Monitoring of Maintenance Dredging Plumes – Gladstone Harbour, November and December 2018 - Final Report

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Synopsis: **A report detailing the effects of maintenance dredging and sea disposal of dredged material by the Trailing Suction Hopper Dredge (TSHD) Brisbane on ambient water quality at Port Curtis in November and December 2018.**

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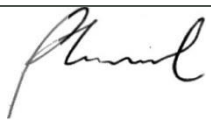
0	1/02/2019	PAG		DLR	
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Executive Summary

Background

Gladstone Ports Corporation (GPC) is responsible for the maintenance dredging of the Port of Gladstone which is undertaken by the Trailer Suction Hopper Dredge *Brisbane*. Dredged material is disposed at sea at the *East Banks Sea Disposal Site* (EBSDS) in accordance with sea dumping permits issued by the Department of the Environment and Energy (DOEE). Gladstone Harbour has been maintenance dredged since the mid 1970s.

Dredging, disposal of dredged sediments and the subsequent re-suspension of dredged sediments leads to short-term increases in suspended sediment concentrations, as has been documented for the Port of Gladstone maintenance dredging program. The National Assessment Guidelines for Dredging (NAGD) provides a basis for assessing potential dredging and disposal impacts. There are several components relevant to assessing potential sediment water quality impacts of dredging and disposal:

- Sediment quality assessments in accordance with the decision-tree set out in Section 4.2 of NAGD. This provides a basis to assess chemical constituents in dredged sediments. The first two steps in the decision tree involve an examination of existing information and chemical characterisation of sediments. For the Port of Gladstone, results to date showed dredged sediments did not exceed screening levels and background (i.e. do not pose an ecotoxicity risk), and therefore there is no requirement to assess other lines of evidence to determine suitability for dredged material disposal (i.e. bioavailability testing, toxicity, weight of evidence assessment).
- Assessments of potential impacts to receiving environment (Section 4.3 of NAGD). BMT WBM (2017) undertook a review of existing information and numerical modelling to characterise potential impacts of dredge plumes. It was concluded that dredging and dredged material disposal pose a low risk to receiving environments. In addition, GPC also undertook monitoring of metal and metalloid burdens in oyster tissues deployed at the EBSDS however this approach was found to be unsuitable for measuring dredge plume impacts.
- Monitoring of impacts (Section 4.4 of NAGD). In order to satisfy the request from the Technical Advisory and Consultative Committee (TACC) to gather further results and evidence to test these predictions of BMT WBM (2017), it was recommended that monitoring be undertaken to validate modelling and to test the following impact hypotheses which are stated and embedded in GPC's Long-term Maintenance Dredging Management Plan:
    - '*Sediments generated during dredging and disposal do not subsequently reach sensitive areas in amounts that would be harmful to the ecological value and amenity of the area'.*
    - *'Pollutant concentrations within dredge plumes at the loading and disposal sites do not reach levels where toxic effects or algae blooms could occur.'*

As a substitute for oyster tissue monitoring, and to improve the understanding of dredging and disposal impacts, the Technical Advisory and Consultative Committee recommended that environmental assessments be carried out to assess dredging and disposal impacts in accordance with NAGD. This report describes monitoring works undertaken in accordance with Section 4.4.2 of NAGD to determine the spatial extent and temporal patterns of chemical constituents generated by maintenance dredging and dredged material disposal. Together with other complementary assessments undertaken by GPC (i.e. modelling of turbidity and sediment

deposition, monitoring of benthic macroinvertebrates at the DMPA), the present study provides a basis to assess dredging and disposal-related impacts in Port Curtis in line with NAGD, and the need or otherwise further assessments.

Approach

Sampling was conducted during neap tides and calm weather, therefore providing a conservative basis to distinguish dredging and disposal plumes from background. The monitoring consisted of a baseline water quality assessment prior to the dredging and monitoring of plumes during dredging and disposal operations (November - December 2018).

Monitoring focused on suspended sediments, which is the key stressor generated by dredging and disposal. Monitoring of sediment plumes was undertaken at five locations; Wild Cattle Cutting, Golding Cutting, Gatcombe Channel, Jacobs Channel and EBSDS. The timing of the sampling during different tidal stages (ebb and flood tides) considered the plume direction most likely to affect nearby sensitive receptor sites. An Acoustic Doppler Current Profiler (ADCP) was used to infer turbidity and TSS from the backscatter calibrated from field samples throughout the water column along transects of the dredge plumes. Turbidity and TSS concentrations were also measured through the water column to calibrate ADCP measurements.

The monitoring program also examined the concentrations of metals, metalloids and nutrients in dredge plumes. These parameters do not occur in high concentrations in dredged sediments and therefore are not considered to represent key stressors in the context of dredging and disposal activities. Monitoring was undertaken at three locations; Jacobs Channel, Gatcombe Head and EBSDS. These three locations occur near sensitive receptors and, in the case of Jacobs Channel, contain the highest proportions of silty sediments (and associated contaminants) in maintenance dredged areas.

Sediment Plume Measurements

TSS concentrations of over 57 mg/L and turbidity levels over 95 NTU were measured near the seabed at Jacobs Channel during dredge overflow. Dredge plumes at all other monitoring sites had low TSS (<25 mg/L) and turbidity (<20 NTU) values. At all sites, plume dispersion was rapid and measured sediment concentrations generally returned to background concentration within 1.5 hours. None of the measured plumes advected over sensitive receptor locations during the monitoring period. These results were consistent with numerical modelling which suggests that suspended sediment plumes follow dredged channels and represent short-lived features.

Water Quality Impacts

Temperature, salinity, pH and dissolved oxygen were consistent throughout the water column at all locations and similar between baseline and plume monitoring. Phytoplankton (chlorophyll *a*) concentrations were consistently low in both baseline and test samples. Thus, algal blooms were not evident and are not expected to occur as a result of the maintenance dredging. Furthermore, there is no evidence that dredging lead to dissolved oxygen suppression or created acidic conditions.

Nutrient concentrations were: (i) lower than recorded by BMT WBM (2014; 2015); and (ii) generally similar between test (dredge/disposal) and baseline samples. The exception was a short-term increase in total phosphorus and ammonia concentration in the dredge plume at the Jacobs Channel dredge site, which were near background levels within 30-60 minutes of dredging. A further increase in total phosphorus and suspended solids concentrations was observed at the Jacobs Channel dredge site at the completion of

monitoring two hours after dredging, most likely in response to sediment resuspension processes. Concentrations of bioavailable nutrient species (ortho-phosphorus, nitrogen oxides) were similar between baseline and test samples at all sites.

Dredging activities led to temporary (measured in 10's of minutes) increases in the concentrations of several metals/metalloids in the water column, especially at Jacobs Channel. Concentrations of total metals/metalloids at all dredge and disposal sites rapidly declined over time (measured in 10s of minutes). In accordance with ANZECC/ARMCANZ (2018), the dissolved (unfiltered) fraction was compared with guideline values, as *"it is generally the dissolved fraction that is bioavailable rather than any particulate forms".* Concentrations of dissolved metals and metalloids were typically either below the laboratory detection limits or below their respective ANZECC/ARMCANZ (2018) default guideline values[1] in both test and baseline samples. The exception was dissolved copper at Jacobs Channel, which was above the ANZECC/ARMCANZ (2018) default guideline value of 1.3 mg/L in one test sample and one background sample (both 2 mg/L). These two samples were tagged 'as suspect' as total copper concentrations were less than the dissolved fraction, as can occur at concentrations near the laboratory detection limit. In any case, the concentration of dissolved copper in all test samples at this location were within the range of background, which does not suggest a dredging effect.

Overall, these results agree with the findings of modelling predictions and previous field investigations that maintenance dredging and disposal creates short term (measured in 10's to 100's of minutes) changes to water quality conditions. Measured changes to water quality were short-term and of low intensity, and highly unlikely to cause detectable effects to sensitive ecological receptors. Plumes created by maintenance dredging and disposal are transient features (measured in 10s of minutes) that disperse between dredge runs (time between runs measured in hours of greater) and are therefore highly unlikely to cause cumulative water quality impacts to sensitive ecological receptors.

As the results of the present study therefore suggest that dredging and disposal plumes do not lead to impairment to environmental quality, it therefore it does not trigger the need for Stage 3 testing in accordance with the monitoring framework set out in Section 4.4.2 of NAGD. The study further proved the hypothesis that sediments generated during dredging and disposal do not subsequently reach sensitive areas in amounts that would be harmful to the ecological value and amenity of the area' and 'Pollutant concentrations within dredge plumes at the loading and disposal sites do not reach levels where toxic effects or algae blooms could occur.' While not required under NAGD, it is suggested that: (i) major changes to dredging practices should trigger the need for further testing; (ii) to better understand the bioavailability of metals from sources other than dredging, it is suggested that similar plume assessments could be conducted following flood events.

[1] 95% species protection level

Contents

Contents

List of Figures

List of Tables

Contents

1 Introduction

1.1 Background

Gladstone Ports Corporation (GPC) is responsible for the maintenance dredging of the Port of Gladstone. Maintenance dredging is undertaken on an approximately annual basis by the *TSHD Brisbane*. The dredged material is placed at sea within the East Banks Sea Disposal Site (EBSDS) in accordance with sea dumping permits issued by the Department of the Environment (DOEE).

The conservation goals relevant to the maintenance dredging project are as follows:

- Ensure that maintenance dredging activities do not impact on the Outstanding Universal Value (OUV) of the Great Barrier Reef World Heritage Area (GBRWHA). This will be achieved by minimising or avoiding impacts to marine ecological values (Species, communities and habitats) supported in the Gladstone Harbour which contribute to the OUV of the GBRWHA.
- Undertake appropriate marine ecological condition monitoring to inform adaptive management actions that aim to minimise or avoid impacts to marine ecological components, process and services. This monitoring should coordinate with other broader national, GBR-wide and regional programs, in particular Port Curtis Integrated Monitoring Program (PCIMP) and the Gladstone Healthy Harbour Partnership (GHHP).

The Technical Advisory and Consultative Committee recommended that environmental assessments be carried out to assess dredging and disposal impacts in accordance with National Assessment Guidelines for Dredging (NAGD).

There are several components relevant to assessing potential sediment water quality impacts of dredging and disposal:

- Sediment quality assessments in accordance with the decision-tree set out in Section 4.2 of NAGD. This provides a basis to assess chemical constituents in dredged sediments. The first two steps in the decision tree involve an examination of existing information and chemical characterisation of sediments. Results to date indicate dredged sediments did not exceed screening levels and background (i.e. do not pose an ecotoxicity risk), and therefore there is no requirement to assess other lines of evidence to determine suitability for dredged material disposal (i.e. bioavailability testing, toxicity, weight of evidence assessment).
- Assessments of potential impacts to receiving environment (Section 4.3 of NAGD). BMT WBM (2018) undertook a review of existing information and numerical modelling to characterise potential impacts of dredge plumes. It was concluded that dredging and dredged material disposal pose a low risk to receiving environments. In addition, GPC also undertook monitoring of metal and metalloid burdens in oyster tissues deployed at the EBSDS however this approach was found to be unsuitable for measuring dredge plume impacts.
- Monitoring of impacts (Section 4.4 of NAGD). While developed to monitor the effects of dredge material placement, the process can be adapted to also consider dredging (loading) impacts. NAGD recommends that monitoring specifically considers:

- Changes to water quality conditions, including turbidity and any water quality toxicants, due to dredging and disposal.
- Changes to benthic communities due to smothering at the dredge disposal site. This is considered in a separate GPC study.

The conceptual process set out in Section 4.4.2 of NAGD consists of the following stages:

- Stage 1 – Monitoring of physical processes (sediment movements).
- Stage 2 – Chemical and biological measurements.
- Stage 3 – Further testing if there is evidence of impairment to environmental quality.

The present study informs Stages 1 and 2 (specifically with regard to water quality issues only) and provides a basis to assess dredging and disposal-related impacts in Port Curtis in line with NAGD, and to determine the need or otherwise further assessments.

1.2 Study Objectives

The monitoring was carried out to test the following impact hypotheses:

'Sediments generated during dredging and disposal do not subsequently reach sensitive areas in amounts that would be harmful to the ecological value and amenity of the area'.

'Pollutant concentrations within dredge plumes at the loading and disposal sites do not reach levels where toxic effects or algae blooms could occur'.

The objectives of this study are to:

(1) Measure sediment and pollutant (metals, metalloids, nutrients) concentrations in plumes created during dredging and sediment disposal activities, and their degradation over time;

(2) Determine whether sediment plumes created by dredging and disposal extend to sensitive marine communities such as seagrass and reef communities;

(3) Determine whether concentrations of pollutants in dredge plumes at the loading and disposal sites occur at levels where toxic effects or algae blooms could occur, based on a comparison of data to water quality guideline values; and

(4) Assess the need or otherwise for further testing in accordance with the NAGD monitoring framework.

Note that in the context of objective (3), the present study is intended to replace the discontinued oyster bioaccumulation monitoring program at EBSDS.

1.3 The Dredging Process

The TSHD *Brisbane* (Figure 1-1) is a 85 m long ocean-going vessel which performs maintenance and capital dredging works within the Port of Brisbane for around three months of the year and contract maintenance dredging services for other ports, including the Port of Gladstone, for the remainder.

The TSHD *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 five metres below the water line.

Depending upon the nature of sediments to be dredged, dredging to effectively fill the dredge hopper generally lasts between 1 and 1.5 hours, typically without any overflow from the hopper occurring in the first 15-20 minutes. Subsequently, a dredging overflow plume of turbid water is usually obvious as the overflow water and suspended sediments discharged from the underside of the keel are entrained to the water surface by the action of the vessel's propellers operating near the stern of the vessel as it moves ahead. This results in an obvious surface plume of dredged sediment astern of the TSHD Brisbane for the remainder of the dredging duration.

Typically, the turbid water plume produced by overflow dredging extends from the water surface through the full height of the water column as the overflow sediments settle astern of the dredger. The turbid plumes formed by dredging can be extremely variable both spatially and temporally depending upon such factors as the mode and track of the dredger, the prevailing current regime and the sediments being dredged. Following cessation of dredging the TSHD *Brisbane* typically delivers its load of dredged material to a the EBSDS. On arrival at the EBSDS the dredger typically slows to a speed of a few knots 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.

Figure 1-1 TSHD *Brisbane* Dredging in APLNG Swing Basin

2 Methodology

2.1 Dredge Plume Monitoring

2.1.1 General Approach

The sampling program was designed to maximise the potential for detecting dredge plumes at sensitive receptor sites. In this regard:

- The present study monitored the behaviour of individual sediment plumes at loading and disposal locations in close proximity to known sensitive ecological receptor sites identified by BMT WBM (2014a). Five general locations were monitored (Figure 2-1):
  - Wild Cattle Cutting;
  - Golding Cutting;
  - Gatcombe Channel;
  - Passage Island (or Jacobs) Channel; and
  - EBSDS – disposal location for maintenance dredged material, also known as the Dredged Material Placement Area (DMPA).
- Detailed investigations of the behaviour of physico-chemical parameters at a subset of these sites; as follows:
  - Gatcombe Channel;
  - Passage Island (or Jacobs) Channel; and
  - EBSDS.
- Sampling occurred during periods when ambient background turbidity would be lowest, thereby increasing the ability to detect dredge-generated turbidity. Background turbidity and suspended sediment concentrations are often high during average or spring tide conditions in Gladstone Harbour. Whilst turbid plumes would typically travel farthest during spring tide conditions, the ability to distinguish these plumes against elevated background concentrations would be severely limited. Therefore, small range neap tide conditions were targeted for the plume measurements.

The plume monitoring was planned to occur on either a flooding or ebbing tide (or both) for each of the five study locations depending on the location of sensitive marine communities (such as seagrass or corals) that would be potentially affected. The baseline water quality sampling was targeted for a mid-range tide to establish background levels during 'average' conditions in Gladstone Harbour.

2.1.2 Baseline Measurements

The baseline water quality sampling was undertaken between the 29th of November and the 3rd of December 2018, around a neap low tide covering both ebb and flood flows. Measurements were collected from the five study locations, refer Figure 2-1. Baseline samples were collected at three depths:

- Depth A - 1-2 m from the surface.

- Depth B – located >2 m below the surface and >1 m above the seabed.
- Depth C - within 0.5-1 m from the seabed.

The following field measuring instrumentation and techniques were employed during the course of the baseline measurements:

- Water quality profiling using a YSI model 6600 water quality sonde of water turbidity, temperature, electrical conductivity, salinity, pH, and dissolved oxygen concentration.
- Water sampling for laboratory analysis of TSS, total and dissolved nutrients (Total N and P, nitrate + nitrite, ammonia, reactive phosphorus) and total Organic Carbon (TOC) for comparison with the Queensland Water Quality Guidelines 2009 (QWQG) values for enclosed coastal areas in the Central Coast Queensland region. All samples were also analysed for total and dissolved metals (Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Ag, Zn) for comparison against the respective ANZECC/ARMCANZ (2018) marine trigger limits. Samples were collected from both the surface and near-bed.

2.1.3 Test (During and Following Dredging) Measurements

2.1.3.1 Survey Design

Water quality sampling was conducted at each of the five sites to characterise to characterise spatial and temporal changes in water quality during and following dredging and disposal activities. These are hereafter referred to as 'Test' measurements, in accordance with ANZECC/ARMCANZ (2018).

The survey design varied between the three sampling methods, as follows:

- ADCP measurements – at each of the five sites, sampling was conducted along a single transect running perpendicular through the dredge plume. Sampling was conducted soon after when a visual plume was detected at the surface.
- *In-situ* water quality profiling – at each of the five sites, measurements were collected through the water column at sites within and adjacent to the dredge plume. Measurements were collected at the dredge or disposal site at the following time intervals relative to the first visual observations of the dredge plume or commencement of overflow, whatever is first: 0, 15, 30, 60 and 120-minutes.
- Grab water quality sampling – at three sites, grab samples were collected at the same five time intervals described for in-situ water quality profiling, at the aforementioned A, B and C depth horizons.

The sampling procedures for each of these survey methods is describing below.

2.1.3.2 Sampling Procedure

All field measurements were conducted from a BMT crewed research vessel. The test measurements were undertaken during neap tides between the 29th of November and the 3rd of December 2018. During the test measurements, BMT communicated and co-ordinated measurement and sampling activities with GPC and the *TSHD Brisbane* via mobile telephone or VHF marine radio.

Sampling was undertaken in accordance with relevant international standards including ISO 5667-1:2006, ISO 5667-2:1991, and ISO 5667-3:2003, along with relevant Australian Standards including AS/NZS 5667.1:1998. Table 2-1 provides details on the sampling equipment and sampling and analysis procedures.

The potential water quality impacts of the turbid plumes were evaluated by water quality profiling measurements allied with grab water sample collection through the water column. The water quality profiling measurements at each site included those at the nearest sensitive marine communities before and after the specific dredging event.

The plume sediment concentrations and plume extents were defined in real-time using a vessel-based Teledyne RD Instruments 1200 kHz ADCP interfaced with differential and heading GPS allied with profiling water quality and optical backscatter instruments. Water quality profiling measurements from the YSI sonde included water temperature, electrical conductivity, salinity, dissolved oxygen, pH and turbidity.

Conversion of acoustic and optical backscatter concentrations in the dredge plumes to sediment concentrations in mg/L was achieved by the concurrent collection of multiple water samples at varying times and plume horizons at each site to allow calibration (samples will be collected at the top, middle and bottom of the water column). The samples were analysed for TSS concentration and selected samples (one at each of the five monitoring locations) were analysed for the particle size fractions of the suspended material. Refer to Section 2.2.2 for calibration procedures.

Plume samples were also collected and analysed for total and dissolved nutrients (dissolved – ammonia, nitrate, nitrite, FRP, total – N and P, TOC), total and dissolved metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, silver, zinc) and chlorophyll *a*. Intensive field sampling was undertaken at three locations – one in the inner harbour (Jacobs Channel), one in the outer harbour (Gatcombe or Golding Channel), and one at the East Banks DMPA. Samples were collected at the top, middle and bottom of the water column within the main body of the plume at intervals of 0, 15, 30, 60 and 120 minutes after the passage of the dredge (5 x 3 = 15 samples per monitoring session).

Table 2-1 Water Quality Sampling Equipment and Procedures

Methodology	Equipment	Parameters measured	Sampling Procedure	Data Analysis	QA/QC
ADCP measurements	Downward facing vessel mounted Model 1200 kHz Teledyne RDI Acoustic doppler current profiler (ADCP)	Acoustic backscatter, calibrated to estimate suspended sediment concentrations	Transects were conducted perpendicular and through the plume at each site. This was used to estimate suspended sediment concentrations in two dimensions (vertical through water column and along the horizontal transect).	Refer to Section 2.2 for details.	Refer to Section 2.2 for details regarding calibrations and data accuracy.
In-situ water quality profiling	Yellow Stone Instruments (YSI) EXO multi-parameter water quality sonde	Turbidity (NTU), water temperature (ºC), electrical conductivity (mS/cm), salinity (ppt), pH, and dissolved oxygen concentration (mg/L and % saturation), depth (m) and time	The multi-probe was slowly lowered through the water column, from the surface to the seabed, recording water quality parameters, depth and time at 15 second intervals. Sampling was conducted on the same transects as the ADCP measurements.	Water quality profiles were generated in Microsoft Excel to characterise changes in water quality parameters through the water column.	This instrument was calibrated in Brisbane prior to the site visit and the calibration was checked again once at site using appropriate calibration solutions. The instrument accuracy was checked regularly during the field program, and a final calibration was performed at the completion of the field program to check for any drift in parameters.
Grab sampling for laboratory analysis	Van Dorn Water Sampler	Total suspended solids (mg/L) Nutrients - Total nitrogen and phosphorus, nitrate + nitrite, ammonia, ortho-phosphorus, Total Organic Carbon (%) Dissolved and total metals/metalloids – aluminium, arsenic, cadmium, chromium, copper, iron, manganese, mercury, nickel, silver, zinc (all µg/L) Particle size distribution (% by mass)	The Van Dorn sampler was lowered through the water column to collect three separate samples at the three depth horizons (surface, mid and near bed). Sampling was conducted on the same transects as the ADCP measurements.	Water quality time-series were generated in Microsoft Excel for detected parameters. Data were also tabulated and compared with Queensland Water Quality Guidelines 2009 (QWQG) values for enclosed coastal areas in the Central Coast Queensland region. Dissolved metals/metalloid concentrations were compared against the respective ANZECC/ARMCANZ (2018) default marine trigger limits for 95% species protection level[2].	QA/QC procedures in accordance with the Department of Environment and Science (DES) Monitoring and Sampling Manual 2018. Sampling for nutrients and metals included collection of: • Intra-laboratory duplicates to test for primary laboratory variation - 20% of samples for both baseline and plume monitoring; • Inter-laboratory duplicates to test for laboratory variation in analyses - 10% of samples for both baseline and plume monitoring; • Field blanks to test for potential sample contamination during sampling - One sample for each baseline and plume monitoring; and • Rinsate blank to test for potential sample contamination from sampling equipment - One sample for each baseline and plume monitoring.

[2] ANZECC/ARMCANZ (2018) refers to default guideline values for metals/metalloids outlined in ANZECC/ARMCANZ (2018) guidelines

LEGEND

- Water Quality Measurement Locations
- East Banks Sea Disposal Site
- Channel Extent
- Composite Seagrass Distribution (2002-2012)
- Seagrass Distribution (2012)
- Reefs (BMT WBM)
- Reefs (GBRMPA 2014)

Title:
Water Quality Measurement Sites

Figure: **2-1**

Rev: **A**

N

0 3 6km

Approx.Scale

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Filepath : I:\B20617_I_GML Gladstone Dredge Monitoring CDM\DRG\WQU_001_140513_ Water Quality Measurement Sites.wor

2.2 Data Processing

2.2.1 ADCP Data Processing

Processed ADCP measurements were used to remotely measure the suspended sediment in the water column with a sufficient resolution to provide a profile view of the suspended sediment associated with dredging.

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 from 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 backscatter echo can be translated into TSS values through a series of steps as detailed below.

Laboratory analysis of the TSS in water samples spanning a wide range of sediment concentrations provides the means to calibrate the handheld OBS turbidity profiling instrument. By correlating the TSS values with the Nephelometric Turbidity Units (NTU), recorded in the field by the OBS, the site- and date-specific NTU-TSS relationship can be determined.

The turbidity profiles measured with the OBS, once converted to TSS, are then used to derive a relationship between the ADCP acoustic signal backscatter intensity and TSS. The software package VISEA includes a built-in calibration module for this purpose which is based on acoustic theory. The calibration process requires information on water temperature and salinity at the site and various scaling factors and offsets for each of the four transducers.

The estimates of TSS obtained from the ADCP backscatter signal are typically plotted as a function of depth and chainage along each transect. 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 and a measurement “blanking-distance”, the ADCP was only able to resolve TSS profiles below a depth of approximately 1.5 m. The ADCP was also unable to estimate the TSS within approximately 1 m from the bed.

ADCP backscatter measurements are prone to occasional spikes/elevated values that are un-related to TSS in the water column. These spikes may arise due to a number of sources of interference, including bubbles generated near the surface by the dredge, survey vessel, 3rd-party vessel or other objects ‘ensonified’ in the water-column such as plankton, fish or seaweed. The data presented in this report has not been “cleaned” other than the TSS cap mentioned above.

2.2.2 ADCP Data Calibration

2.2.2.1 Calibration, Turbidity (NTU) to TSS

A total of 34 of the water samples analysed for TSS were and used to derive the NTU-TSS relationship of the OBS, a procedure detailed in Section 2.2. Refer to Appendix A for the tabulated TSS values and Figure 2-2 for the derived relationship. The relationship was derived using linear regression.

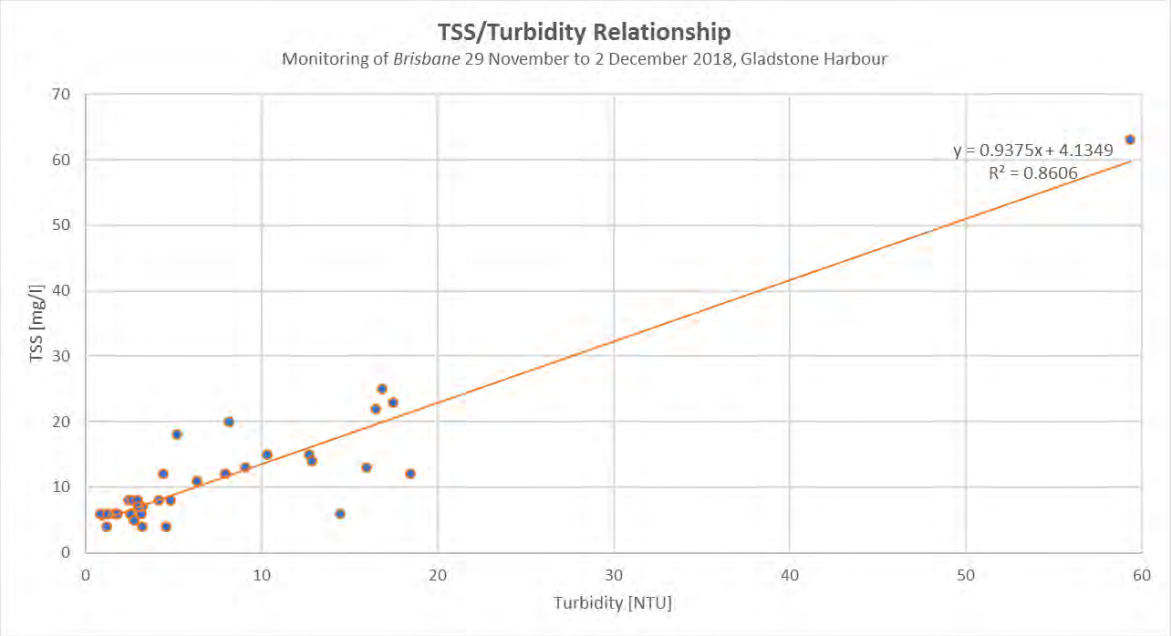

Figure 2-2 TSS / Turbidity Relationship

2.2.3 Calibration, Backscatter to TSS

The calibration was performed as outlined in Section 2.2 using the VISEA calibration module. Sufficient data were available to perform site specific calibrations for all monitored sites.

The calibration is deemed adequate for the purposes of this study and observations made using the ADCP are consistent with those made using the OBS, the analysis of collected water samples and what was observed visually on each measurement day. Refer to Appendix G for the calibration plots.

2.3 Water Sample Data Processing

Water samples were sent to the NATA accredited laboratories of Australian Laboratory Services (primary laboratory) and Envirolab (secondary laboratory) for analysis of nutrients and metals/metalloids. All laboratory LORs were either below or at their respective trigger limits where applicable.

The measured concentrations were assessed against the relevant QWQG (nutrients, TSS and chlorophyll a) and ANZECC/ARMCANZ (2018) (metals and metalloids) default guideline values (GVs) for marine waters (95% species protection level). As stated in ANZECC/ARMCANZ (2018), *"since it is generally the dissolved fraction that is bioavailable rather than any particulate forms, the fraction that passes through a 0.45 µm filter membrane is compared to the guideline value."* Therefore, the dissolved fraction of metals and metalloids was used for comparison against the ANZECC/ARMCANZ (2018) GV.

2.3.1 QA/QC Samples

Sampling for nutrients and metals included collection of QA/QC samples:

- Intra-laboratory duplicates to test for primary laboratory variation - 20% of samples for both baseline and plume monitoring;

- Inter-laboratory duplicates to test for laboratory variation in analyses - 10% of samples for both baseline and plume monitoring;
- Field blanks on sampling equipment to test for potential sample contamination during sampling - One sample for each baseline and plume monitoring; and
- Trip blank in sample bottles to test for potential sample contamination during transport of samples - One sample for each baseline and plume monitoring.

An assessment of all QA/QC data was undertaken and the Relative Percent Difference between samples calculated for both intra- and inter- laboratory samples. The assessment criteria were as follows:

- Intra- and inter-laboratory duplicate samples should ideally agree within ±50%. It is, however, noted that this may not always the case, e.g. in case of concentrations measured close to the LOR. Small differences in concentrations close to the LOR can lead to relatively large changes in the RPD; and
- Field and trip blank sample concentrations should be at or near the detection limit of the method used.

2.4 Presentation of Results

2.4.1 ADCP Data

Figure 2-3 is an example plot demonstrating how the sediment plume measurement results have been presented in this report. The plots are comprised of two components, an upper and a lower component. The upper component is a profile-view of the ADCP transect which depicts the TSS concentrations along the transect and down through the water column. The lower component depicts the depth averaged plume concentrations in plan-view along the transect.

The coloured circles in the upper component of Figure 2-3 depict the two OBS profiles performed during the transect. The colour of the circles represents the TSS concentration returned by the OBS which align with those returned by the ADCP. The OBS profiles are plotted directly onto the elevation-chainage axes. As the OBS 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 OBS profiles do not appear vertical. OBS profiles were undertaken on selected transects with the aim to obtain measurements over a broad range of turbidity values to facilitate ADCP data calibration.

The red ‘x’ plotted in the lower component of Figure 2-3 identifies the start of the ADCP transect which extends from left to right in the upper profile-view component of the plot. The timing of the measurement within the tidal cycle is depicted in the upper right hand corner of the plot (date shown on x-axis).

The extents of the nearest sensitive marine receptors are also plotted on the lower component of the plots. The patches of red diagonal stripes depict the composite seagrass distribution for 2002-2012 (Davies *et al.* 2013). The patches of dark green with black grass patterns depict the extents of

seagrass meadows as of 2012 (Davies *et al.* 2013). The patches of light blue with black dot patterns depict the extents of known reefs (BMT WBM 2013).

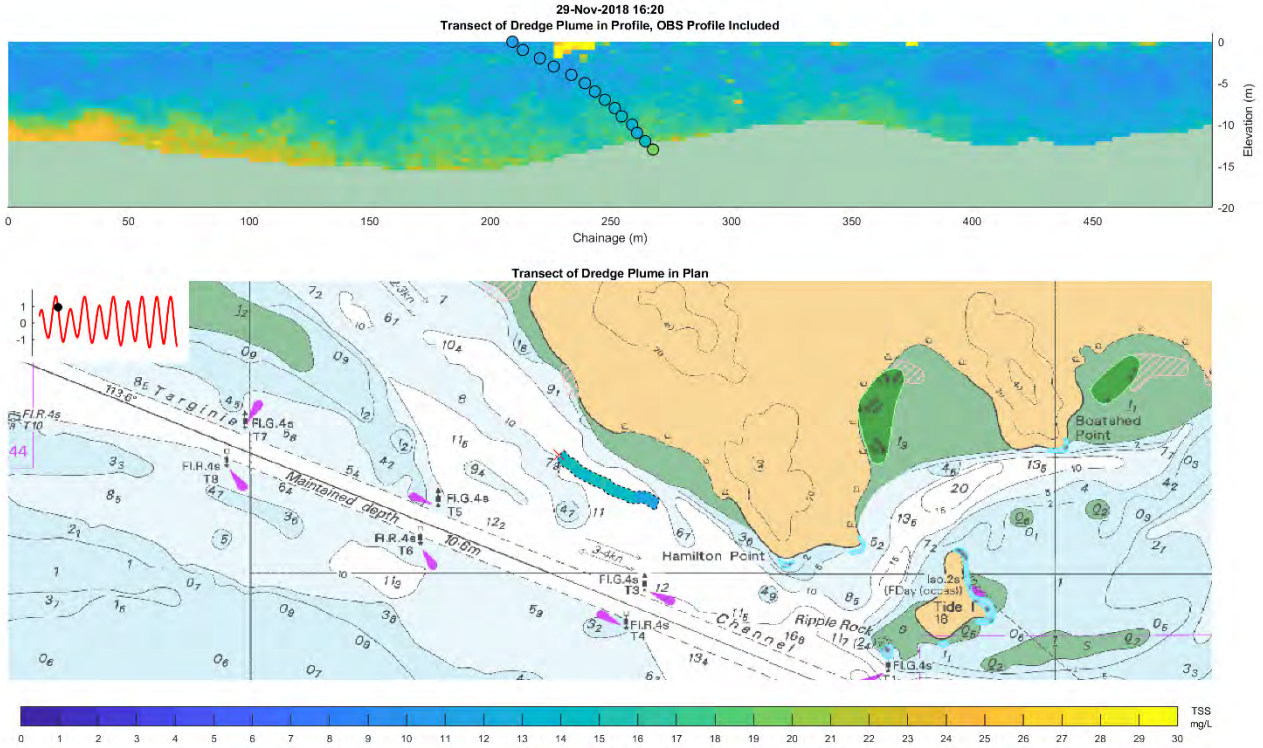

Figure 2-3 Example Figure

3 Results

3.1 Dredging at Jacobs Channel, Ebb Tide on 29th November 2018

3.1.1 Plume Monitoring

ADCP measurements of the dredge plumes at Jacobs Channel are summarised in Figure 3-1 to Figure 3-4 and a complete set of ADCP measurements, which also depict the timing and locations of OBS profiling, is provided in Appendix B. Dredging by TSHD *Brisbane* was conducted on an ebbing tide with a tidal range of approximately 2.8 m. Suspended sediment concentrations of up to 30 mg/L were measured, but were confined to the deeper channel areas and returned to background levels within 1.5 hours.

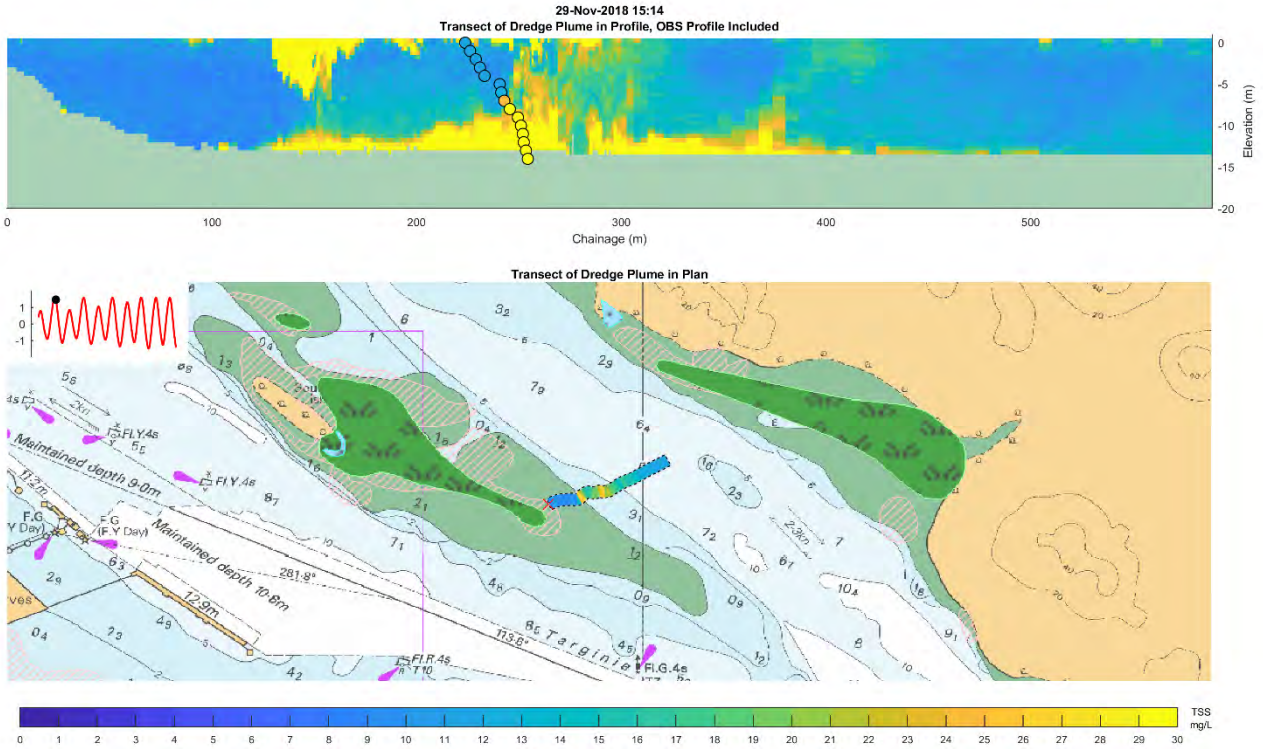

Figure 3-1 Dredging at Jacobs Channel – Ebb Tide

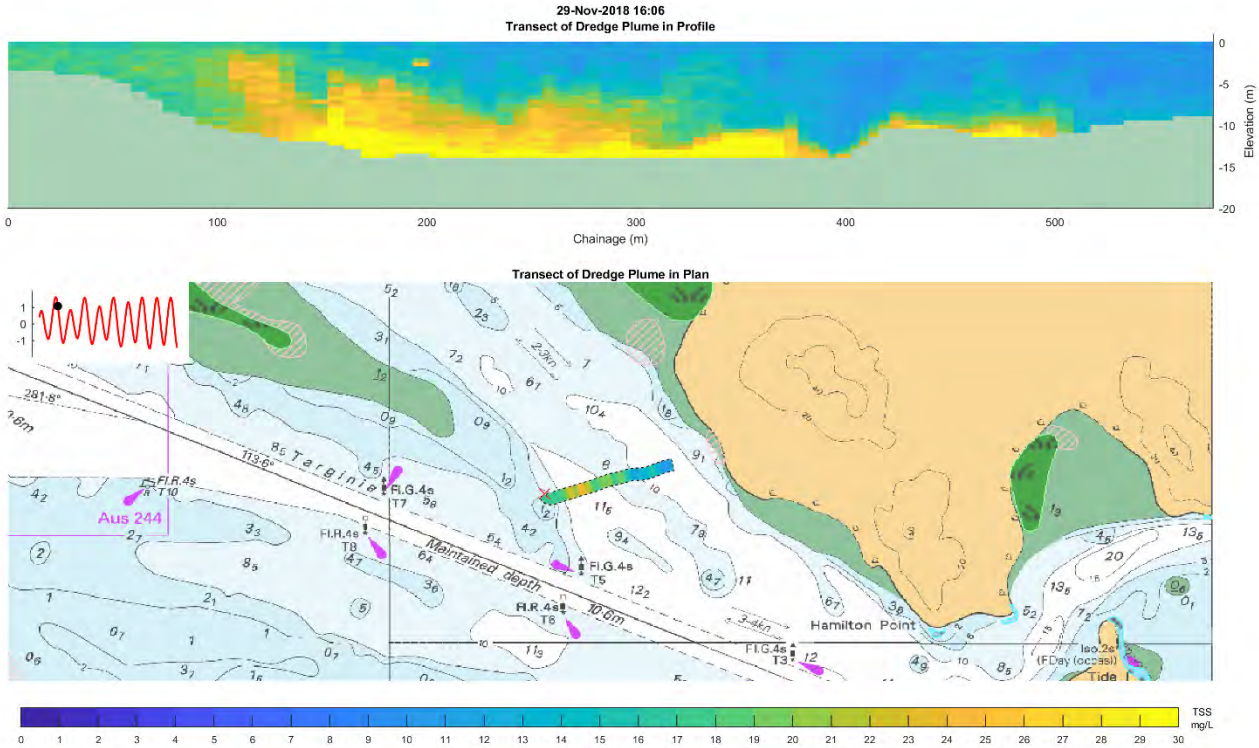

Figure 3-2 Dredging at Jacobs Channel – Ebb Tide

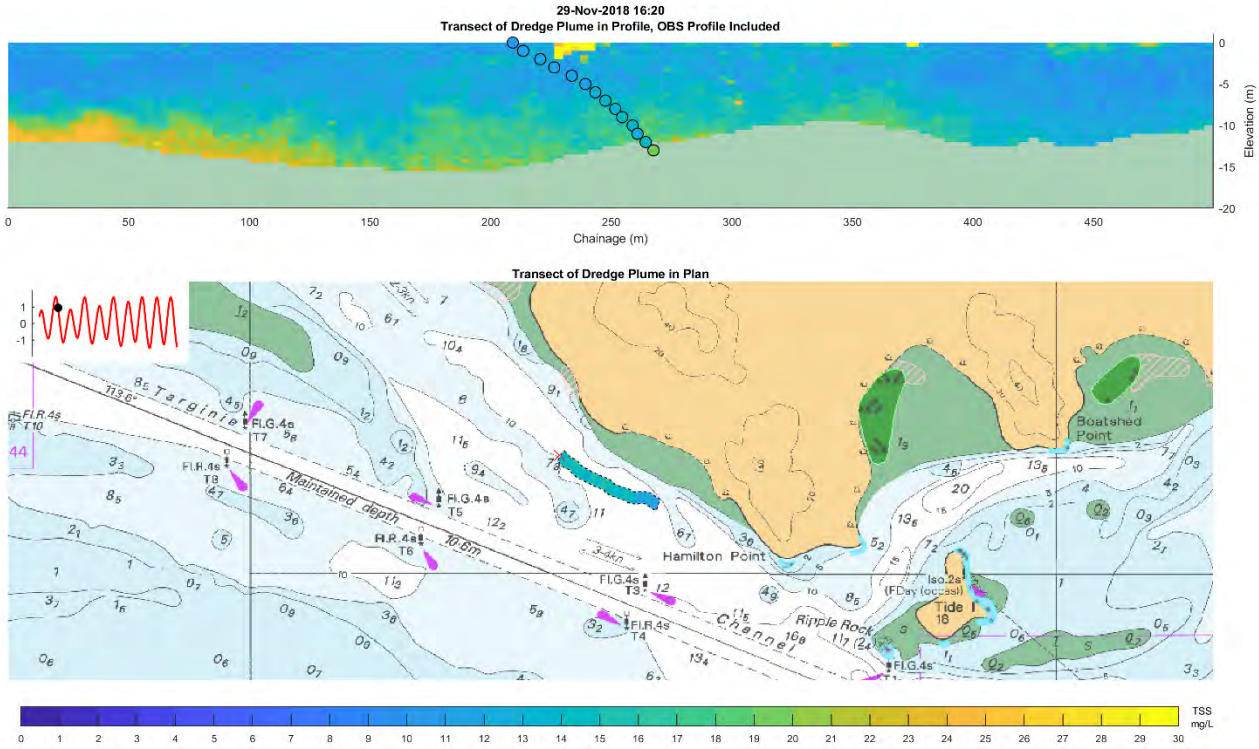

Figure 3-3 Dredging at Jacobs Channel – Ebb Tide

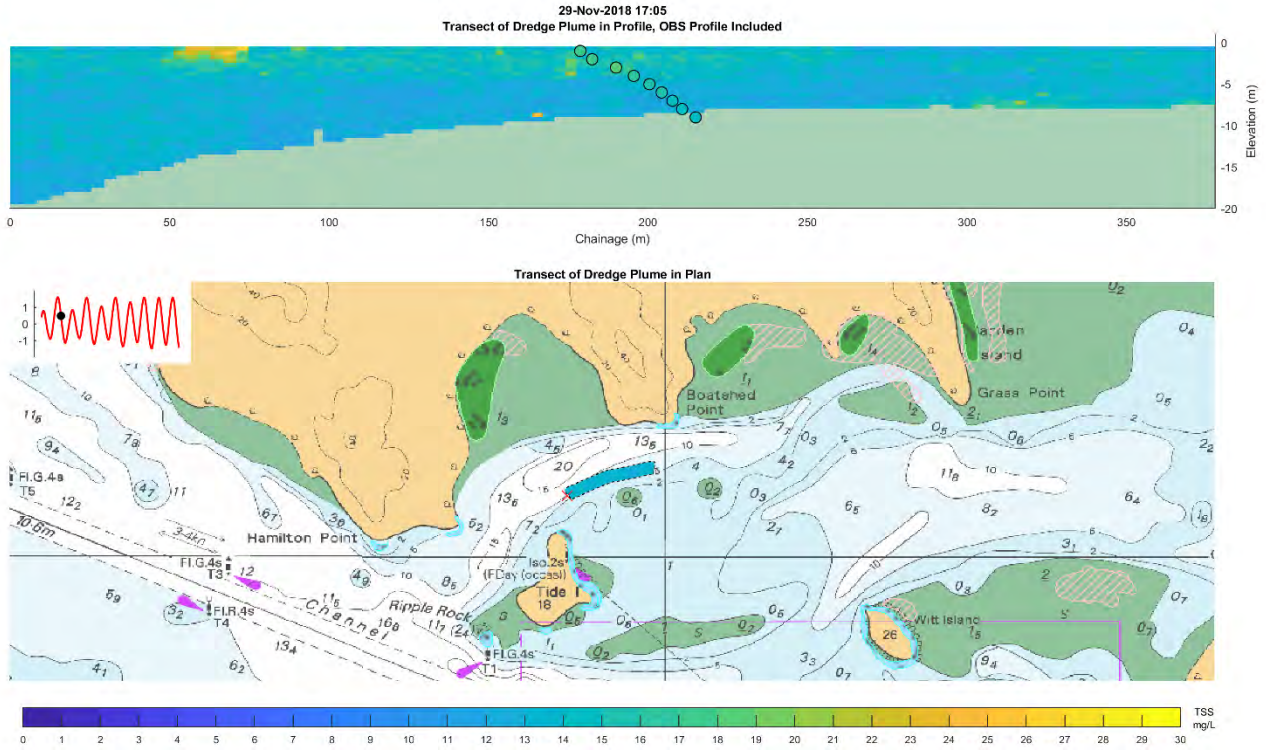

Figure 3-4 Dredging at Jacobs Channel – Ebb Tide

3.1.2 Water Quality

3.1.2.1 Water Quality Profiles

Table 3-1 summarises *in situ* water quality data at ebb tide for Jacobs Channel, as well as the baseline sample collected during flood tide, profile data. Temperature, salinity and pH were consistent through the water column and over time. Average dissolved oxygen were ~80% saturation in baseline and plume profiles.

Turbidity profiles are presented in Figure 3-5. Baseline average turbidity was ~12 NTU, increasing to 20 NTU at time interval 0, 22 NTU at 15 minutes, and fell to 12 NTU at 30-60 minute interval intervals, before increasing again to 21 NTU at time interval 120 minutes. Near-bed turbidity at 0 and 15 minute intervals was far greater than surface turbidity, indicating the formation of a near-bed dredge plume at this location. The near-bed plume was a short-term feature that was not detected after the 15 minute time interval.

