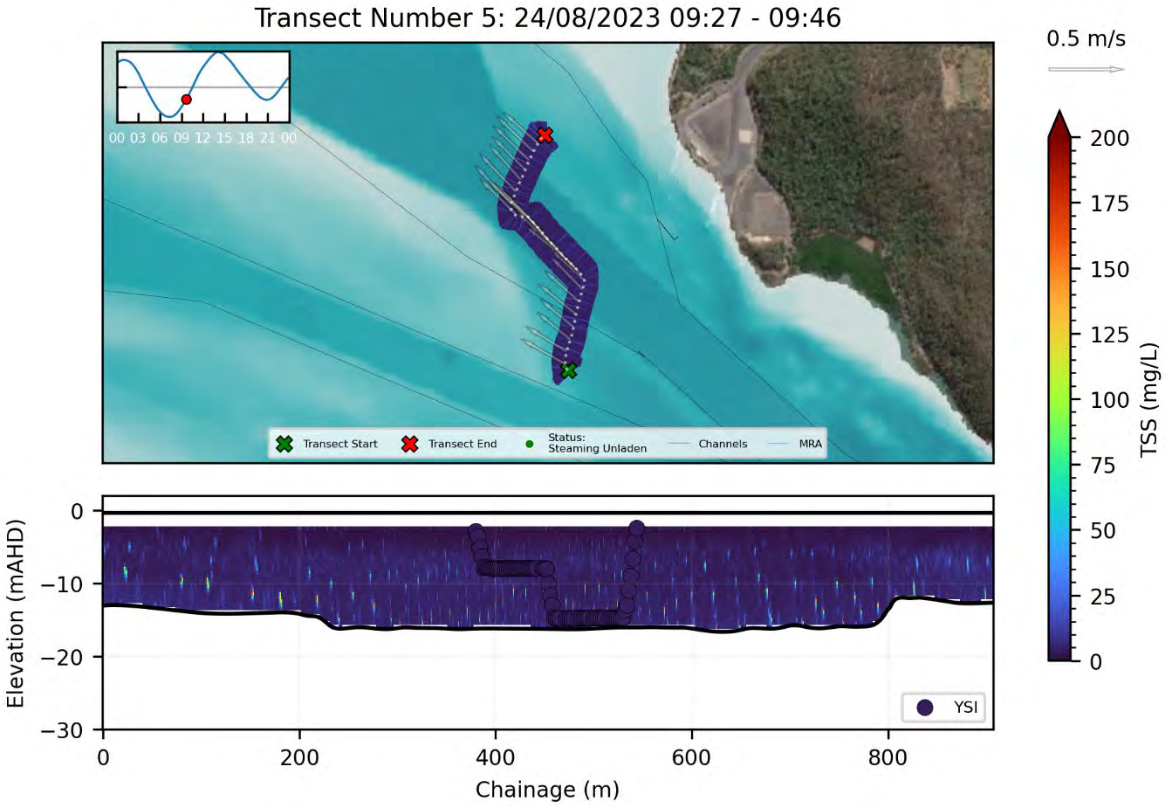


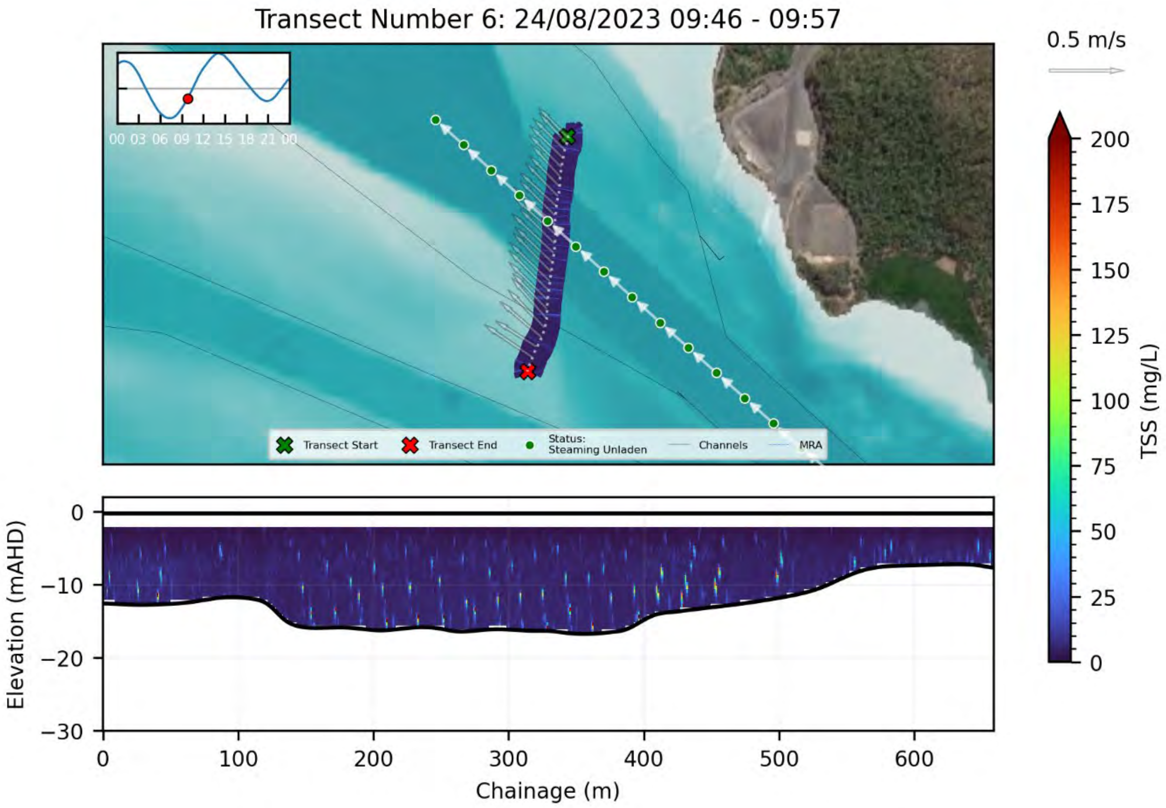


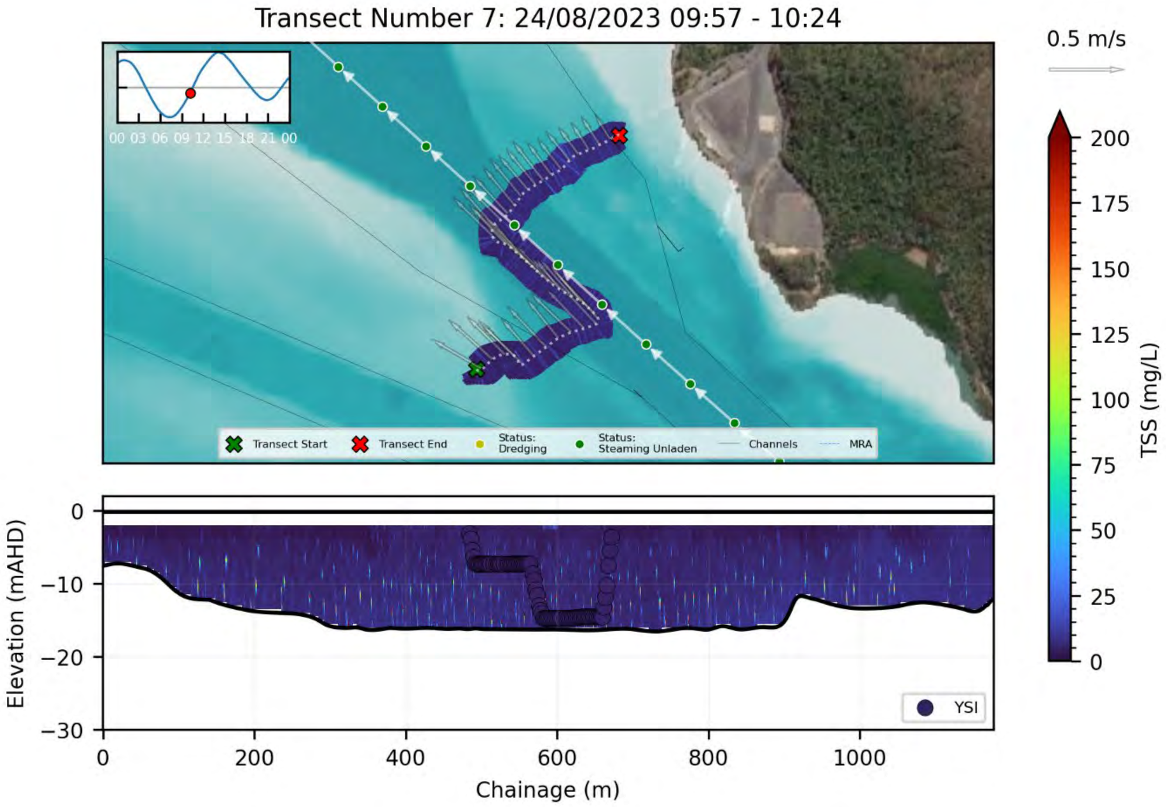
Transect Number 3: 24/08/2023 08:53 - 09:18
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
Elevation (mAHD)
YSI
Chainage (m)
TSS (mg/L)
0
25
50
75
100
125
150
175
200

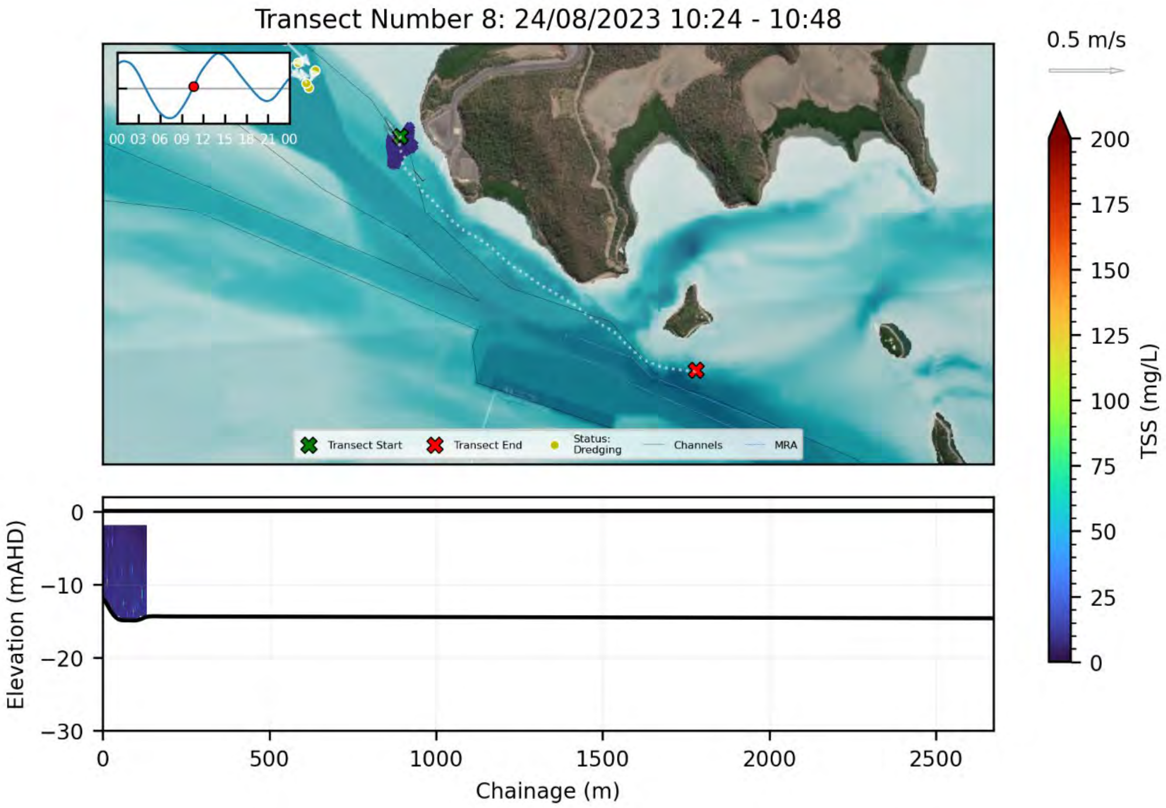


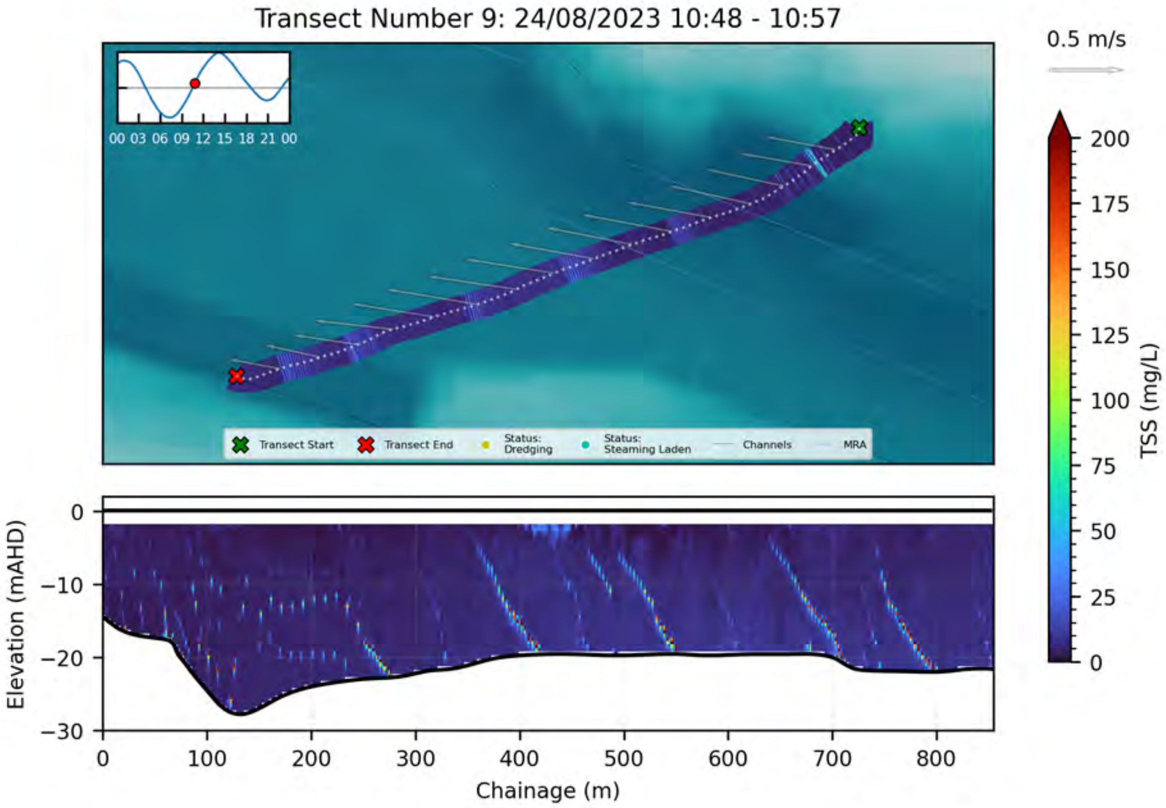
Transect Number 4: 24/08/2023 09:18 - 09:27
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
Elevation (mAHD)
Chainage (m)
TSS (mg/L)

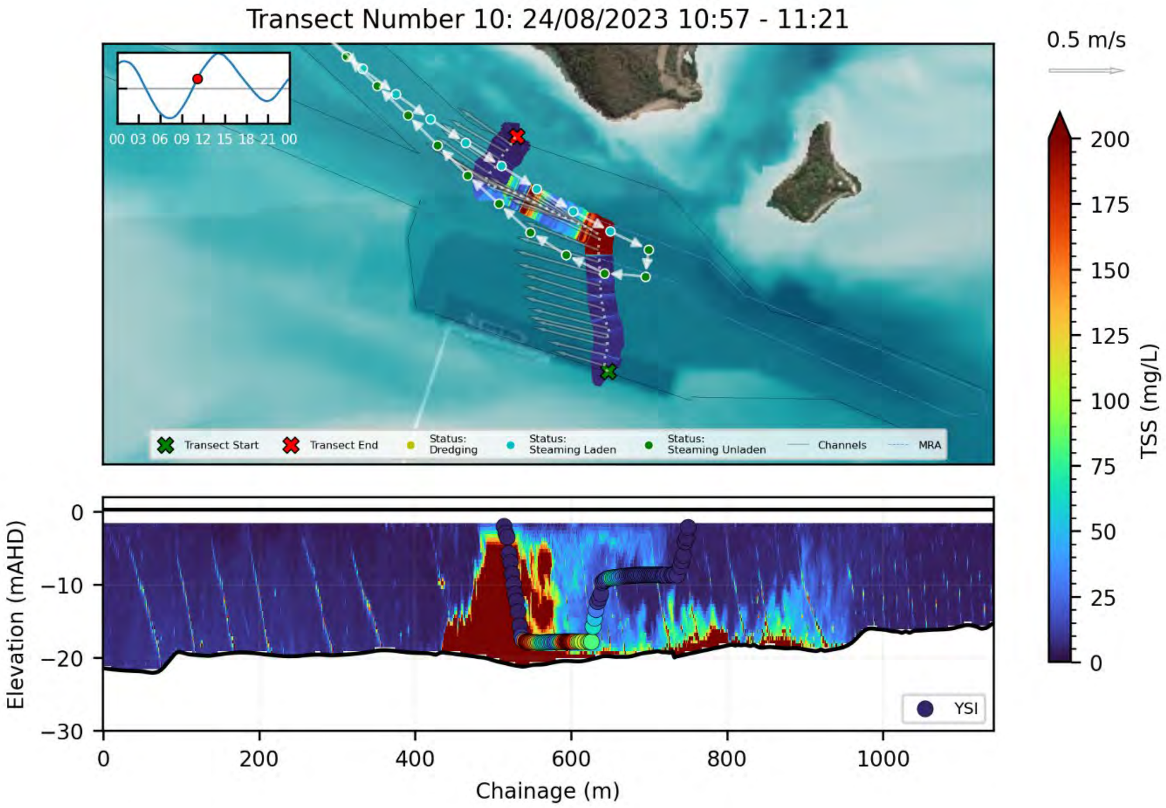

Transect Number 5: 24/08/2023 09:27 - 09:46
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
YSI
Chainage (m)
0
200
400
600
800

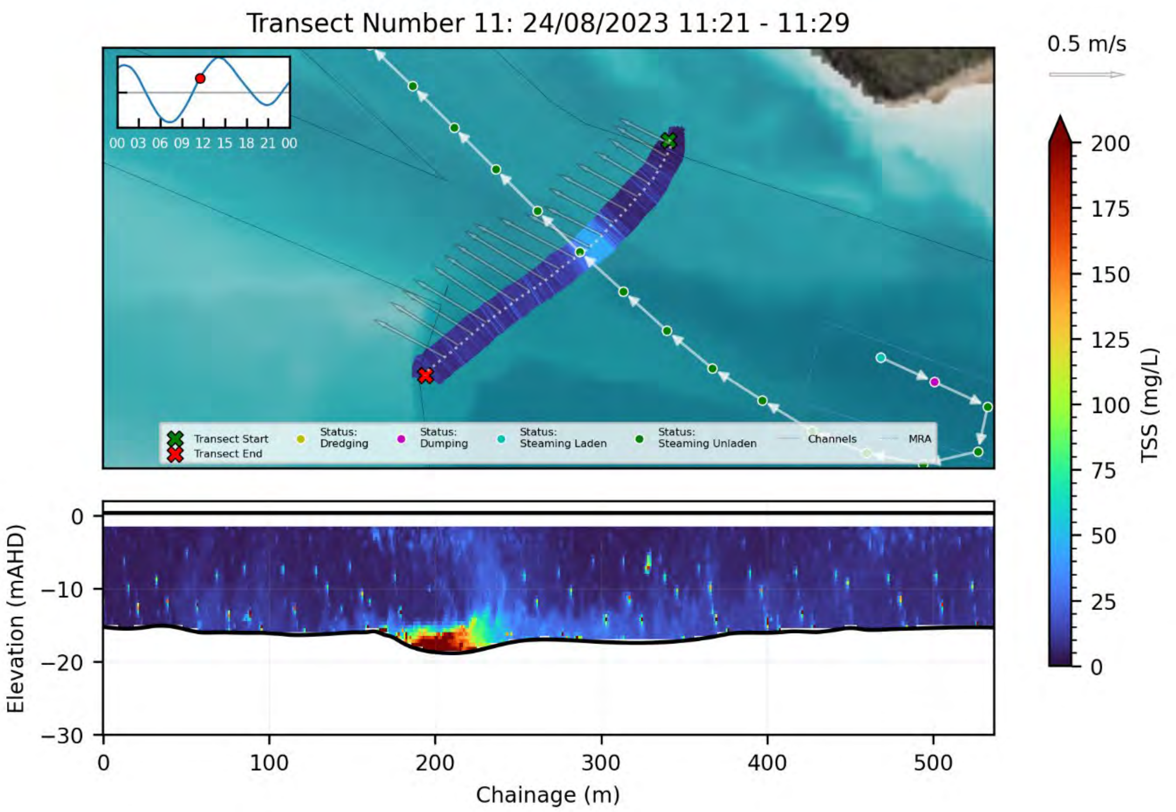

Transect Number 6: 24/08/2023 09:46 - 09:57
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
Chainage (m)
0
100
200
300
400
500
600

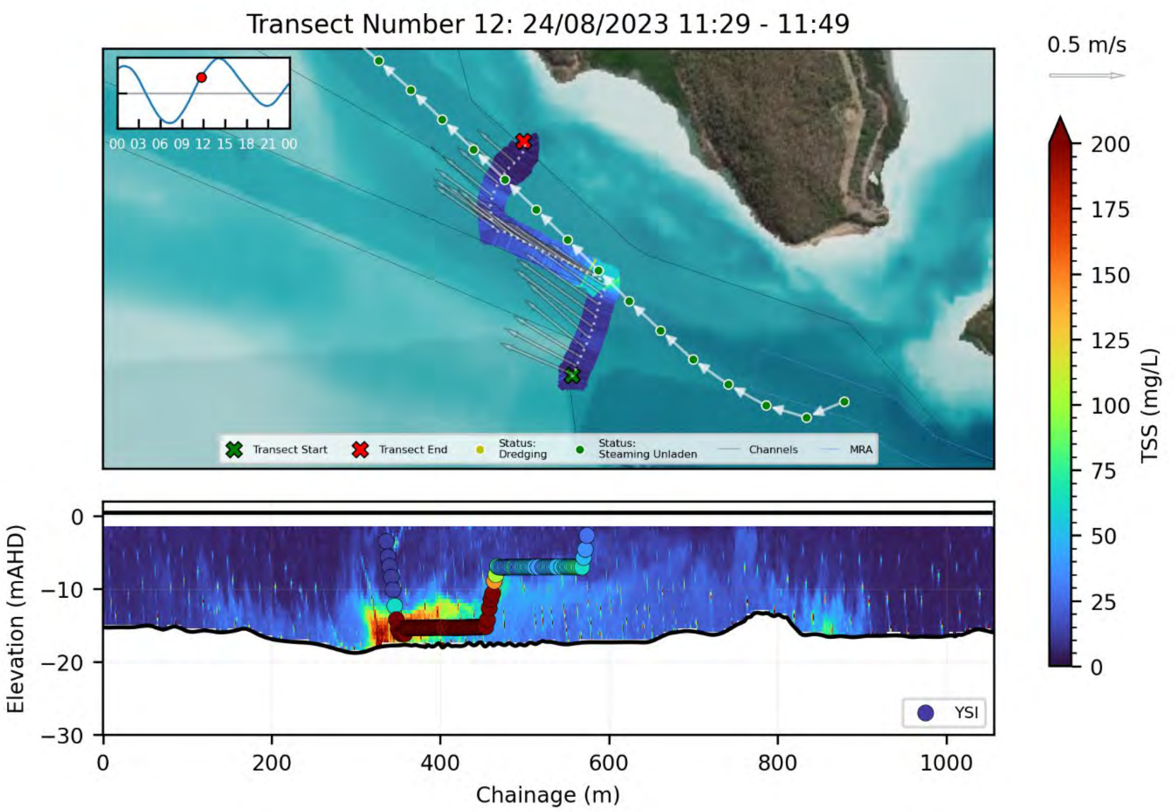

Transect Number 7: 24/08/2023 09:57 - 10:24
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
Elevation (mAHD)
YSI
Chainage (m)
TSS (mg/L)

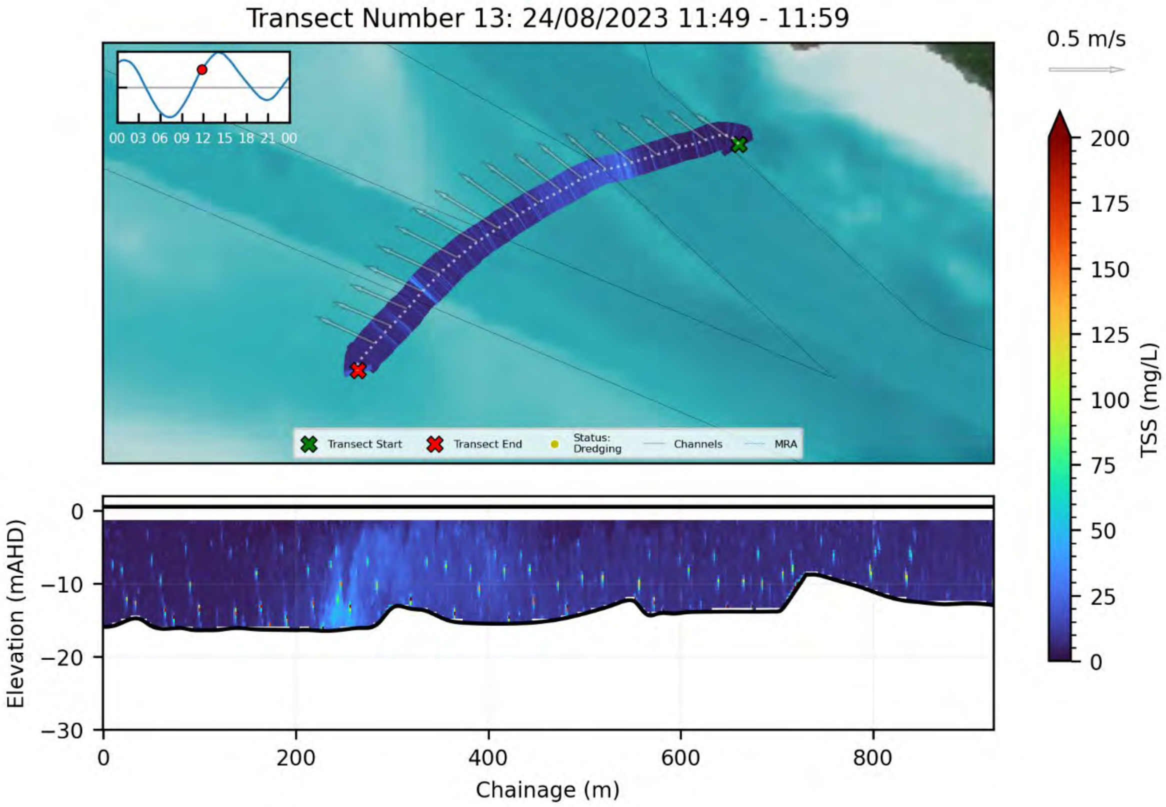

Transect Number 8: 24/08/2023 10:24 - 10:48
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Channels
MRA
Elevation (mAHD)
Chainage (m)
TSS (mg/L)

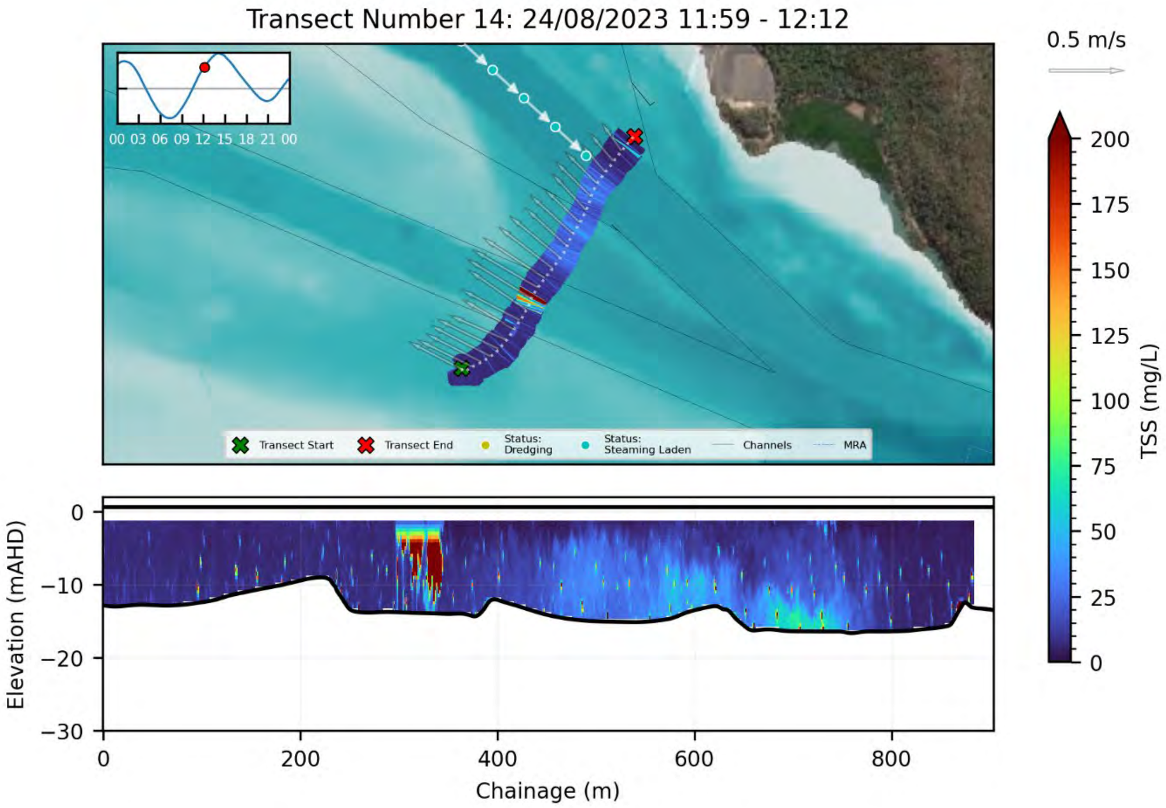

Transect Number 9: 24/08/2023 10:48 - 10:57
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

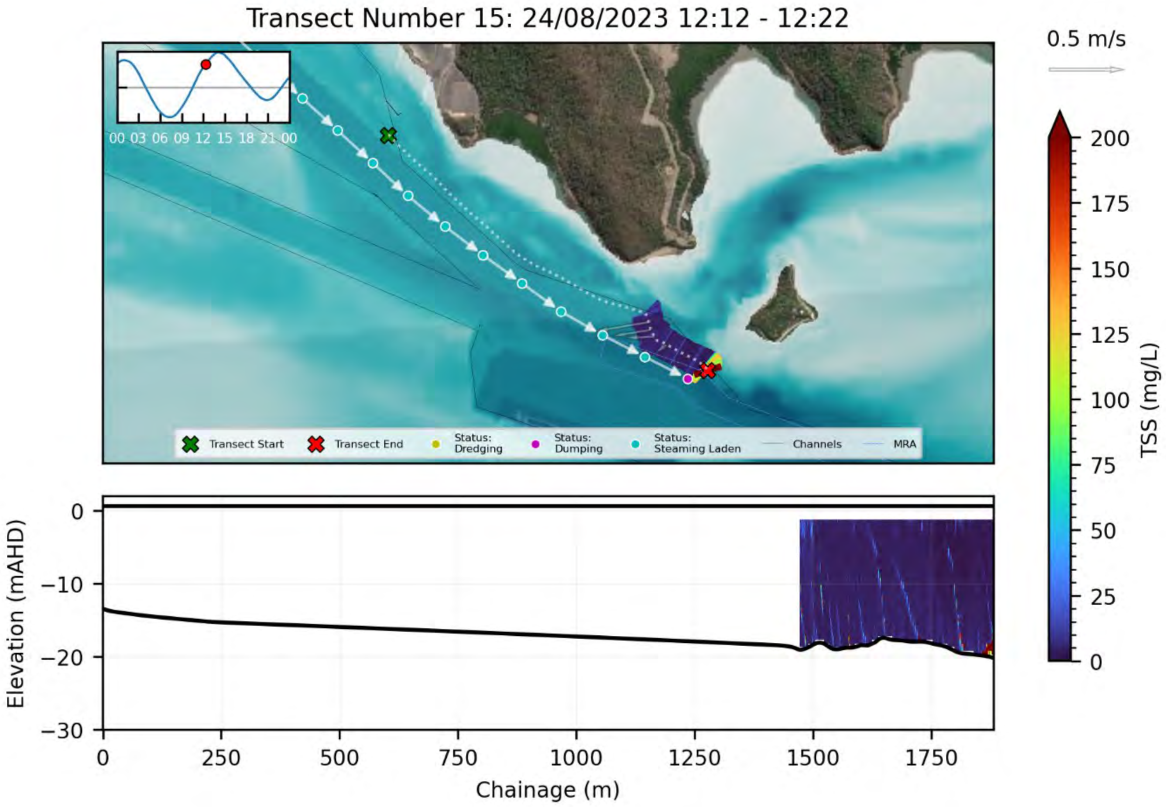

Transect Number 10: 24/08/2023 10:57 - 11:21
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
YSI
Chainage (m)

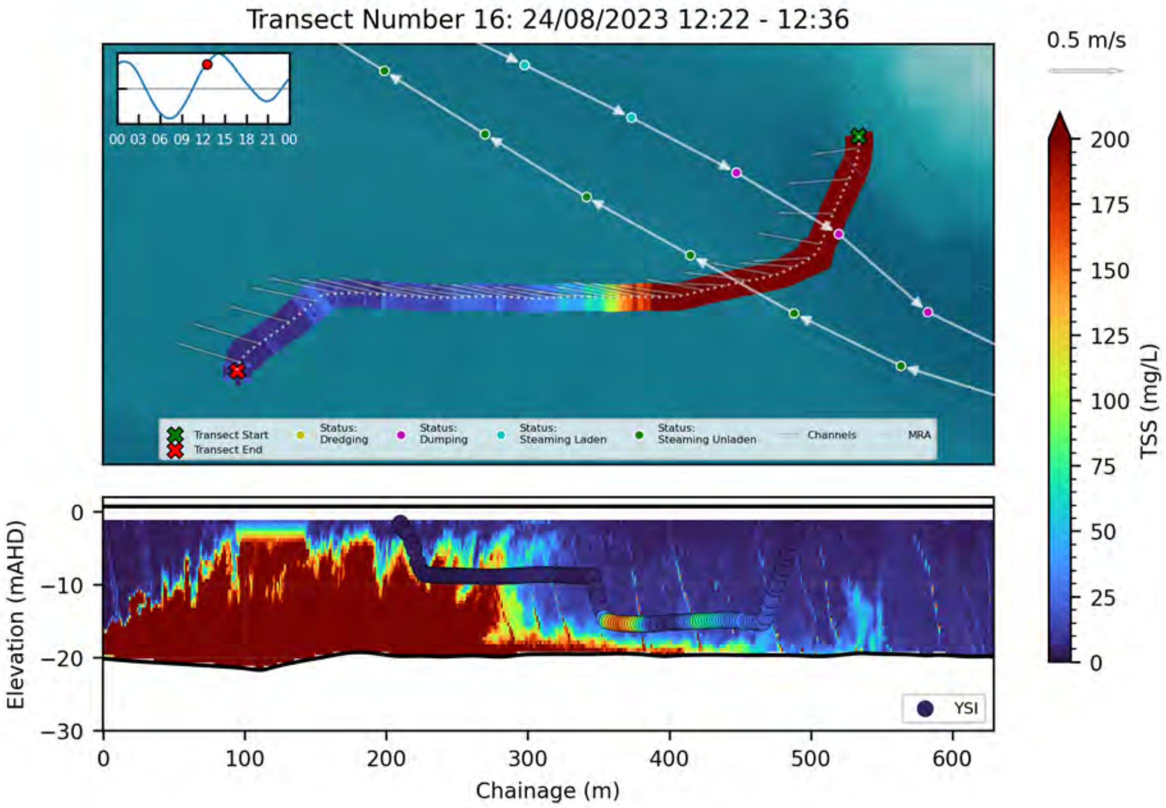

Transect Number 11: 24/08/2023 11:21 - 11:29
00 03 06 09 12 15 18 21 00
0.5 m/s
Transect Start
Transect End
Status: Dredging
Status: Dumping
Status: Steaming Laden
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
0
100
200
300
400
500
Chainage (m)

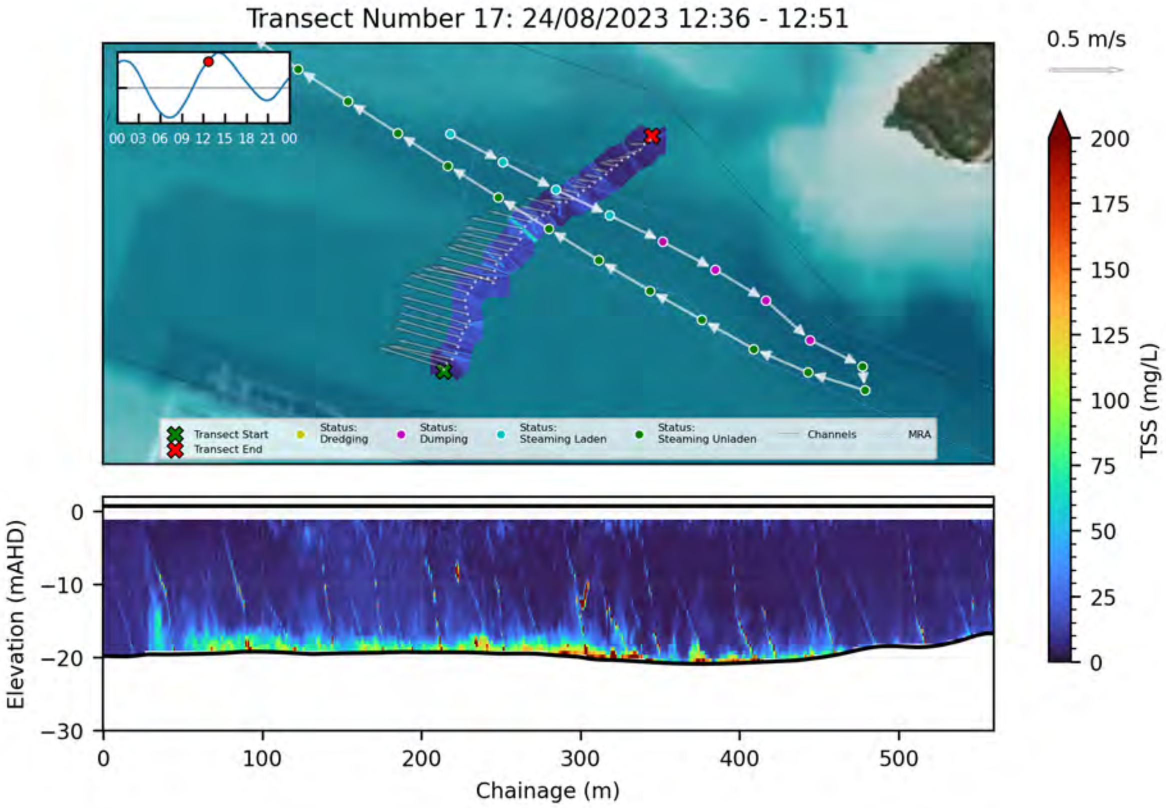

Transect Number 12: 24/08/2023 11:29 - 11:49
00 03 06 09 12 15 18 21 00
0.5 m/s
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
YSI
0
200
400
600
800
1000
Chainage (m)

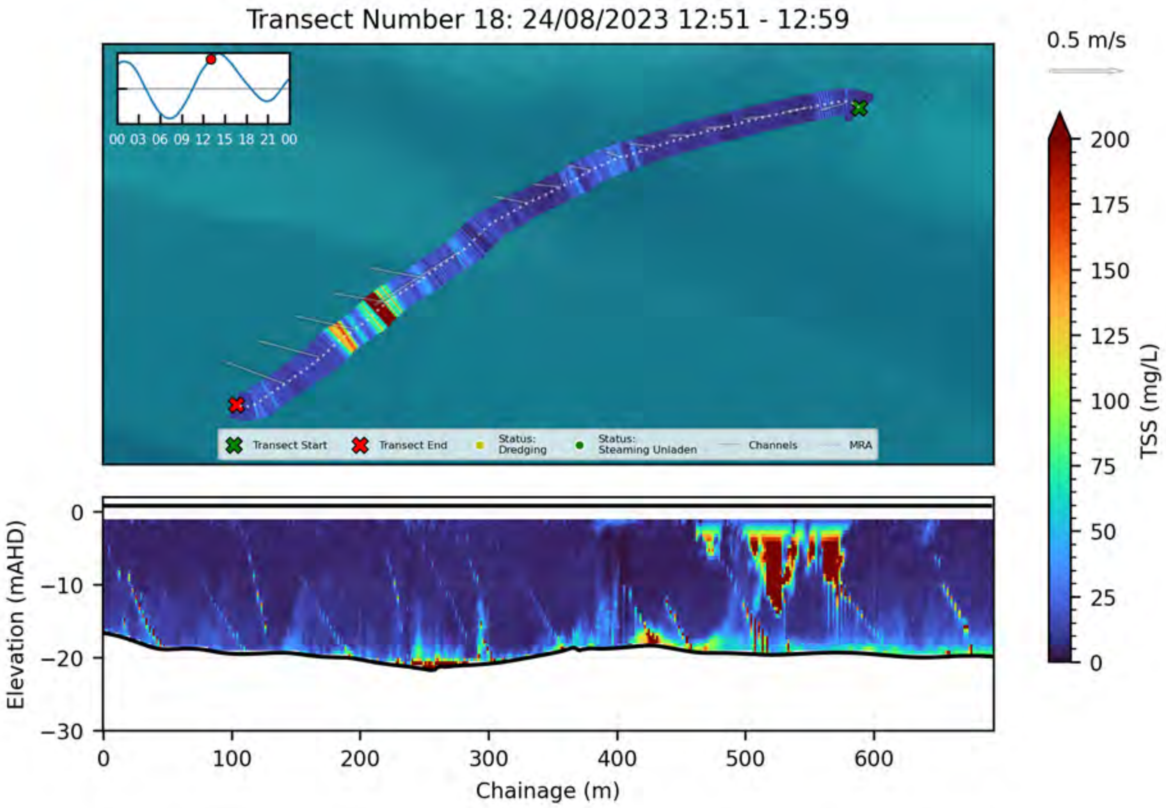

Transect Number 13: 24/08/2023 11:49 - 11:59
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

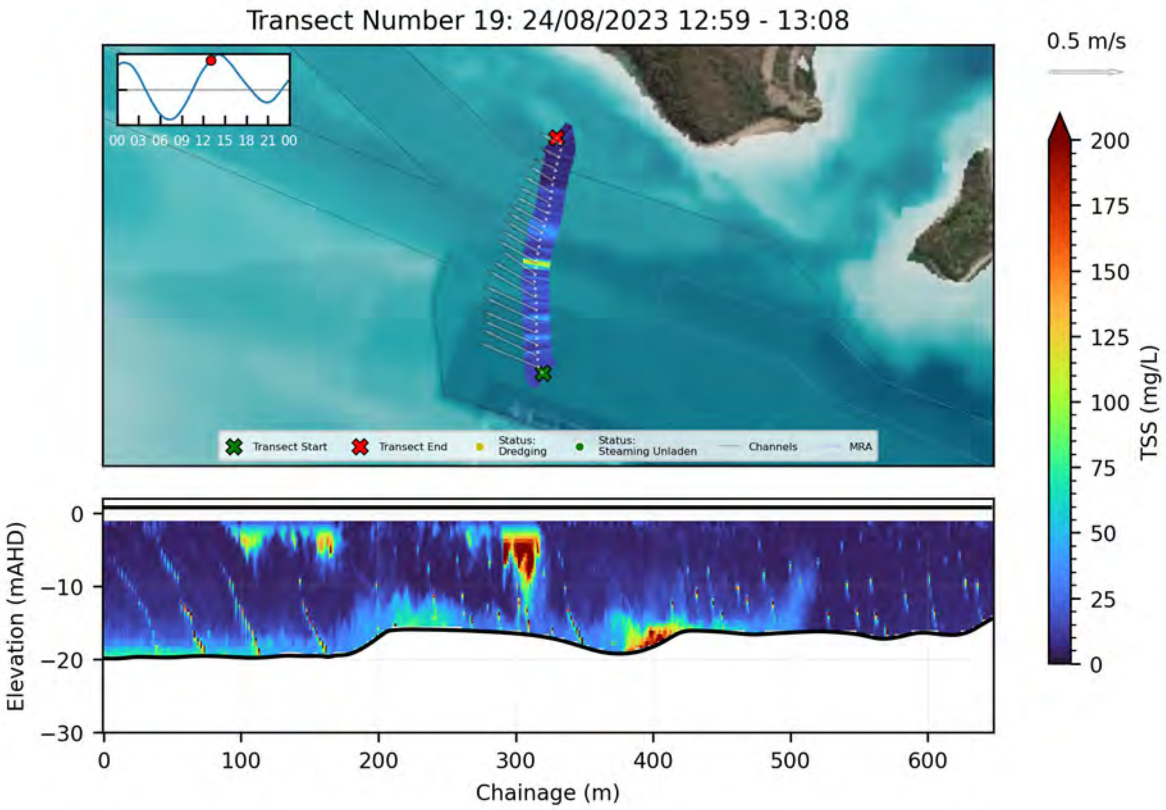

Transect Number 14: 24/08/2023 11:59 - 12:12
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

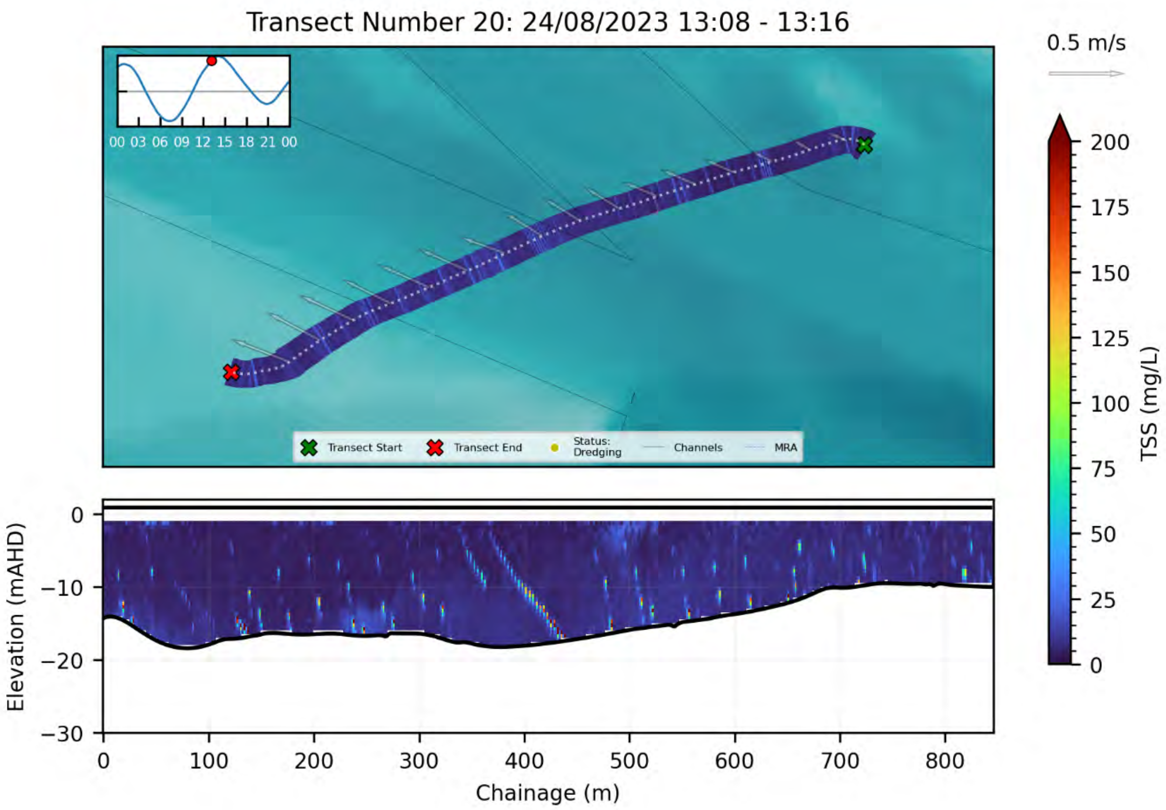

Transect Number 15: 24/08/2023 12:12 - 12:22
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Dumping
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
Chainage (m)
0
250
500
750
1000
1250
1500
1750

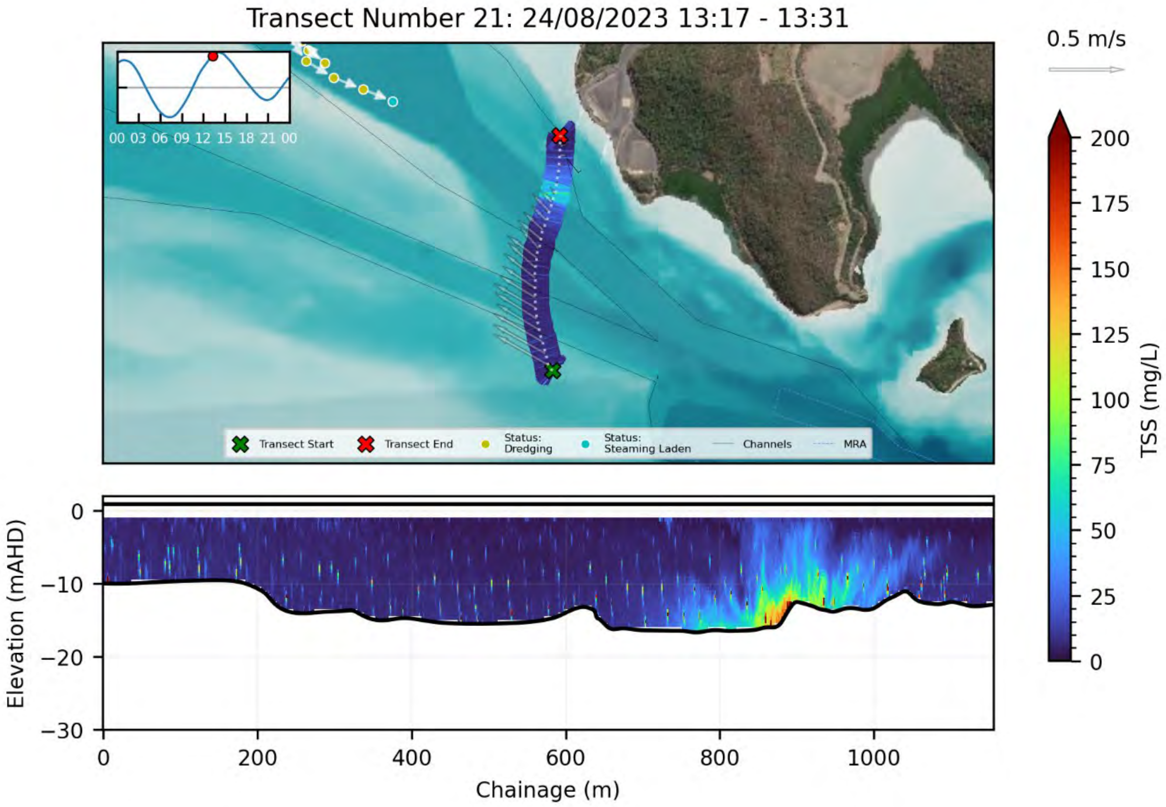

Transect Number 16: 24/08/2023 12:22 - 12:36
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Dumping
Status: Steaming Laden
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
YSI
Chainage (m)
0
100
200
300
400
500
600

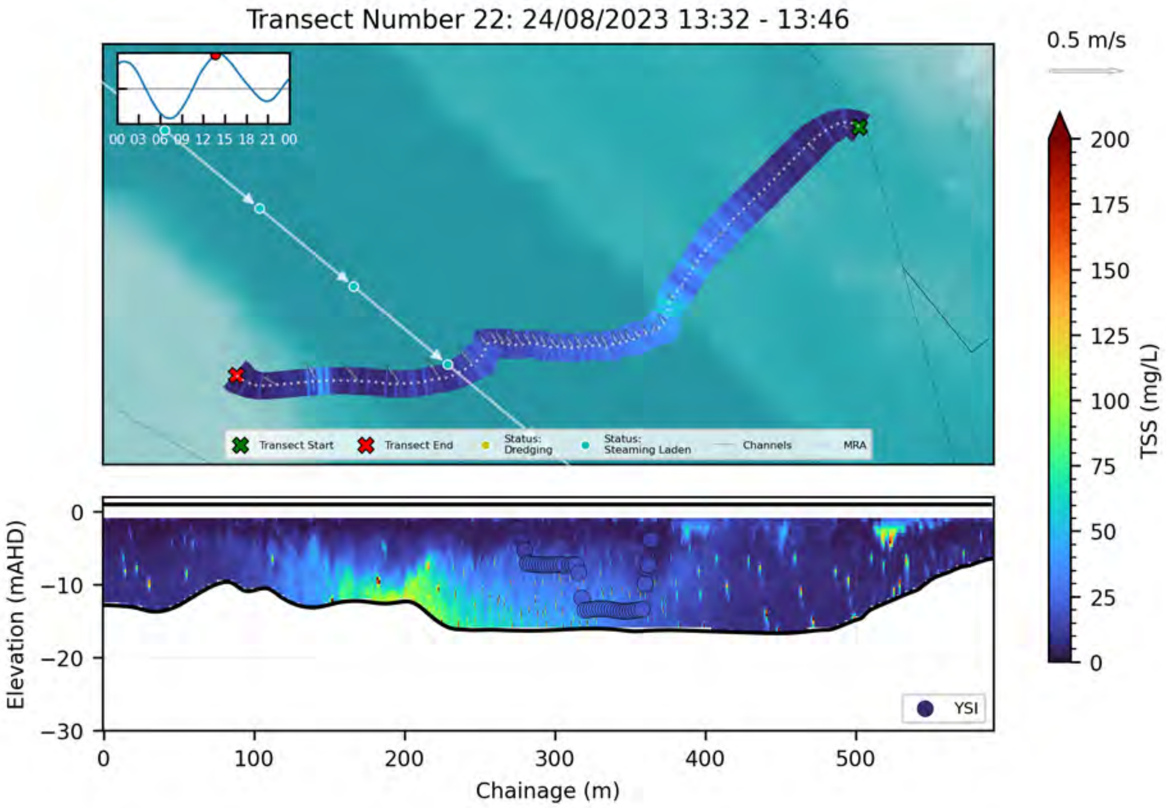

Transect Number 17: 24/08/2023 12:36 - 12:51
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Dumping
Status: Steaming Laden
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
200
175
150
125
100
75
50
25
0
Elevation (mAHD)
0
−10
−20
−30
Chainage (m)
0
100
200
300
400
500

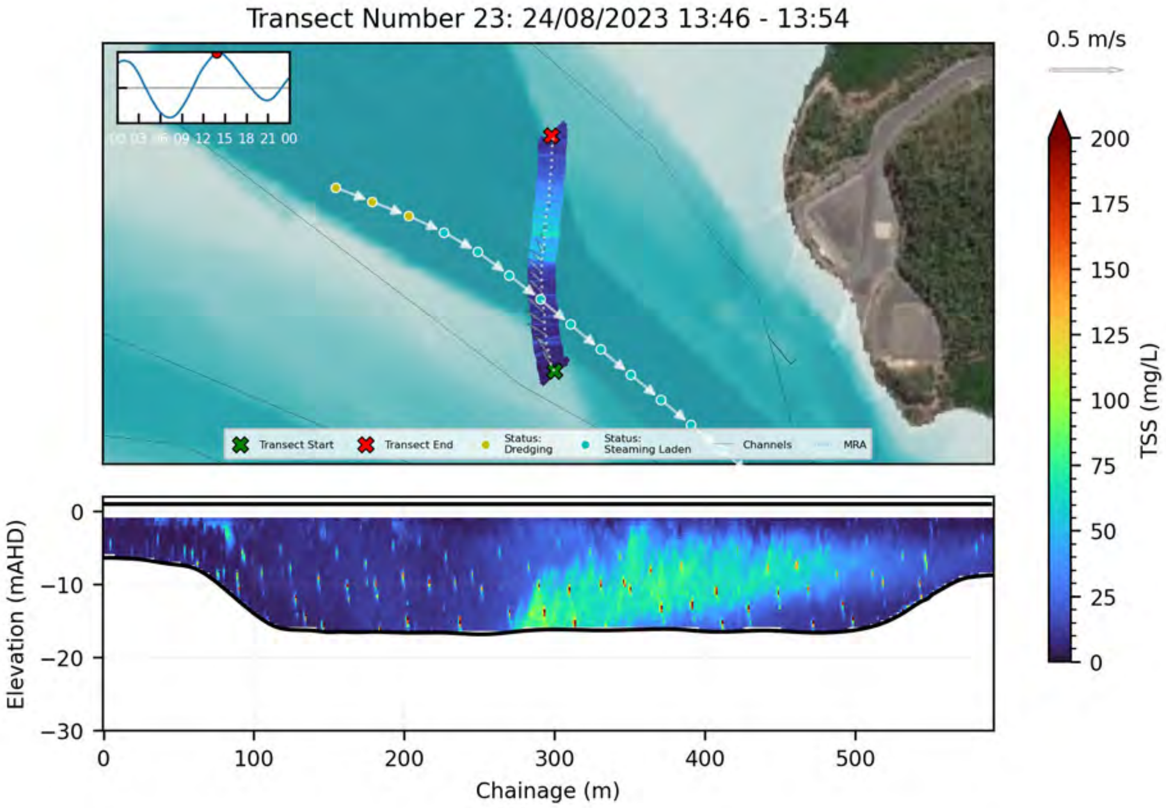

Transect Number 18: 24/08/2023 12:51 - 12:59
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
200
175
150
125
100
75
50
25
0
Elevation (mAHD)
0
−10
−20
−30
Chainage (m)
0
100
200
300
400
500
600

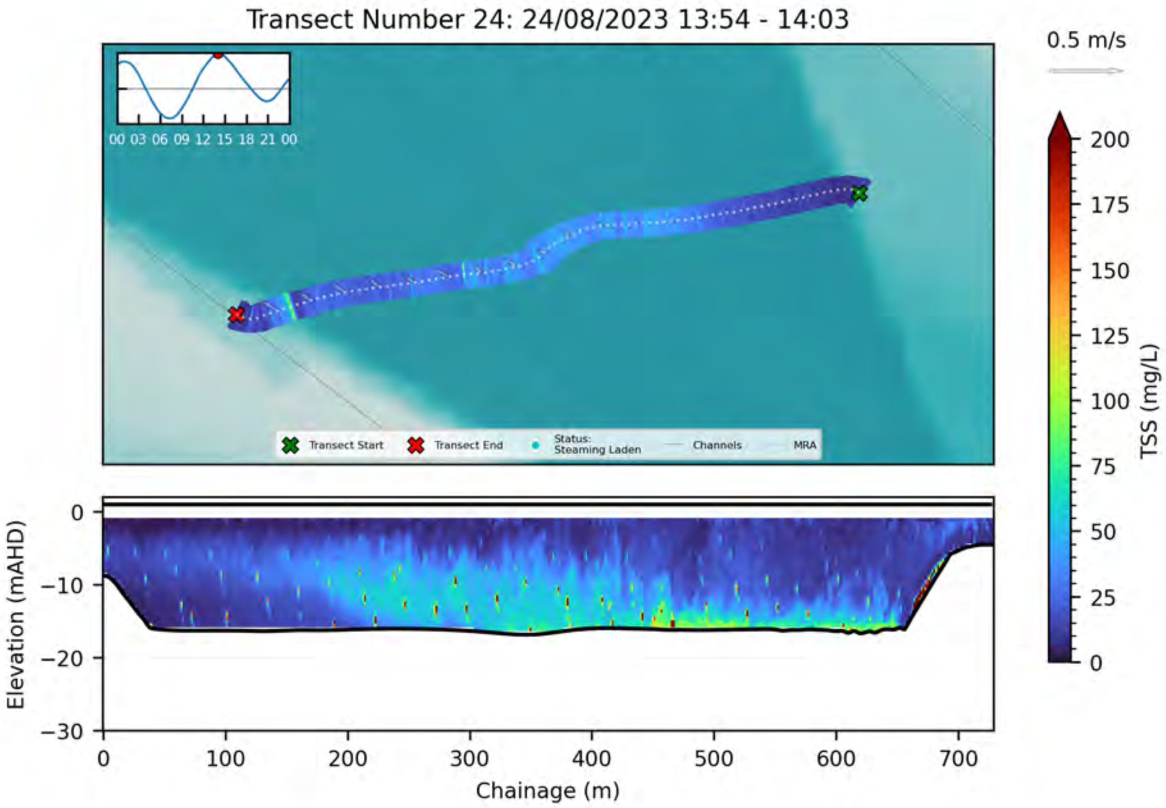

Transect Number 19: 24/08/2023 12:59 - 13:08
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)
0
−10
−20
−30
0 100 200 300 400 500 600

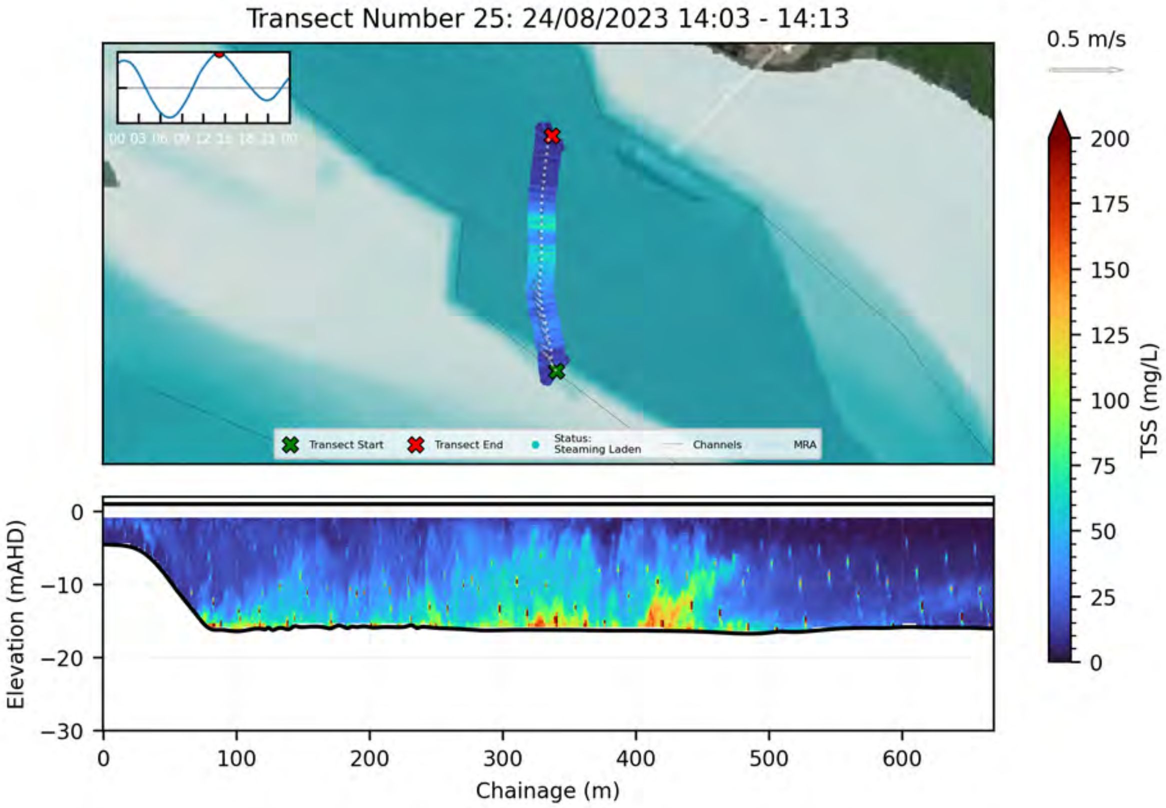

Transect Number 20: 24/08/2023 13:08 - 13:16
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)
0
−10
−20
−30
0 100 200 300 400 500 600 700 800

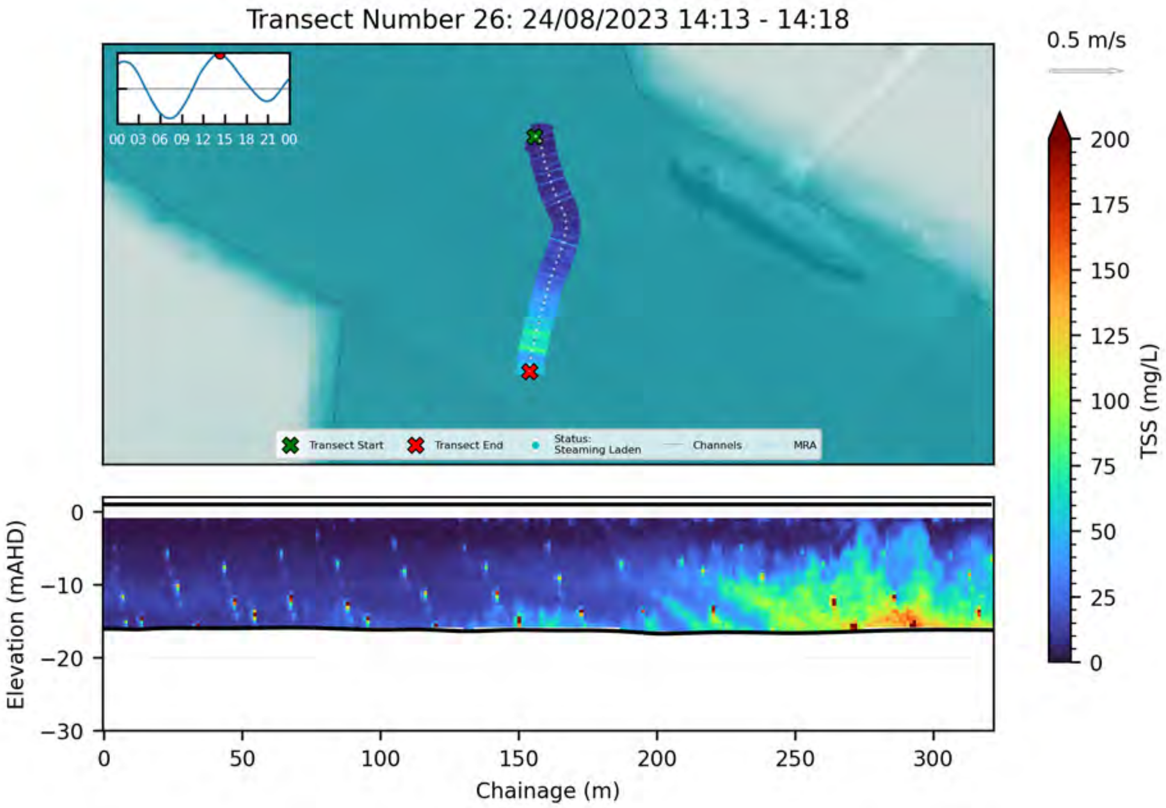

Transect Number 21: 24/08/2023 13:17 - 13:31
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
Elevation (mAHD)
Chainage (m)
TSS (mg/L)

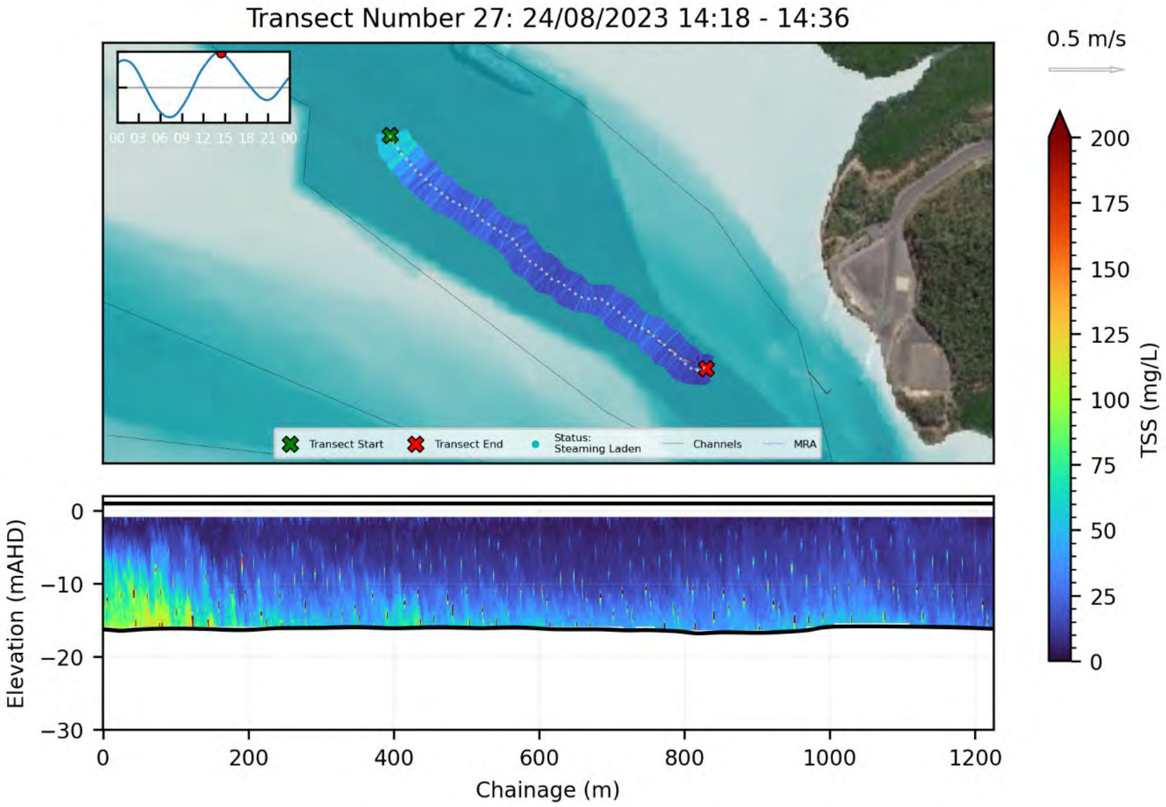

Transect Number 22: 24/08/2023 13:32 - 13:46
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
YSI
Elevation (mAHD)
Chainage (m)
TSS (mg/L)

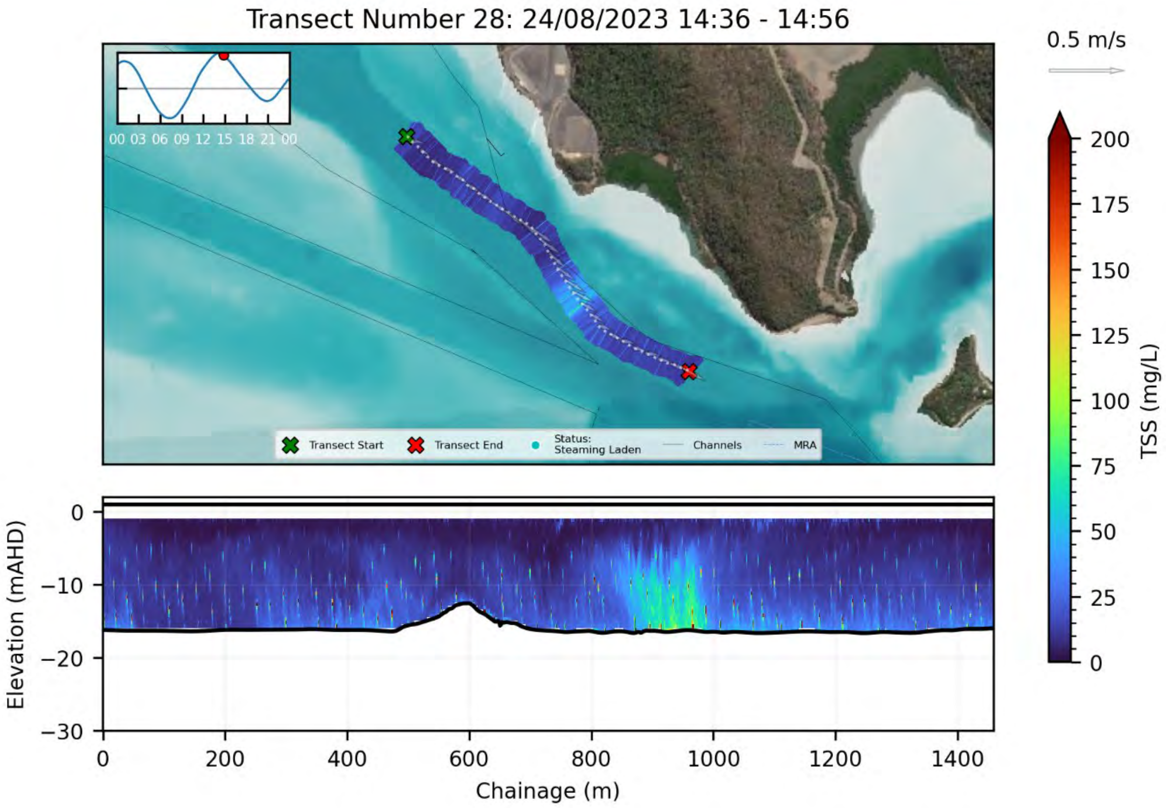

Transect Number 23: 24/08/2023 13:46 - 13:54
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
Elevation (mAHD)
0
−10
−20
−30
0
100
200
300
400
500
Chainage (m)
TSS (mg/L)
200
175
150
125
100
75
50
25
0

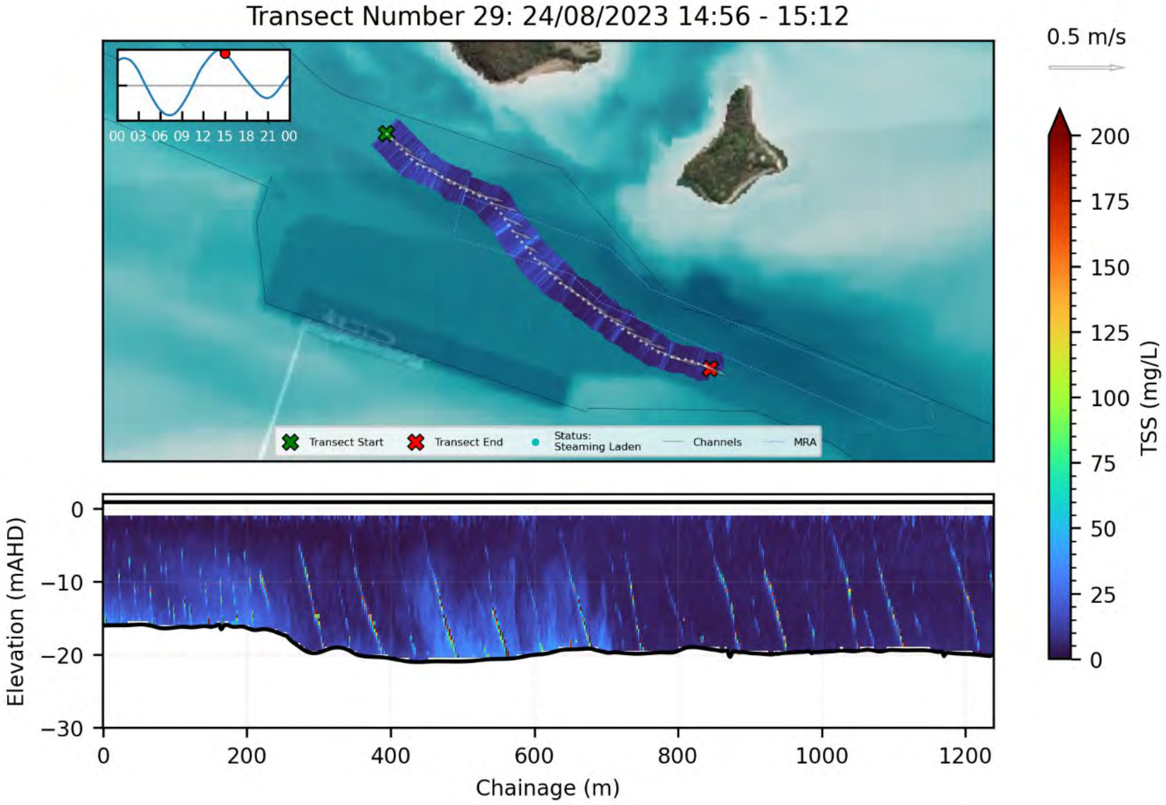

Transect Number 24: 24/08/2023 13:54 - 14:03
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
Elevation (mAHD)
0
−10
−20
−30
0
100
200
300
400
500
600
700
Chainage (m)
TSS (mg/L)
200
175
150
125
100
75
50
25
0

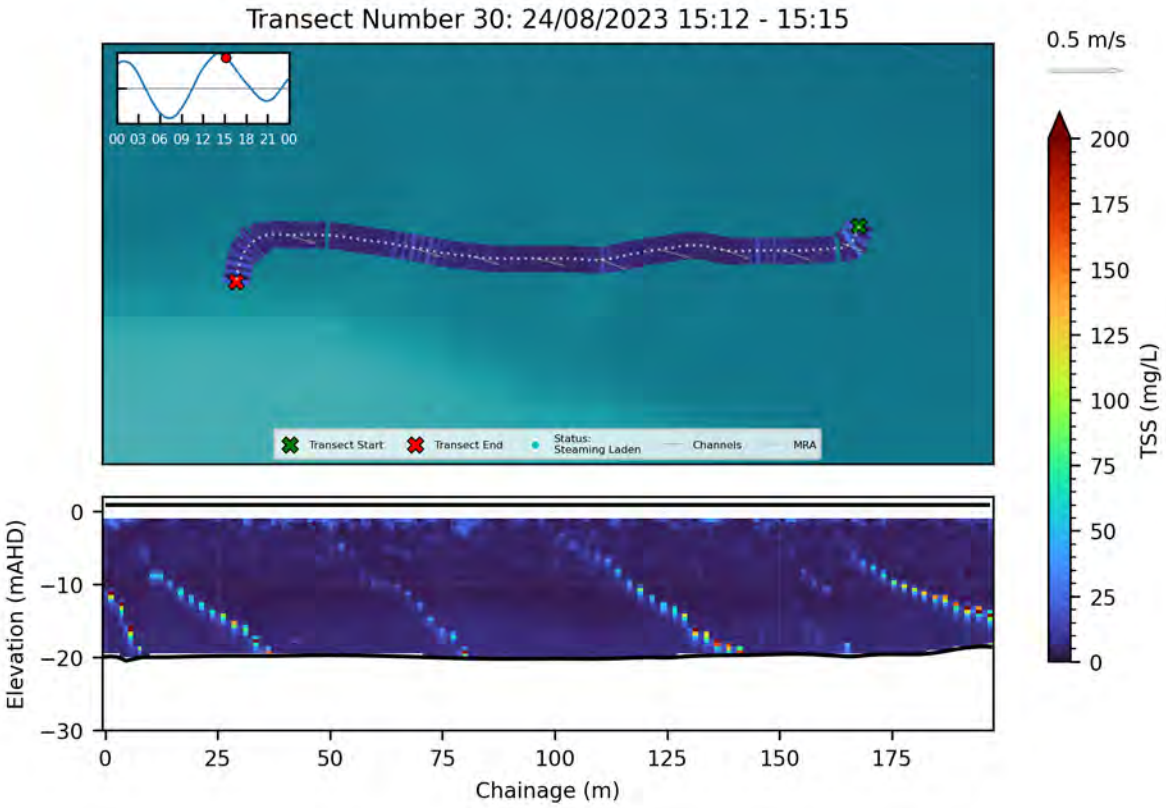

Transect Number 25: 24/08/2023 14:03 - 14:13
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
Chainage (m)
0
100
200
300
400
500
600


Transect Number 26: 24/08/2023 14:13 - 14:18
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
Chainage (m)
0
50
100
150
200
250
300

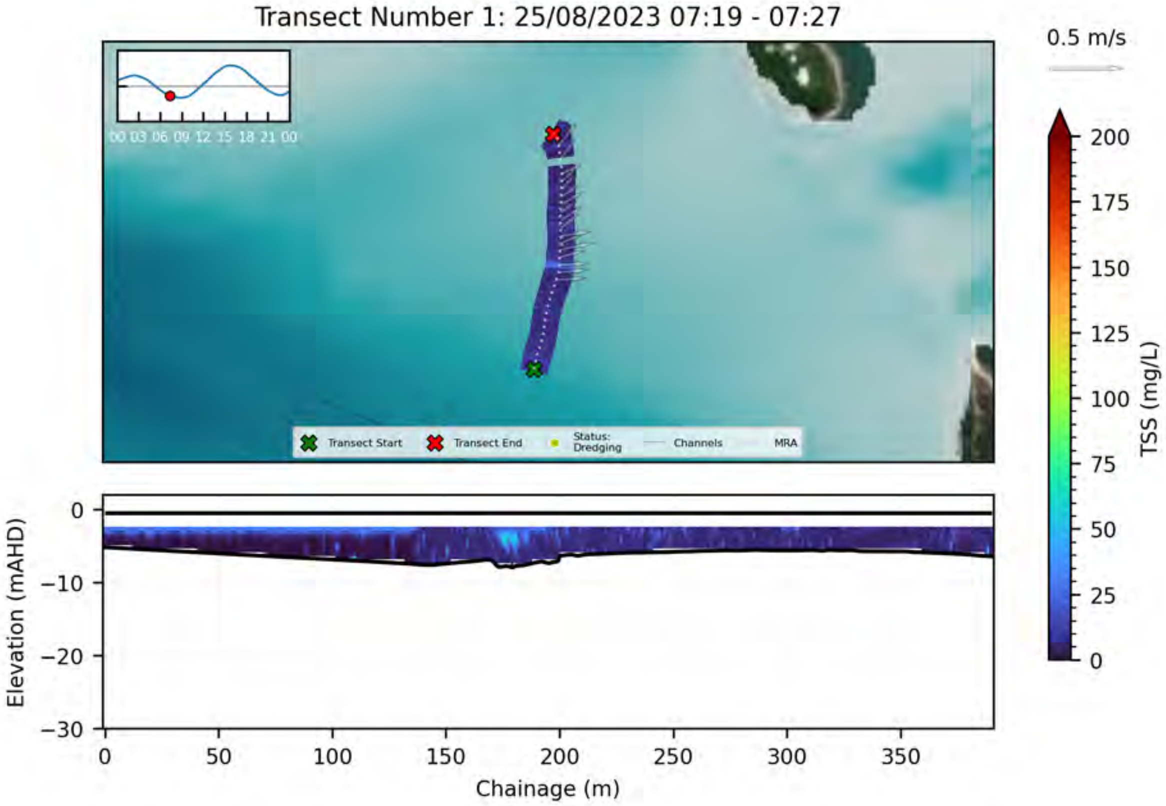

Transect Number 27: 24/08/2023 14:18 - 14:36
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

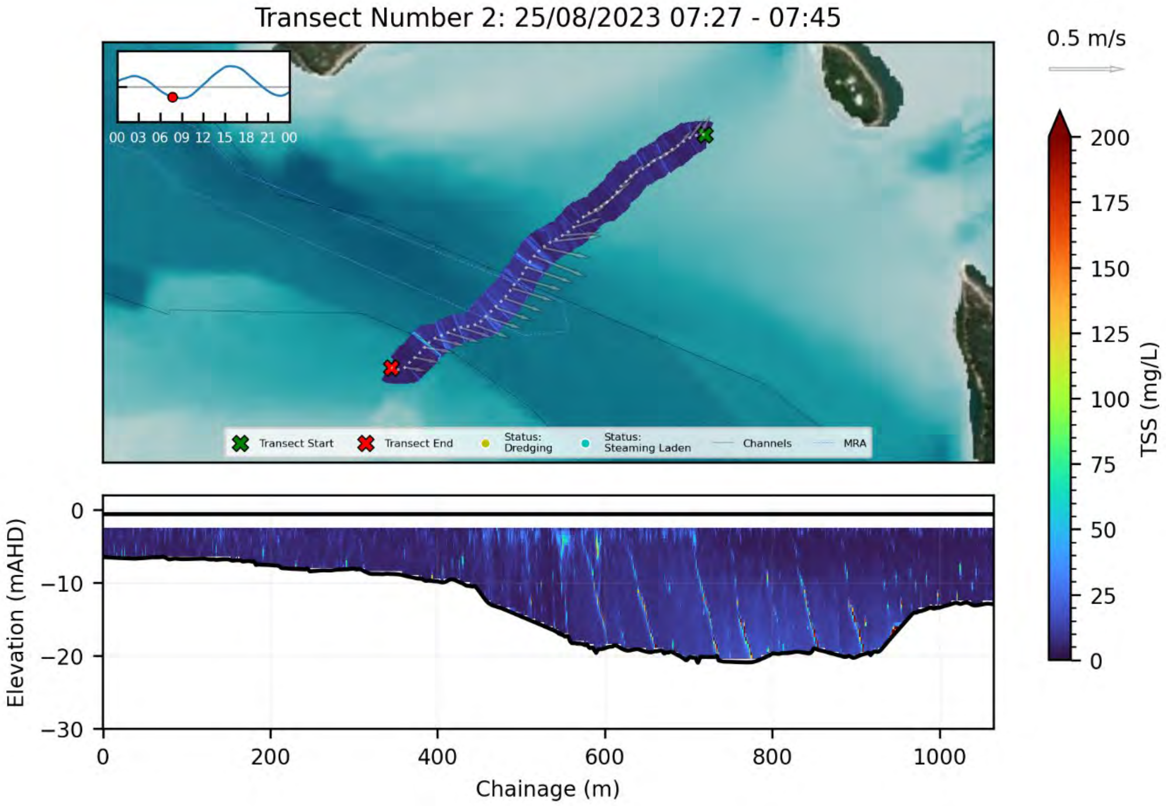

Transect Number 28: 24/08/2023 14:36 - 14:56
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

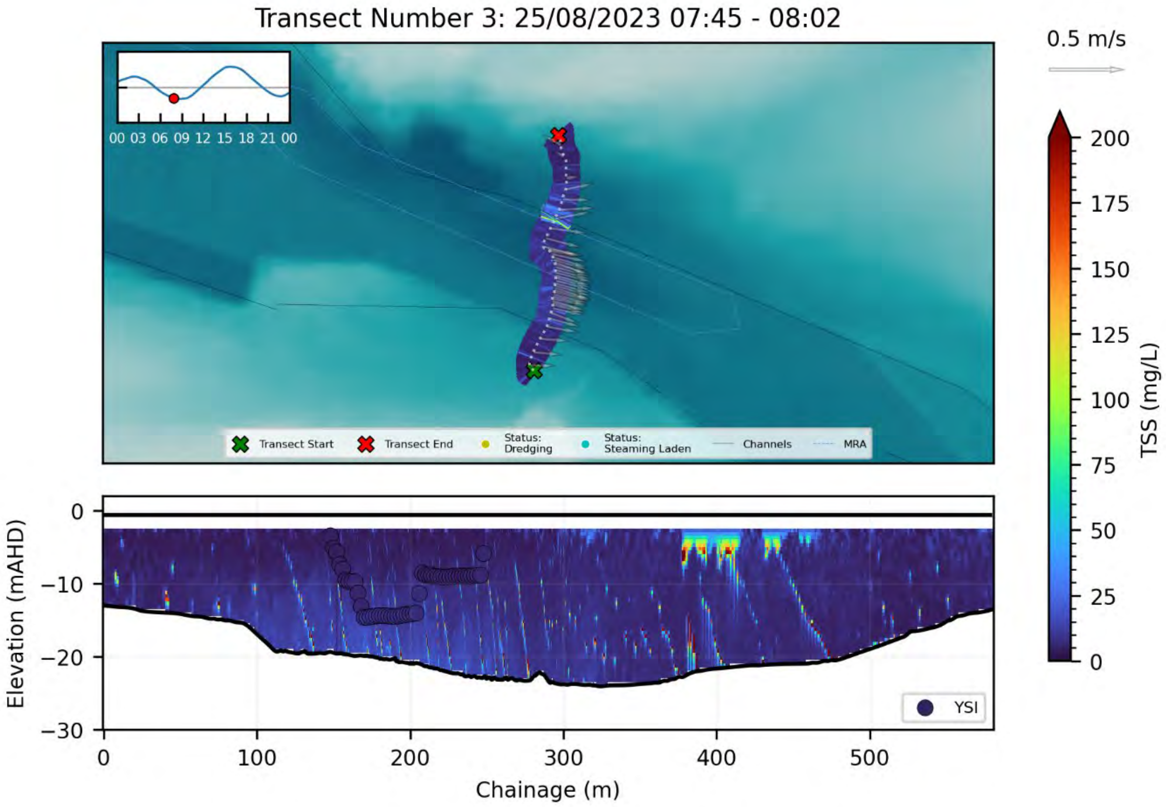

Transect Number 29: 24/08/2023 14:56 - 15:12
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
0
200
400
600
800
1000
1200
Chainage (m)

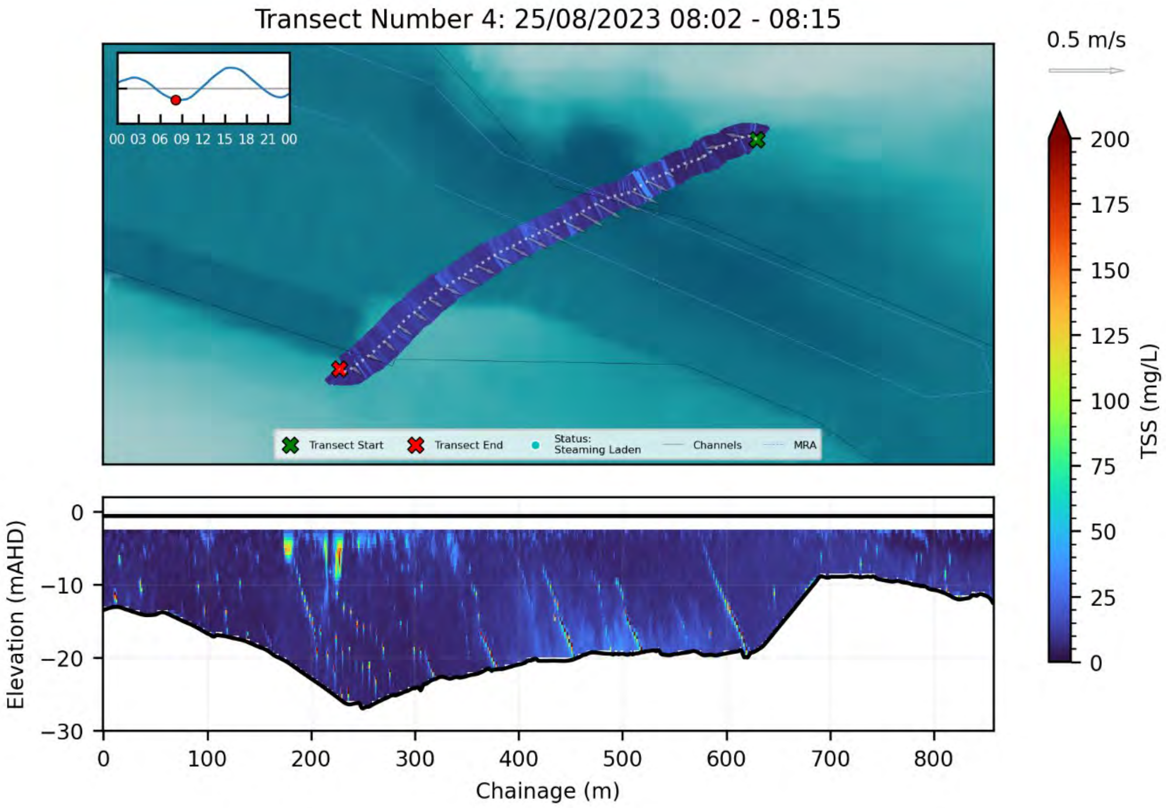

Transect Number 30: 24/08/2023 15:12 - 15:15
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
0
25
50
75
100
125
150
175
Chainage (m)

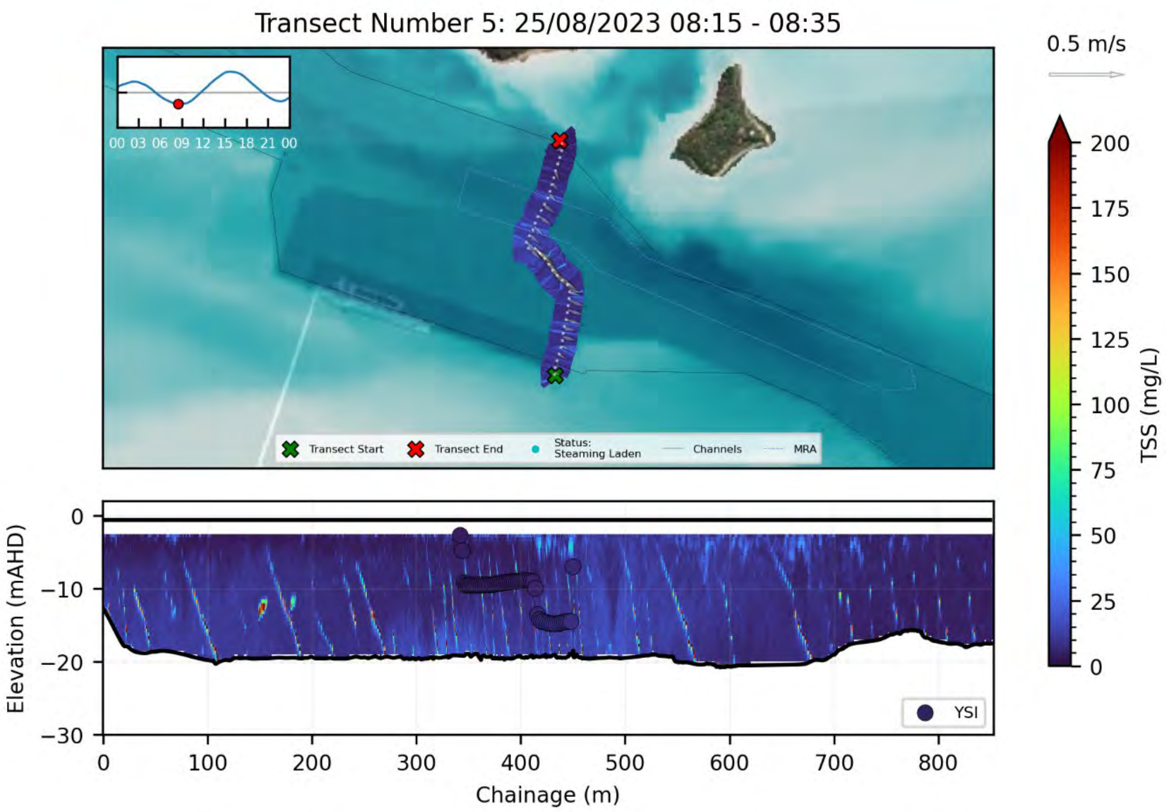
Annex L ADCP Derived TSS Transects 25th August 2023

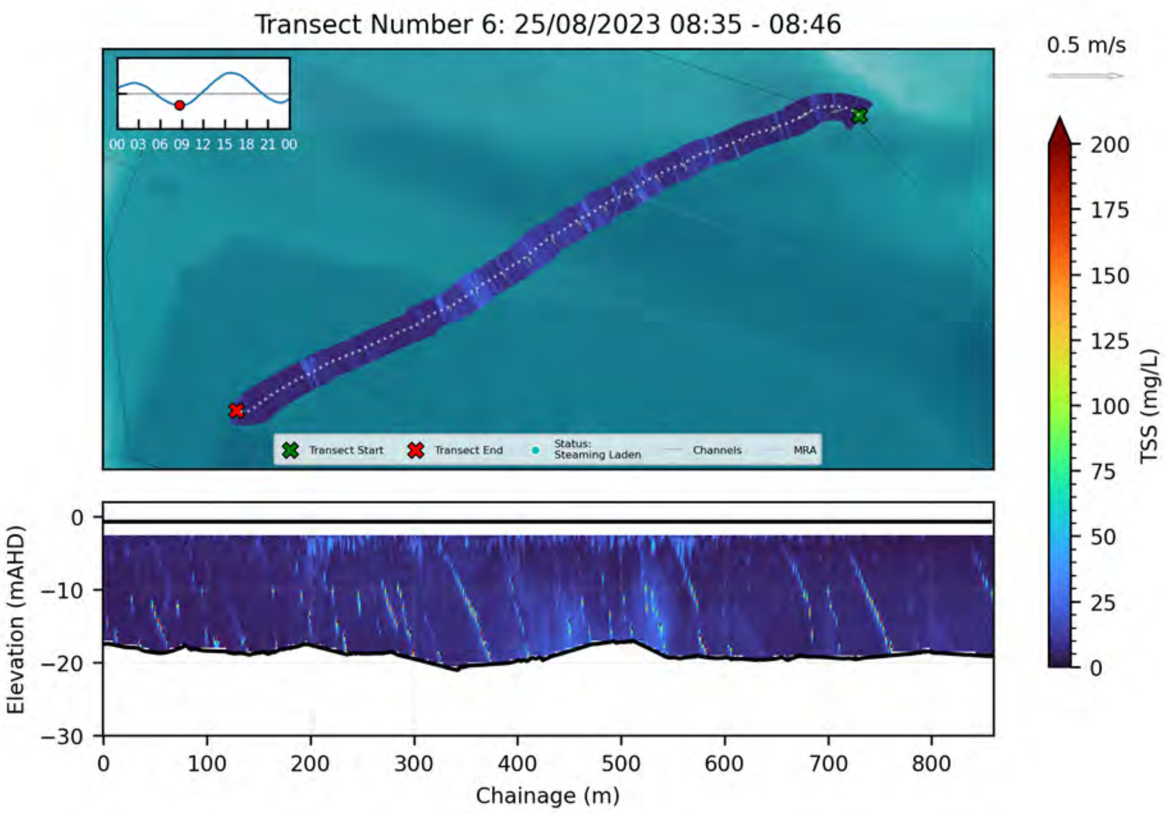


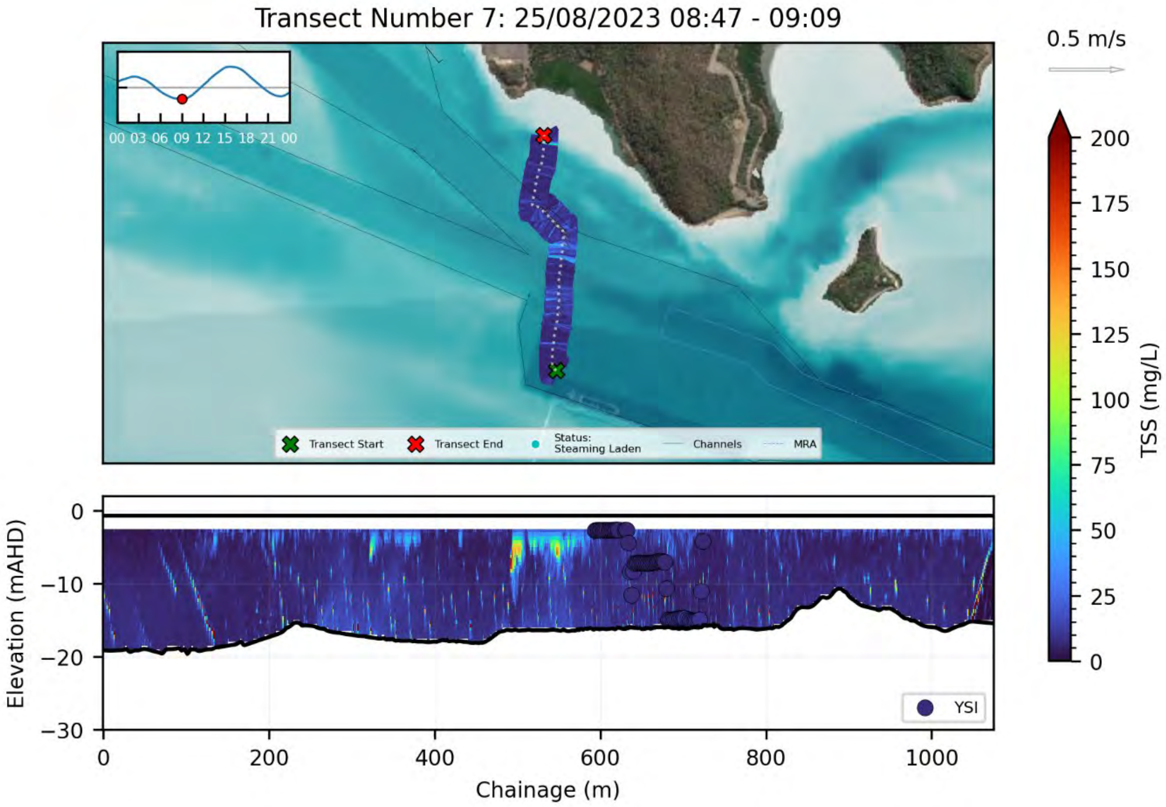


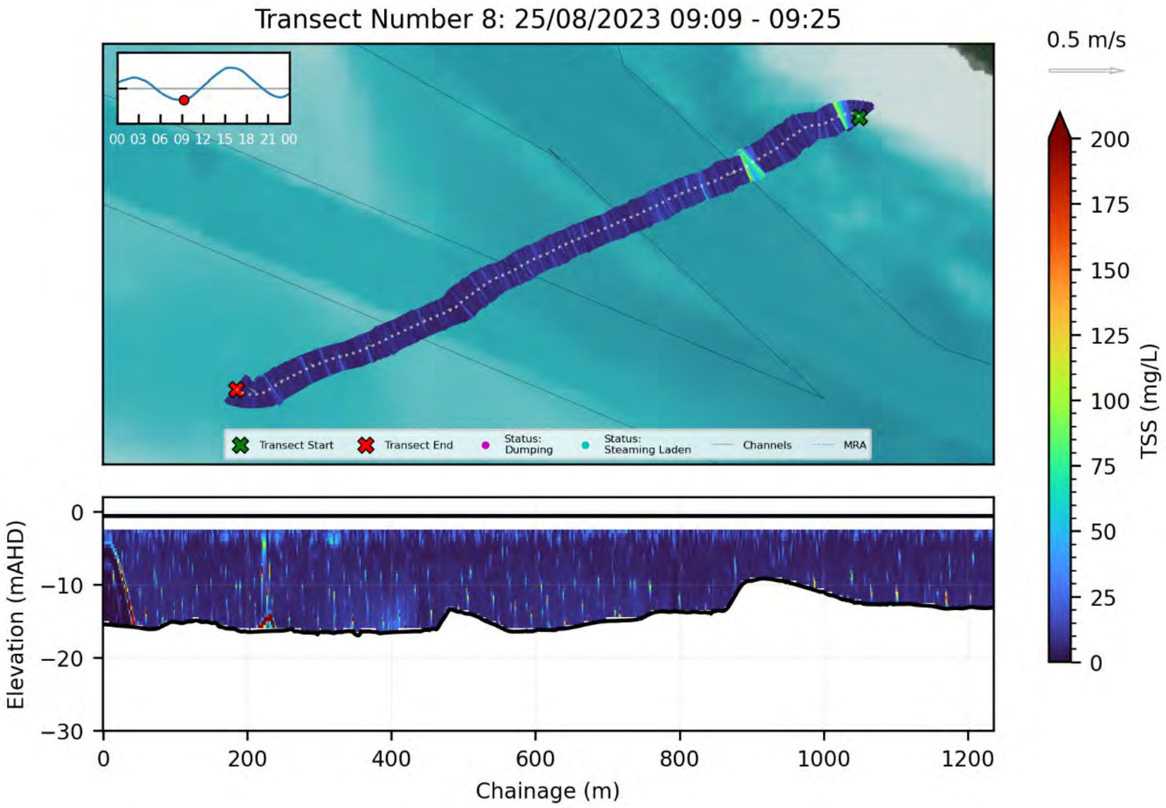

Transect Number 3: 25/08/2023 07:45 - 08:02
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
Elevation (mAHD)
YSI
Chainage (m)
TSS (mg/L)

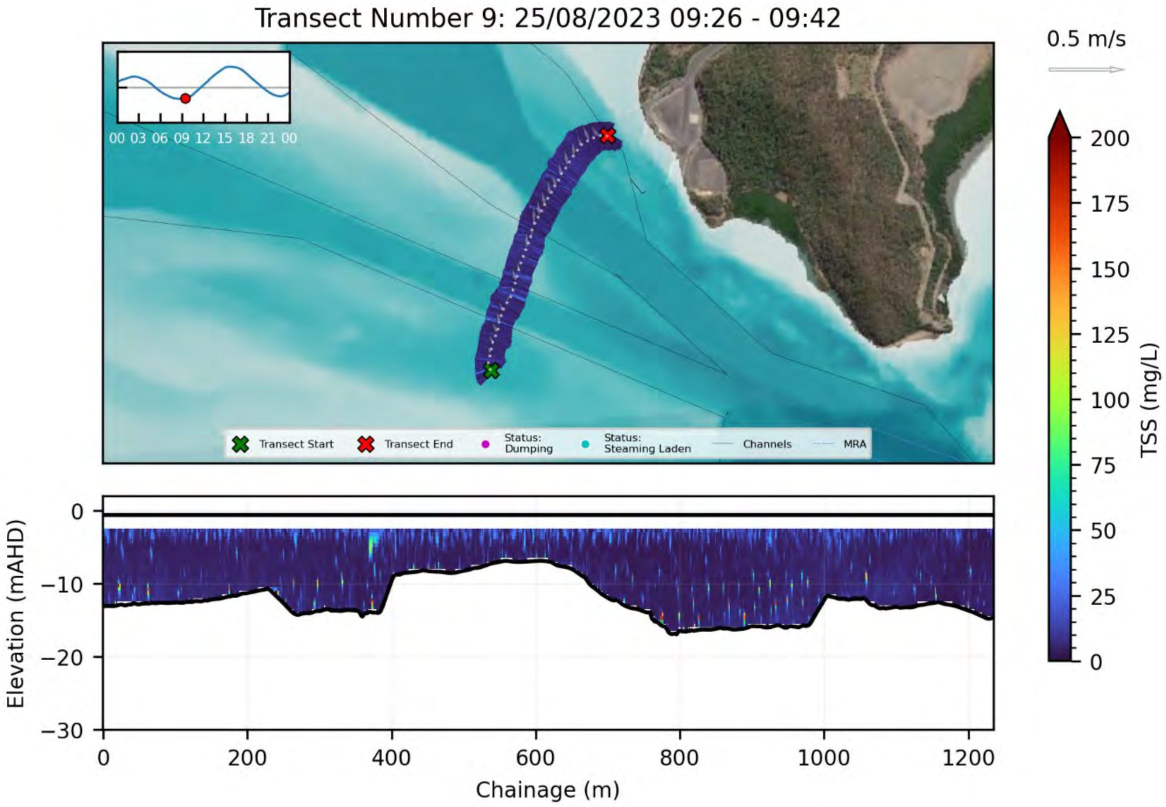

Transect Number 4: 25/08/2023 08:02 - 08:15
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
Elevation (mAHD)
Chainage (m)
TSS (mg/L)


Transect Number 5: 25/08/2023 08:15 - 08:35
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
Elevation (mAHD)
YSI
Chainage (m)
TSS (mg/L)

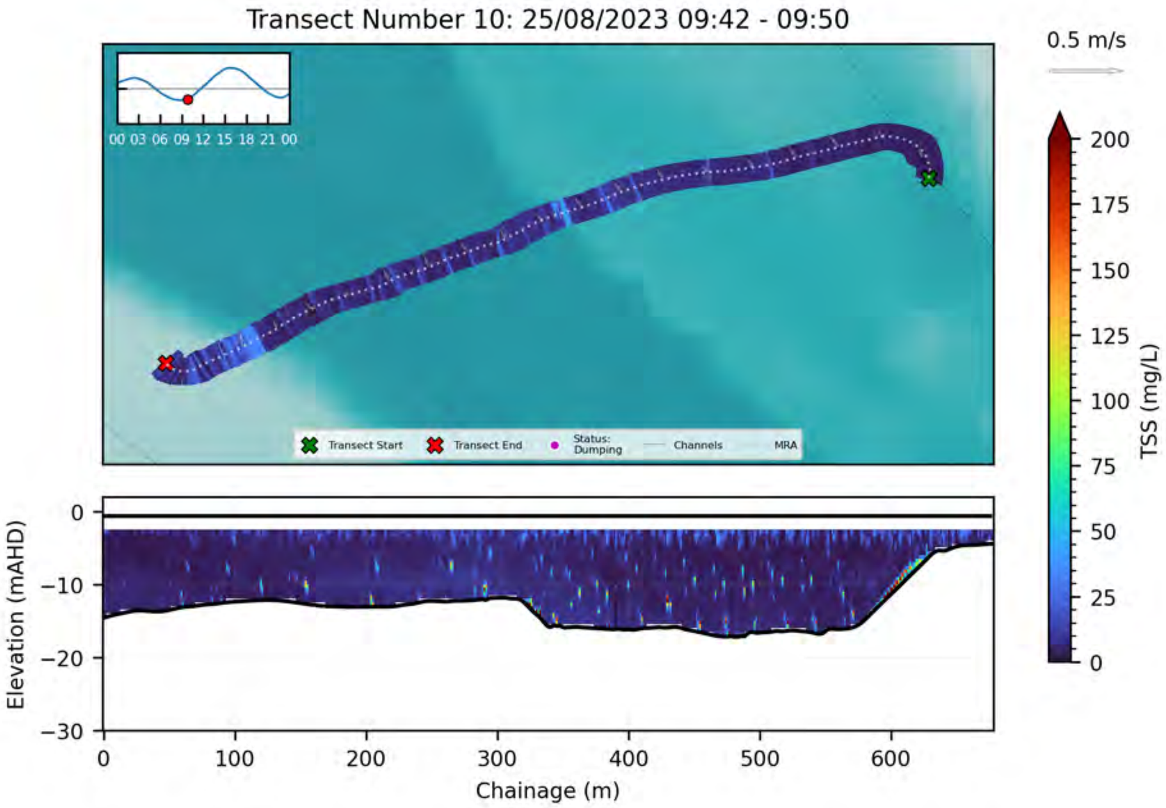

Transect Number 6: 25/08/2023 08:35 - 08:46
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
Elevation (mAHD)
Chainage (m)
TSS (mg/L)


Transect Number 7: 25/08/2023 08:47 - 09:09
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)
YSI

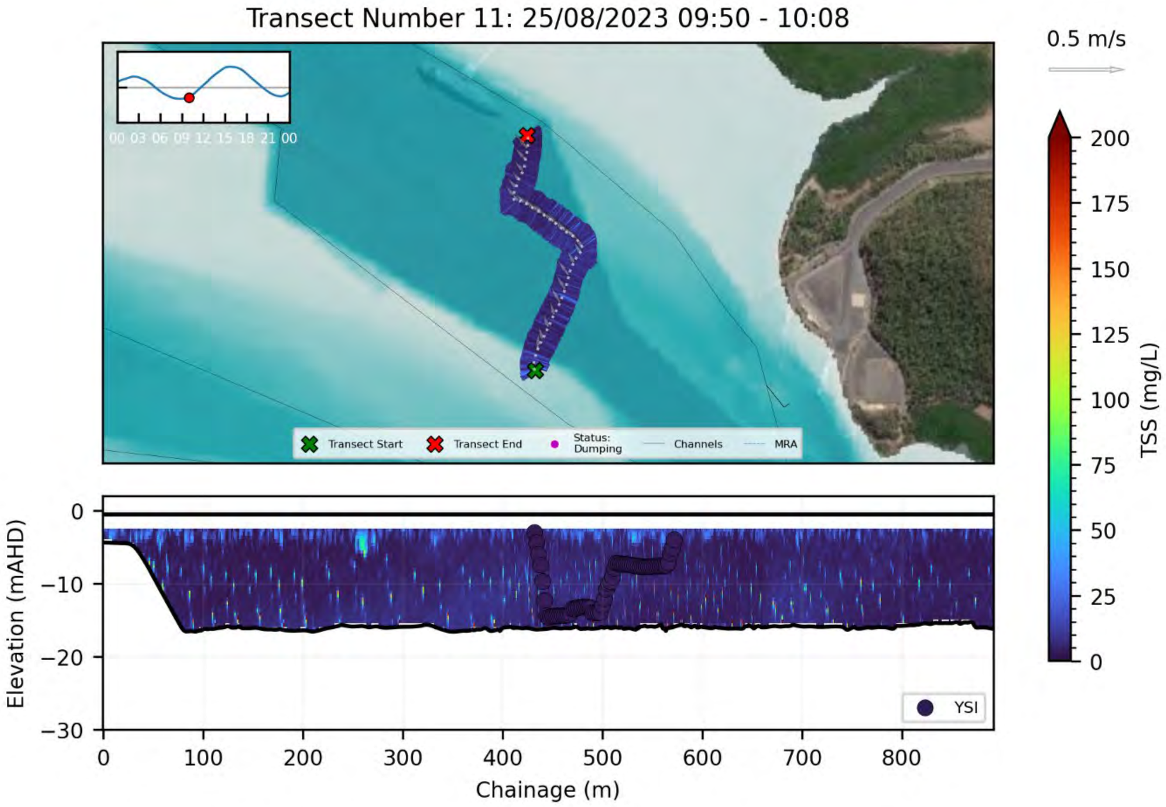

Transect Number 8: 25/08/2023 09:09 - 09:25
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)