Table 3-1 Water quality profile summary-Jacobs Channel

Jacobs Channel	Parameter	Temp (°C)	Salinity (ppt)	pH	Dissolved Oxygen (%)	Turbidity (NTU)
Baseline 29/11/18, 14:20	Min	27.73	37.42	7.96	79.9	10.1
	Max	27.98	37.44	7.98	83.2	15.2
	Average	27.89	37.43	7.97	81.63	11.95
Plume at 0 29/11/18, 15:33	Min	27.86	37.42	7.99	79.8	10.1
	Max	27.99	37.44	8.01	83.7	98.2
	Average	27.94	37.43	8.01	82.34	17.52
Plume at 15 29/11/18, 15:33	Min	27.82	37.44	7.99	77.5	10.6
	Max	27.93	37.46	8.01	81.5	68.2
	Average	27.87	37.45	8.01	80.44	22.6
Plume at 30 29/11/18, 15:54	Min	27.78	37.45	8	78.1	9.8
	Max	27.94	37.46	8.01	81.6	21
	Average	27.88	37.46	8.01	80.61	12.1
Plume at 60 29/11/18, 16:18	Min	27.79	37.47	8.02	80.2	9.4
	Max	27.9	37.48	8.02	82.2	21.1
	Average	27.85	37.48	8.02	81.28	12.26
Plume at 120 29/11/18, 17:04	Min	27.78	37.47	8.01	80.2	16.6
	Max	27.83	37.48	8.02	80.9	27.2
	Average	27.80	37.48	8.02	80.51	20.38

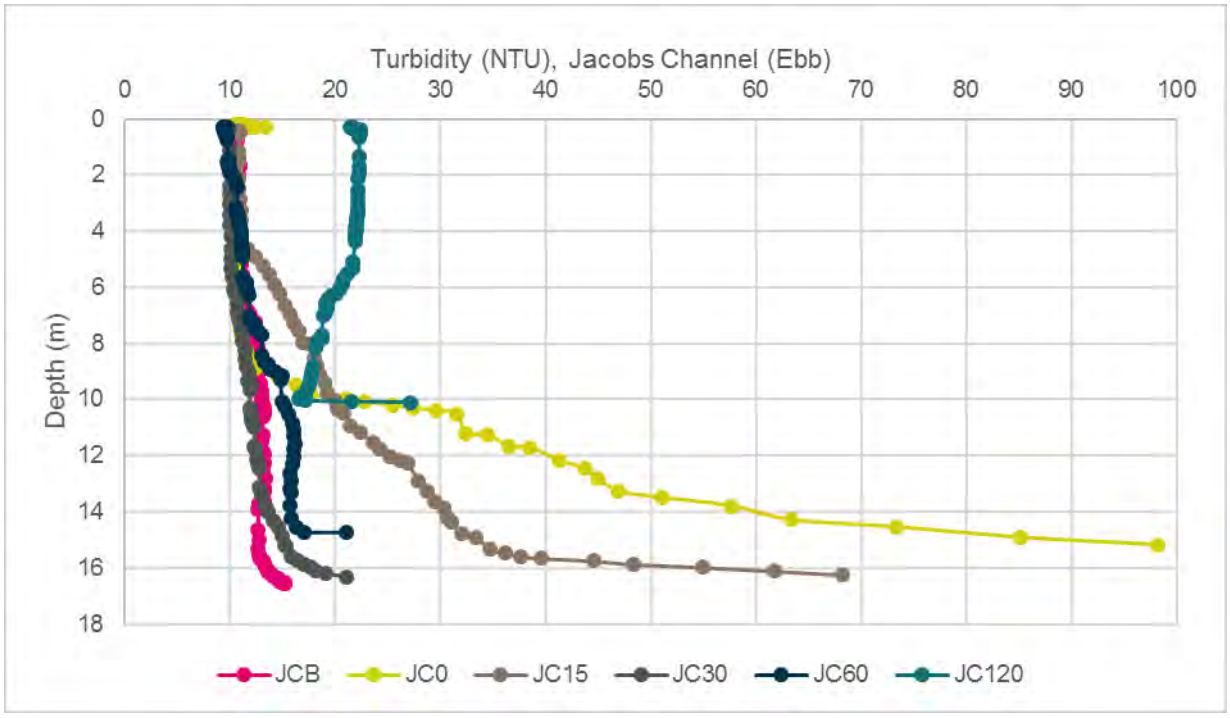

Figure 3-5 Turbidity profiles- Jacobs Channel

3.1.2.2 Water Quality Grab Samples

The water quality grab sampling results for the ebb tide Jacobs Channel measurements are presented in Table 3-2.

Nutrient and TSS concentrations were typically higher in test samples compared to the baseline measurements, as follows:

- Phosphorus - Total phosphorus concentrations exceeded the QWQG GV (20 µg/L) in most test samples, peaking at 0 and 15 intervals (19-98 µg/L), before declining to 11-13 µg/L) at 30 minutes, and rising to 21-24 g/L at 120 minutes. Near-bed total phosphorus concentrations were higher than surface waters in most test samples, similar to trends in turbidity. Reactive phosphorus was below the LOR and/or QWQG GV.
- Nitrogen – Nitrogen oxide (nitrite + nitrate) concentrations were well above the QWQG GV (3 µg/L) in all samples, and showed no consistent differences between baseline (16-18 µg/L) and plume samples (11-25 µg/L). Ammonia was below the QWQG GV, and was typically less than the LOR. The QWQG GV of 200 µg/L for total nitrogen was met in all samples except baseline B, 0-A, 30-B and 30-C. For all forms of nitrogen, there was no clear differences through the depth profile, nor between baseline and test conditions.
- TSS concentrations exceeded the QWQG limit (15 mg/) in multiple baseline (11-16 mg/L) and test (12-63 mg/L) samples. TSS was highest near the bed at 0 and 15 minute intervals (57-63 mg/L), and a low magnitude near-bed plume was also detected at 30 (22 mg/L) and 60 (26 mg/L) minute intervals.
- All samples were at or below the QWQG GV for chlorophyll *a*.

Total copper exceeded the ANZECC GV in seven test samples. In accordance with the hierarchy presented in ANZECC/ARMCANZ (2018), where the total fraction exceeds the GV, the dissolved fraction should then compared to the GV to assess the risk of the potential bioavailable fraction. In all seven samples where the total copper concentration exceeded the GV, the dissolved fraction was either not detected or less than the GV, indicating a low toxicant risk.

Two samples (one background, one test sample) had dissolved copper concentrations above the ANZECC/ ARMCANZ GV. In both cases samples, total copper was less or slightly greater than the LOR, and the dissolved fraction was greater than the total fraction. These samples are therefore considered anomalous, which can occur where concentrations are near the LOR.

All other parameters had dissolved and total metal/metalloid concentrations below ANZECC/ARMCANZ (2018) GVs. Total concentrations of aluminium, iron and to a lesser extent manganese and zinc were higher in the test samples compared to the baseline samples. The dissolved fraction of these metals was either below the LOR or similar between baseline and test measurements. These results suggest that metals/metalloids were at concentrations that are unlikely to pose a toxicant risk.

Table 3-2 Water quality results - Jacobs Channel

Jacobs Channel - Parameter	Unit	LOR	GV	Baseline			Test														
Time interval (minutes)				Pre-dredge			0			15			30			60			120		
Depth interval				A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Nutrients, TSS, Chlorophyll (note – QWQG GV adopted below)																					
Total Phosphorus	µg/L	5	20	11	13	12	22	19	49	35	31	98	14	17	18	10	14	21	21	24	22
Ortho-Phosphorus	µg/L	1	6	<LOR	<LOR	<LOR	1	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	2	<LOR	1	<LOR	<LOR	1	<LOR	<LOR
Ammonia-Nitrogen	µg/L	5	8	<LOR	7	<LOR	14	<LOR	8	<LOR	<LOR	15	<LOR	25	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Nitrite + Nitrate (as N)	µg/L	2	3	18	18	16	25	12	12	13	15	13	11	22	10	14	15	11	11	11	11
Total Nitrogen	µg/L	50	200	172	253	151	313	179	191	163	178	191	182	277	264	173	149	154	122	136	171
Solids (Suspended)	mg/L	1	15	13	16	11	20	15	57	38	25	63	14	13	22	12	15	26	25	24	20
Chlorophyll a	µg/L	0.001	2	1	2	2	2	2	1	1	2	2	2	1	2	1	2	1	1	1	1
Total Organic Carbon	mg/L	1	-	3	2	2	2	2	<1	3	2	3	2	3	3	2	3	3	2	2	3
Metals and Metalloids (note – ANZECC Toxicity GV adopted below)																					
Aluminium (Total)	µg/L	5	-	299	479	397	730	386	1490	1070	809	2010	641	526	553	309	435	783	762	815	534
Aluminium (Dissolved)	µg/L	5	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Arsenic (Total)	µg/L	0.5	-	1.5	1.6	1.6	1.8	1.5	2.4	2.1	1.9	2.7	1.8	1.6	1.8	1.5	1.7	2.2	2	1.8	1.6
Arsenic (Dissolved)	µg/L	0.5	-	1.2	<LOR	1.2	1.1	1.2	1.3	1	1.2	1.2	1.1	1	0.9	1.1	1.1	1.2	1.1	1	1
Cadmium (Total)	µg/L	0.2	0.7	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Cadmium (Dissolved)	µg/L	0.2	0.7	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium (Total)	µg/L	0.5	4.4	<LOR	1	<LOR	1.3	1.2	2.4	1.6	1.5	2.7	0.6	<LOR	0.7	<LOR	0.5	1.2	0.9	1.2	0.8
Chromium (Dissolved)	µg/L	0.5	4.4	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Copper (Total)	µg/L	1	1.3	<LOR	1	<LOR	2	1	2	2	2	3	1	1	1	1	1	2	1	2	1
Copper (Dissolved)	µg/L	1	1.3	2	<LOR	<LOR	1	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	2	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Iron (Total)	µg/L	5	-	363	603	462	998	531	2170	1590	1260	2870	682	635	785	427	593	1160	1120	1110	770
Iron (Dissolved)	µg/L	5	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Lead (Total)	µg/L	0.2	4.4	<LOR	0.4	<LOR	0.5	<0.2	0.7	0.3	0.2	0.8	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Lead (Dissolved)	µg/L	0.2	4.4	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Manganese (Total)	µg/L	0.5	-	11.2	15.2	12.1	21.3	17.6	43.6	31.4	26.1	60.5	13.9	13.2	19.5	12.4	15.7	27.4	26.2	24.8	19.3
Manganese (Dissolved)	µg/L	0.5	-	1.4	<LOR	1.6	2.4	1.9	7.4	5	3.3	12.4	2	1.8	3.2	1.5	1.9	2.5	3.1	2.8	2.1
Mercury (Total)	µg/L	0.00004	0.1	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Mercury (Dissolved)	µg/L	0.00004	0.1	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Nickel (Total)	µg/L	0.5	7	<LOR	3	<LOR	<LOR	<LOR	1.5	1.2	1	1.5	<LOR	0.7	0.7	<LOR	<LOR	0.7	0.7	0.6	0.6
Nickel (Dissolved)	µg/L	0.5	7	0.7	<LOR	<LOR	0.6	<LOR	<LOR	<LOR	<LOR	<LOR	0.5	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver (Total)	µg/L	0.1	1.4	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver (Dissolved)	µg/L	0.1	1.4	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Zinc (Total)	µg/L	5	15	9	11	6	13	<LOR	10	<LOR	<LOR	10	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Zinc (Dissolved)	µg/L	1	15	7	<LOR	6	7	<LOR	<LOR	<LOR	6	<LOR	<LOR	9	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

Orange shading = guideline exceeded; green shading = concentration below the laboratory limit of reporting (LOR)

3.2 Dredging at Wild Cattle Cutting, Ebb Tide on 30th November 2018

3.2.1 Plume Monitoring

The ADCP measurements of the dredge plumes at Wild Cattle Cutting are summarised in Figure 3-6 to Figure 3-8 and a complete set of ADCP measurements is provided in Appendix C. Dredging by the TSHD *Brisbane* was conducted on an ebbing tide going into slack tide, with an ebb tidal range of approximately 1.7 m. Plumes concentrations of up to 25 mg/L were measured, but returned rapidly to background levels before advecting any significant distance.

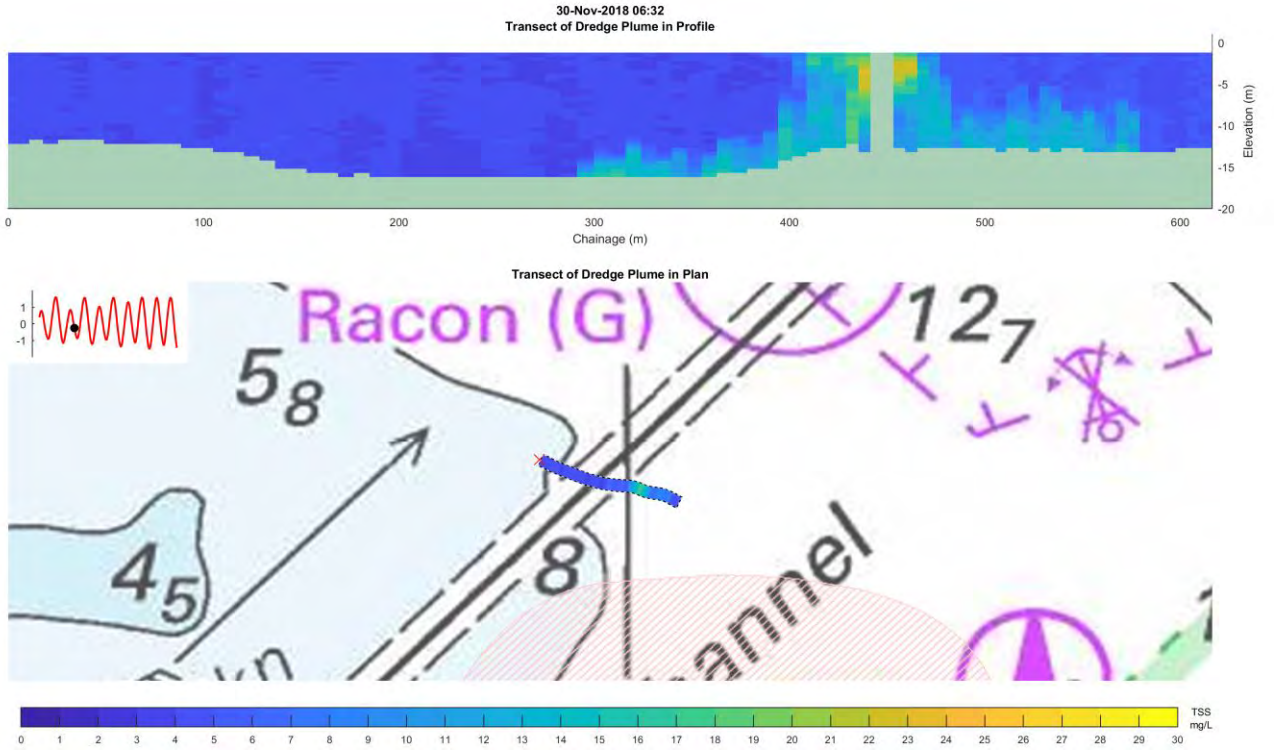

Figure 3-6 Dredging at Wild Cattle Cutting – Ebb Tide

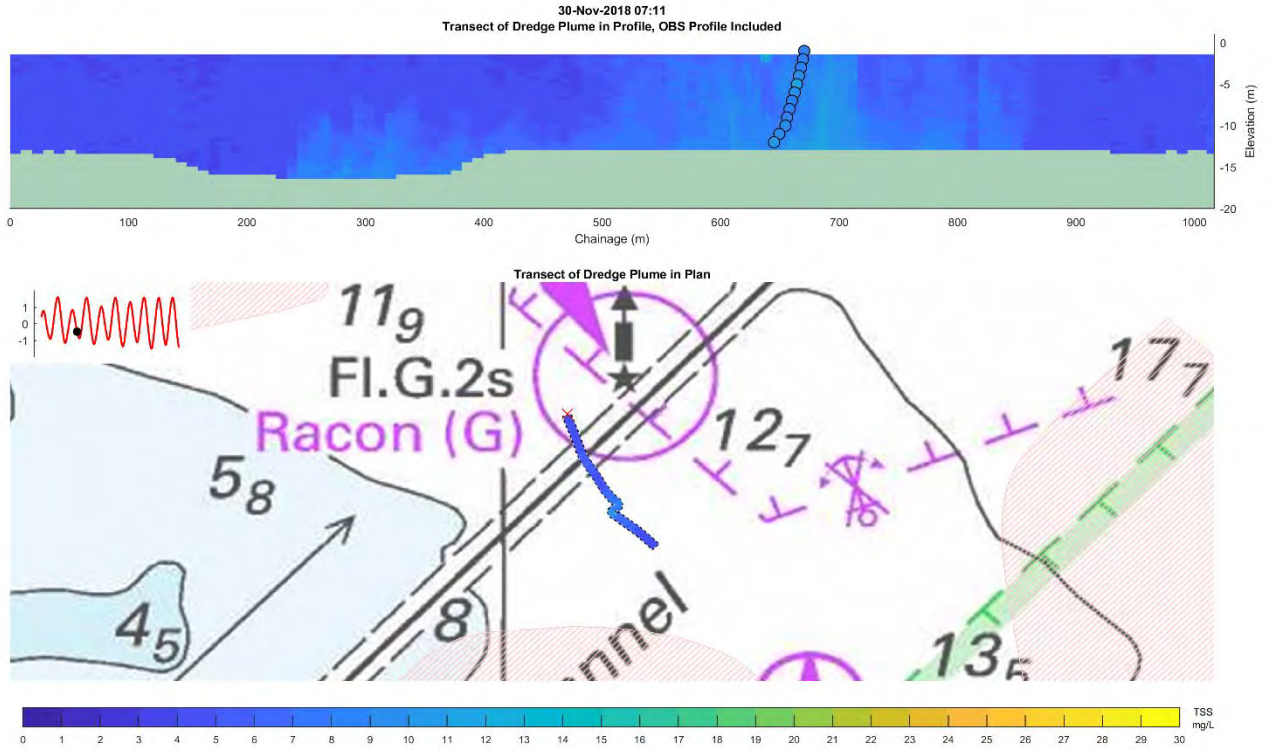

Figure 3-7 Dredging at Wild Cattle Cutting – Ebb Tide

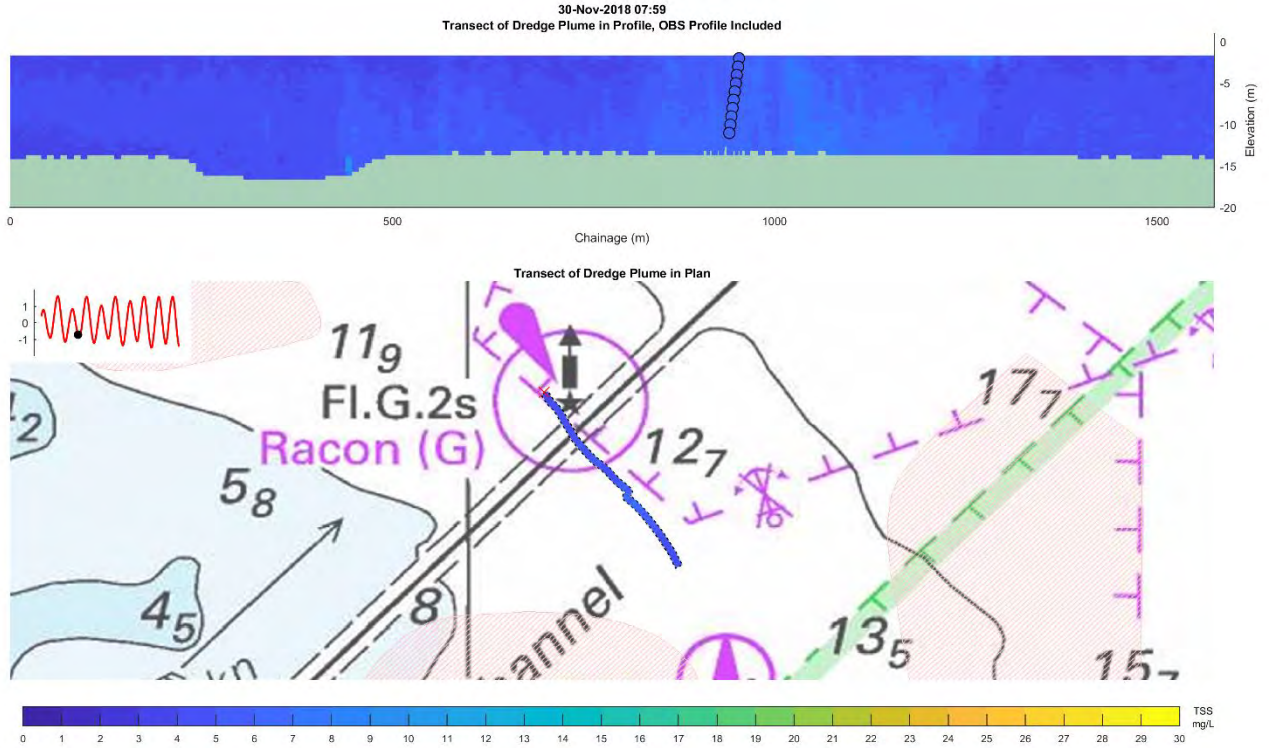

Figure 3-8 Dredging at Wild Cattle Cutting – Ebb Tide

3.2.2 Water Quality

Plume water quality sampling was not conducted at this site. Results from baseline samples collected 3rd December 2018 are provided in Appendix H.

3.2.3 Plume Monitoring

The ADCP measurements of the dredge plumes during an ebb tide in the Golding Cutting are summarised in Figure 3-9 to Figure 3-12. A complete set of ADCP measurements is provided in Appendix D. Dredging by TSHD *Brisbane* was conducted on an ebb tide, with an ebb tidal range of approximately 2m. Plume concentrations over 30mg/L were measured, but returned to background levels within 1.5 hours. The plume advected to the northeast of the shipping channel.

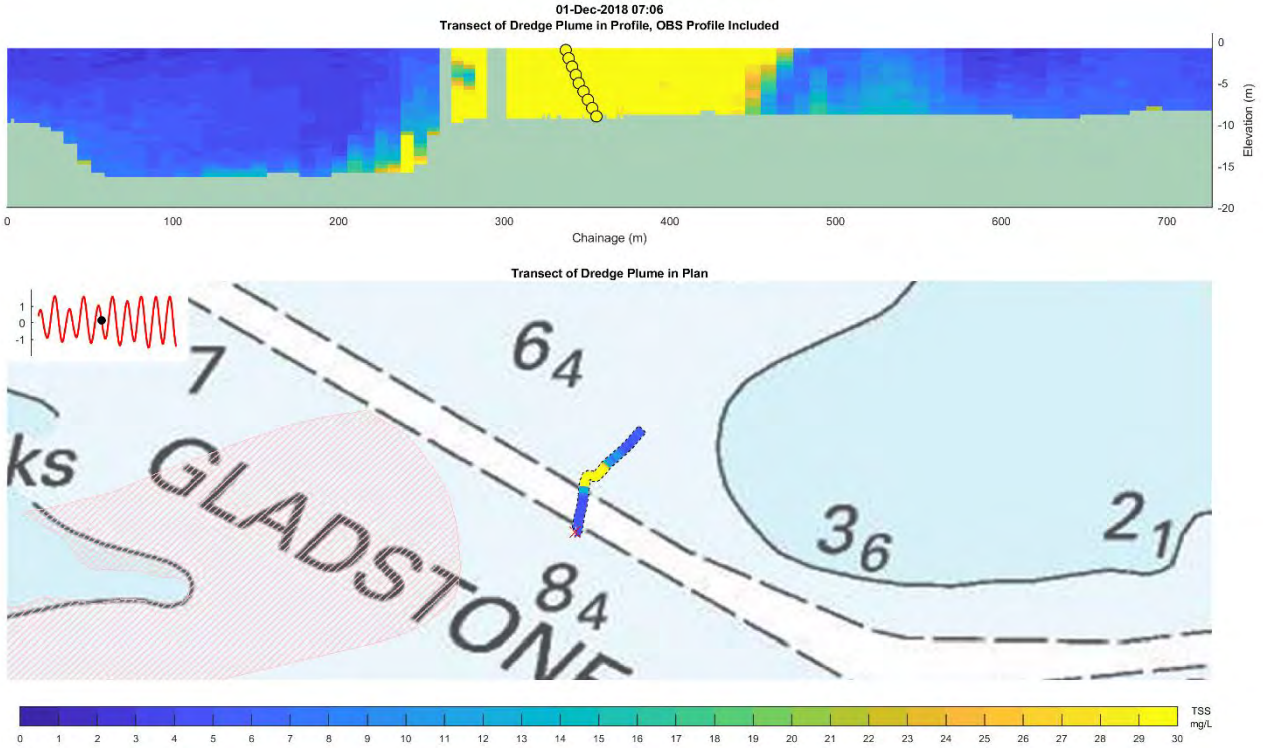

Figure 3-9 Dredging at Golding Cutting – Ebb Tide

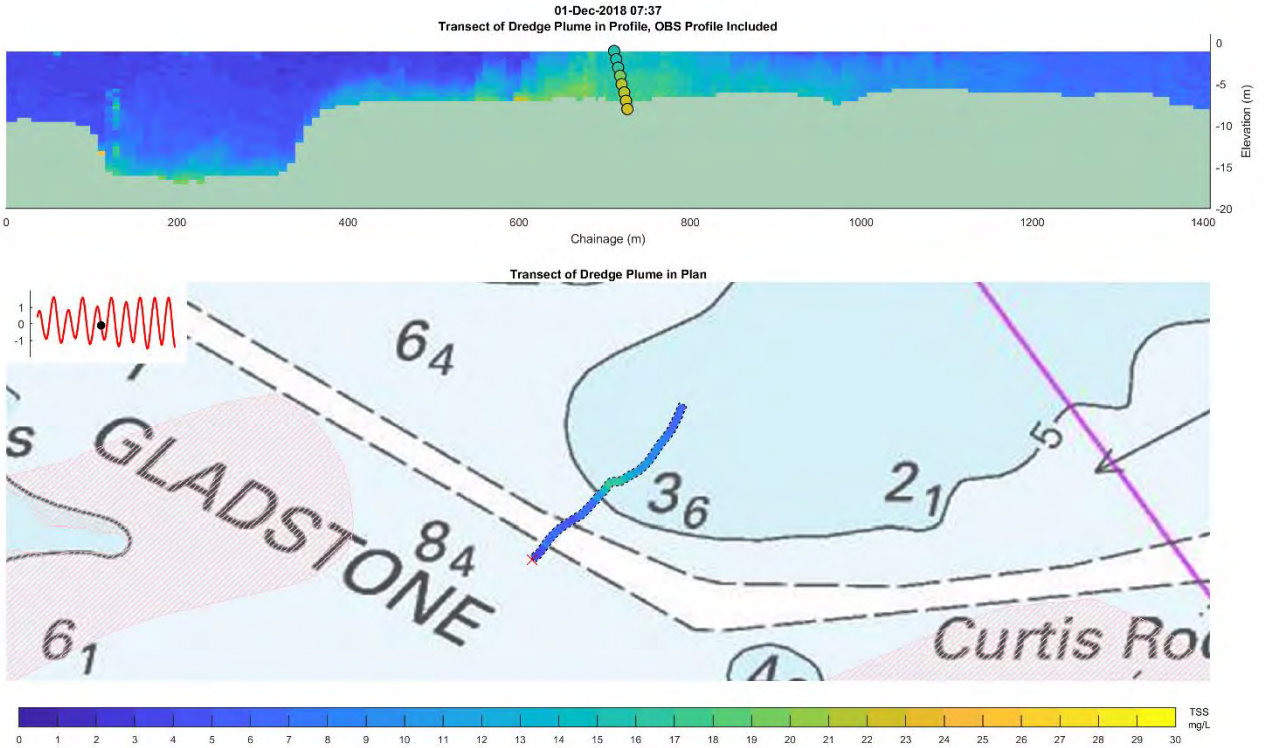

Figure 3-10 Dredging at Golding Cutting – Ebb Tide

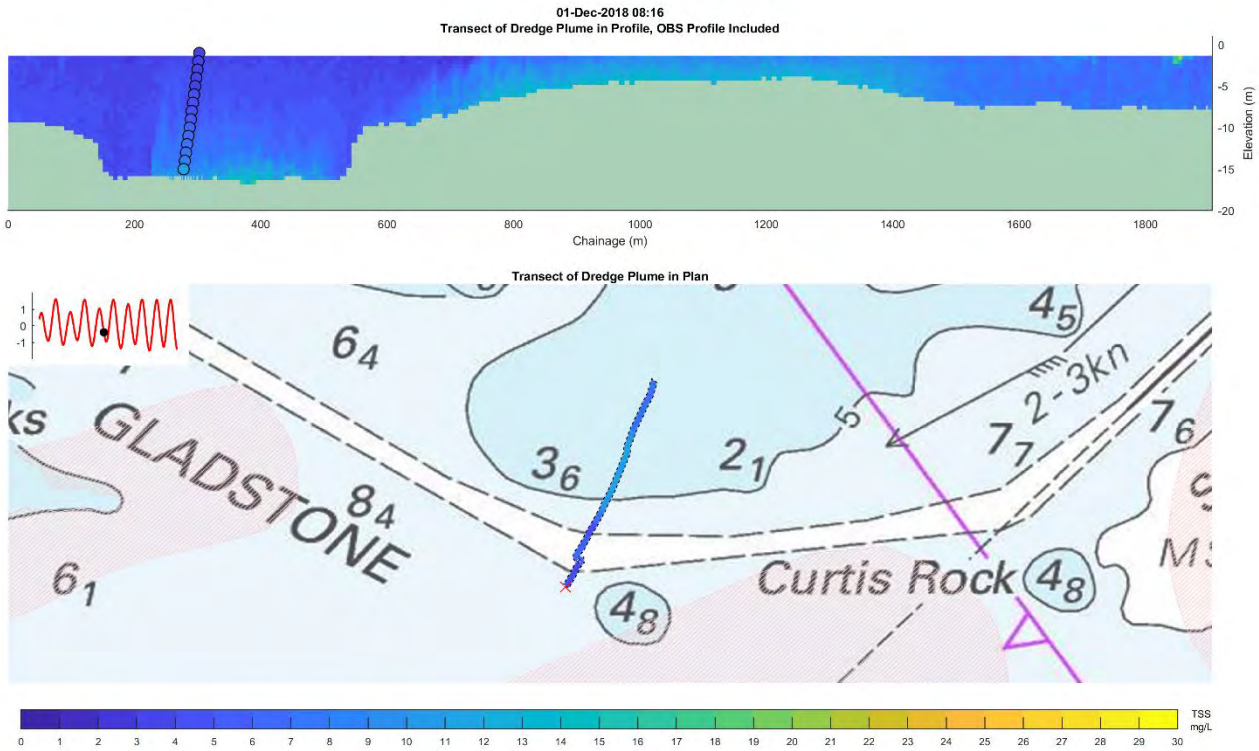

Figure 3-11 Dredging at Golding Cutting – Ebb Tide

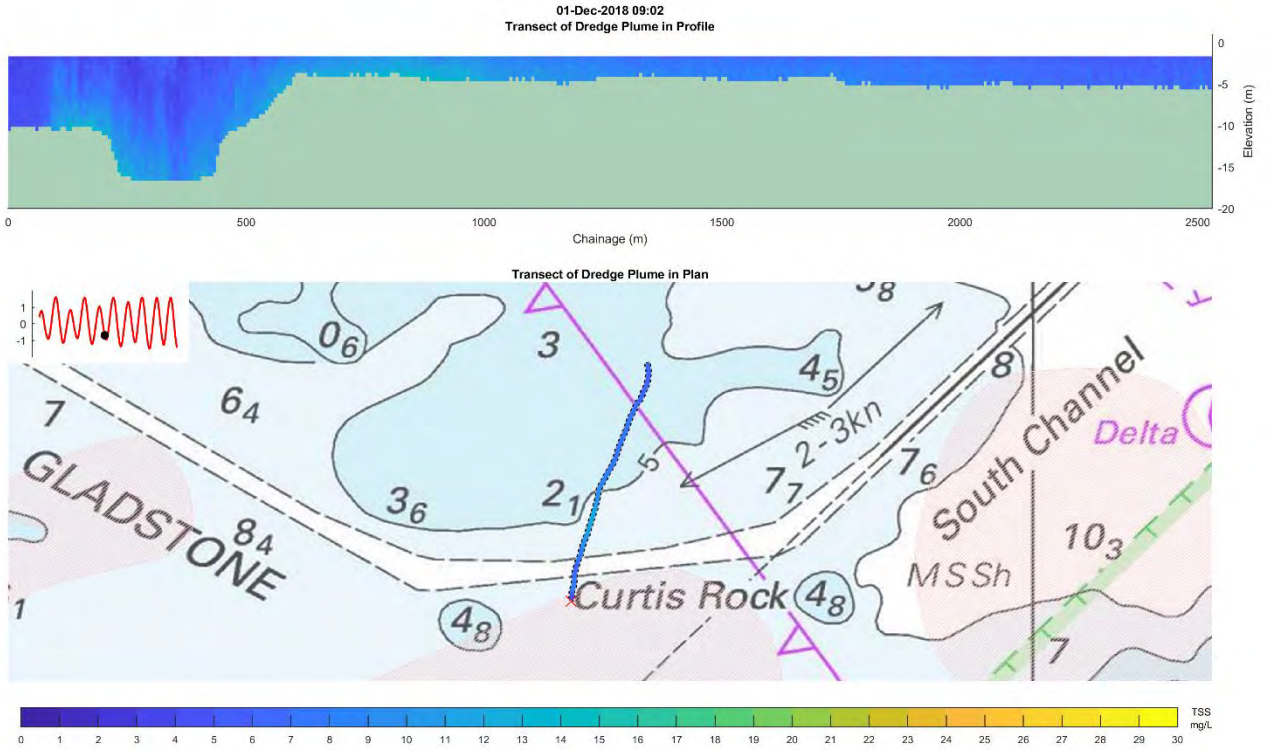

Figure 3-12 Dredging at Golding Cutting – Ebb Tide

3.2.4 Water Quality

No test water quality measurements were carried out at this location. Results from baseline samples collected 3rd December 2018 are provided in Appendix H, Table H-1.

3.3 Dredging at Gatcombe Channel, Ebb Tide on 2nd December 2018

3.3.1 Plume Monitoring

ADCP measurements of the dredge plumes at Gatcombe Channel are summarised in Figure 3-13 to Figure 3-15 and a complete set of ADCP measurements, which also depict the timing and locations of OBS profiling, is provided in Appendix E. Dredging by TSHD *Brisbane* was conducted on an ebbing tide with a tidal range of approximately 2.4m. Very low plume concentrations were measured, indicating that the dredge was not generating significant plumes at the time of monitoring.

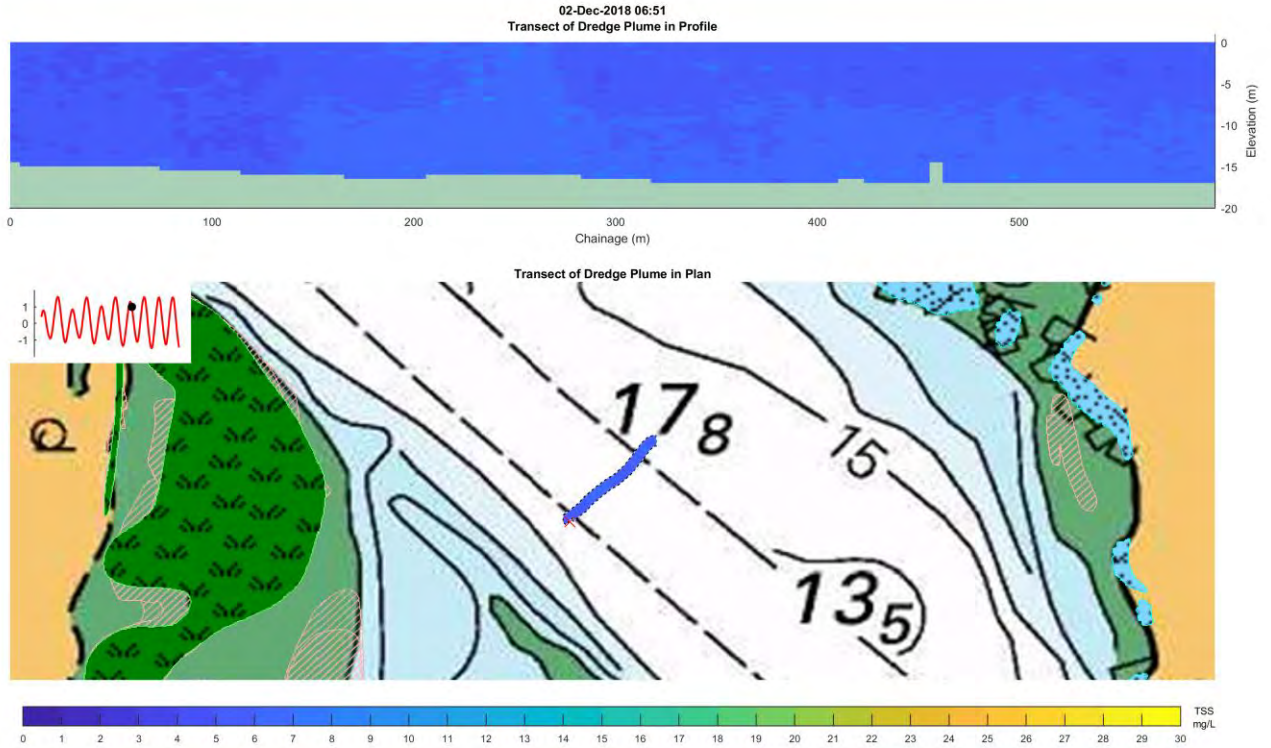

Figure 3-13 Dredging at Gatcombe Channel – Ebb Tide

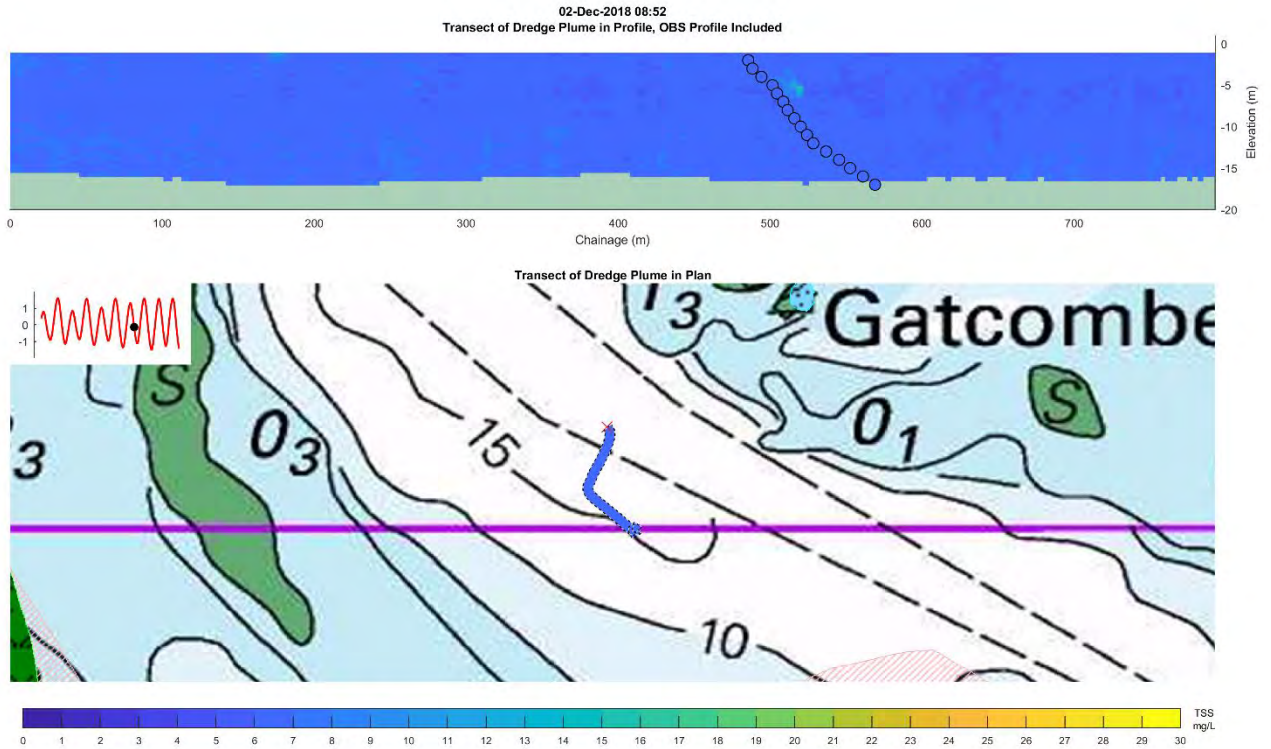

Figure 3-14 Dredging at Gatcombe Channel – Ebb Tide

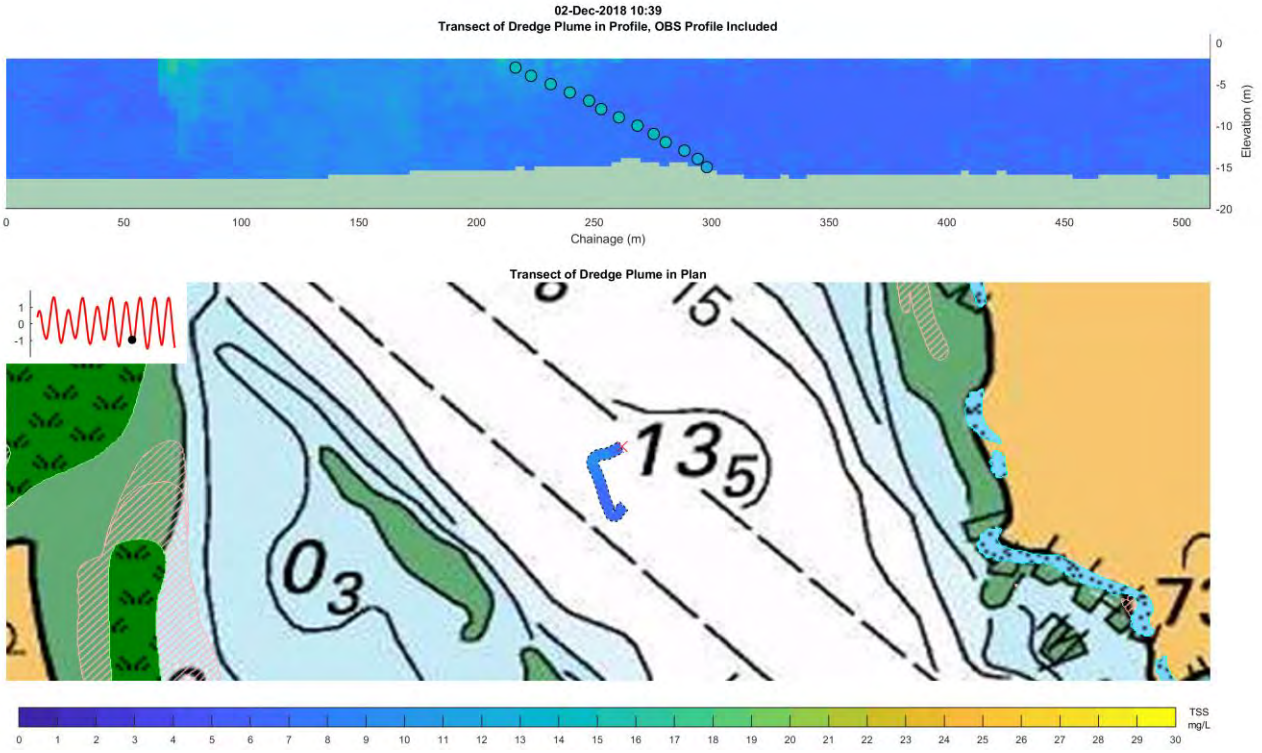

Figure 3-15 Dredging at Gatcombe Channel – Ebb Tide

3.3.2 Water Quality

3.3.2.1 Water Quality Profiles

All samples for Gatcombe Channel were collected during an ebb tide, on the 2nd of December 2018. The measurements for all environmental parameters including those from the baseline assessment are summarised in Table 3-4. Temperature, salinity, pH and dissolved oxygen showed little variation over time (baseline and test sampling) and through the water column. Salinity was slightly higher during the baseline assessment compared to test measurements. Dissolved oxygen concentrations ranged from 81.5% to 84.9% saturation.

Turbidity profiles, including that from the baseline assessment, are presented in Figure 3-16. The measured turbidity in the baseline survey was consistent through the water column (3-4 NTU). By comparison, average turbidity (at each time interval) during and after dredging ranged from 7 NTU at time 0, 6 NTU at the 15 minutes interval, and remained around 5 NTU at 30 to 120 minute intervals. There was little variation in turbidity through the water column in test samples (i.e. no evidence of near-bed plume formation).

Table 3-3 Water quality profile summary - Gatcombe Channel (ebb)

Gatcombe Channel (ebb)	Parameter	Temp (°C)	Salinity (ppt)	pH	Dissolved Oxygen (%)	Turbidity (NTU)
Baseline 2/12/18, 6:31	Min	27.58	37.59	8.14	82.5	3
	Max	27.61	37.63	8.19	84.6	4.1
	Average	27.60	37.61	8.16	83.41	3.47
Plume at 0 2/12/18, 8:10	Min	27.54	37.41	8.14	81.8	6.8
	Max	27.58	37.44	8.18	84	8
	Average	27.55	37.42	8.16	82.69	7.41
Plume at 15 2/12/18, 8:19	Min	27.55	37.39	8.12	81.3	4.3
	Max	27.57	37.4	8.13	82.9	5.4
	Average	27.56	37.40	8.12	81.97	5.0
Plume at 30 2/12/18, 8:25	Min	27.56	37.36	8.12	81.5	5.1
	Max	27.58	37.37	8.12	84	6
	Average	27.57	37.37	8.12	82.44	5.3
Plume at 60 2/12/18, 8:51	Min	27.59	37.36	8.12	81.7	4.9
	Max	27.62	37.37	8.16	83.9	5.9
	Average	27.60	37.36	8.14	82.53	5.3
Plume at 120 2/12/18, 10:05	Min	27.72	37.38	8.08	82.8	3.7
	Max	28.01	37.54	8.14	84	13.8
	Average	27.74	37.39	8.13	83.43	4.3

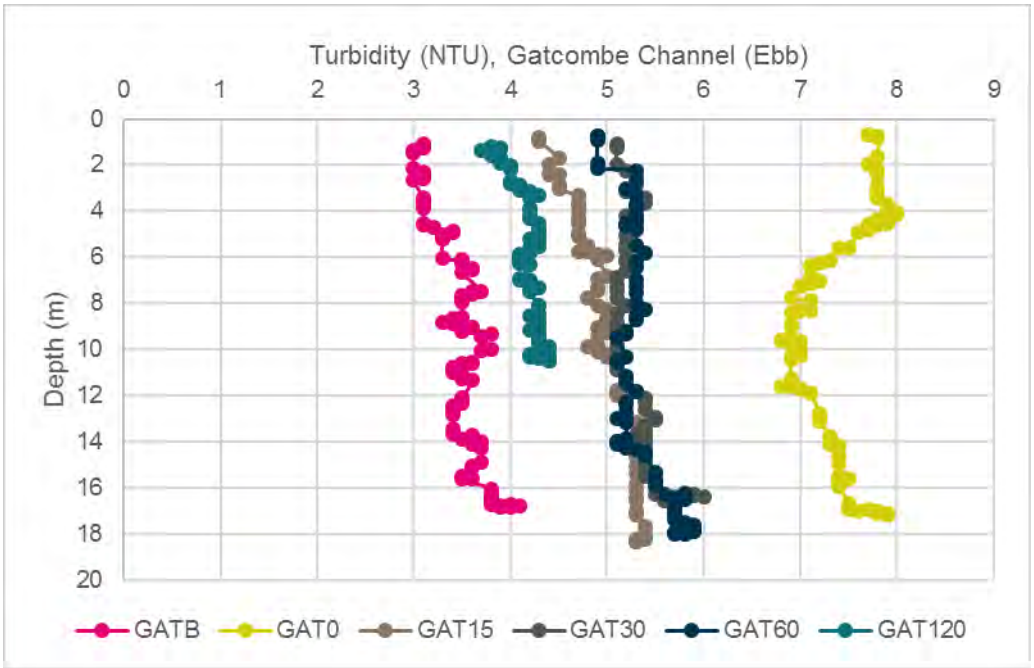

Figure 3-16 Turbidity profiles - Gatcombe Channel (ebb)

3.3.2.2 *Water Quality Grab Samples*

Results of the water quality grab sampling for both the baseline and test sampling at the Gatcombe Channel are presented in Table 3-4.

TSS concentrations were generally higher in the test samples compared to the baseline samples. With the exception of one test sample, TSS concentrations remained below the QWQG trigger value. In contrast, there was no evidence that dredging increased nutrient concentrations in the water column. Total phosphorus, reactive phosphorus and ammonia concentrations were less than the LOR. Total nitrogen and nitrogen oxides (nitrate + nitrite) during test conditions were within the range of baseline conditions. Nitrogen oxides concentrations exceeded or were at the QWQG GV in most samples, except mid-depth and near-bed baseline samples which met the GV.

Dissolved metal/metalloid concentrations were either below the LOR or below ANZECC/ARMCANZ (2018) GVs in all samples. Total iron was higher in all test samples compared to the baseline assessment. However, the dissolved fraction for iron was below the LOR in all baseline and test samples. Total manganese at time interval 0 (8-19 mg/L) was greater than baseline values (3-5 mg/L), and slowly declined over time (time interval 120 = 6-6.5 mg/L). Dissolved manganese was less than the LOR in most test samples but detected at low concentrations in baseline samples. Overall, these results suggest that metals/metalloids were at concentrations that are unlikely to pose a toxicant risk.