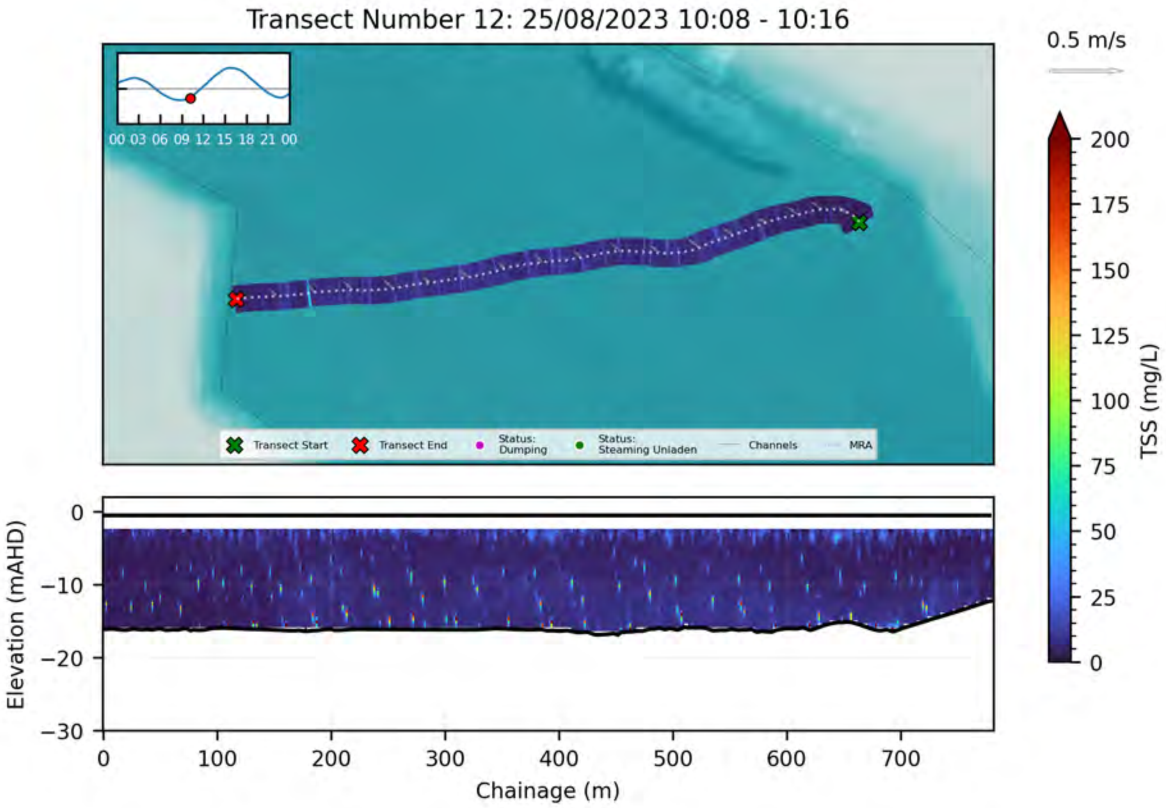


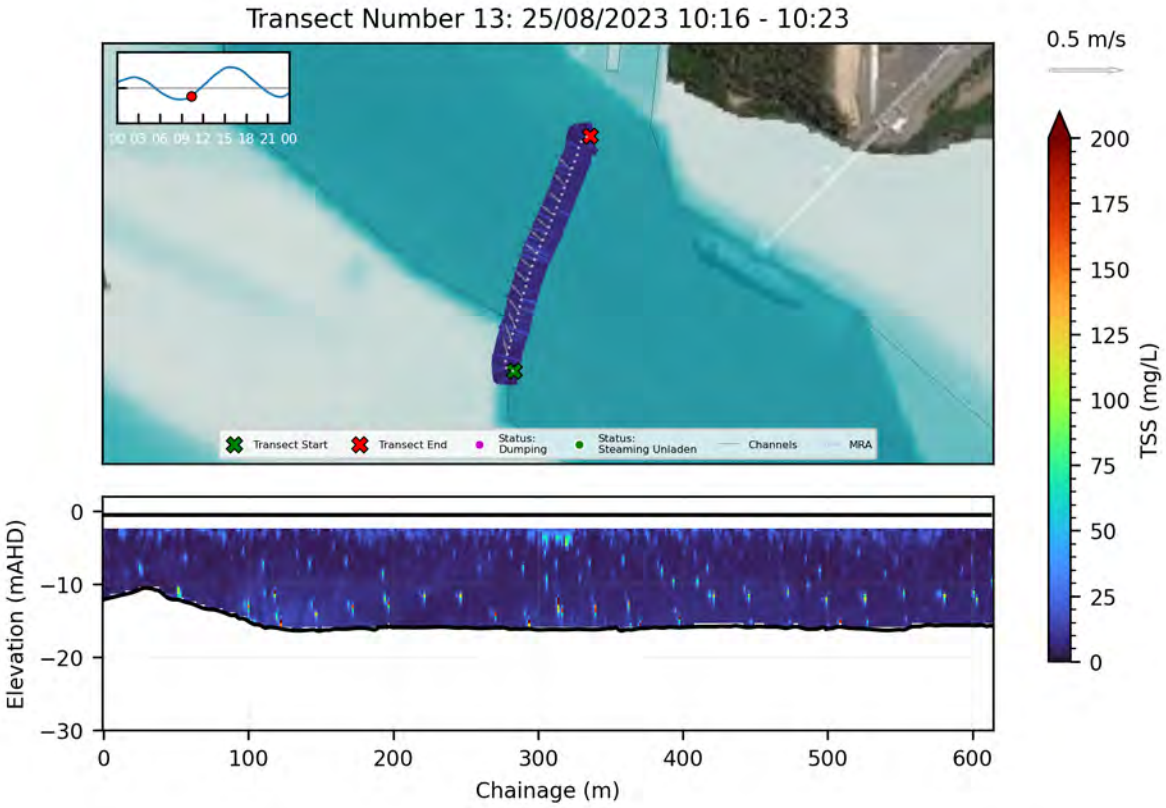
Transect Number 9: 25/08/2023 09:26 - 09:42
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
Chainage (m)
0
200
400
600
800
1000
1200

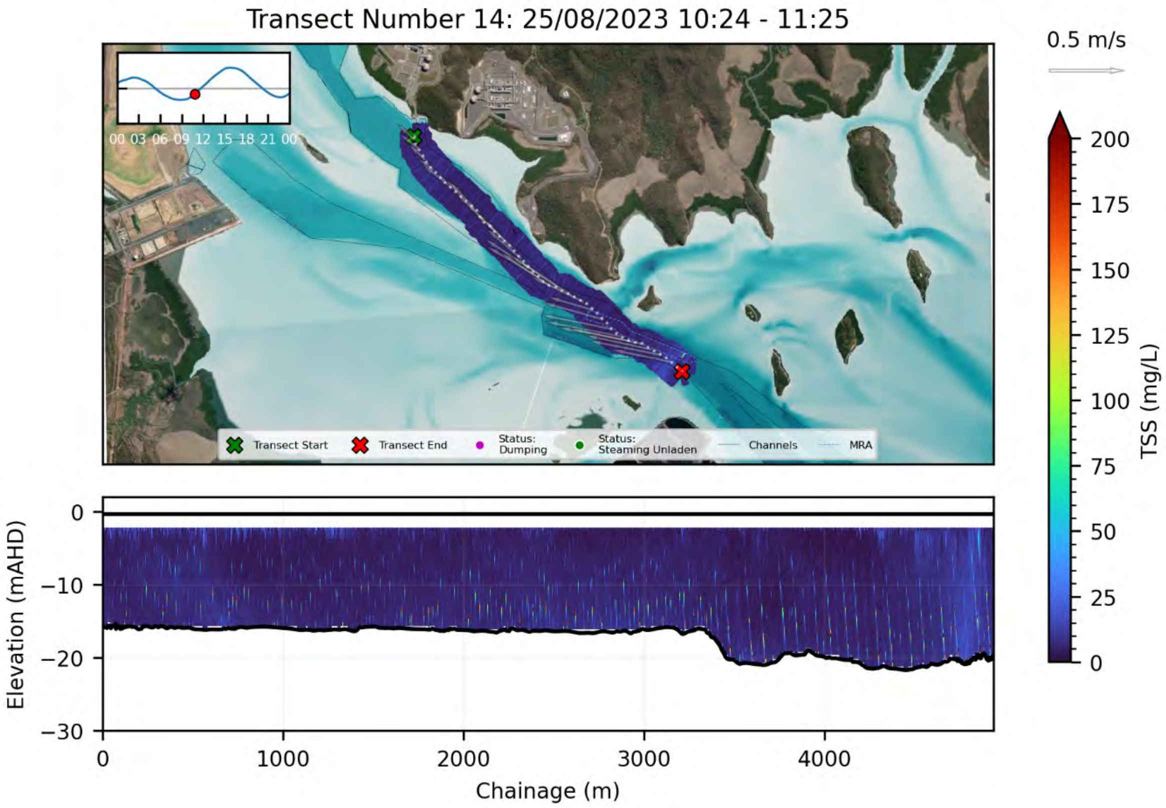


Transect Number 10: 25/08/2023 09:42 - 09:50
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
Chainage (m)
0
100
200
300
400
500
600

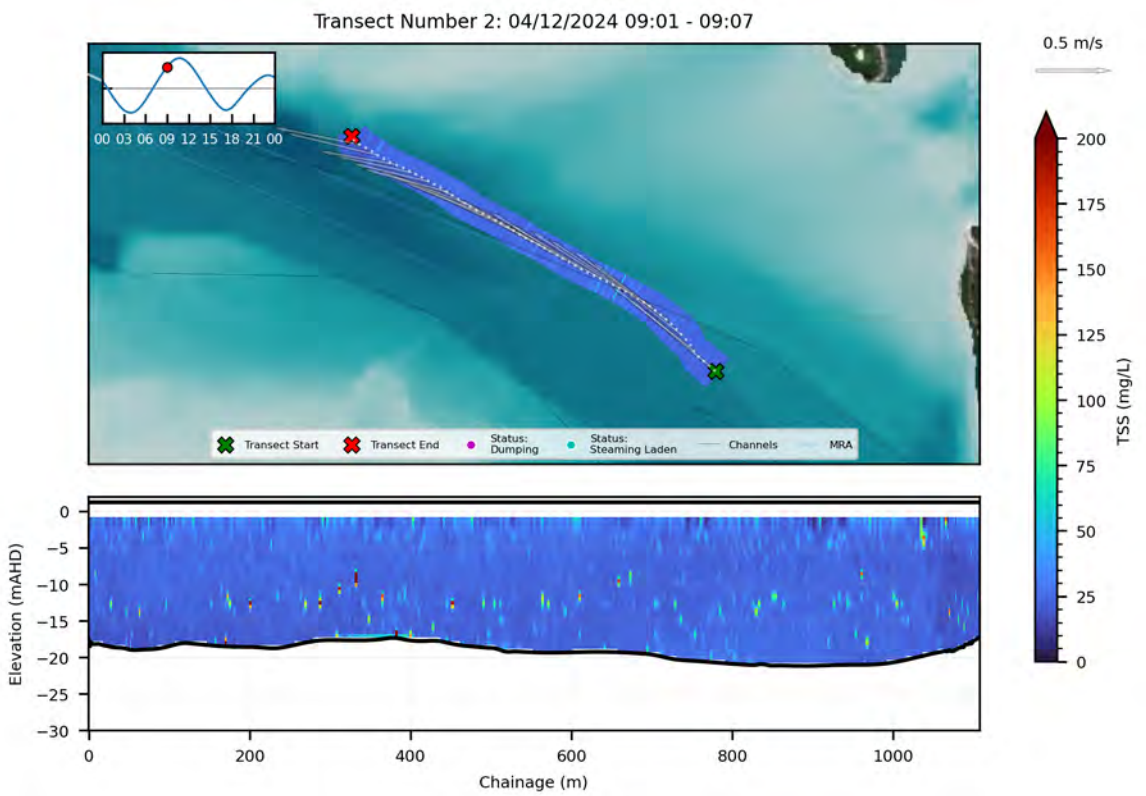

Transect Number 11: 25/08/2023 09:50 - 10:08
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
YSI
0
100
200
300
400
500
600
700
800
Chainage (m)

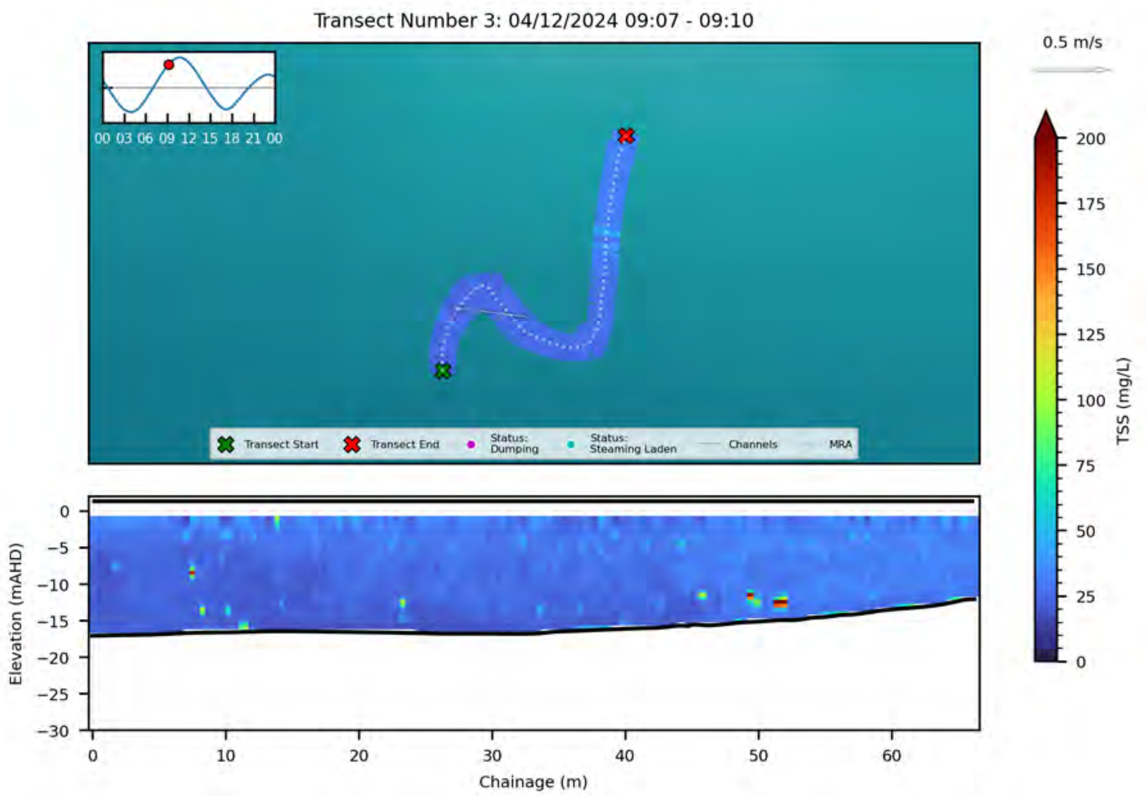

Transect Number 12: 25/08/2023 10:08 - 10:16
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−10
−20
−30
0
100
200
300
400
500
600
700
Chainage (m)

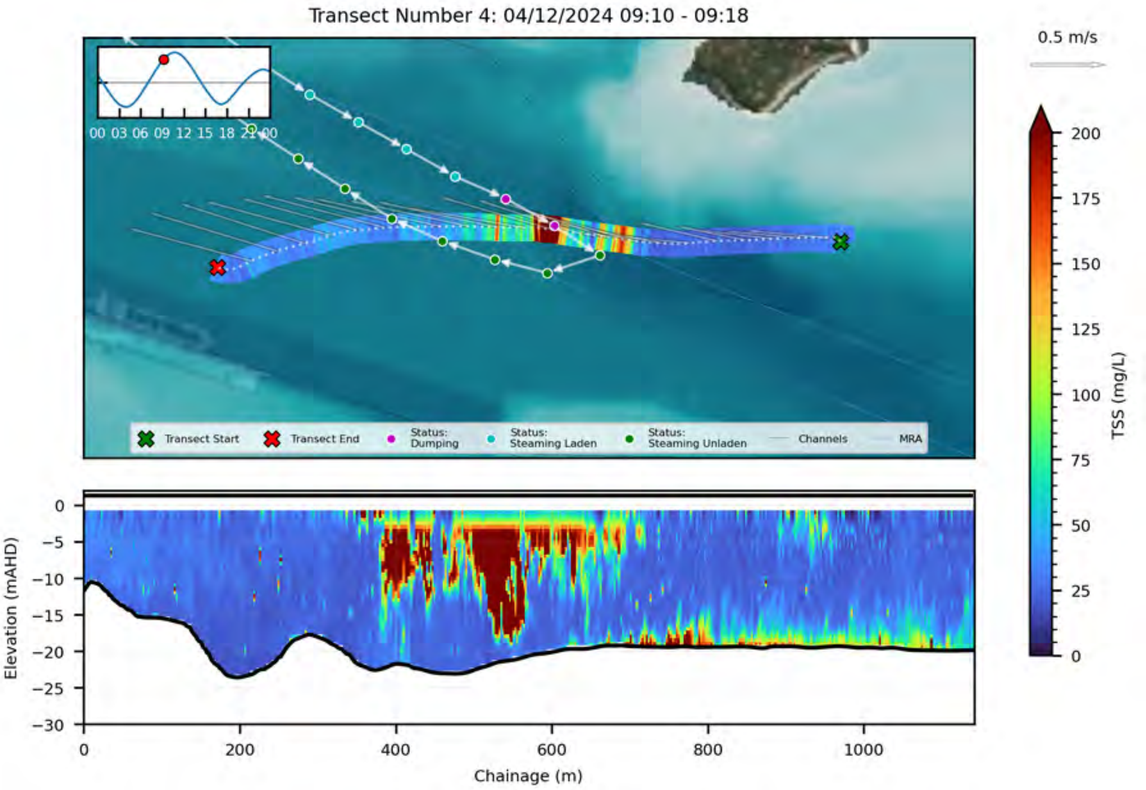

Transect Number 13: 25/08/2023 10:16 - 10:23
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
200
175
150
125
100
75
50
25
0
Elevation (mAHD)
Chainage (m)

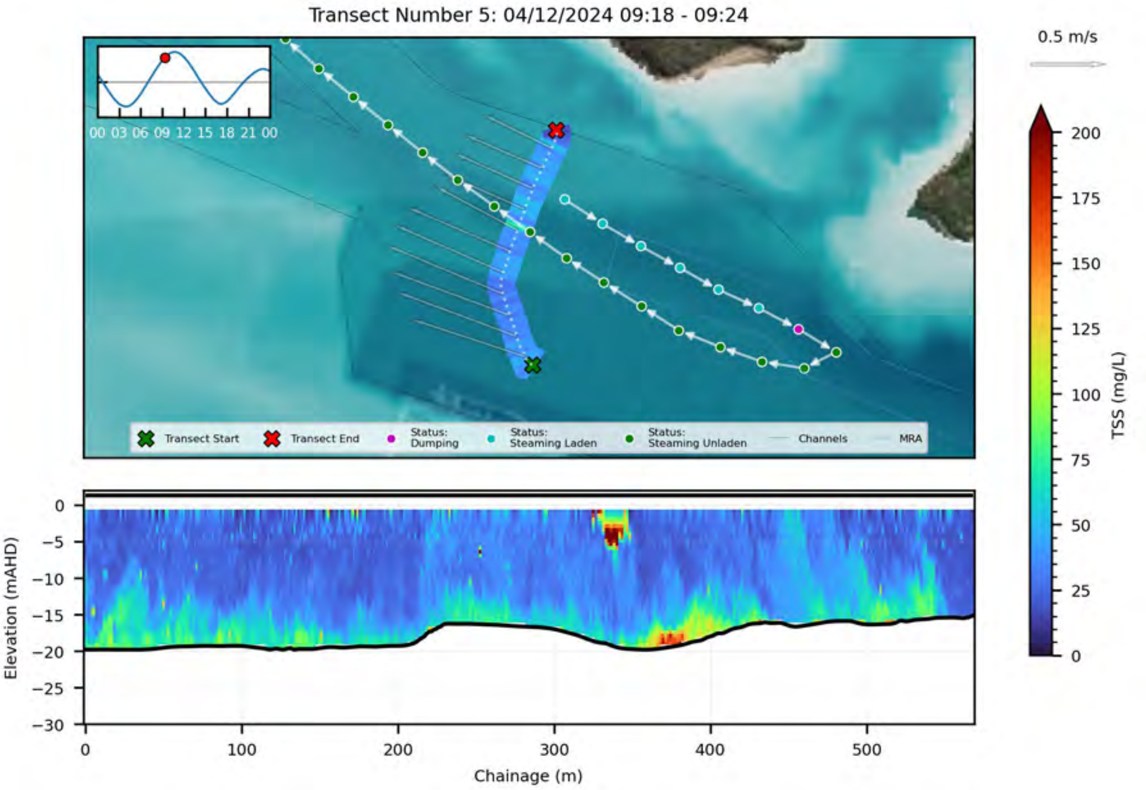

Transect Number 14: 25/08/2023 10:24 - 11:25
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
200
175
150
125
100
75
50
25
0
Elevation (mAHD)
Chainage (m)

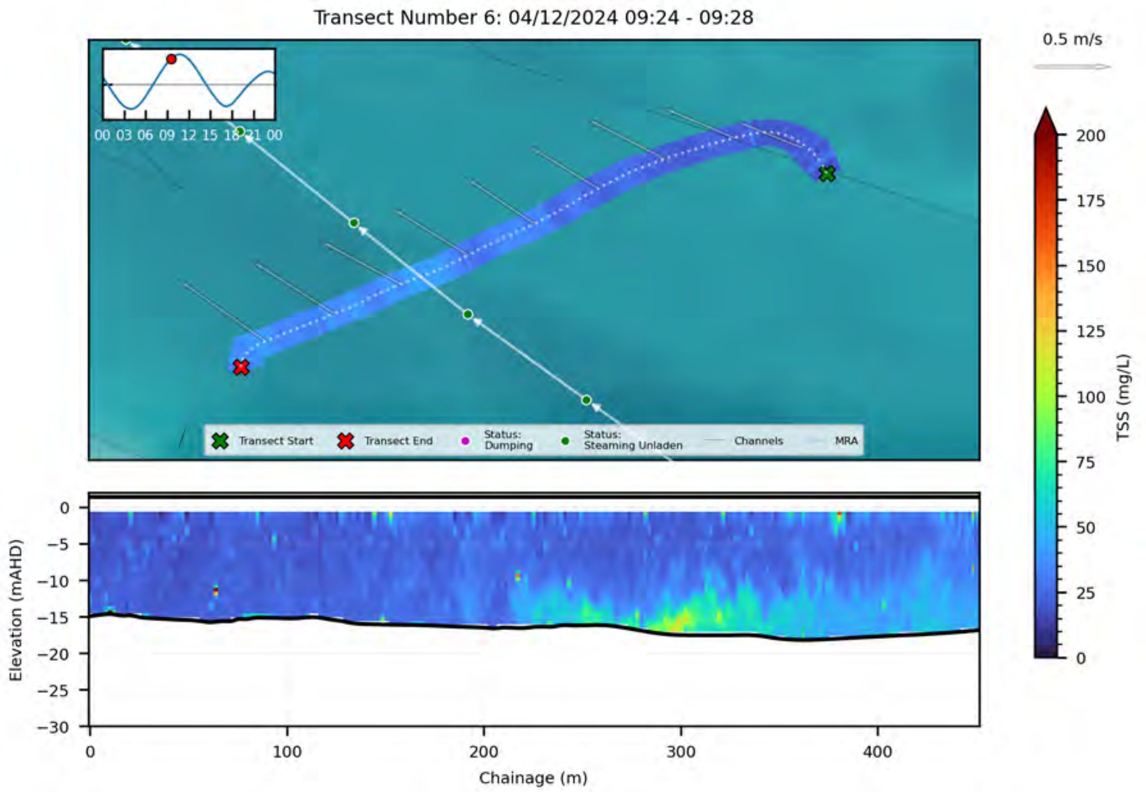
Annex M ADCP Derived TSS Transects 4th December 2024

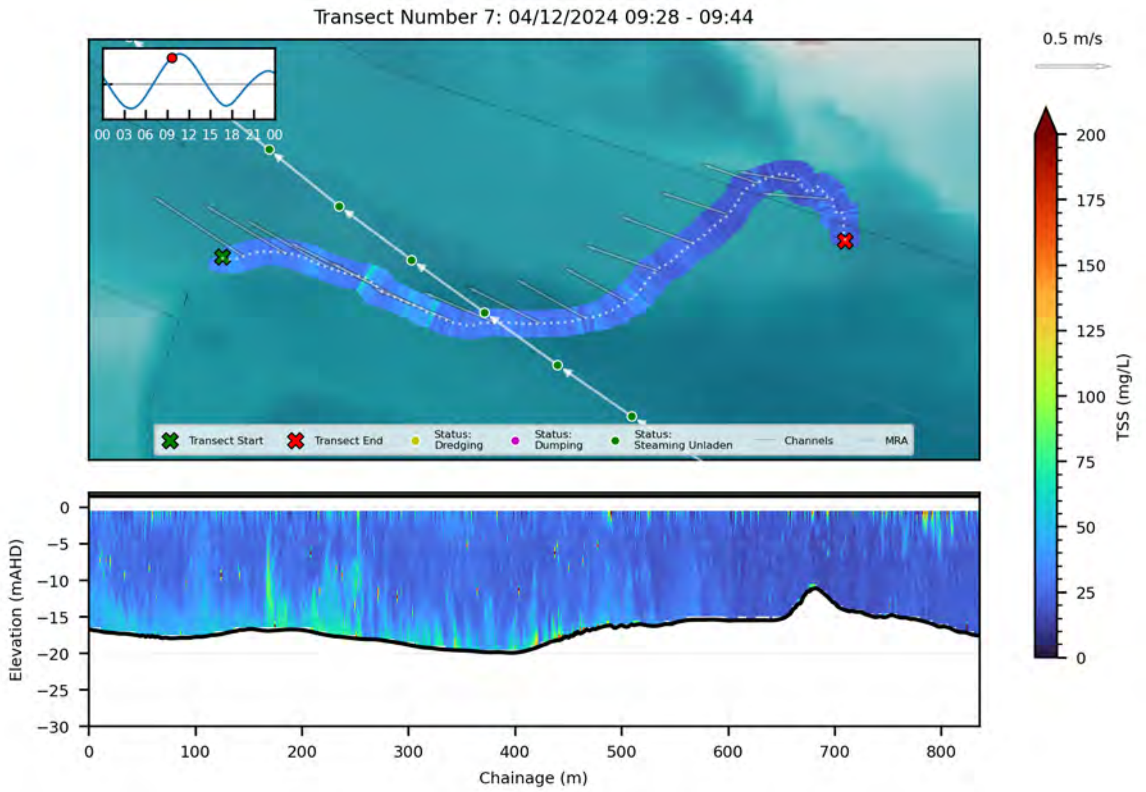


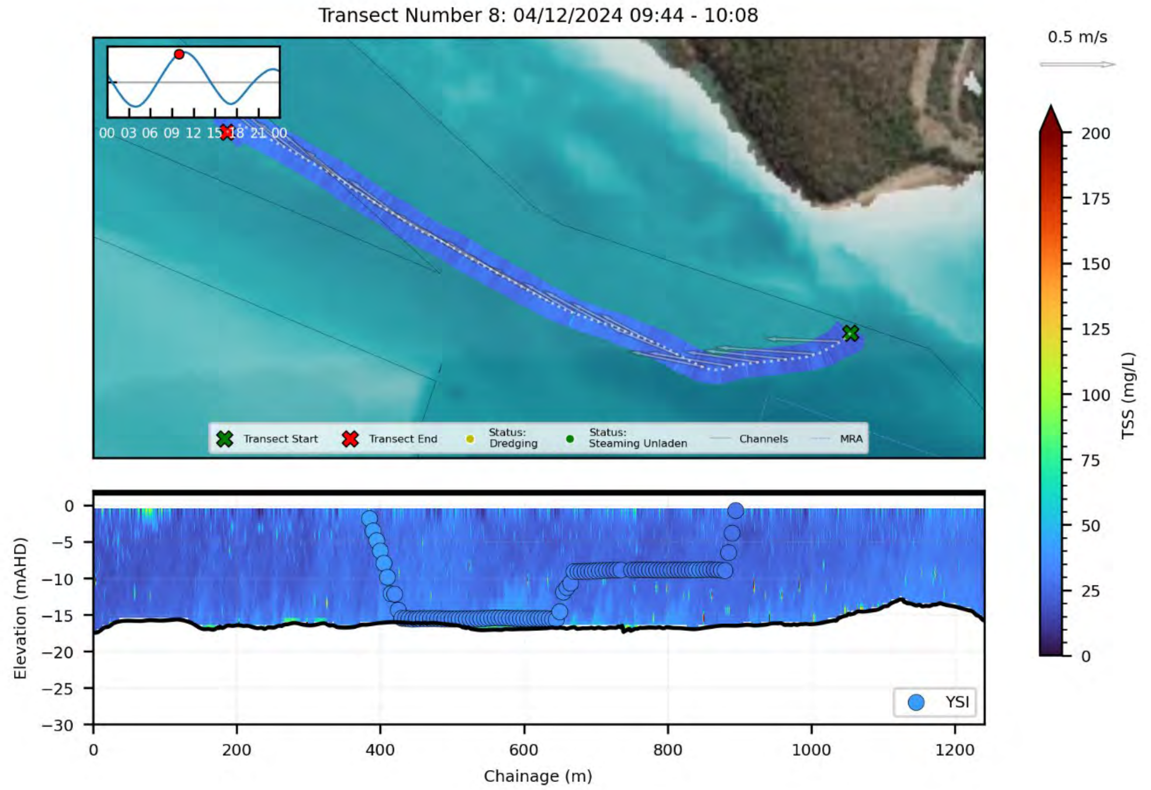


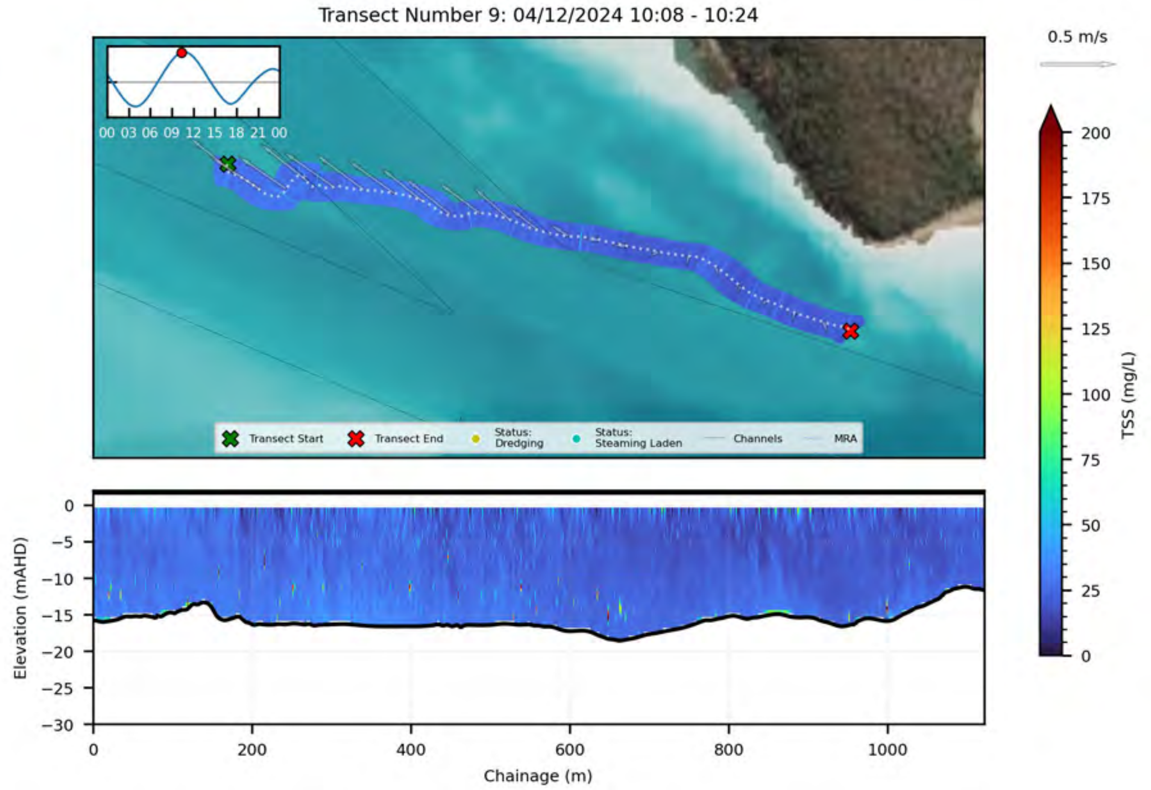

Transect Number 4: 04/12/2024 09:10 - 09:18
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Laden
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)
0
−5
−10
−15
−20
−25
−30
0
200
400
600
800
1000

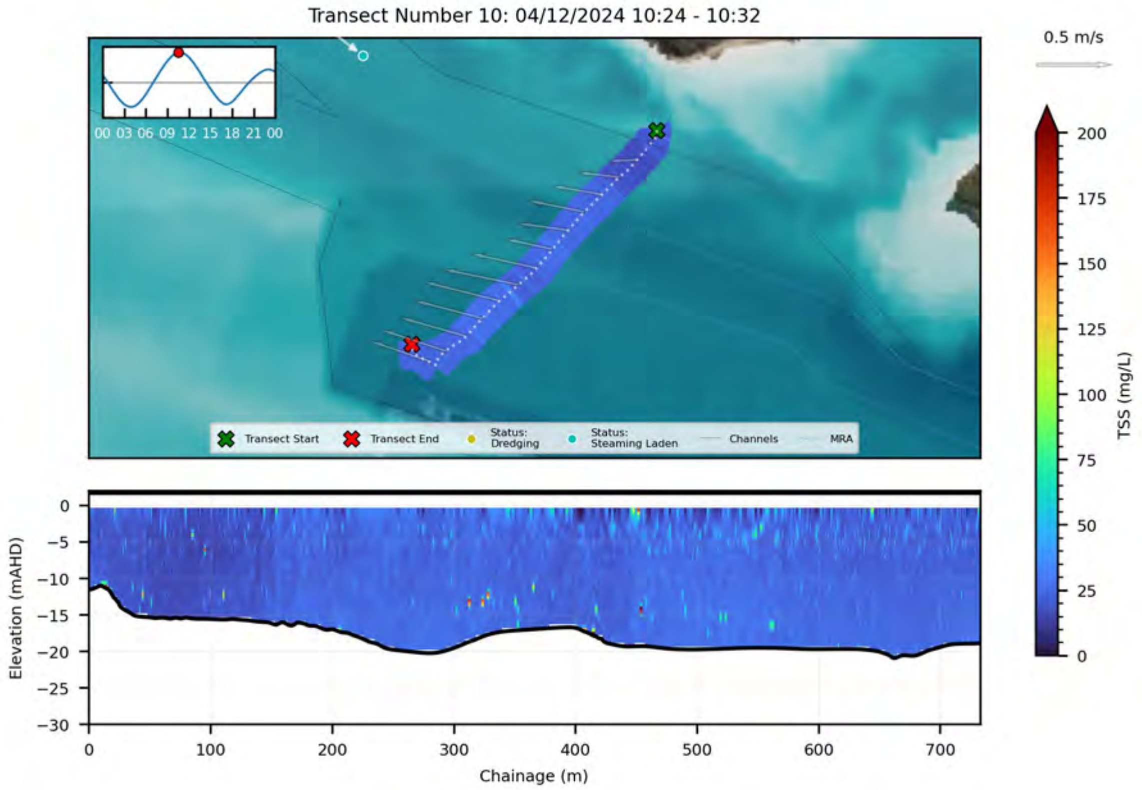

Transect Number 5: 04/12/2024 09:18 - 09:24
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Laden
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)
0
−5
−10
−15
−20
−25
−30
0
100
200
300
400
500

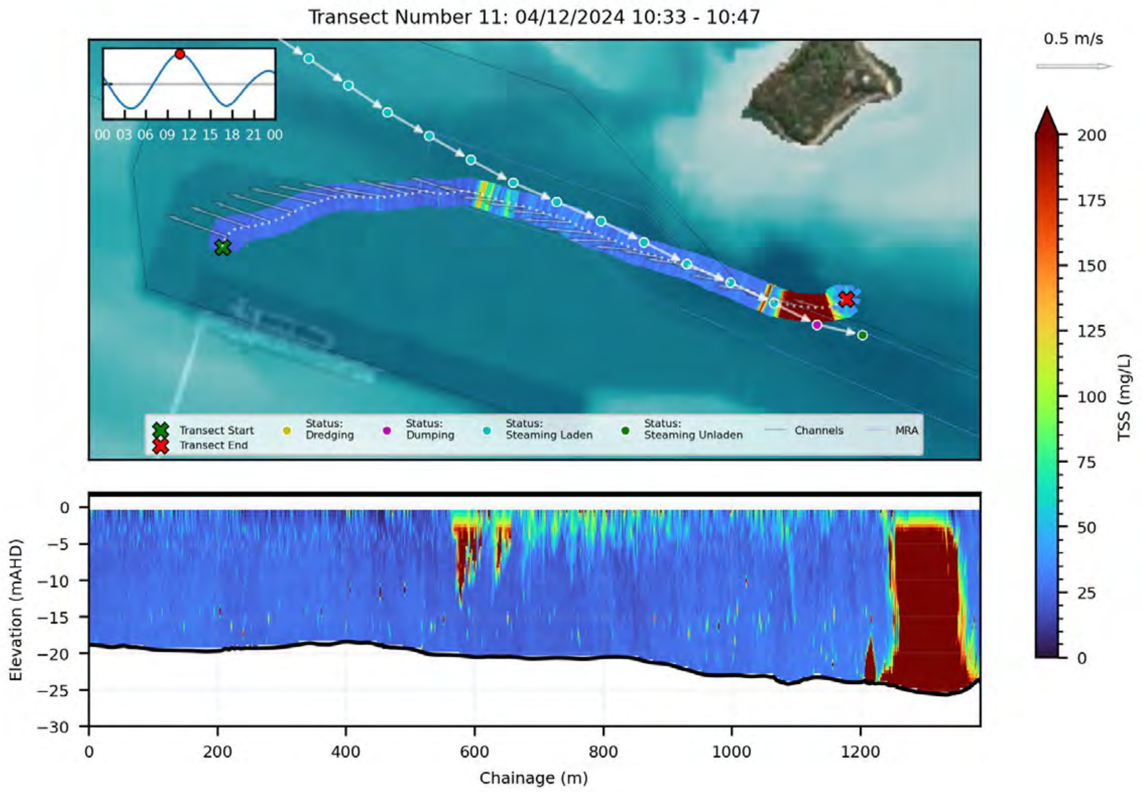

Transect Number 6: 04/12/2024 09:24 - 09:28
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Unladen
Channels
MRA
Elevation (mAHD)
Chainage (m)
TSS (mg/L)


Transect Number 7: 04/12/2024 09:28 - 09:44
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Dumping
Status: Steaming Unladen
Channels
MRA
Elevation (mAHD)
Chainage (m)
TSS (mg/L)

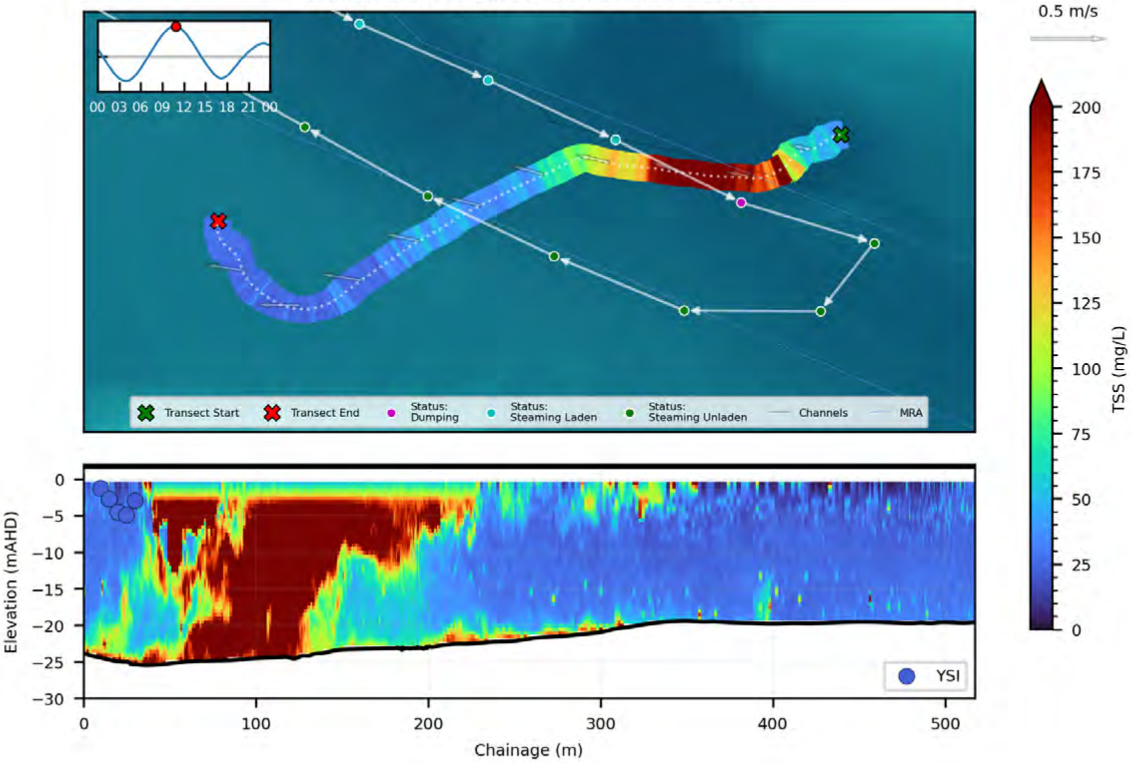

Transect Number 8: 04/12/2024 09:44 - 10:08
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
YSI
Elevation (mAHD)
Chainage (m)


Transect Number 9: 04/12/2024 10:08 - 10:24
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

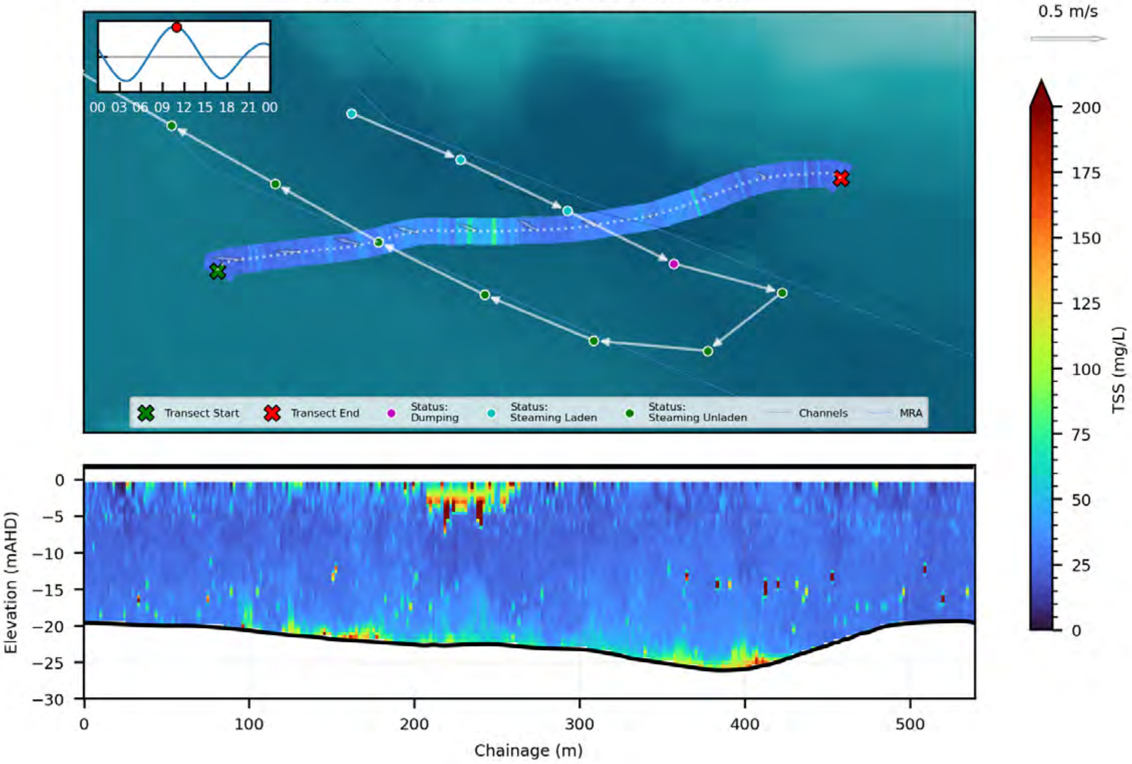

Transect Number 10: 04/12/2024 10:24 - 10:32
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
Elevation (mAHD)
Chainage (m)
TSS (mg/L)

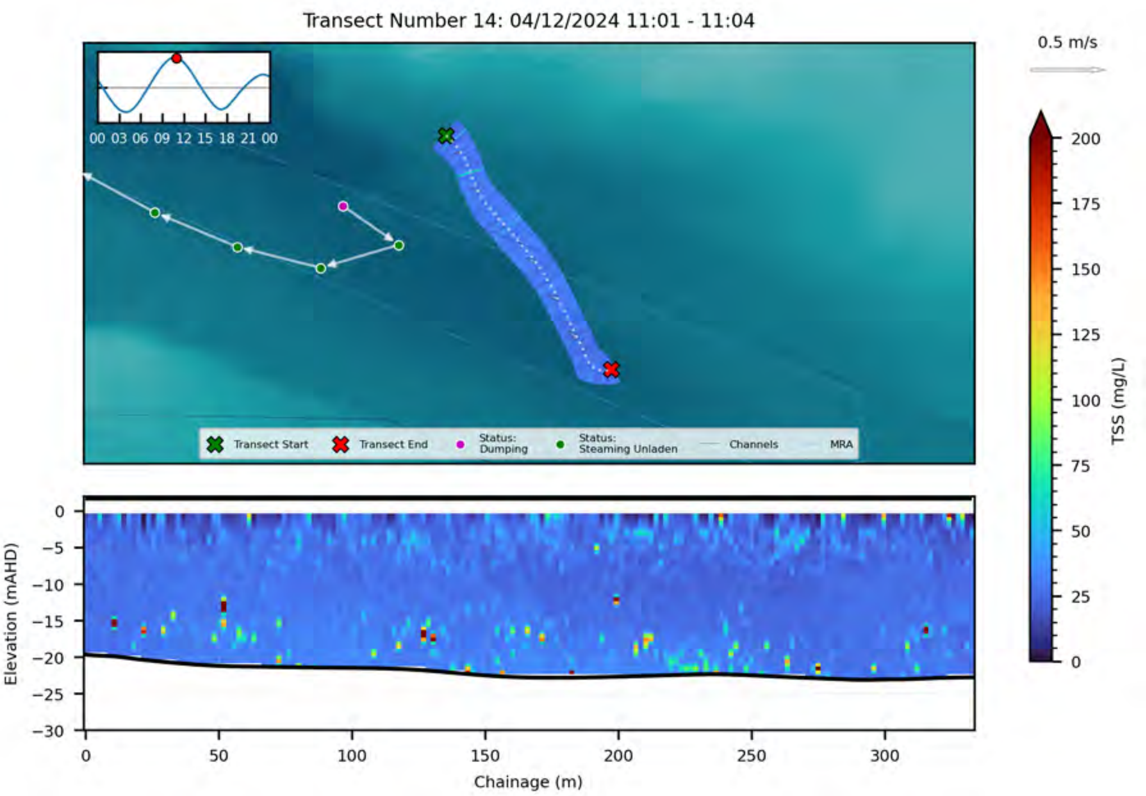

Transect Number 11: 04/12/2024 10:33 - 10:47
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Dumping
Status: Steaming Laden
Status: Steaming Unladen
Channels
MRA
Elevation (mAHD)
Chainage (m)
TSS (mg/L)

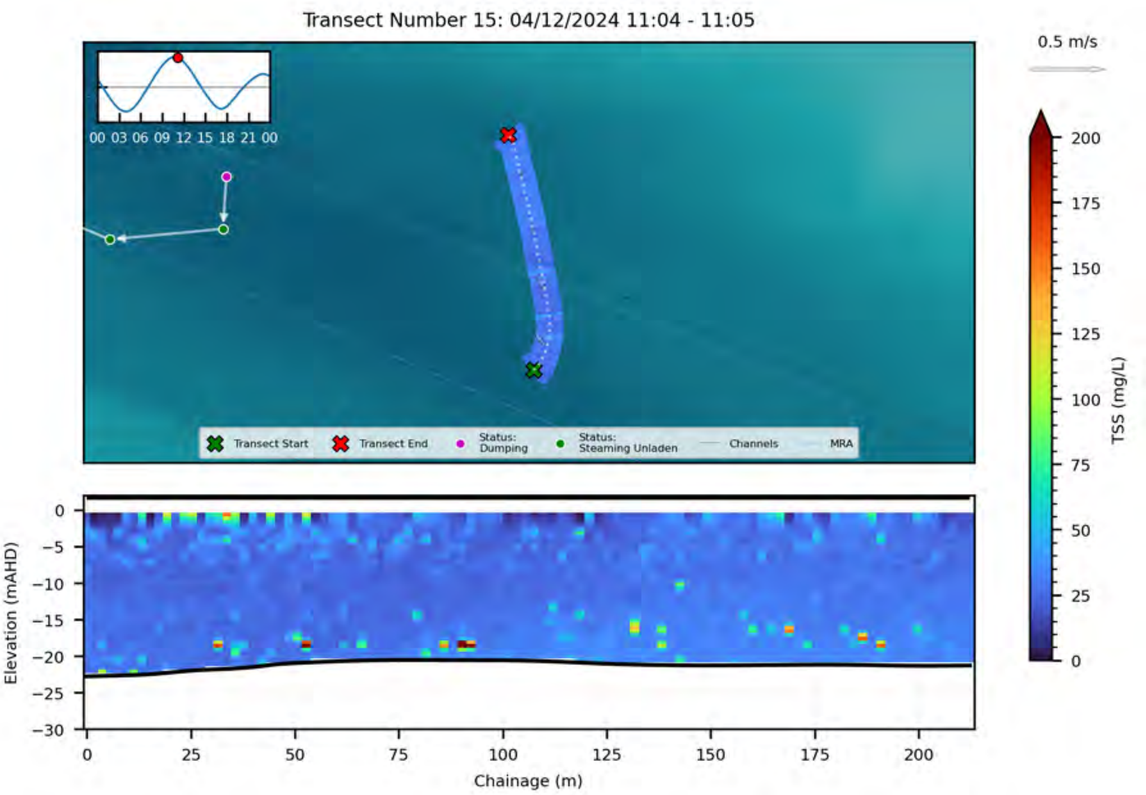
Transect Number 12: 04/12/2024 10:47 - 10:56

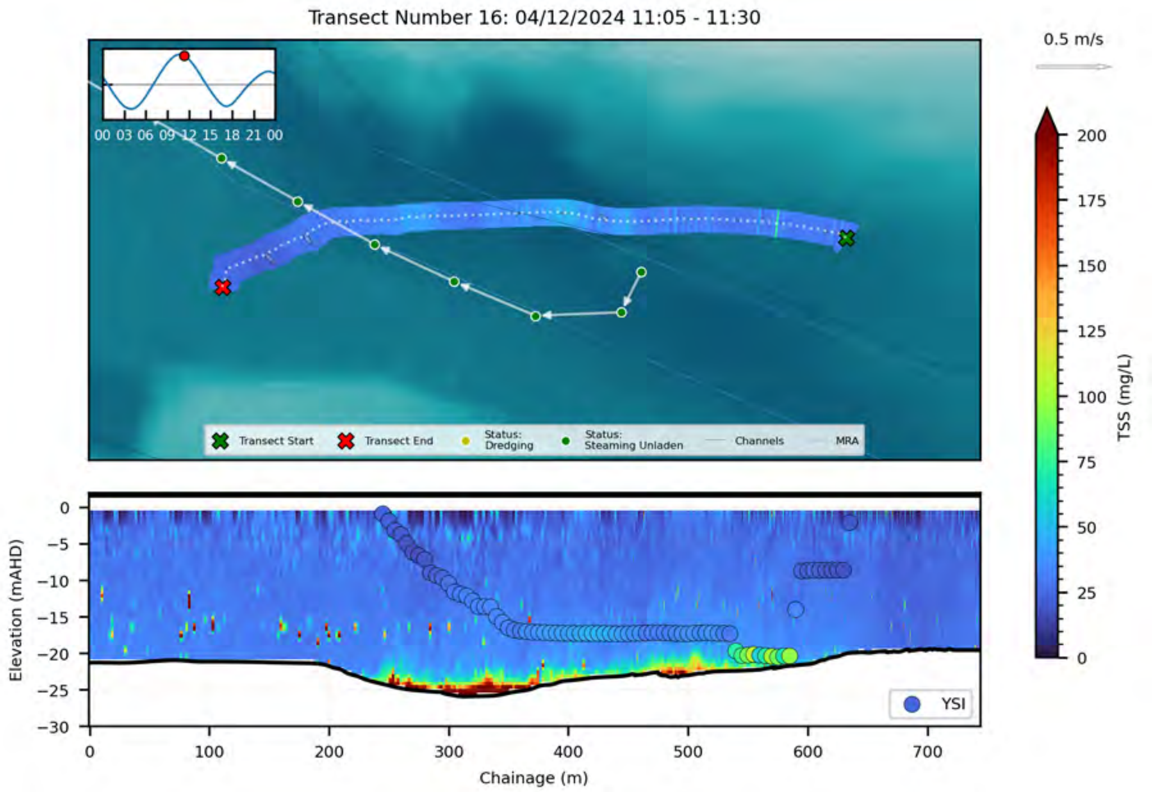


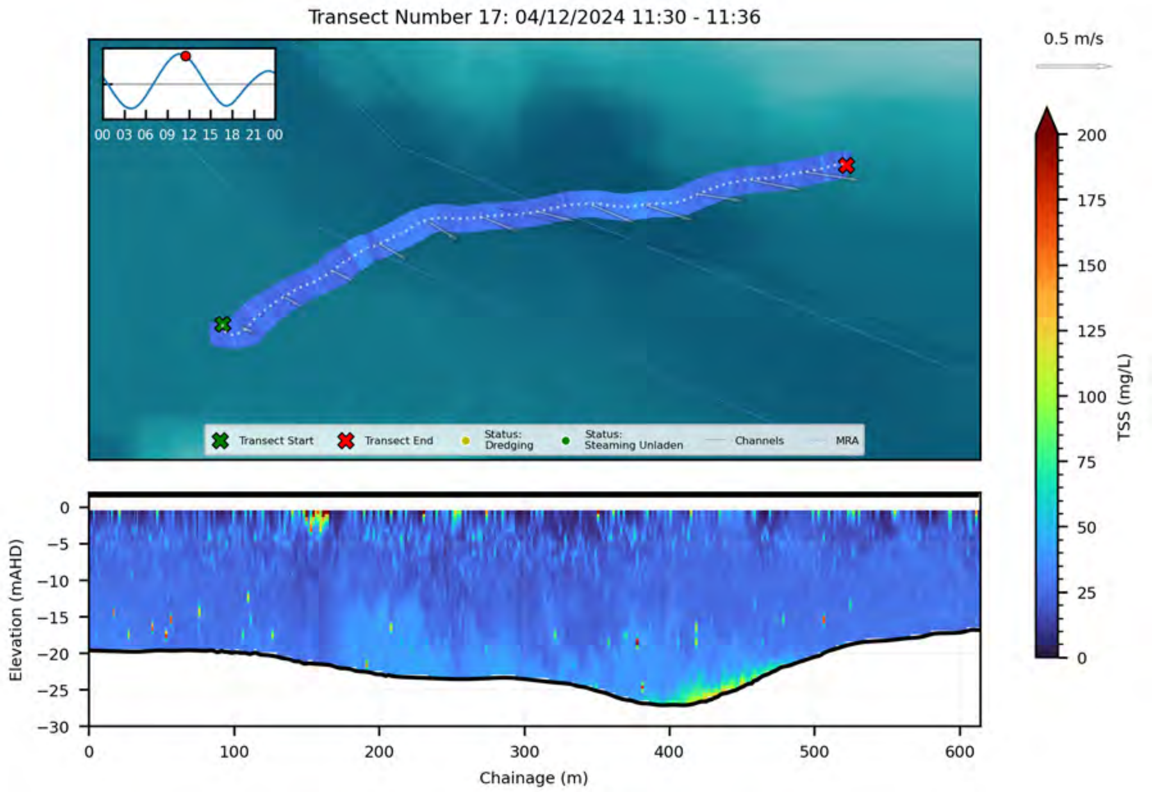
Transect Number 13: 04/12/2024 10:56 - 11:01

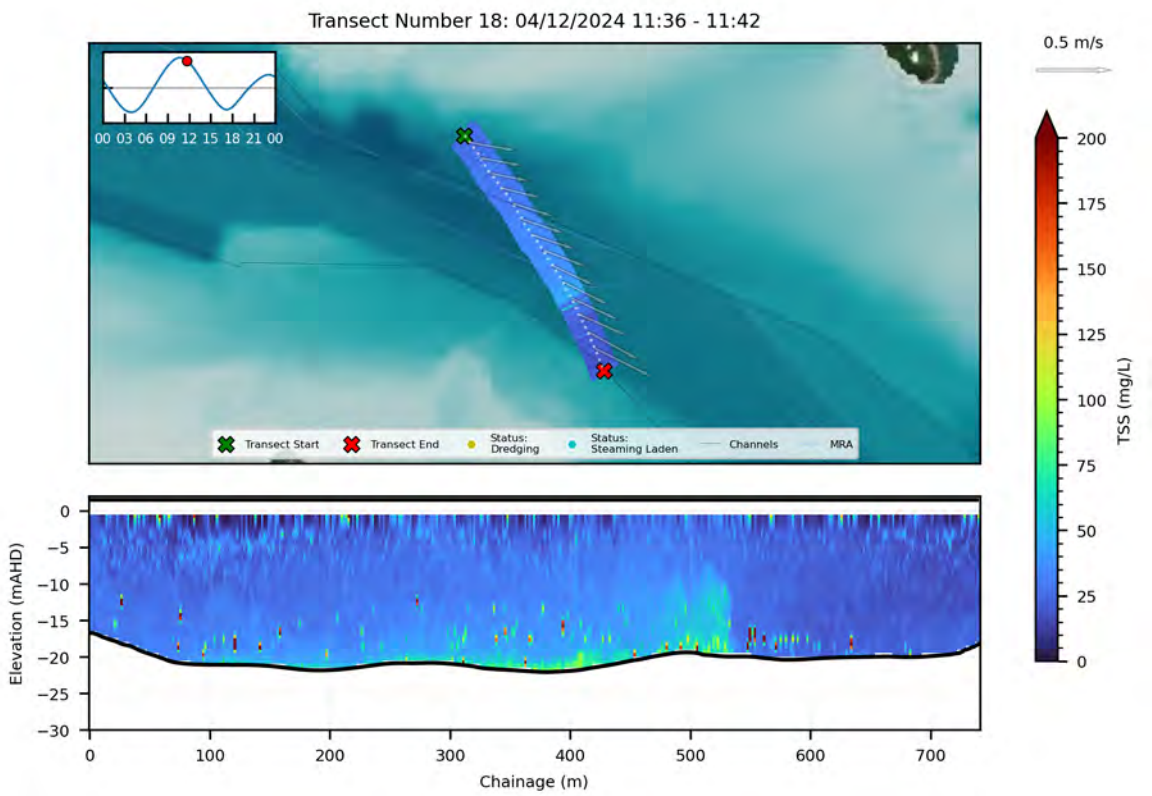


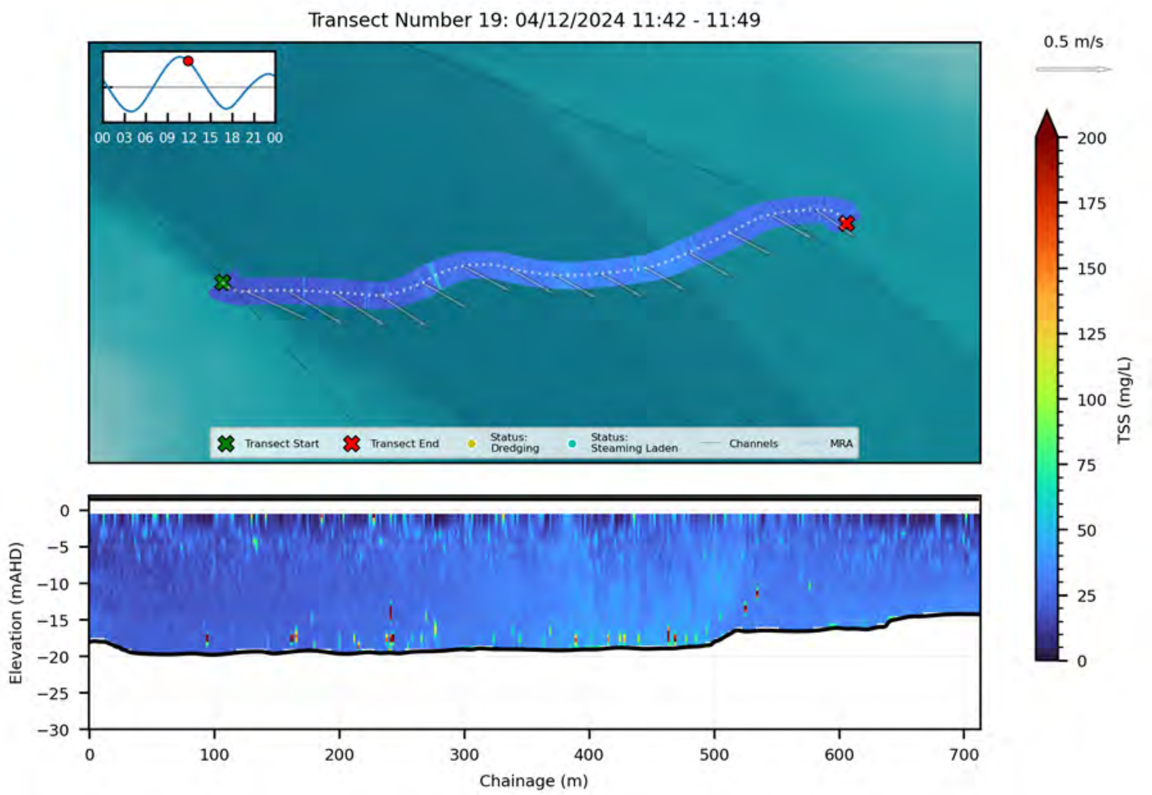

Transect Number 14: 04/12/2024 11:01 - 11:04
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Unladen
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

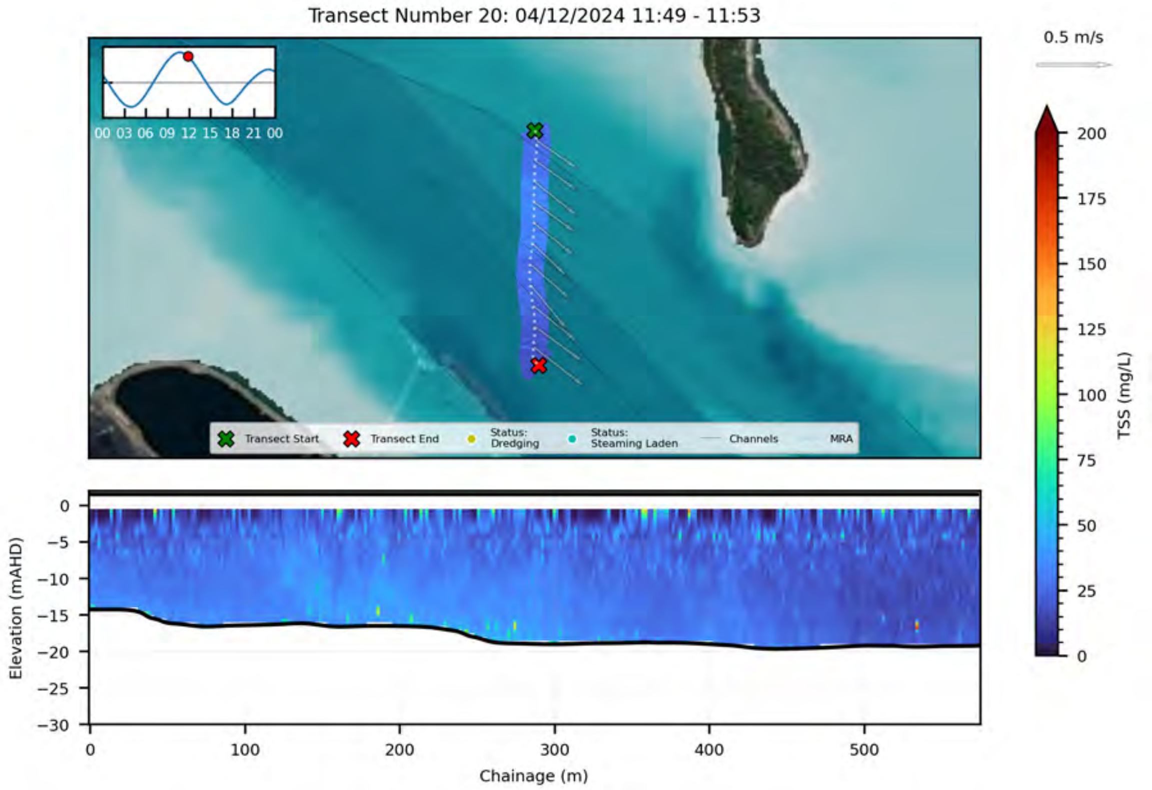

Transect Number 15: 04/12/2024 11:04 - 11:05
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Unladen
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

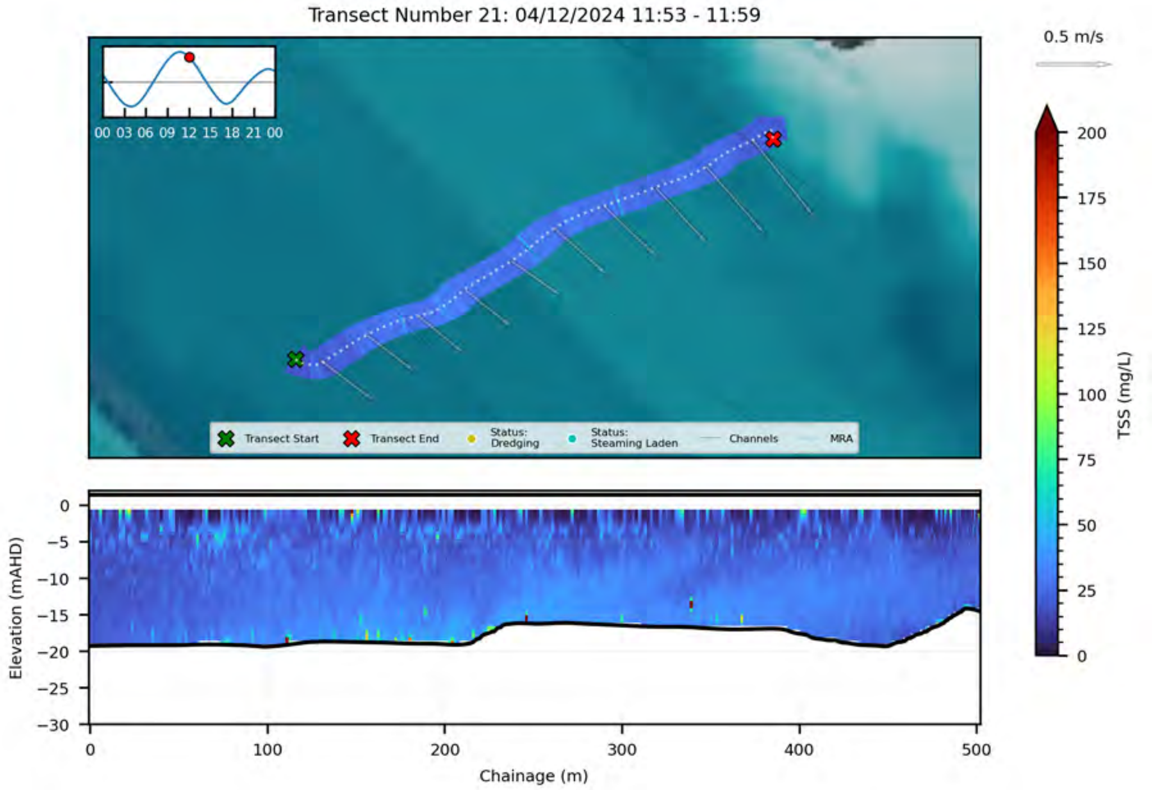

Transect Number 16: 04/12/2024 11:05 - 11:30
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
YSI
Elevation (mAHD)
Chainage (m)
TSS (mg/L)

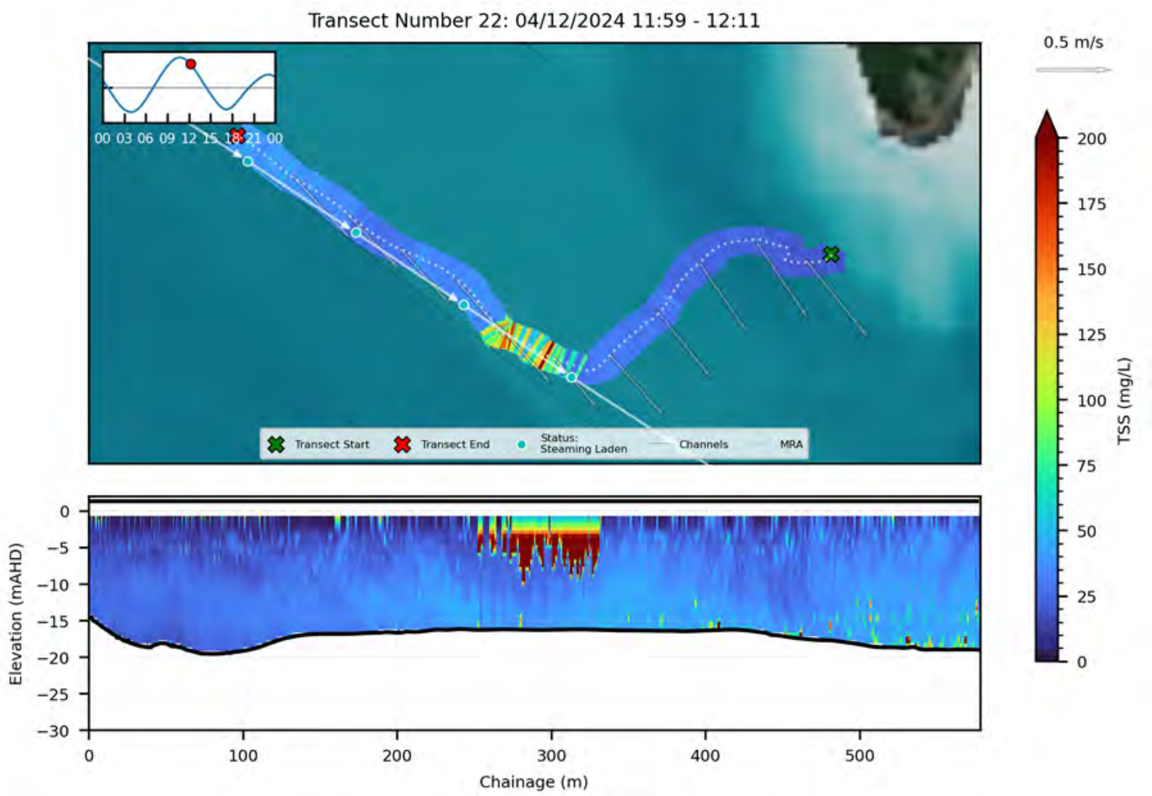

Transect Number 17: 04/12/2024 11:30 - 11:36
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
Elevation (mAHD)
Chainage (m)
TSS (mg/L)

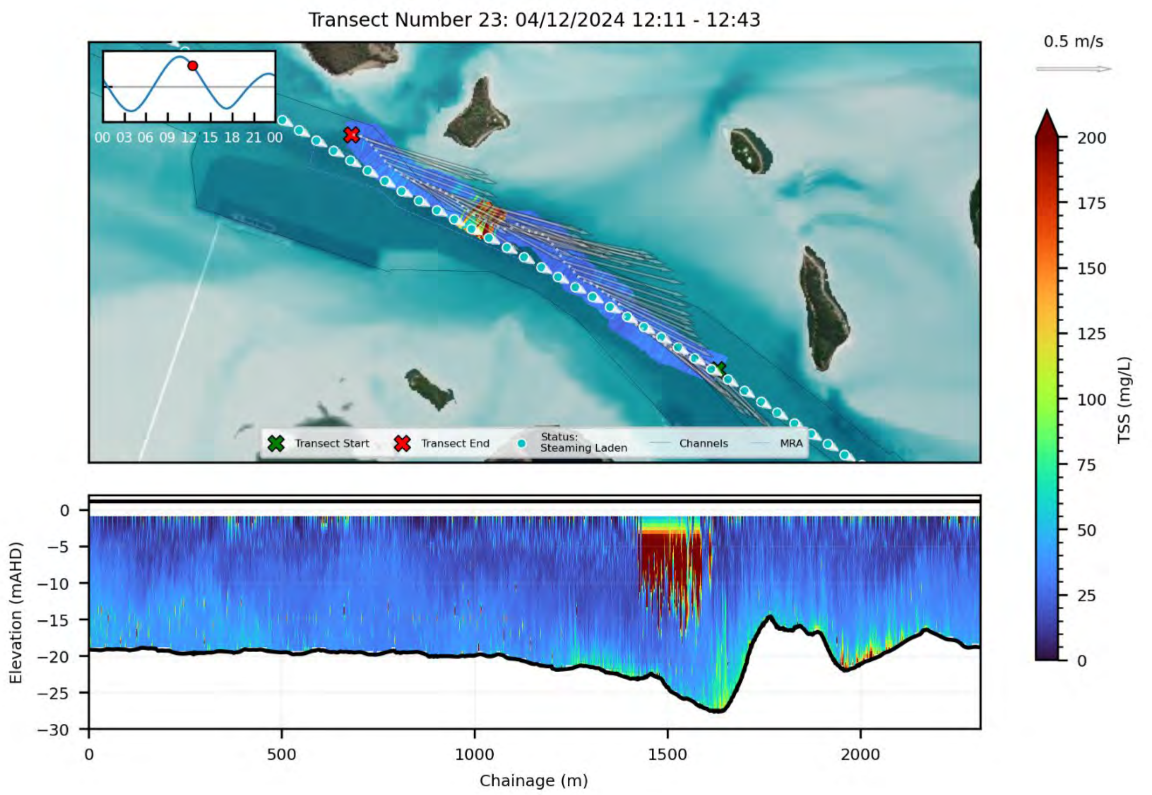

Transect Number 18: 04/12/2024 11:36 - 11:42
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

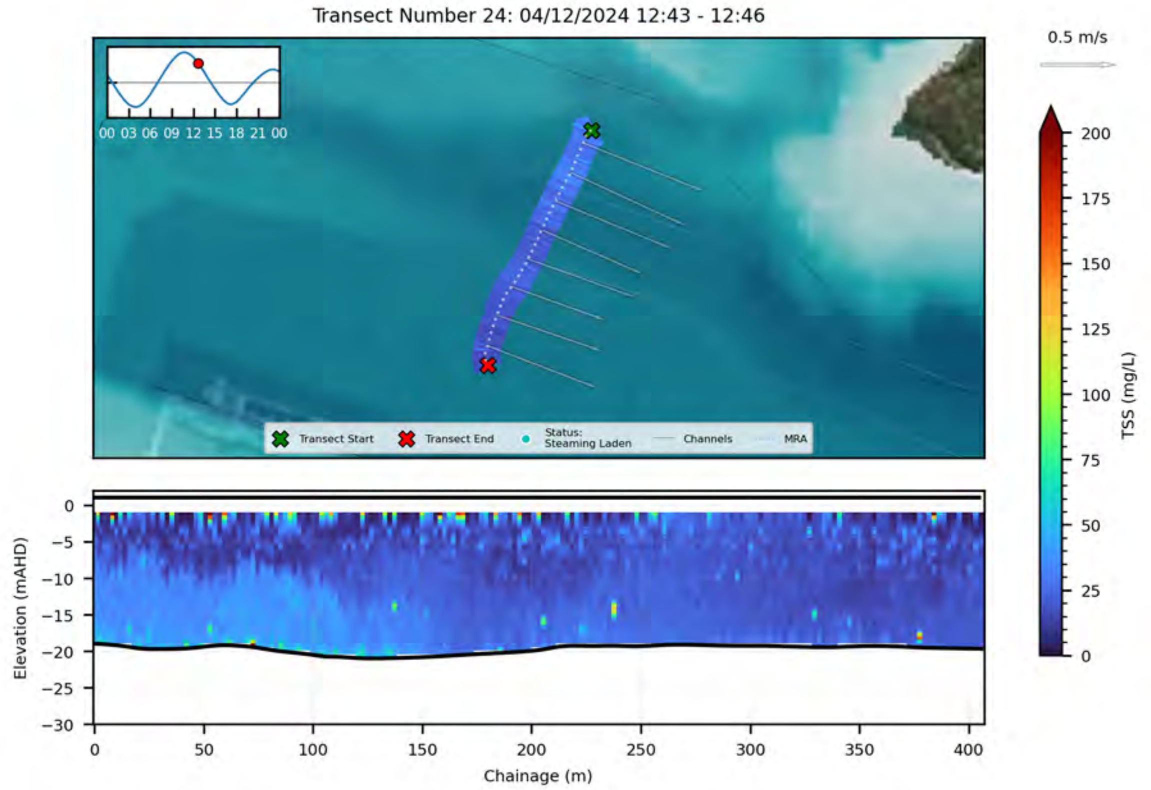

Transect Number 19: 04/12/2024 11:42 - 11:49
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

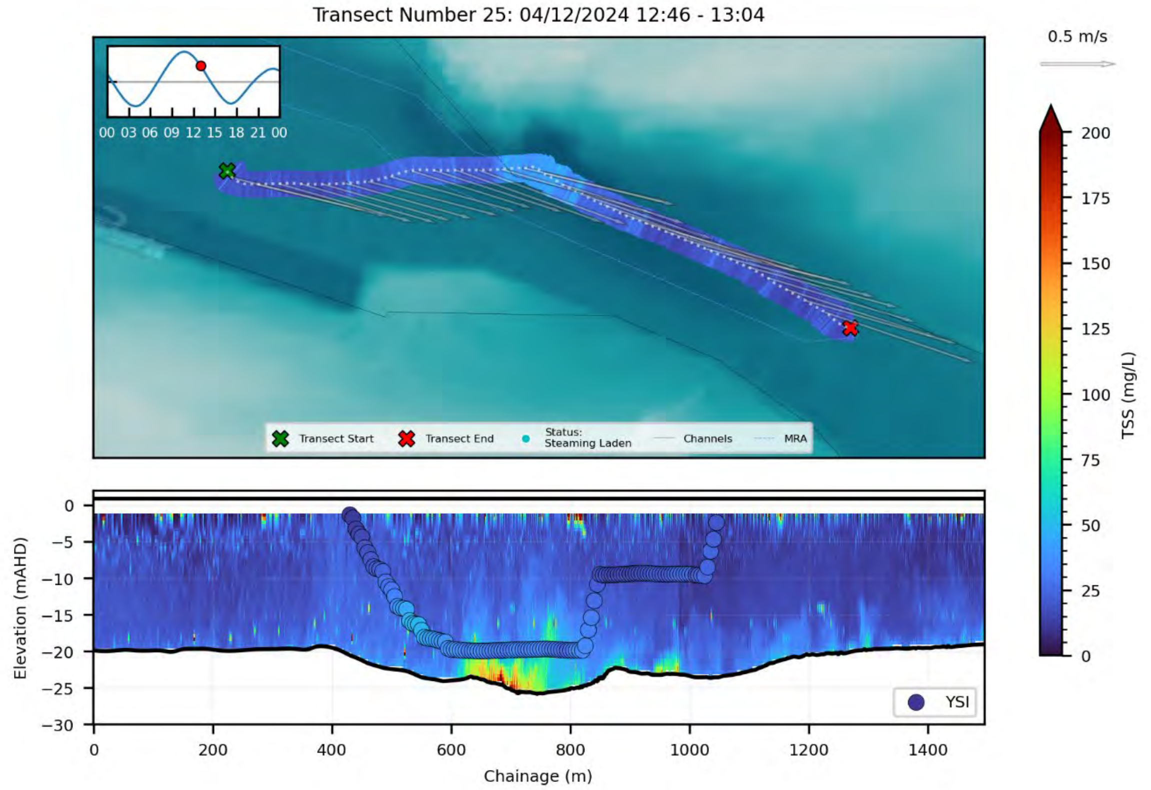

Transect Number 20: 04/12/2024 11:49 - 11:53
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)
0
−5
−10
−15
−20
−25
−30
100
200
300
400
500

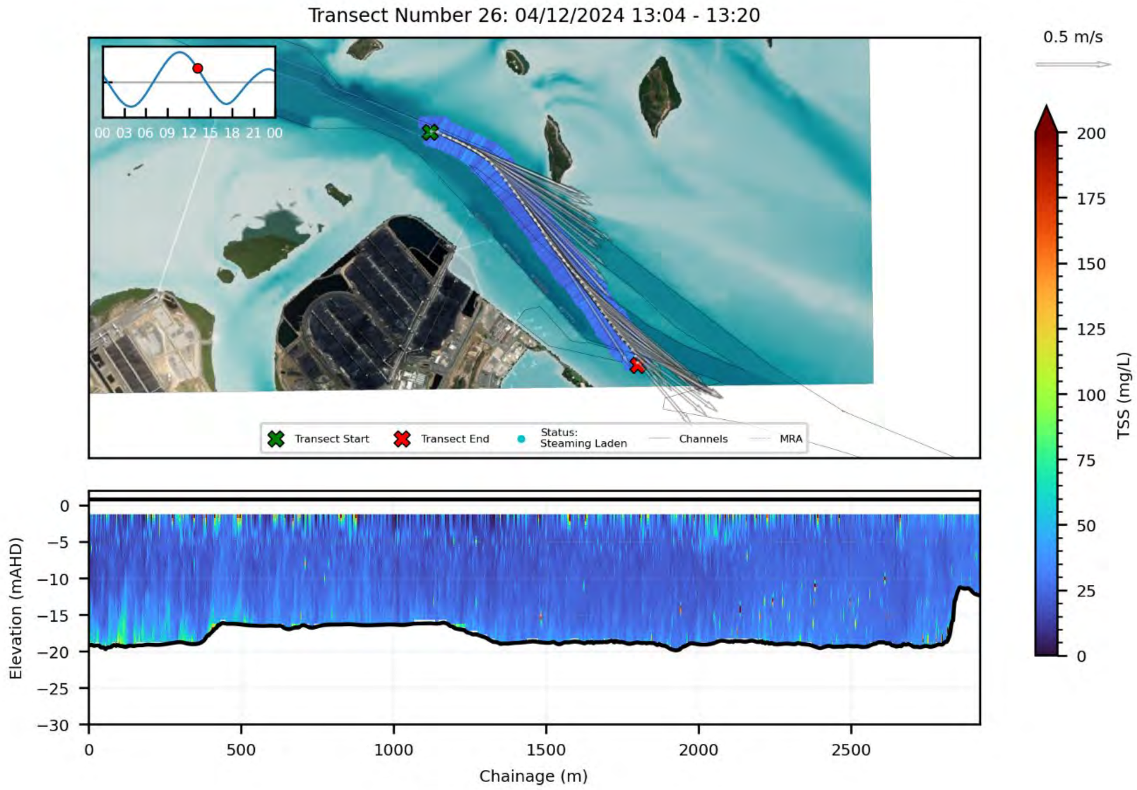

Transect Number 21: 04/12/2024 11:53 - 11:59
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)
0
−5
−10
−15
−20
−25
−30
100
200
300
400
500

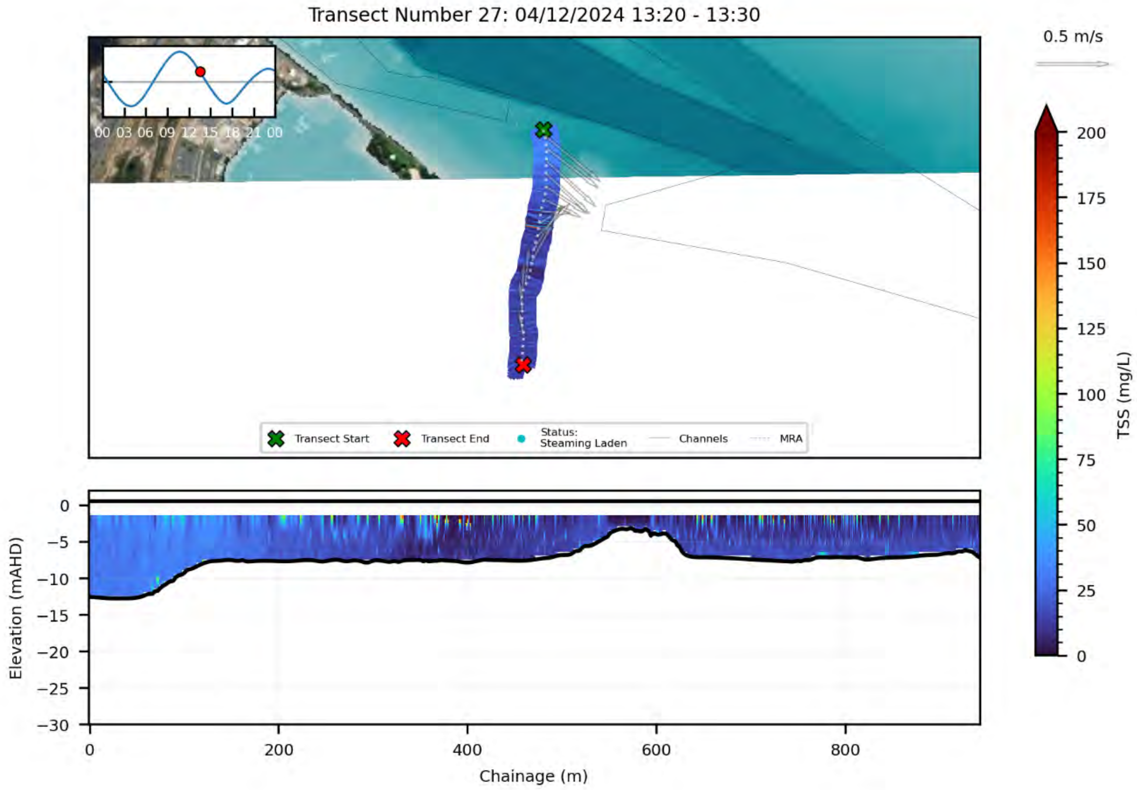

Transect Number 22: 04/12/2024 11:59 - 12:11
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)
0
100
200
300
400
500
0
−5
−10
−15
−20
−25
−30

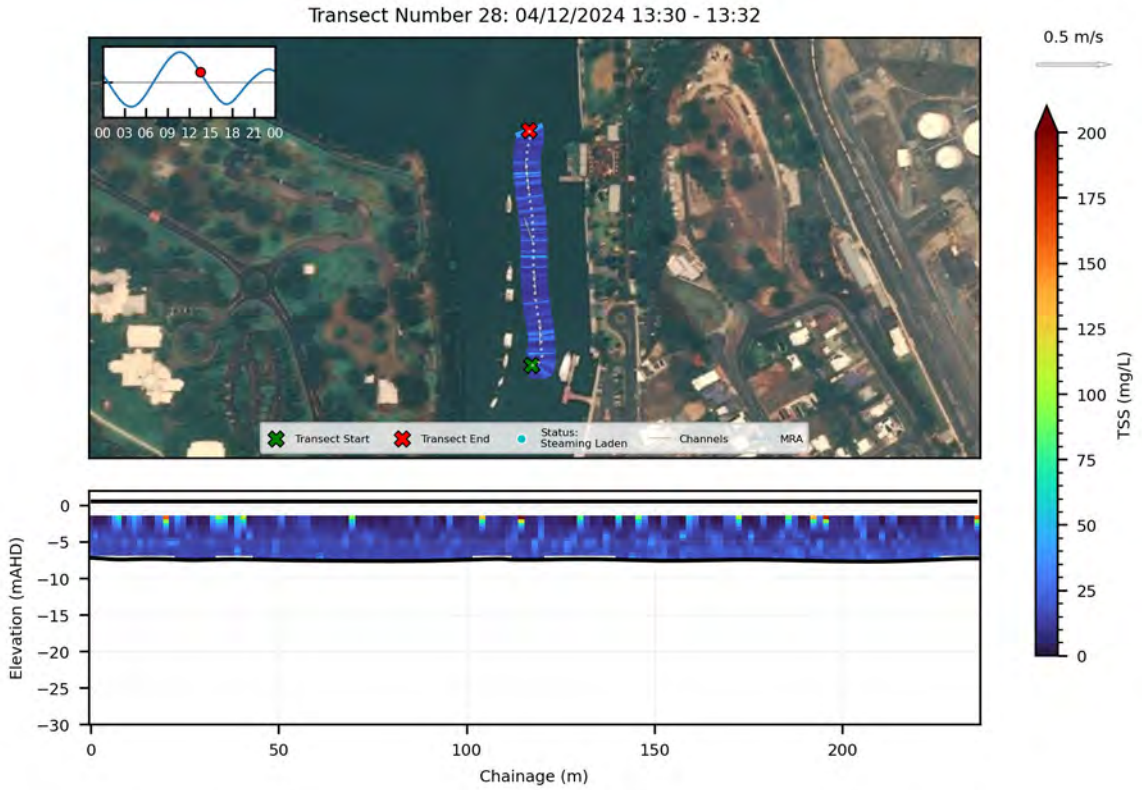

Transect Number 23: 04/12/2024 12:11 - 12:43
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)
0
500
1000
1500
2000
0
−5
−10
−15
−20
−25
−30

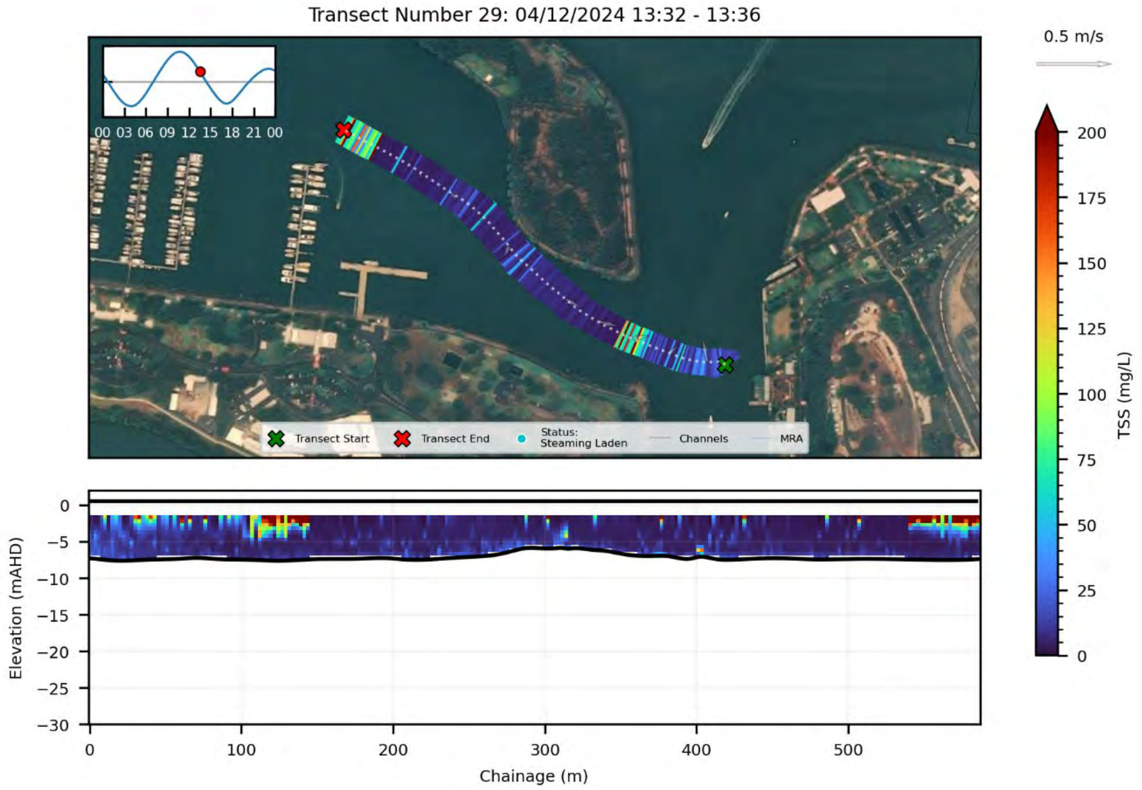

Transect Number 24: 04/12/2024 12:43 - 12:46
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
0
50
100
150
200
250
300
350
400
Chainage (m)


Transect Number 25: 04/12/2024 12:46 - 13:04
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
YSI
0
200
400
600
800
1000
1200
1400
Chainage (m)

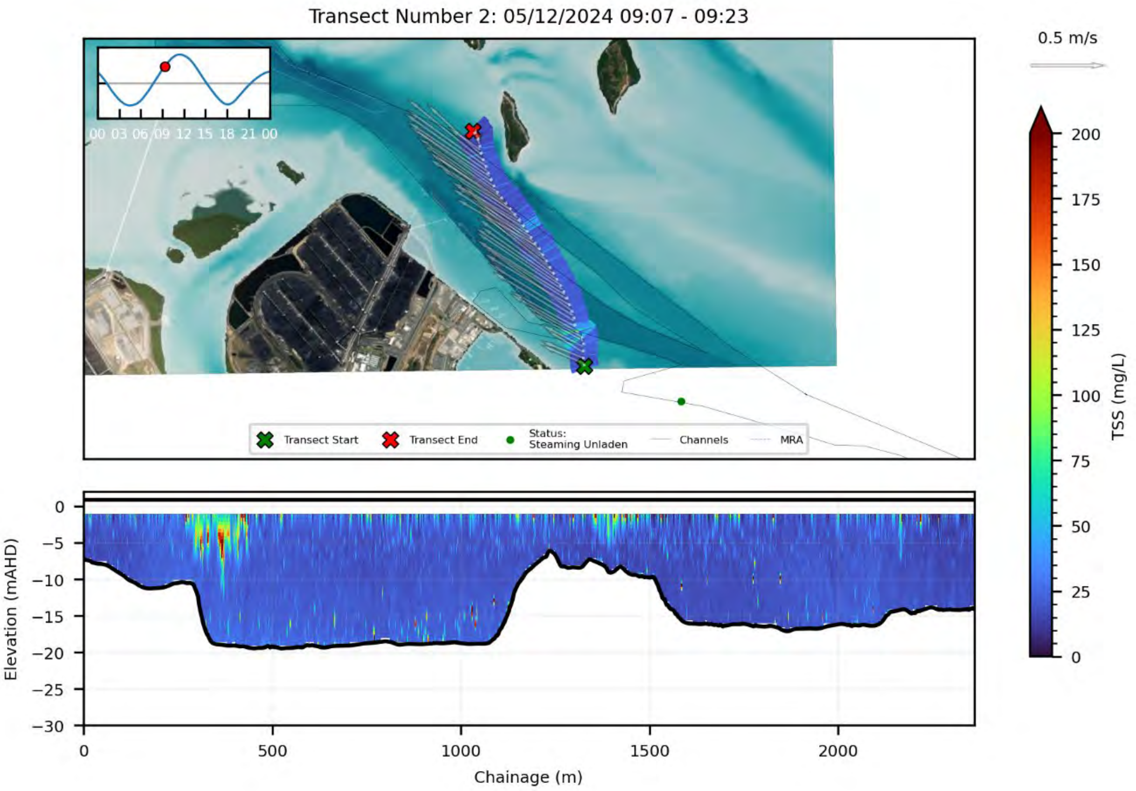

Transect Number 26: 04/12/2024 13:04 - 13:20
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
0
500
1000
1500
2000
2500
Chainage (m)

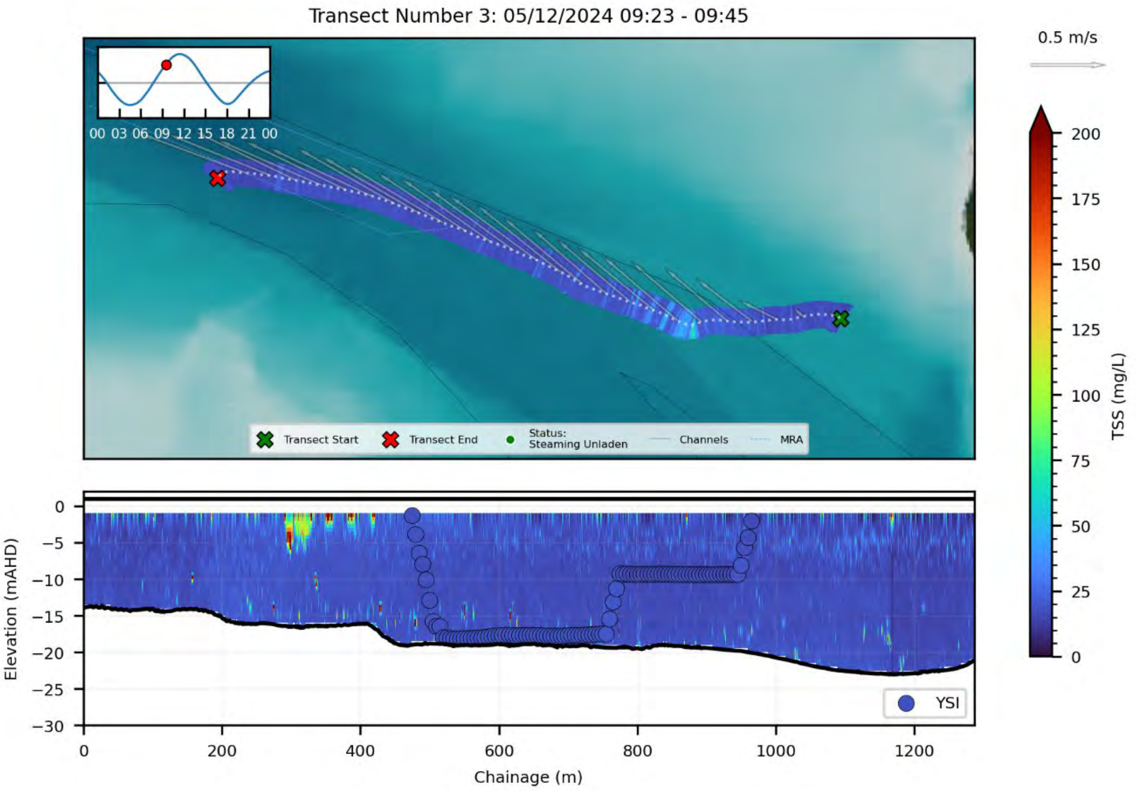

Transect Number 27: 04/12/2024 13:20 - 13:30
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
0
200
400
600
800
Chainage (m)

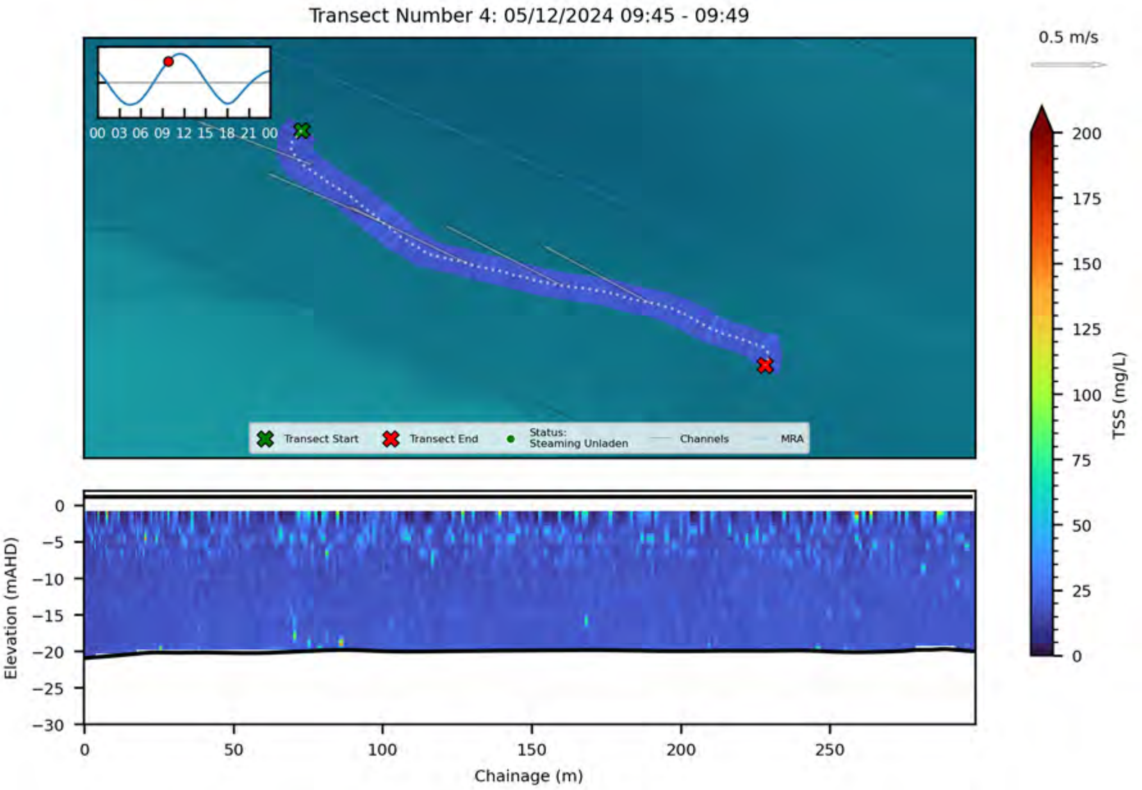

Transect Number 28: 04/12/2024 13:30 - 13:32
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
Chainage (m)
0
50
100
150
200

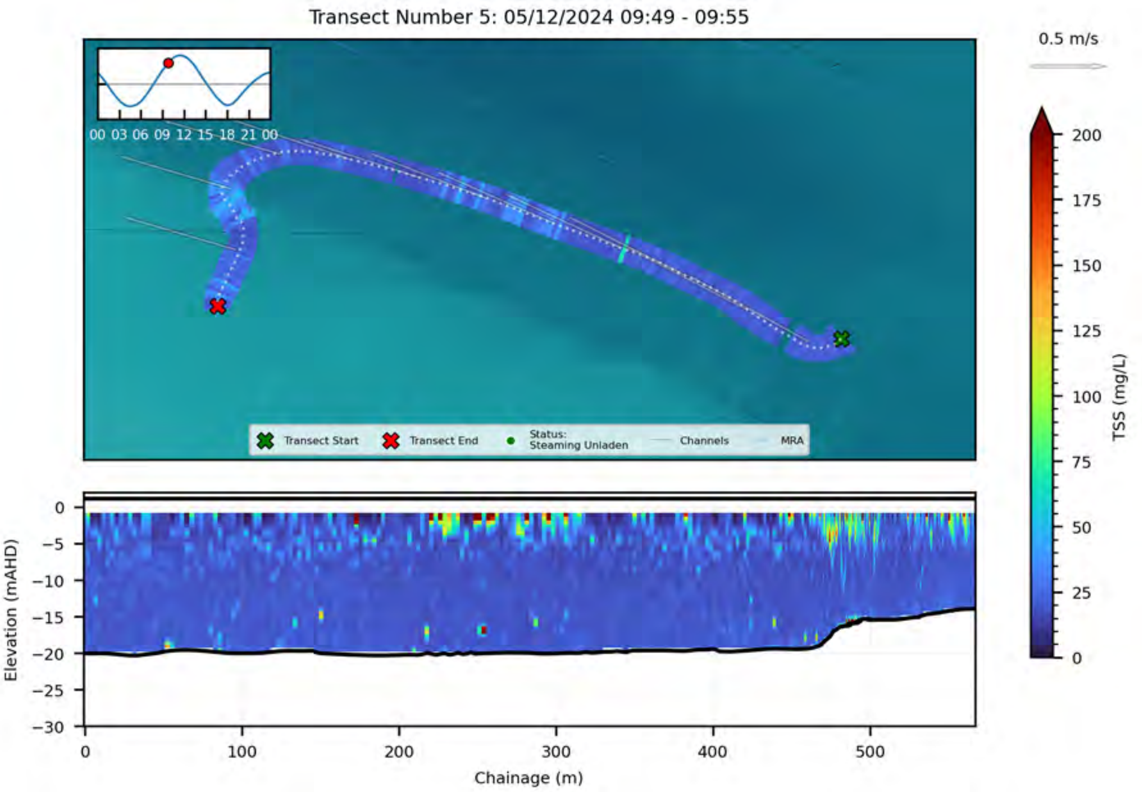

Transect Number 29: 04/12/2024 13:32 - 13:36
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
Chainage (m)
0
100
200
300
400
500

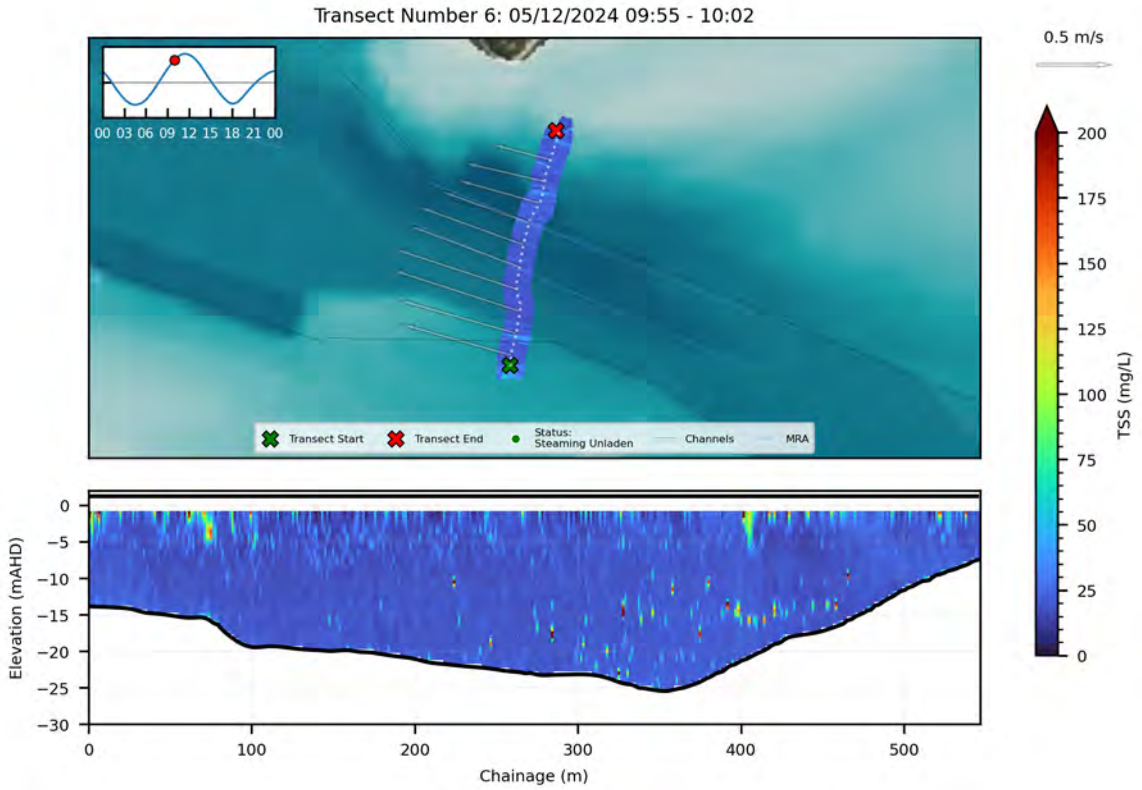
Annex N ADCP Derived TSS Transects 5th December 2024

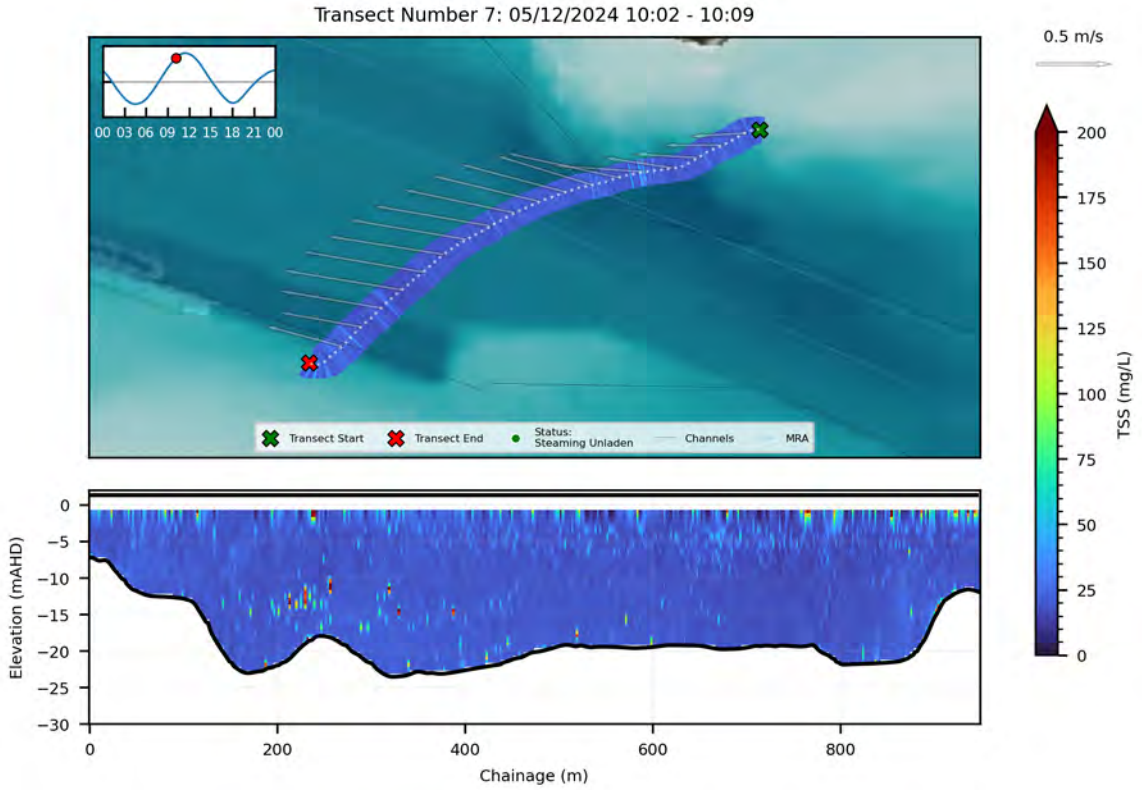




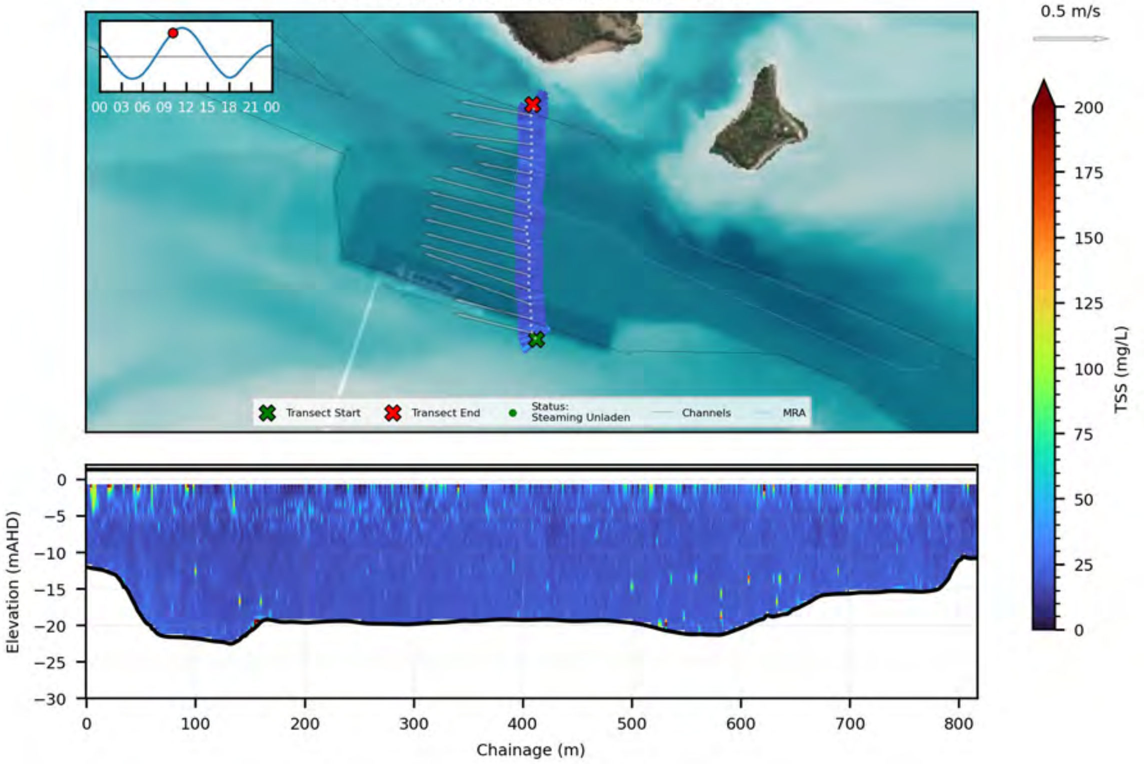

Transect Number 4: 05/12/2024 09:45 - 09:49
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
0
50
100
150
200
250
Chainage (m)


Transect Number 5: 05/12/2024 09:49 - 09:55
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
0
100
200
300
400
500
Chainage (m)