Table 3-4 Water quality results - Gatcombe Channel (ebb)

Gatcombe Channel - Parameter	Unit	LOR	GV	Baseline			Test													
Time interval (mins)				Pre-dredge			0			15			30			60			120		
Depth interval				A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Nutrients, TSS, Chlorophyll (note – QWQG GV adopted below)																					
Total Phosphorus	µg/L	5	20	<LOR	<LOR	<LOR	0.008	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Ortho-Phosphorus	µg/L	1	6	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Ammonia-Nitrogen	µg/L	5	8	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	0.007	<LOR	<LOR
Nitrite + Nitrate (as N)	µg/L	2	3	6	2	2	6	6	6	6	4	5	7	7	5	6	5	5	5	4	4
Total Nitrogen	µg/L	50	200	188	173	154	146	157	167	165	145	144	142	148	146	158	145	161	155	65	166
Solids (Suspended)	mg/L	1	15	6	4	6	18	8	8	8	8	8	6	5	6	5	6	8	6	6	6
Chlorophyll a	µg/L	0.001	2	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	1	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Total Organic Carbon	mg/L	1	-	2	2	3	2	2	4	1	2	3	2	3	2	2	2	2	3	3	2
Metals and Metalloids (note – ANZECC Toxicity GV adopted below)																					
Aluminium (Total)	µg/L	5	-	40	61	95	254	158	148	156	141	196	112	85	74	131	82	107	114	130	152
Aluminium (Dissolved)	µg/L	5	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Arsenic (Total)	µg/L	0.5	-	1.8	1.8	1.7	1.9	1.9	1.8	1.8	1.6	1.8	1.9	1.6	1.7	1.8	1.7	1.6	1.8	1.5	1.7
Arsenic (Dissolved)	µg/L	0.5	-	1.5	1.5	1.5	1.7	1.6	1.5	1.7	1.6	1.6	1.7	1.6	1.7	1.6	1.6	1.5	1.6	1.6	1.5
Cadmium (Total)	µg/L	0.2	0.7	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Cadmium (Dissolved)	µg/L	0.2	0.7	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium (Total)	µg/L	0.5	4.4	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium (Dissolved)	µg/L	0.5	4.4	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Copper (Total)	µg/L	1	1.3	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Copper (Dissolved)	µg/L	1	1.3	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	1	<LOR	1	1	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Iron (Total)	µg/L	5	-	40	73	116	384	219	202	203	184	259	150	111	93	168	116	145	184	171	190
Iron (Dissolved)	µg/L	5	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Lead (Total)	µg/L	0.2	4.4	<LOR	<LOR	0.5	0.2	<LOR	<LOR	<LOR	0.2	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	0.2	<LOR
Lead (Dissolved)	µg/L	0.2	4.4	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Manganese (Total)	µg/L	0.5	-	3	3.3	5.4	18.9	9.9	7.7	9	7.9	8.6	7.3	5.3	4.6	5.8	5.9	6.3	5.7	6.4	6.5
Manganese (Dissolved)	µg/L	0.5	-	0.6	0.5	0.7	0.8	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Mercury (Total)	µg/L	0.00004	0.1	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Mercury (Dissolved)	µg/L	0.00004	0.1	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Nickel (Total)	µg/L	0.5	7	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	0.5	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Nickel (Dissolved)	µg/L	0.5	7	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver (Total)	µg/L	0.1	1.4	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver (Dissolved)	µg/L	0.1	1.4	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Zinc (Total)	µg/L	5	15	6	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Zinc (Dissolved)	µg/L	1	15	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

Orange shading = guideline exceeded; green shading = concentration below the laboratory limit of reporting (LOR)

3.4 Placement at EBSDS, Flood Tide on 2nd December 2018

3.4.1 Plume Monitoring

The ADCP measurements of plumes during placement of dredged material at the EBSDS a during flood tide are summarised in Figure 3-17 to Figure 3-19. A complete set of ADCP measurements which also depict the timing and locations OBS profiling is provided in Appendix F. Plume concentrations of up to 30 mg/L were measured, mostly near the water surface. Plume advection and dispersion caused a gradual reduction in the concentrations measured following placement.

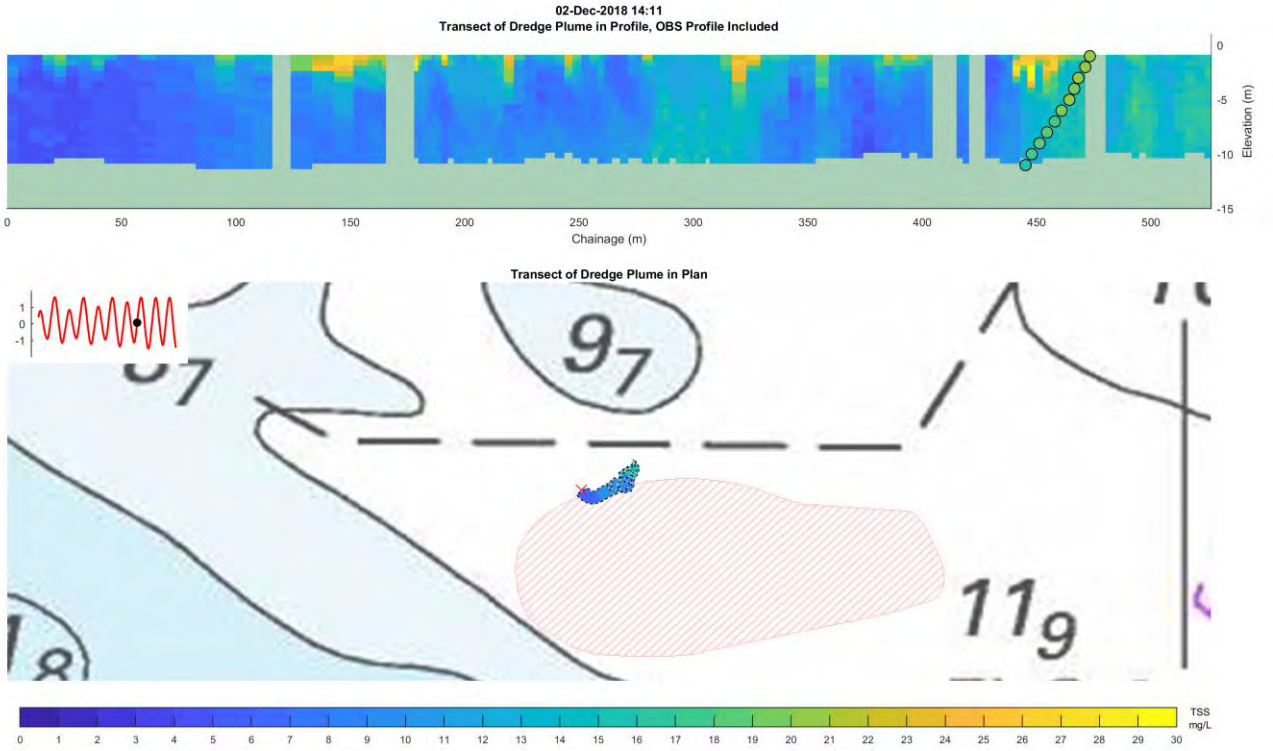

Figure 3-17 Disposal at EBSDS

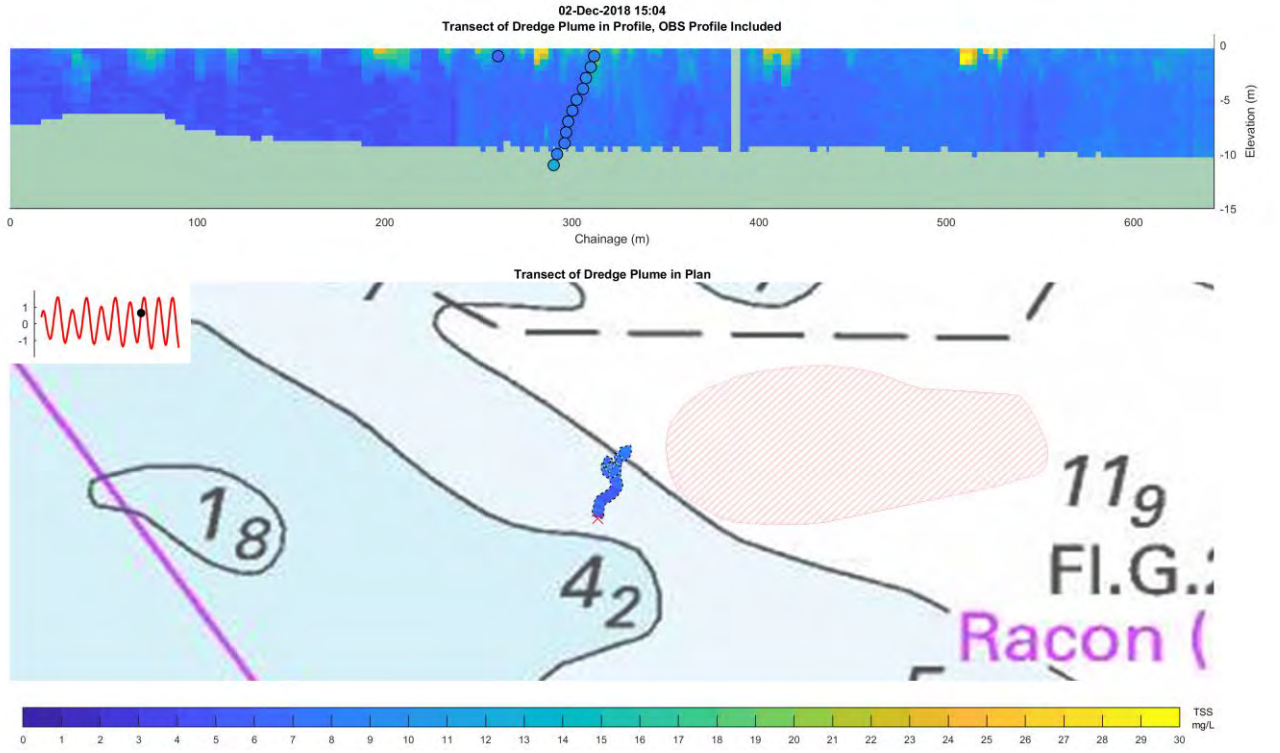

Figure 3-18 Disposal at EBSDS

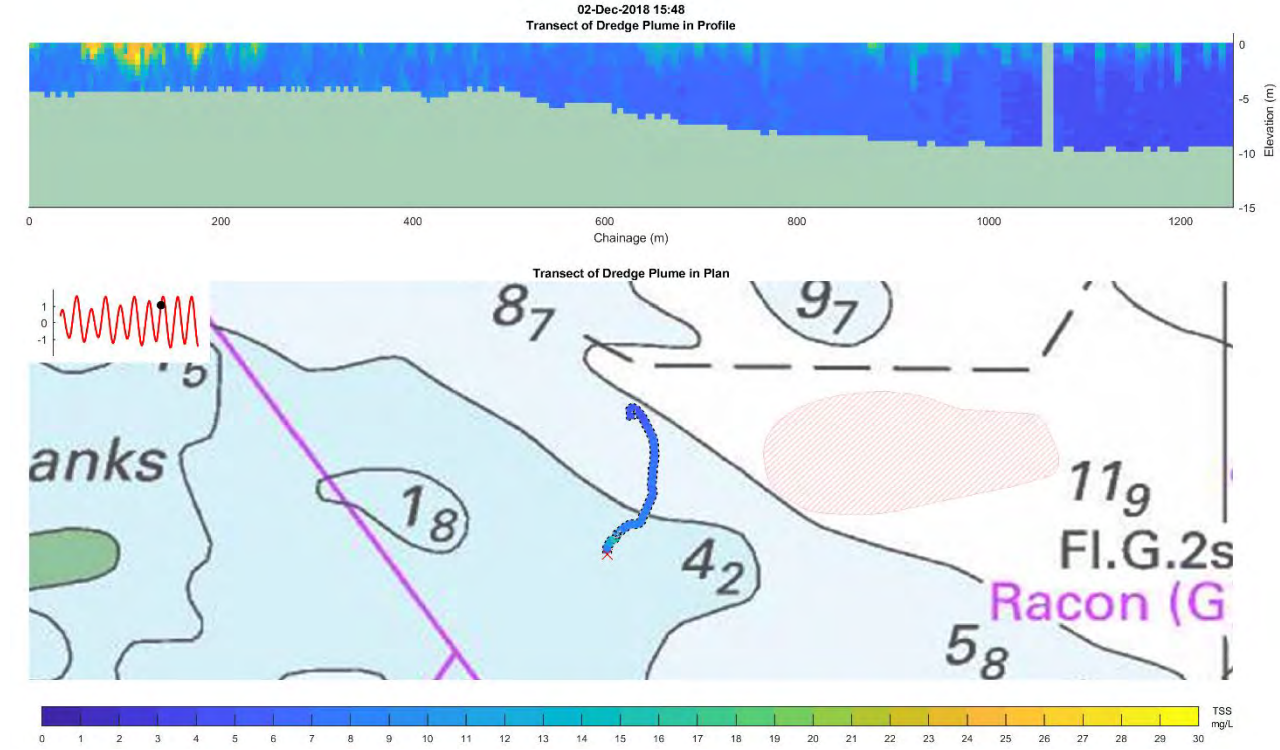

Figure 3-19 Disposal at EBSDS

3.4.2 Water Quality

3.4.2.1 Water Quality Profiles

Table 3-5 summarises *in situ* water quality data at the EBSDS. Temperature, salinity, pH and dissolved oxygen were consistent through the water column for both baseline and test measurements.

Turbidity profiles for each period are shown in Figure 3-20. Average turbidity in test profiles (5-20 NTU) was higher than the average baseline turbidity (<1 NTU). Turbidity peaked within 15 minutes of disposal and was higher in the middle and lower part of the water column (>5 NTU) than near the surface (<5 NTU) during these periods. There was a gradual decline in turbidity between 30 and 120 minutes (5-8 NTU), and turbidity was uniform throughout the water column during these sampling periods. Turbidity levels did not return to baseline levels at the 120 minute interval.

Table 3-5 Water quality profile summary- EBSDS

EBSBS	Parameter	Temp (°C)	Salinity (ppt)	pH	Dissolved Oxygen (%)	Turbidity (NTU)
Baseline 2/12/18, 13:07	Min	27.47	37.15	8.2	85.8	0.8
	Max	27.56	37.18	8.21	86.7	1
	Average	27.52	37.16	8.20	86.22	0.83
Plume at 0, 2/12/18, 14:04	Min	27.54	37.13	8.18	85.9	4.8
	Max	27.56	37.13	8.19	86.6	17.5
	Average	27.55	37.13	8.19	86.28	10.33
Plume at 15 2/12/18, 14:07	Min	27.54	37.13	8.18	85.7	17.8
	Max	27.55	37.13	8.18	86.1	22.9
	Average	27.54	37.13	8.18	85.92	21.50
Plume at 30 2/12/18, 14:38	Min	27.54	37.1	8.19	85.9	8
	Max	27.55	37.11	8.21	86.4	9.2
	Average	27.54	37.11	8.20	86.14	8.70
Plume at 60 2/12/18, 15:04	Min	27.57	37.13	8.18	86	7
	Max	27.58	37.14	8.19	86.9	8.8
	Average	27.58	37.14	8.18	86.46	8.09
Plume at 120 2/12/18, 16:00	Min	27.57	37.13	8.18	86	5.4
	Max	27.58	37.13	8.18	86.5	5.9
	Average	27.57	37.13	8.18	86.24	5.54

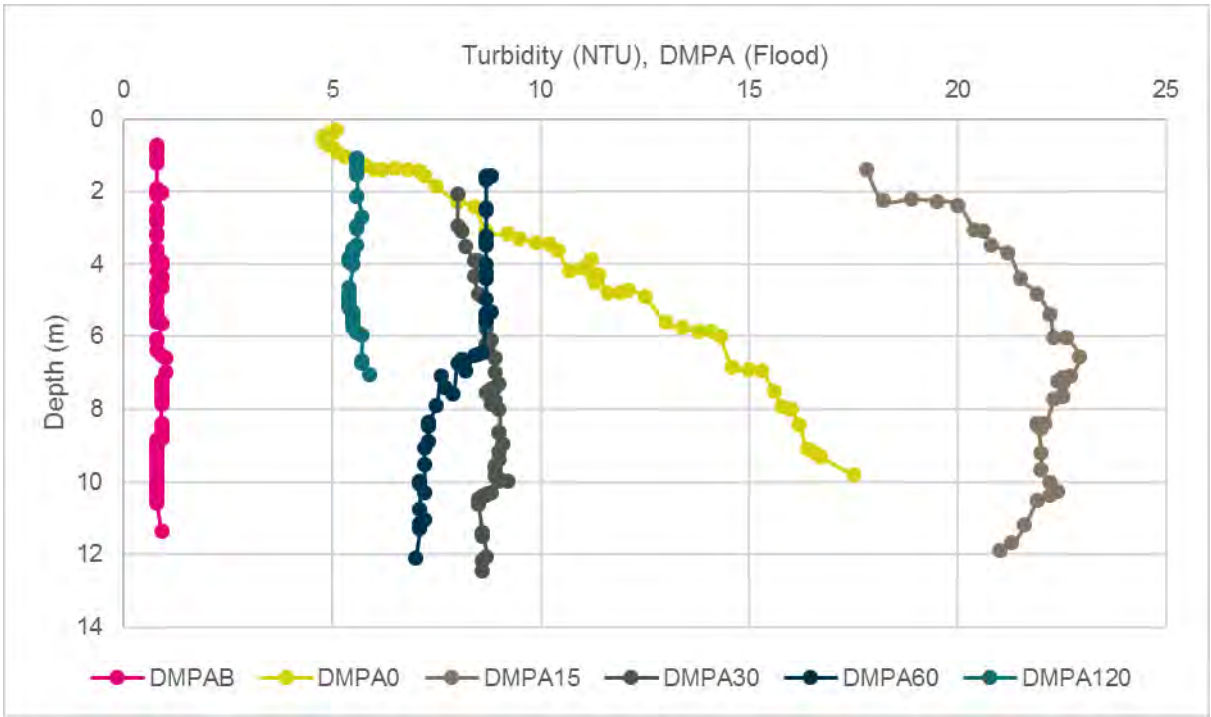

Figure 3-20 Turbidity profiles- EBSDS

3.4.2.2 Water Quality Grab Samples

The water quality analysis results for the EBSDS baseline and test samples are presented in Table 3-5. In summary:

- TSS - Consistent with turbidity, TSS was higher in test samples than baseline samples. The TSS concentration exceeded the QWQG GV in three test samples, whereas the TSS concentration was below the LOR for the baseline samples.
- Nutrients – Concentrations of most nutrients were less than the LOR and QWQG GV. Total phosphorus concentrations exceeded the QWQG GV in one baseline sample, while all other samples were below the LOR. The concentration of nitrate + nitrite exceeded the QWQG GV in two test and one baseline sample. Reactive phosphorus and ammonia-nitrogen concentrations were below the LOR. Overall, these results do not suggest that disposal lead to increased nutrient concentrations in the water column, despite the higher TSS values.
- Chlorophyll *a* was below the LOR in all test and baseline samples.

Concentrations of total aluminium, iron and manganese were higher in test samples than baseline samples. Consistent with trends in TSS, concentrations of these three metals had not returned to baseline levels 120 minutes post disposal. There is no ANZECC GV for these three parameters.

Total copper concentrations exceeded the ANZECC GV of 1.3 mg/L in two test samples (both 2 mg/L). In both samples, the dissolved fraction was less than the LOR, indicating that they are unlikely to pose a toxicant risk.

All other dissolved and total metals/metalloids had concentrations that were below ANZECC/ARMCANZ (2018) GVs. All other metals/metalloids had concentrations in all baseline and

plume samples below the LOR, or if detected, had similar concentrations between baseline and test samples.

Overall, these results suggest that metals/metalloids were at concentrations that are unlikely to pose a toxicant risk.

Table 3-12 Water quality results- EBSDS

Parameter	Unit	LOR	GV	Baseline			Test													
Time interval (mins)				Pre-dredging			0			15			30			60			120		
Depth interval				A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Nutrients, TSS, Chlorophyll (note – QWQG GV adopted below)																					
Total Phosphorus	µg/L	5	20	<LOR	24	<LOR	<LOR	<LOR	<LOR	0.008	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Ortho-Phosphorus	µg/L	1	6	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Ammonia-Nitrogen	µg/L	5	8	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Nitrite + Nitrate (as N)	µg/L	2	3	5	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	4	2	2	14	2	<LOR
Total Nitrogen	µg/L	50	200	222	159	172	167	169	162	151	152	18	165	159	191	181	186	198	211	169	107
Solids (Suspended)	mg/L	1	15	<LOR	<LOR	<LOR	<LOR	13	6	12	23	14	8	20	17	4	12	11	7	7	4
Chlorophyll a	µg/L	0.001	2	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Total Organic Carbon	mg/L	1	-	2	2	2	2	2	2	2	2	2	2	<1	2	2	<1	2	2	2	2
Metals and Metalloids (note – ANZECC Toxicity GV adopted below)																					
Aluminium (Total)	µg/L	5	-	19	11	17	121	59	294	569	229	147	330	270	45	41	131	199	62	148	125
Aluminium (Dissolved)	µg/L	5	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Arsenic (Total)	µg/L	0.5	-	1.7	1.9	1.7	2	1.8	2.1	2.2	1.8	1.8	2	2	1.8	1.8	1.9	2	2	1.7	1.6
Arsenic (Dissolved)	µg/L	0.5	-	1.6	1.6	1.5	1.5	1.5	1.6	1.8	1.7	1.7	1.6	1.6	1.7	1.5	1.6	1.7	1.6	1.3	1.2
Cadmium (Total)	µg/L	0.2	0.7	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Cadmium (Dissolved)	µg/L	0.2	0.7	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium (Total)	µg/L	0.5	4.4	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Chromium (Dissolved)	µg/L	0.5	4.4	<LOR	<LOR	<LOR	<LOR	<LOR	0.6	0.7	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Copper (Total)	µg/L	1	1.3	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	2	<LOR	<LOR	2	1	<LOR	<LOR	<LOR	1	<LOR	<LOR	<LOR
Copper (Dissolved)	µg/L	1	1.3	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Iron (Total)	µg/L	5	-	23	16	16	214	81	607	1120	402	285	645	549	79	69	218	323	93	247	173
Iron (Dissolved)	µg/L	5	-	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Lead (Total)	µg/L	0.2	4.4	0.9	<LOR	<LOR	0.6	<LOR	0.4	0.6	0.3	0.2	0.3	0.3	<LOR	0.3	0.2	0.2	0.3	0.2	0.2
Lead (Dissolved)	µg/L	0.2	4.4	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Manganese (Total)	µg/L	0.5	-	3.7	3.5	3.3	13.5	7.4	26.1	34.7	16.7	14	20.3	19.9	6.6	6.2	13.2	13.4	8.5	9.3	8.4
Manganese (Dissolved)	µg/L	0.5	-	1.7	1.5	1.5	2	1.7	2.1	2.7	2.4	2.1	2.6	2.5	2	1.9	2.3	2.1	2	2	2
Mercury (Total)	µg/L	0.00004	0.1	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Mercury (Dissolved)	µg/L	0.00004	0.1	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Nickel (Total)	µg/L	0.5	7	<LOR	<LOR	<LOR	<LOR	<LOR	0.6	1.1	<LOR	<LOR	0.6	<LOR	<LOR	<LOR	0.5	<LOR	<LOR	<LOR	<LOR
Nickel (Dissolved)	µg/L	0.5	7	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	0.5	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver (Total)	µg/L	0.1	1.4	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Silver (Dissolved)	µg/L	0.1	1.4	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Zinc (Total)	µg/L	5	15	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR
Zinc (Dissolved)	µg/L	1	15	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR	<LOR

Orange shading = guideline exceeded; green shading = concentration below the laboratory limit of reporting (LOR)

3.5 Water Sample QA/QC Assessment

The results of the QA/QC sample assessment (refer to Section 2.3.1 for details) are discussed below. All raw data are presented in the appendices to this report.

3.5.1 Field Blanks

The field blank test has been undertaken to detect any potential contamination from the sampling equipment used for obtaining the water samples. Concentrations of all nutrients and metals/metalloids were below the laboratory LOR (Table 3-6). The field blank assessment indicated that the sampling equipment and procedures did not lead to contamination of the samples.

3.5.2 Trip Blanks

The trip blank test was undertaken to test for any potential contamination due to the sample bottles used or during transport of the samples (Table 3-6). Concentrations of all nutrients and metals/metalloids were below the laboratory LOR in the blank samples. This indicated that no sample contamination occurred during transport of the sample bottles.

3.5.3 Intra-lab and Inter-lab Duplicates

The intra-lab duplicate assessment was undertaken to test for potential variation in the analyses undertaken by the primary laboratory (Table 3-6). The purpose of the inter-lab assessment was to test for variation between the primary and secondary laboratories (Table 3-7).

The intra-lab and inter-lab duplicate assessments were generally satisfactory with the Relative Percent Difference (RPD) and Relative Standard Deviation (RSD) for most parameters within the ±50% criterion. The exception was one a field duplicate sample at Gatcombe Channel, which had high inter-sample variability for nitrate. Given the low concentrations for this parameter, this variability does not change the overall observed patterns in water quality and the conclusions drawn from the water quality samples.

Table 3-6 QA/QC – Blanks and RSD Calculations for Field Duplicates

Parameter	Unit	Field blank	Trip blank	GCBA	GCBD	RPD(%)	WCCBA	WCCBD	RSD/ RPD(%)*
Ortho-Phosphorus	µg/L	<LOR	<LOR	<LOR	<LOR	NC	<LOR	<LOR	NC
Total Phosphorus	µg/L	<LOR	<LOR	<LOR	<LOR	NC	<LOR	<LOR	NC
Ammonia-Nitrogen	µg/L	<LOR	<LOR	<LOR	<LOR	NC	<LOR	<LOR	NC
Nitrite + Nitrate (as N)	µg/L	<LOR	<LOR	0.008	0.002	120*	0.003	0.002	40*
Nitrite (as N)	mg/L	<LOR	<LOR	<LOR	<LOR	NC	<LOR	<LOR	NC
Nitrate (as N)	mg/L	<LOR	<LOR	0.008	0.002	120*	0.003	0.002	40*
Total Nitrogen	µg/L	<LOR	<LOR	0.185	0.193	4.23*	0.173	0.178	2.85*
Total Kjeldahl Nitrogen	mg/L	<LOR	<LOR	0.177	0.191	7.61*	0.17	0.176	47.48*
Solids (Suspended)	mg/L	-	-	5	-	NC	2	-	NC
Chlorophyll a	µg/L	-	-	2	-	NC	<LOR	-	NC
Total Organic Carbon	mg/L	-	-	2	-	NC	2	-	NC
Aluminium (Dissolved)	µg/L	<LOR	-	<LOR	<LOR	NC	<LOR	<LOR	NC
Arsenic (Dissolved)	µg/L	<LOR	-	1	1.1	9.52*	1.2	1.2	0*
Cadmium (Dissolved)	µg/L	<LOR	-	<LOR	<LOR	NC	<LOR	<LOR	NC
Chromium (Dissolved)	µg/L	<LOR	-	<LOR	<LOR	NC	<LOR	<LOR	NC
Copper (Dissolved)	µg/L	<LOR	-	<LOR	<LOR	NC	<LOR	<LOR	NC
Iron (Dissolved)	µg/L	<LOR	-	<LOR	<LOR	NC	<LOR	<LOR	NC
Lead (Dissolved)	µg/L	<LOR	-	<LOR	<LOR	NC	<LOR	<LOR	NC
Manganese (Dissolved)	µg/L	<LOR	-	<LOR	<LOR	NC	0.8	0.8	0*
Mercury (Dissolved)	µg/L	<LOR	-	<LOR	<LOR	NC	<LOR	<LOR	NC
Nickel (Dissolved)	µg/L	<LOR	-	<LOR	<LOR	NC	<LOR	<LOR	NC
Silver (Dissolved)	µg/L	<LOR	-	<LOR	<LOR	NC	<LOR	<LOR	NC
Zinc (Dissolved)	µg/L	<LOR	-	<LOR	<LOR	NC	<LOR	<LOR	NC
Aluminium (Total)	µg/L	<LOR	<LOR	172	106	47.48*	59	71	18.46*
Arsenic (Total)	µg/L	<LOR	<LOR	202	165	20.16*	65	73	11.59*
Cadmium (Total)	µg/L	<LOR	<LOR	1.7	1.3	26.67*	1.6	1.7	6.06*
Chromium (Total)	µg/L	<LOR	<LOR	<LOR	<LOR	NC	<LOR	<LOR	NC
Copper (Total)	µg/L	<LOR	<LOR	<LOR	<LOR	NC	<LOR	<LOR	NC
Iron (Total)	µg/L	<LOR	<LOR	<LOR	<LOR	NC	<LOR	<LOR	NC
Lead (Total)	µg/L	<LOR	<LOR	0.3	0.3	0*	0.4	0.4	0*
Manganese (Total)	µg/L	<LOR	<LOR	5.1	4.2	19.35*	2.8	2.9	3.51*
Mercury (Total)	µg/L	<LOR	<LOR	<LOR	<LOR	NC	<LOR	<LOR	NC
Nickel (Total)	µg/L	<LOR	<LOR	<LOR	<LOR	NC	<LOR	<LOR	NC
Silver (Total)	µg/L	<LOR	<LOR	<LOR	<LOR	NC	<LOR	<LOR	NC
Zinc (Total)	µg/L	<LOR	<LOR	<LOR	<LOR	NC	<LOR	<LOR	NC

Orange highlight = value >50% acceptance criteria; green highlight = <LOR; NC = not calculated as one or more values <LOR

Table 3-7 QA/QC –RPD Calculations for Field Triplicates

Parameter	Unit	GAT30A	GAT30D	GAT30A Sec Lab	RSD/ RPD(%)*	GAT60A	GAT60D	GAT60A Sec Lab	RSD/ RPD(%)*	GAT120A	GAT120D	GAT120A Sec Lab	RSD/ RPD(%)*	DMPA60A	DMPA60D	GAT60A Sec Lab	RSD/ RPD(%)*	DMPA 120A	DMPA 120D	DMPA120A Sec Lab	RSD/ RPD(%)*
Ortho-Phosphorus	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Total Phosphorus	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Ammonia-Nitrogen	µg/L	<LOR	<LOR	0.017	NC	<LOR	<LOR	0.016	NC	0.007	<LOR	0.016	NC	<LOR	<LOR	0.01	NC	<LOR	<LOR	0.01	NC
Nitrite + Nitrate (as N)	µg/L	0.007	0.006	-	15.38*	0.006	0.007	-	15.38*	0.005	0.007	-	33.33*	0.004	0.004	-	0*	0.014	0.013	-	7.407*
Nitrite (as N)	mg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Nitrate (as N)	mg/L	0.007	0.006	0.006	9.12	0.006	0.007	0.006	9.12	0.005	0.007	0.007	18.23	0.004	0.004	<LOR	NC	0.014	0.013	0.01	16.88
Total Nitrogen	µg/L	0.142	0.145	<LOR	NC	0.158	0.131	<LOR	NC	0.155	0.18	<LOR	NC	0.181	0.202	<LOR	NC	0.211	0.165	<LOR	NC
Total Kjeldahl Nitrogen	mg/L	0.135	0.139	-	2.92*	0.152	0.124	-	20.29*	0.15	0.173	-	14.24*	0.177	0.198	-	11.2*	0.197	0.152	-	25.79*
Solids (Suspended)	mg/L	6	-	-	NC	5	-	-	NC	6	-	-	NC	4	-	-	NC	7	-	-	NC
Chlorophyll a	µg/L	<LOR	-	-	NC	<LOR	-	-	NC	<LOR	-	-	NC	<LOR	-	-	NC	<LOR	-	-	NC
Total Organic Carbon	mg/L	2	-	-	NC	2	-	-	NC	3	-	-	NC	2	-	-	NC	2	-	-	NC
Aluminium (Dissolved)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Arsenic (Dissolved)	µg/L	1.7	1.6	1	26.41	1.6	1.5	1	23.52	1.6	1.2	1	24.12	1.5	1.6	2	15.56	1.6	1.5	1	23.52
Cadmium (Dissolved)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Chromium (Dissolved)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Copper (Dissolved)	µg/L	1	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Iron (Dissolved)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Lead (Dissolved)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Manganese (Dissolved)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	1.9	1.9	<LOR	NC	2	1.8	<LOR	NC
Mercury (Dissolved)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Nickel (Dissolved)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Silver (Dissolved)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Zinc (Dissolved)	µg/L	<LOR	<LOR	2	NC	<LOR	<LOR	2	NC	<LOR	<LOR	1	NC	<LOR	<LOR	1	NC	<LOR	<LOR	2	NC
Aluminium (Total)	µg/L	112	93	100	9.45	131	96	80	25.49	114	125	70	28.26	41	42	50	11.13	62	164	80	53.38
Arsenic (Total)	µg/L	150	128	190	20.15	168	126	140	14.78	184	176	140	14.06	69	62	82	14.29	93	248	160	46.55
Cadmium (Total)	µg/L	1.9	1.8	2	5.26	1.8	1.8	2	6.19	1.8	1.8	2	6.19	1.8	1.7	2	8.33	2	1.7	2	9.12
Chromium (Total)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Copper (Total)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Iron (Total)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Lead (Total)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	0.2	140	NC	<LOR	0.4	<LOR	NC	0.3	0.3	<LOR	NC	0.3	0.4	<LOR	NC
Manganese (Total)	µg/L	7.3	6.3	10	24.33	5.8	6.7	7	9.61	5.7	5.6	6	3.61	6.2	6.3	7	6.71	8.5	8.5	11	15.46
Mercury (Total)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Nickel (Total)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Silver (Total)	µg/L	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	0.2	<LOR	NC	<LOR	<LOR	<LOR	NC	<LOR	<LOR	<LOR	NC
Zinc (Total)	µg/L	<LOR	<LOR	4	NC	<LOR	<LOR	3	NC	<LOR	<LOR	2	NC	<LOR	<LOR	2	NC	<LOR	<LOR	3	NC

Orange highlight = value >50% acceptance criteria; green highlight = <LOR; NC = not calculated as one or more values <LOR

4 Discussion

The measured behaviour of sediment plumes generated by maintenance dredging and dredged material disposal by the *TSHD Brisbane* during the November-December 2018 campaign was consistent with past data collection campaigns and modelling-based predictions carried out by BMT WBM (2014a, 2014b, 2015 and 2017). The key findings of these studies are as follows.

4.1 Turbid Plumes at Sensitive Ecological Receptor Sites

4.1.1 Neap Tides

BMT WBM (2014a) identified and mapped the distribution of key sensitive ecological receptors within and adjacent to Port Curtis. The two key sensitive ecological receptors in the context of dredge plumes were:

- Reefs – particularly corals and algae, which require light for energy production and are therefore sensitive to sediment loading.
- Seagrass – which also require light for energy production and therefore may be affected by high sediment concentrations.

Whilst such sensitive ecological receptors do not inhabit dredged facilities they often grow where dredge plumes can potentially pass over in the prevailing tidal currents. Dredge plumes may reduce the ability for sunlight to reach these reef and seagrass communities which can adversely impact on their health. Furthermore the suspended sediments within the plumes have the potential to settle onto such communities again adversely impacting on their health.

Consistent with modelling predictions, field measurements carried out in the present study confirmed that turbid plumes created by dredging and disposal operations during neap tides were transient features measurable for less than a few hours. At Golding Channel, for example, depth-averaged TSS concentrations at the deep water seagrass site were over 30 mg/L, but subsided to background levels within 1.5 hrs, consistent with previous measurements in 2014 (BMT WBM 2015). Given the rapid dispersion of this plume, it is unlikely that any deep water seagrass meadows would be harmed by the maintenance dredging operations over the measured neap tides. The plume did not advect to existing seagrass communities or reef habitats, including those at Jacobs Channel (see Figure 3-1).

The results of the present study therefore support the impact hypothesis that: *'Sediments generated during dredging and disposal do not subsequently reach sensitive areas in amounts that would be harmful to the ecological value and amenity of the area'.*

4.1.2 Spring Tides

The monitoring works presented in this study were conducted during neap tides when the ambient concentration of suspended sediment was minimal. This made it possible to easily measure the dredge plumes. During spring tides, when the tidal currents are significantly stronger, the potential for dredge plumes to reach sensitive ecological receptors is greater. This is because the relatively stronger currents have the potential to maintain the sediments in suspension longer and advect them

further from the dredge material loading sites. However, dredge plumes are difficult to detect above the high background turbidity during spring tides in Gladstone harbour.

On this basis, the plume measurements conducted in this study cannot be directly used to assess the potential impacts to sensitive receptors during spring tide conditions. Modelling studies such as BMT WBM (2017) which are calibrated using field monitoring data should be used for such assessments.

4.2 Other Water Quality Parameters

4.2.1 Physical Parameters

The measurements of physical parameters were consistent with the maintenance dredge plume monitoring undertaken in February 2014 (BMT WBM 2014b) and November 2014 (BMT WBM 2015).

No major differences between the temperature, salinity, pH or dissolved oxygen were detected between the water quality profiles conducted pre-dredging (baseline conditions) and those targeting dredge plumes. These parameters remained relatively constant throughout the water column, reflecting the well mixed, marine-dominated nature of waters within Port Curtis and EBSDS.

The average and peak turbidity and TSS within the plume profiles were higher than the baseline values at all locations, as described in Section 4.1. TSS concentrations in the plume samples often exceeded the QWQG GV of 15 mg/L, as also frequently occurs during the spring tides throughout Port Curtis and during wave events offshore by concentrations of naturally resuspended sediments (BMT WBM 2015). As discussed in the QWQG, the GVs for most physico-chemical stressors is based on long term (seasonal, annual) percentile (20^{th}, 50^{th}, 80^{th}) values from reference sites. Dredge and disposal plumes are short-term features, lasting no more than several hours, which are therefore highly unlikely to substantially alter long term (seasonal, annual) turbidity metrics at dredge and disposal sites. On this basis, sediment plumes created by dredging and disposal are unlikely to affect the capacity for a site to meet QWQG GV value at seasonal and annual time-scales.

4.2.2 Nutrients

The present study found that nutrient concentrations in dredging and disposal plumes were typically within the range of baseline conditions. The exception was a short-term increase in total phosphorus and ammonia concentration in the dredge plume at the Jacobs Channel dredge site, but which declined to near background levels within 30-60 minutes of dredging. An increase in total phosphorus and total suspended solid concentrations occurred between the 60 and 120 minute test intervals, which was inconsistent with the declining trends observed in the prior periods. Total phosphorus and suspended sediments increased across all depth strata between the 60 and 120 minute test intervals at this location, and there was no evidence of a distinct near-bed plume, unlike that created by dredging. Given the high degree of flushing that would have occurred over this two hour period, it is more likely that the observed increase in total phosphorus and suspended sediments was a product of natural background processes (e.g. natural suspension).

Nutrient concentrations recorded in the present study were lower than recorded by BMT WBM (2014; 2015). BMT WBM (2014; 2015) found that nutrient concentrations were generally higher in the dredge plume water samples compared to those collected during baseline conditions. Total nutrient

concentrations in the plumes were typically two to six times higher than during baseline conditions. Dissolved reactive phosphorus concentrations were typically four to six times higher than the QWQG trigger limit. Exceedances of more than 40 times the water quality trigger limit for dissolved NOx were measured in two plume samples in the Gatcombe and Jacobs Channels, however these were exceptions. It is noted that the baseline NOx concentration was also elevated more than 6 times above the GV in the surface baseline sample in the Wild Cattle Cutting.

There are several factors that could contribute to differences between studies, including spatial differences in sediment types, and temporal changes in sediment nutrient concentrations. Sediment nutrient concentrations can vary over time in response to inputs of material by flood events, natural sediment resuspension processes, as well as the maintenance dredging history of the site. Elsewhere in the GBR region, floods are known to deliver large quantities of sediments and nutrients to nearshore waters, resulting in major increases to sediment nutrient concentrations (Furnas *et al*. 2011). Major flood events occurred in 2011 and 2013, which would have delivered large quantities of catchment derived sediment and nutrients to Port Curtis. The BMT WBM (2014, 2015) occurred one to two years after these large flood events. Since this time there have been only minor floods events in the region, and 2018 experienced drought conditions. There are gaps in the knowledge base regarding the influence of flood-drought cycles on sediment nutrient dynamics in the Port Curtis region.

Concentrations of other bioavailable nutrient species (ortho-phosphorus, nitrogen oxides) were similar between baseline and test samples at all sites. Furthermore, chlorophyll *a* concentrations were consistently low in both baseline and test samples. Thus, algal blooms were not evident and are not expected to occur as a result of the maintenance dredging.

With regard to nutrients and chlorophyll measurements, the results of the present study therefore support the impact hypothesis that: *'Pollutant concentrations within dredge plumes at the loading and disposal sites do not reach levels where toxic effects or algae blooms could occur.'*

4.2.3 Metals and Metalloids

As expected, the dredging activities led to suspension of sediments in the water column. As a result, total concentrations of aluminium, iron, and to a lesser extent manganese and zinc were elevated in the dredge plumes, consistent with BMT WBM (2015). In almost all cases, total metal/metalloid concentrations were far greater than the dissolved, bioavailable fraction, indicating that most metals were bound to sediments (i.e. particulate forms). Particulate forms of metals and metalloids are typically not readily bioavailable, i.e. they are not taken up by organisms or likely to cause direct biological effects.

Some forms of dissolved metals/metalloids are bioavailable and therefore able to cause direct biological effects. The results of the present study found that most dissolved metals and metalloids were either below the laboratory detection limits or below their respective ANZECC/ARMCANZ (2018) GV in test plume and baseline samples. The exception was dissolved copper, which had two samples (one background, one test sample, both at Jacobs Channel) with concentrations above the ANZECC/ARMCANZ (2018) GV. In both cases, the dissolved fraction was greater than the total fraction, therefore results from both samples are flagged as 'suspect'. Such anomalies can occur at low concentrations that are near the laboratory LOR, as occurred here.

With regard to metals and metalloids measurements, the results of the present study therefore support the impact hypothesis that: *'Pollutant concentrations within dredge plumes at the loading and disposal sites do not reach levels where toxic effects or algae blooms could occur.'*

4.3 Recommendations

The results of the present study are consistent with previous modelling and monitoring assessments which suggest that dredge plumes are transient features that are typically restricted to within and directly adjacent to the dredge channel and the EBSDS, and do not pose a significant risk to aquatic ecosystems. The risk of plume impacts to aquatic ecosystems is largely dependent on:

- The physical and physico-chemical characteristics of dredged material.
- The proximity of the loading and disposal site to sensitive receptors, which also varies spatially, and in the case of seagrass, temporally.

The results of the present study, which are consistent with previous studies, demonstrate that dredging and disposal plumes do not lead to impairment to environmental quality. On this basis, there is no requirement to proceed to Stage 3 testing in accordance with the monitoring framework set out in Section 4.4.2 of NAGD.

Although not a requirement under NAGD, further sampling could be undertaken to better define the characteristics of dredge plumes under different environmental conditions. A comparison of results from the present study and previous studies suggest that the water quality characteristics of dredge plumes vary over time (especially nutrients and suspended sediments), which is possibly linked to temporal variations in sediment properties (see Section 4.2.2). While it is well known that sediment properties vary spatially throughout the Port area (BMT WBM 2017), temporal patterns are presently unresolved.

It is therefore recommended that dredge plume monitoring be repeated in accordance with the design and methods adopted in the present study. The frequency and timing of sampling should be based on antecedent climatic conditions (especially frequency and intensity of floods) and any major changes to dredging practices. A nominal sampling frequency of 4-5 years should be considered, subject to the timing of flood events.

In addition, it is recommended that duplicate sediment grab samples are collected from the dredge site during the plume monitoring program to characterise the physical and physico-chemical properties of dredged sediments. Sediment quality data should be reviewed together with data collected in GPC's sediment Sampling and Analysis Plan to determine potential linkages between the sediment properties at the dredge site and water quality characteristics of the dredge and disposal plumes.

5 Conclusion

The monitoring of the plumes generated by the TSHD *Brisbane* during December 2018 as it performed both loading and disposal operations within Gladstone Harbour during the neap tides allowed for:

- The quantification of the behaviour of the dredge plumes and its constituents (sediments, metals, metalloids and nutrients) during these conditions.
- Assessment of the potential exposure of sensitive ecological receptors to dredge plumes during these conditions.
- Assessment of potential exposure of sensitive ecological receptors to dredge disposal at EBSDS.

Consistent with the findings of previous dredge monitoring campaigns at Port Curtis, the results of the present study suggest that plumes generated by dredging and disposal represent short term features (measured in 10s of minutes to hours) and pose a low risk to the environment. In summary:

- Measured suspended sediment concentrations indicate that plume dispersion was rapid (near-background within 1.5 hours) and the measured plumes did not interact significantly with any sensitive receptors (noting that monitoring occurred during neap tide conditions).
- Nutrient concentrations were generally similar between test (dredge/disposal) and baseline samples. The exception was a short-term increase in total phosphorus and ammonia concentration in the dredge plume at the Jacobs Channel dredge site, which were near background levels within 30-60 minutes of dredging. A further increase in total phosphorus and suspended solids concentrations was observed at the Jacobs Channel dredge site two hours after dredging, most likely in response to sediment resuspension processes.
- Concentrations of bioavailable nutrient species (ortho-phosphorus, nitrogen oxides) were similar between baseline and test samples at all sites.
- Nutrient concentrations recorded in the present study were lower than recorded by BMT WBM (2014; 2015). This likely reflects changes to sediment nutrient pools over time and space (i.e. different dredge areas). It is hypothesised that the delivery of sediments and nutrients by floods in 2011 and 2013 may have increased the sediment nutrient pool in Port Curtis, resulting in the higher nutrient concentrations in dredge plumes reported by BMT WBM (2014, 2015). Further assessments would be required to test this hypothesis.
- Chlorophyll *a* concentrations were consistently low in both baseline and test samples. Thus, algal blooms were not evident and are not expected to occur as a result of the maintenance dredging.
- Dissolved oxygen and pH was consistent across test and baseline samples. There is no evidence that dredging lead to dissolved oxygen suppression or created acidic conditions.
- Dredging activities led to suspension of sediments in the water column, increasing concentrations of certain metals in the water column. Consistent with predictions of BMT WBM (2015), concentrations of total metals/metalloids declined over time, as sediment-bound metals quickly settled to the seafloor.

- Concentrations of dissolved metals and metalloids, which is typically the most bioavailable fraction, were typically either below the laboratory detection limits or below their respective ANZECC/ARMCANZ (2018) GV in test plume and baseline samples. The exception was dissolved copper at Jacobs Channel, which was above the ANZECC/ARMCANZ (2018) GV in two test samples. The data for these two samples was flagged as suspect, as total copper concentrations in all three samples were less than the dissolved fraction. Such anomalies can occur at low concentrations that are near the laboratory LOR, as occurred here.
- The results of the present study therefore support the impact hypothesis that:
  - 'Sediments generated during dredging and disposal do not subsequently reach sensitive areas in amounts that would be harmful to the ecological value and amenity of the area'.
  - 'Pollutant concentrations within dredge plumes at the loading and disposal sites do not reach levels where toxic effects or algae blooms could occur.'
- The results of the present study therefore suggest that dredging and disposal plumes do not lead to impairment to environmental quality, therefore it does not trigger the need for Stage 3 testing in accordance with the framework set out in Section 4.4.2 of NAGD.
- Although not a requirement under NAGD, further sampling could be undertaken to better define the characteristics of dredge plumes under different environmental conditions (especially post-flooding) and should there be major changes to dredging practices.