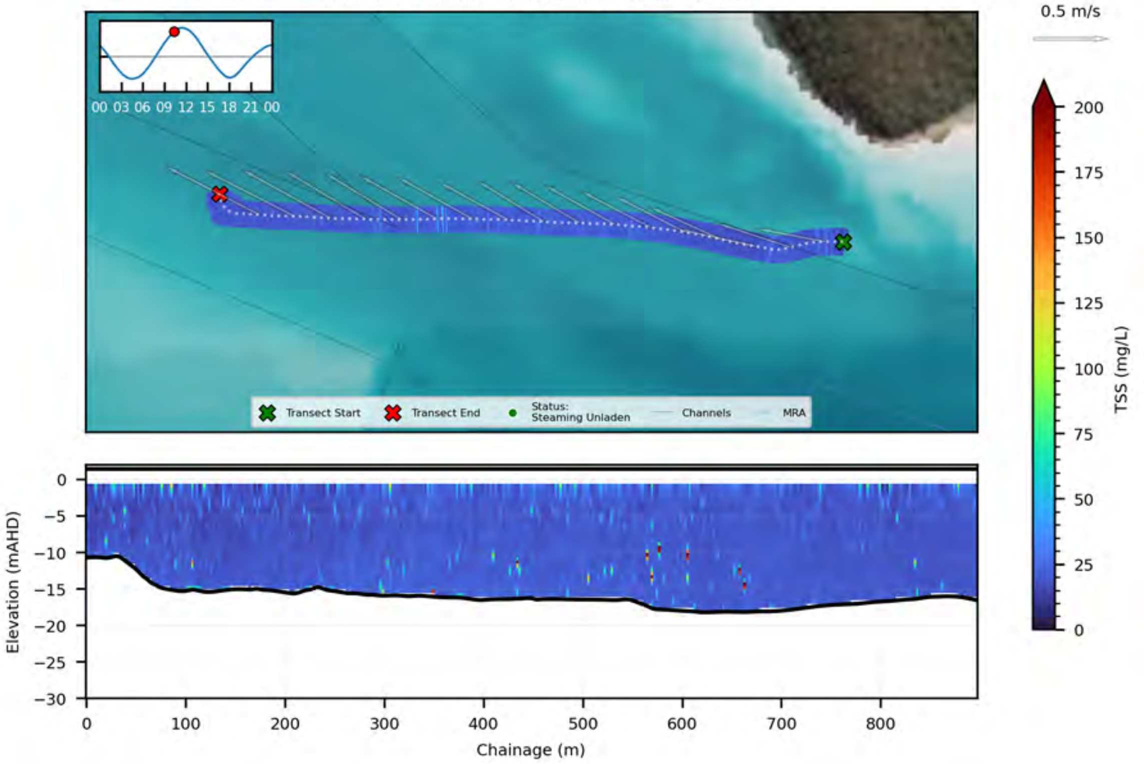

Transect Number 6: 05/12/2024 09:55 - 10:02
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

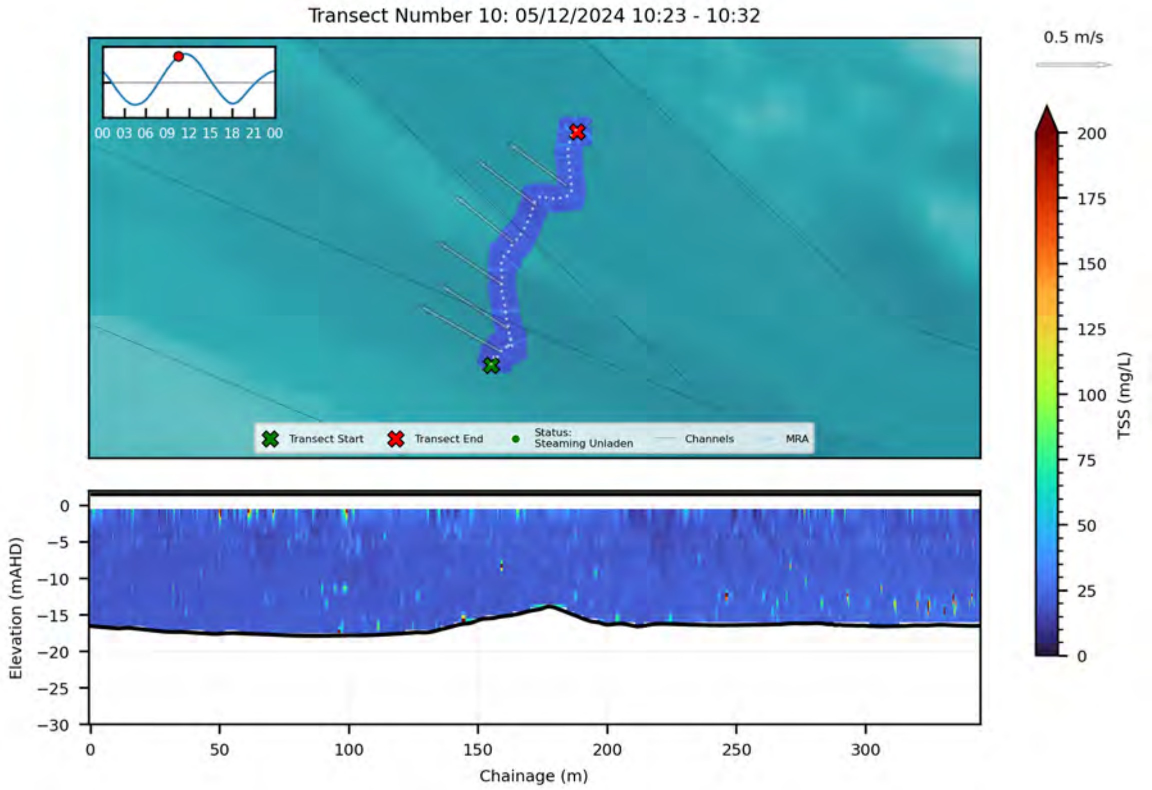

Transect Number 7: 05/12/2024 10:02 - 10:09
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

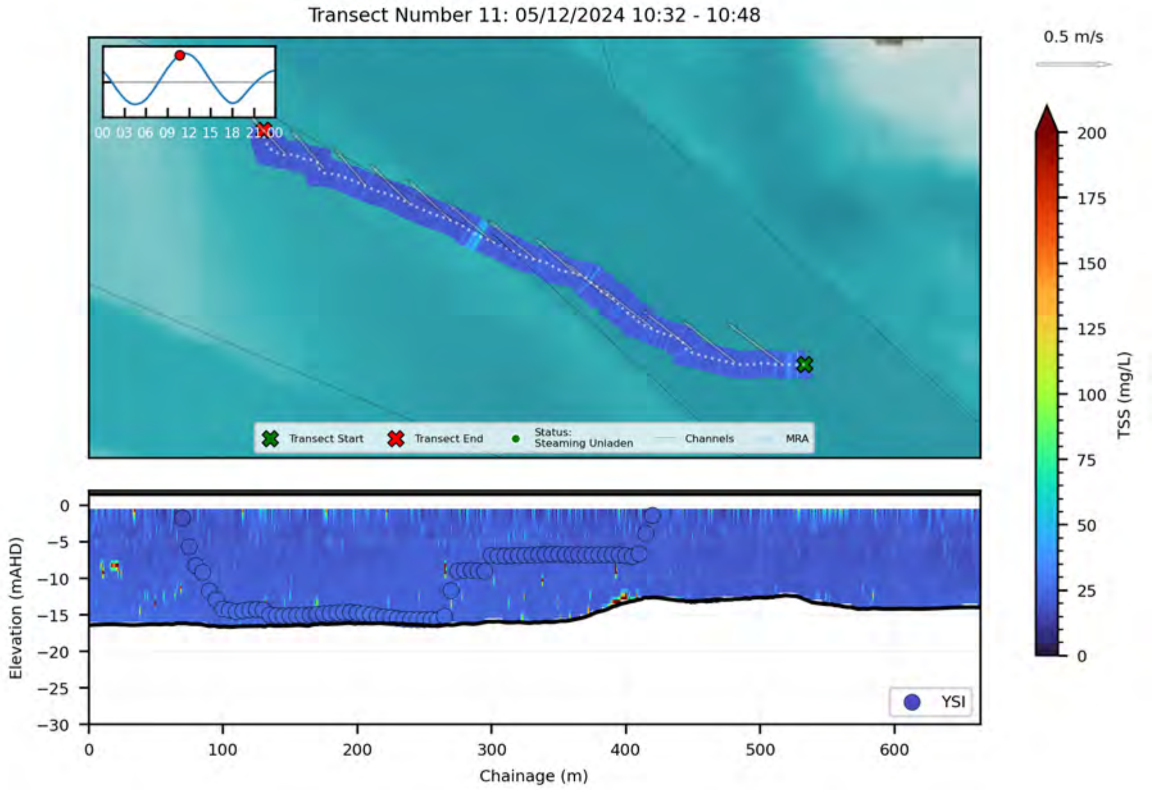
Transect Number 8: 05/12/2024 10:09 - 10:17

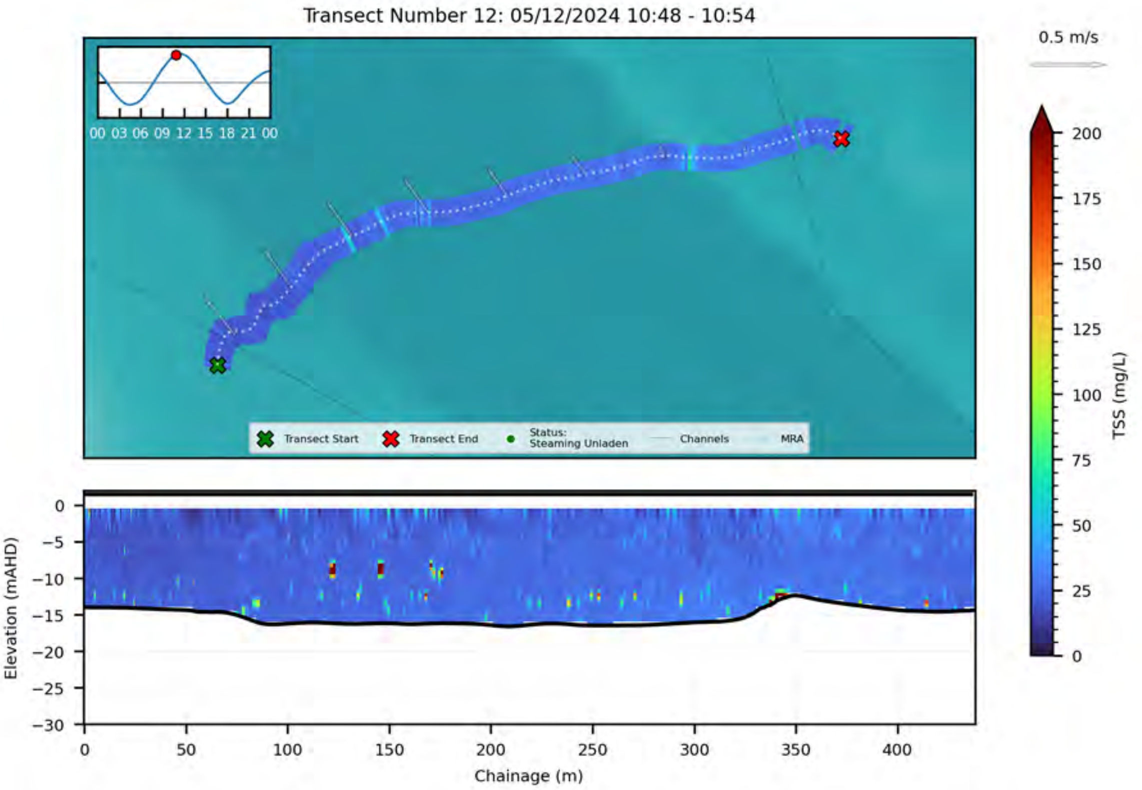


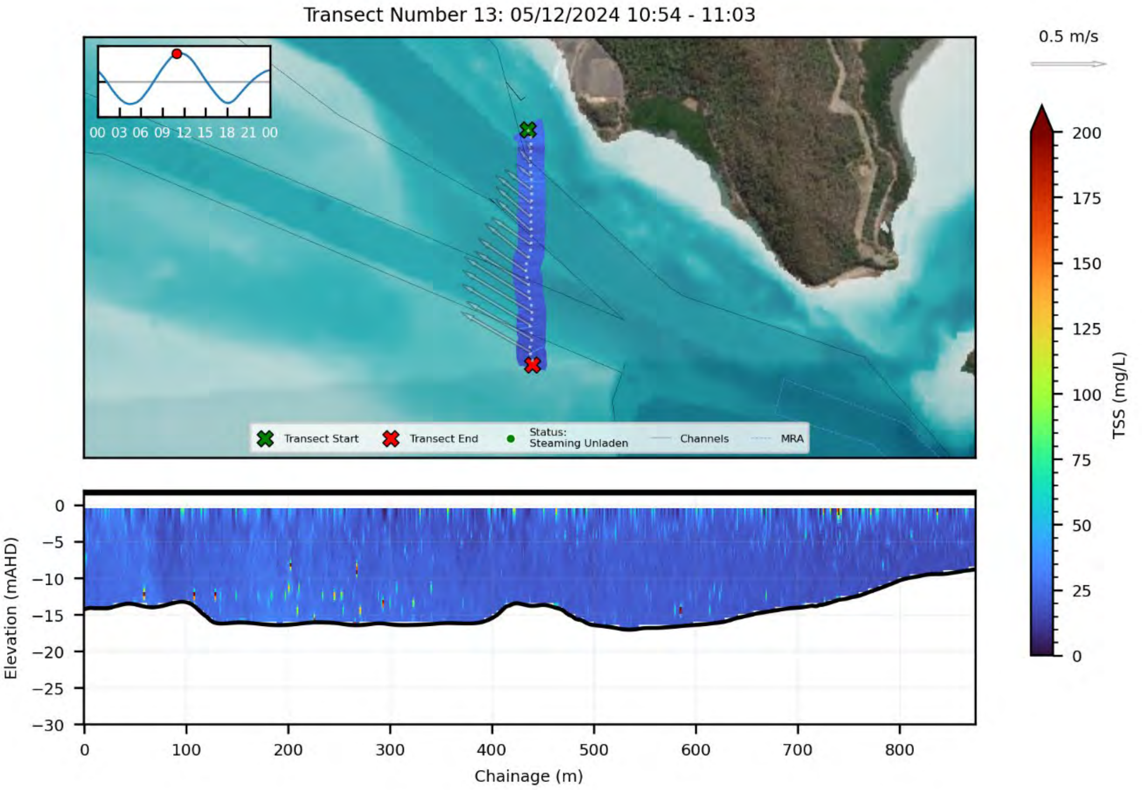
Transect Number 9: 05/12/2024 10:17 - 10:23

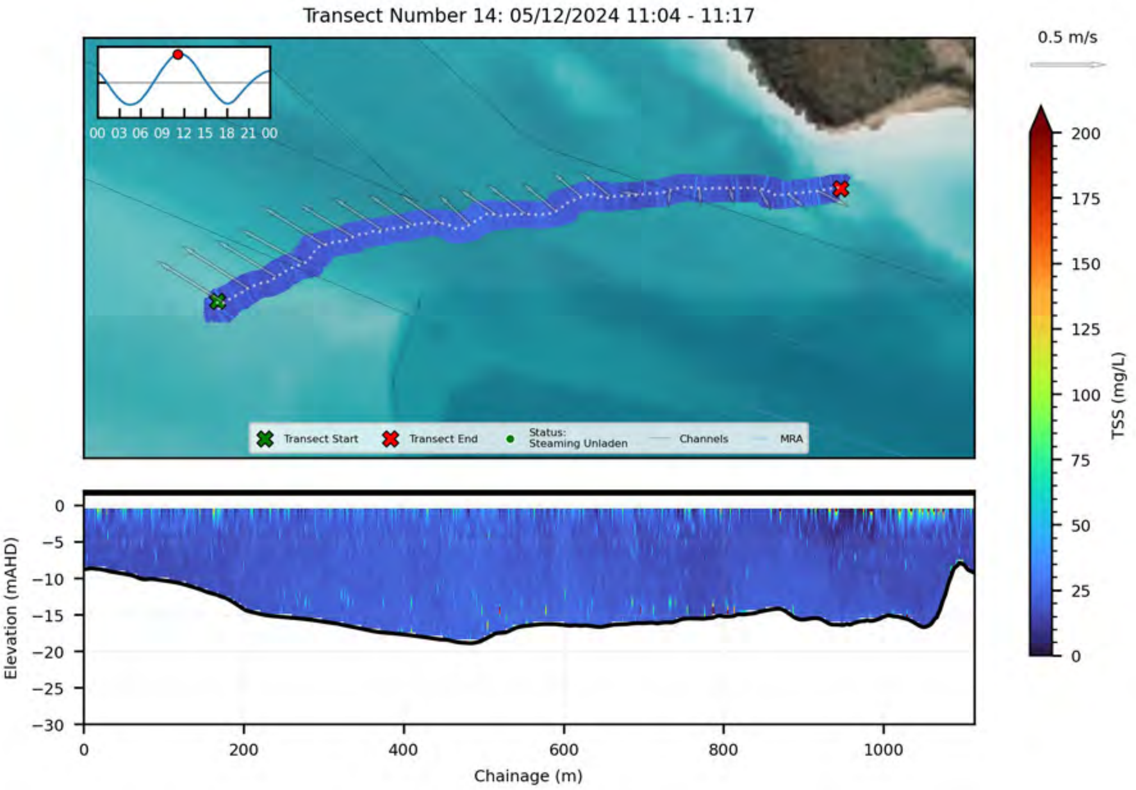


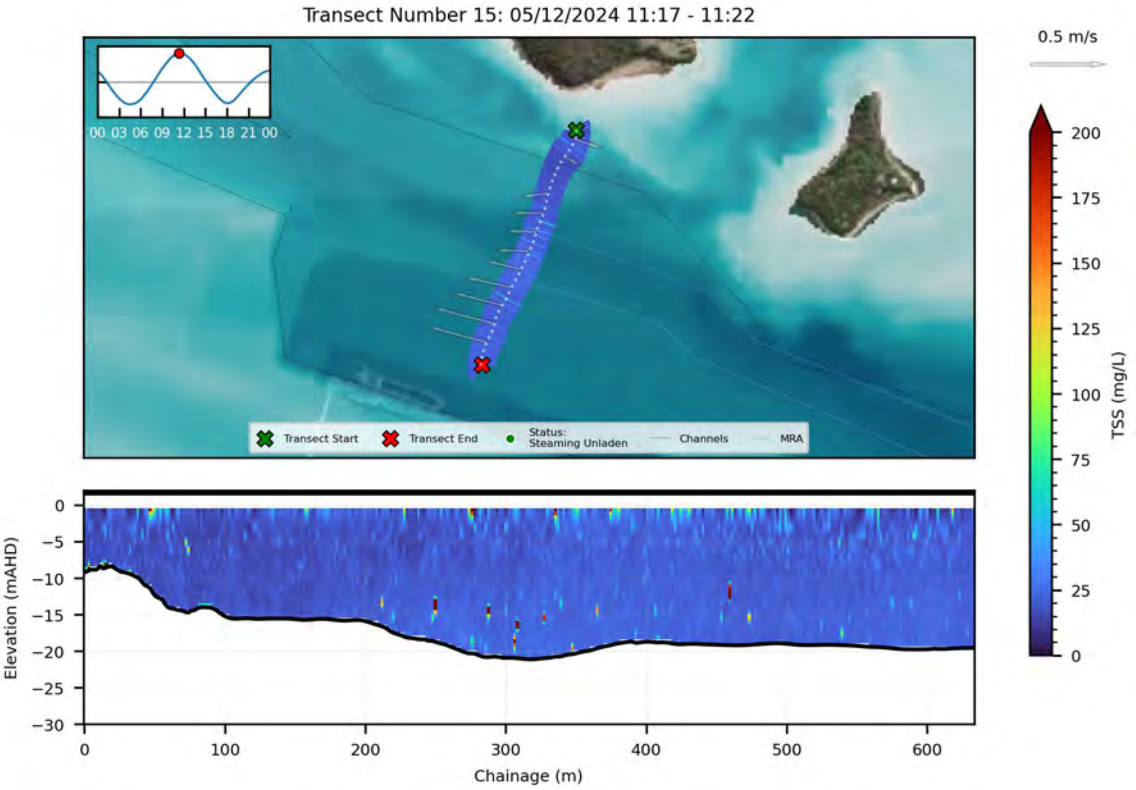

Transect Number 10: 05/12/2024 10:23 - 10:32
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
0
50
100
150
200
250
300
Chainage (m)

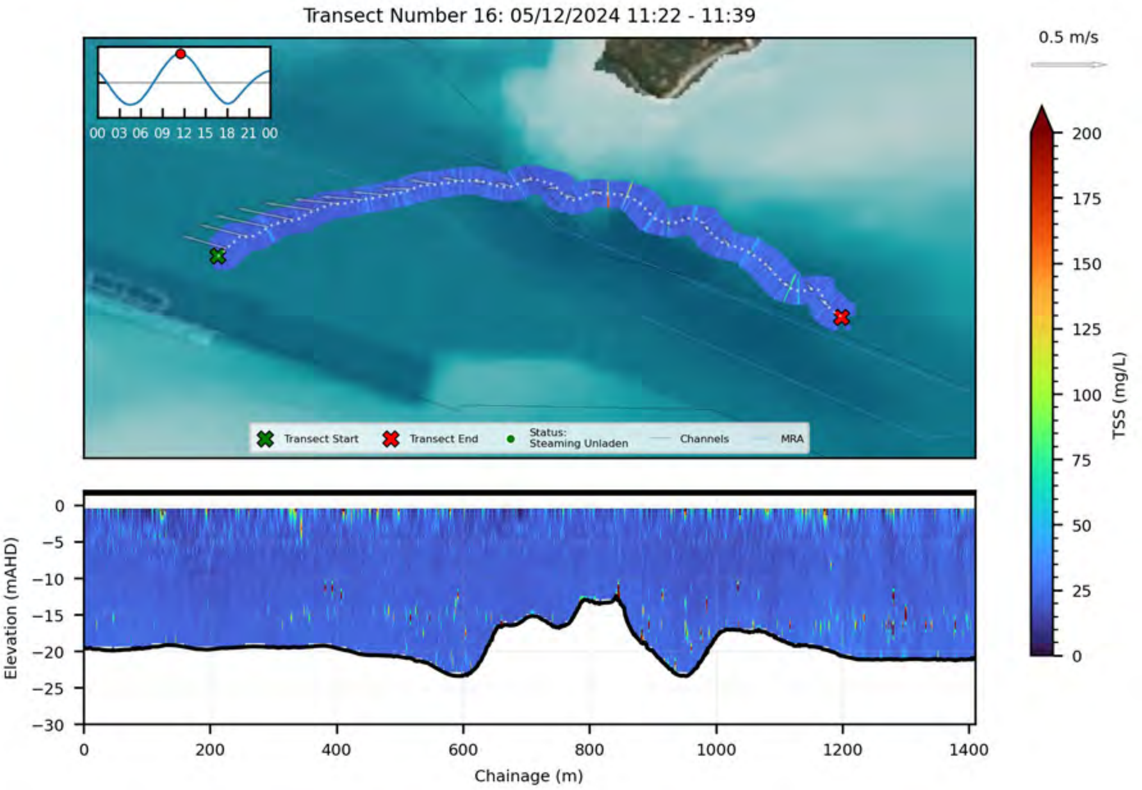

Transect Number 11: 05/12/2024 10:32 - 10:48
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
YSI
0
100
200
300
400
500
600
Chainage (m)

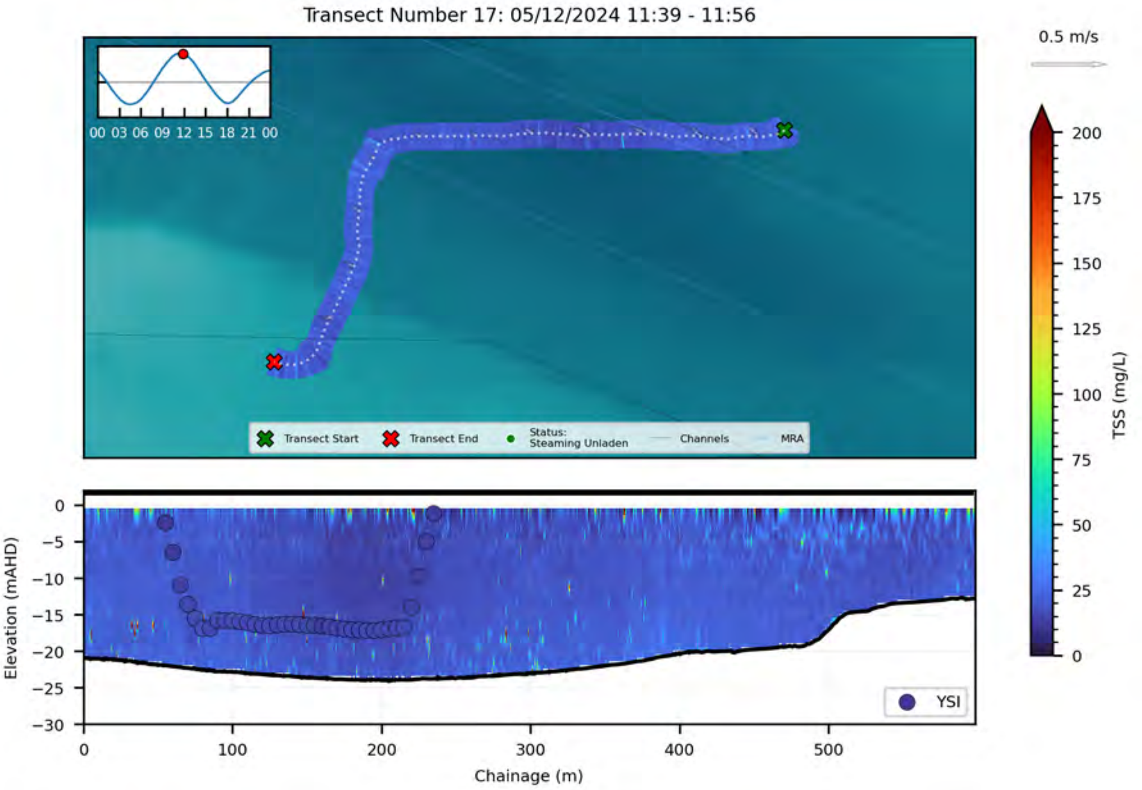

Transect Number 12: 05/12/2024 10:48 - 10:54
00 03 06 09 12 15 18 21 00
0.5 m/s
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
Chainage (m)
0
50
100
150
200
250
300
350
400

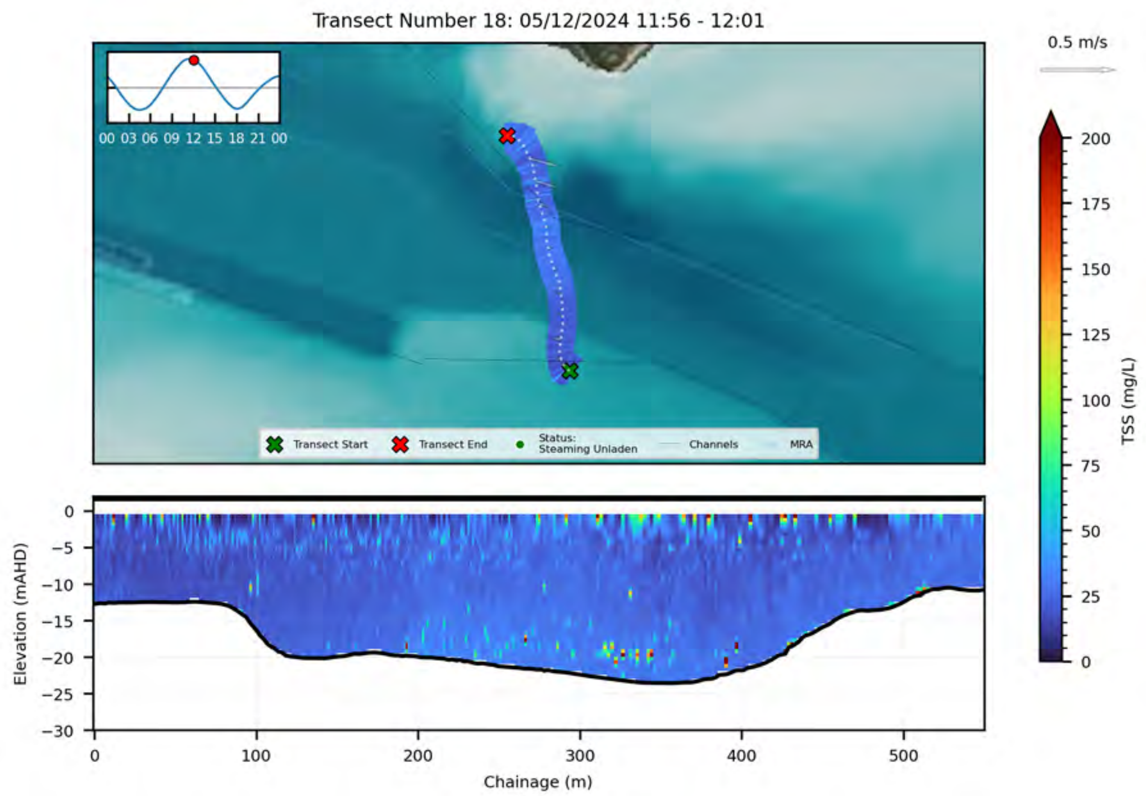

Transect Number 13: 05/12/2024 10:54 - 11:03
00 03 06 09 12 15 18 21 00
0.5 m/s
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
Chainage (m)
0
100
200
300
400
500
600
700
800

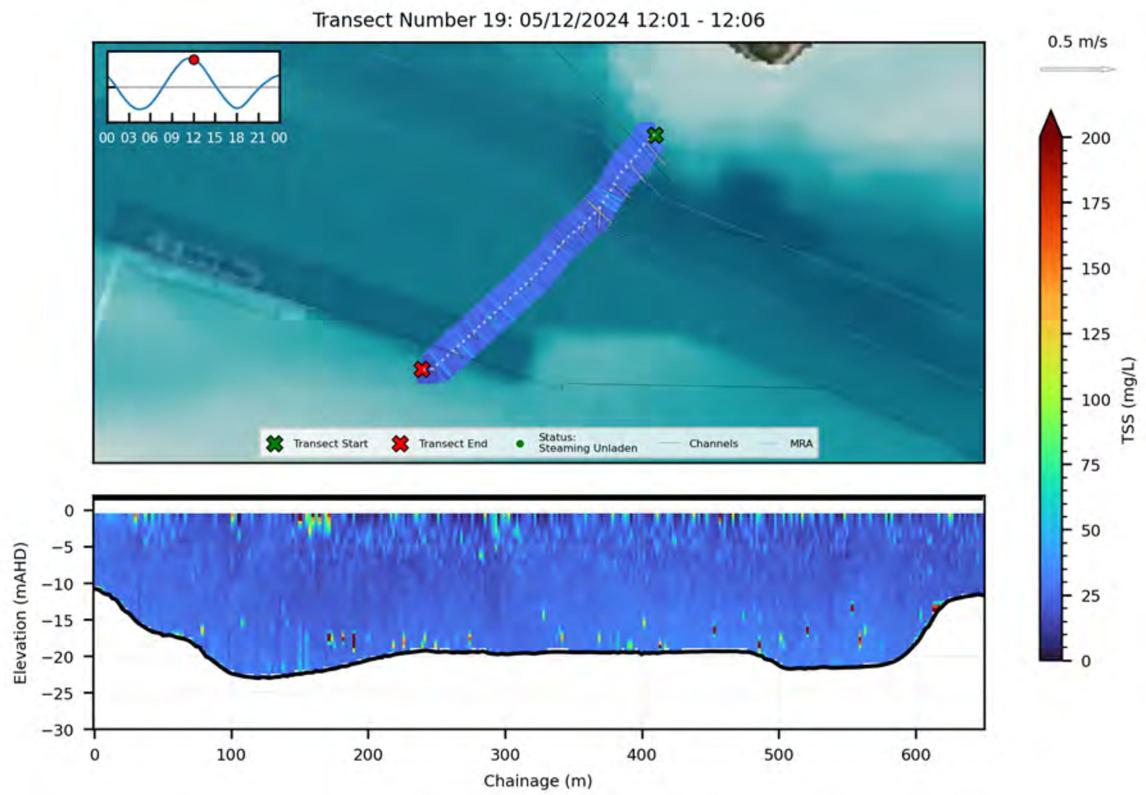

Transect Number 14: 05/12/2024 11:04 - 11:17
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
Elevation (mAHD)
Chainage (m)
TSS (mg/L)

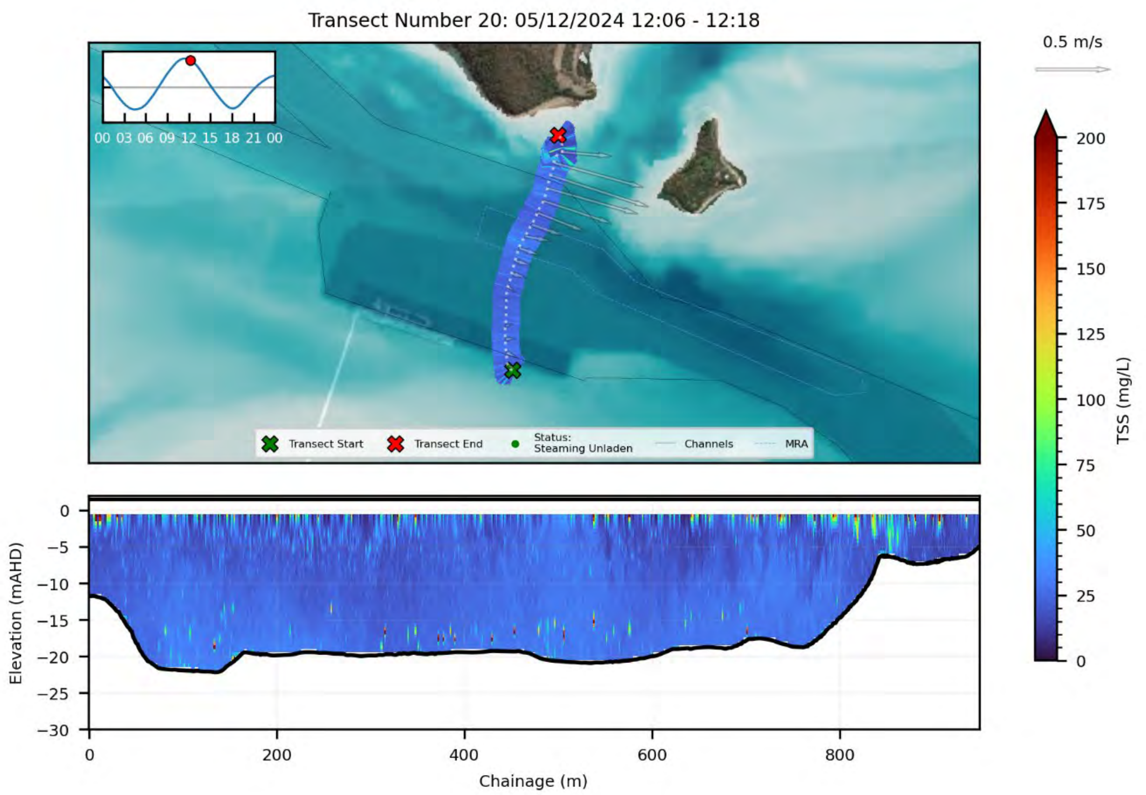

Transect Number 15: 05/12/2024 11:17 - 11:22
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
Elevation (mAHD)
Chainage (m)
TSS (mg/L)

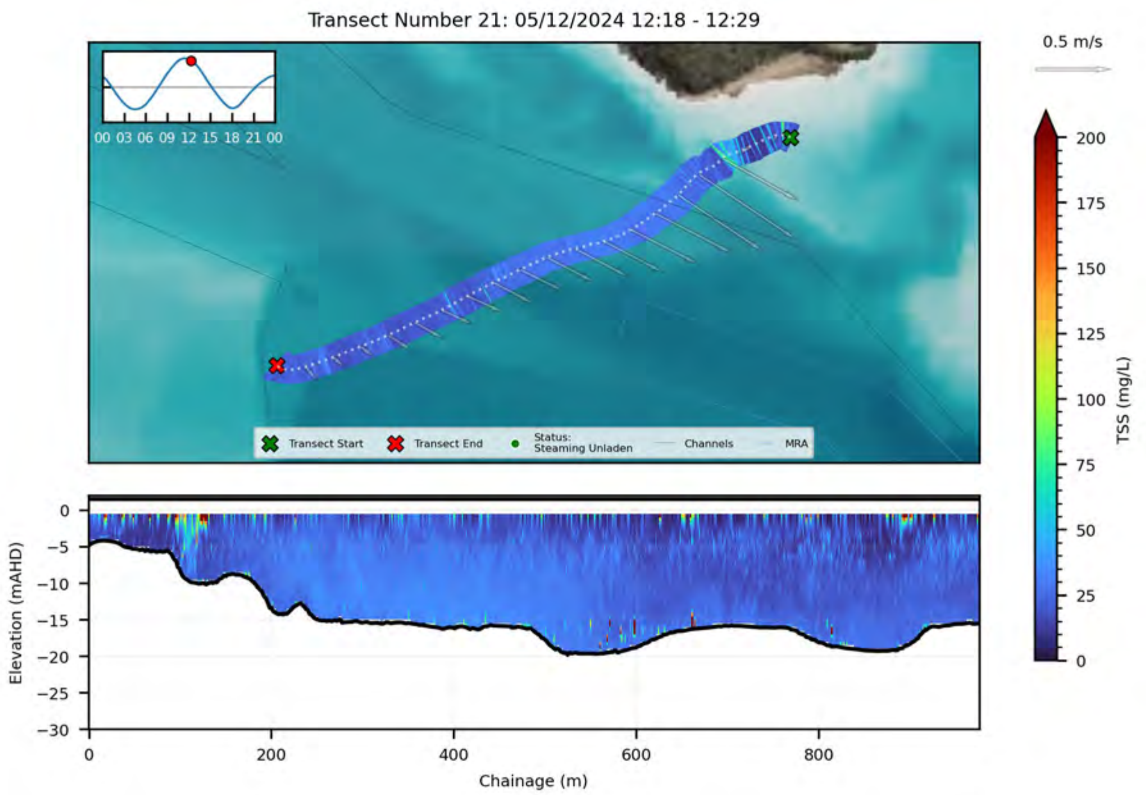

Transect Number 16: 05/12/2024 11:22 - 11:39
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)

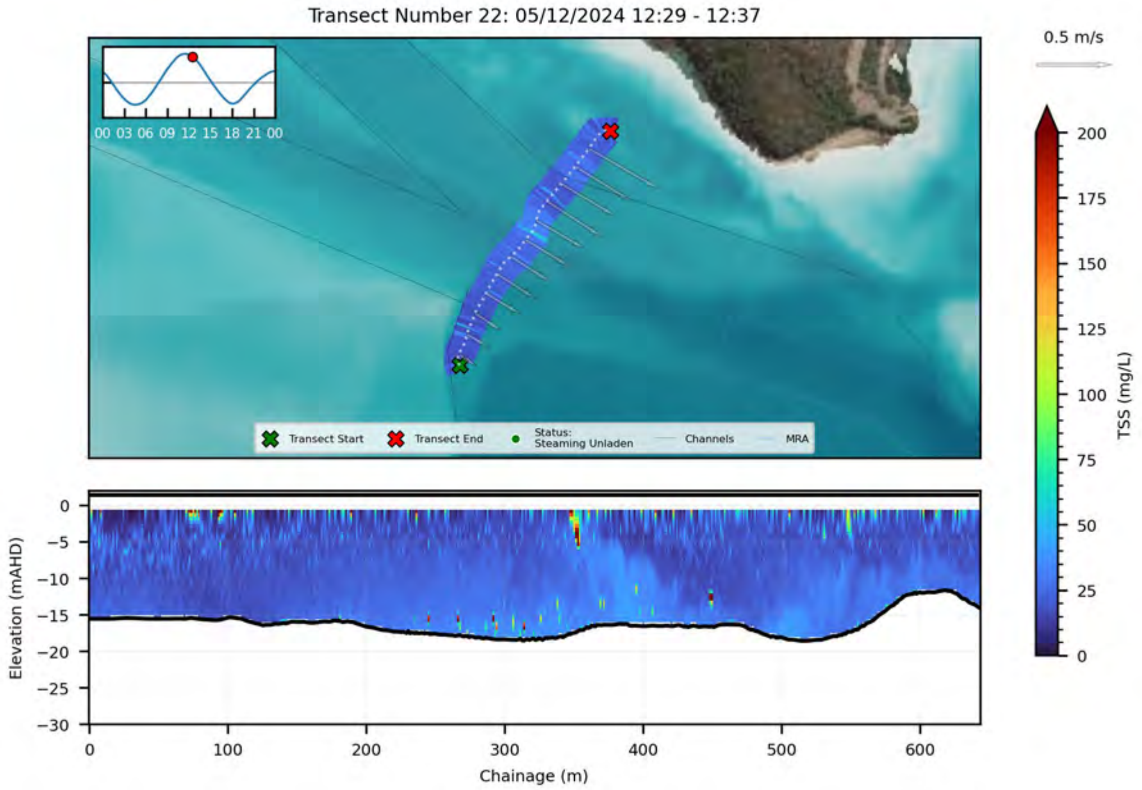

Transect Number 17: 05/12/2024 11:39 - 11:56
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
0.5 m/s
TSS (mg/L)
YSI
Elevation (mAHD)
Chainage (m)

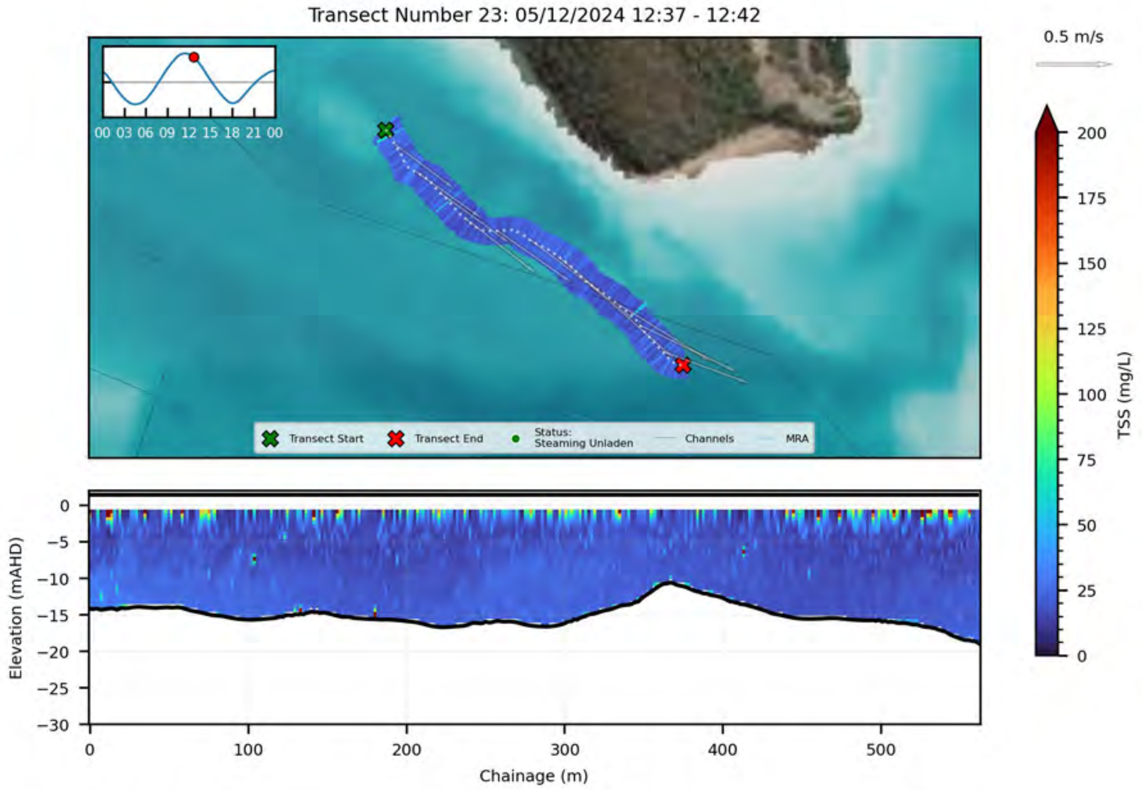

Transect Number 18: 05/12/2024 11:56 - 12:01
00 03 06 09 12 15 18 21 00
0.5 m/s
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
0
100
200
300
400
500
Chainage (m)

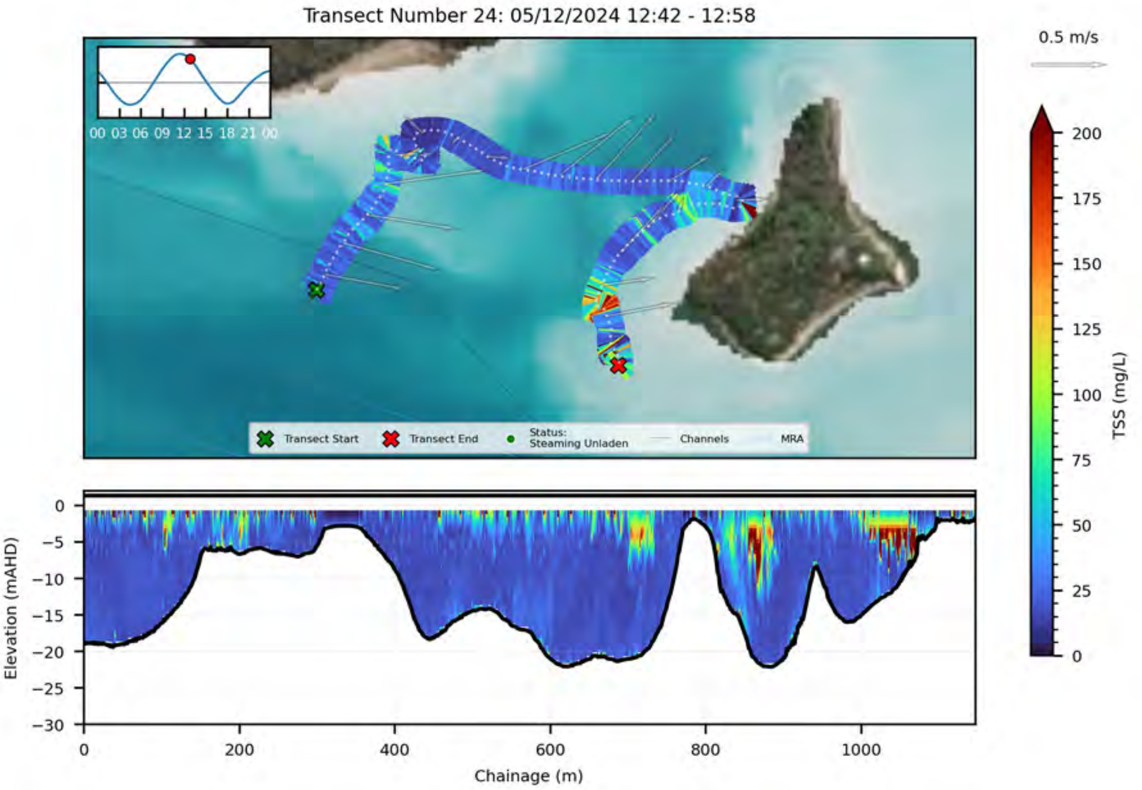

Transect Number 19: 05/12/2024 12:01 - 12:06
00 03 06 09 12 15 18 21 00
0.5 m/s
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
0
100
200
300
400
500
600
Chainage (m)

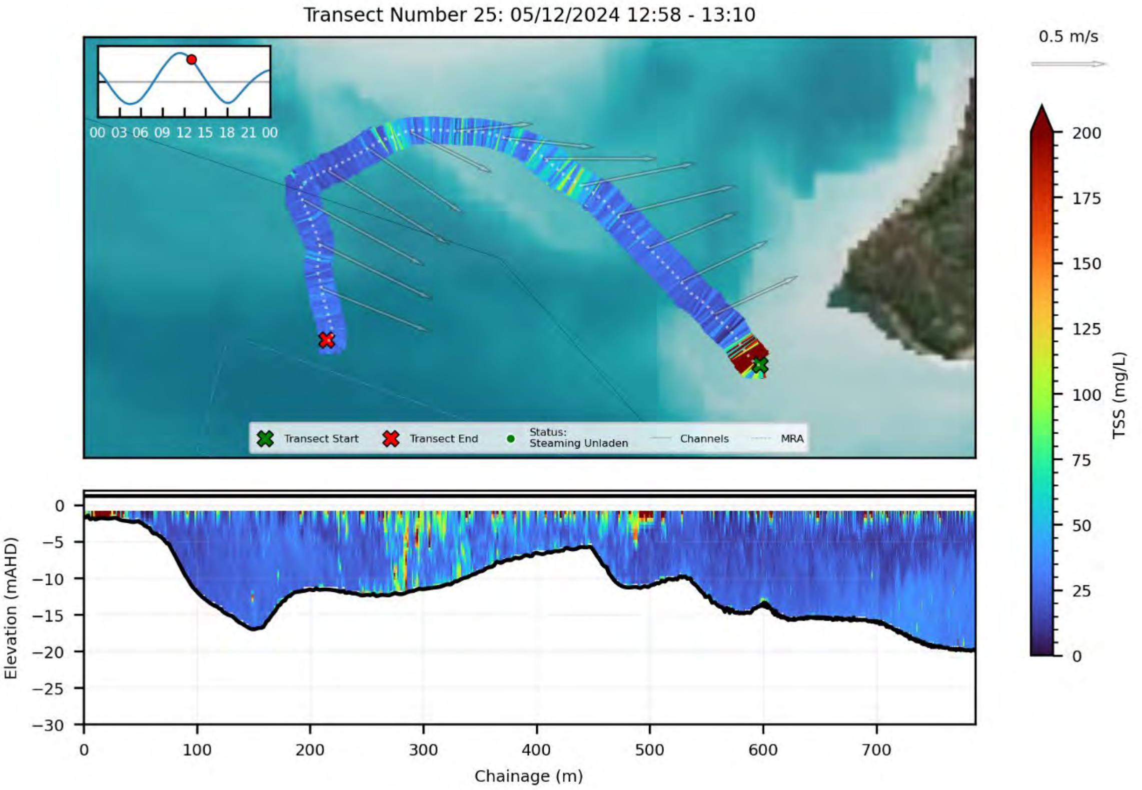

Transect Number 20: 05/12/2024 12:06 - 12:18
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

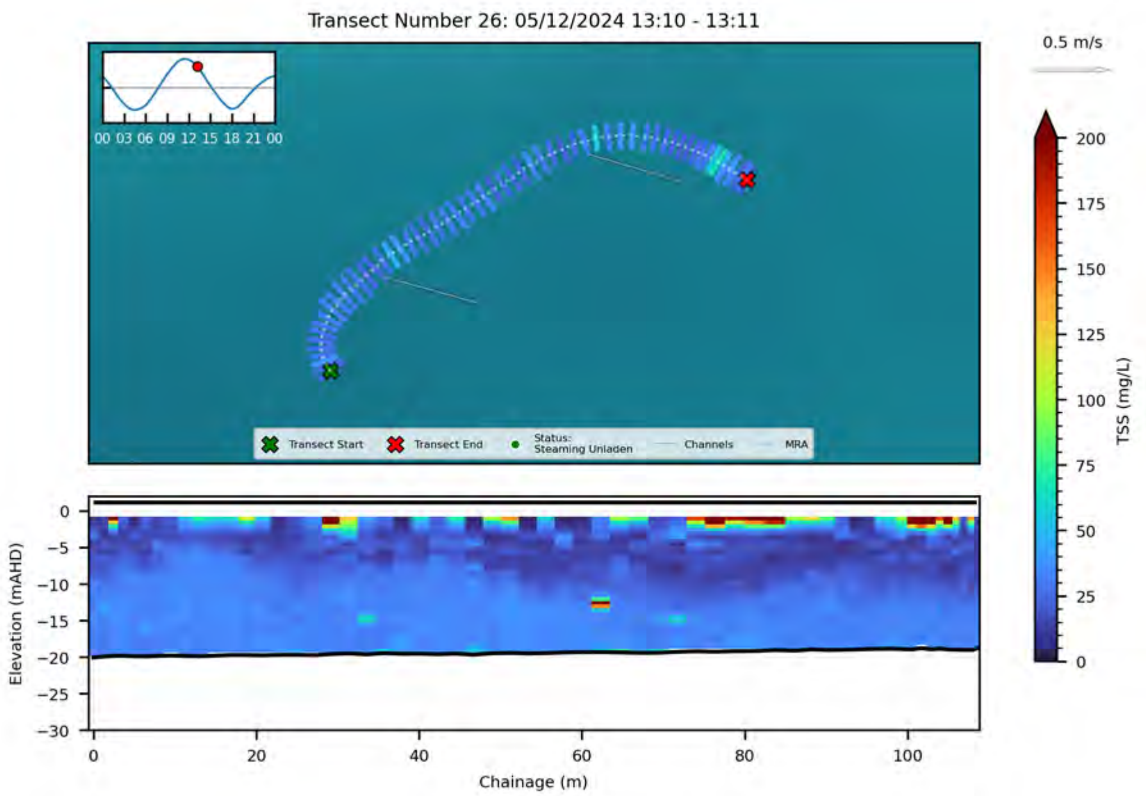

Transect Number 21: 05/12/2024 12:18 - 12:29
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

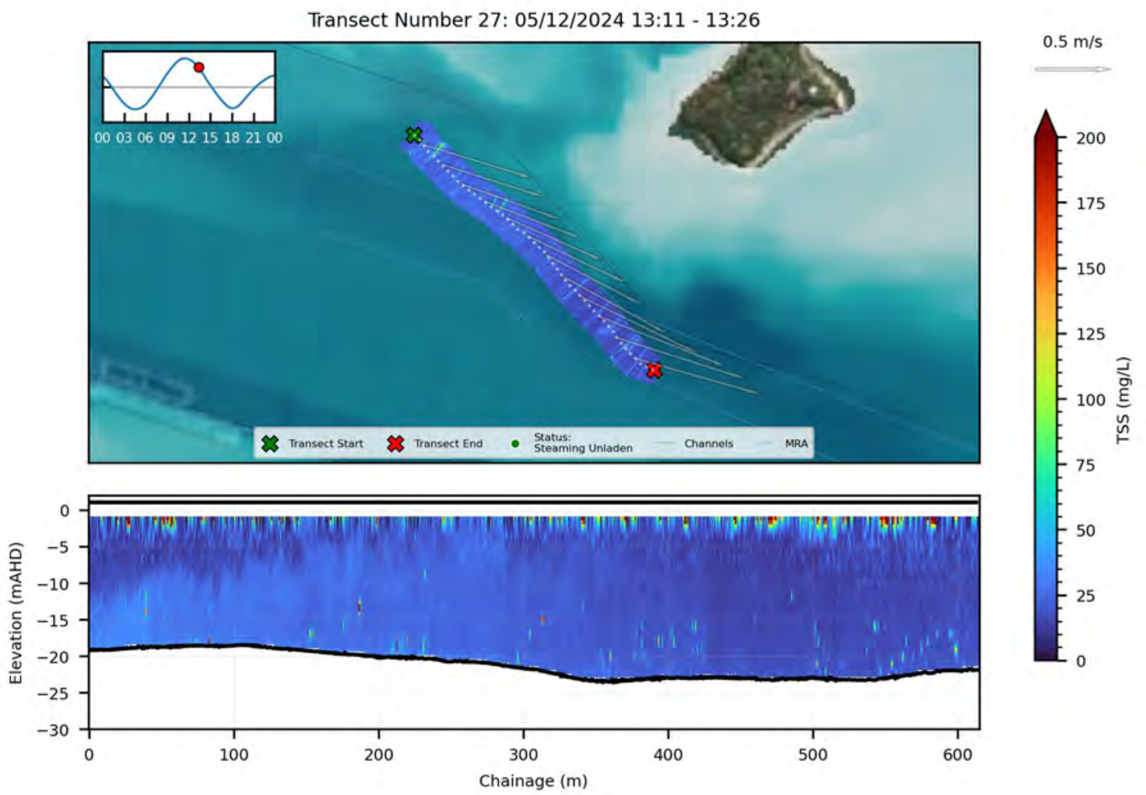

Transect Number 22: 05/12/2024 12:29 - 12:37
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
Chainage (m)
0
100
200
300
400
500
600

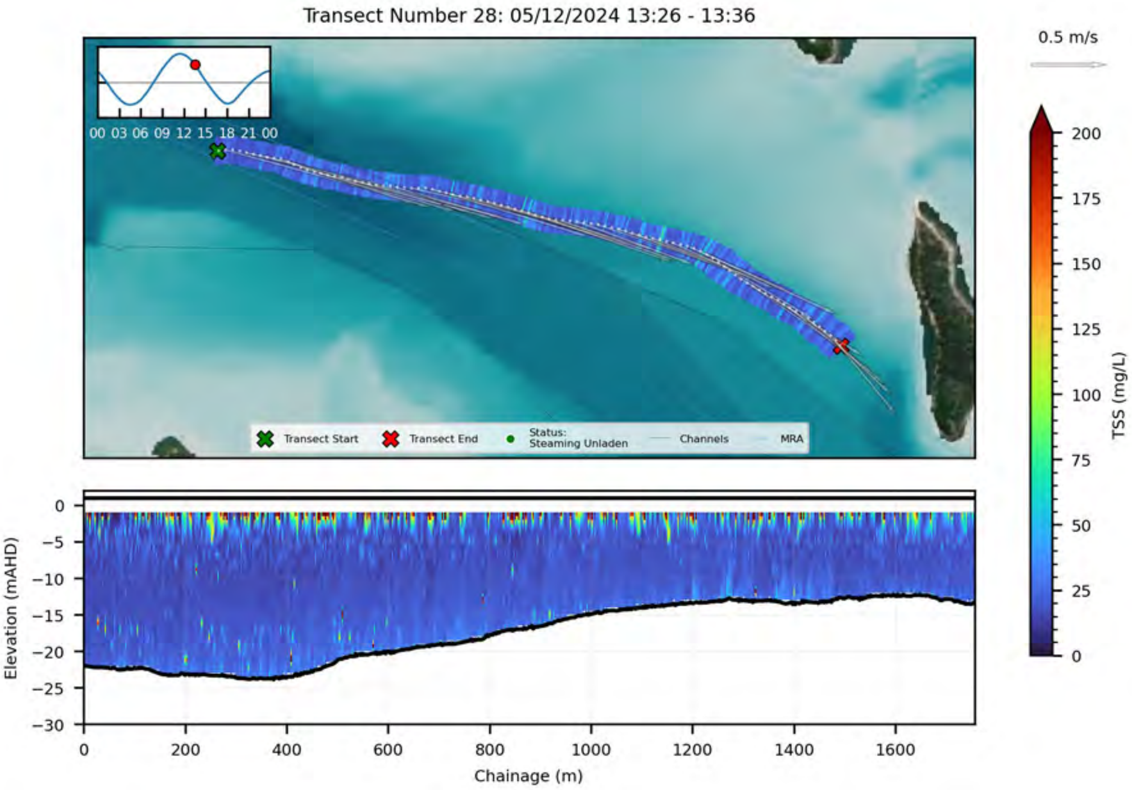

Transect Number 23: 05/12/2024 12:37 - 12:42
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
Chainage (m)
0
100
200
300
400
500