6 References

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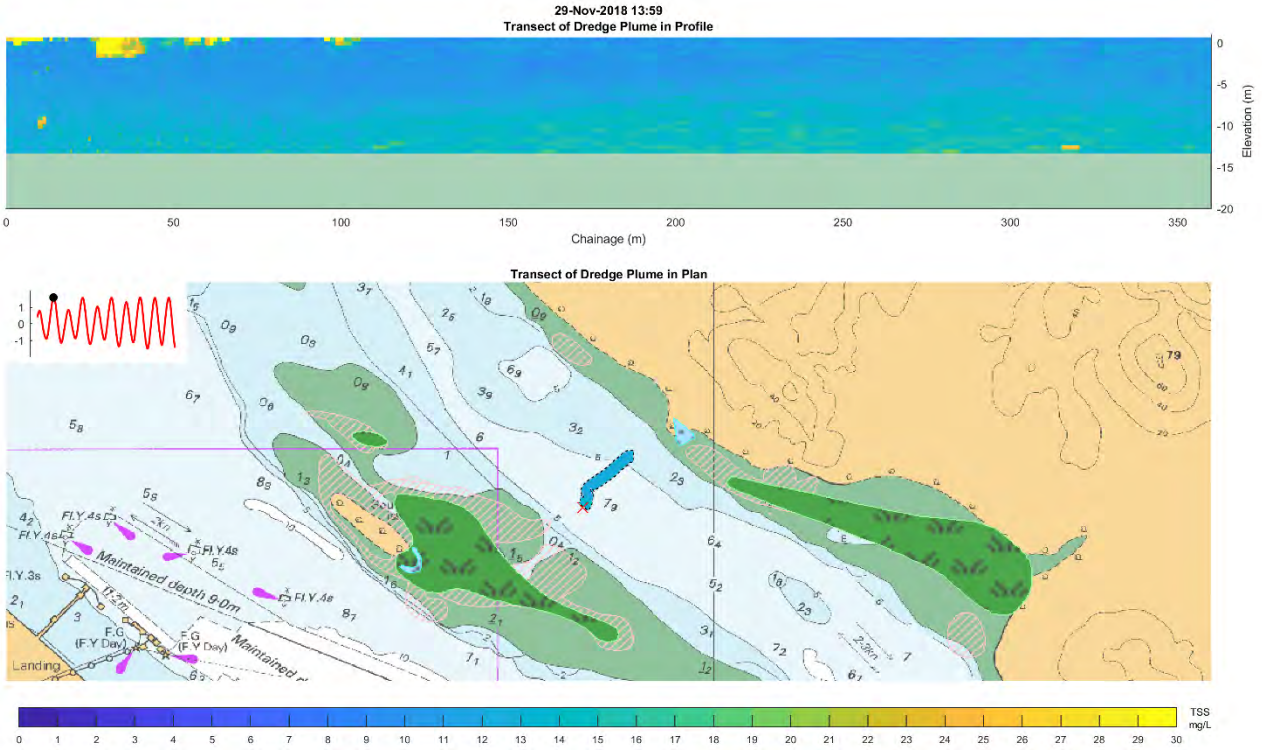
Appendix A Water Samples, TSS Analysis

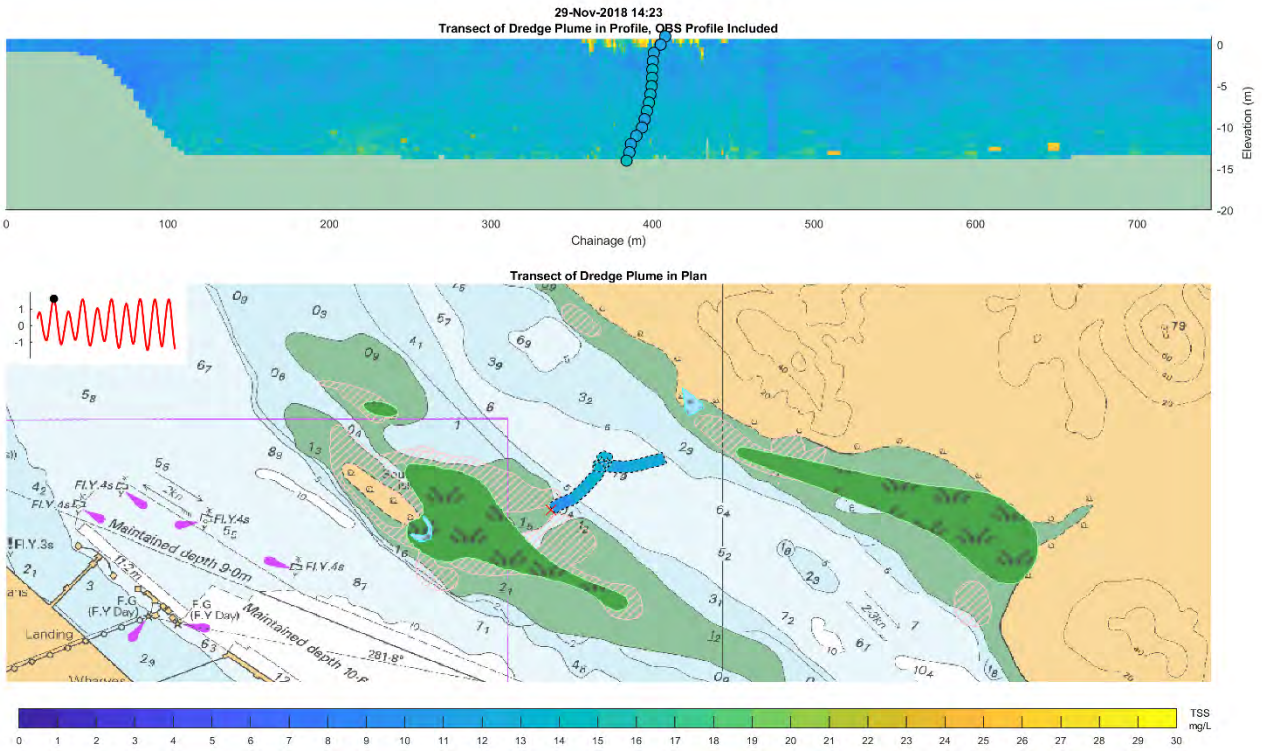
TIME	DEPTH (m)	TSS (mg/L)
29/11/2018 13:55	1.5	13
29/11/2018 14:15	7.5	16
29/11/2018 14:20	15	11
29/11/2018 15:10	1.5	20
29/11/2018 15:12	8	15
29/11/2018 15:14	15.6	57
29/11/2018 15:30	1.5	38
29/11/2018 15:32	7.5	25
29/11/2018 15:34	15	63
29/11/2018 15:45	1.5	14
29/11/2018 15:47	7.5	13
29/11/2018 15:49	15	22
29/11/2018 16:15	1.5	12
29/11/2018 16:17	8	15
29/11/2018 16:19	9.5	26
29/11/2018 17:05	1.5	25
29/11/2018 17:07	7	24
29/11/2018 17:09	9.5	20
02/12/2018 06:10	1.5	6
02/12/2018 06:12	8	4
02/12/2018 06:14	16	6
02/12/2018 08:00	1.5	18
02/12/2018 08:02	8	8
02/12/2018 08:04	16	8
02/12/2018 08:15	1.5	8
02/12/2018 08:17	8	8
02/12/2018 08:19	16.5	8
02/12/2018 08:30	1.5	6
02/12/2018 08:32	8	5
02/12/2018 08:34	15	6
02/12/2018 09:00	1.5	5
02/12/2018 09:02	8	6
02/12/2018 09:04	16	8

Water Samples, TSS Analysis

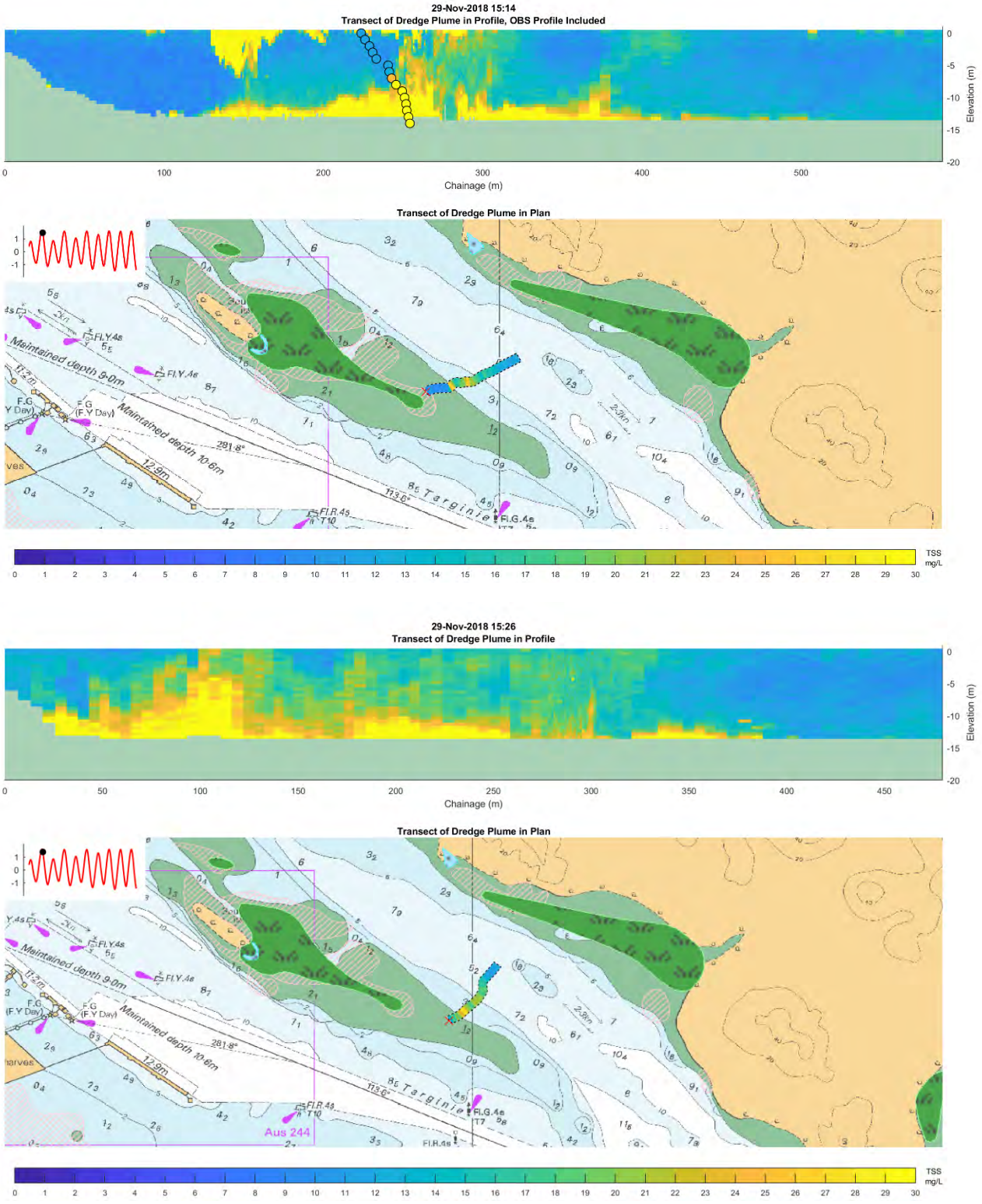
TIME	DEPTH (m)	TSS (mg/L)
02/12/2018 10:00	1.5	6
02/12/2018 10:02	5	6
02/12/2018 10:04	10	6
02/12/2018 13:00	1.5	<1
02/12/2018 13:02	6	<1
02/12/2018 13:04	10	<1
02/12/2018 13:55	1.5	<1
02/12/2018 13:57	5	13
02/12/2018 13:59	10	6
02/12/2018 14:10	1.5	12
02/12/2018 14:12	6	23
02/12/2018 14:14	11	14
02/12/2018 14:25	1.5	8
02/12/2018 14:27	6	20
02/12/2018 14:29	11	17
02/12/2018 14:55	1.5	4
02/12/2018 14:57	6	12
02/12/2018 14:59	11	11
02/12/2018 15:55	1.5	7
02/12/2018 15:57	3	7
02/12/2018 15:59	5	4

Appendix B Dredging at Jacobs Channel 29th November 2018





Dredging at Jacobs Channel 29th November 2018



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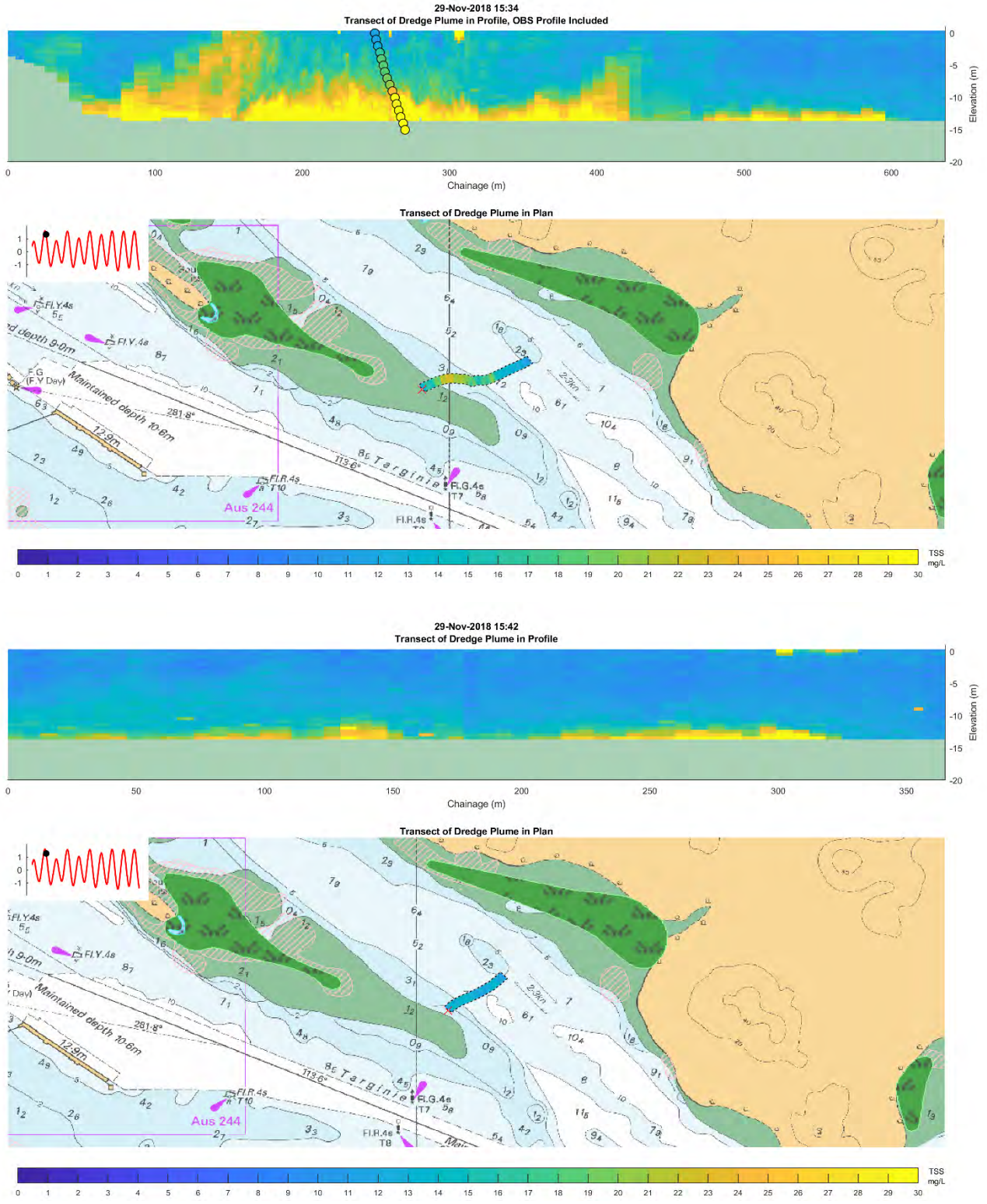

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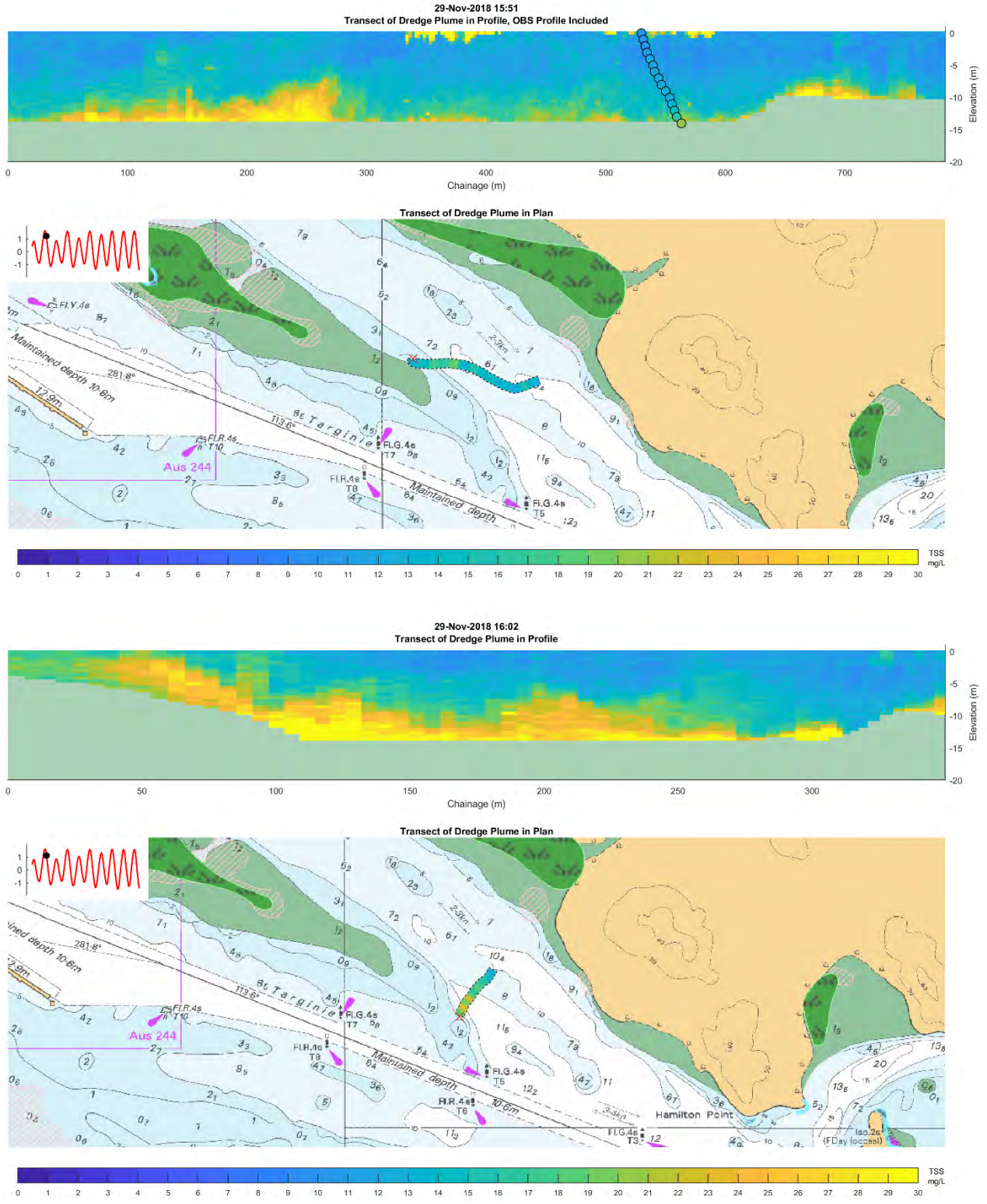

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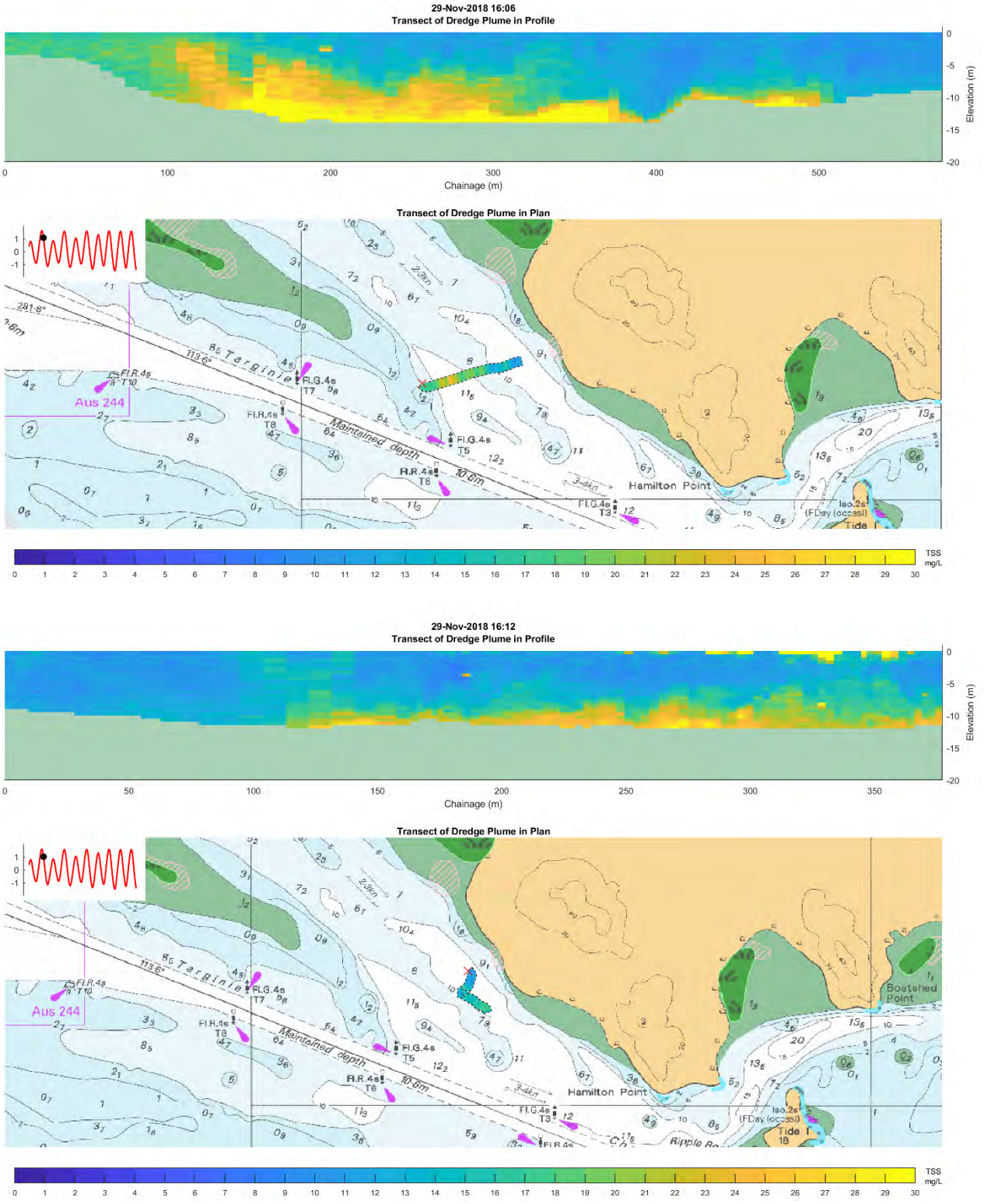

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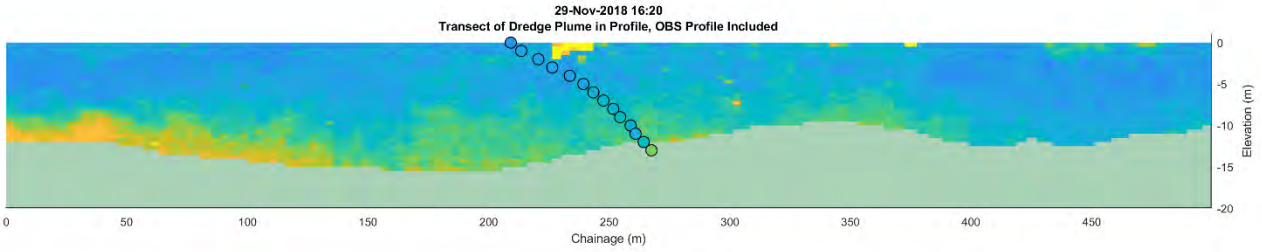

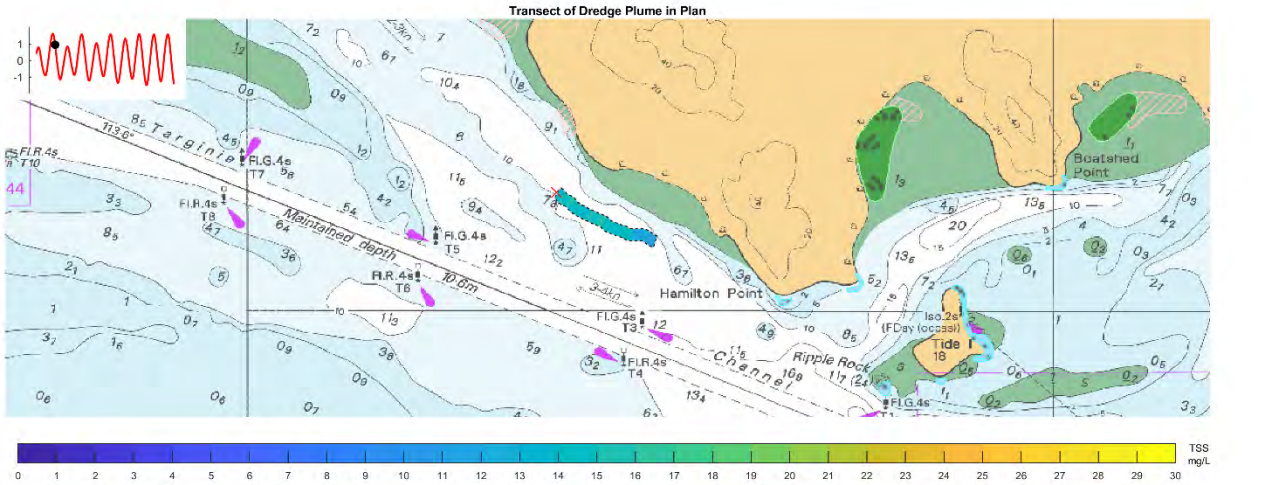

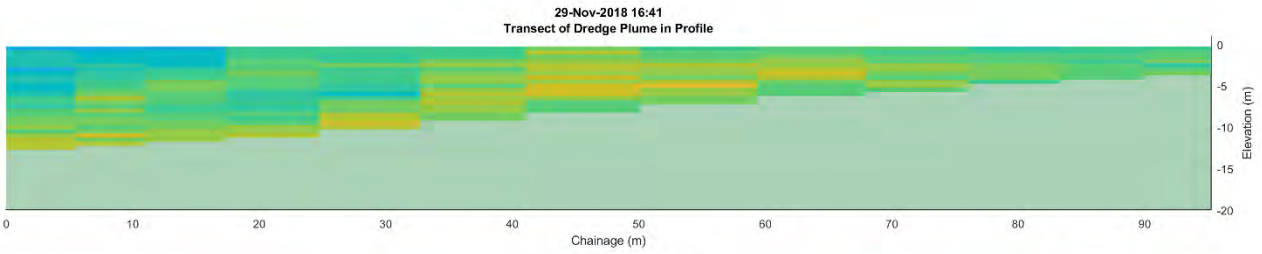

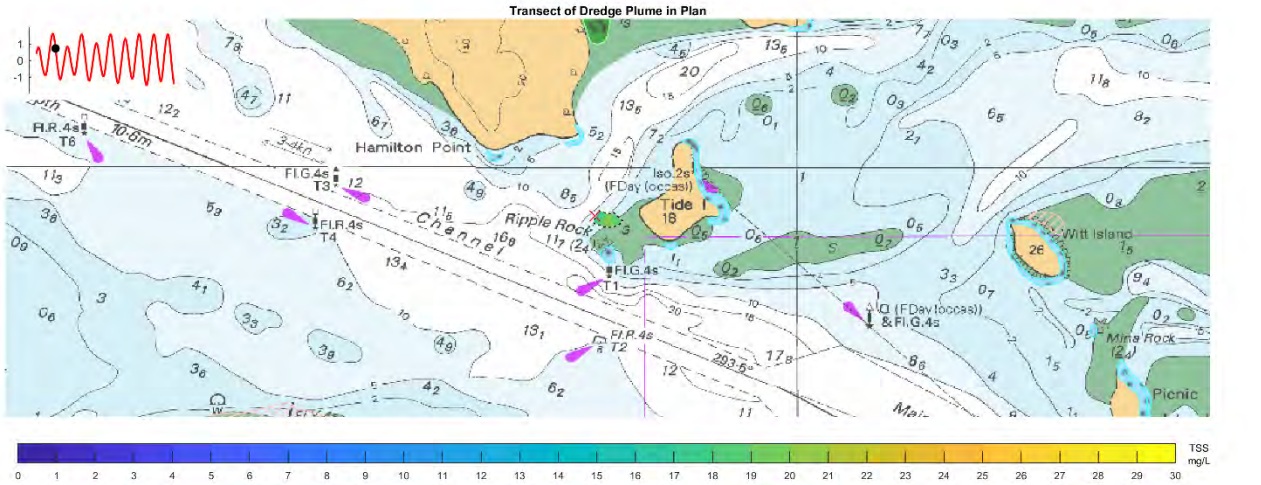

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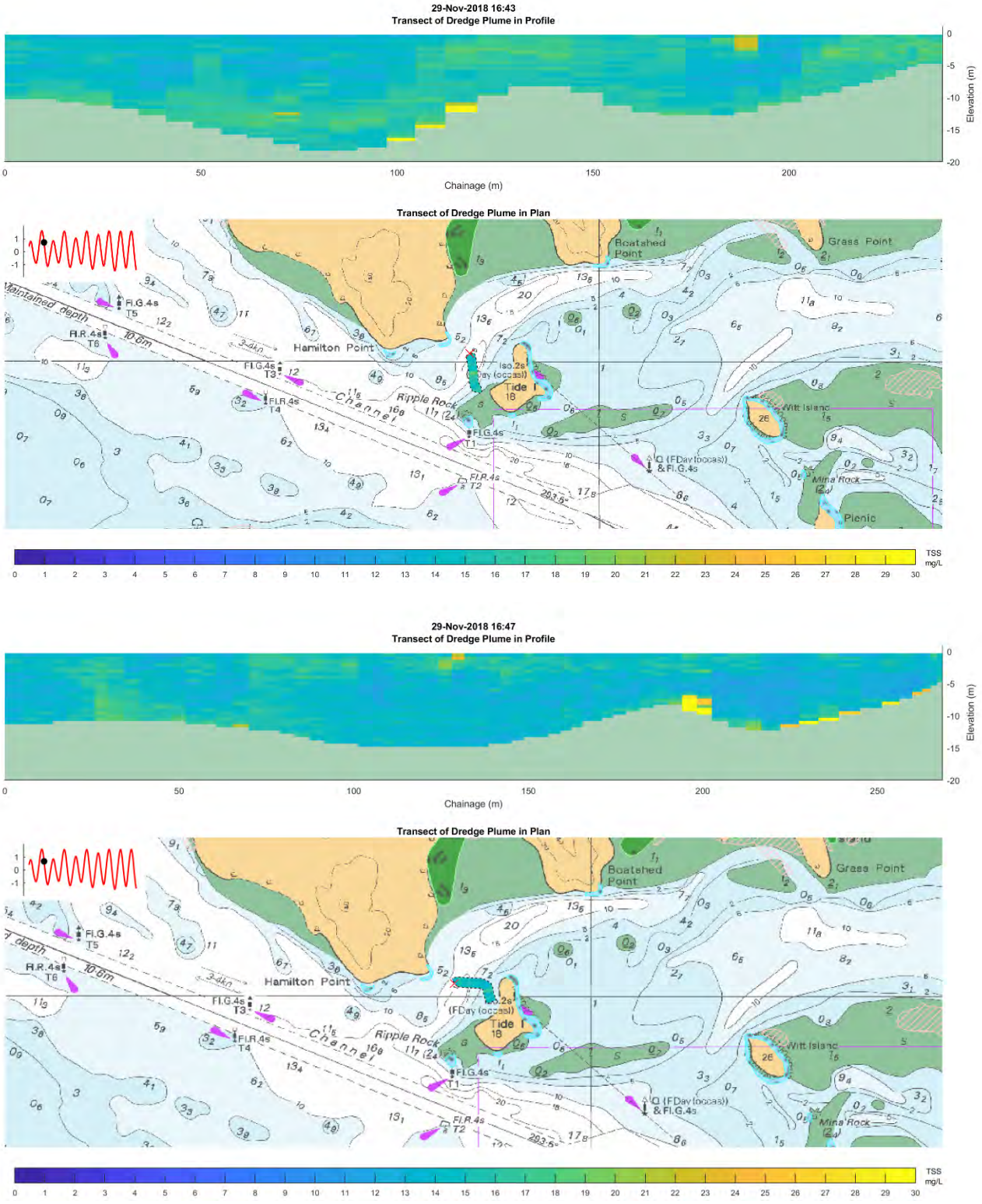

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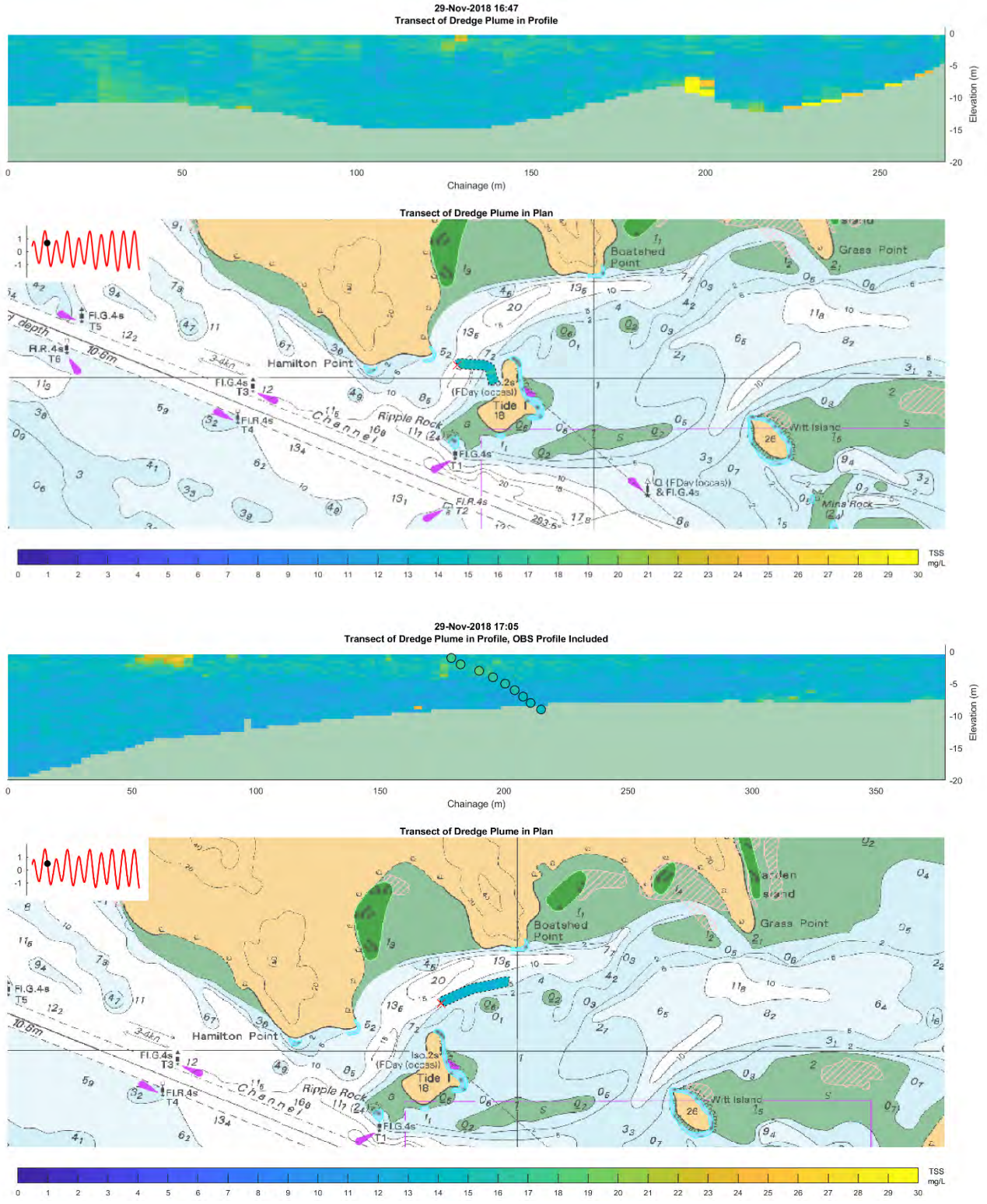
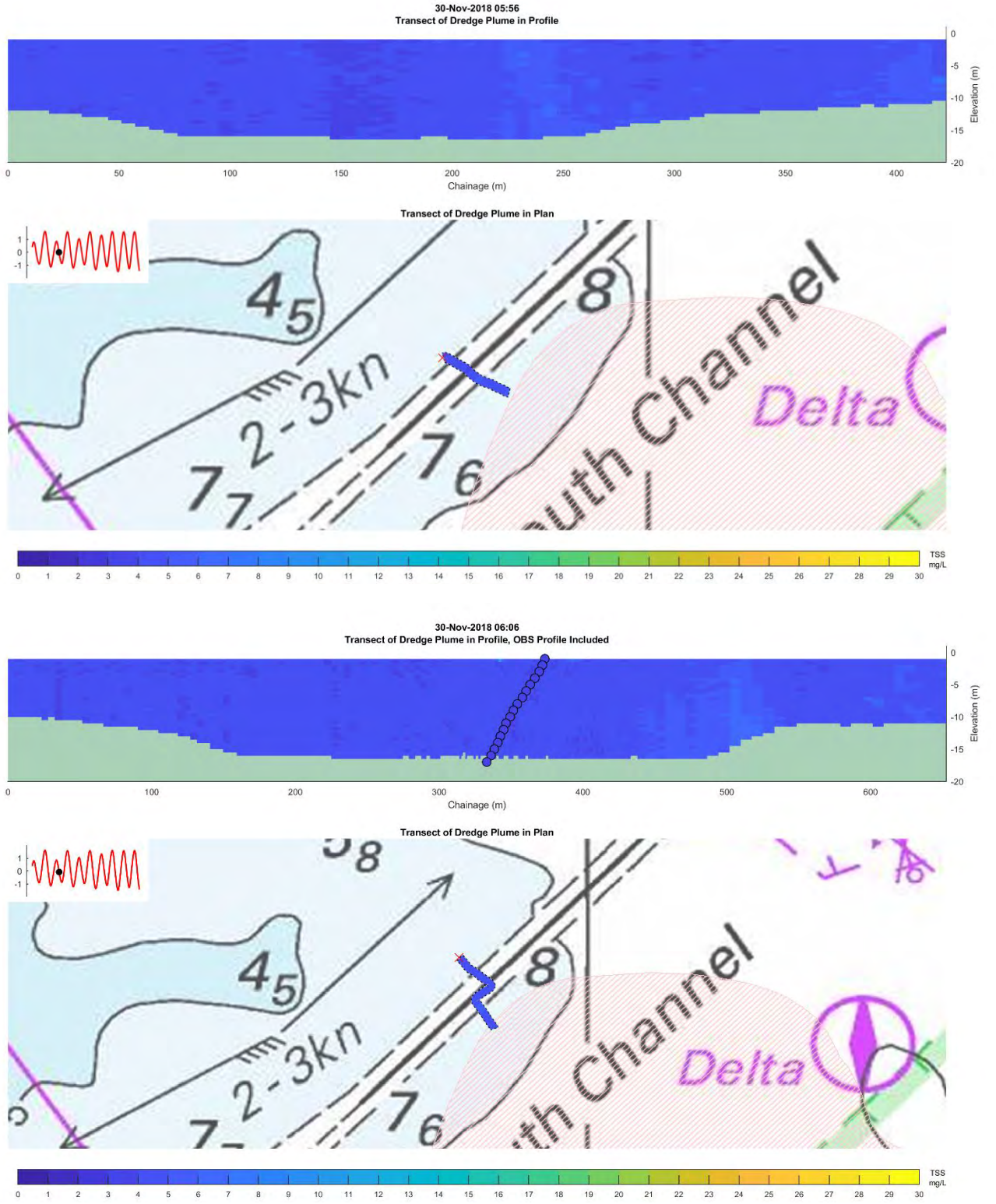
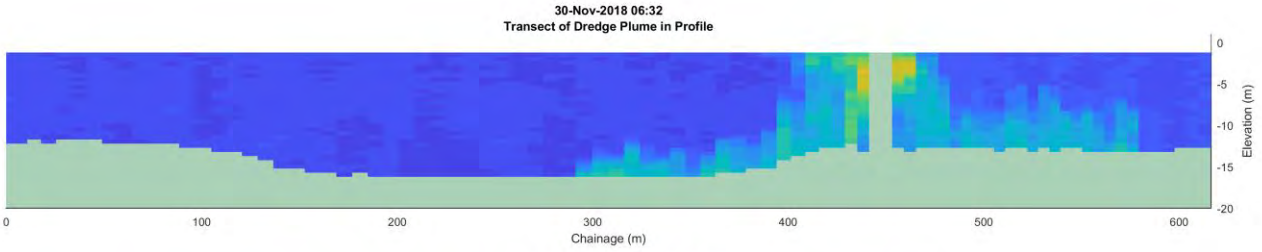
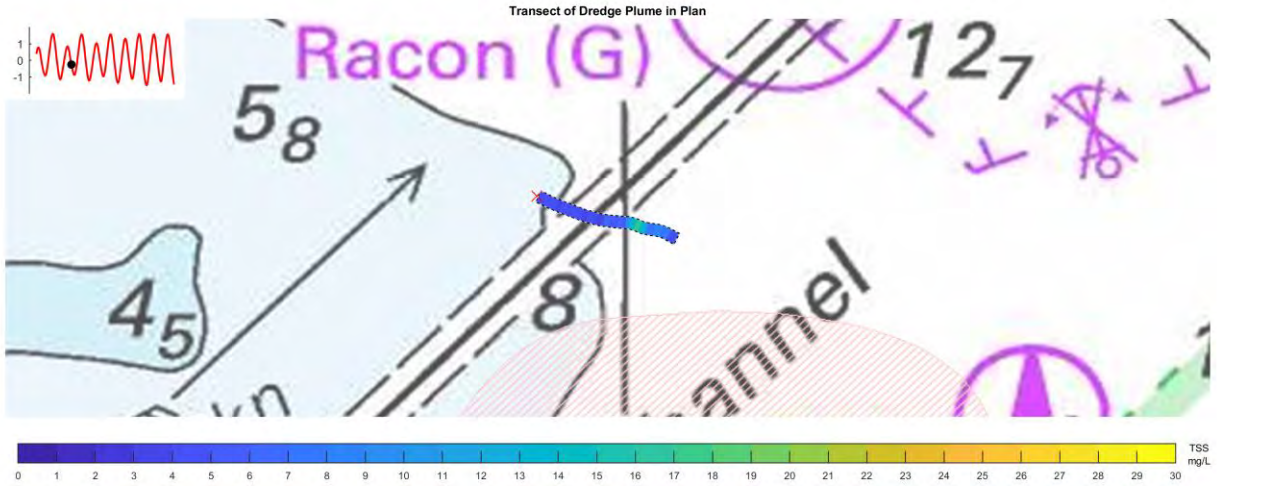


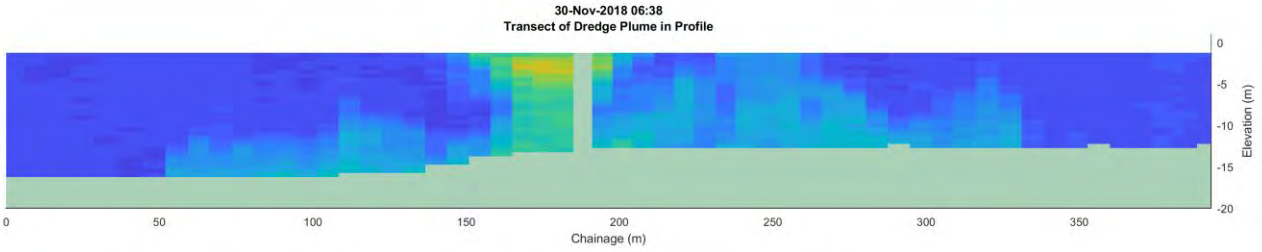
Appendix C Dredging at Wild Cattle Cutting, 30th November 2018

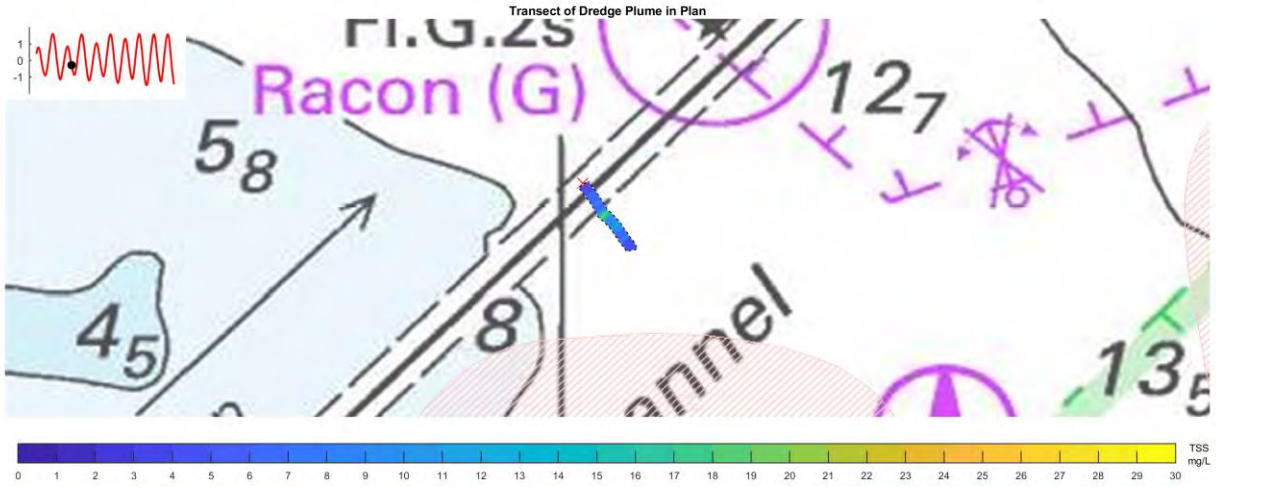


Dredging at Wild Cattle Cutting, 30th November 2018

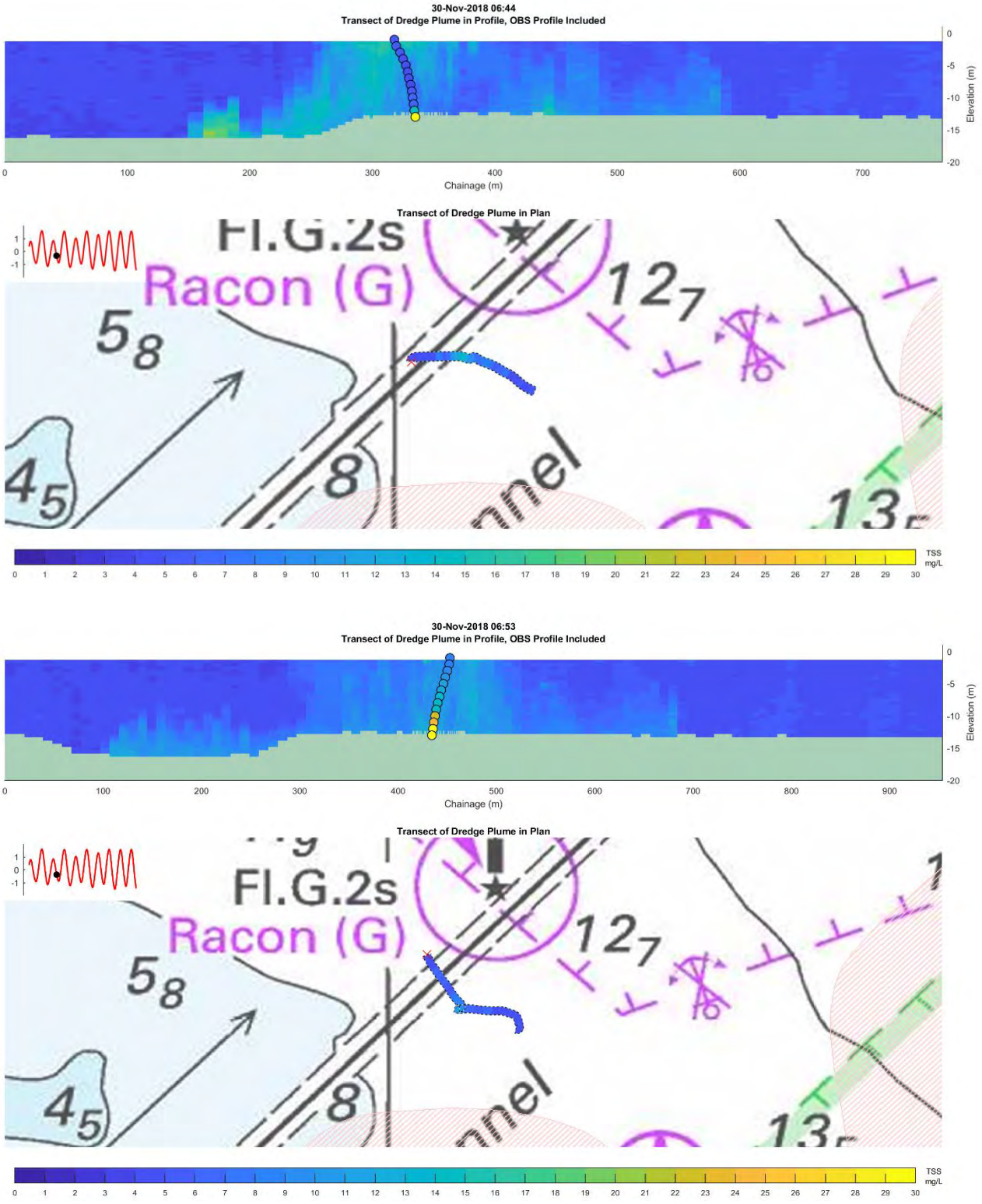




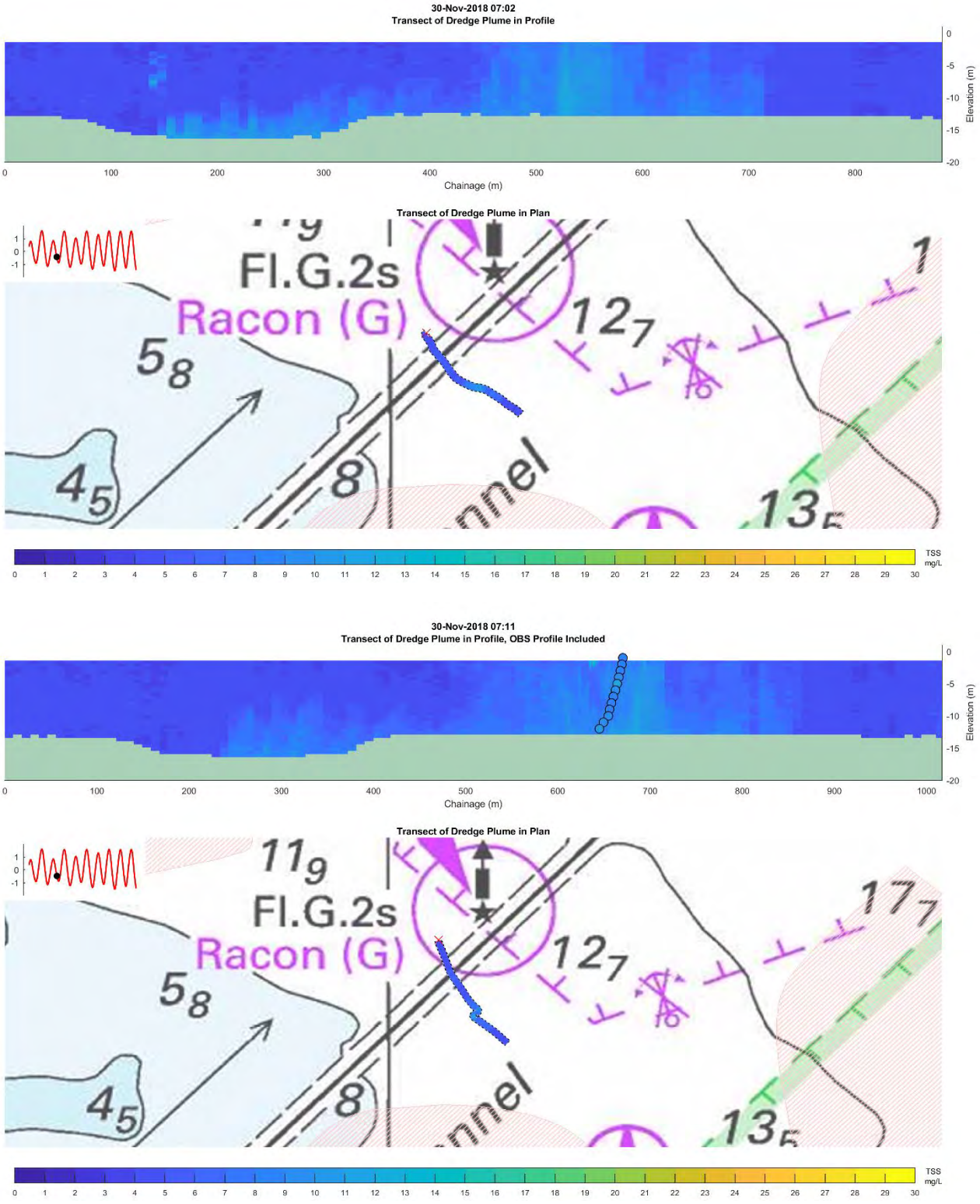




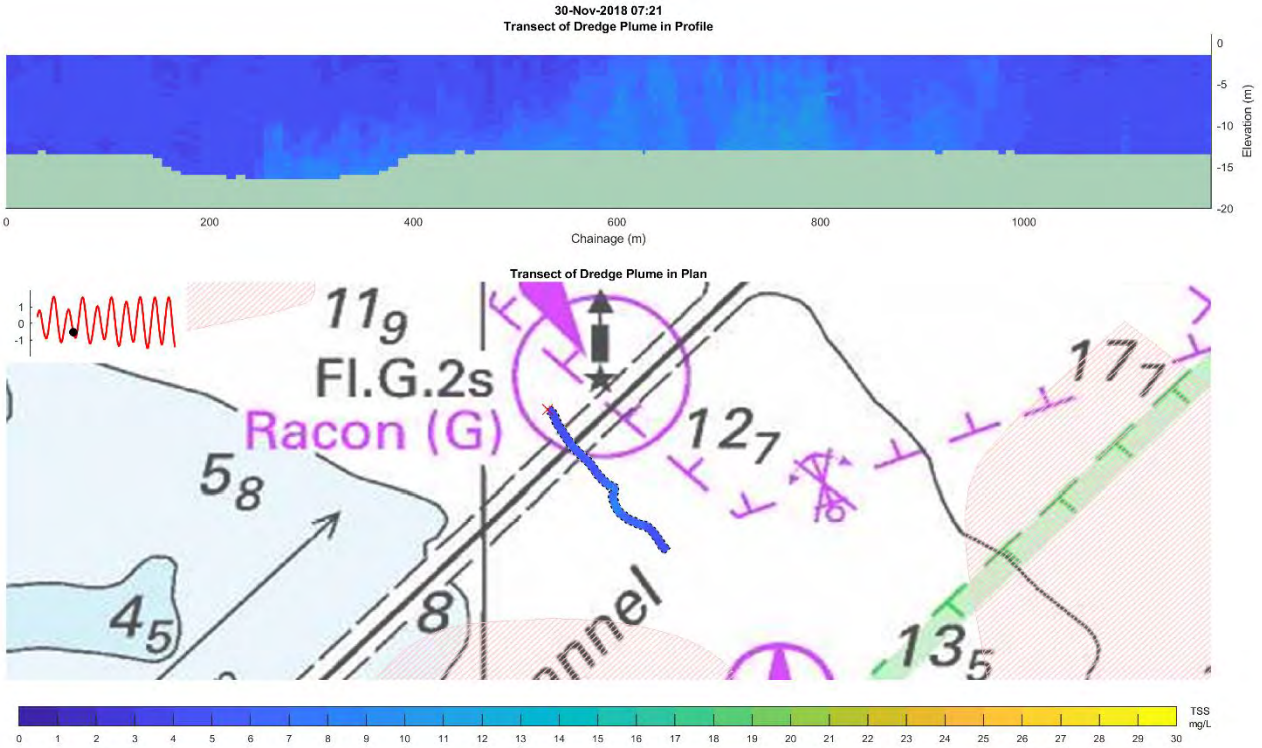
Dredging at Wild Cattle Cutting, 30th November 2018

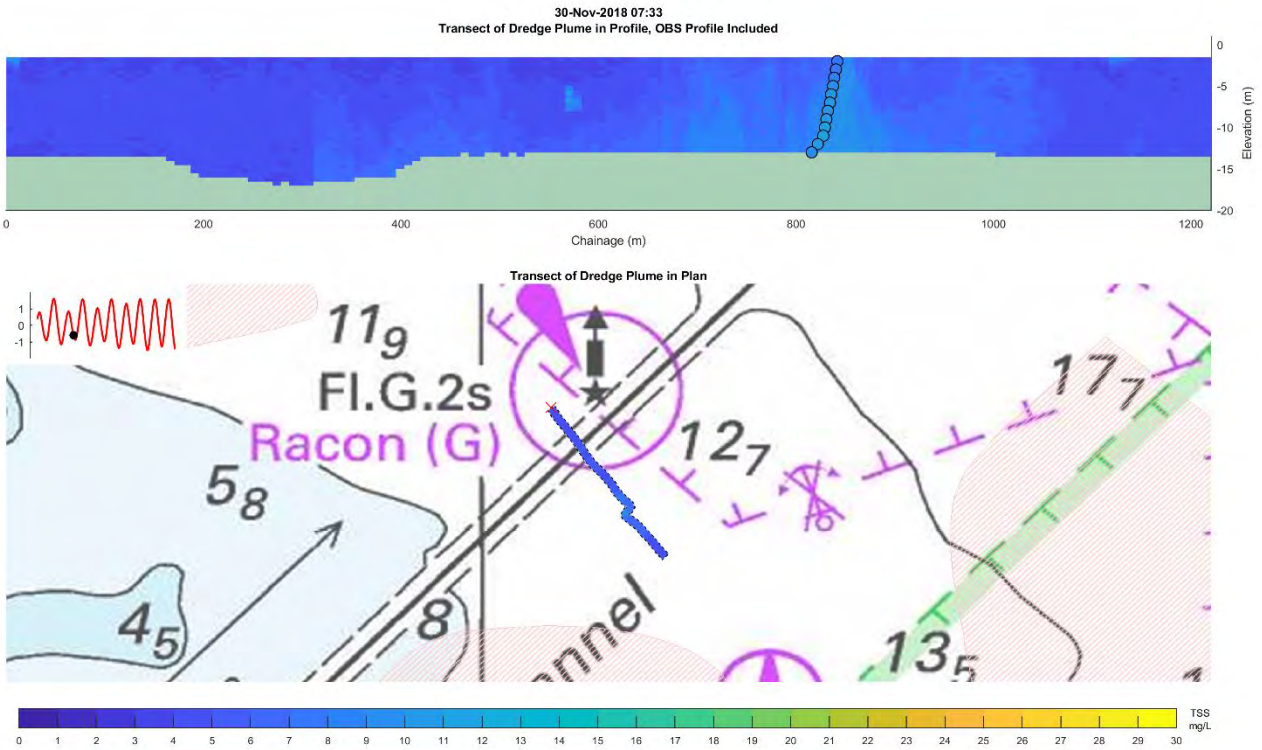


Dredging at Wild Cattle Cutting, 30th November 2018

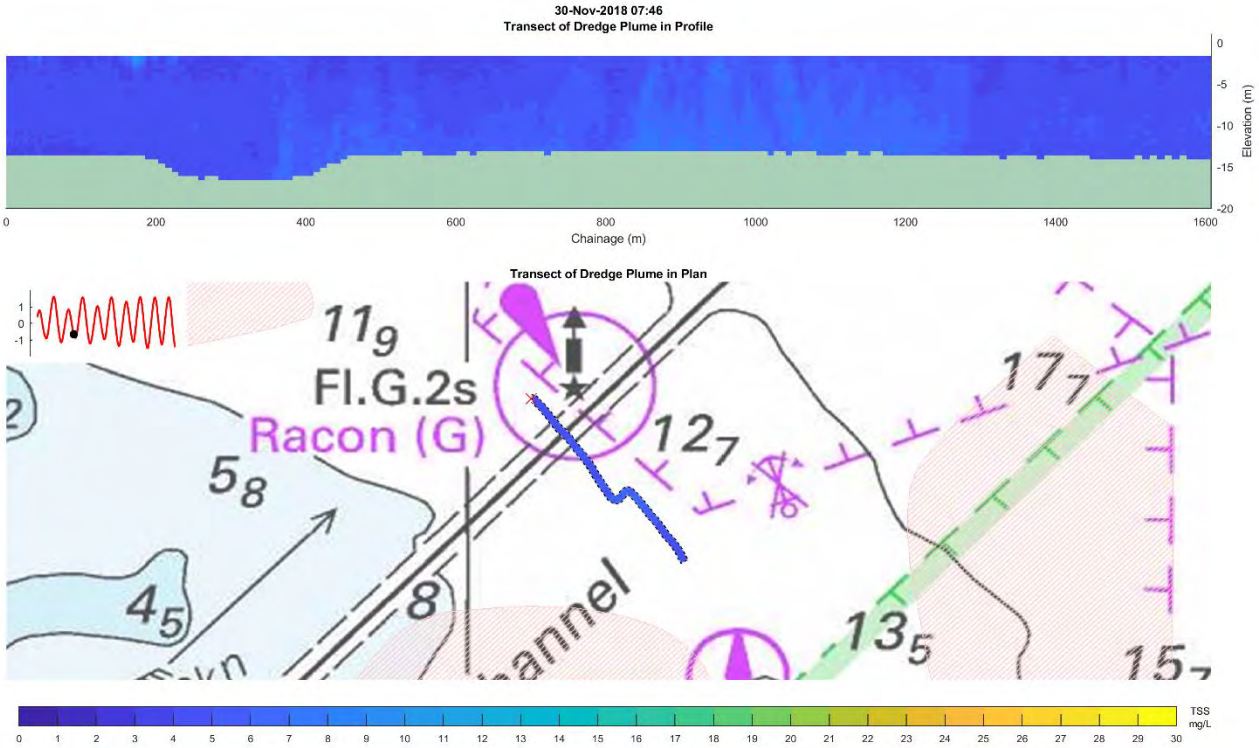


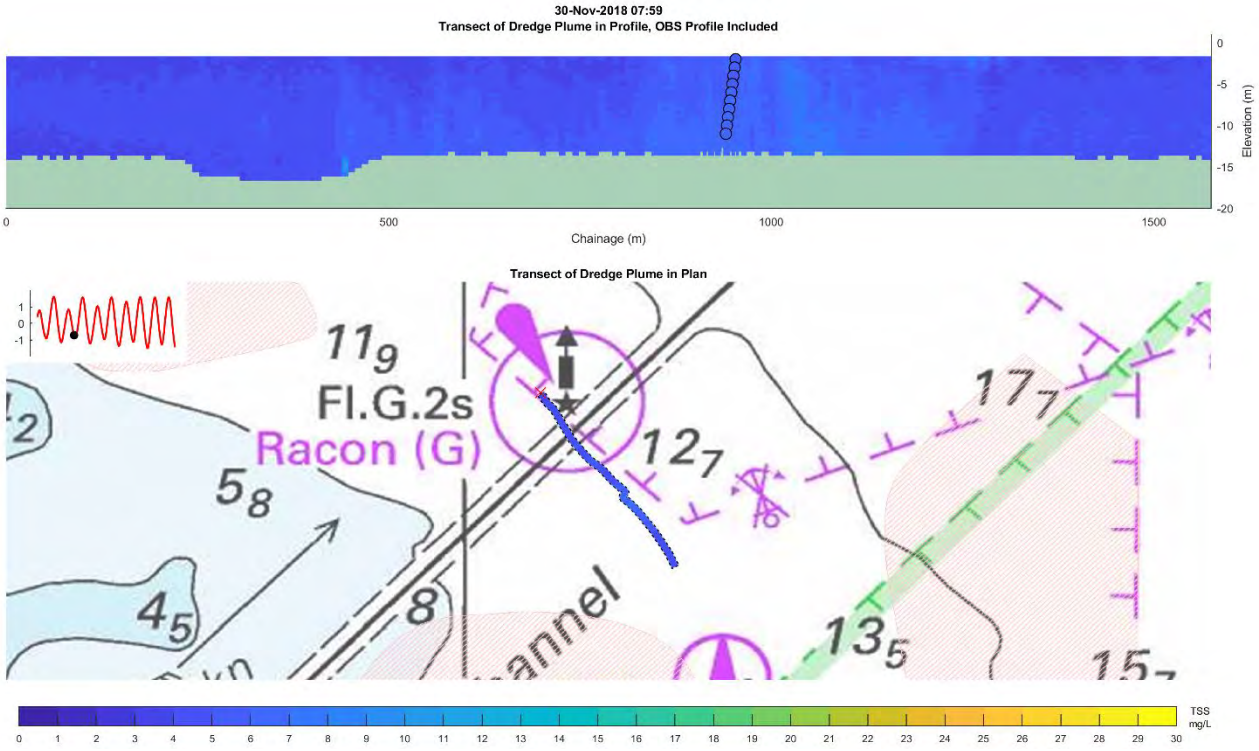
Dredging at Wild Cattle Cutting, 30th November 2018



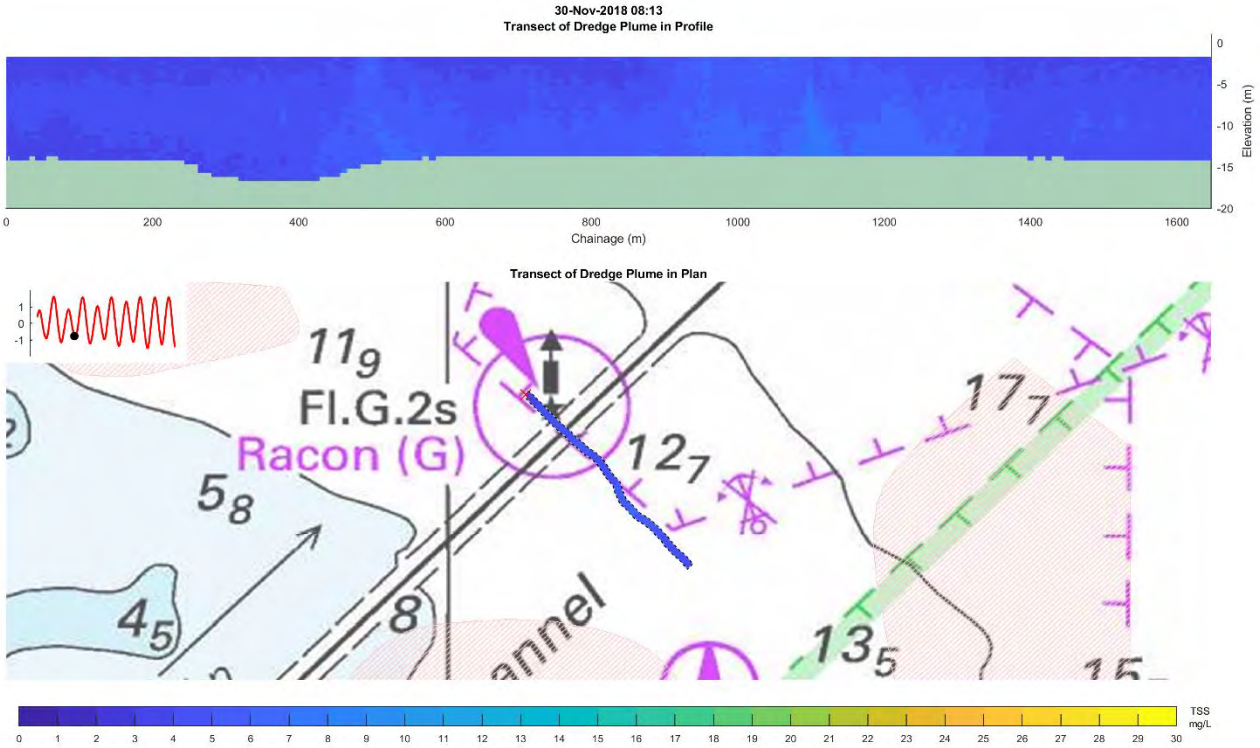


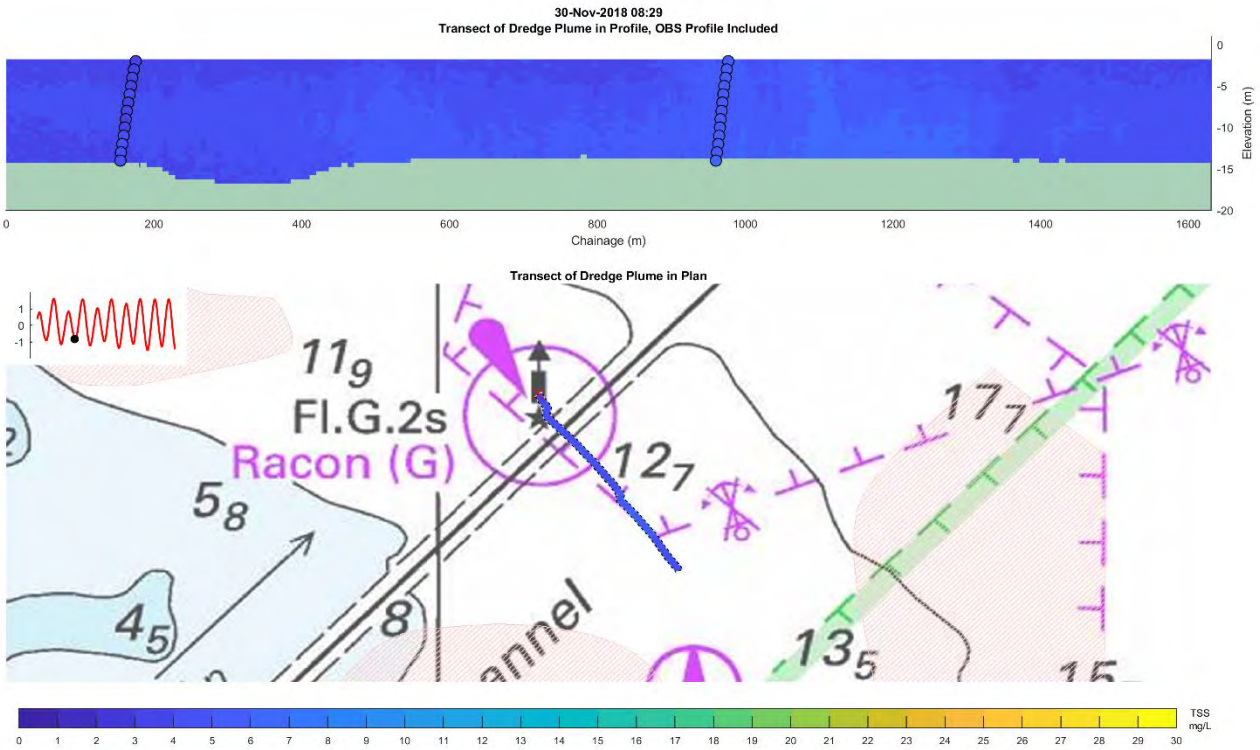
Dredging at Wild Cattle Cutting, 30th November 2018



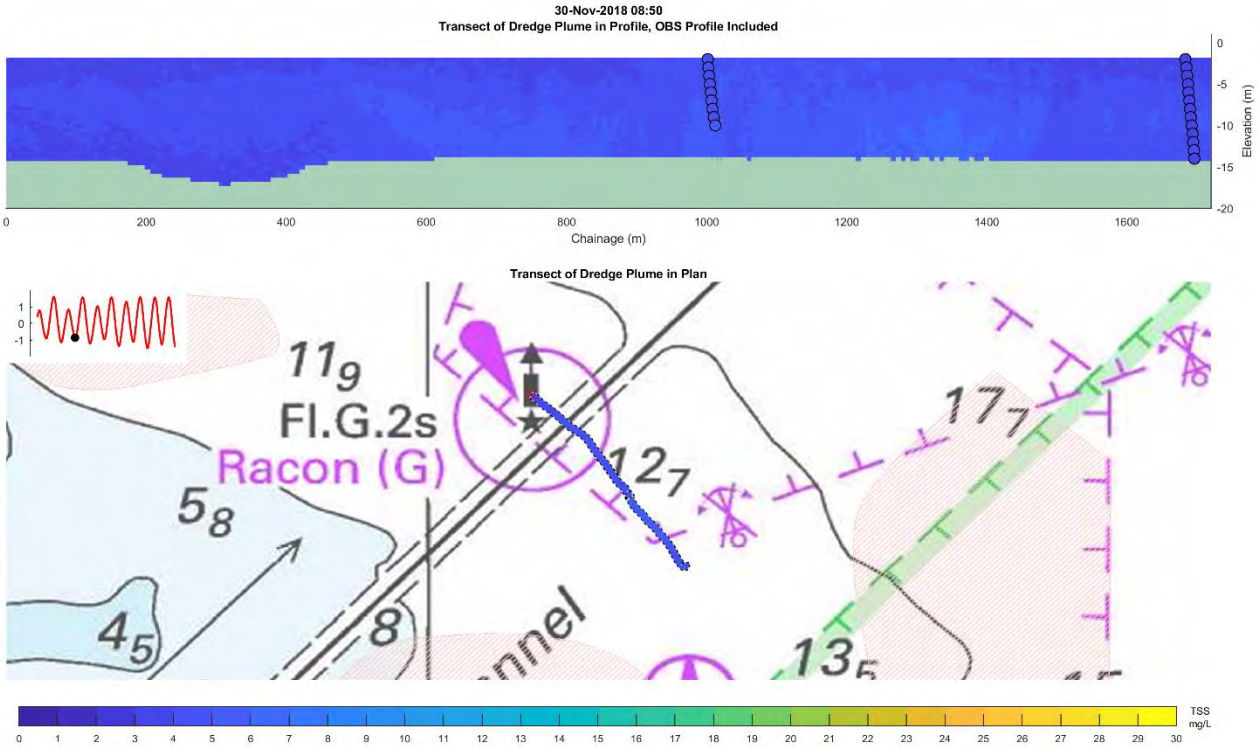


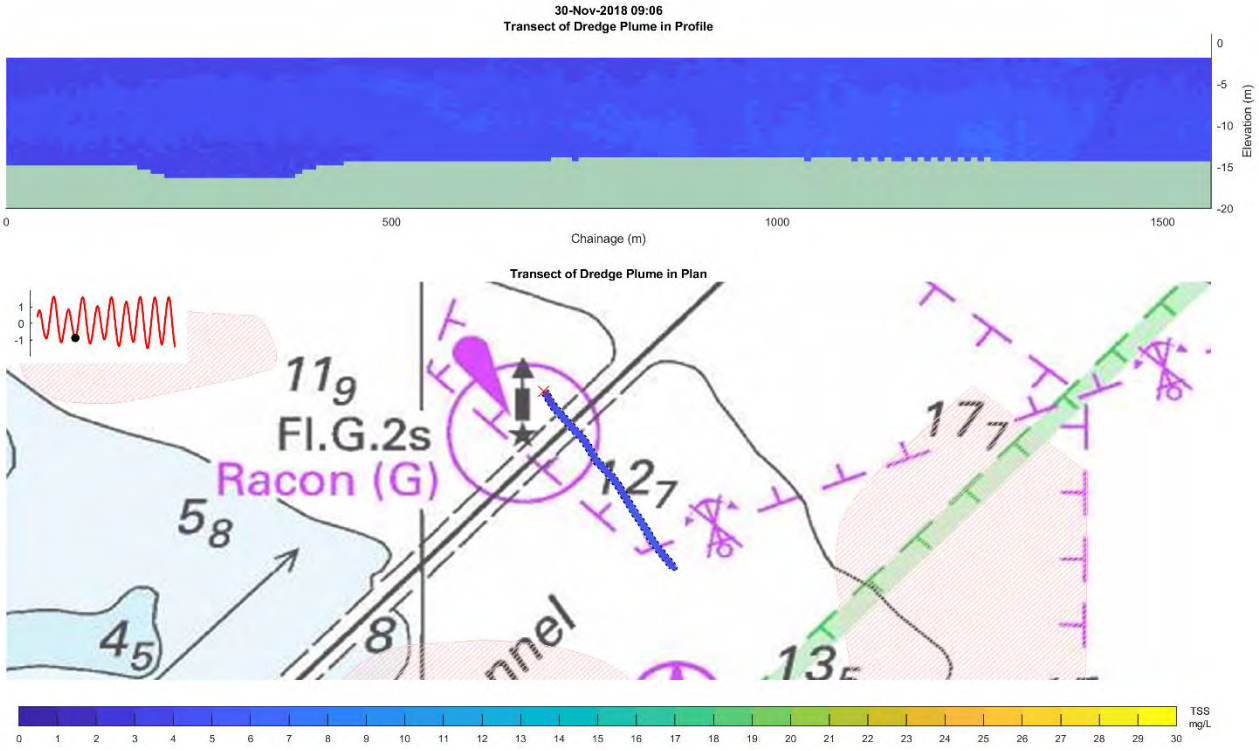
Dredging at Wild Cattle Cutting, 30th November 2018



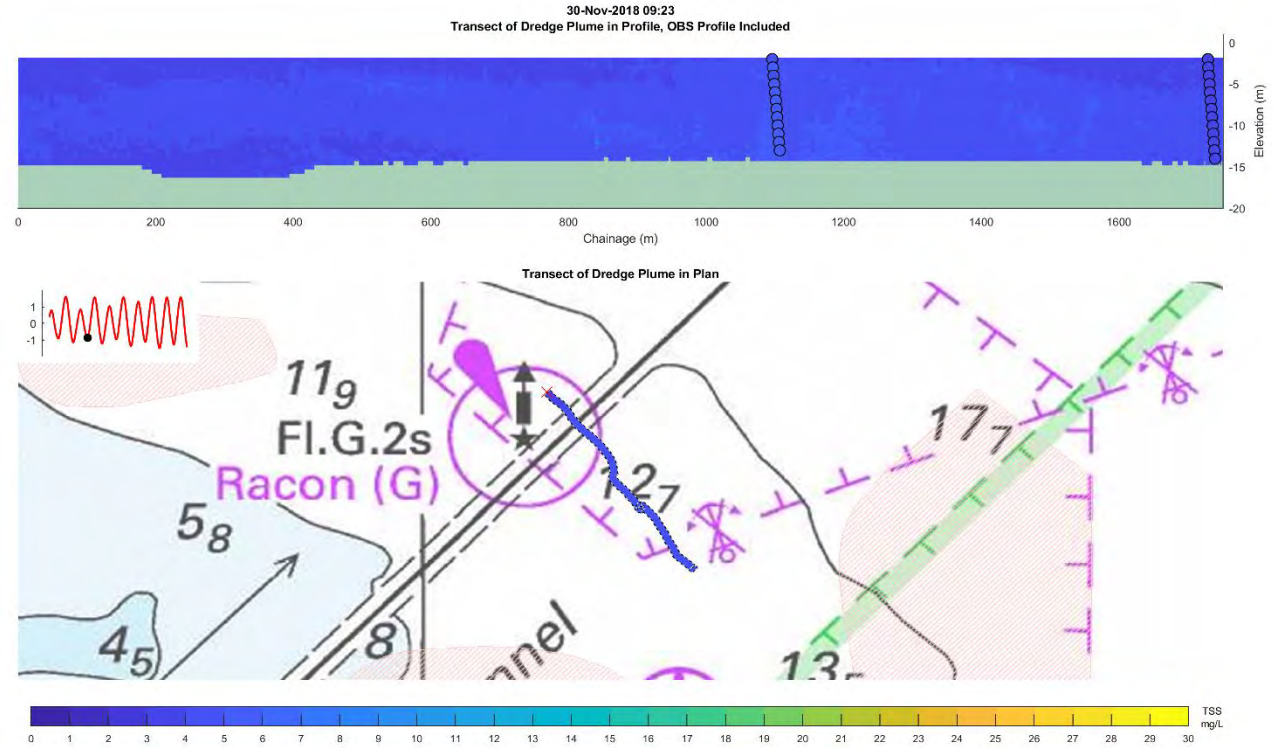


Dredging at Wild Cattle Cutting, 30th November 2018

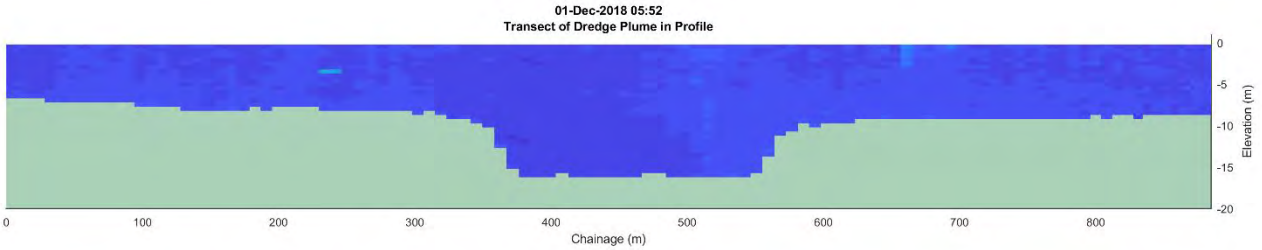


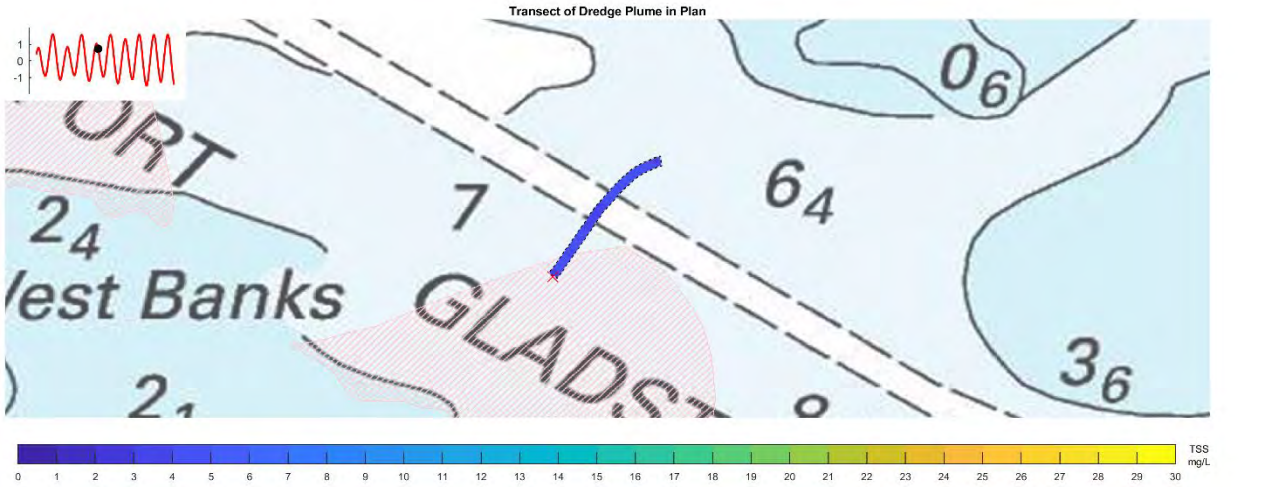


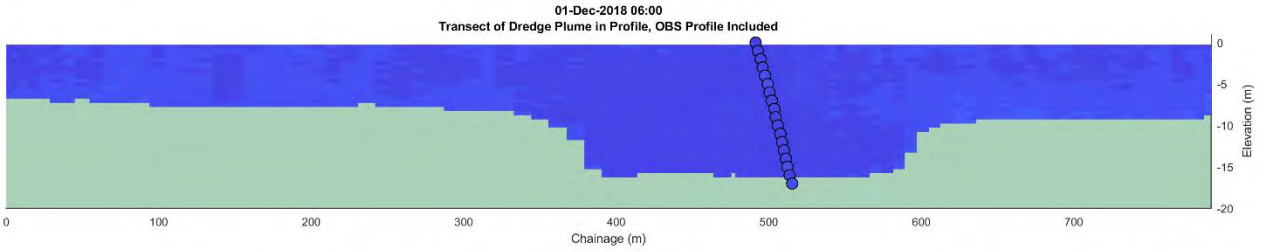
Dredging at Wild Cattle Cutting, 30th November 2018

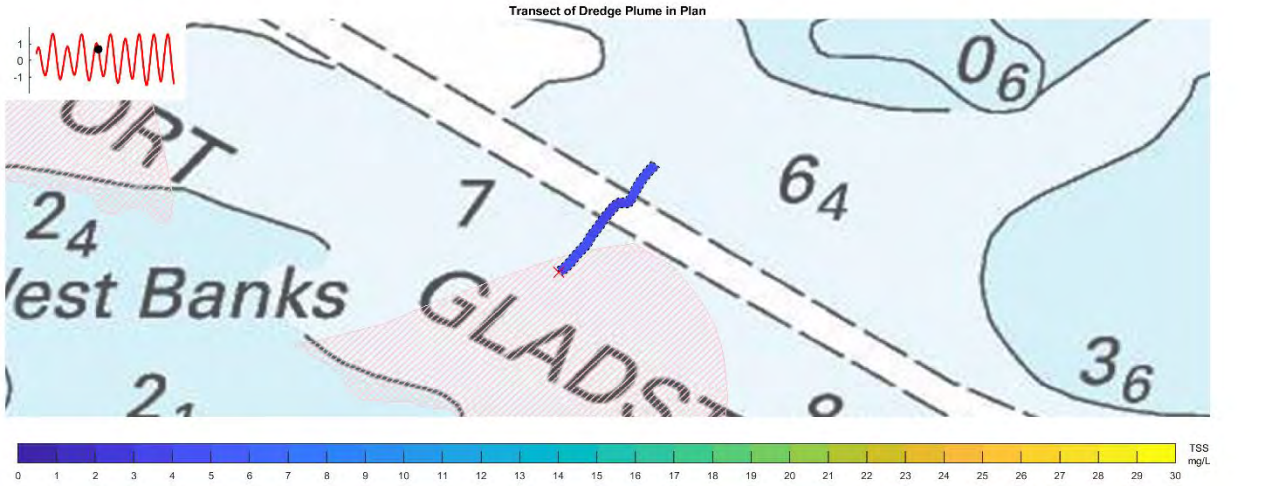


Appendix D Dredging at Golding Cutting, 1st December 2018

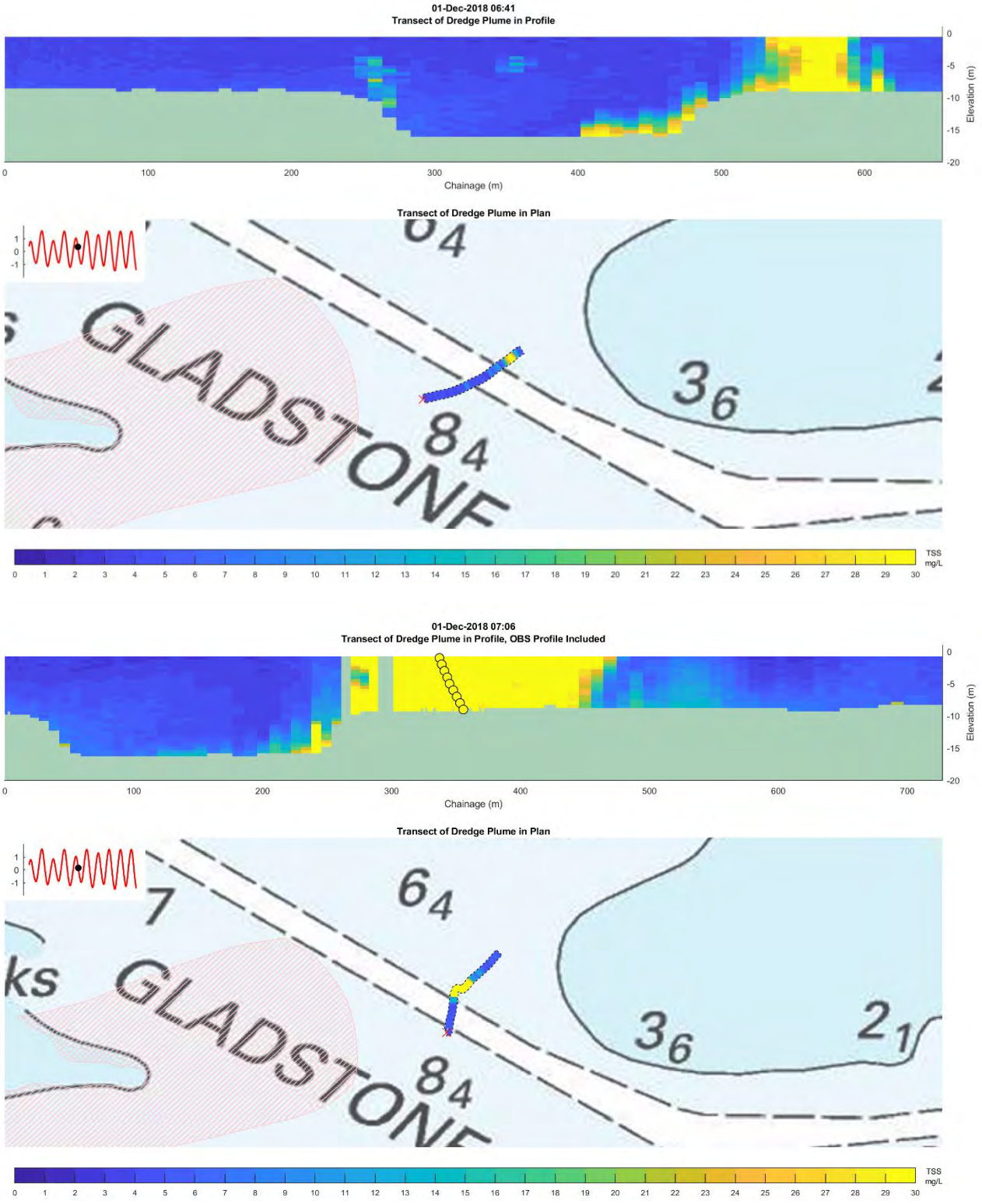




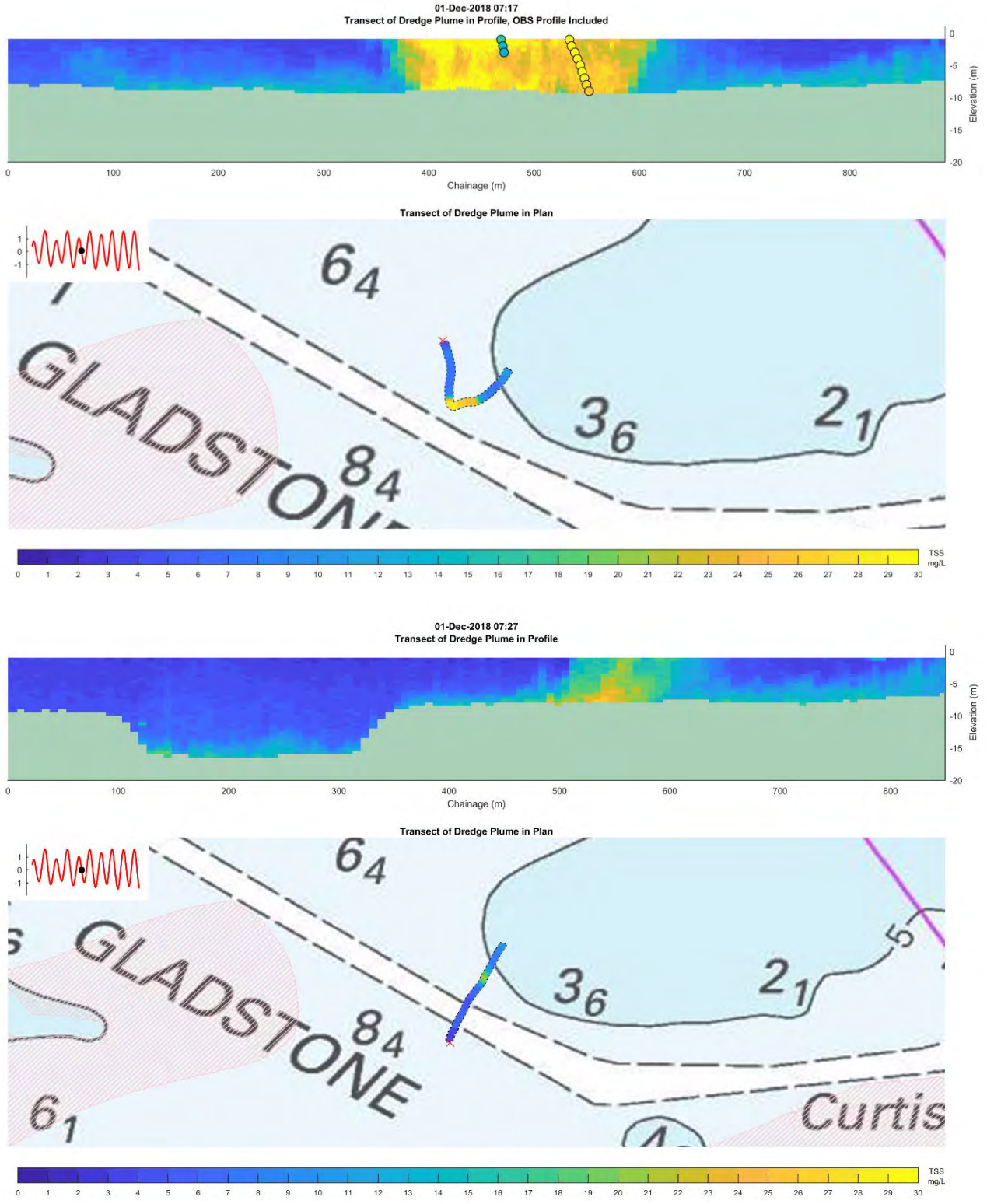




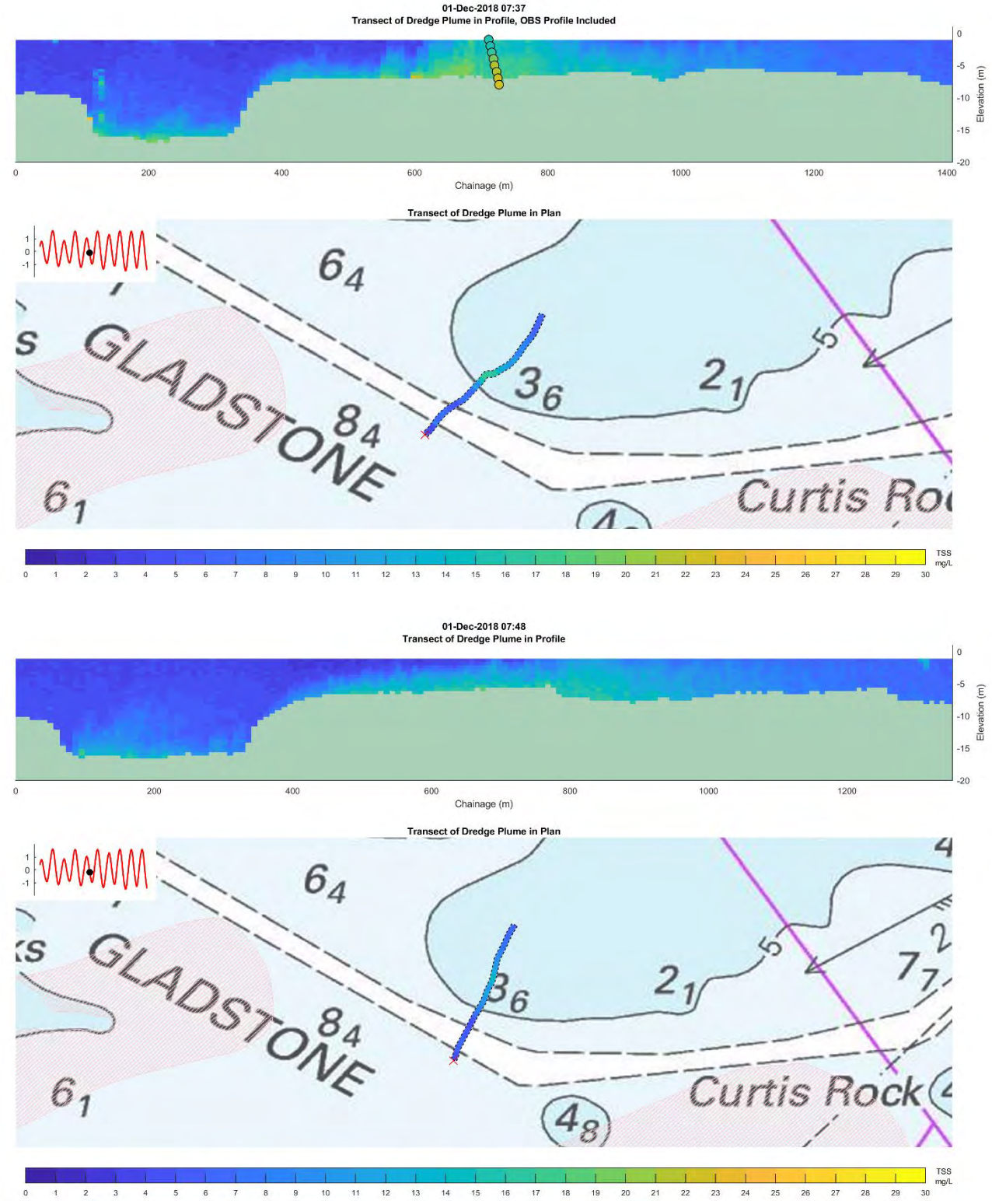
Dredging at Golding Cutting, 1st December 2018