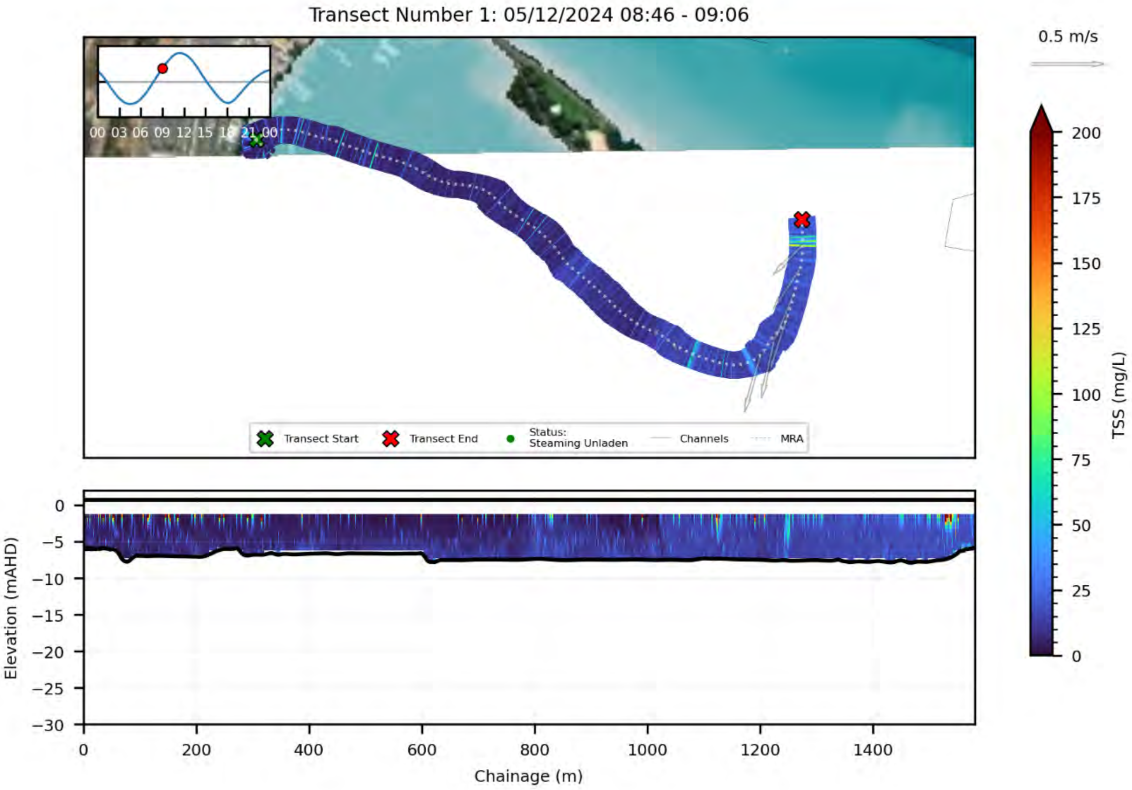

Transect Number 24: 05/12/2024 12:42 - 12:58
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)


Transect Number 25: 05/12/2024 12:58 - 13:10
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)


Transect Number 26: 05/12/2024 13:10 - 13:11
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
Chainage (m)
0
20
40
60
80
100

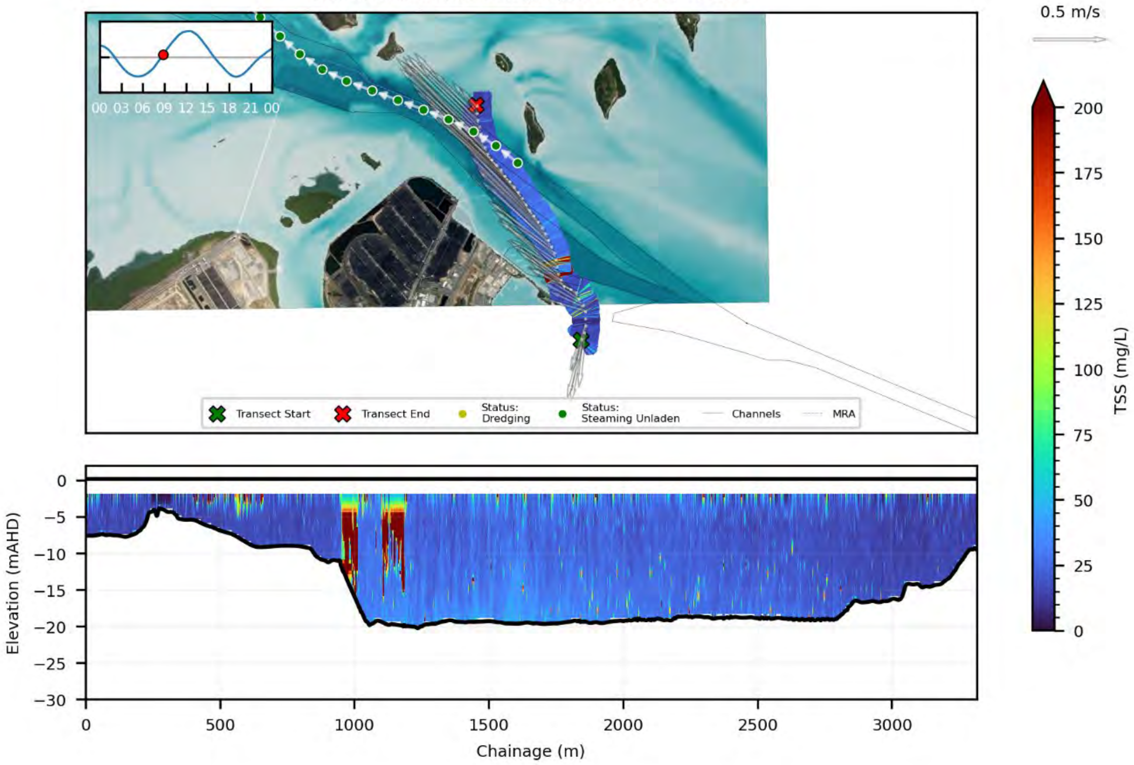

Transect Number 27: 05/12/2024 13:11 - 13:26
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
Chainage (m)
0
100
200
300
400
500
600


Transect Number 28: 05/12/2024 13:26 - 13:36
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)
0
−5
−10
−15
−20
−25
−30
0
200
400
600
800
1000
1200
1400
1600

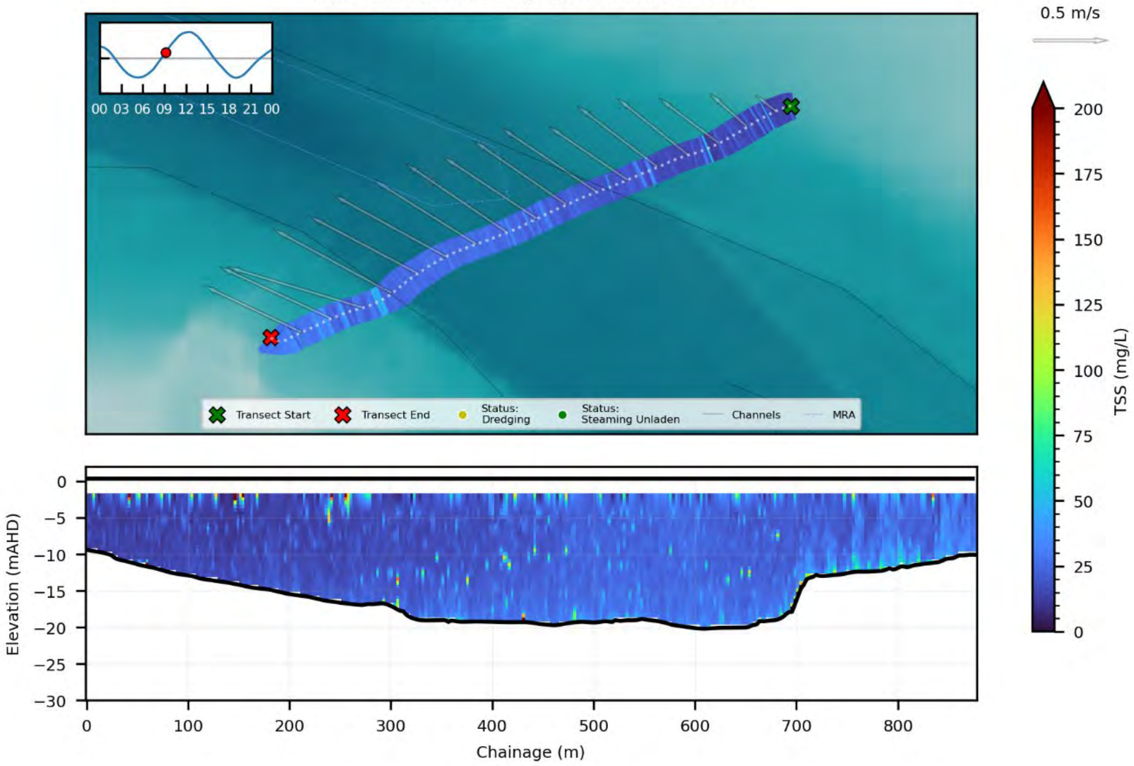

Transect Number 1: 05/12/2024 08:46 - 09:06
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Unladen
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)
0
−5
−10
−15
−20
−25
−30
0
200
400
600
800
1000
1200
1400

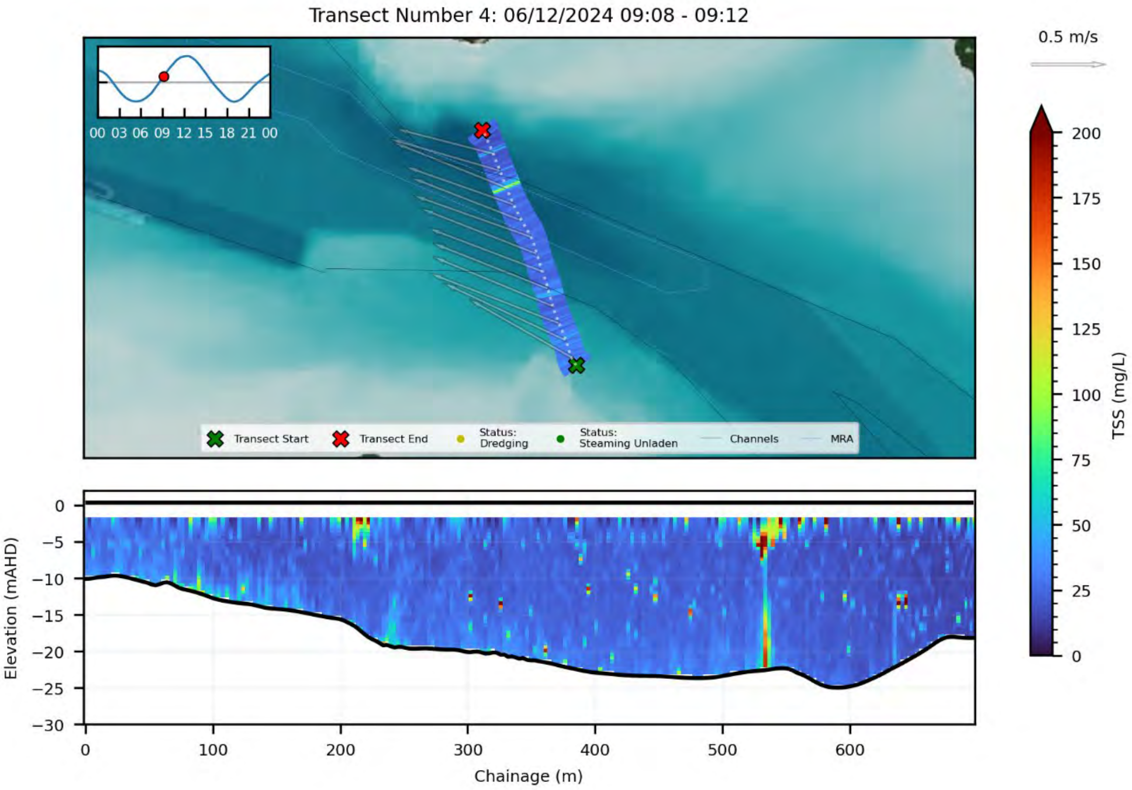
Annex O ADCP Derived TSS Transects 6th December 2024

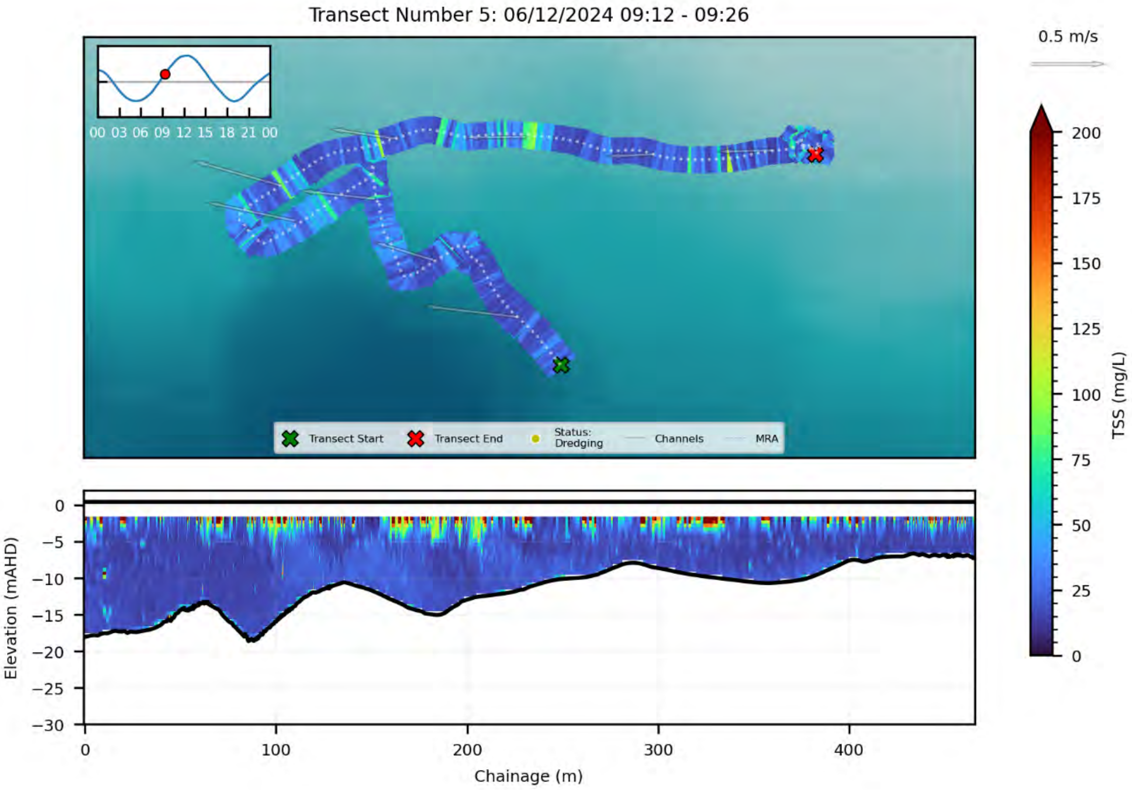
Transect Number 2: 06/12/2024 08:43 - 09:03

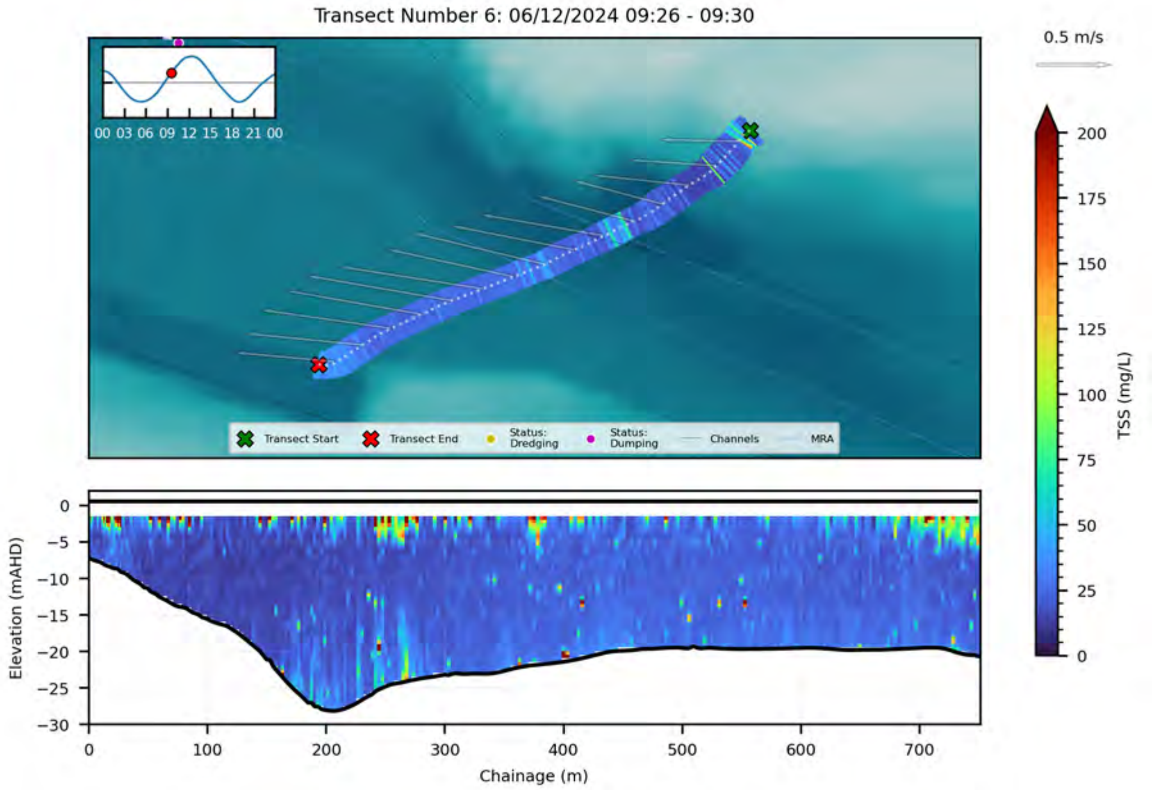


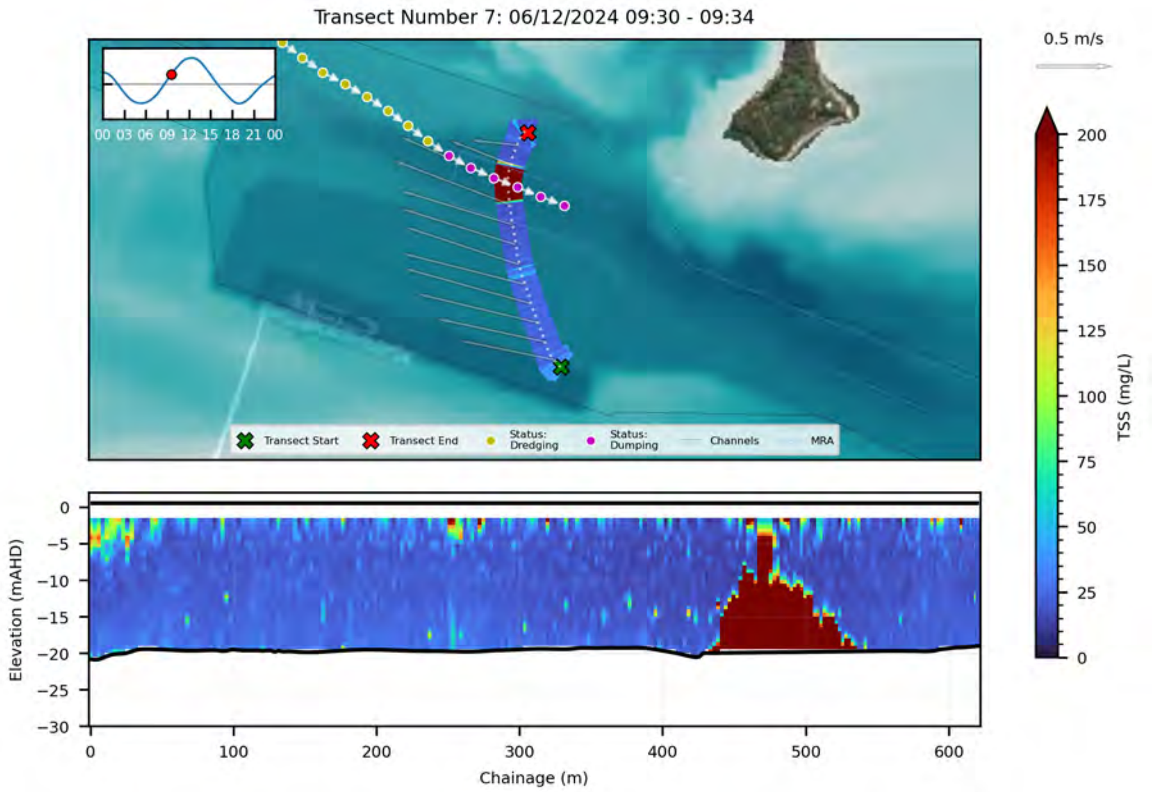
Transect Number 3: 06/12/2024 09:03 - 09:08

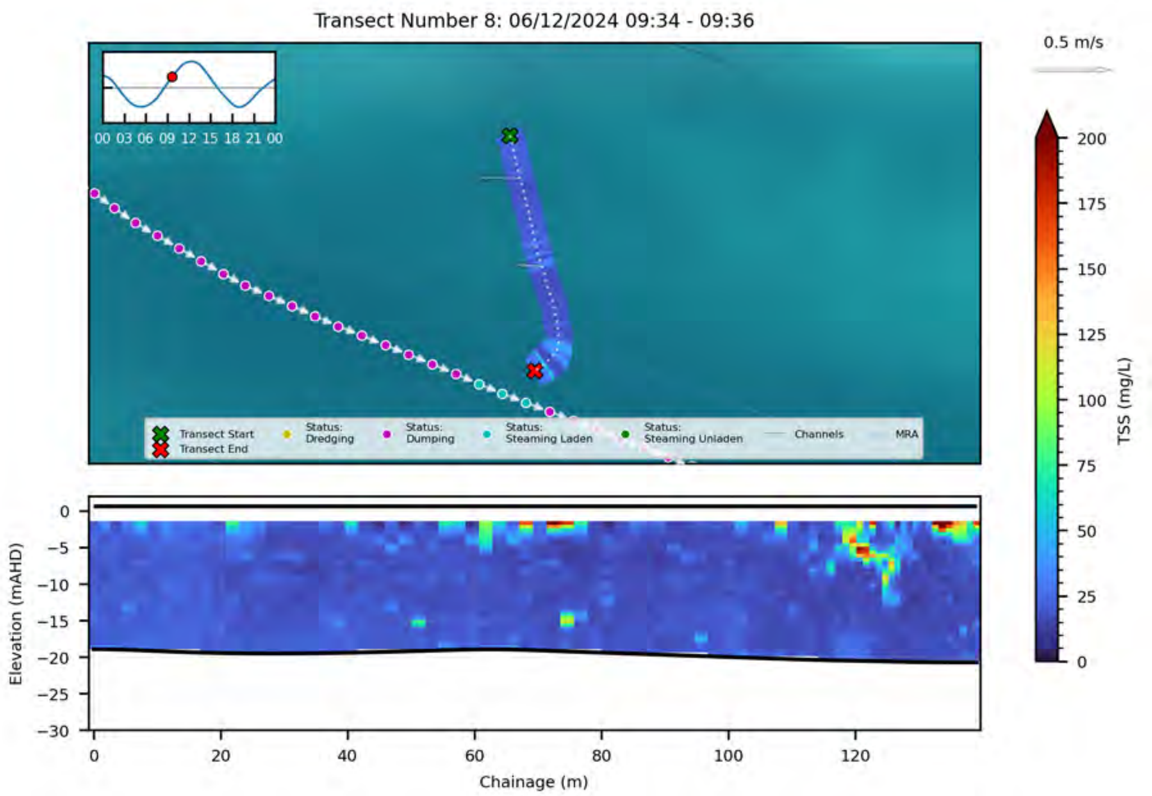


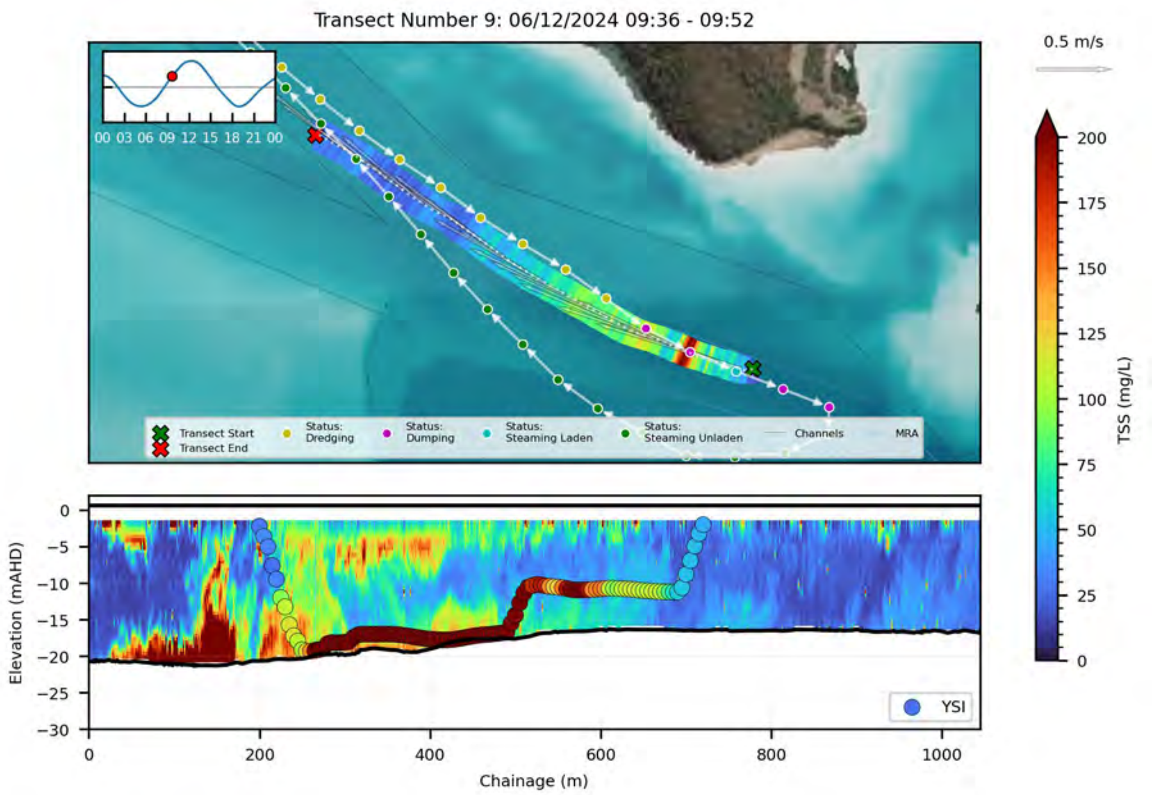

Transect Number 4: 06/12/2024 09:08 - 09:12
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

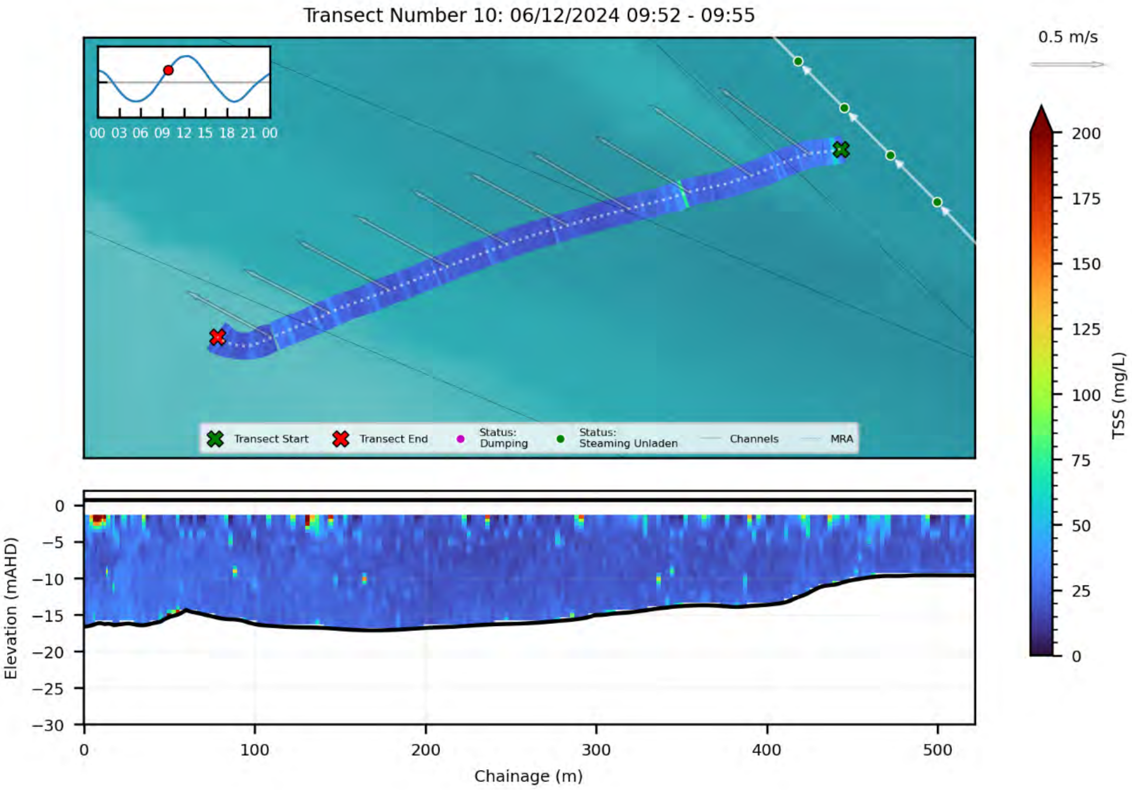

Transect Number 5: 06/12/2024 09:12 - 09:26
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

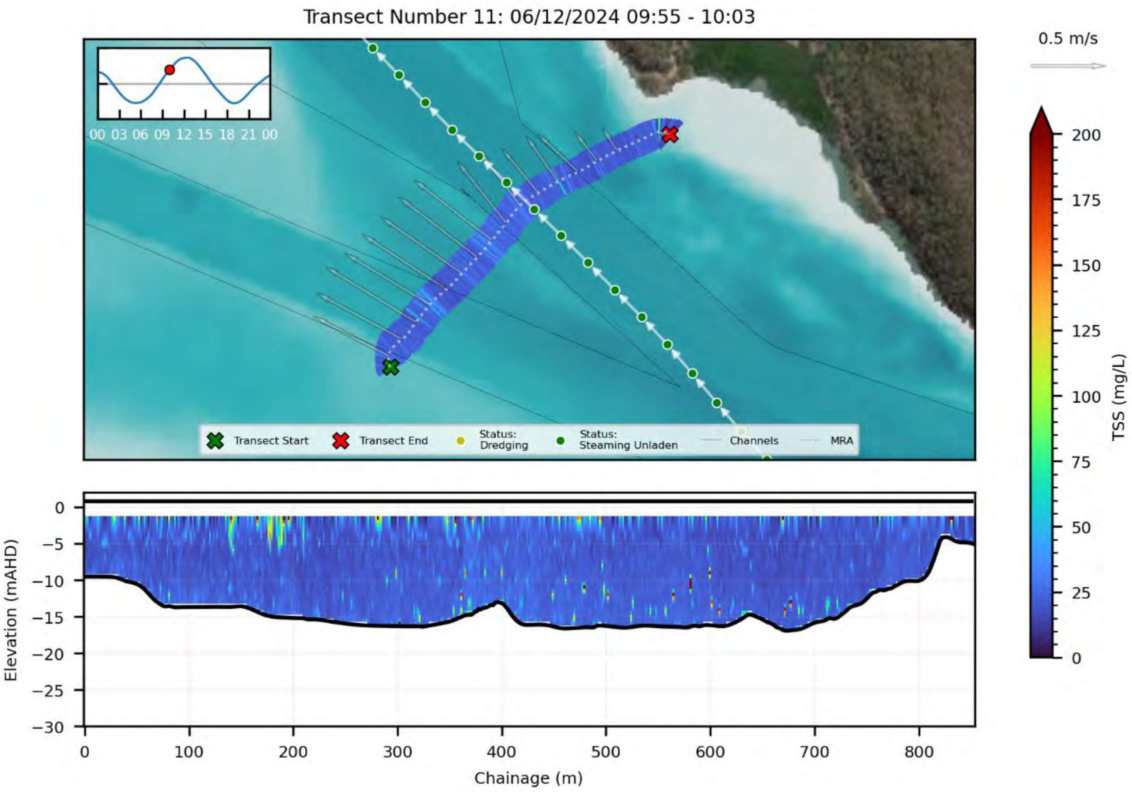

Transect Number 6: 06/12/2024 09:26 - 09:30
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Dumping
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
Chainage (m)
0
100
200
300
400
500
600
700

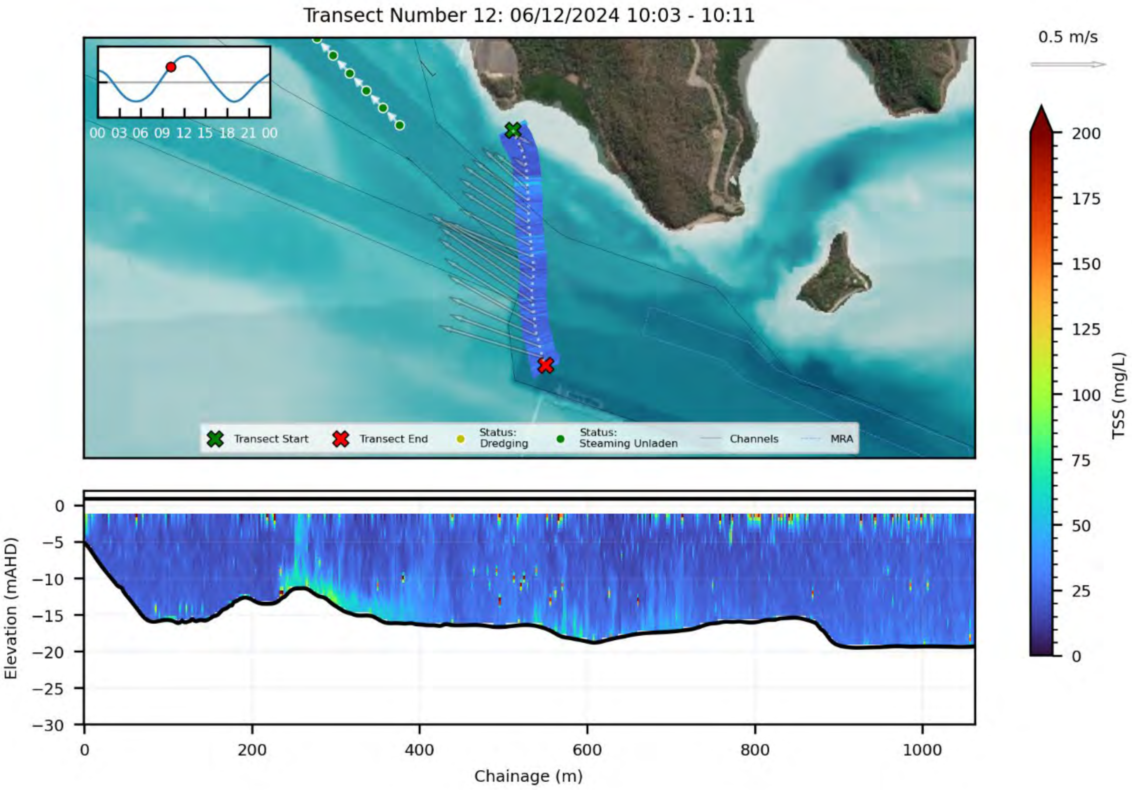

Transect Number 7: 06/12/2024 09:30 - 09:34
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Dumping
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
Chainage (m)
0
100
200
300
400
500
600

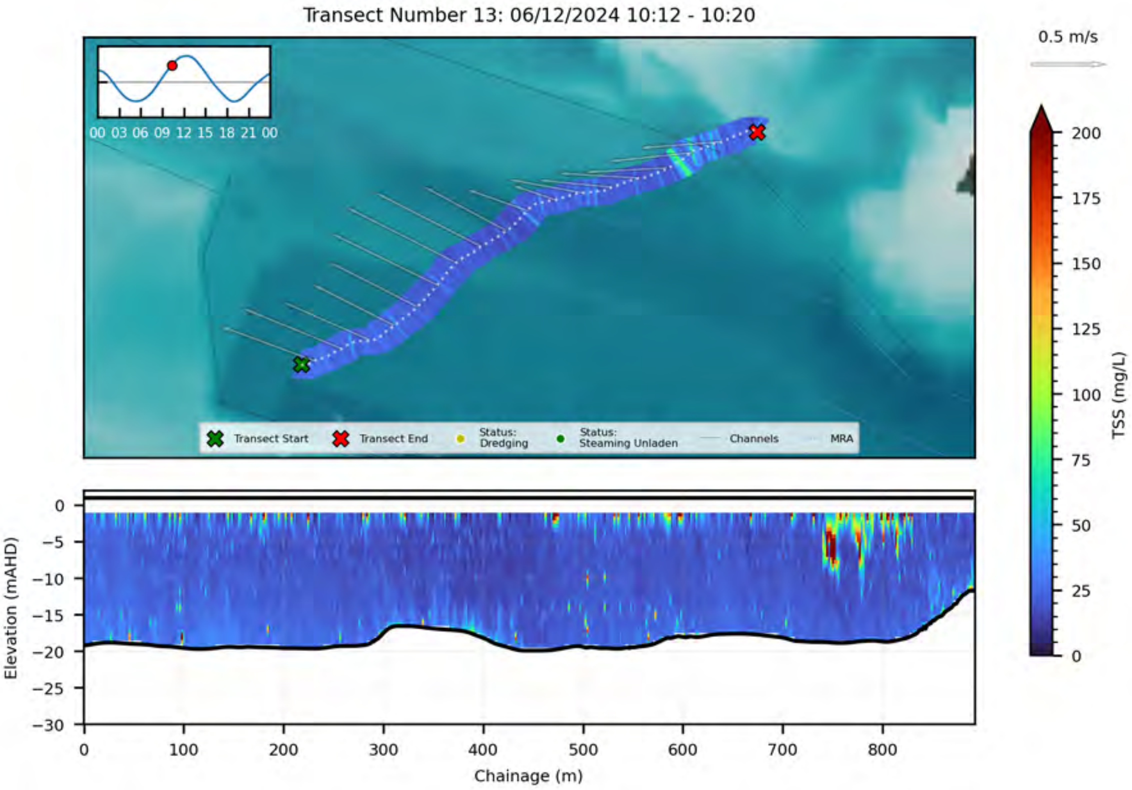

Transect Number 8: 06/12/2024 09:34 - 09:36
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Dumping
Status: Steaming Laden
Status: Steaming Unladen
Channels
MRA
Elevation (mAHD)
Chainage (m)
TSS (mg/L)


Transect Number 9: 06/12/2024 09:36 - 09:52
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Dumping
Status: Steaming Laden
Status: Steaming Unladen
Channels
MRA
YSI
Elevation (mAHD)
Chainage (m)
TSS (mg/L)

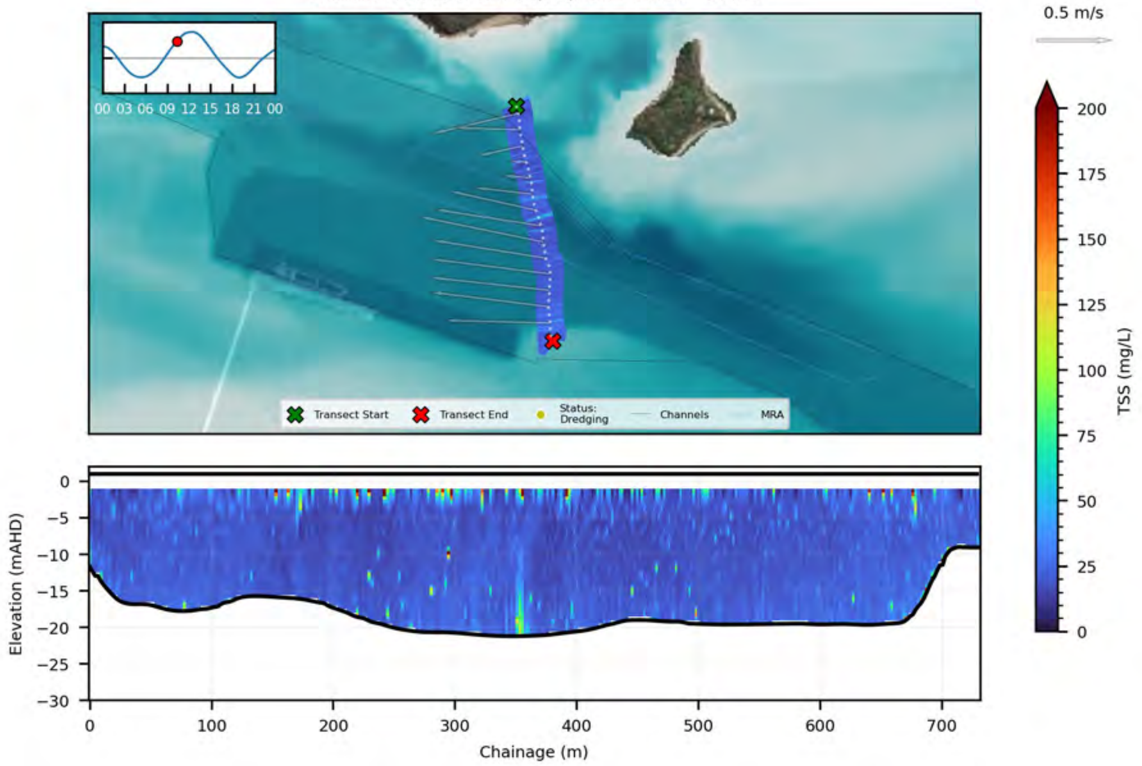

Transect Number 10: 06/12/2024 09:52 - 09:55
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)


Transect Number 11: 06/12/2024 09:55 - 10:03
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

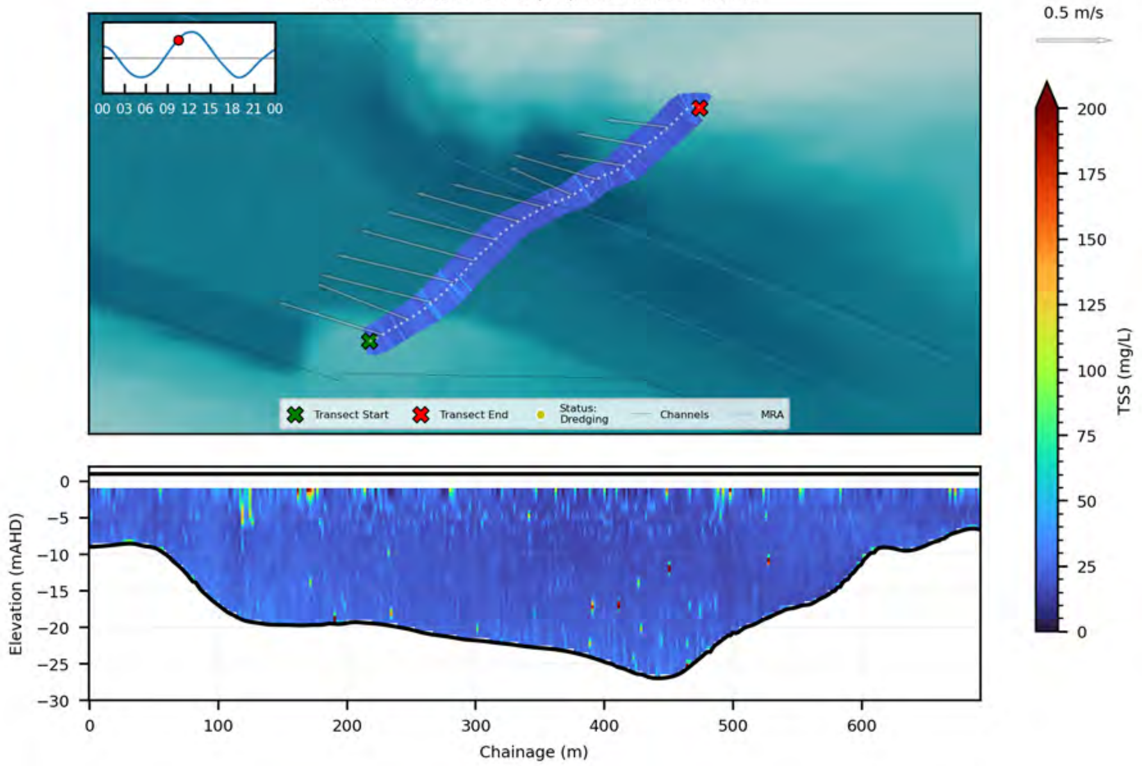

Transect Number 12: 06/12/2024 10:03 - 10:11
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)

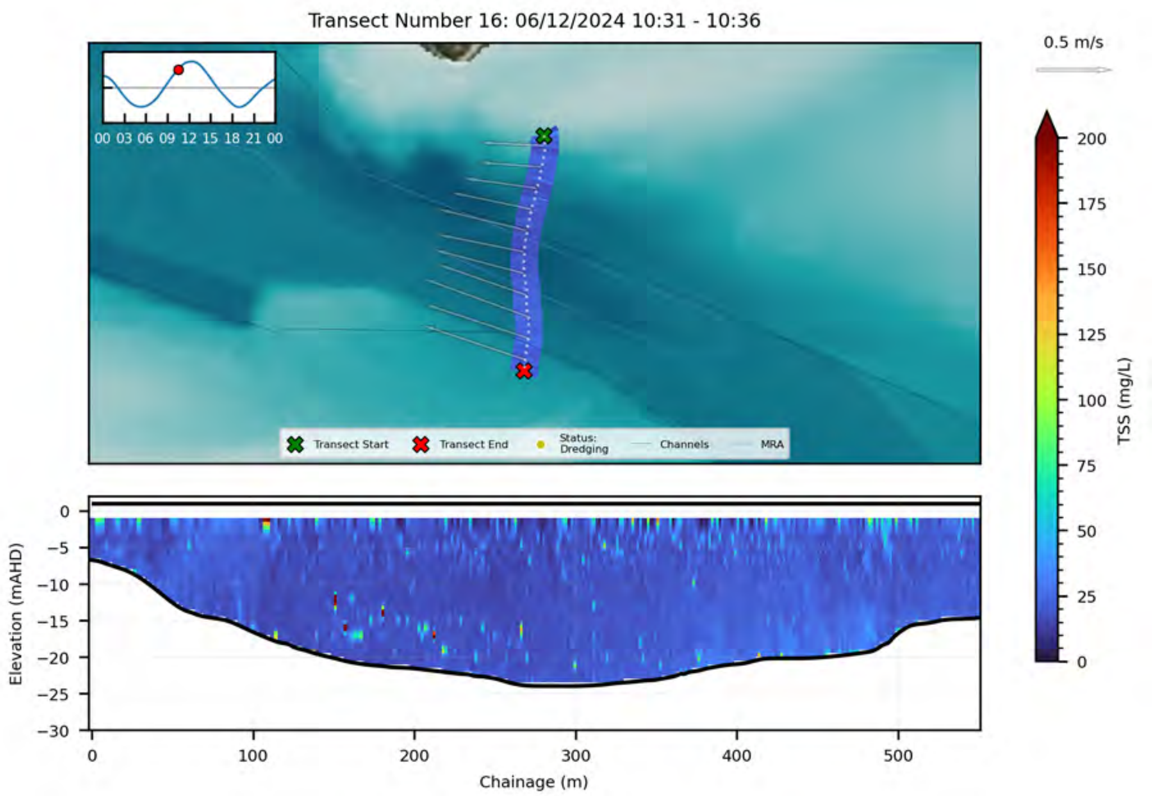

Transect Number 13: 06/12/2024 10:12 - 10:20
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)

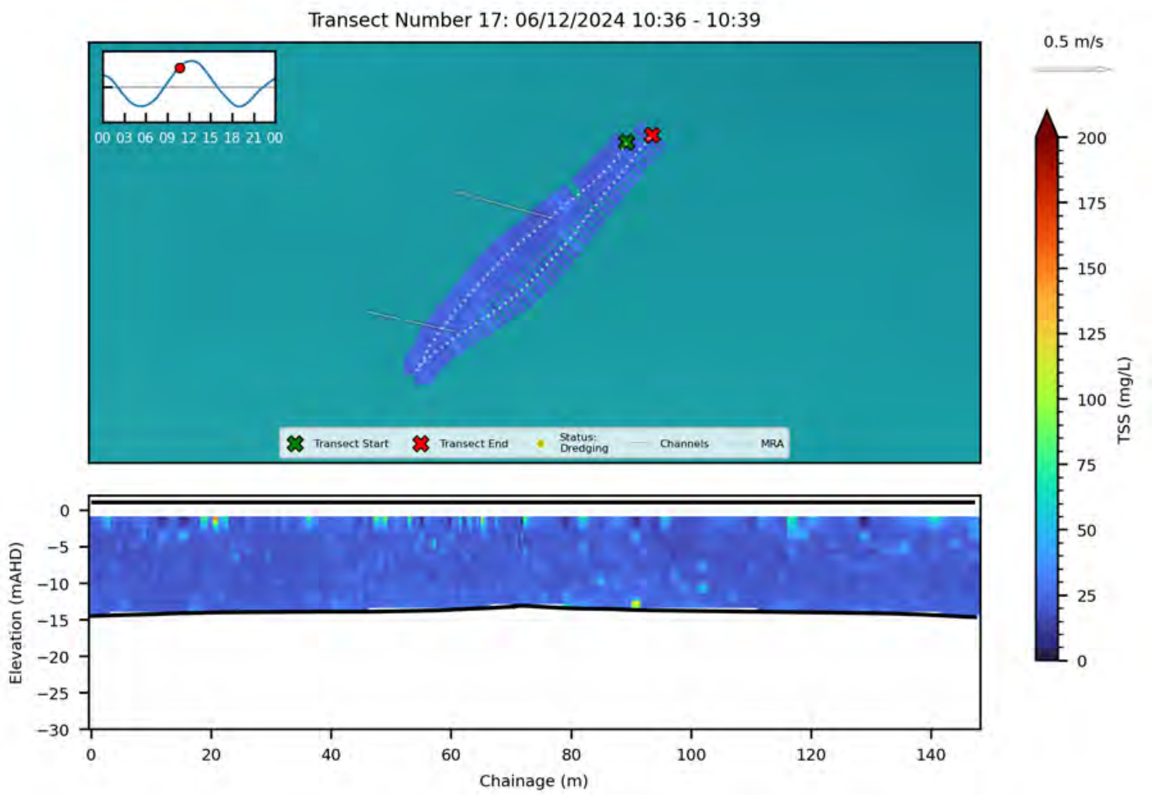
Transect Number 14: 06/12/2024 10:20 - 10:25

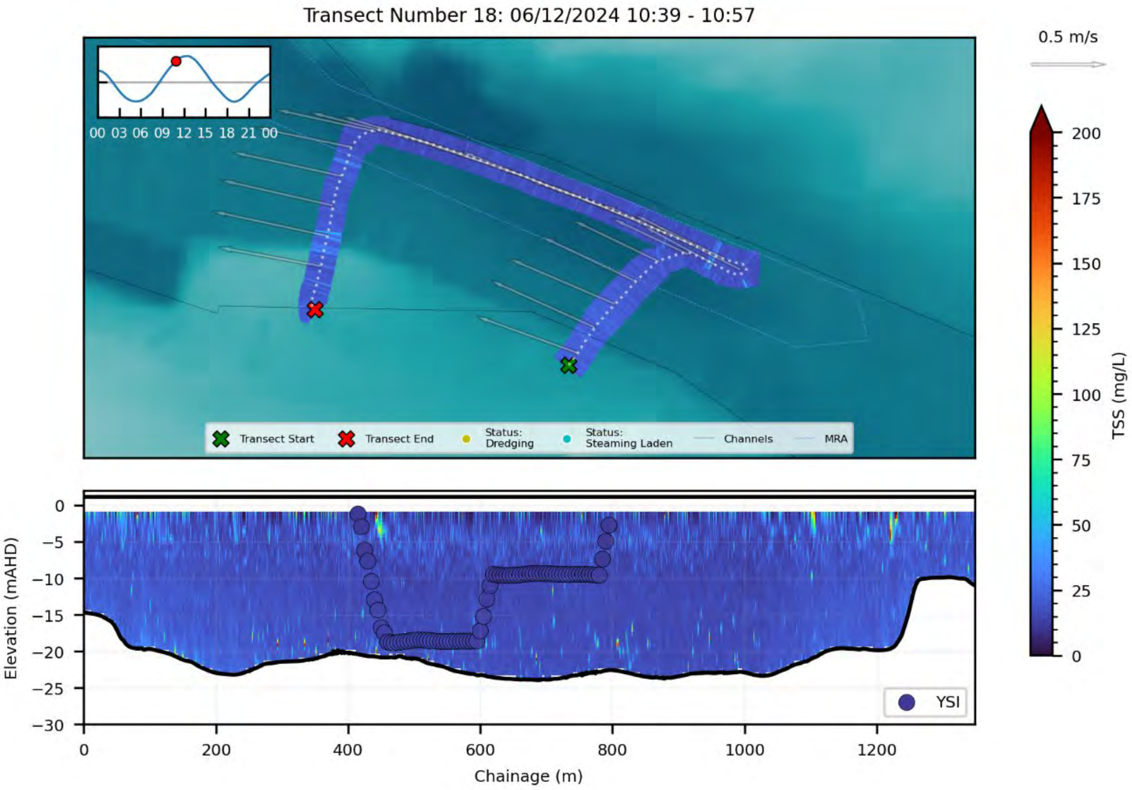


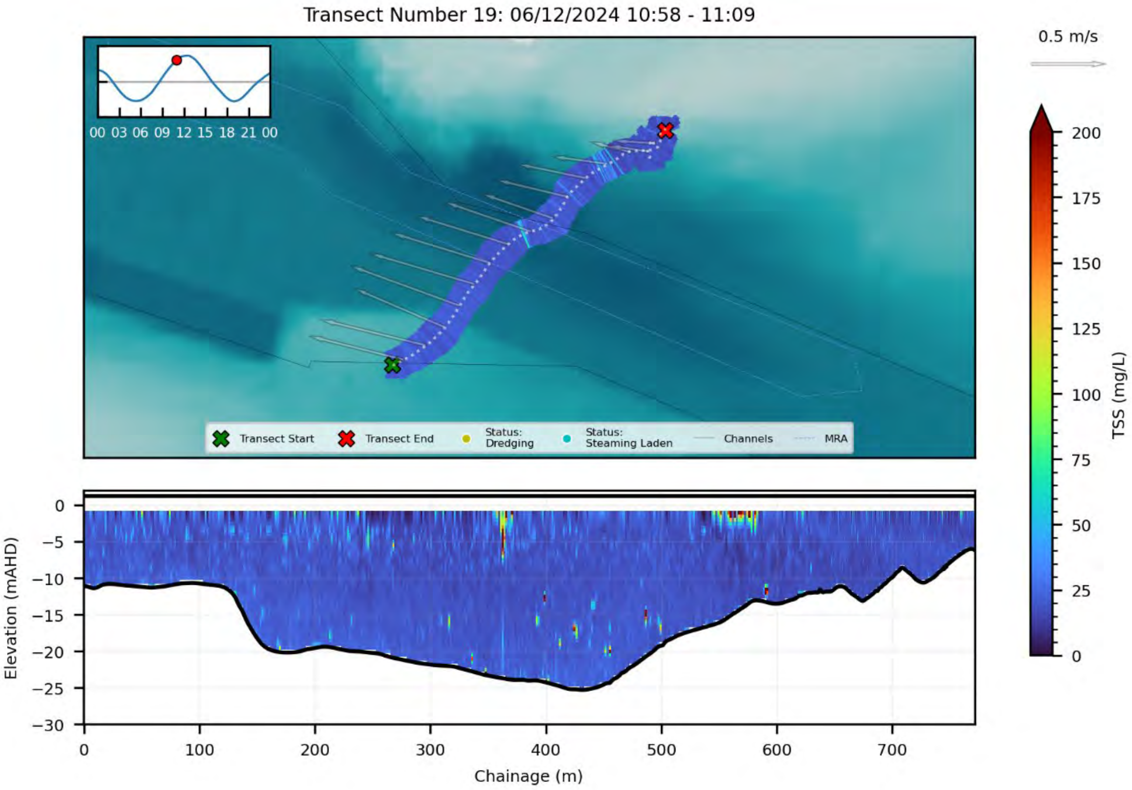
Transect Number 15: 06/12/2024 10:25 - 10:31