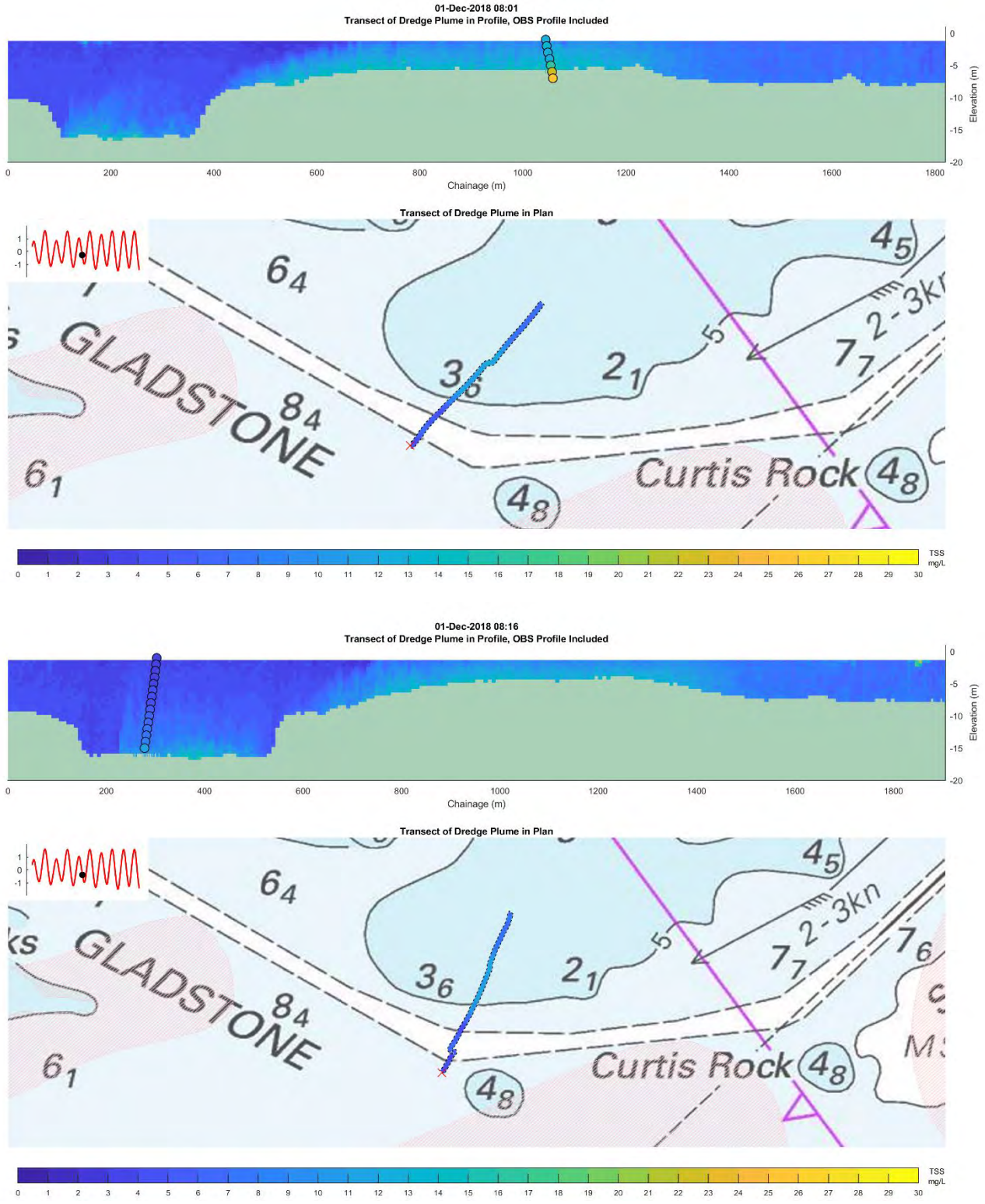
Dredging at Golding Cutting, 1st December 2018



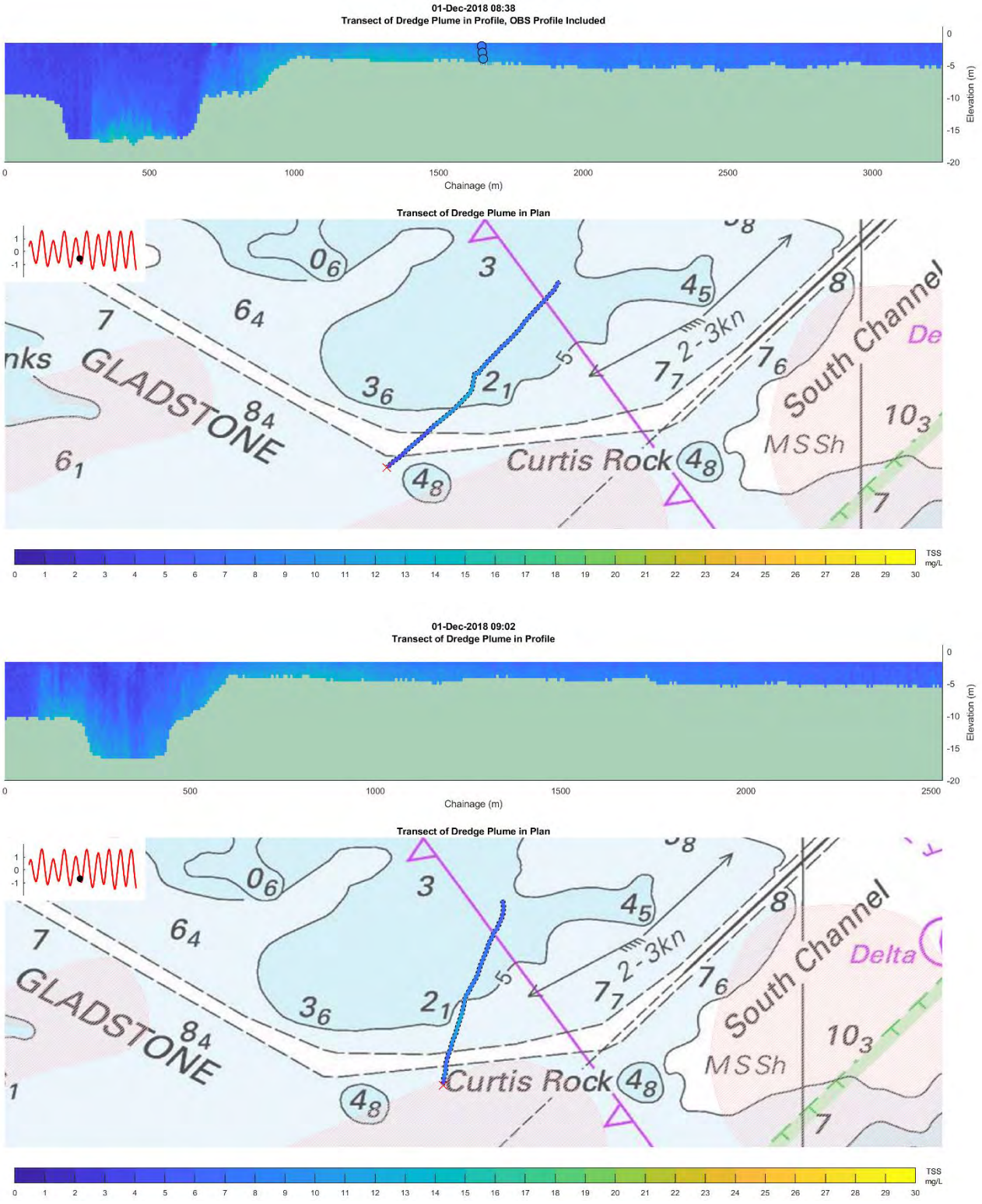
Dredging at Golding Cutting, 1st December 2018



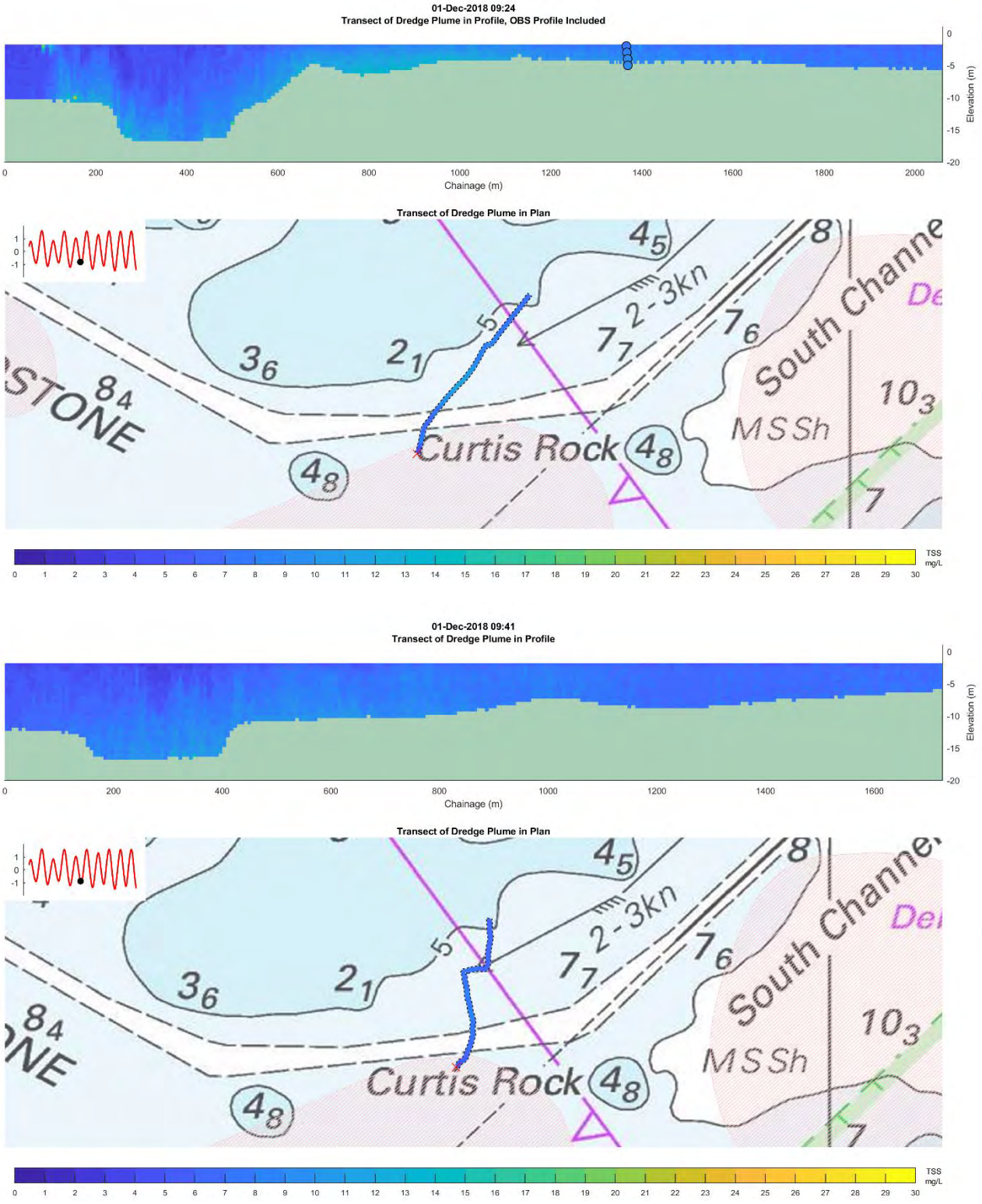
Dredging at Golding Cutting, 1st December 2018



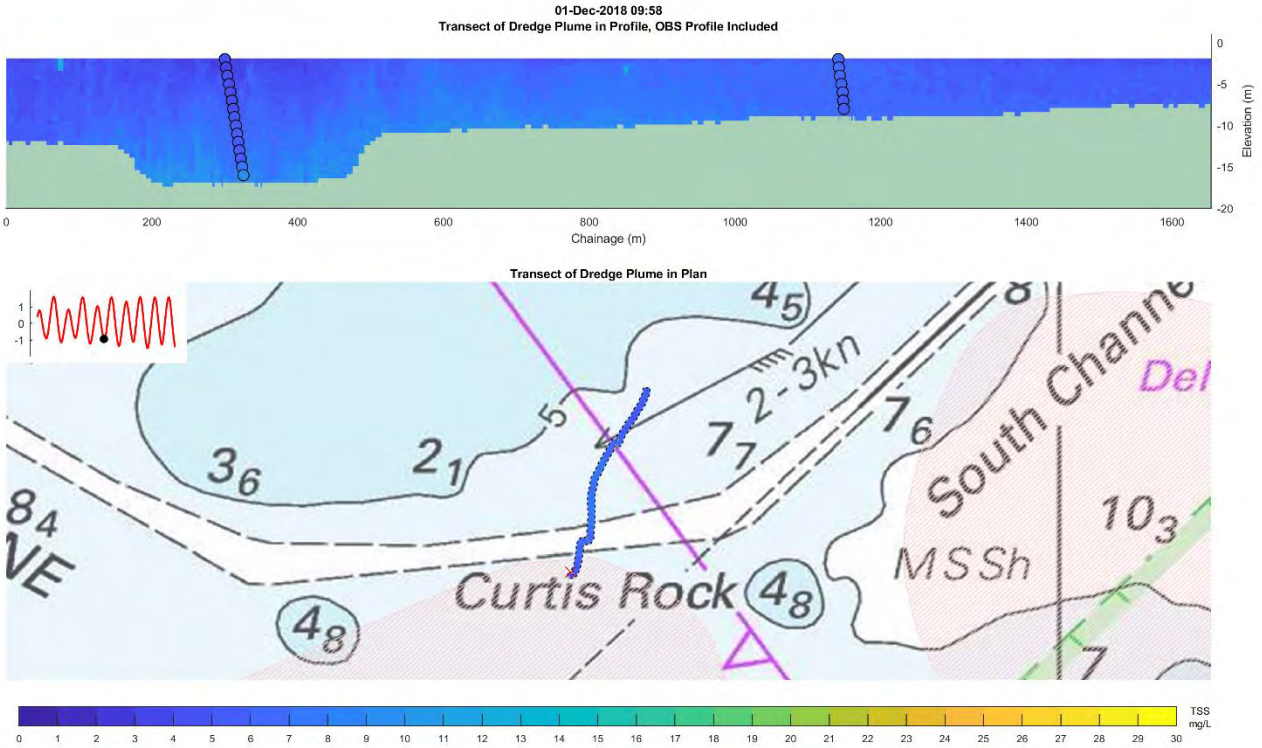
Dredging at Golding Cutting, 1st December 2018



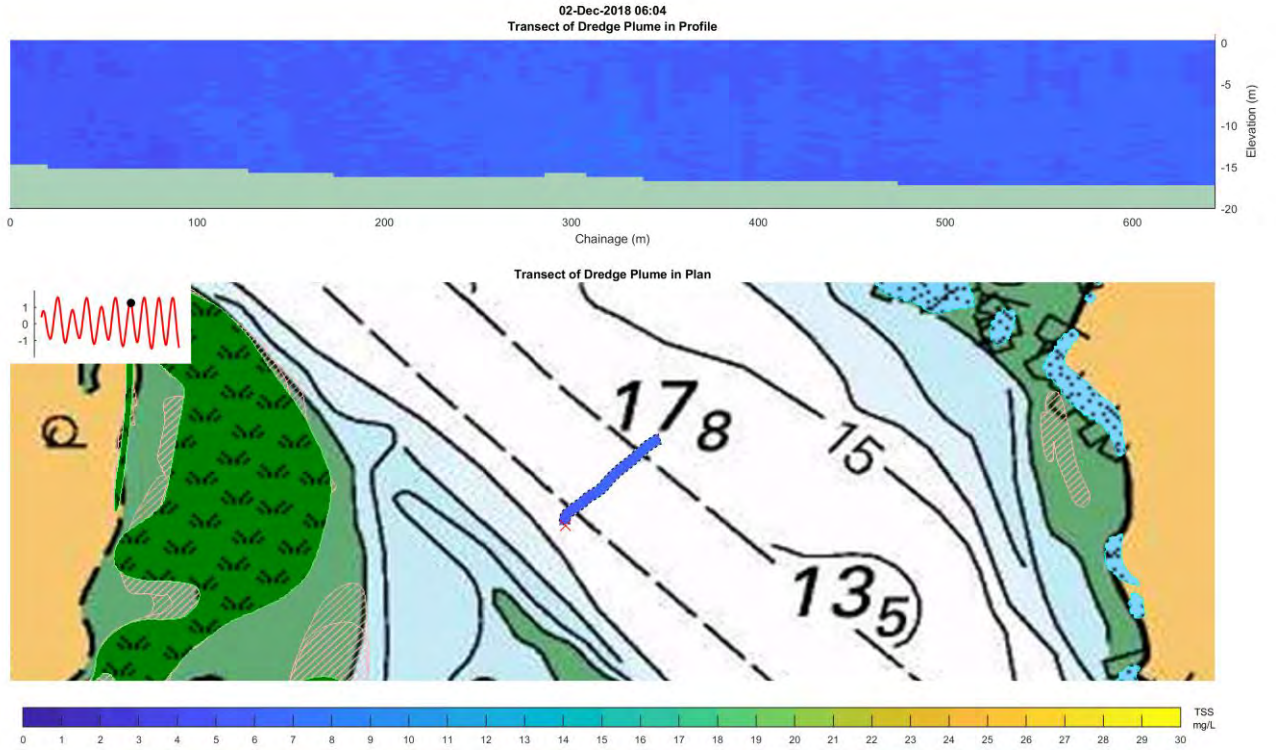
Dredging at Golding Cutting, 1st December 2018

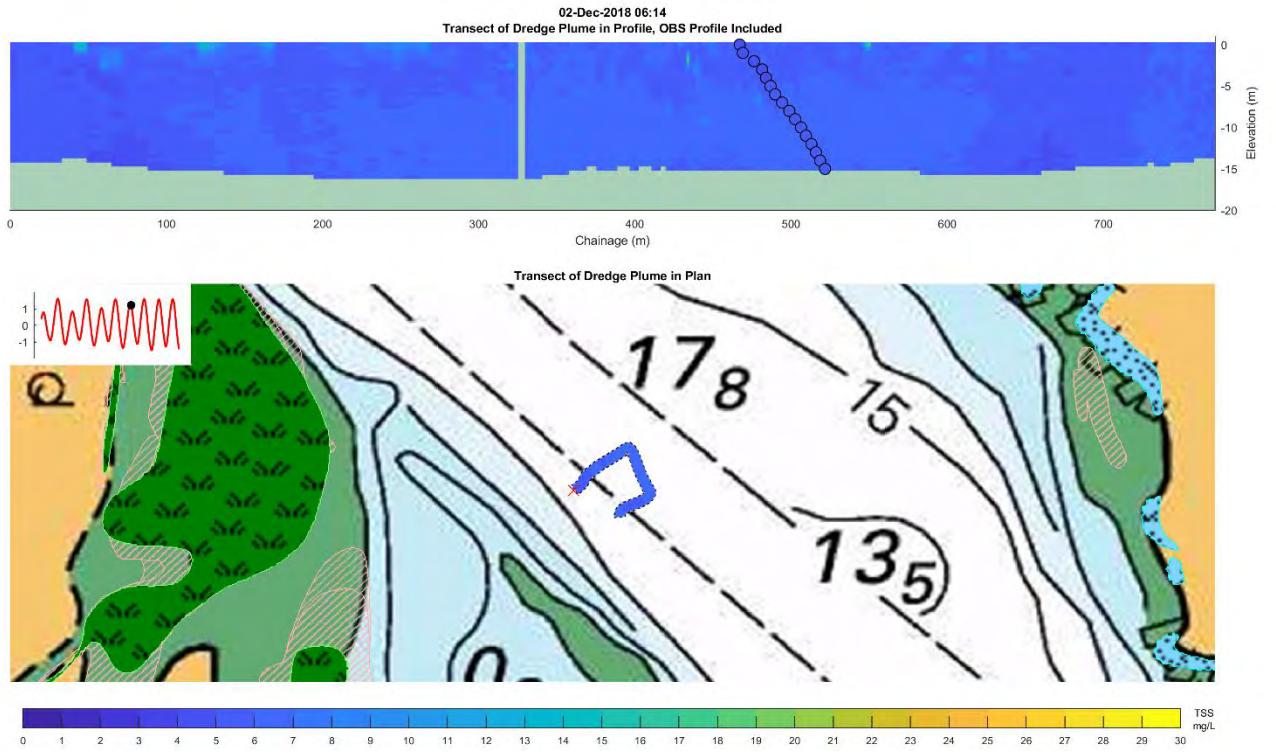


Dredging at Golding Cutting, 1st December 2018

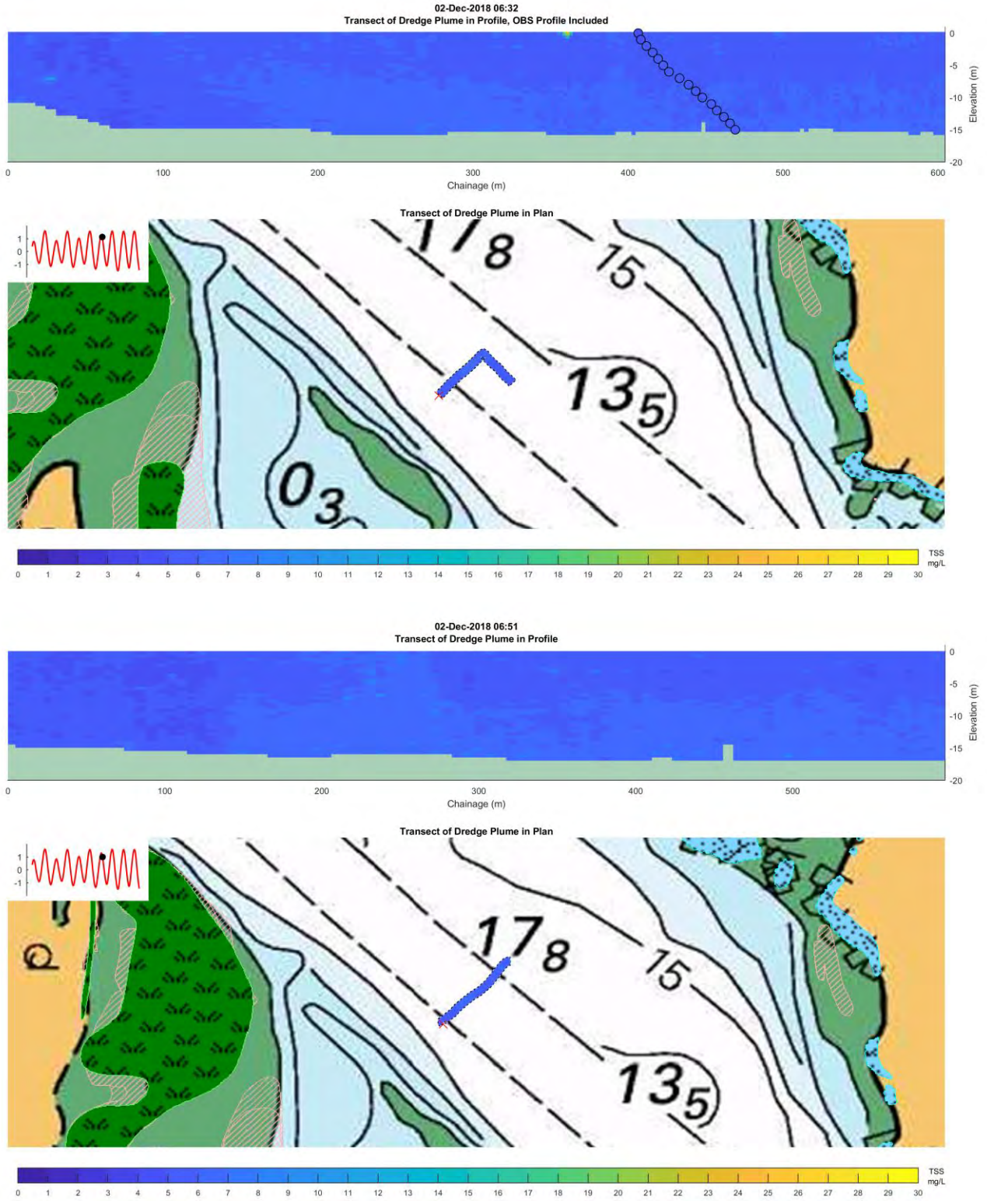


Appendix E Dredging at Gatcombe Channel, 2nd December 2018

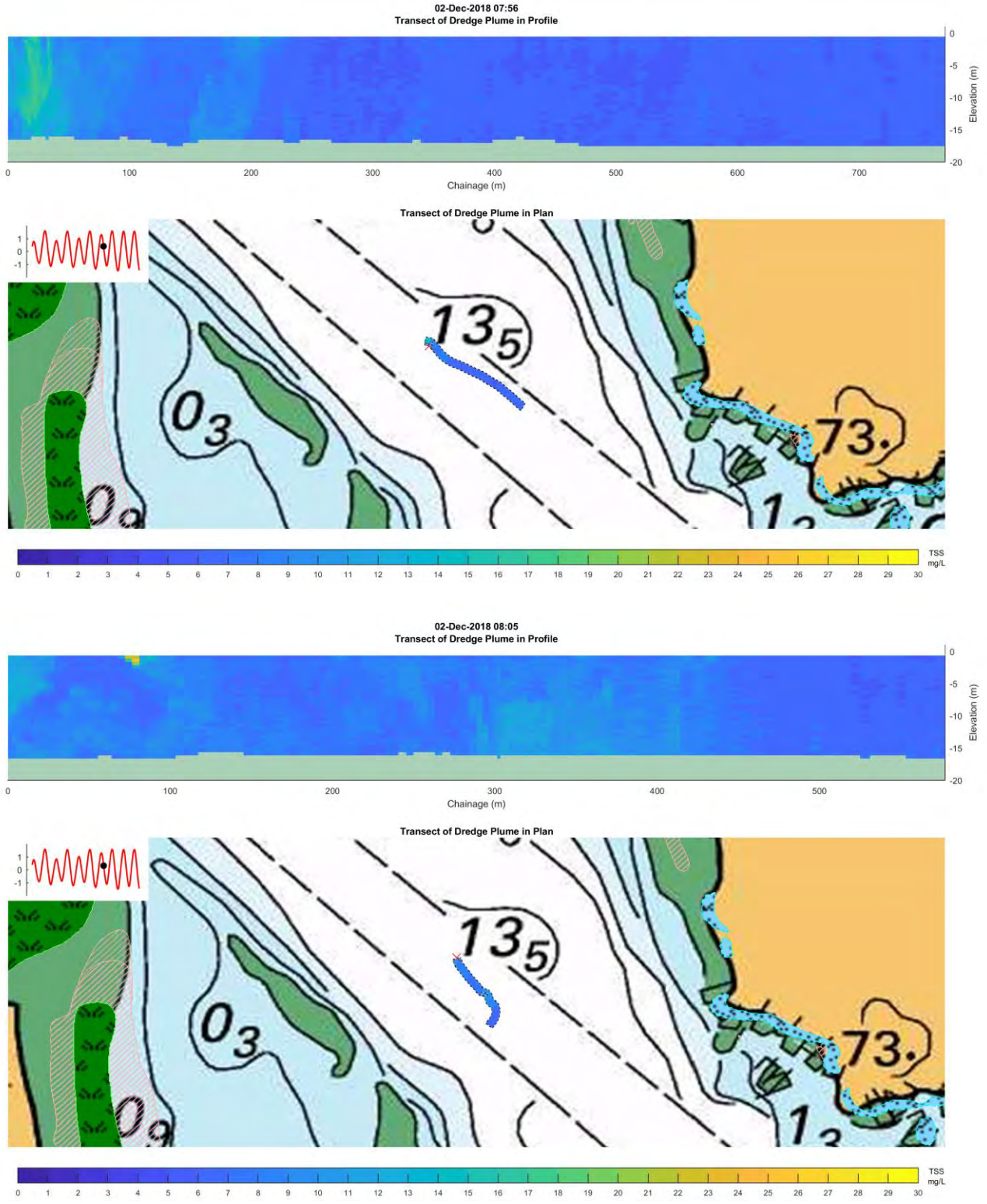




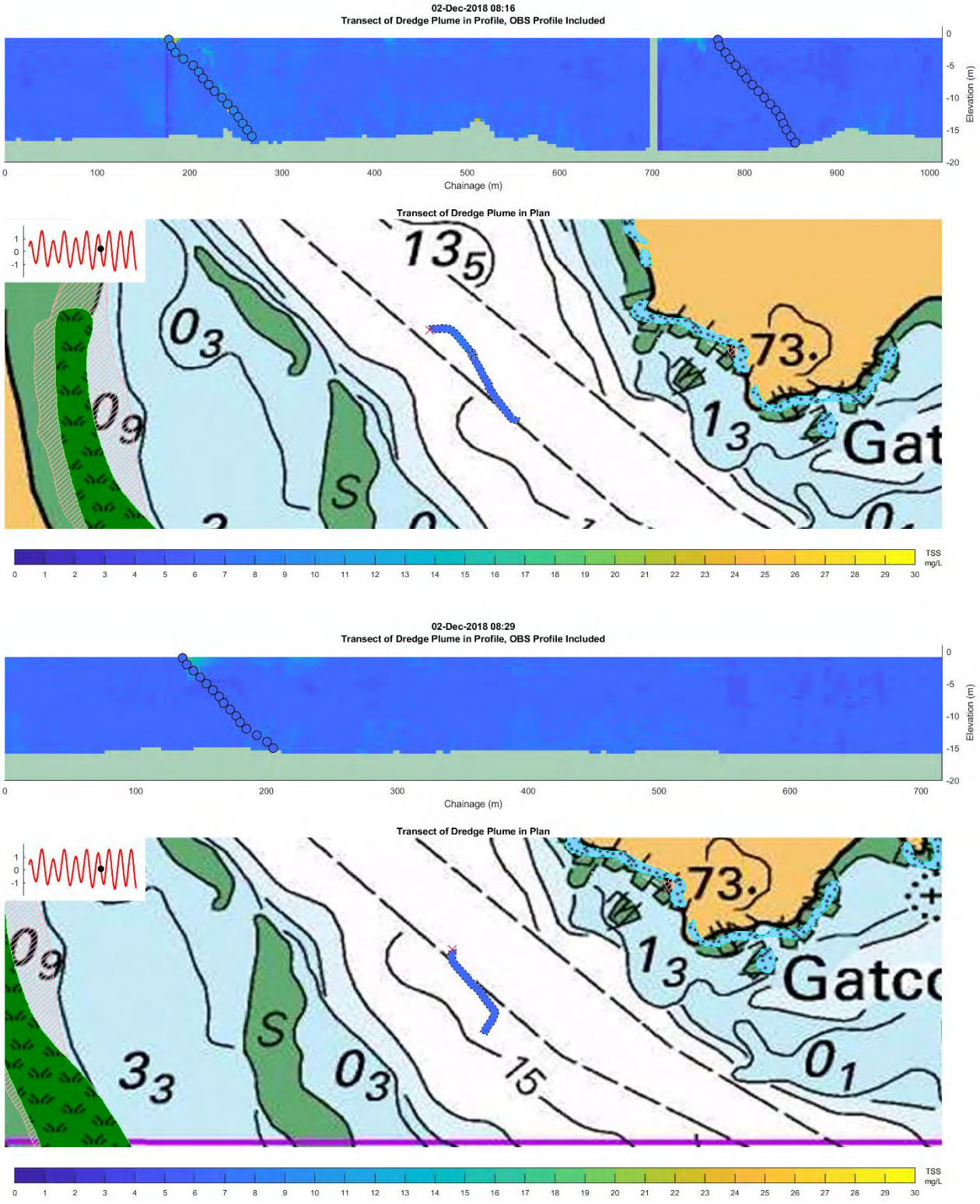
Dredging at Gatcombe Channel, 2nd December 2018



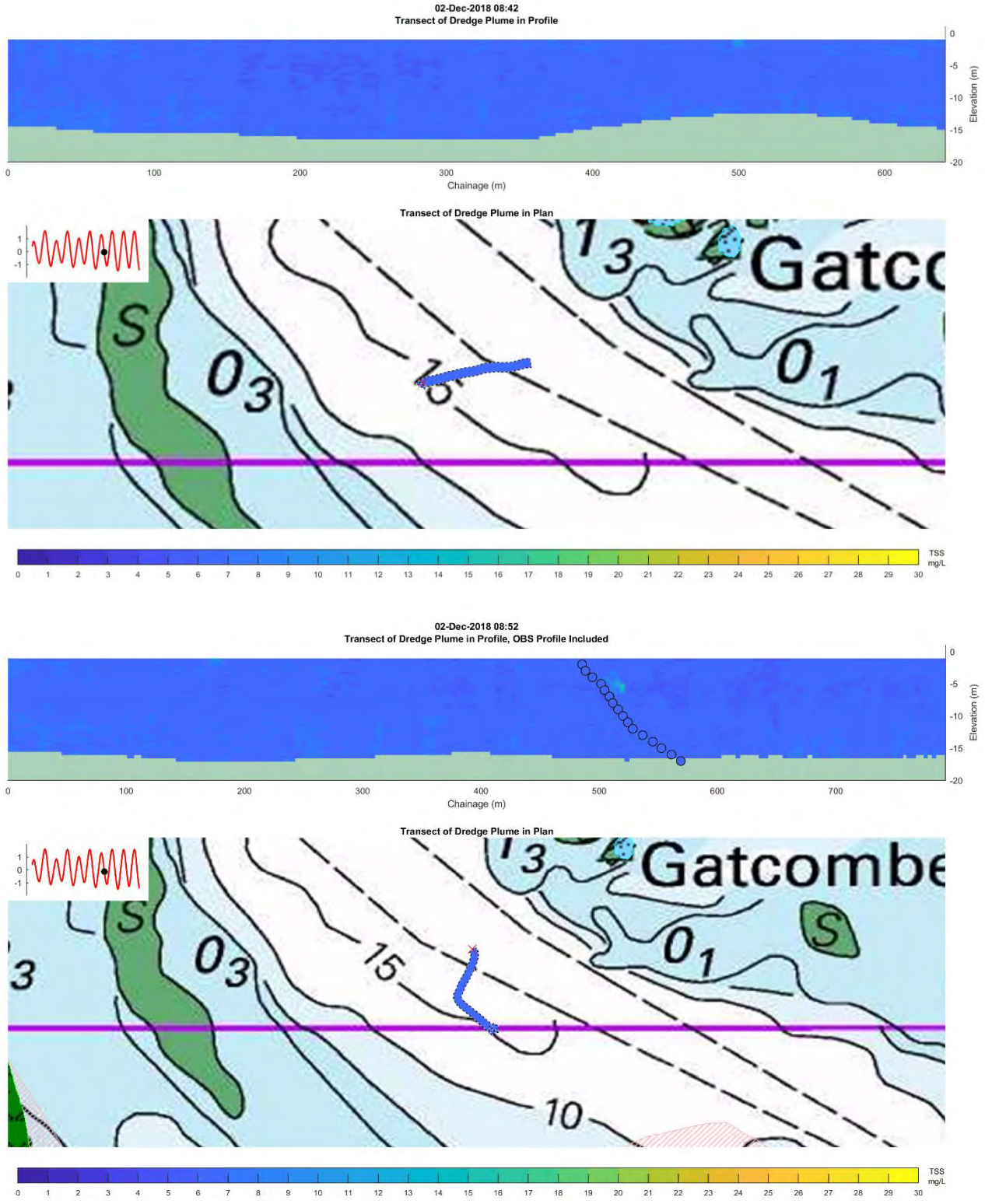
Dredging at Gatcombe Channel, 2nd December 2018



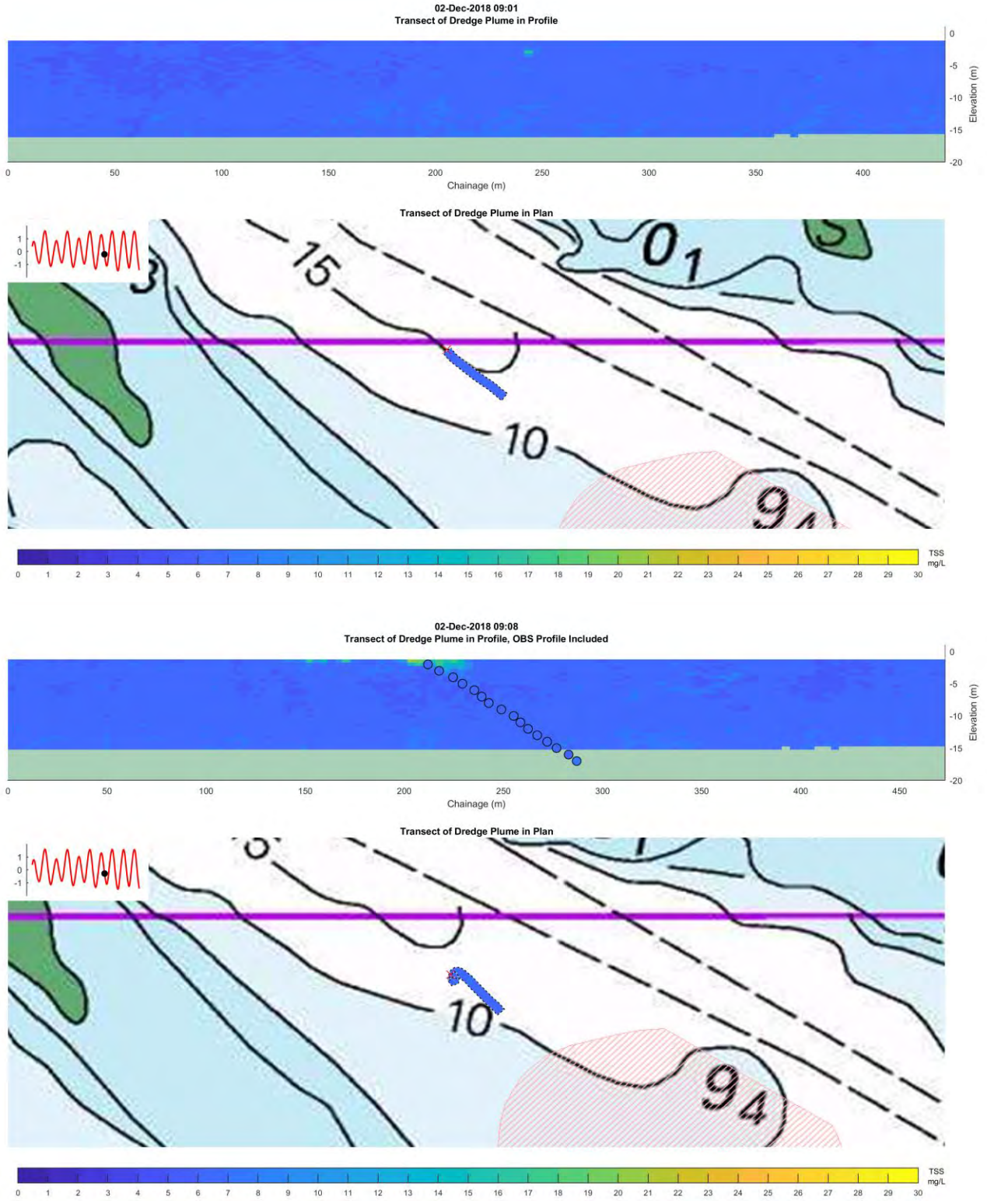
Dredging at Gatcombe Channel, 2nd December 2018



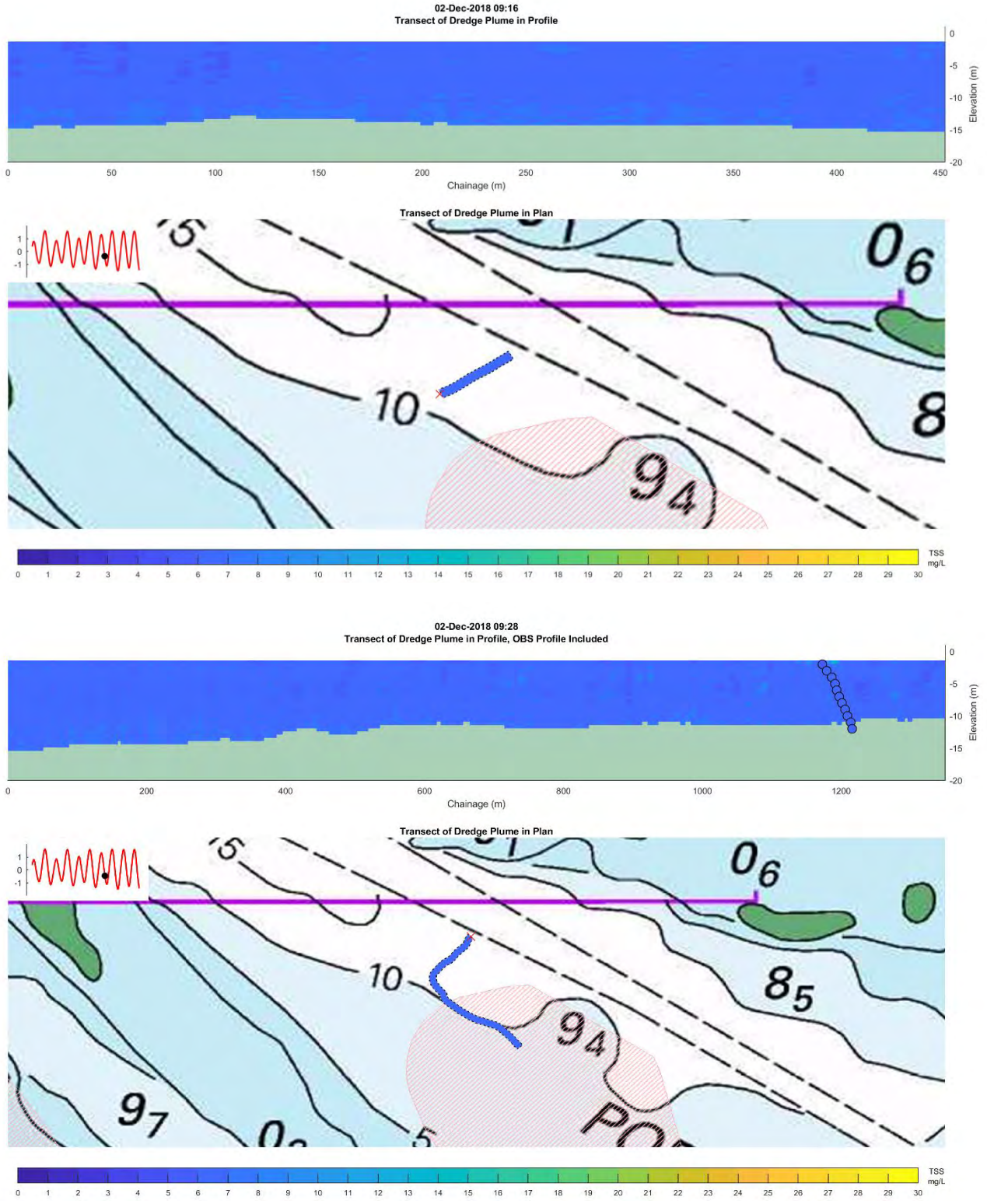
Dredging at Gatcombe Channel, 2nd December 2018

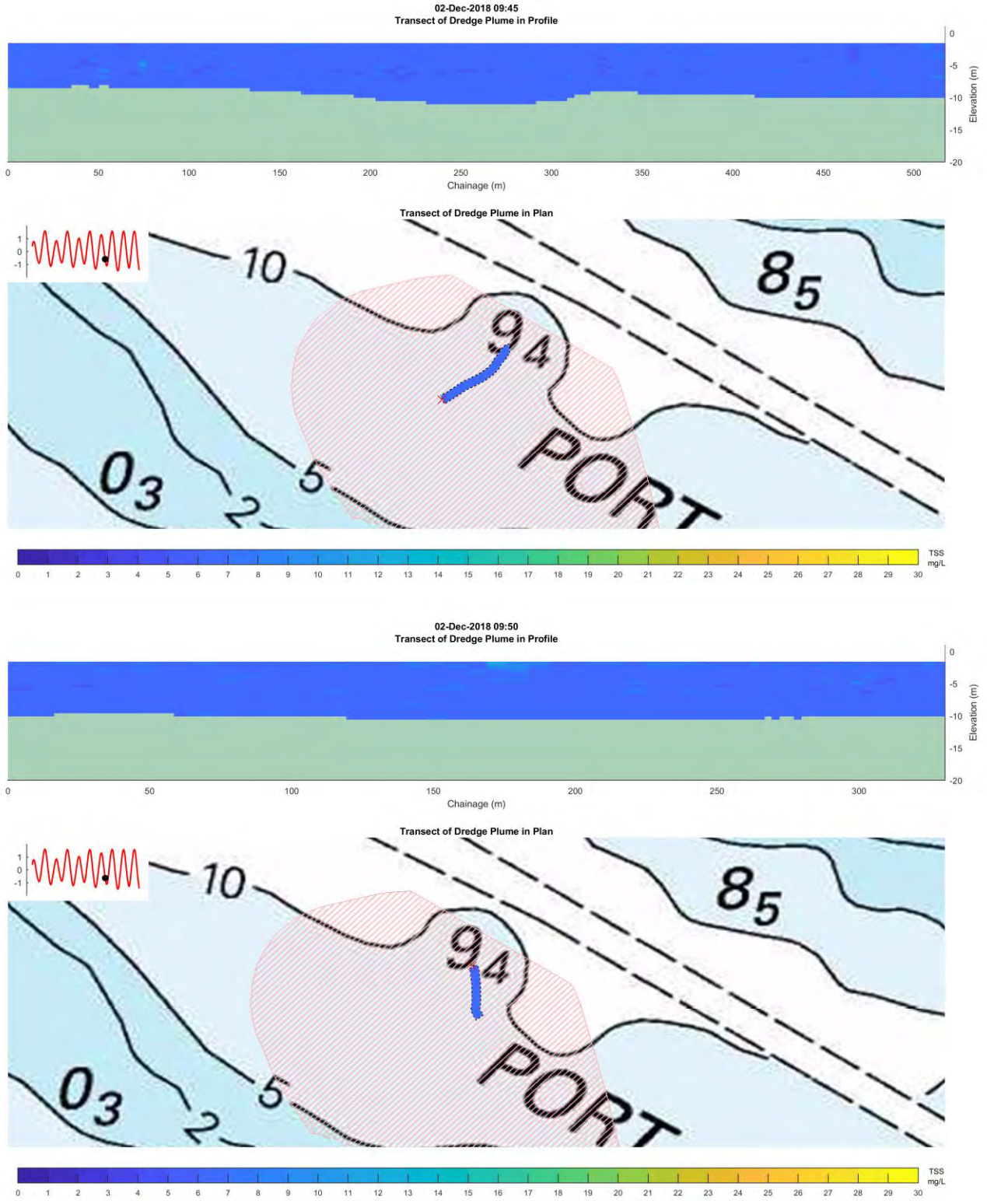


Dredging at Gatcombe Channel, 2nd December 2018

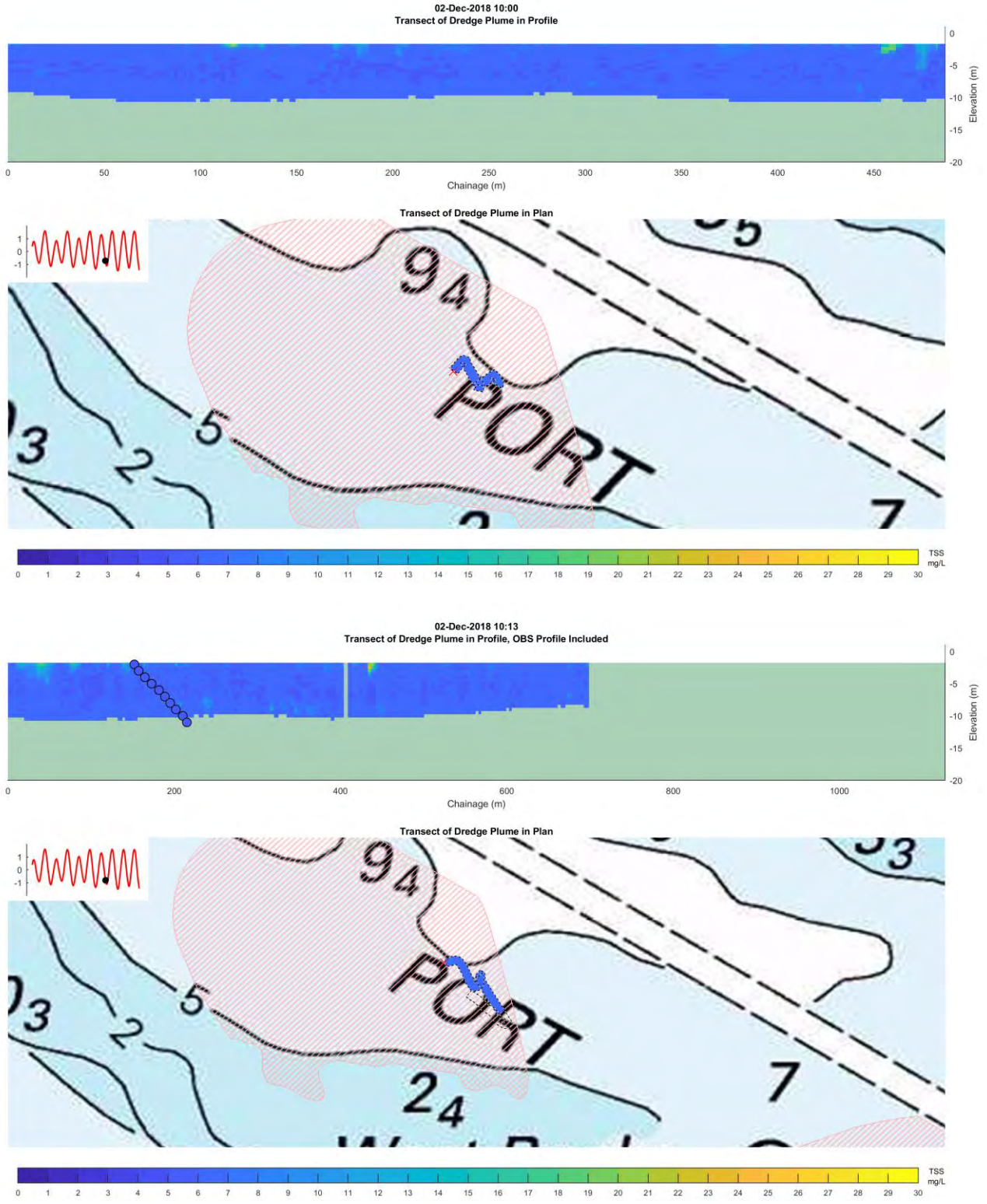


Dredging at Gatcombe Channel, 2nd December 2018

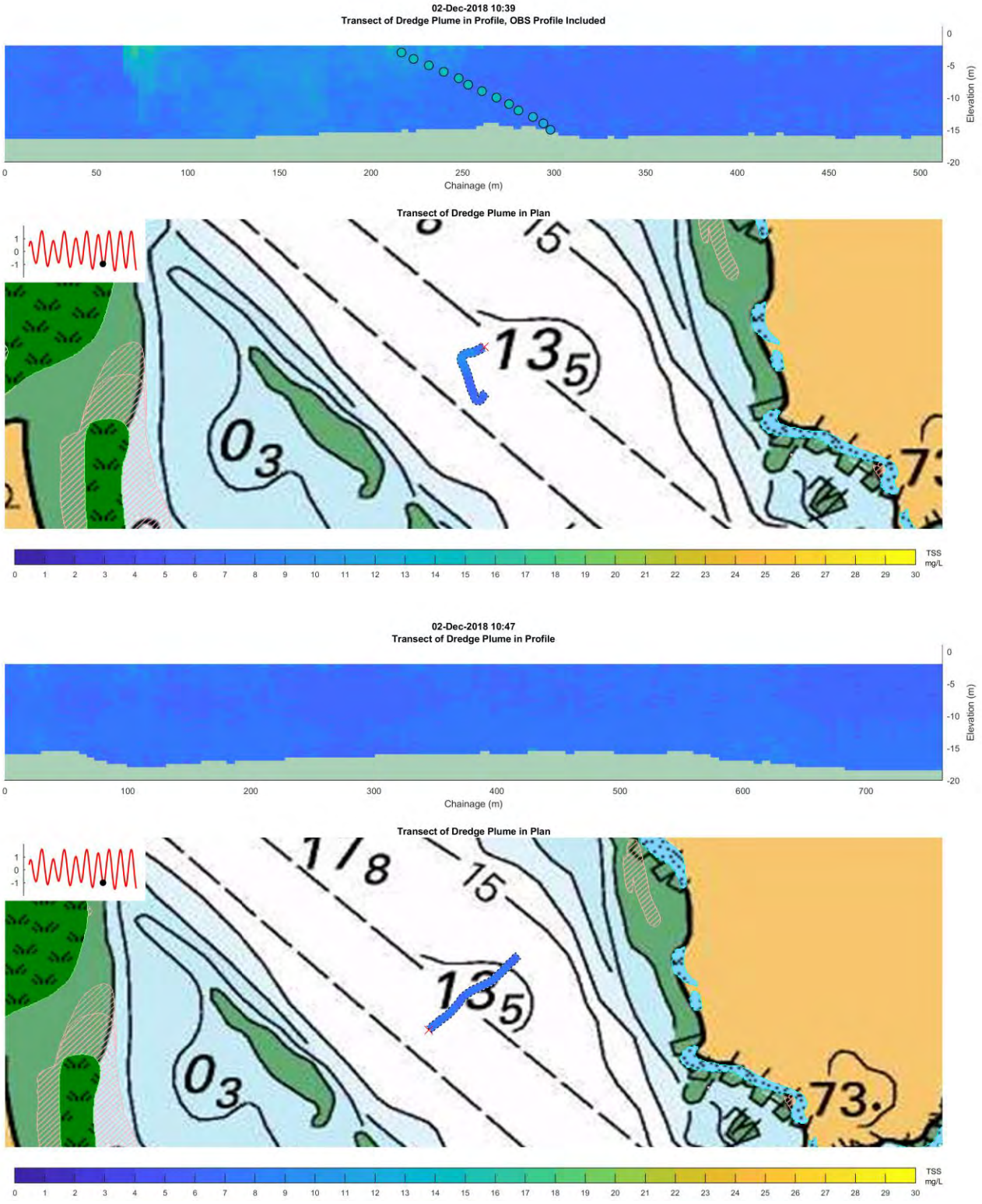



02-Dec-2018 09:45
Transect of Dredge Plume in Profile
Elevation (m)
Chainage (m)
Transect of Dredge Plume in Plan
10
8
5
9
4
0
3
2
5
PORT
TSS
mg/L
02-Dec-2018 09:50
Transect of Dredge Plume in Profile
Elevation (m)
Chainage (m)
Transect of Dredge Plume in Plan
10
8
5
9
4
0
3
2
5
PORT
TSS
mg/L

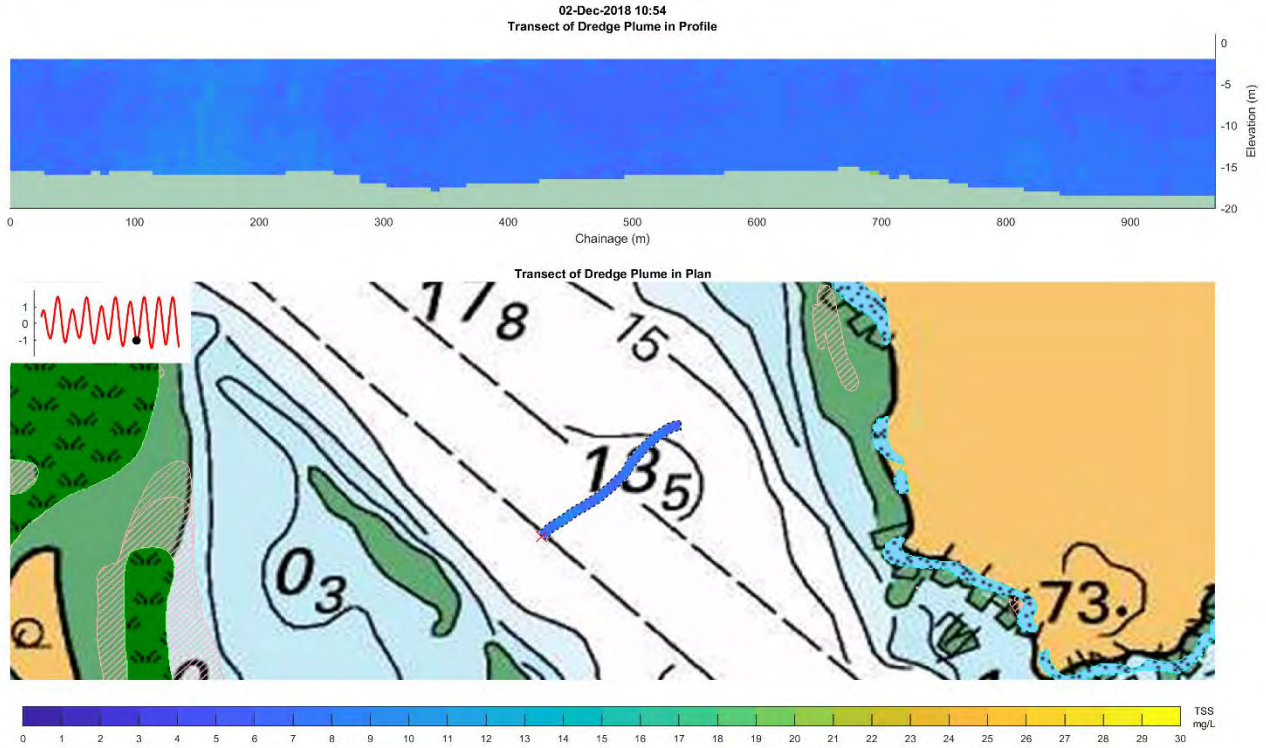
Dredging at Gatcombe Channel, 2nd December 2018

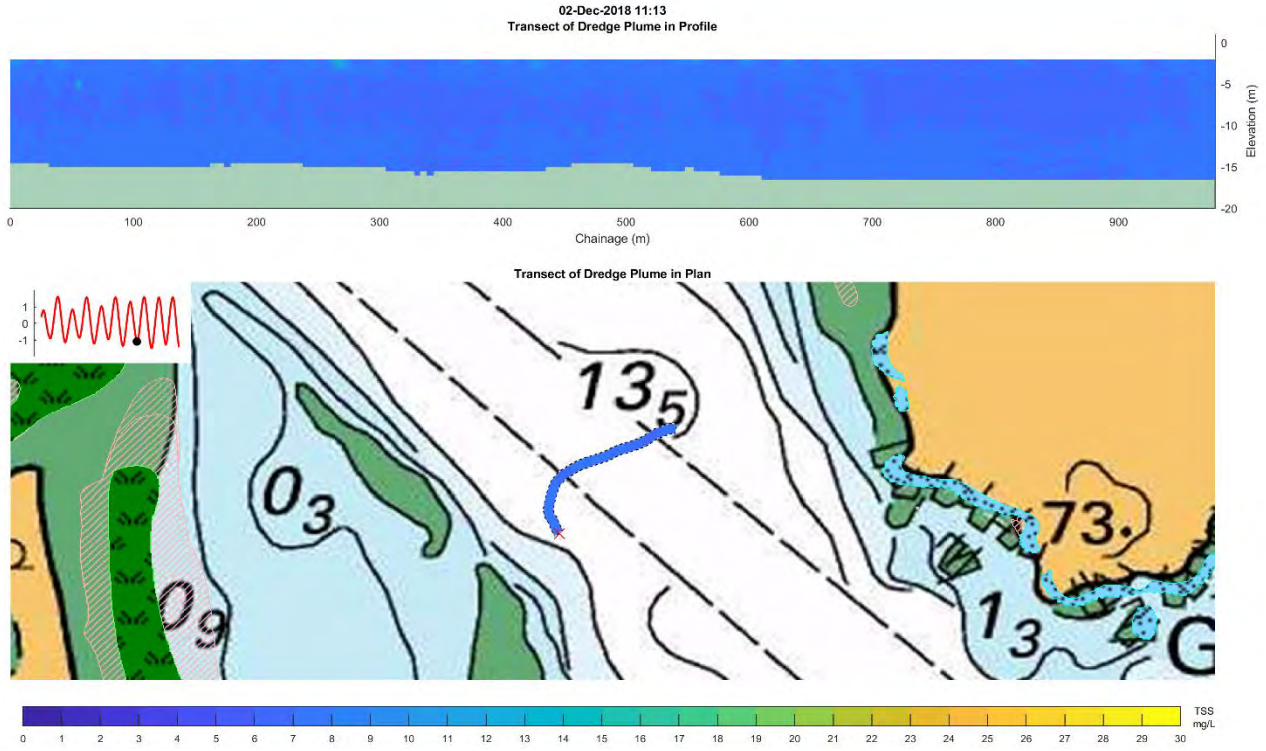


Dredging at Gatcombe Channel, 2nd December 2018

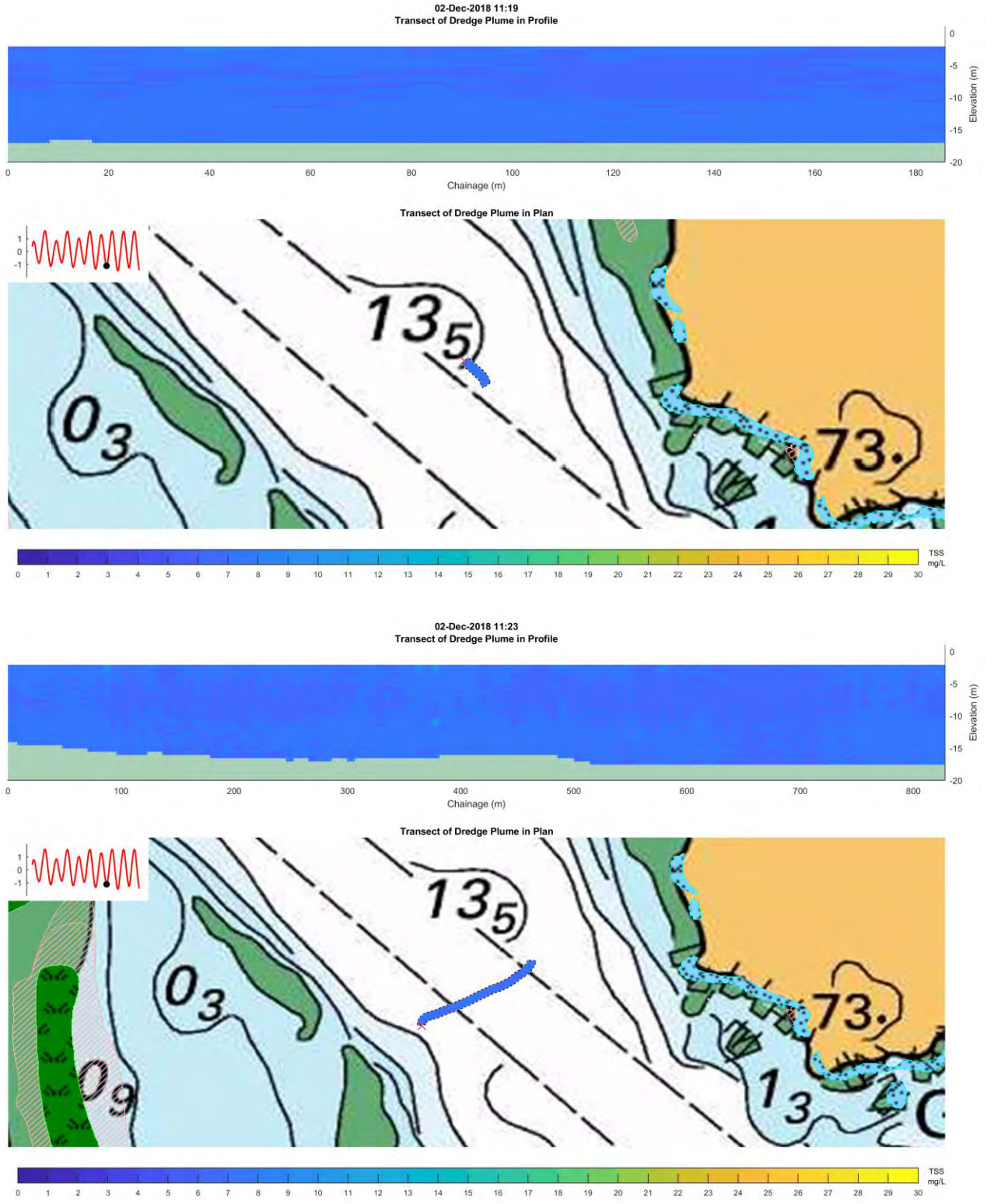


Dredging at Gatcombe Channel, 2nd December 2018

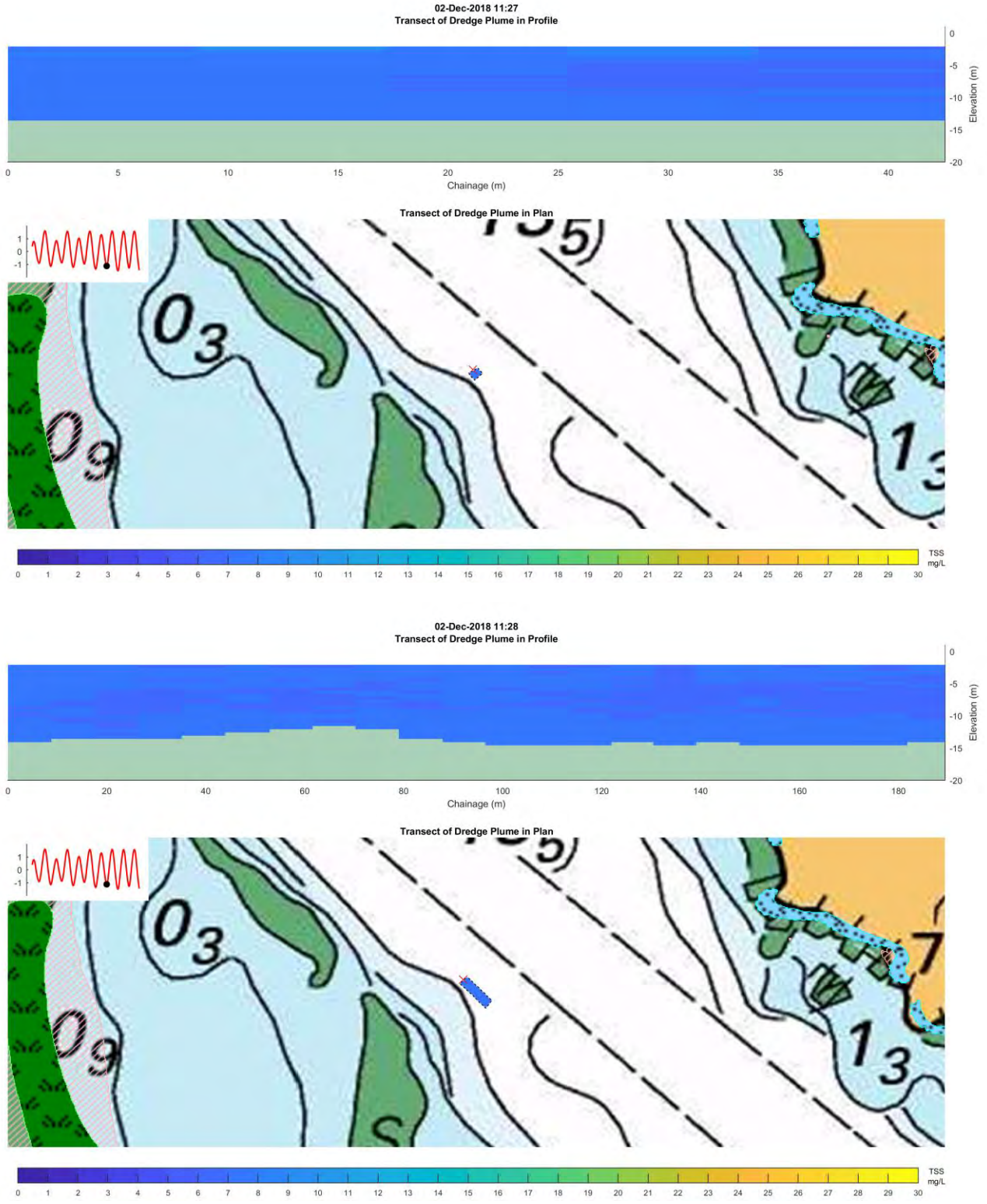




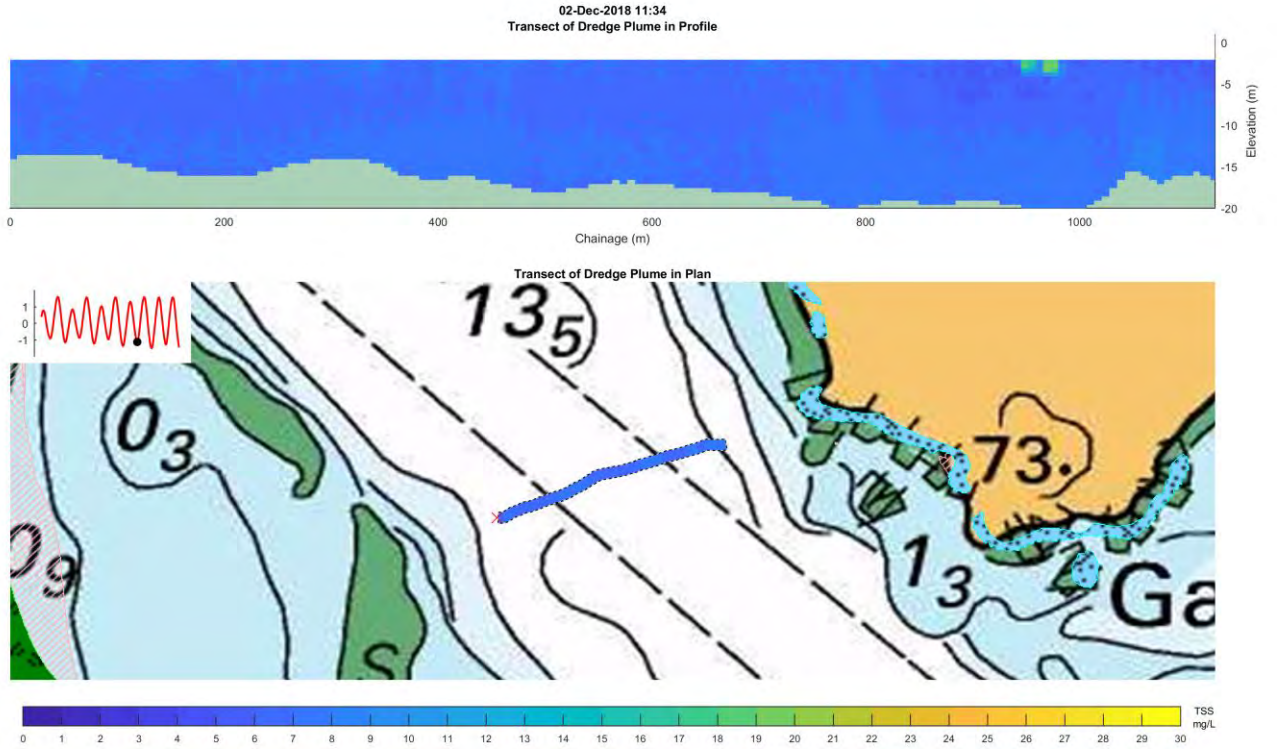
Dredging at Gatcombe Channel, 2nd December 2018



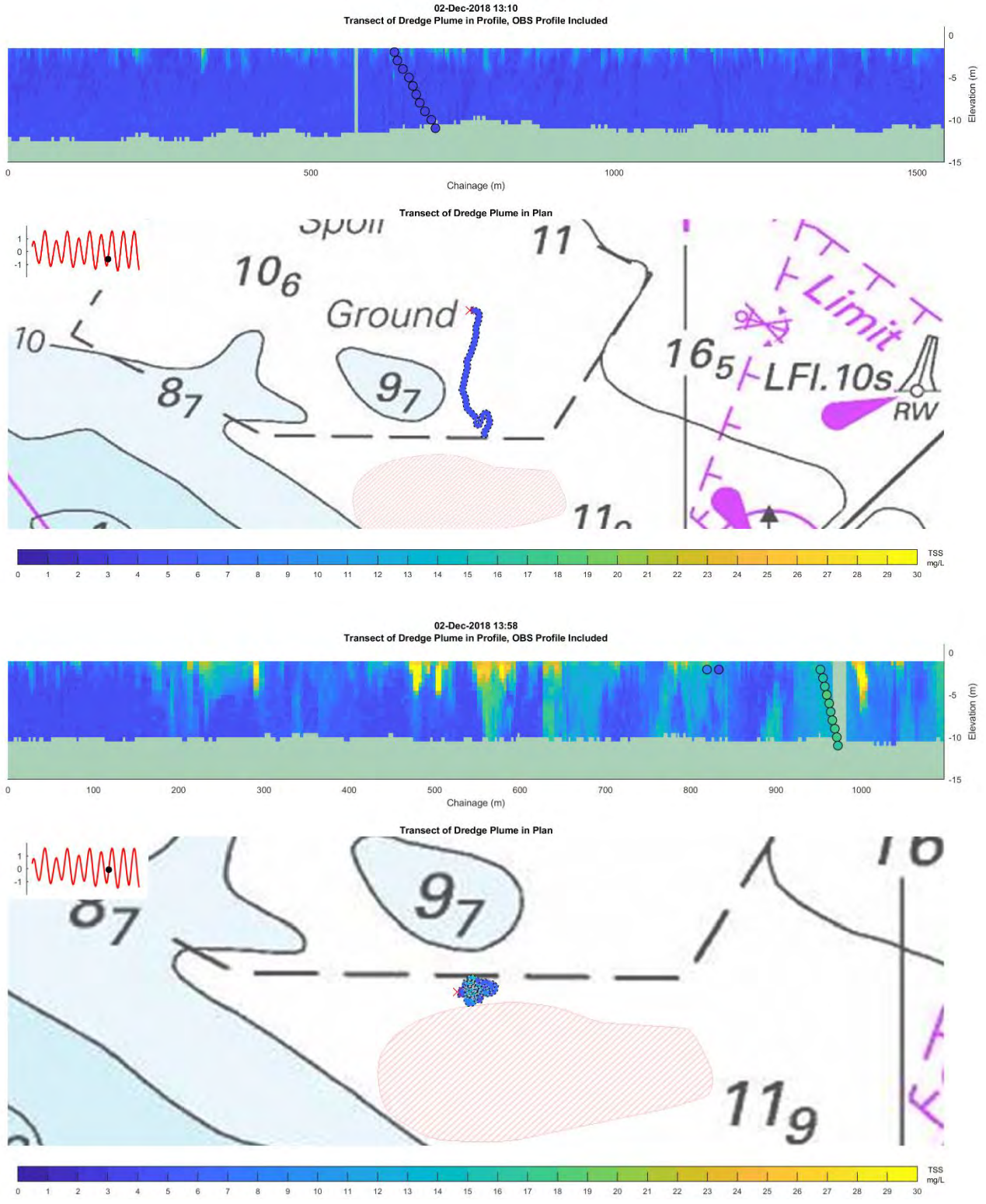
Dredging at Gatcombe Channel, 2nd December 2018



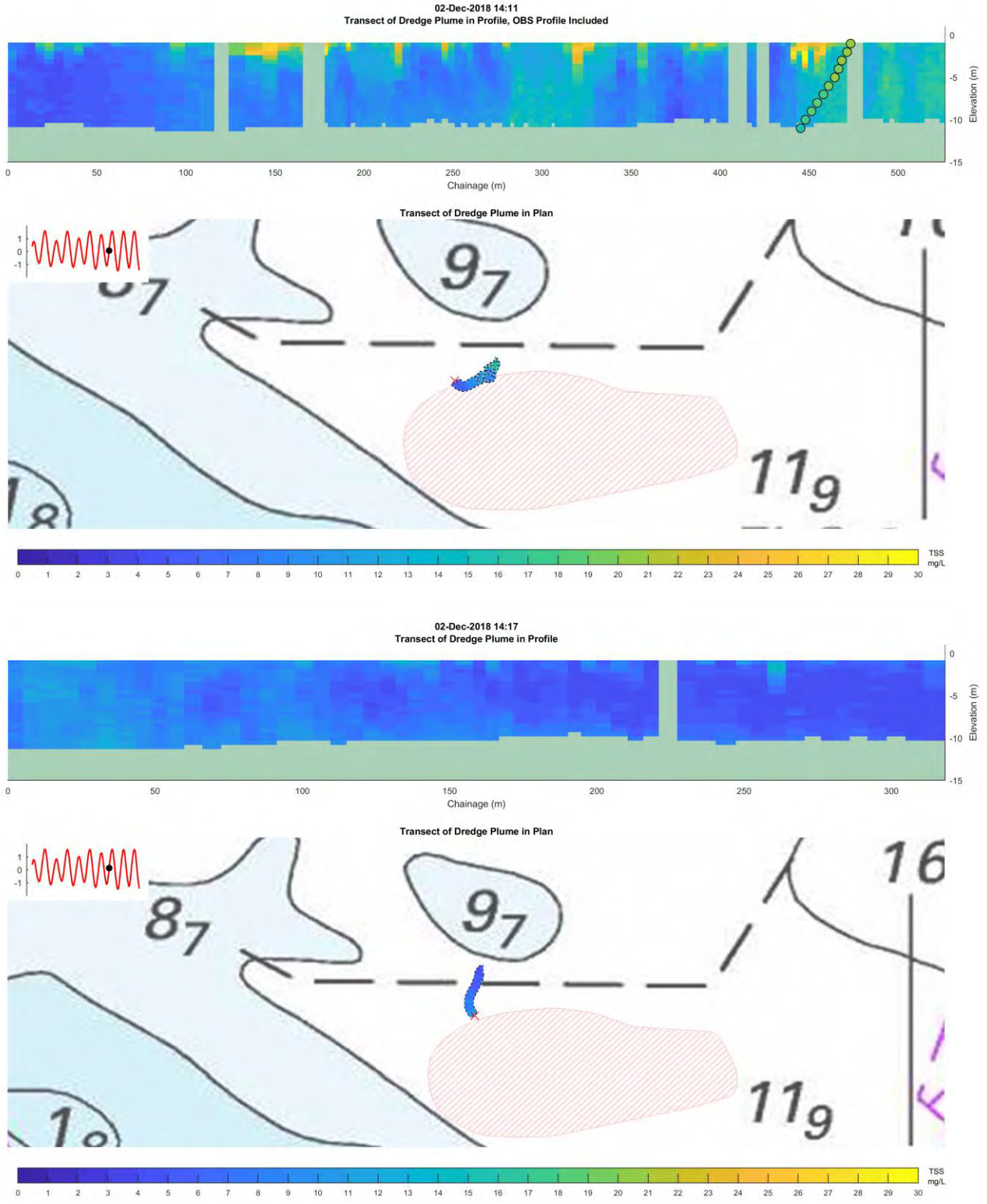
Dredging at Gatcombe Channel, 2nd December 2018



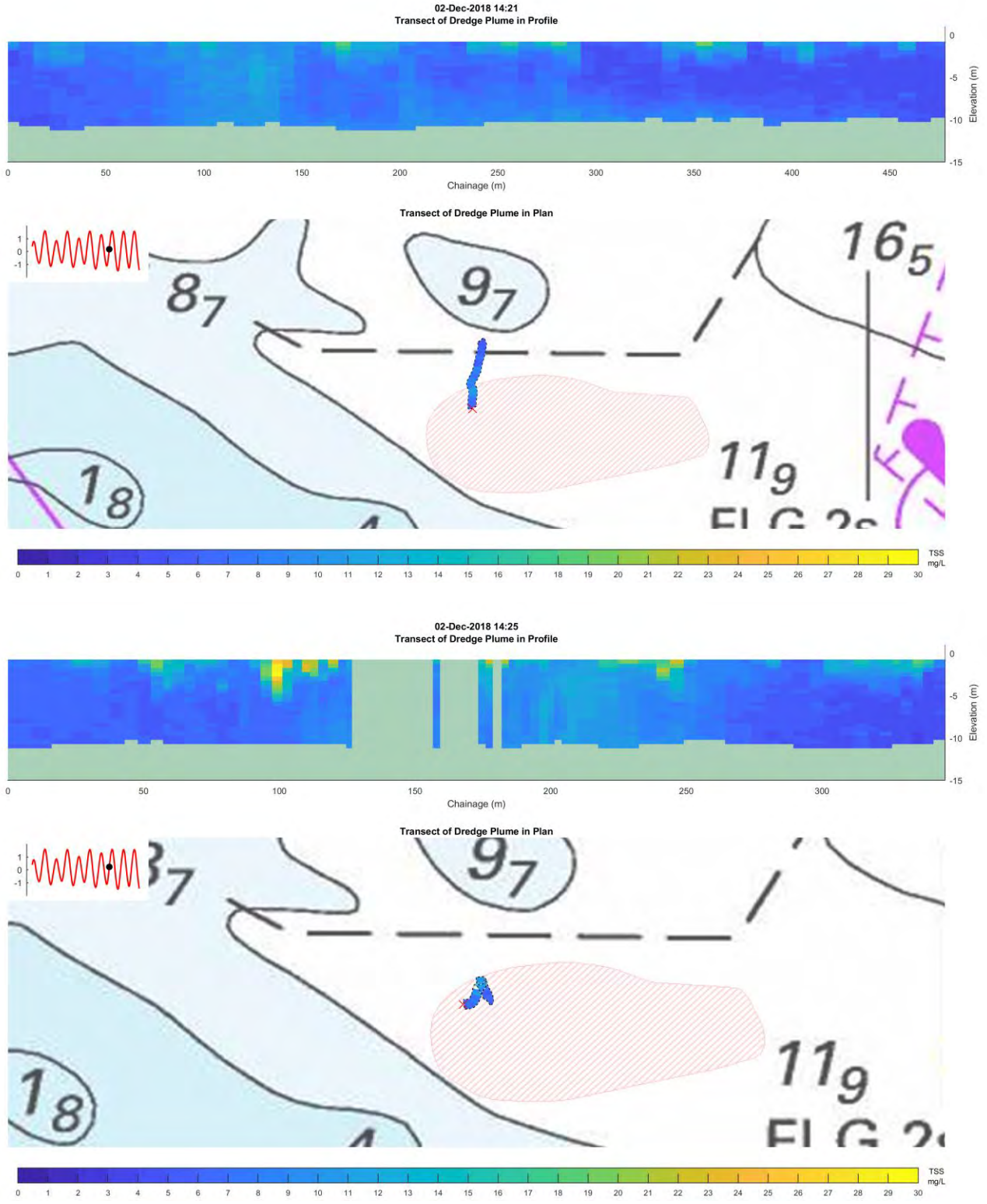
Appendix F Placement at EBSD

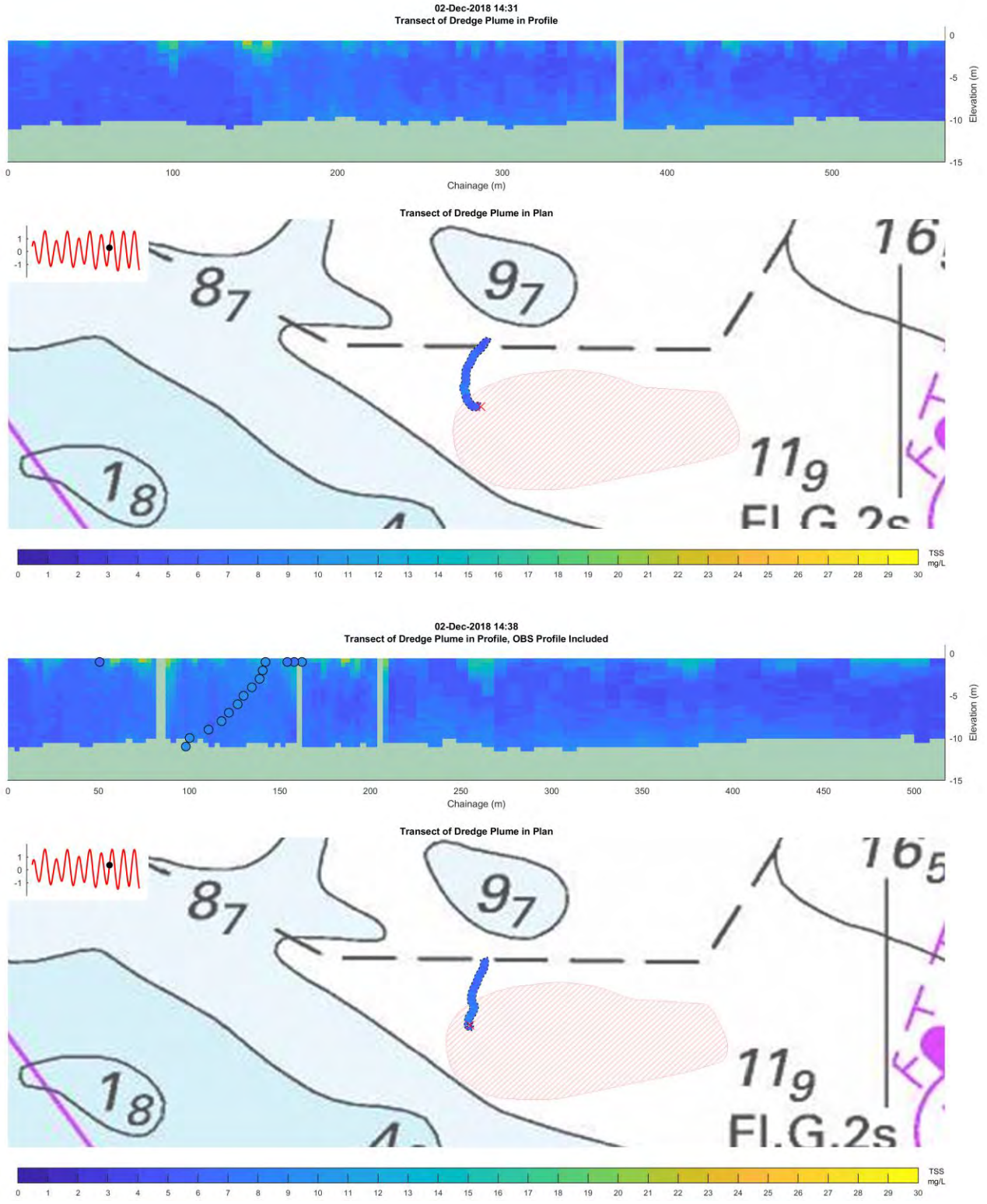


Placement at EBSD

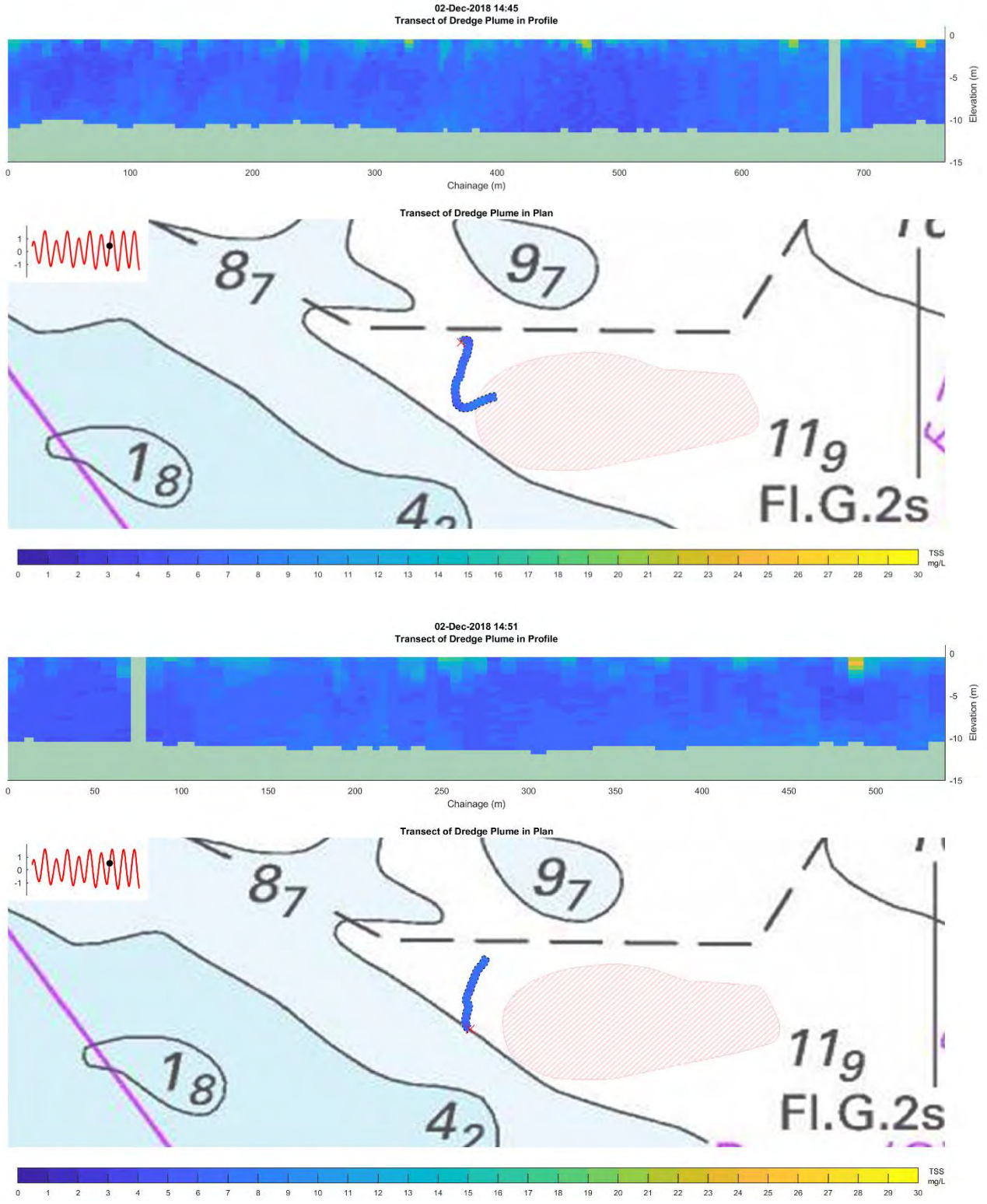


Placement at EBSD

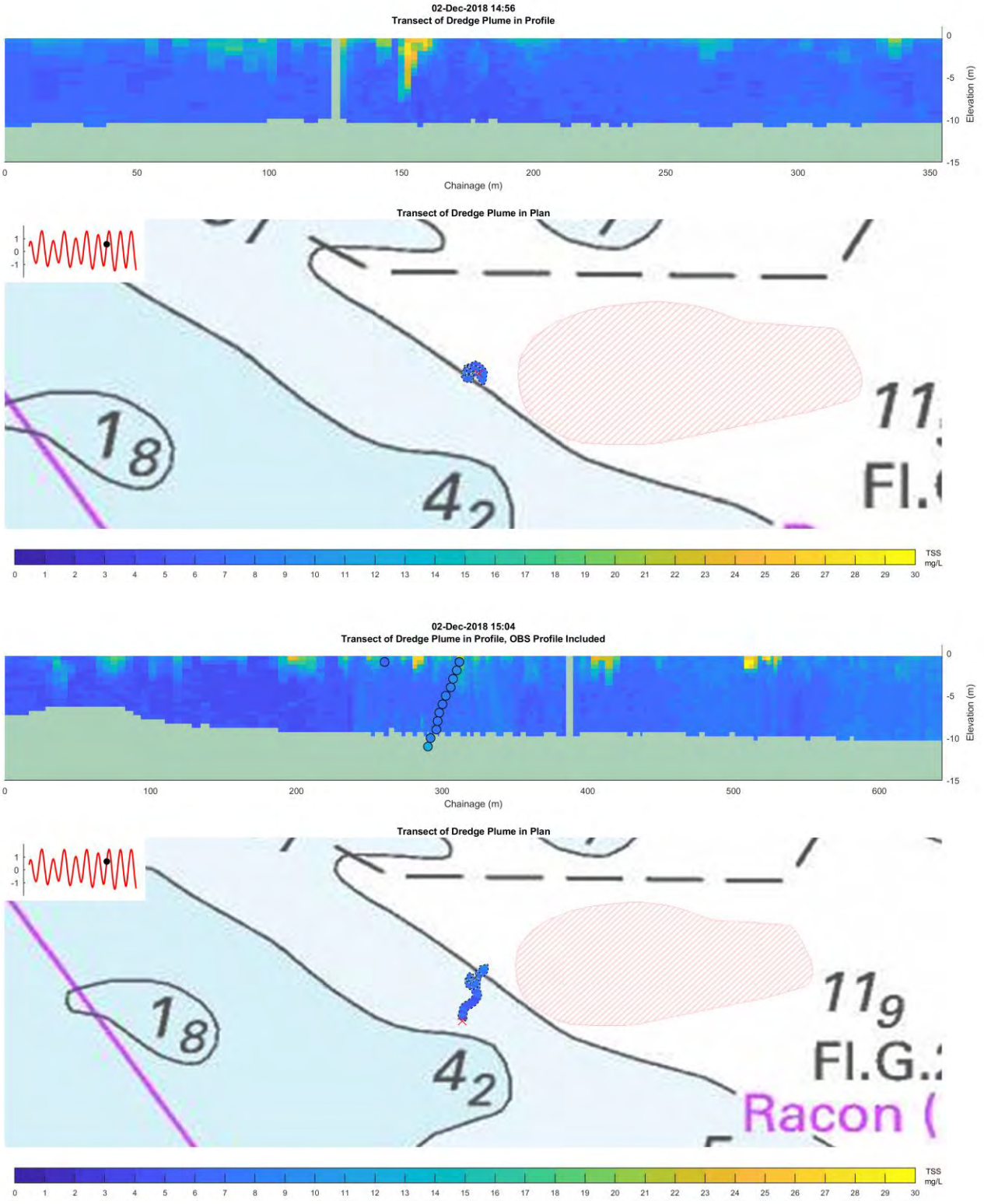



02-Dec-2018 14:31
Transect of Dredge Plume in Profile
Elevation (m)
Chainage (m)
Transect of Dredge Plume in Plan
TSS mg/L
02-Dec-2018 14:38
Transect of Dredge Plume in Profile, OBS Profile Included
Elevation (m)
Chainage (m)
Transect of Dredge Plume in Plan
TSS mg/L