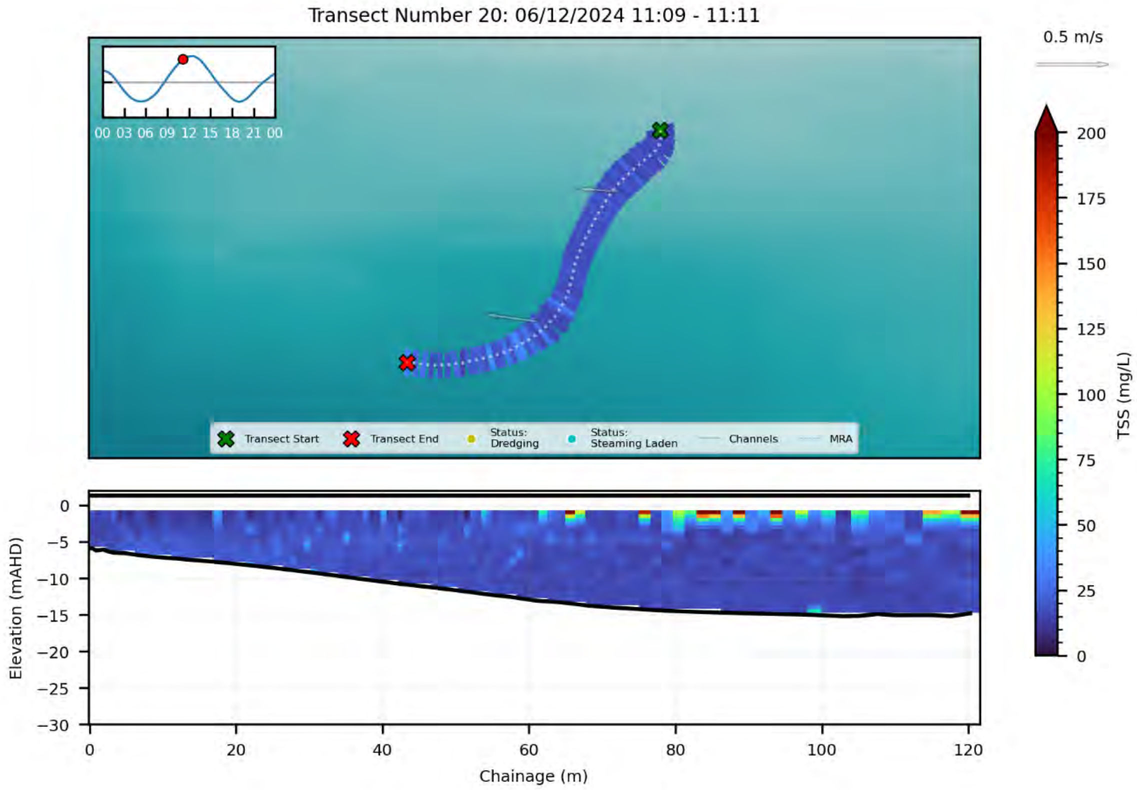



Transect Number 16: 06/12/2024 10:31 - 10:36
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

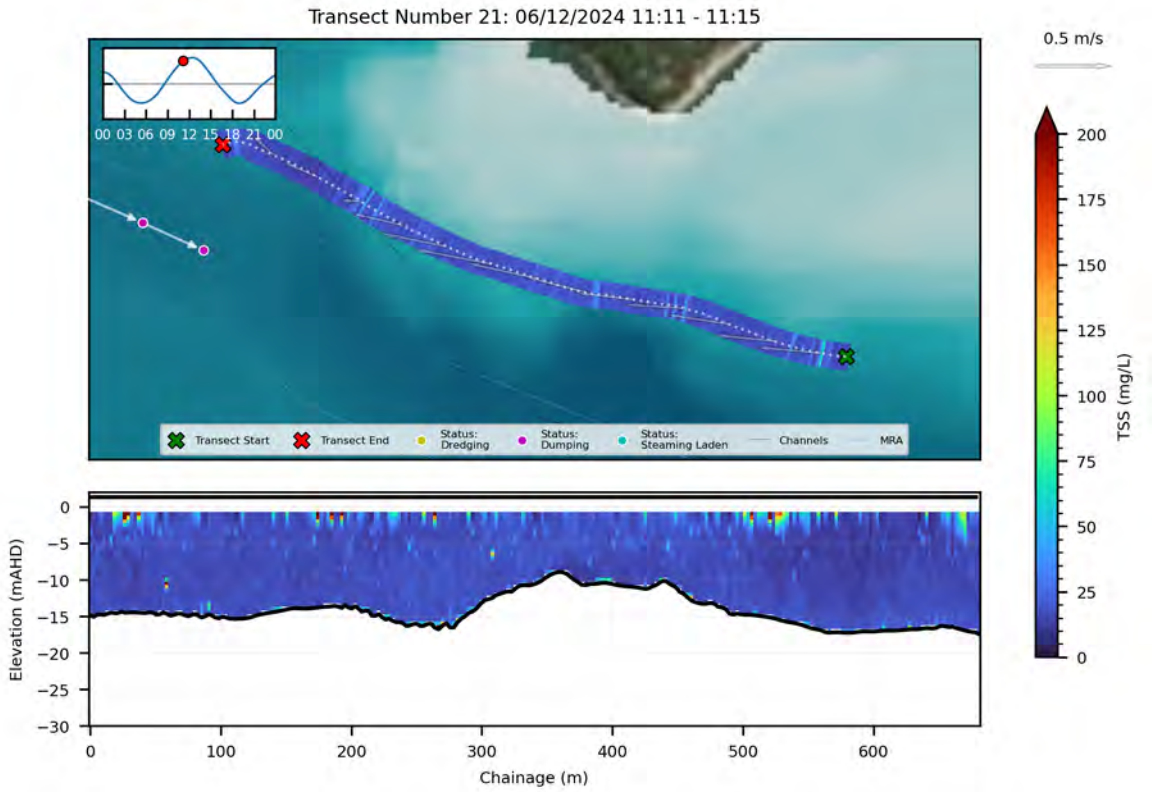

Transect Number 17: 06/12/2024 10:36 - 10:39
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)


Transect Number 18: 06/12/2024 10:39 - 10:57
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)
YSI

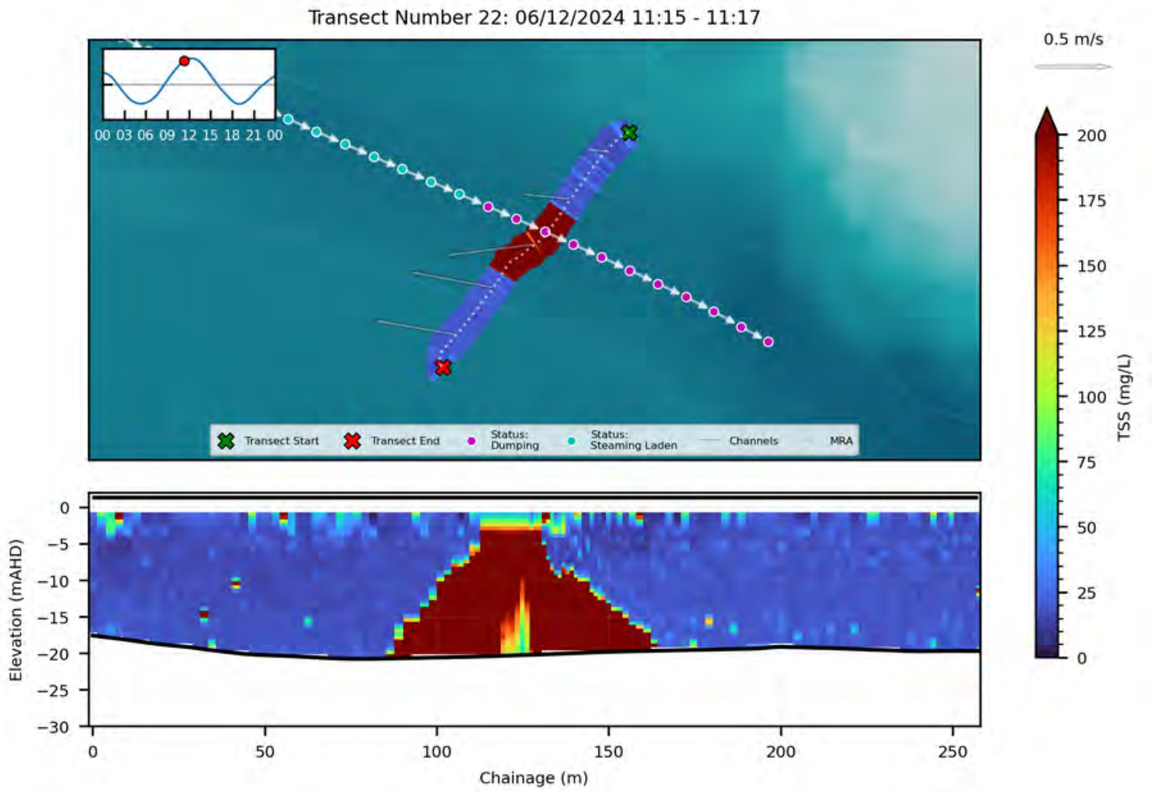

Transect Number 19: 06/12/2024 10:58 - 11:09
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

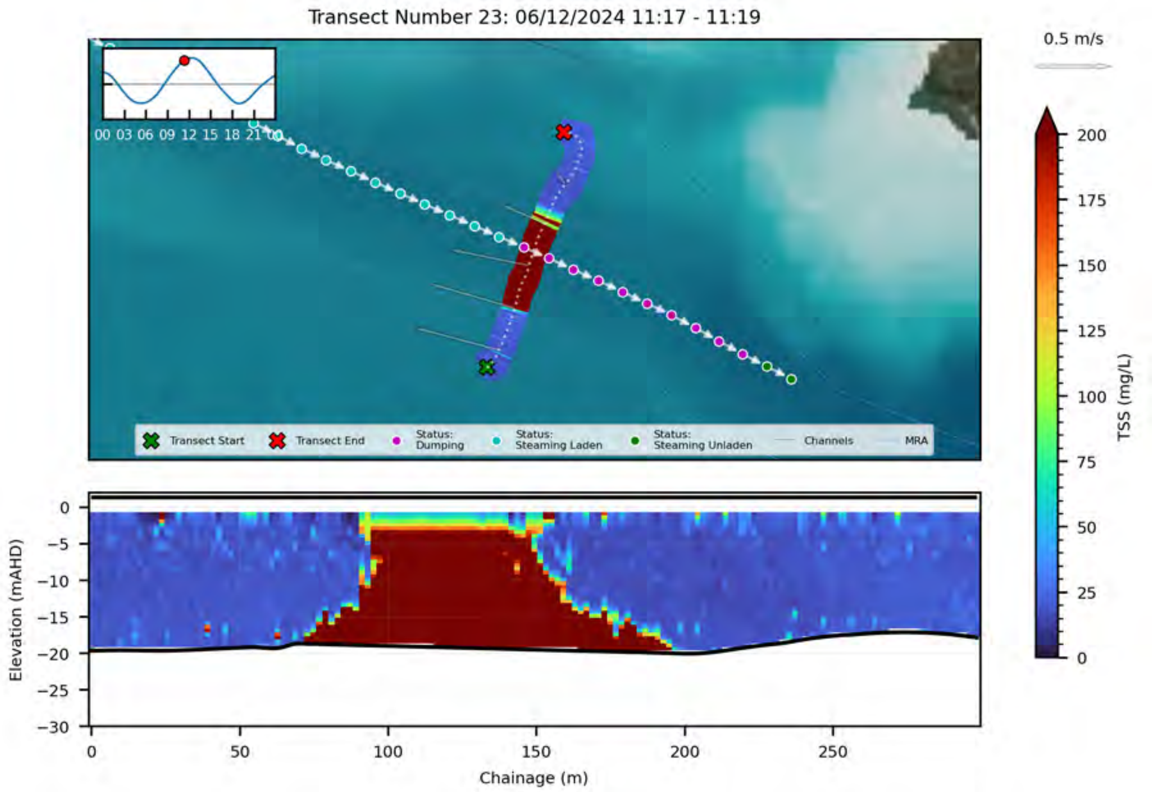


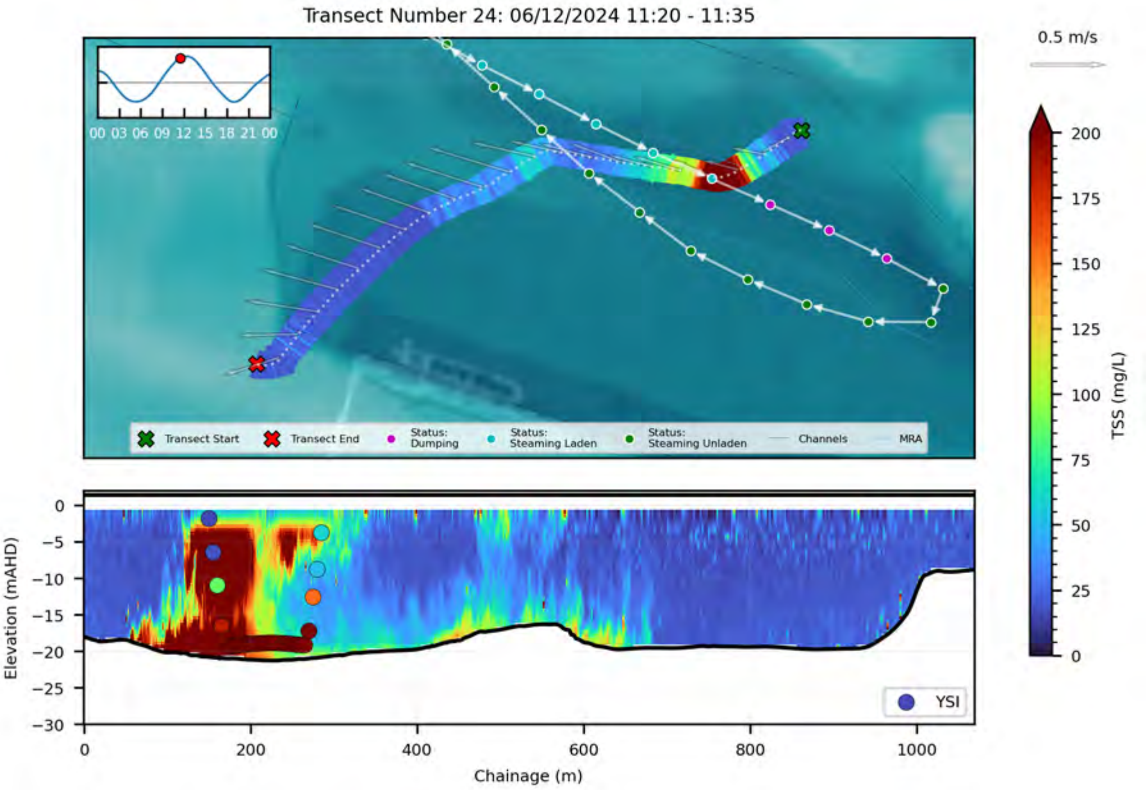
Transect Number 20: 06/12/2024 11:09 - 11:11
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

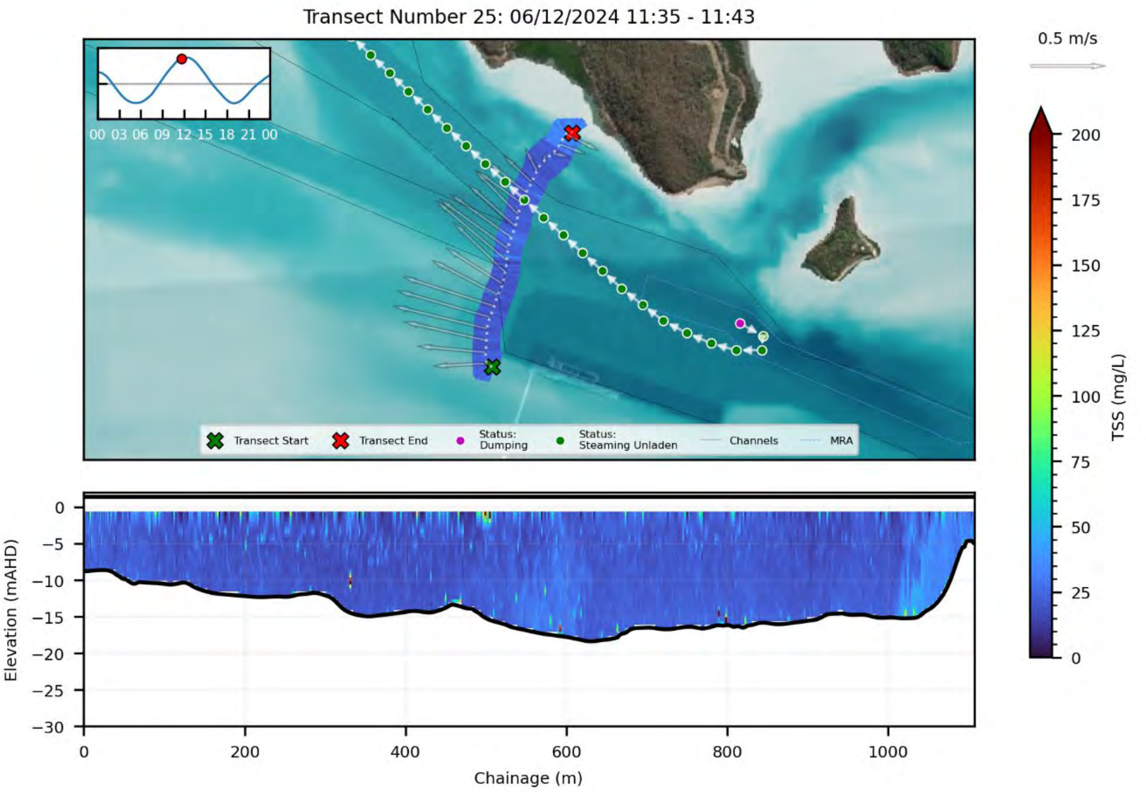


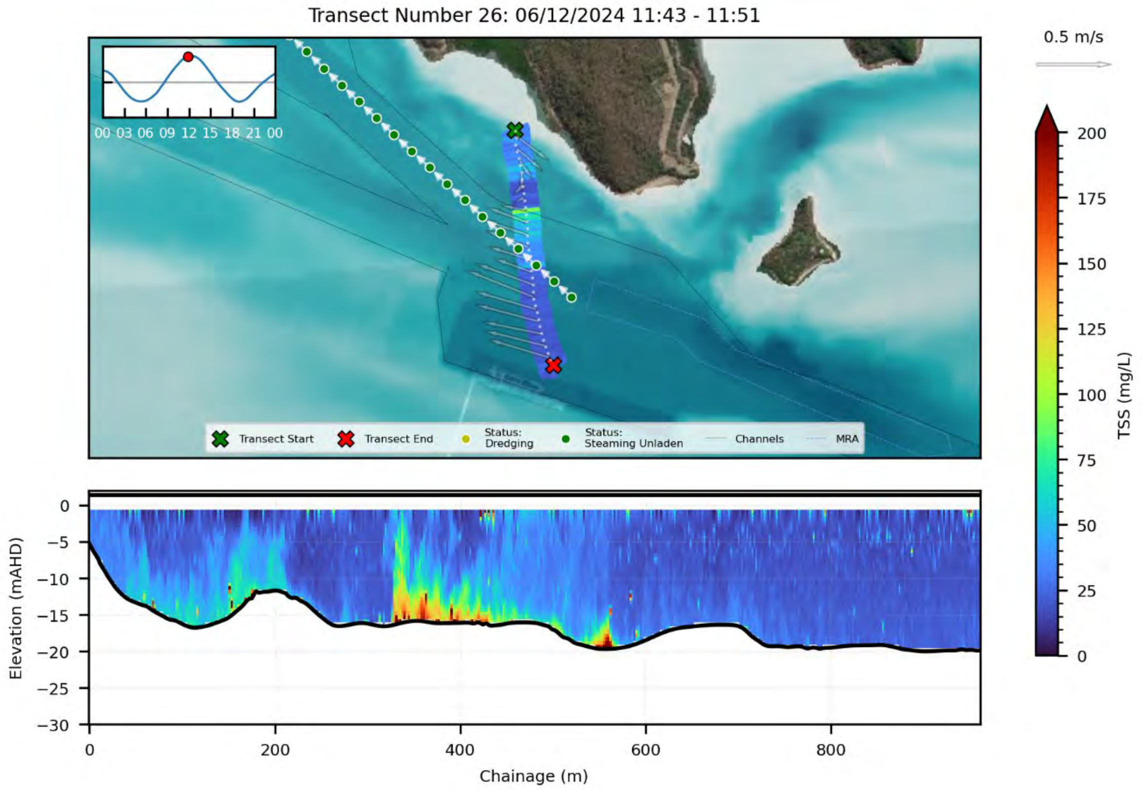
Transect Number 21: 06/12/2024 11:11 - 11:15
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Dumping
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

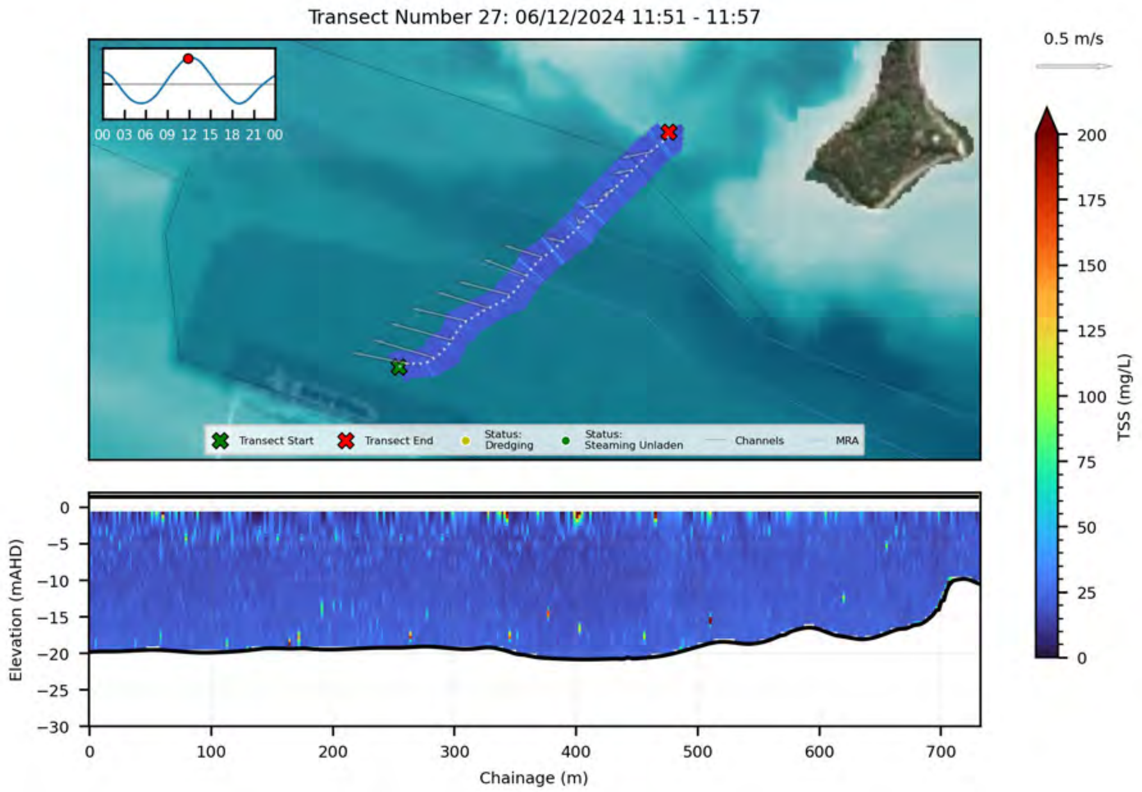

Transect Number 22: 06/12/2024 11:15 - 11:17
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

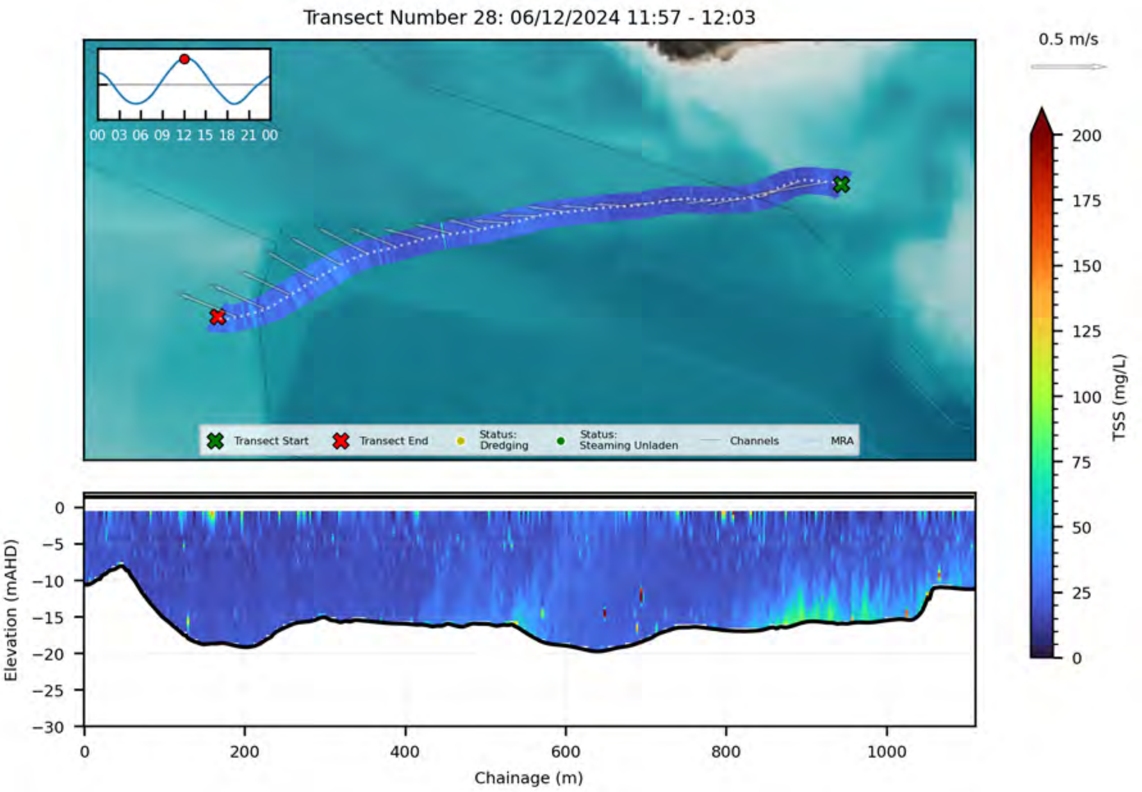

Transect Number 23: 06/12/2024 11:17 - 11:19
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Laden
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

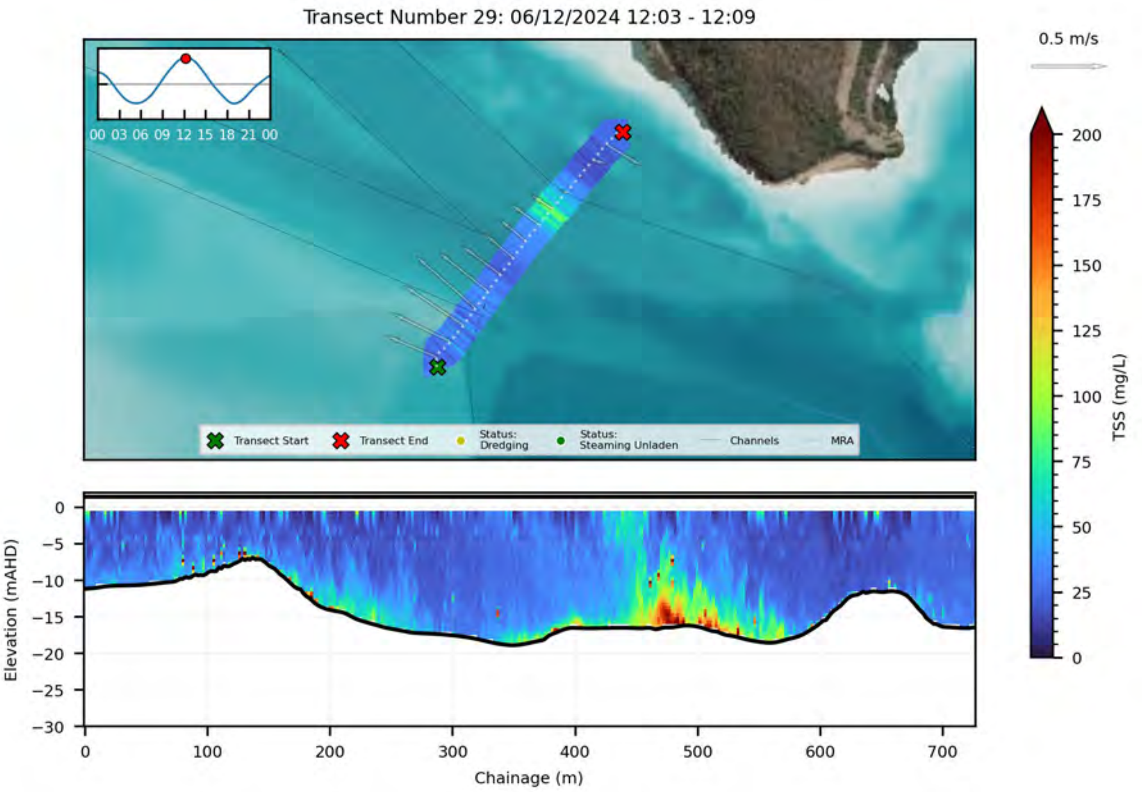

Transect Number 24: 06/12/2024 11:20 - 11:35
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Laden
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
YSI
Chainage (m)

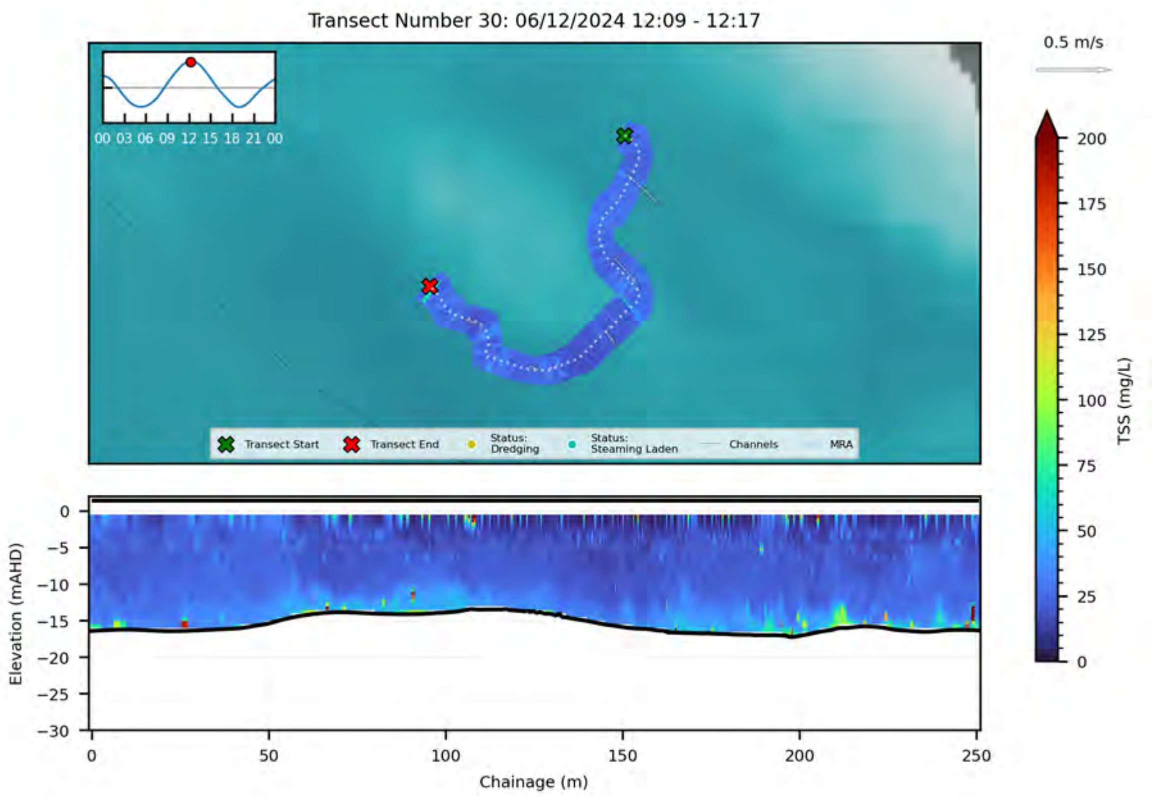

Transect Number 25: 06/12/2024 11:35 - 11:43
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

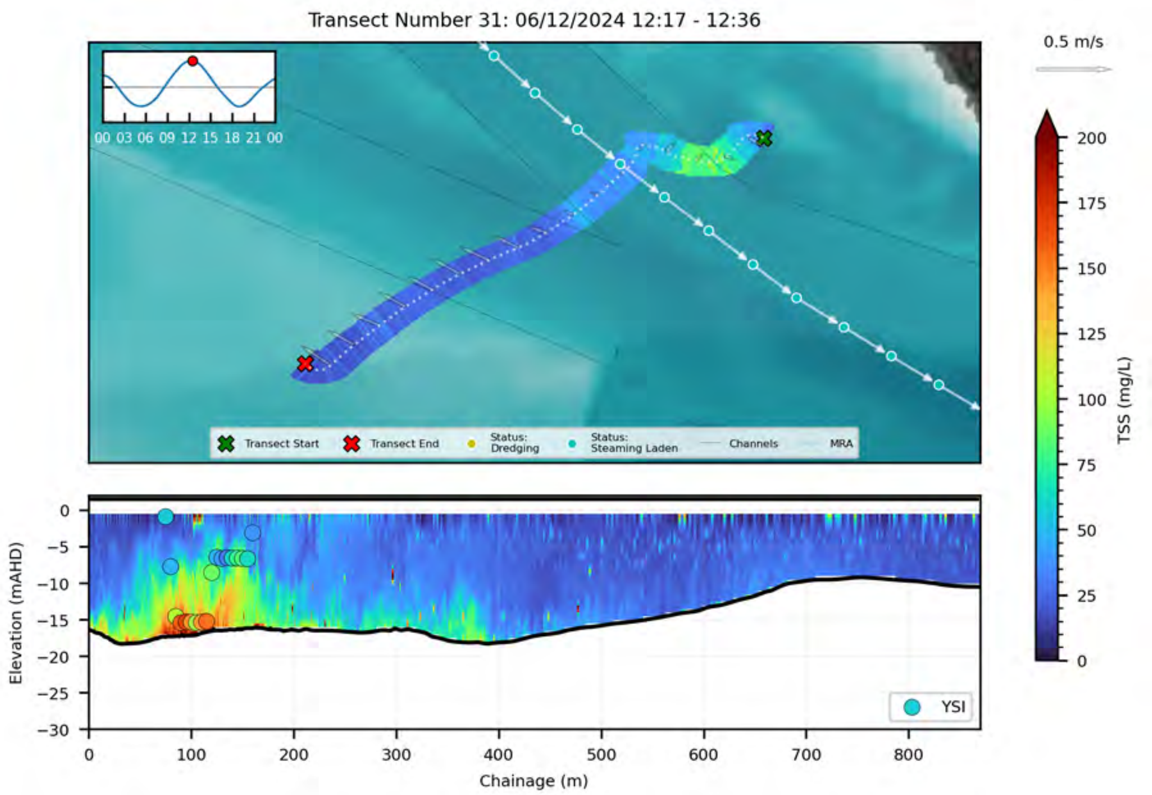

Transect Number 26: 06/12/2024 11:43 - 11:51
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

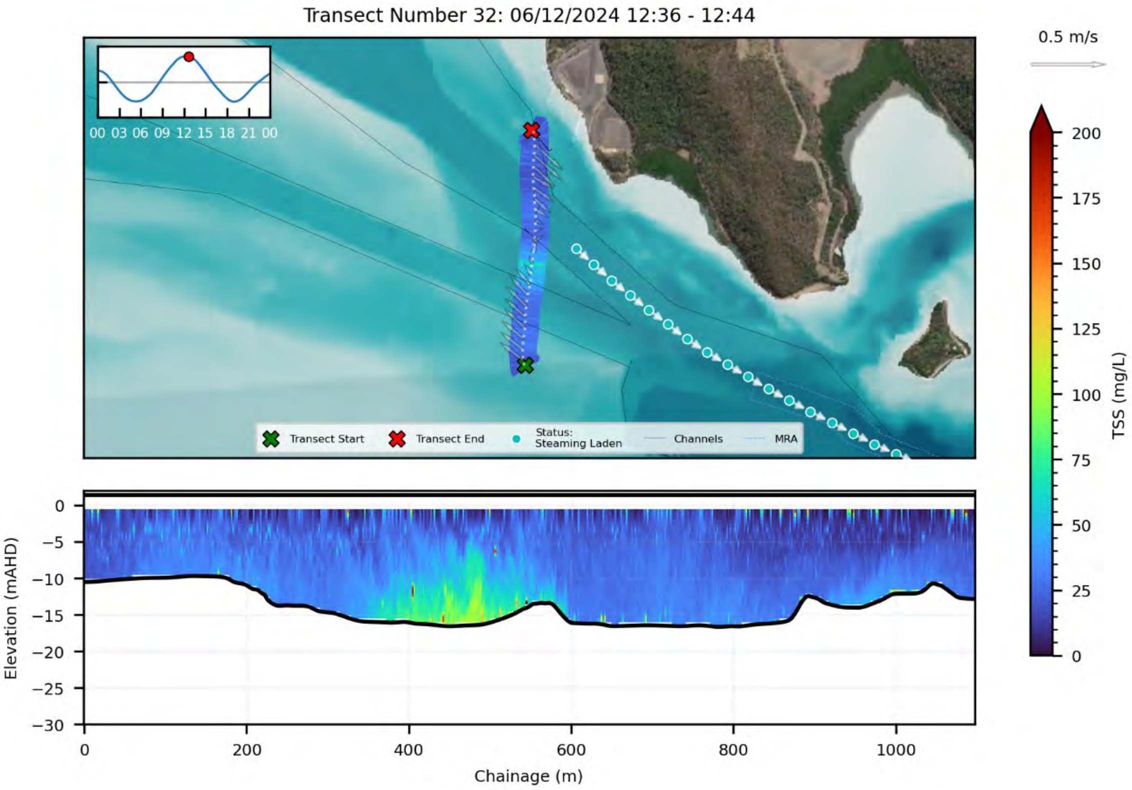

Transect Number 27: 06/12/2024 11:51 - 11:57
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

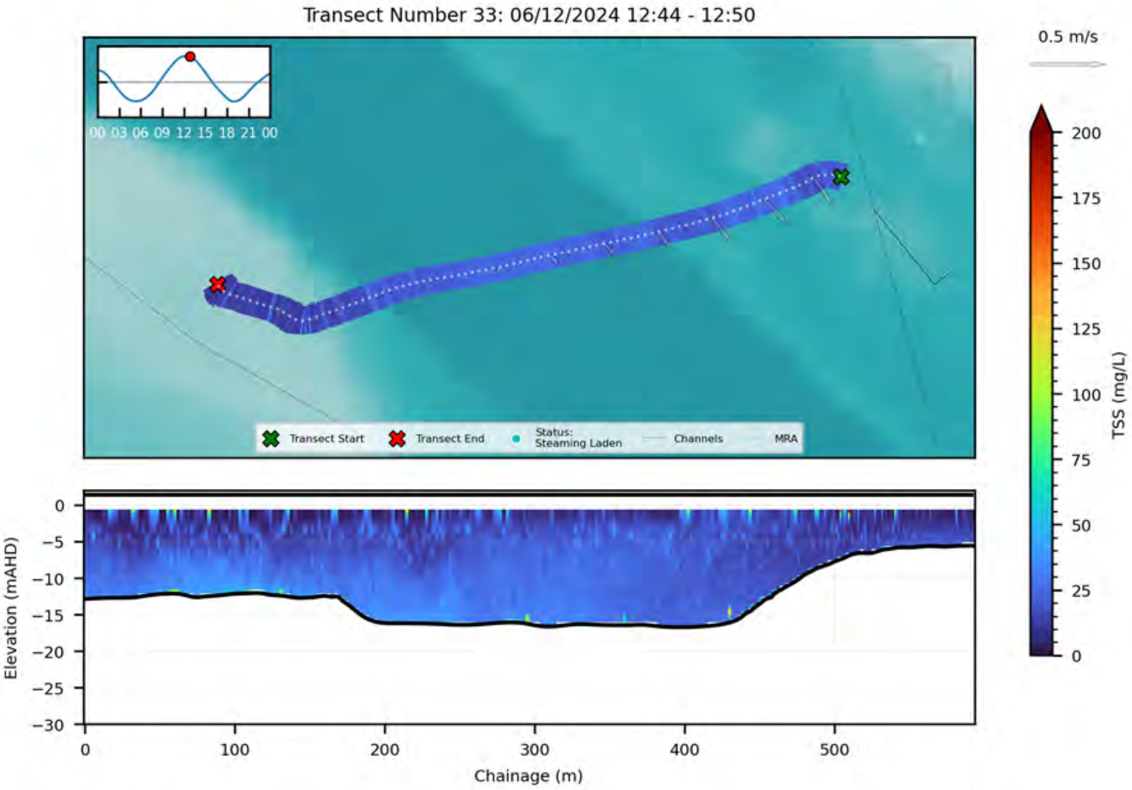

Transect Number 28: 06/12/2024 11:57 - 12:03
00 03 06 09 12 15 18 21 00
0.5 m/s
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
200
175
150
125
100
75
50
25
0
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
0
200
400
600
800
1000
Chainage (m)

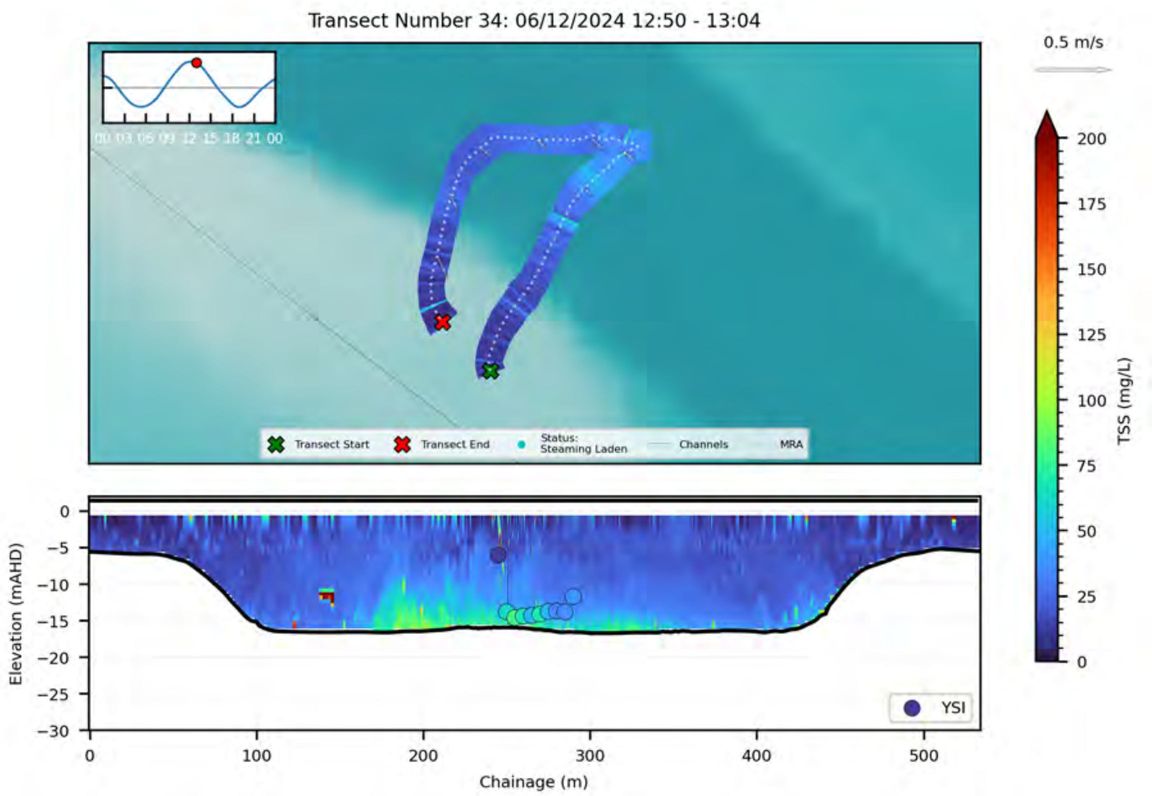

Transect Number 29: 06/12/2024 12:03 - 12:09
00 03 06 09 12 15 18 21 00
0.5 m/s
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
TSS (mg/L)
200
175
150
125
100
75
50
25
0
Elevation (mAHD)
0
−5
−10
−15
−20
−25
−30
0
100
200
300
400
500
600
700
Chainage (m)

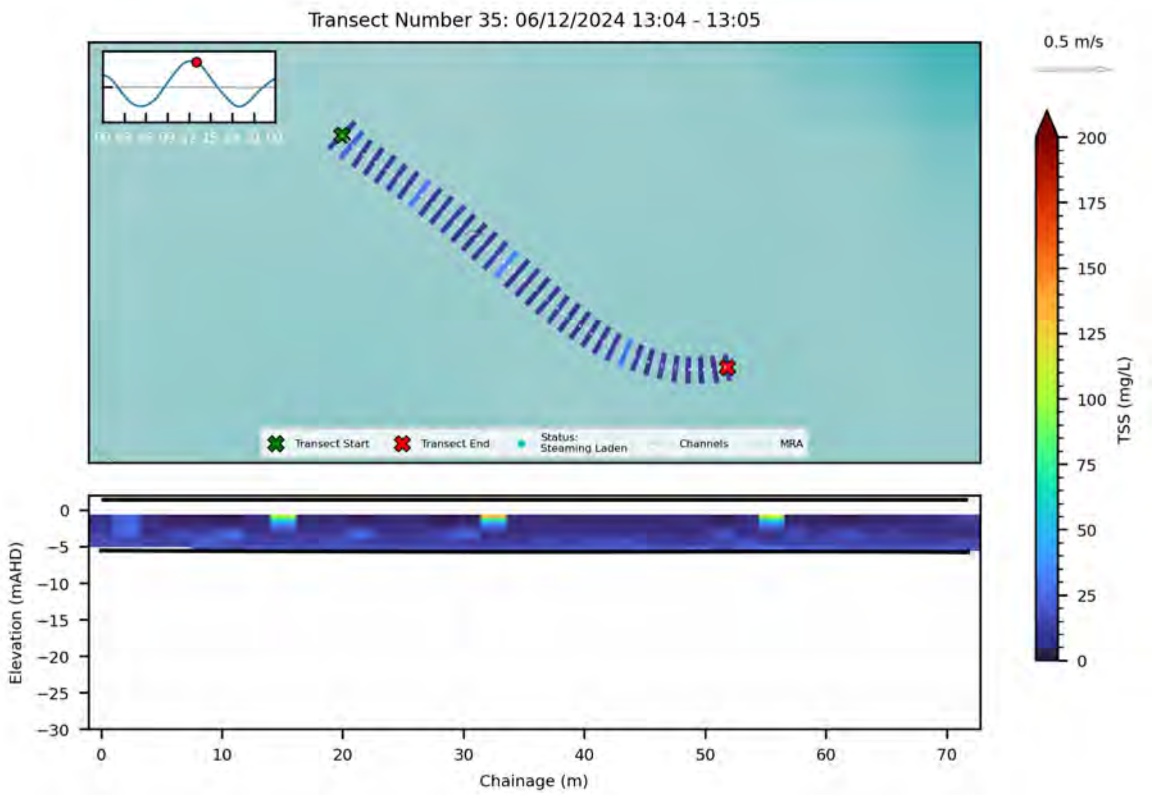

Transect Number 30: 06/12/2024 12:09 - 12:17
00 03 06 09 12 15 18 21 00
0.5 m/s
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)

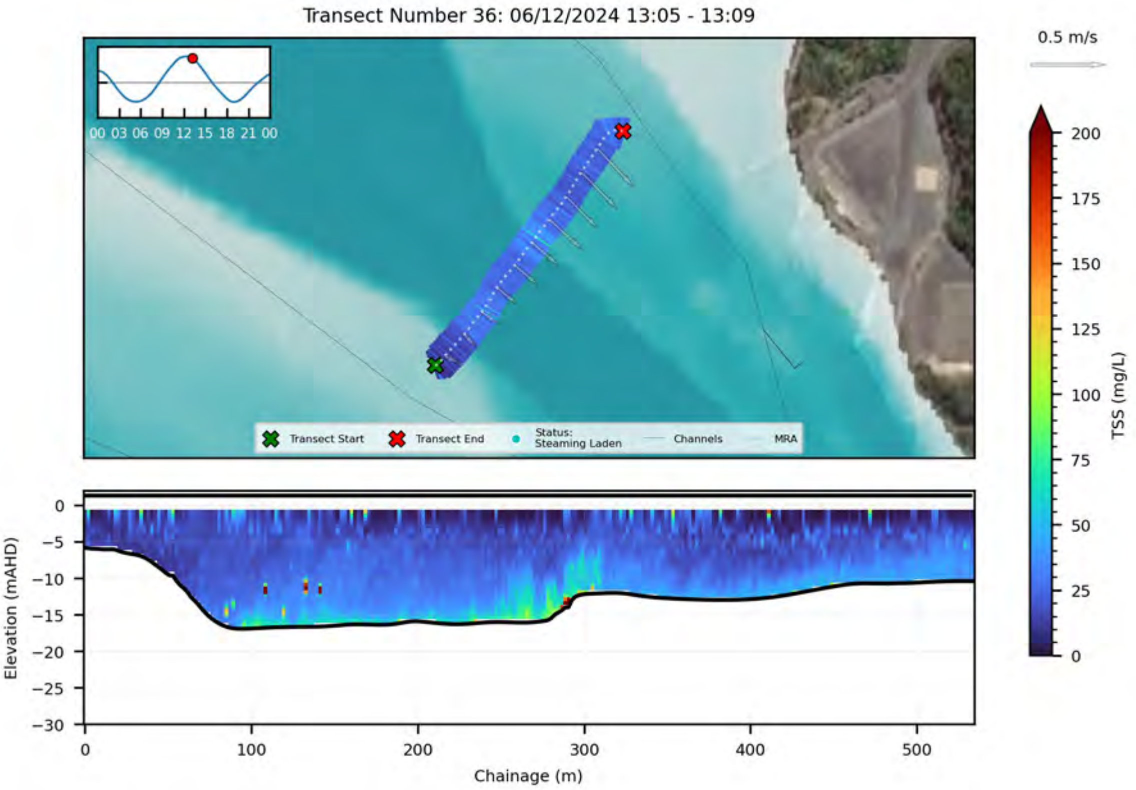

Transect Number 31: 06/12/2024 12:17 - 12:36
00 03 06 09 12 15 18 21 00
0.5 m/s
Transect Start
Transect End
Status: Dredging
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
YSI
Elevation (mAHD)
Chainage (m)

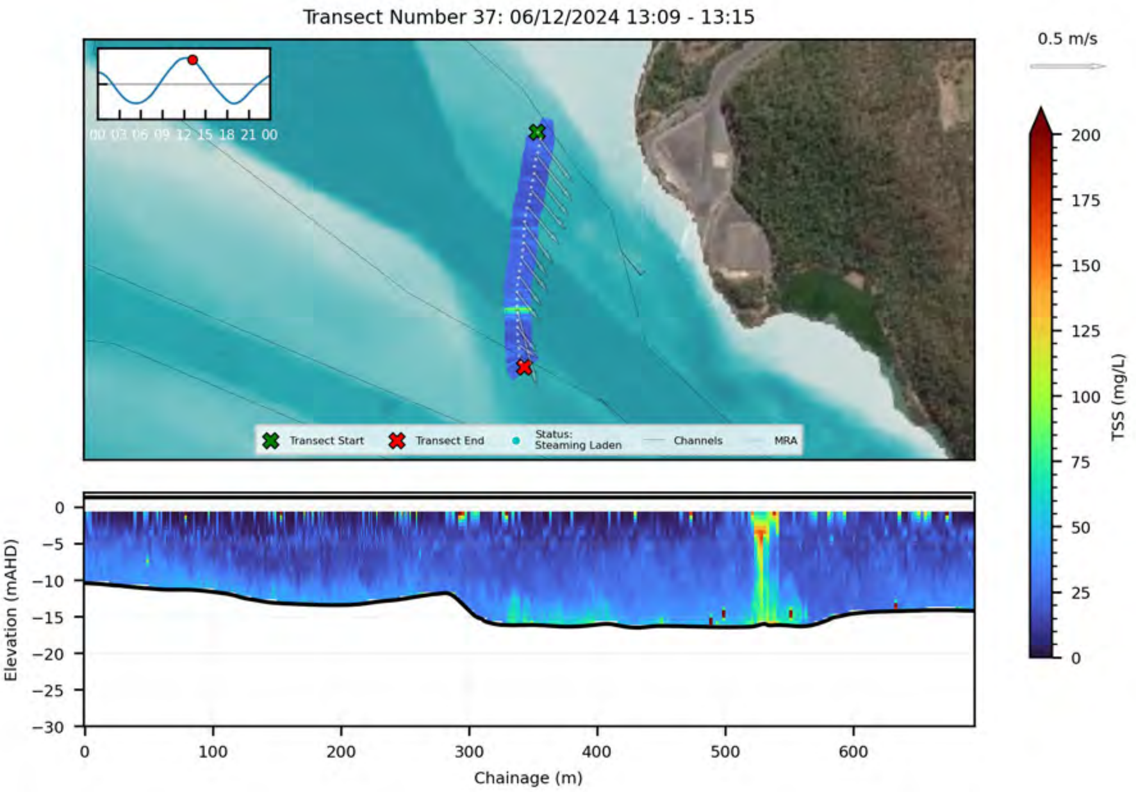

Transect Number 32: 06/12/2024 12:36 - 12:44
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

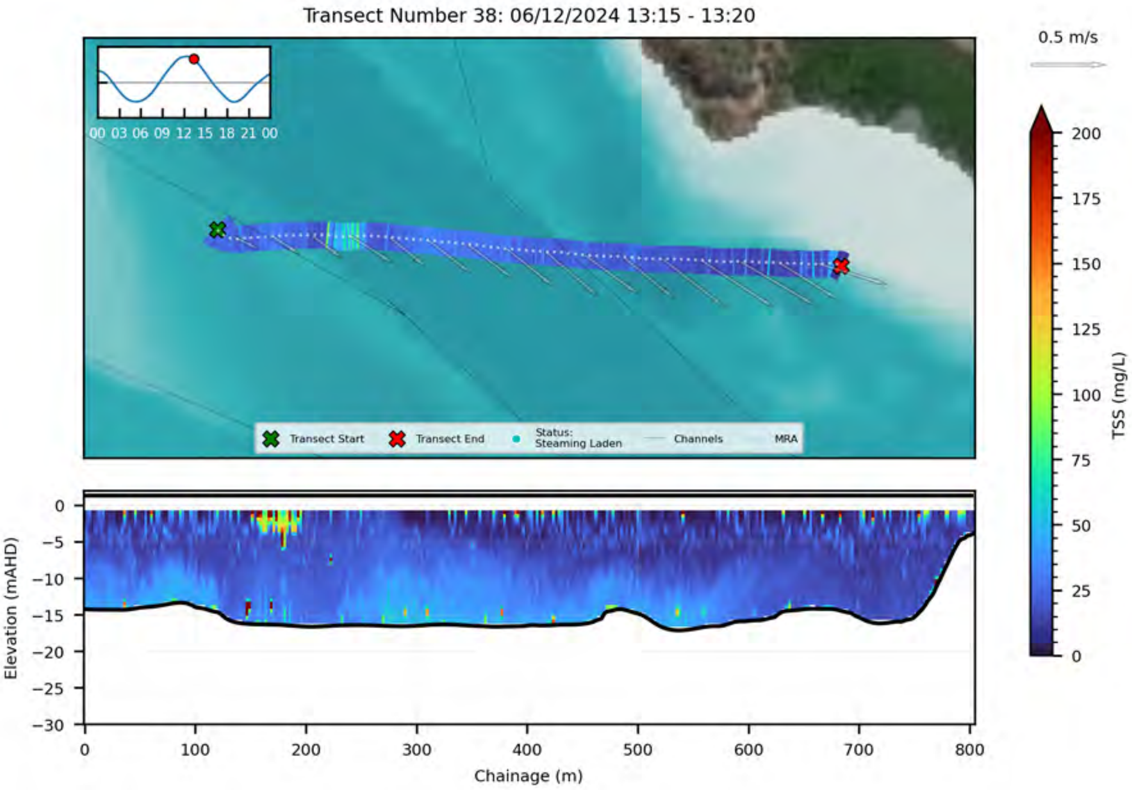

Transect Number 33: 06/12/2024 12:44 - 12:50
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

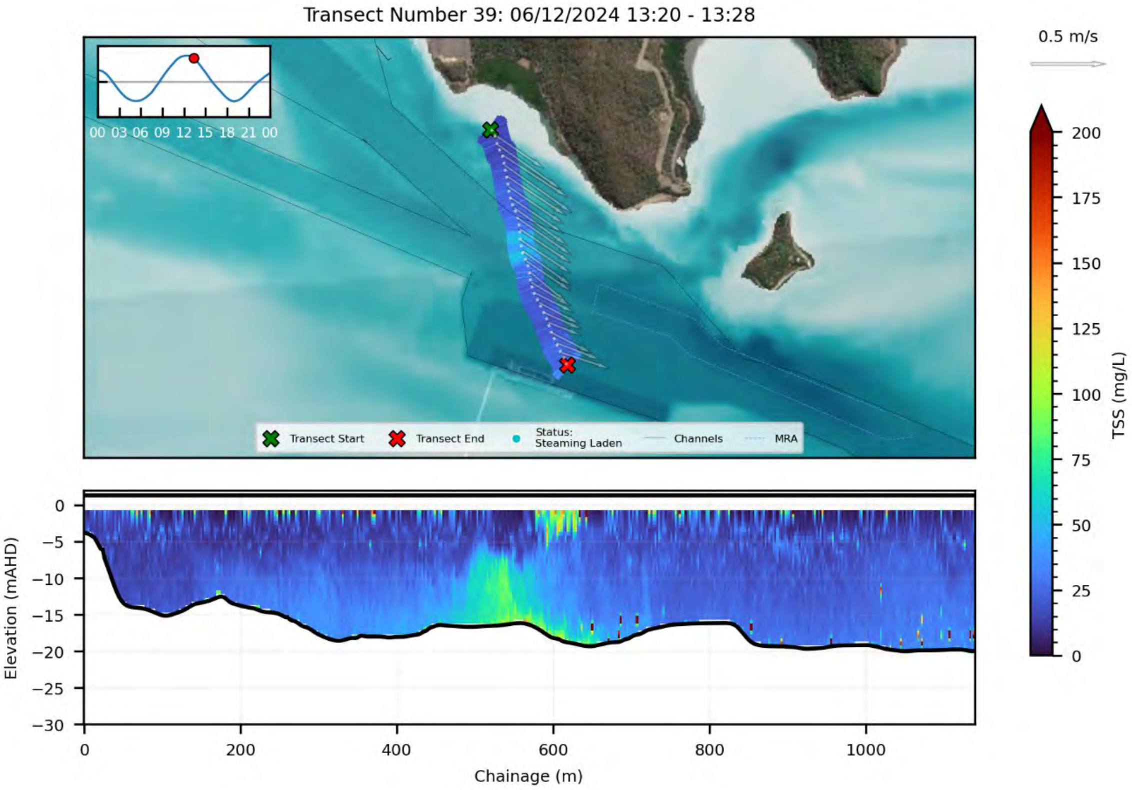

Transect Number 34: 06/12/2024 12:50 - 13:04
0.5 m/s
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
YSI
Chainage (m)
0
100
200
300
400
500

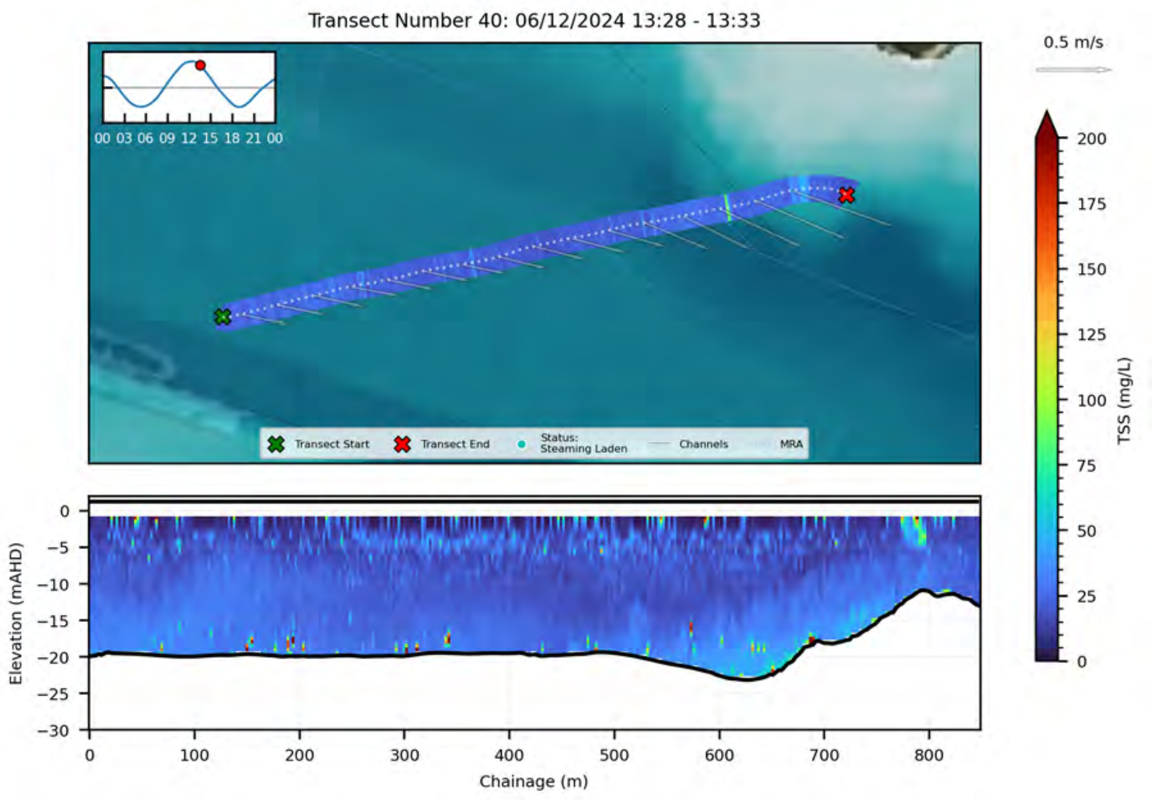

Transect Number 35: 06/12/2024 13:04 - 13:05
0.5 m/s
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)
0
10
20
30
40
50
60
70

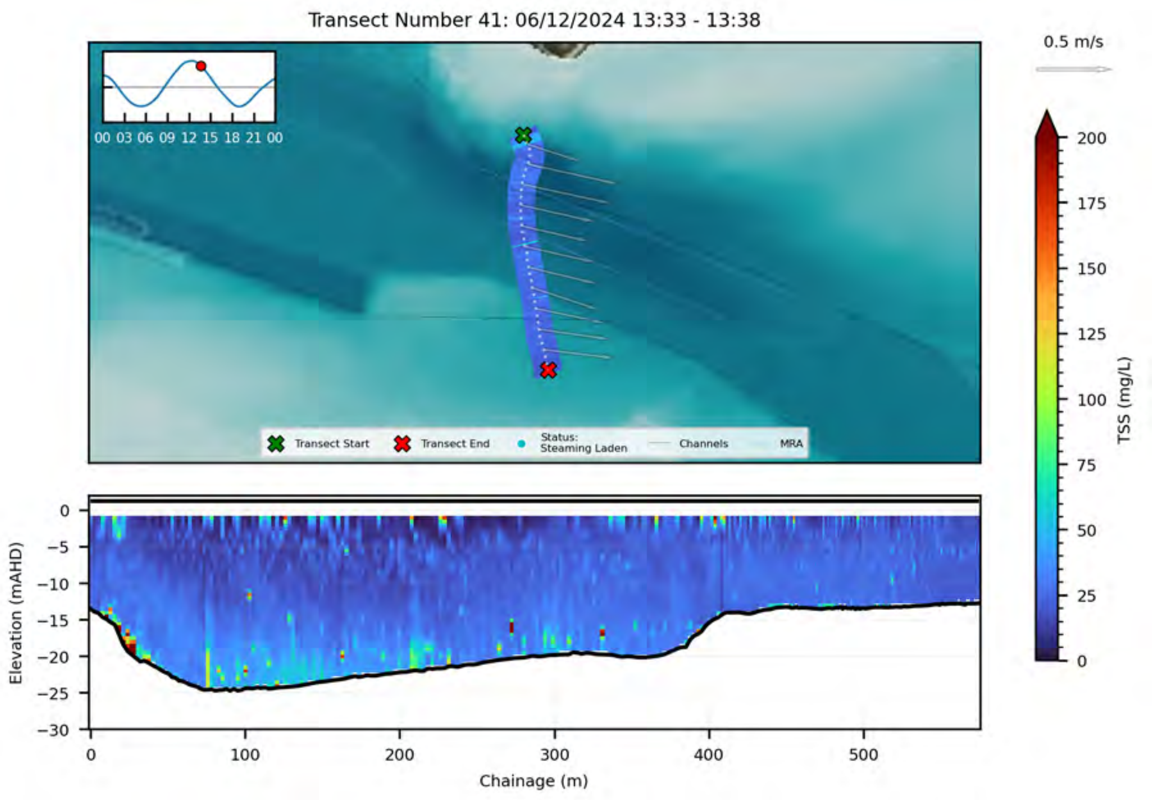

Transect Number 36: 06/12/2024 13:05 - 13:09
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)
0
100
200
300
400
500

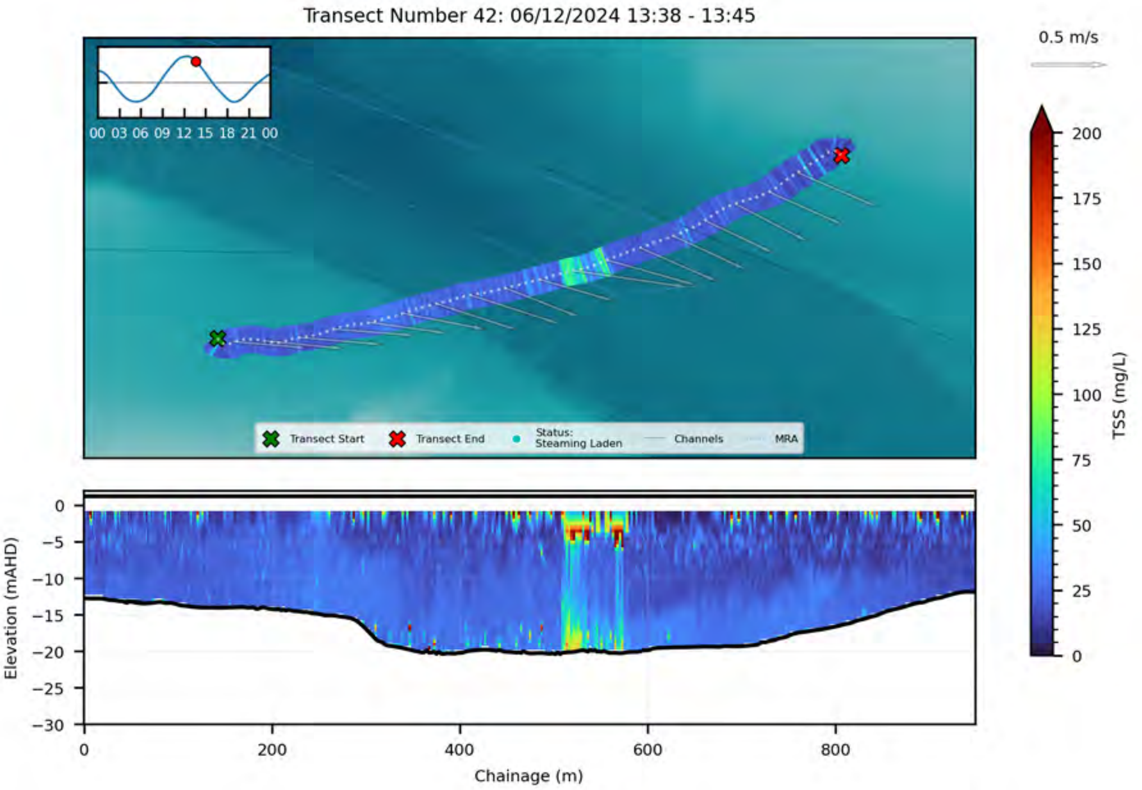

Transect Number 37: 06/12/2024 13:09 - 13:15
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)
0
100
200
300
400
500
600

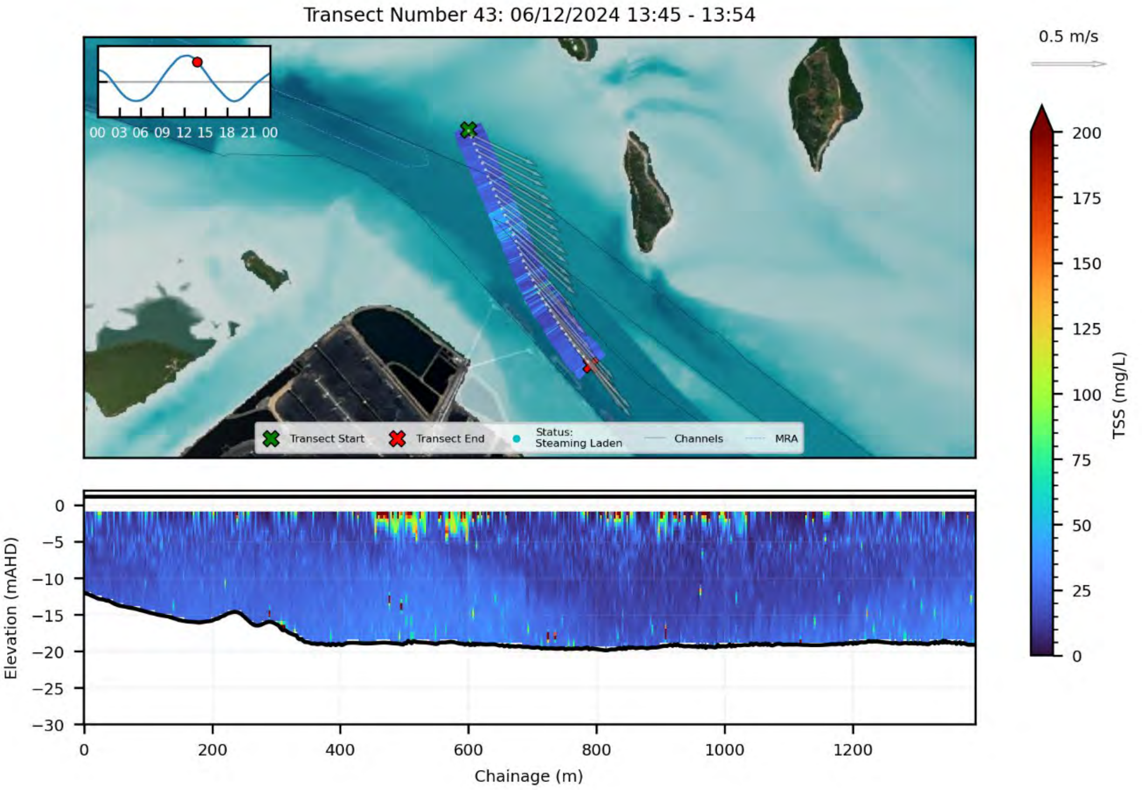

Transect Number 38: 06/12/2024 13:15 - 13:20
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)


Transect Number 39: 06/12/2024 13:20 - 13:28
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

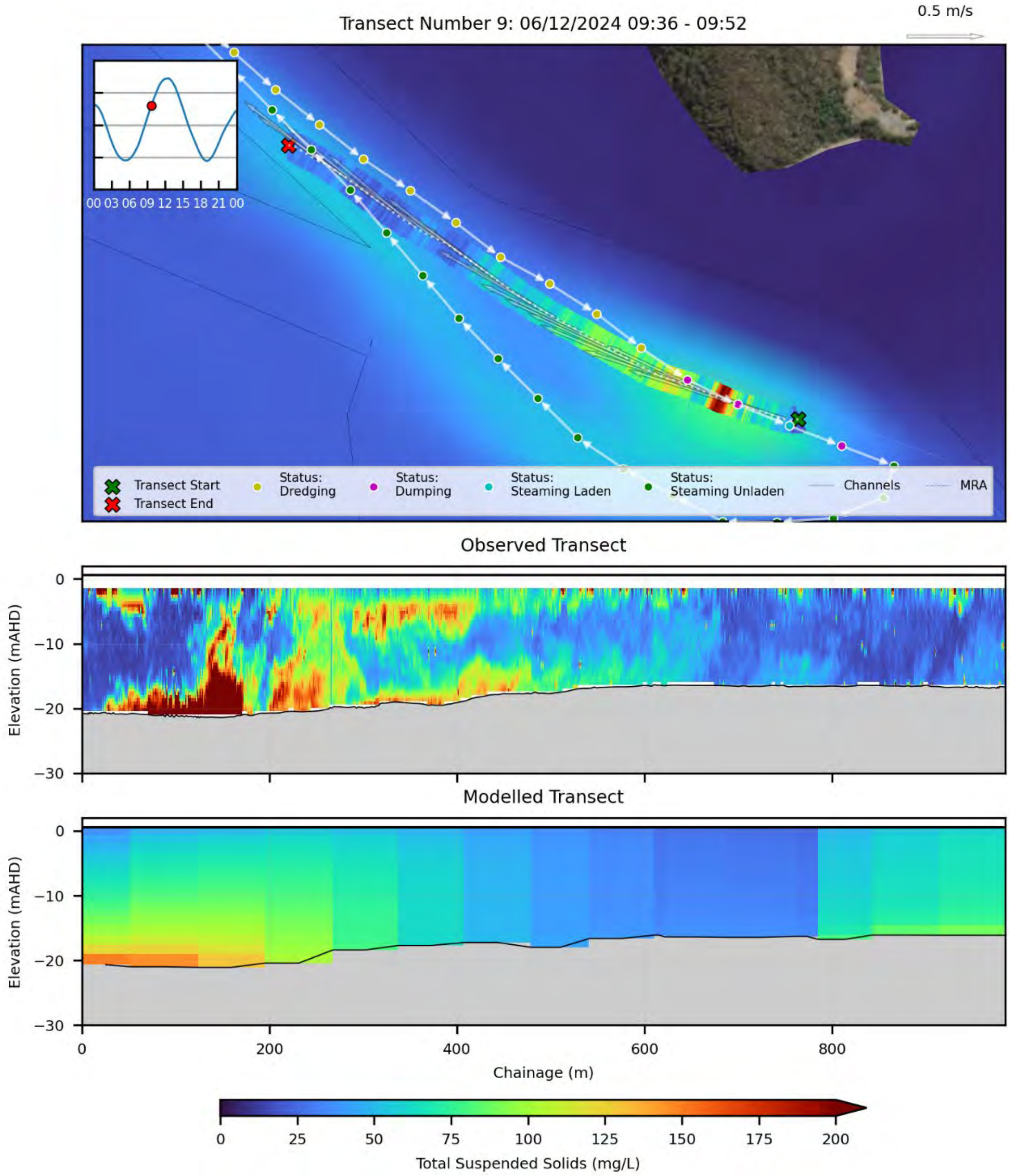

Transect Number 40: 06/12/2024 13:28 - 13:33
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

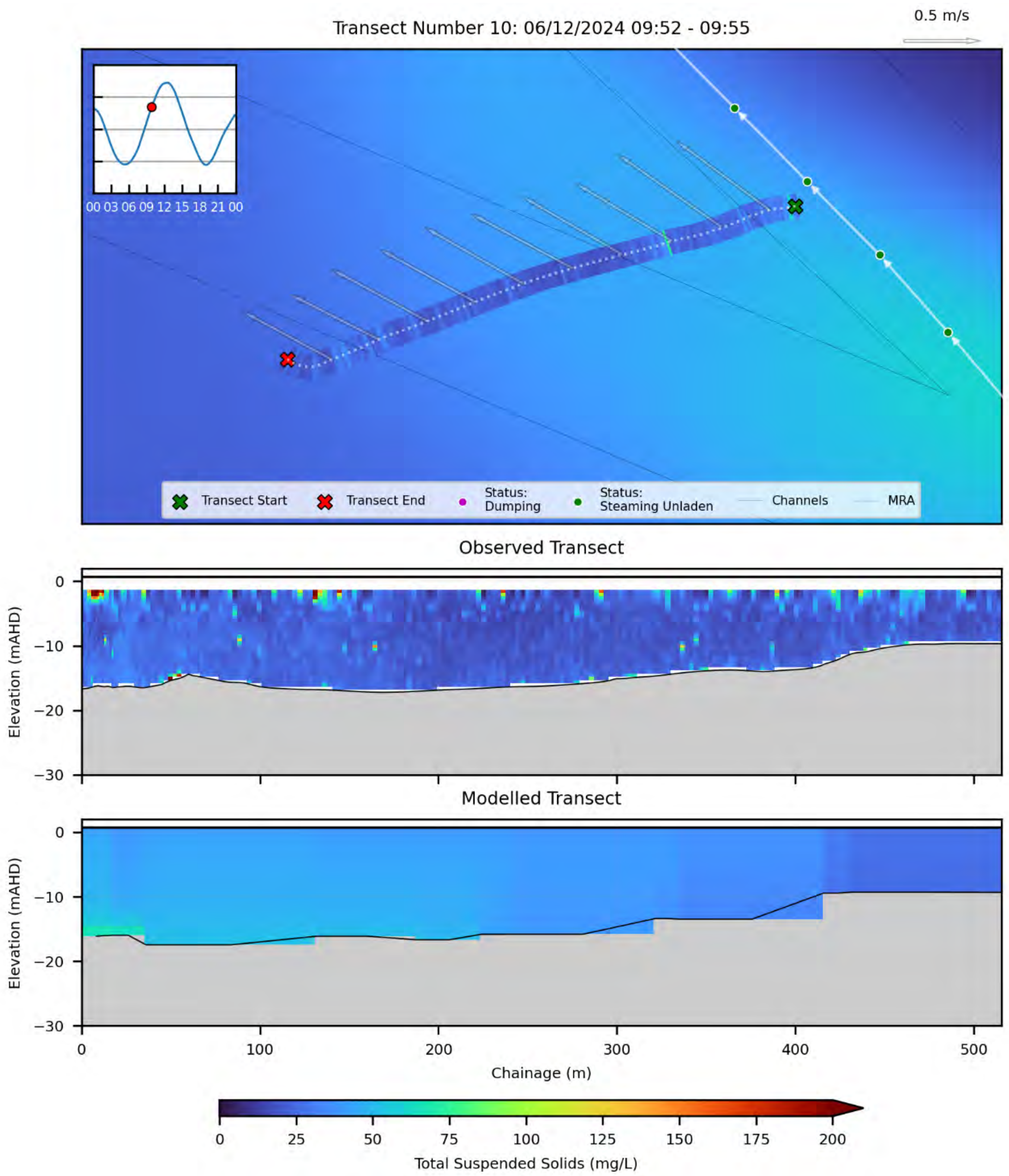

Transect Number 41: 06/12/2024 13:33 - 13:38
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
0.5 m/s
TSS (mg/L)
Elevation (mAHD)
Chainage (m)

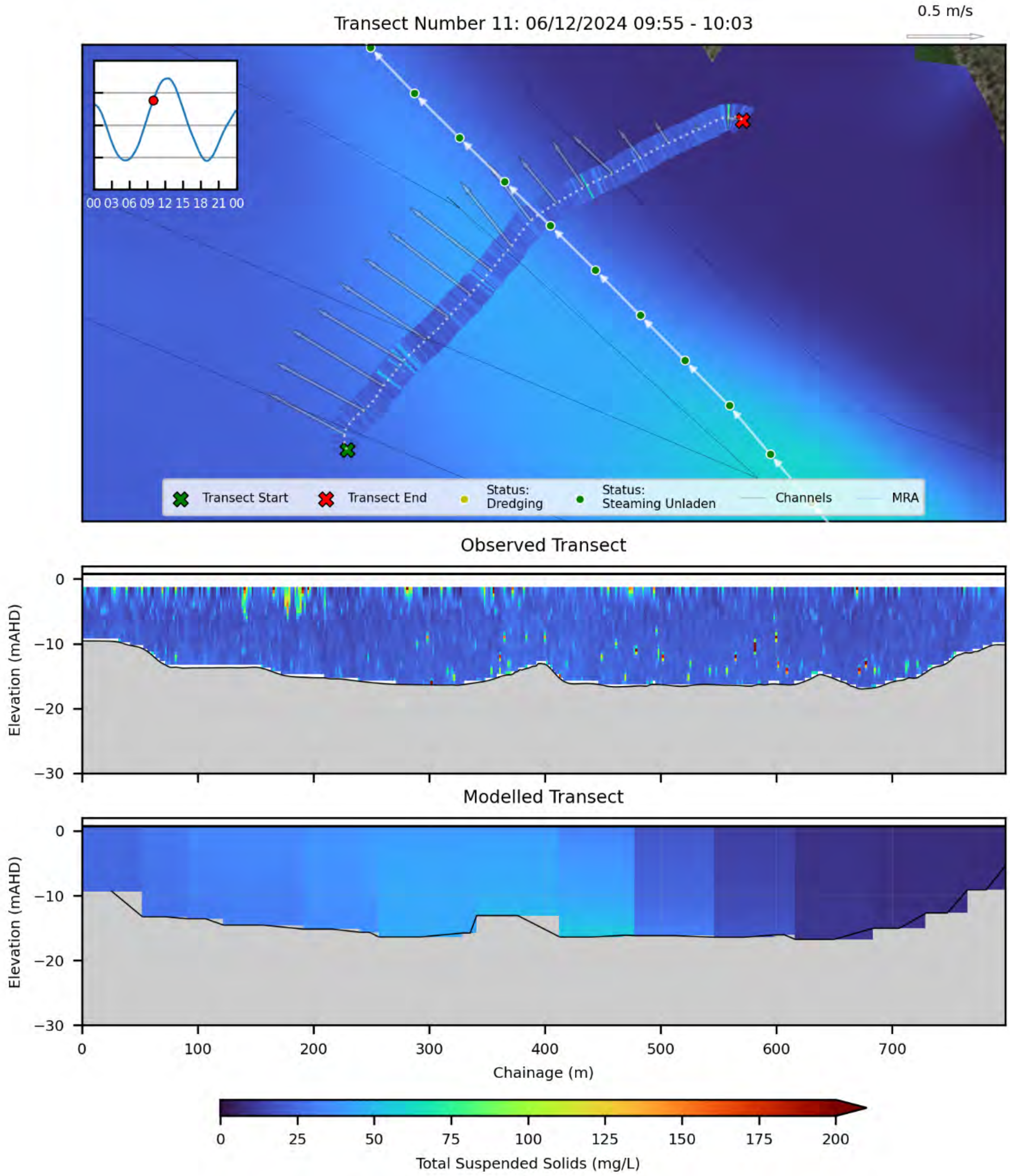

Transect Number 42: 06/12/2024 13:38 - 13:45
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
0
25
50
75
100
125
150
175
200
Elevation (mAHD)
Chainage (m)
0
200
400
600
800

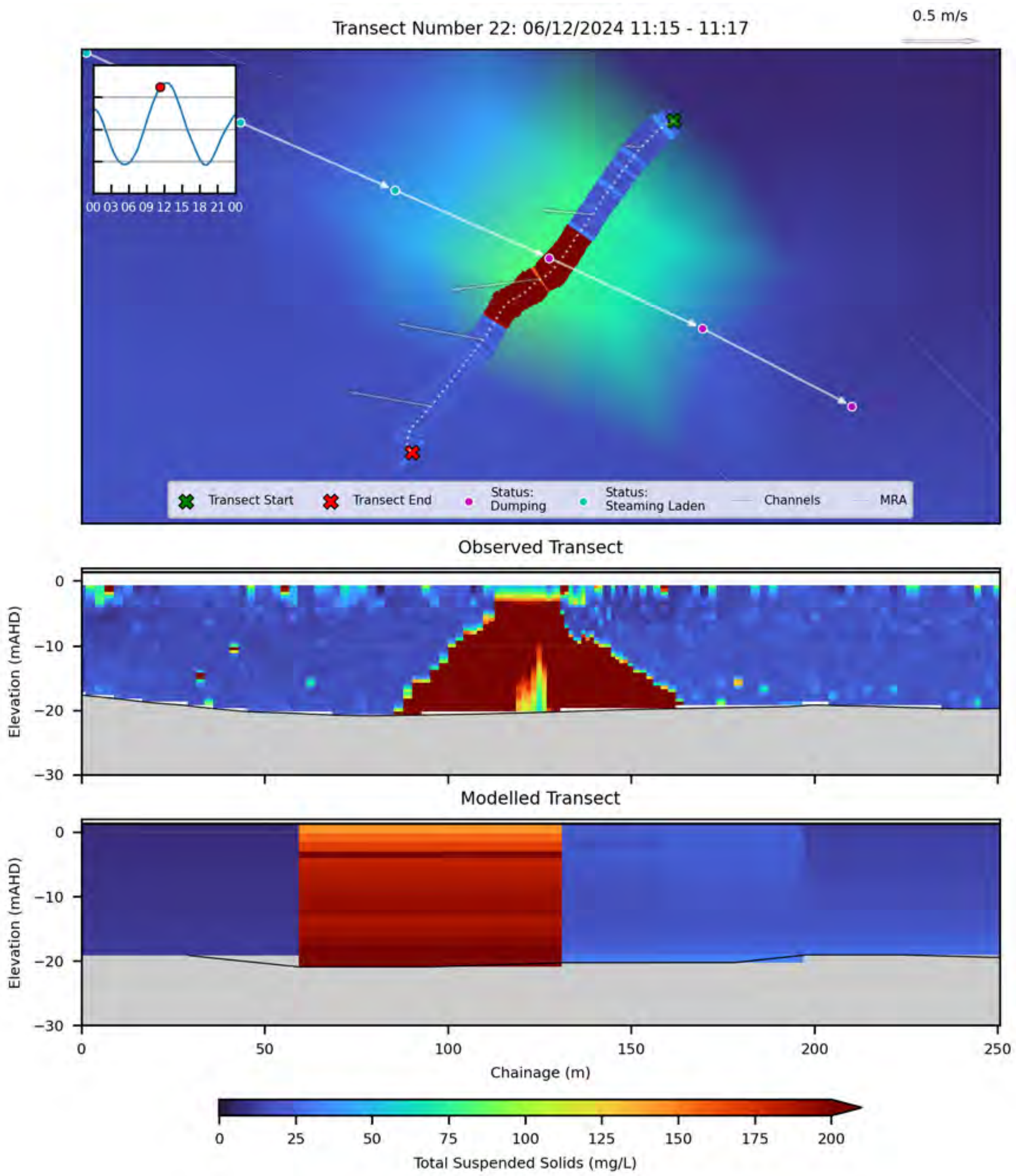

Transect Number 43: 06/12/2024 13:45 - 13:54
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Steaming Laden
Channels
MRA
TSS (mg/L)
Elevation (mAHD)
Chainage (m)
0
200
400
600
800
1000
1200

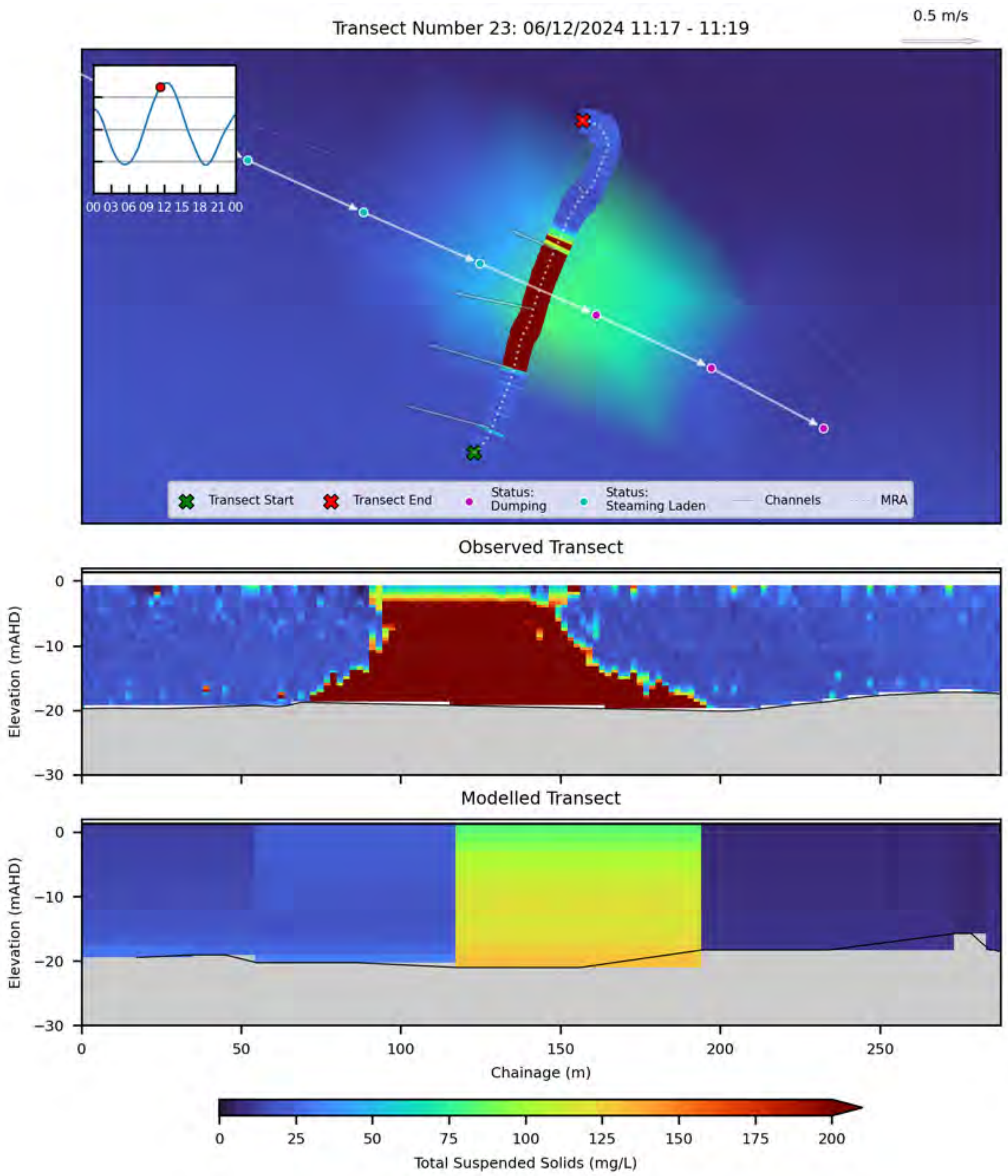
Annex P ADCP Transect Validation Plots


Transect Number 9: 06/12/2024 09:36 - 09:52
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Dumping
Status: Steaming Laden
Status: Steaming Unladen
Channels
MRA
Observed Transect
Modelled Transect
Elevation (mAHD)
0
−10
−20
−30
0
200
400
600
800
Chainage (m)
0
25
50
75
100
125
150
175
200
Total Suspended Solids (mg/L)

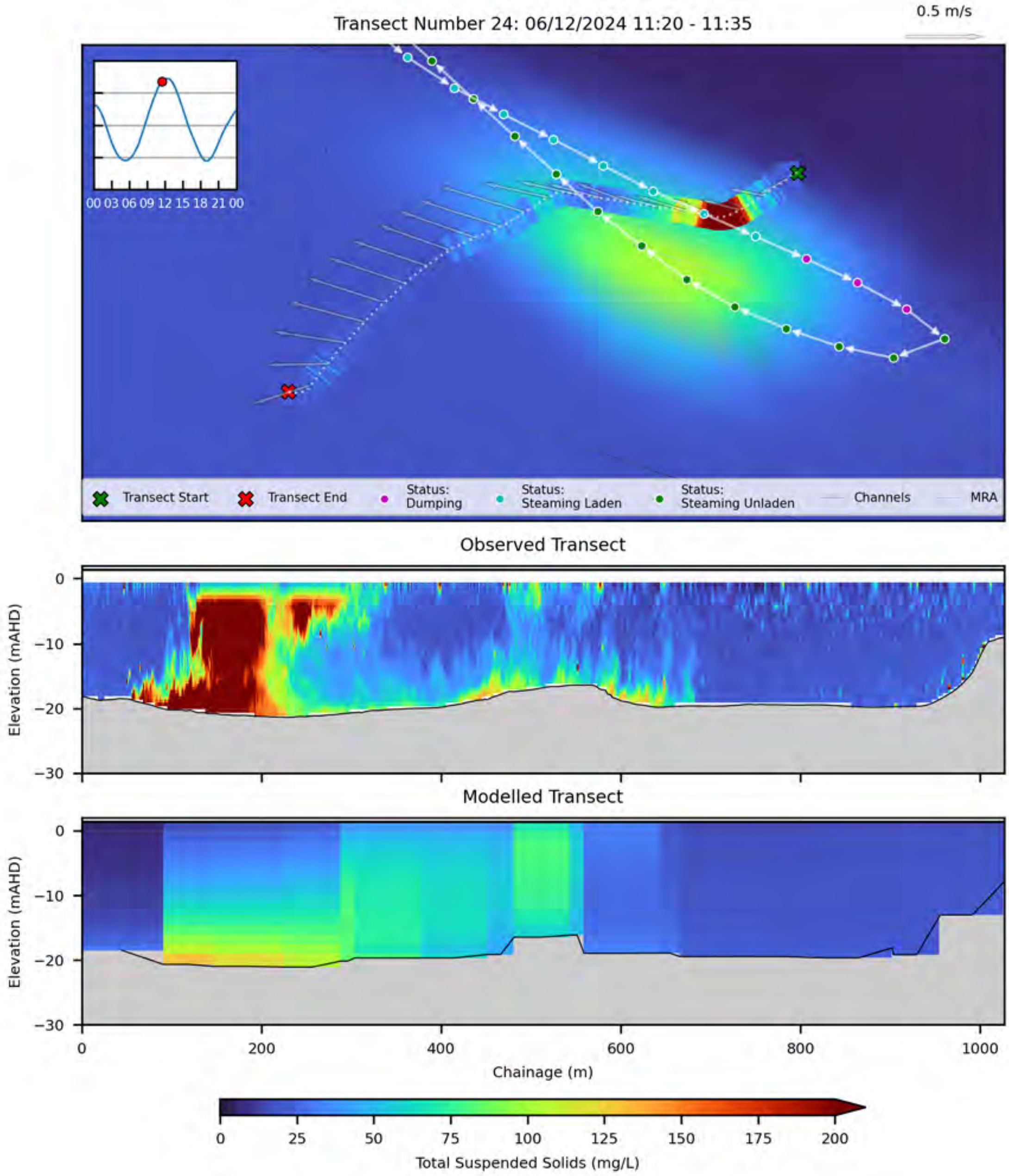

Transect Number 10: 06/12/2024 09:52 - 09:55
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Unladen
Channels
MRA
Observed Transect
Elevation (mAHD)
0
−10
−20
−30
Modelled Transect
Elevation (mAHD)
0
100
200
300
400
500
Chainage (m)
0
25
50
75
100
125
150
175
200
Total Suspended Solids (mg/L)

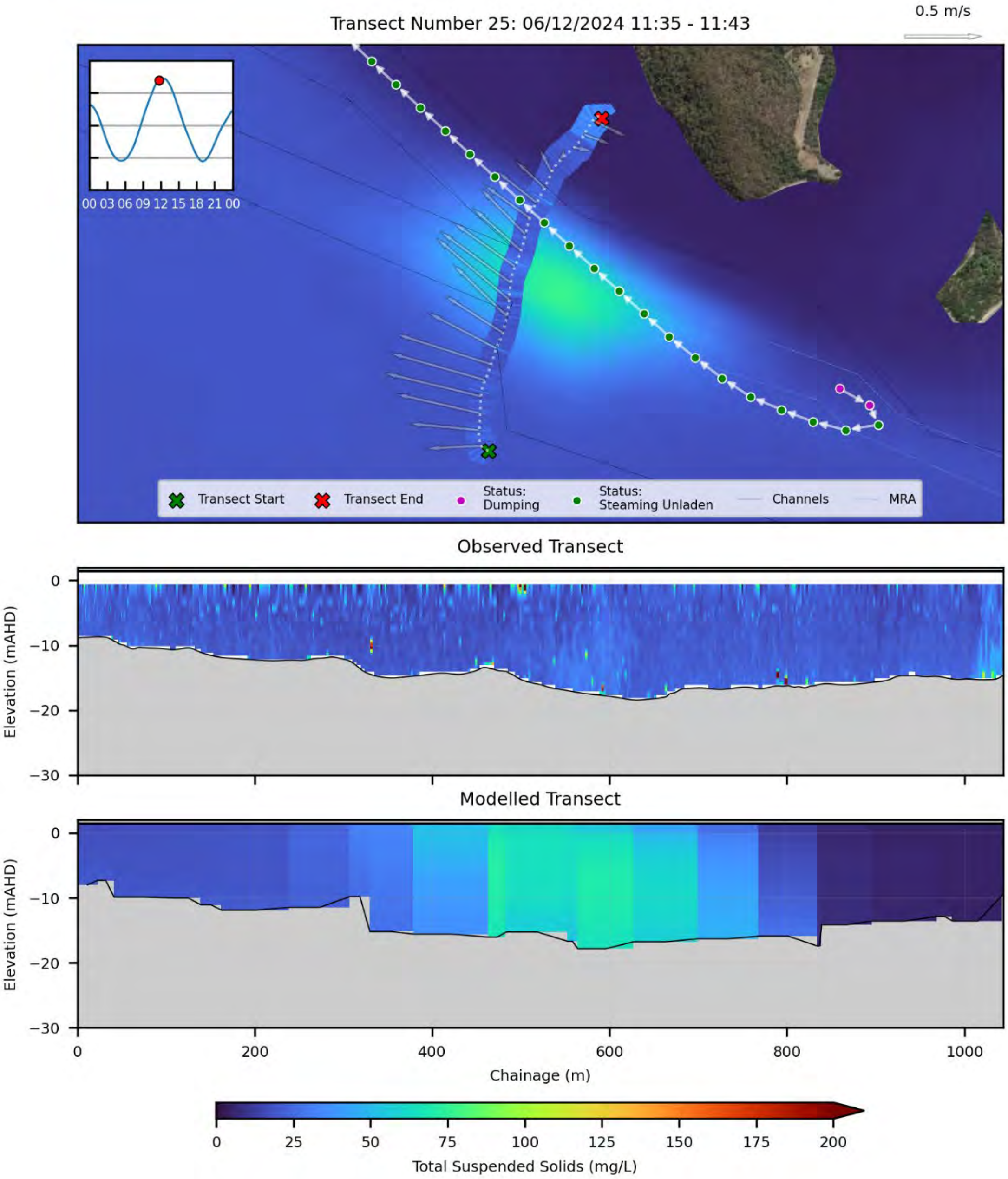

Transect Number 11: 06/12/2024 09:55 - 10:03
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
Observed Transect
Modelled Transect
Elevation (mAHD)
0
−10
−20
−30
0
100
200
300
400
500
600
700
Chainage (m)
0
25
50
75
100
125
150
175
200
Total Suspended Solids (mg/L)

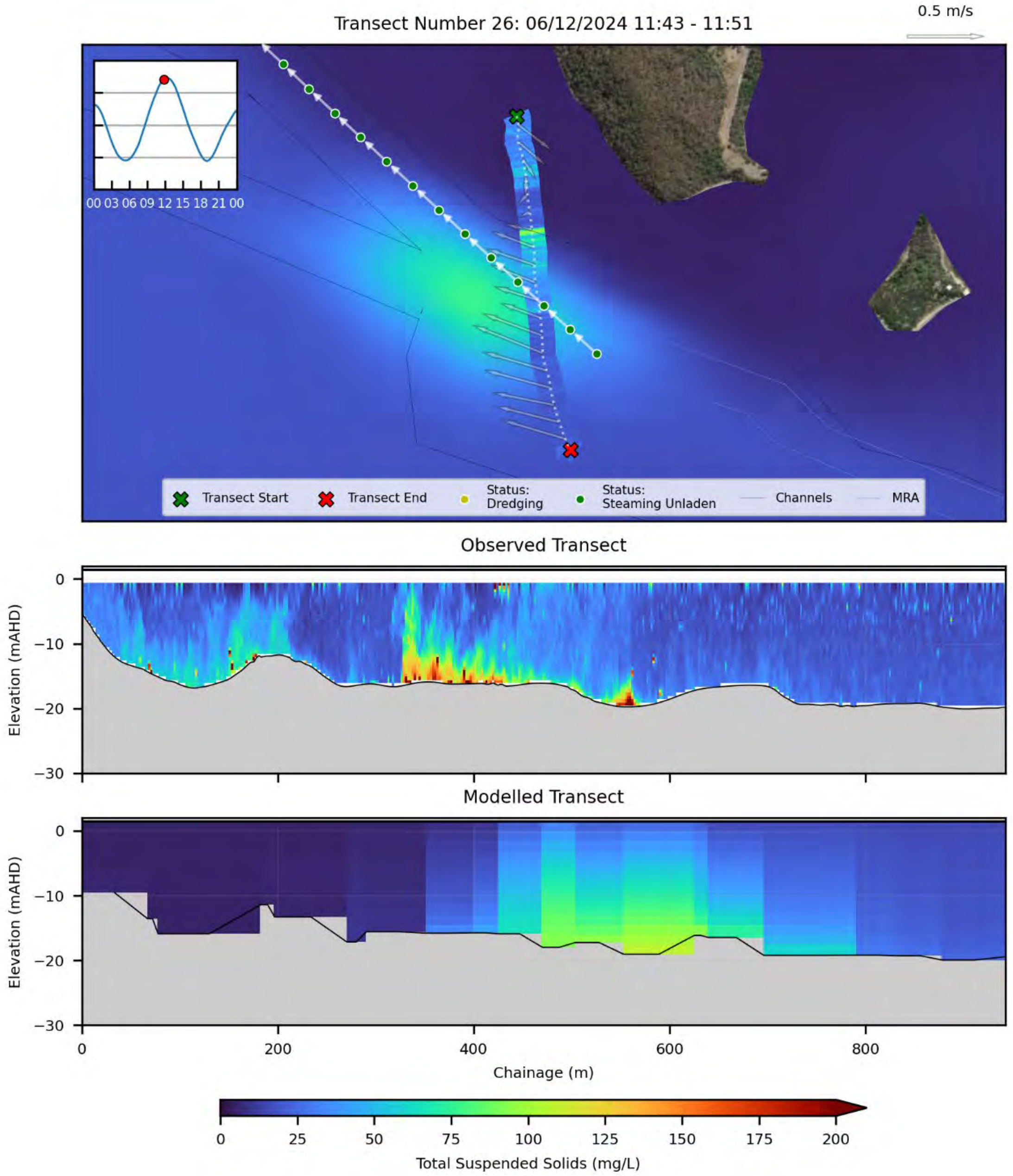

Transect Number 22: 06/12/2024 11:15 - 11:17
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Laden
Channels
MRA
Observed Transect
Elevation (mAHD)
0
−10
−20
−30
Modelled Transect
Elevation (mAHD)
0
−10
−20
−30
0
50
100
150
200
250
Chainage (m)
0
25
50
75
100
125
150
175
200
Total Suspended Solids (mg/L)

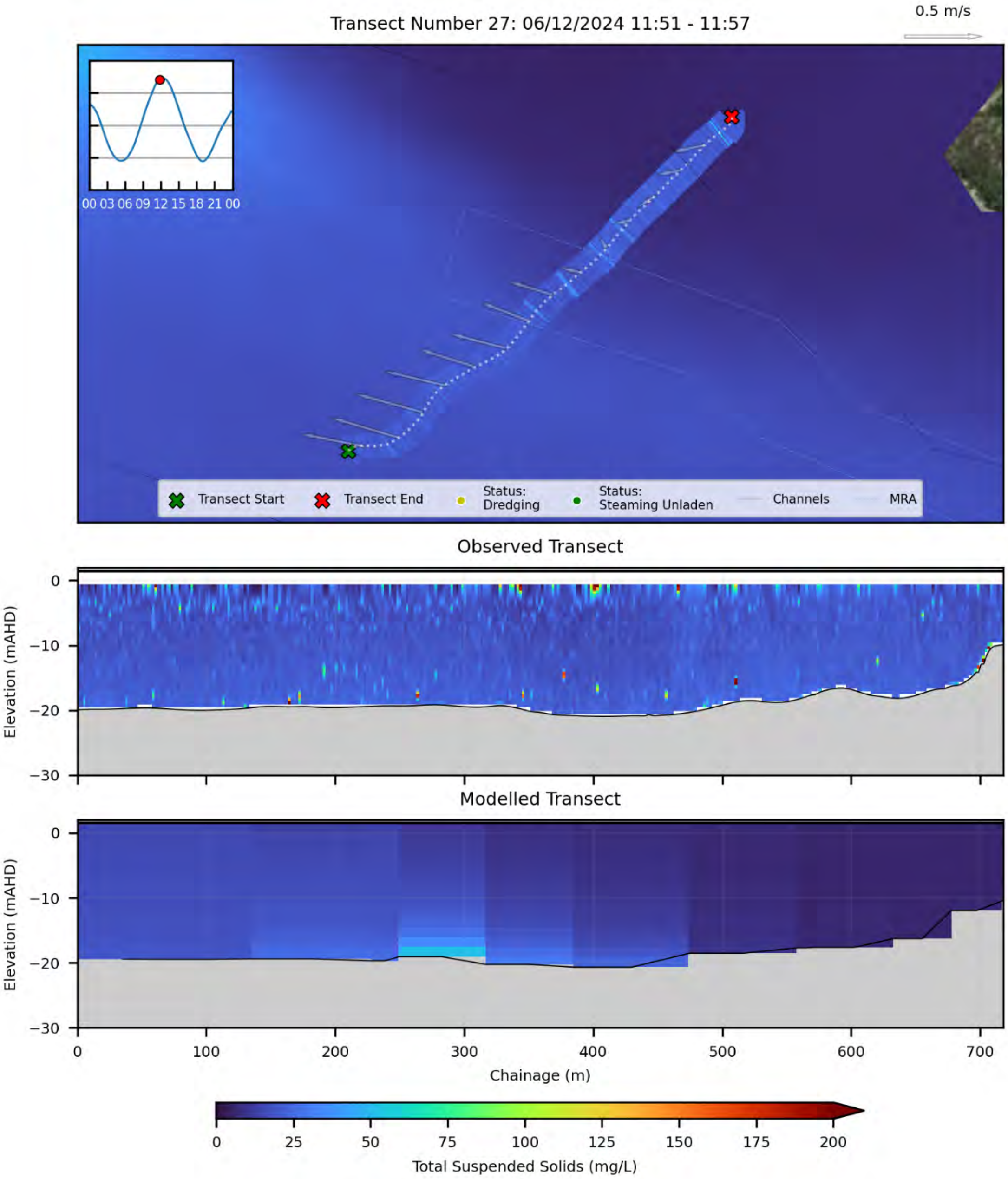


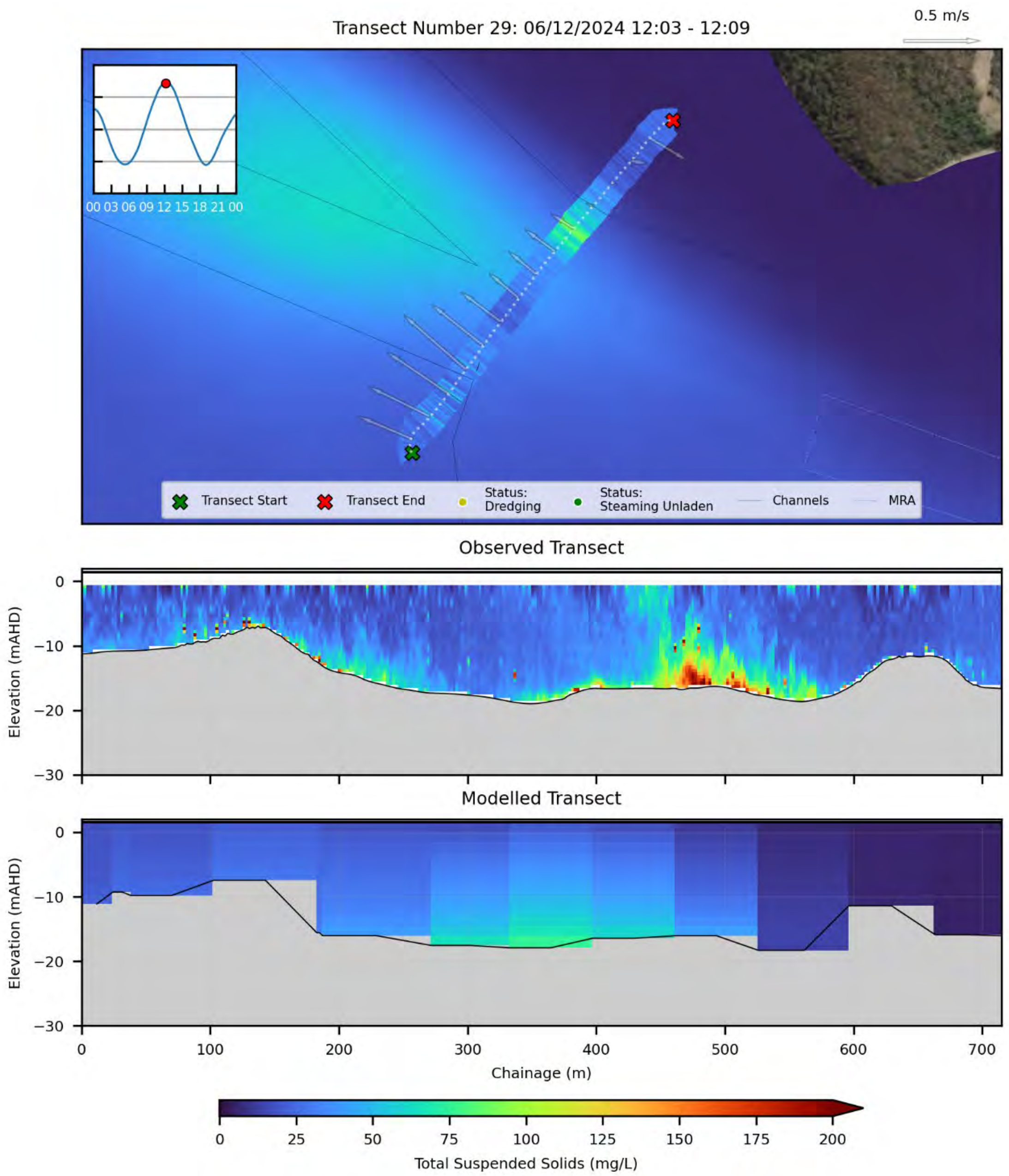
Transect Number 23: 06/12/2024 11:17 - 11:19
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Laden
Channels
MRA
Observed Transect
Elevation (mAHD)
0
−10
−20
−30
Modelled Transect
0
50
100
150
200
250
Chainage (m)
25
75
125
175
Total Suspended Solids (mg/L)

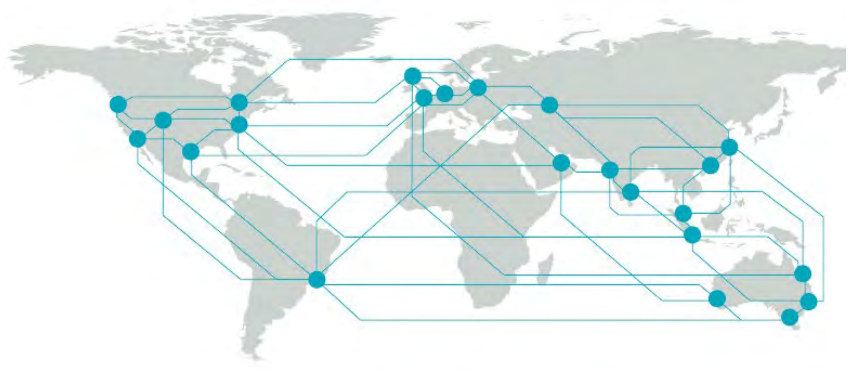

Transect Number 24: 06/12/2024 11:20 - 11:35
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Laden
Status: Steaming Unladen
Channels
MRA
Observed Transect
Elevation (mAHD)
Modelled Transect
Chainage (m)
Total Suspended Solids (mg/L)


Transect Number 25: 06/12/2024 11:35 - 11:43
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dumping
Status: Steaming Unladen
Channels
MRA
Observed Transect
Elevation (mAHD)
Modelled Transect
Chainage (m)
Total Suspended Solids (mg/L)


Transect Number 26: 06/12/2024 11:43 - 11:51
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
Observed Transect
Elevation (mAHD)
Modelled Transect
Chainage (m)
Total Suspended Solids (mg/L)


Transect Number 27: 06/12/2024 11:51 - 11:57
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
Observed Transect
Modelled Transect
Elevation (mAHD)
Chainage (m)
Total Suspended Solids (mg/L)


Transect Number 29: 06/12/2024 12:03 - 12:09
0.5 m/s
00 03 06 09 12 15 18 21 00
Transect Start
Transect End
Status: Dredging
Status: Steaming Unladen
Channels
MRA
Observed Transect
Modelled Transect
Elevation (mAHD)
Chainage (m)
Total Suspended Solids (mg/L)



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