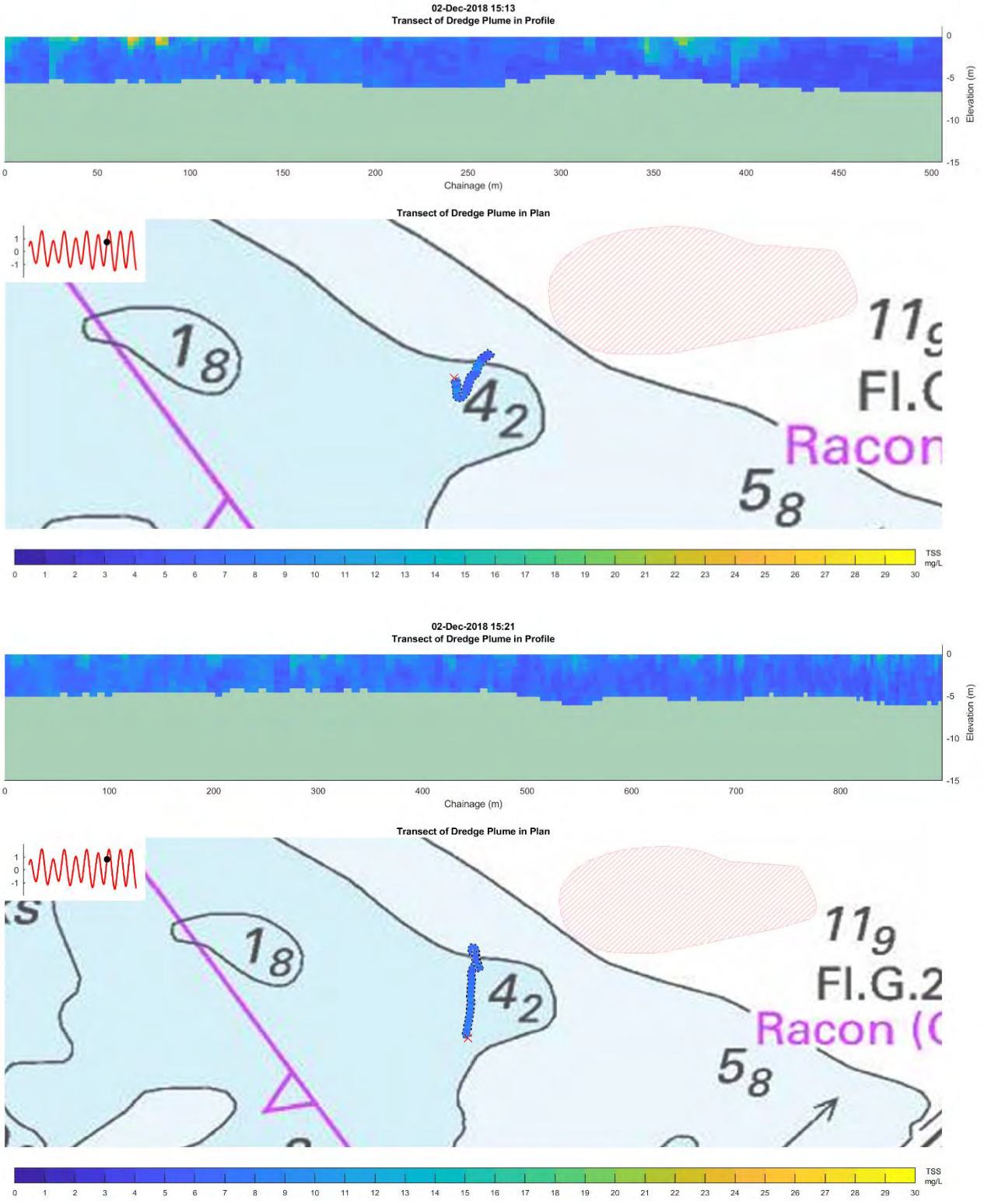
Placement at EBSD



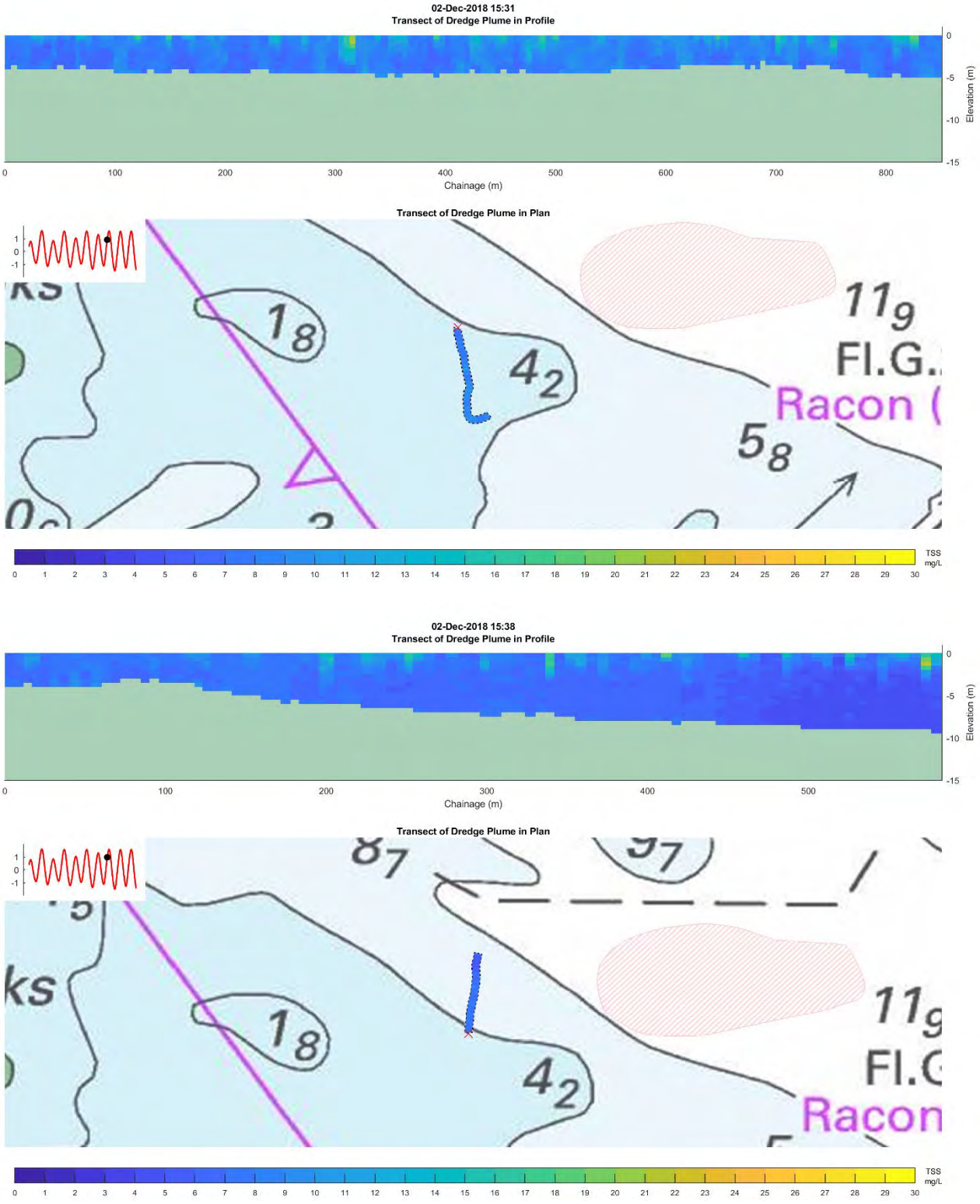
Placement at EBSD

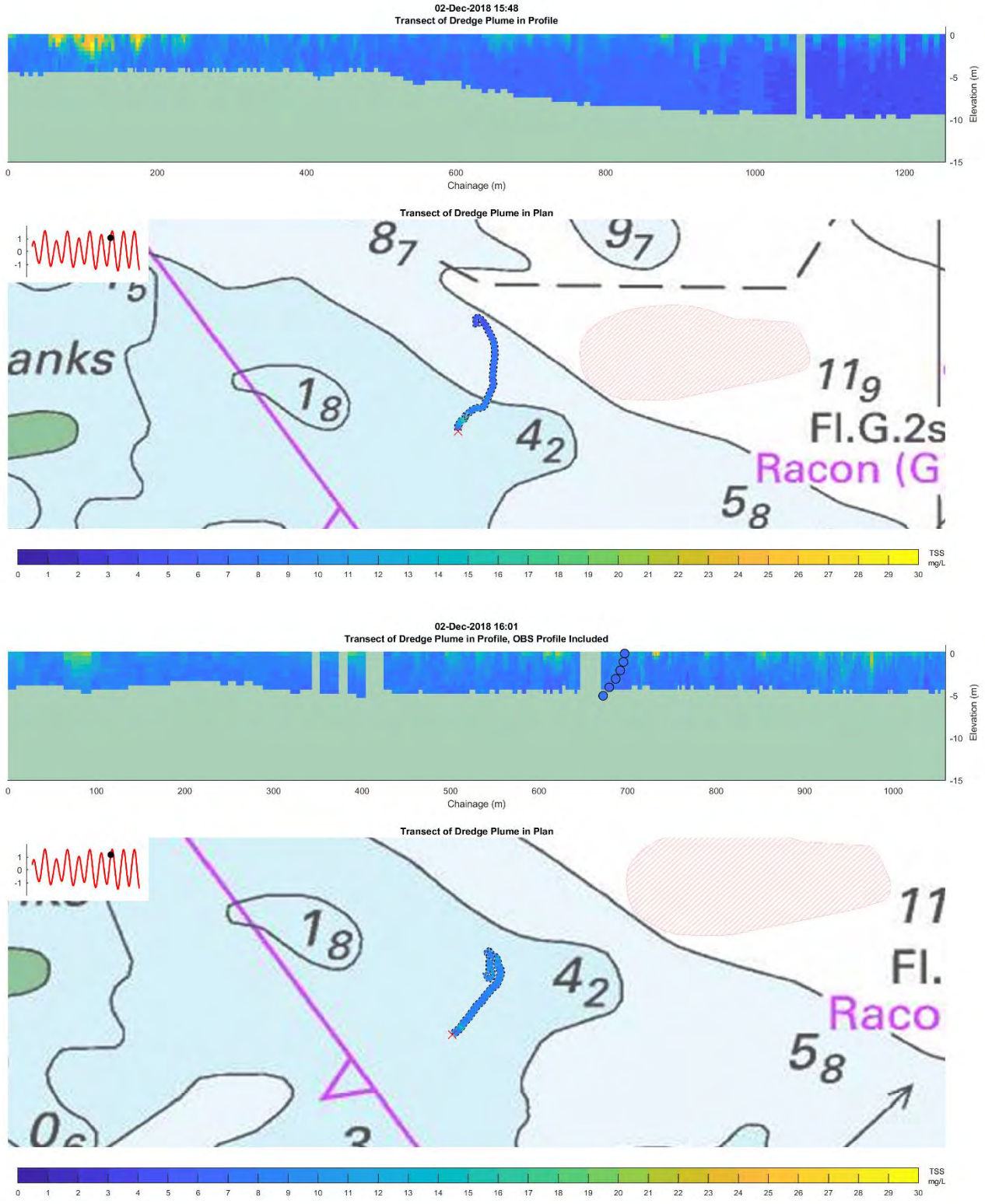


Placement at EBSD

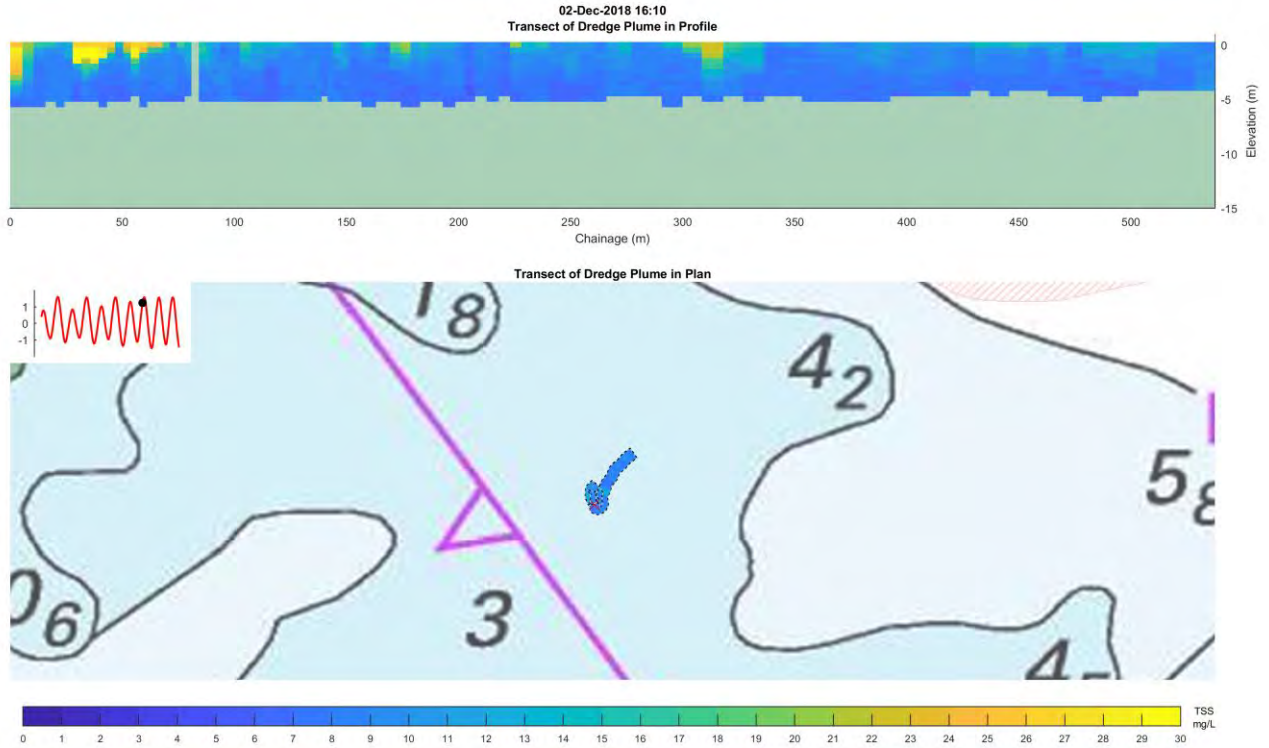


Placement at EBSD

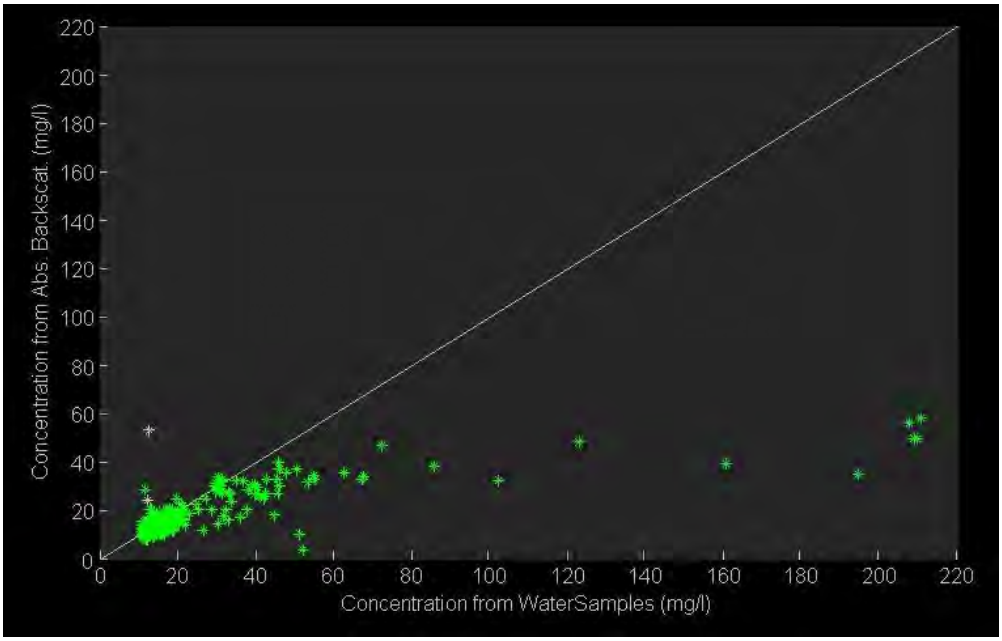


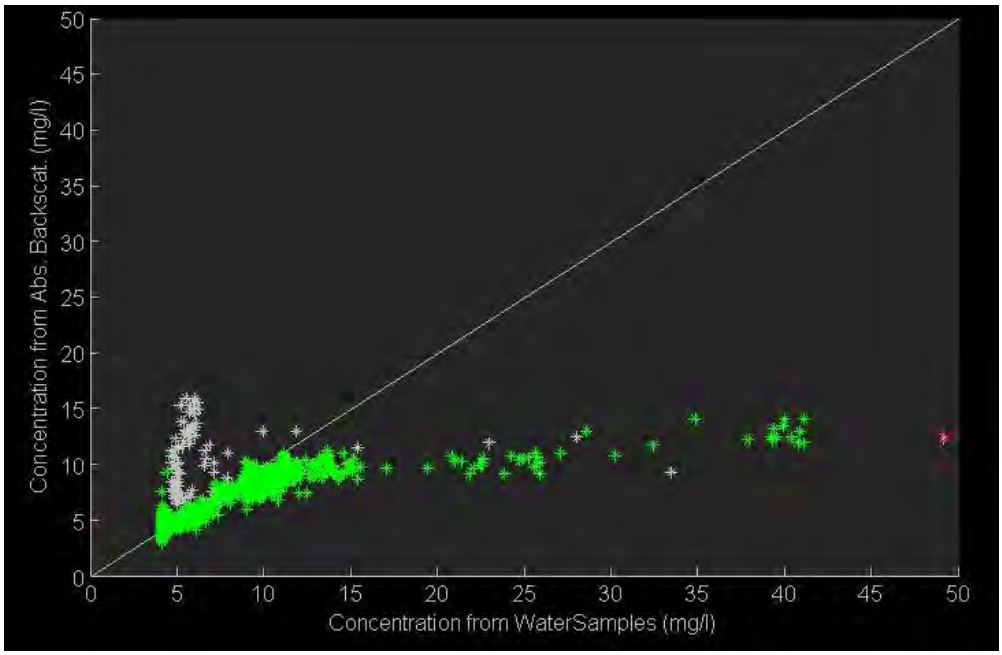

02-Dec-2018 15:48
Transect of Dredge Plume in Profile
Elevation (m)
Chainage (m)
Transect of Dredge Plume in Plan
anks
Fl.G.2s
Racon (G
TSS
mg/L
02-Dec-2018 16:01
Transect of Dredge Plume in Profile, OBS Profile Included
Elevation (m)
Chainage (m)
Transect of Dredge Plume in Plan
Fl.
Raco
TSS
mg/L

Placement at EBSD

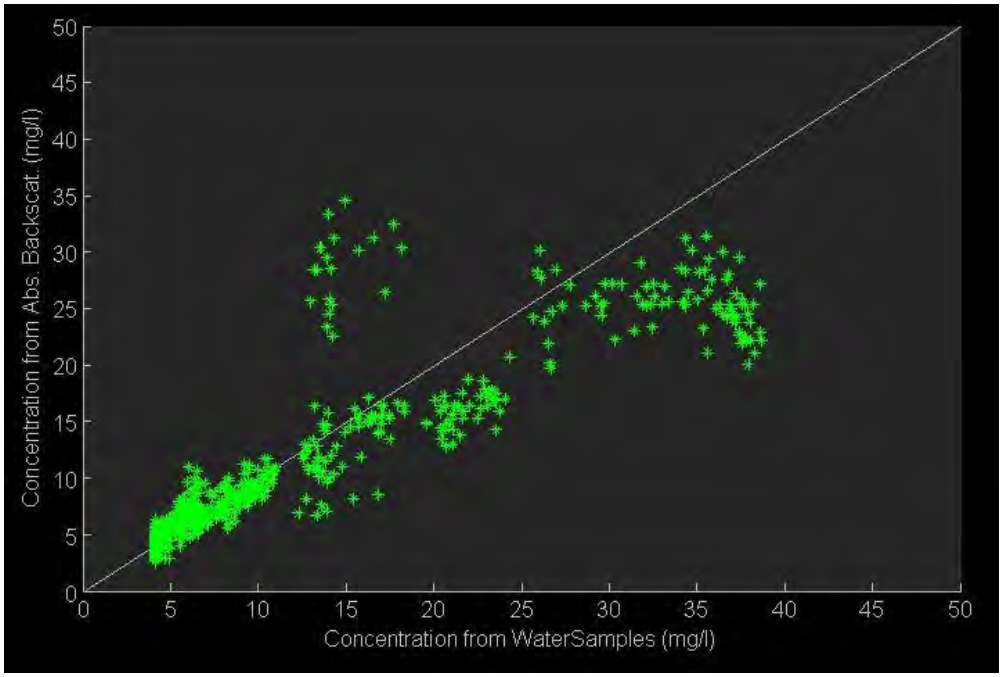


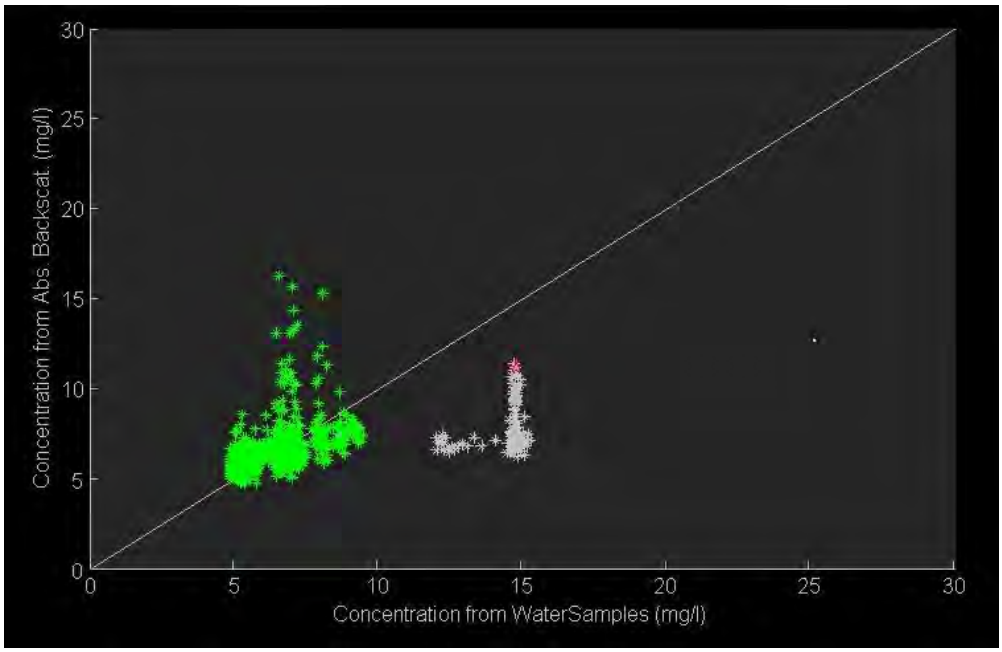
Appendix G Backscatter – TSS Calibration



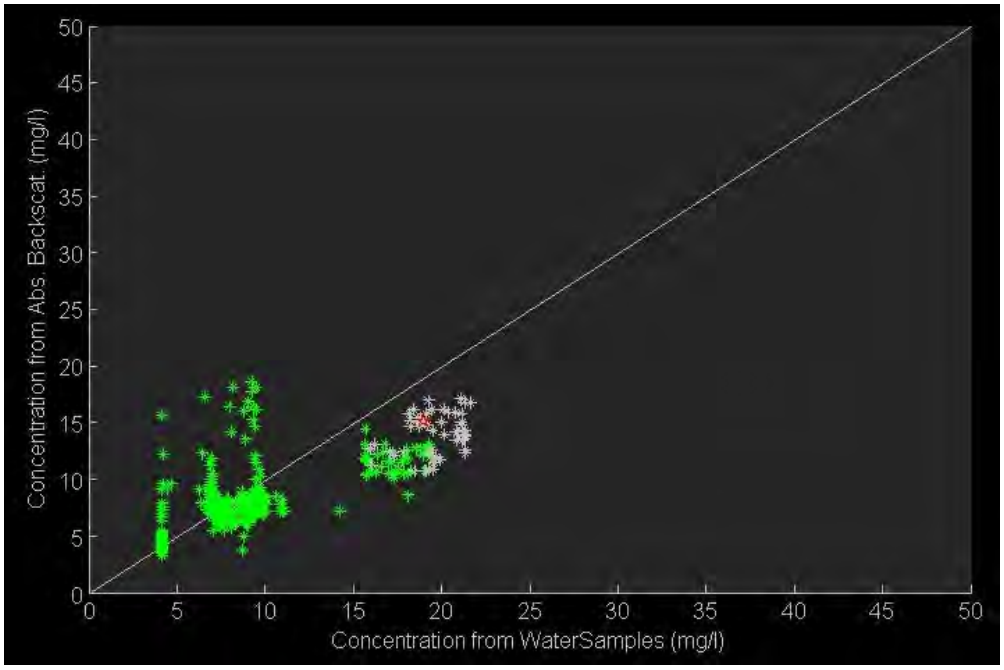


Backscatter – TSS Calibration





Backscatter – TSS Calibration



Appendix H Baseline water quality results, Golding Cutting and Wild Cattle Cutting, 3 December 2018

Table H-1 Water quality results Golding Cutting3

Golding Cutting- Parameter	Unit	ANZECC /QWQG Trigger	Baseline		
			A	B	C
Nutrients, TSS, Chlorophyll					
Total Phosphorus	µg/L	20	<LOR	<LOR	<LOR
Ortho-Phosphorus	µg/L	6	<LOR	<LOR	<LOR
Ammonia-Nitrogen	µg/L	8	<LOR	<LOR	<LOR
Nitrite + Nitrate (as N)	µg/L	3	8	5	<LOR
Total Nitrogen	µg/L	200	185	191	180
Solids (Suspended)	mg/L	15	5	5	4
Chlorophyll a	µg/L	2	1	1	1
Total Organic Carbon	mg/L	-	2	<LOR	2
Metals and Metalloids					
Aluminium (Total)	µg/L	-	172	187	295
Aluminium (Dissolved)	µg/L	-	<LOR	<LOR	<LOR
Arsenic (Total)	µg/L	-	1.7	1.6	1.7
Arsenic (Dissolved)	µg/L	-	1	1.1	1.2
Cadmium (Total)	µg/L	-	<LOR	<LOR	<LOR
Cadmium (Dissolved)	µg/L	0.7	<LOR	<LOR	<LOR
Chromium (Total)	µg/L	-	<LOR	<LOR	0.5
Chromium (Dissolved)	µg/L	4.4	<LOR	<LOR	<LOR
Copper (Total)	µg/L	-	<LOR	<LOR	<LOR
Copper (Dissolved)	µg/L	1.3	<LOR	<LOR	<LOR
Iron (Total)	µg/L	-	202	242	451
Iron (Dissolved)	µg/L	-	<LOR	<LOR	<LOR
Lead (Total)	µg/L	-	0.3	0.3	0.7
Lead (Dissolved)	µg/L	4.4	<LOR	<LOR	<LOR
Manganese (Total)	µg/L	-	5.1	6.6	11.3
Manganese (Dissolved)	µg/L	-	<LOR	<LOR	<LOR
Mercury (Total)	µg/L	-	<LOR	<LOR	<LOR
Mercury (Dissolved)	µg/L	0.1	<LOR	<LOR	<LOR
Nickel (Total)	µg/L	-	<LOR	<LOR	0.6
Nickel (Dissolved)	µg/L	7	<LOR	<LOR	<LOR
Silver (Total)	µg/L	-	<LOR	<LOR	<LOR
Silver (Dissolved)	µg/L	1.4	<LOR	<LOR	<LOR
Zinc (Total)	µg/L	-	<LOR	<LOR	<LOR
Zinc (Dissolved)	µg/L	15	<LOR	<LOR	<LOR

[3] Orange shading = guideline limit met or exceeded; green shading = concentration below the laboratory limit of reporting (LOR)

Table H-2 Water quality results Wild Cattle Cutting4

Golding Cutting-Parameter	Unit	ANZECC /QWQG Trigger	Baseline		
			A	B	C
Nutrients, TSS, Chlorophyll					
Total Phosphorus	µg/L	20	<LOR	<LOR	<LOR
Ortho-Phosphorus	µg/L	6	<LOR	<LOR	<LOR
Ammonia-Nitrogen	µg/L	8	<LOR	<LOR	<LOR
Nitrite + Nitrate (as N)	µg/L	3	3	4	<LOR
Total Nitrogen	µg/L	200	173	190	172
Solids (Suspended)	mg/L	15	2	6	5
Chlorophyll a	µg/L	2	<LOR	<LOR	<LOR
Total Organic Carbon	mg/L	-	2	<LOR	<LOR
Metals and Metalloids					
Aluminium (Total)	µg/L	-	59	122	196
Aluminium (Dissolved)	µg/L	-	<LOR	<LOR	<LOR
Arsenic (Total)	µg/L	-	1.6	1.8	1.8
Arsenic (Dissolved)	µg/L	-	1.2	1.4	1.1
Cadmium (Total)	µg/L	-	<LOR	<LOR	<LOR
Cadmium (Dissolved)	µg/L	0.7	<LOR	<LOR	<LOR
Chromium (Total)	µg/L	-	<LOR	<LOR	<LOR
Chromium (Dissolved)	µg/L	4.4	<LOR	<LOR	<LOR
Copper (Total)	µg/L	-	<LOR	<LOR	<LOR
Copper (Dissolved)	µg/L	1.3	<LOR	<LOR	<LOR
Iron (Total)	µg/L	-	65	178	286
Iron (Dissolved)	µg/L	-	<LOR	<LOR	<LOR
Lead (Total)	µg/L	-	0.4	0.7	0.9
Lead (Dissolved)	µg/L	4.4	<LOR	<LOR	<LOR
Manganese (Total)	µg/L	-	2.8	5.2	8.8
Manganese (Dissolved)	µg/L	-	0.8	1	1.2
Mercury (Total)	µg/L	-	<LOR	<LOR	<LOR
Mercury (Dissolved)	µg/L	0.1	<LOR	<LOR	<LOR
Nickel (Total)	µg/L	-	<LOR	<LOR	0.7
Nickel (Dissolved)	µg/L	7	<LOR	<LOR	<LOR
Silver (Total)	µg/L	-	<LOR	<LOR	<LOR
Silver (Dissolved)	µg/L	1.4	<LOR	<LOR	<LOR
Zinc (Total)	µg/L	-	<LOR	<LOR	<LOR
Zinc (Dissolved)	µg/L	15	<LOR	<LOR	<LOR

[4] Orange shading = guideline limit met or exceeded; green shading = concentration below the laboratory limit of reporting (LOR)

Appendix I Laboratory Raw Data

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1829467**	Page	: 1 of 21
Client	: **BMT EASTERN AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: DR DARREN RICHARDSON	Contact	: Customer Services EB
Address	: PO BOX 203 SPRING HILL BRISBANE QLD 4004	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3831 6744	Telephone	: +61-7-3243 7222
Project	: B23483	Date Samples Received	: 03-Dec-2018 10:40
Order number	:	Date Analysis Commenced	: 04-Dec-2018
C-O-C number	: ----	Issue Date	: 13-Dec-2018 09:57
Sampler	: CHRIS PIETSH		
Site	: ----		
Quote number	: BN/293/18		
No. of samples received	: 44		
No. of samples analysed	: 44		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Christopher Owler	Team Leader - Asbestos	Newcastle - Inorganics, Mayfield West, NSW
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD
Minh Wills	2IC Organic Chemist	Brisbane Organics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EG093-T (Total Metals in Saline Water by ORC-ICP-MS): High Cadmium LCS recovery deemed acceptable as all associated analyte results are less than LOR.
- EP008 (Chlorophyll a and Pheophytin a): Sample DMPA-0-A was diluted due to low sample volume provided. LOR adjusted accordingly.
- EA154: ALS does not hold NATA accreditation for Laser Particle Sizing.
- It is recognised that EG093-T (Total Metals in Saline Water by ORC-ICP-MS) is less than EG093-F (Dissolved Metals in Saline Water by ORC-ICP-MS) for some samples. However, the difference is within experimental variation of the methods.
- EG094-F (Dissolved Metals in Fresh Water): Limit of reporting raised due to insufficient volume.

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	FB-0-A	RB-0-A	GAT-B-A	GAT-B-B	GAT-B-C
				Client sampling date / time	02-Dec-2018 05:30	02-Dec-2018 05:35	02-Dec-2018 06:10	02-Dec-2018 06:12	02-Dec-2018 06:14
					EB1829467-001	EB1829467-002	EB1829467-003	EB1829467-004	EB1829467-005
					Result	Result	Result	Result	Result
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		----	----	**6**	**4**	**6**
EA150: Particle Sizing									
ø +75µm	----	1	%		----	----	-	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		----	----	<5	<5	<5
Arsenic	7440-38-2	0.5	µg/L		----	----	**1.5**	**1.5**	**1.5**
Cadmium	7440-43-9	0.2	µg/L		----	----	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		----	----	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		----	----	<1	<1	<1
Iron	7439-89-6	5	µg/L		----	----	<5	<5	<5
Lead	7439-92-1	0.2	µg/L		----	----	<0.2	<0.2	<0.2
Manganese	7439-96-5	0.5	µg/L		----	----	**0.6**	**0.5**	**0.7**
Nickel	7440-02-0	0.5	µg/L		----	----	<0.5	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		----	----	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		----	----	<5	<5	<5
EG093T: Total Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		----	----	**40**	**61**	**95**
Arsenic	7440-38-2	0.5	µg/L		----	----	**1.8**	**1.8**	**1.7**
Cadmium	7440-43-9	0.2	µg/L		----	----	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		----	----	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		----	----	<1	<1	<1
Iron	7439-89-6	5	µg/L		----	----	**40**	**73**	**116**
Lead	7439-92-1	0.2	µg/L		----	----	<0.2	<0.2	**0.5**
Manganese	7439-96-5	0.5	µg/L		----	----	**3.0**	**3.3**	**5.4**
Nickel	7440-02-0	0.5	µg/L		----	----	<0.5	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		----	----	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		----	----	**6**	<5	<5
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		<5	<5	----	----	----
Arsenic	7440-38-2	0.2	µg/L		<0.2	<0.2	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	FB-0-A	RB-0-A	GAT-B-A	GAT-B-B	GAT-B-C
				Client sampling date / time	02-Dec-2018 05:30	02-Dec-2018 05:35	02-Dec-2018 06:10	02-Dec-2018 06:12	02-Dec-2018 06:14
Compound	CAS Number	LOR	Unit		EB1829467-001	EB1829467-002	EB1829467-003	EB1829467-004	EB1829467-005
					Result	Result	Result	Result	Result
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS - Continued									
Cadmium	7440-43-9	0.05	µg/L		<0.05	<0.05	----	----	----
Chromium	7440-47-3	0.2	µg/L		<0.2	<0.2	----	----	----
Copper	7440-50-8	0.5	µg/L		<0.5	<0.5	----	----	----
Iron	7439-89-6	2	µg/L		<2	<2	----	----	----
Lead	7439-92-1	0.1	µg/L		<0.1	<0.1	----	----	----
Manganese	7439-96-5	0.5	µg/L		<0.5	<0.5	----	----	----
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	----	----	----
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	----	----	----
Zinc	7440-66-6	1	µg/L		<1	<5	----	----	----
EG094T: Total metals in Fresh water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		<5	**6**	----	----	----
Arsenic	7440-38-2	0.2	µg/L		<0.2	<0.2	----	----	----
Cadmium	7440-43-9	0.05	µg/L		<0.05	<0.05	----	----	----
Chromium	7440-47-3	0.2	µg/L		<0.2	<0.2	----	----	----
Copper	7440-50-8	0.5	µg/L		<0.5	<0.5	----	----	----
Iron	7439-89-6	2	µg/L		<2	**6**	----	----	----
Lead	7439-92-1	0.1	µg/L		<0.1	<0.1	----	----	----
Manganese	7439-96-5	0.5	µg/L		<0.5	<0.5	----	----	----
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	----	----	----
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	----	----	----
Zinc	7440-66-6	1	µg/L		<1	**2**	----	----	----
EK255A: Ammonia									
Ammonia as N	7664-41-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EK257A: Nitrite									
Nitrite as N	14797-65-0	0.002	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002
EK258A: Nitrate									
Nitrate as N	14797-55-8	0.002	mg/L		<0.002	<0.002	**0.006**	**0.002**	**0.002**
EK259A: Nitrite and Nitrate (NOx)									
Nitrite + Nitrate as N	----	0.002	mg/L		<0.002	<0.002	**0.006**	**0.002**	**0.002**
EK261A: Total Kjeldahl Nitrogen									
Total Kjeldahl Nitrogen as N	----	0.050	mg/L		<0.050	<0.050	**0.182**	**0.171**	**0.152**
EK262A: Total Nitrogen									
Total Nitrogen as N	----	0.050	mg/L		<0.050	<0.050	**0.188**	**0.173**	**0.154**
EK267A: Total Phosphorus (Persulfate Digestion)									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	FB-0-A	RB-0-A	GAT-B-A	GAT-B-B	GAT-B-C
				Client sampling date / time	02-Dec-2018 05:30	02-Dec-2018 05:35	02-Dec-2018 06:10	02-Dec-2018 06:12	02-Dec-2018 06:14
Compound	CAS Number	LOR	Unit		EB1829467-001	EB1829467-002	EB1829467-003	EB1829467-004	EB1829467-005
					Result	Result	Result	Result	Result
EK267A: Total Phosphorus (Persulfate Digestion) - Continued									
Total Phosphorus as P	----	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EK271A: Reactive Phosphorus									
Reactive Phosphorus as P	14265-44-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**----**	**----**	**2**	**2**	**3**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**----**	**----**	<1	<1	<1

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	GAT-0-A	GAT-0-B	GAT-0-C	GAT-15-A	GAT-15-B
				Client sampling date / time	02-Dec-2018 08:00	02-Dec-2018 08:02	02-Dec-2018 08:04	02-Dec-2018 08:15	02-Dec-2018 08:17
					EB1829467-006	EB1829467-007	EB1829467-008	EB1829467-009	EB1829467-010
					Result	Result	Result	Result	Result
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		**18**	**8**	**8**	**8**	**8**
EA150: Particle Sizing									
ø +75µm	----	1	%		**-**	**----**	**----**	**----**	**----**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		<5	<5	<5	<5	<5
Arsenic	7440-38-2	0.5	µg/L		**1.7**	**1.6**	**1.5**	**1.7**	**1.6**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		<1	<1	<1	**1**	<1
Iron	7439-89-6	5	µg/L		<5	<5	<5	<5	<5
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	7439-96-5	0.5	µg/L		**0.8**	<0.5	<0.5	<0.5	<0.5
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	<5
EG093T: Total Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		**254**	**158**	**148**	**156**	**141**
Arsenic	7440-38-2	0.5	µg/L		**1.9**	**1.9**	**1.8**	**1.8**	**1.6**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		<1	<1	<1	<1	<1
Iron	7439-89-6	5	µg/L		**384**	**219**	**202**	**203**	**184**
Lead	7439-92-1	0.2	µg/L		**0.2**	<0.2	<0.2	<0.2	**0.2**
Manganese	7439-96-5	0.5	µg/L		**18.9**	**9.9**	**7.7**	**9.0**	**7.9**
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	**0.5**	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	<5
EK255A: Ammonia									
Ammonia as N	7664-41-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EK257A: Nitrite									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GAT-0-A	GAT-0-B	GAT-0-C	GAT-15-A	GAT-15-B
				Client sampling date / time	02-Dec-2018 08:00	02-Dec-2018 08:02	02-Dec-2018 08:04	02-Dec-2018 08:15	02-Dec-2018 08:17
Compound	CAS Number	LOR	Unit		EB1829467-006	EB1829467-007	EB1829467-008	EB1829467-009	EB1829467-010
					Result	Result	Result	Result	Result
EK257A: Nitrite - Continued									
Nitrite as N	14797-65-0	0.002	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002
EK258A: Nitrate									
Nitrate as N	14797-55-8	0.002	mg/L		**0.006**	**0.006**	**0.006**	**0.006**	**0.004**
EK259A: Nitrite and Nitrate (NOx)									
Nitrite + Nitrate as N	----	0.002	mg/L		**0.006**	**0.006**	**0.006**	**0.006**	**0.004**
EK261A: Total Kjeldahl Nitrogen									
Total Kjeldahl Nitrogen as N	----	0.050	mg/L		**0.140**	**0.151**	**0.161**	**0.159**	**0.141**
EK262A: Total Nitrogen									
Total Nitrogen as N	----	0.050	mg/L		**0.146**	**0.157**	**0.167**	**0.165**	**0.145**
EK267A: Total Phosphorus (Persulfate Digestion)									
Total Phosphorus as P	----	0.005	mg/L		**0.008**	<0.005	<0.005	<0.005	<0.005
EK271A: Reactive Phosphorus									
Reactive Phosphorus as P	14265-44-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**2**	**2**	**4**	**1**	**2**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GAT-15-C	GAT-30-A	GAT-30-B	GAT-30-C	GAT-30-D
				Client sampling date / time	02-Dec-2018 08:19	02-Dec-2018 08:30	02-Dec-2018 08:32	02-Dec-2018 08:34	02-Dec-2018 08:30
Compound	CAS Number	LOR	Unit		EB1829467-011	EB1829467-012	EB1829467-013	EB1829467-014	EB1829467-015
					Result	Result	Result	Result	Result
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		8	6	5	6	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		<5	<5	<5	<5	<5
Arsenic	7440-38-2	0.5	µg/L		1.6	1.7	1.6	1.7	1.6
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		1	1	<1	<1	<1
Iron	7439-89-6	5	µg/L		<5	<5	<5	<5	<5
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	7439-96-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	<5
EG093T: Total Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		196	112	85	74	93
Arsenic	7440-38-2	0.5	µg/L		1.8	1.9	1.6	1.7	1.8
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		<1	<1	<1	<1	<1
Iron	7439-89-6	5	µg/L		259	150	111	93	128
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	7439-96-5	0.5	µg/L		8.6	7.3	5.3	4.6	6.3
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	<5
EK255A: Ammonia									
Ammonia as N	7664-41-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EK257A: Nitrite									
Nitrite as N	14797-65-0	0.002	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002
EK258A: Nitrate									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GAT-15-C	GAT-30-A	GAT-30-B	GAT-30-C	GAT-30-D
				Client sampling date / time	02-Dec-2018 08:19	02-Dec-2018 08:30	02-Dec-2018 08:32	02-Dec-2018 08:34	02-Dec-2018 08:30
Compound	CAS Number	LOR	Unit		EB1829467-011	EB1829467-012	EB1829467-013	EB1829467-014	EB1829467-015
					Result	Result	Result	Result	Result
EK258A: Nitrate - Continued									
Nitrate as N	14797-55-8	0.002	mg/L		**0.005**	**0.007**	**0.007**	**0.005**	**0.006**
EK259A: Nitrite and Nitrate (NOx)									
Nitrite + Nitrate as N	----	0.002	mg/L		**0.005**	**0.007**	**0.007**	**0.005**	**0.006**
EK261A: Total Kjeldahl Nitrogen									
Total Kjeldahl Nitrogen as N	----	0.050	mg/L		**0.139**	**0.135**	**0.141**	**0.141**	**0.139**
EK262A: Total Nitrogen									
Total Nitrogen as N	----	0.050	mg/L		**0.144**	**0.142**	**0.148**	**0.146**	**0.145**
EK267A: Total Phosphorus (Persulfate Digestion)									
Total Phosphorus as P	----	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EK271A: Reactive Phosphorus									
Reactive Phosphorus as P	14265-44-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**3**	**2**	**3**	**2**	**----**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<1	<1	<1	**1**	**----**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GAT-60-A	GAT-60-B	GAT-60-C	GAT-60-D	GAT-120-A
				Client sampling date / time	02-Dec-2018 09:00	02-Dec-2018 09:02	02-Dec-2018 09:04	02-Dec-2018 09:00	02-Dec-2018 10:00
Compound	CAS Number	LOR	Unit		EB1829467-016	EB1829467-017	EB1829467-018	EB1829467-019	EB1829467-020
					Result	Result	Result	Result	Result
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		**5**	**6**	**8**	**----**	**6**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		<5	<5	<5	<5	<5
Arsenic	7440-38-2	0.5	µg/L		**1.6**	**1.6**	**1.5**	**1.5**	**1.6**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		<1	<1	<1	<1	<1
Iron	7439-89-6	5	µg/L		<5	<5	<5	<5	<5
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	7439-96-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	<5
EG093T: Total Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		**131**	**82**	**107**	**96**	**114**
Arsenic	7440-38-2	0.5	µg/L		**1.8**	**1.7**	**1.6**	**1.8**	**1.8**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		<1	<1	<1	<1	<1
Iron	7439-89-6	5	µg/L		**168**	**116**	**145**	**126**	**184**
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	**0.2**	<0.2
Manganese	7439-96-5	0.5	µg/L		**5.8**	**5.9**	**6.3**	**6.7**	**5.7**
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	<5
EK255A: Ammonia									
Ammonia as N	7664-41-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	**0.007**
EK257A: Nitrite									
Nitrite as N	14797-65-0	0.002	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002
EK258A: Nitrate									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GAT-60-A	GAT-60-B	GAT-60-C	GAT-60-D	GAT-120-A
				Client sampling date / time	02-Dec-2018 09:00	02-Dec-2018 09:02	02-Dec-2018 09:04	02-Dec-2018 09:00	02-Dec-2018 10:00
Compound	CAS Number	LOR	Unit		EB1829467-016	EB1829467-017	EB1829467-018	EB1829467-019	EB1829467-020
					Result	Result	Result	Result	Result
EK258A: Nitrate - Continued									
Nitrate as N	14797-55-8	0.002	mg/L		**0.006**	**0.005**	**0.005**	**0.007**	**0.005**
EK259A: Nitrite and Nitrate (NOx)									
Nitrite + Nitrate as N	----	0.002	mg/L		**0.006**	**0.005**	**0.005**	**0.007**	**0.005**
EK261A: Total Kjeldahl Nitrogen									
Total Kjeldahl Nitrogen as N	----	0.050	mg/L		**0.152**	**0.140**	**0.156**	**0.124**	**0.150**
EK262A: Total Nitrogen									
Total Nitrogen as N	----	0.050	mg/L		**0.158**	**0.145**	**0.161**	**0.131**	**0.155**
EK267A: Total Phosphorus (Persulfate Digestion)									
Total Phosphorus as P	----	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EK271A: Reactive Phosphorus									
Reactive Phosphorus as P	14265-44-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**2**	**2**	**2**	**----**	**3**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<1	<1	<1	**----**	<1

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	GAT-120-B	GAT-120-C	GAT-120-D	DMPA-B-A	DMPA-B-B
				Client sampling date / time	02-Dec-2018 10:02	02-Dec-2018 10:04	02-Dec-2018 10:00	02-Dec-2018 13:00	02-Dec-2018 13:02
					EB1829467-021	EB1829467-022	EB1829467-023	EB1829467-024	EB1829467-025
					Result	Result	Result	Result	Result
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		**6**	**6**	**----**	<1	<1
EA150: Particle Sizing									
ø +75µm	----	1	%		**----**	**----**	**----**	**-**	**----**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		<5	<5	<5	<5	<5
Arsenic	7440-38-2	0.5	µg/L		**1.6**	**1.5**	**1.2**	**1.6**	**1.6**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		<1	<1	<1	<1	<1
Iron	7439-89-6	5	µg/L		<5	<5	<5	<5	<5
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	7439-96-5	0.5	µg/L		<0.5	<0.5	<0.5	**1.7**	**1.5**
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	<5
EG093T: Total Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		**130**	**152**	**125**	**19**	**11**
Arsenic	7440-38-2	0.5	µg/L		**1.5**	**1.7**	**1.8**	**1.7**	**1.9**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		<1	<1	<1	<1	<1
Iron	7439-89-6	5	µg/L		**171**	**190**	**176**	**23**	**16**
Lead	7439-92-1	0.2	µg/L		**0.2**	<0.2	**0.4**	**0.9**	<0.2
Manganese	7439-96-5	0.5	µg/L		**6.4**	**6.5**	**5.6**	**3.7**	**3.5**
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	**0.2**	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	<5
EK255A: Ammonia									
Ammonia as N	7664-41-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EK257A: Nitrite									

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	GAT-120-B	GAT-120-C	GAT-120-D	DMPA-B-A	DMPA-B-B
				Client sampling date / time	02-Dec-2018 10:02	02-Dec-2018 10:04	02-Dec-2018 10:00	02-Dec-2018 13:00	02-Dec-2018 13:02
					EB1829467-021	EB1829467-022	EB1829467-023	EB1829467-024	EB1829467-025
					Result	Result	Result	Result	Result
EK257A: Nitrite - Continued									
Nitrite as N	14797-65-0	0.002	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002
EK258A: Nitrate									
Nitrate as N	14797-55-8	0.002	mg/L		**0.004**	**0.004**	**0.007**	**0.005**	<0.002
EK259A: Nitrite and Nitrate (NOx)									
Nitrite + Nitrate as N	----	0.002	mg/L		**0.004**	**0.004**	**0.007**	**0.005**	<0.002
EK261A: Total Kjeldahl Nitrogen									
Total Kjeldahl Nitrogen as N	----	0.050	mg/L		**0.061**	**0.162**	**0.173**	**0.217**	**0.159**
EK262A: Total Nitrogen									
Total Nitrogen as N	----	0.050	mg/L		**0.065**	**0.166**	**0.180**	**0.222**	**0.159**
EK267A: Total Phosphorus (Persulfate Digestion)									
Total Phosphorus as P	----	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	**0.024**
EK271A: Reactive Phosphorus									
Reactive Phosphorus as P	14265-44-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**3**	**2**	**----**	**2**	**2**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<1	<1	**----**	<1	<1

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	DMPA-B-C	DMPA-0-A	DMPA-0-B	DMPA-0-C	DMPA-15-A
				Client sampling date / time	02-Dec-2018 13:04	02-Dec-2018 13:55	02-Dec-2018 13:57	02-Dec-2018 13:59	02-Dec-2018 14:10
					EB1829467-026	EB1829467-027	EB1829467-028	EB1829467-029	EB1829467-030
					Result	Result	Result	Result	Result
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		<1	<1	**13**	**6**	**12**
EA150: Particle Sizing									
ø +75µm	----	1	%		**----**	**-**	**----**	**----**	**----**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		<5	<5	<5	<5	<5
Arsenic	7440-38-2	0.5	µg/L		**1.5**	**1.5**	**1.5**	**1.6**	**1.8**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		<1	<1	<1	<1	<1
Iron	7439-89-6	5	µg/L		<5	<5	<5	<5	<5
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	7439-96-5	0.5	µg/L		**1.5**	**2.0**	**1.7**	**2.1**	**2.7**
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	<5
EG093T: Total Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		**17**	**121**	**59**	**294**	**569**
Arsenic	7440-38-2	0.5	µg/L		**1.7**	**2.0**	**1.8**	**2.1**	**2.2**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	**0.6**	**0.7**
Copper	7440-50-8	1	µg/L		<1	<1	<1	<1	**2**
Iron	7439-89-6	5	µg/L		**16**	**214**	**81**	**607**	**1120**
Lead	7439-92-1	0.2	µg/L		<0.2	**0.6**	<0.2	**0.4**	**0.6**
Manganese	7439-96-5	0.5	µg/L		**3.3**	**13.5**	**7.4**	**26.1**	**34.7**
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	**0.6**	**1.1**
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	<5
EK255A: Ammonia									
Ammonia as N	7664-41-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EK257A: Nitrite									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DMPA-B-C	DMPA-0-A	DMPA-0-B	DMPA-0-C	DMPA-15-A
				Client sampling date / time	02-Dec-2018 13:04	02-Dec-2018 13:55	02-Dec-2018 13:57	02-Dec-2018 13:59	02-Dec-2018 14:10
Compound	CAS Number	LOR	Unit		EB1829467-026	EB1829467-027	EB1829467-028	EB1829467-029	EB1829467-030
					Result	Result	Result	Result	Result
EK257A: Nitrite - Continued									
Nitrite as N	14797-65-0	0.002	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002
EK258A: Nitrate									
Nitrate as N	14797-55-8	0.002	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002
EK259A: Nitrite and Nitrate (NOx)									
Nitrite + Nitrate as N	----	0.002	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002
EK261A: Total Kjeldahl Nitrogen									
Total Kjeldahl Nitrogen as N	----	0.050	mg/L		**0.172**	**0.167**	**0.169**	**0.162**	**0.151**
EK262A: Total Nitrogen									
Total Nitrogen as N	----	0.050	mg/L		**0.172**	**0.167**	**0.169**	**0.162**	**0.151**
EK267A: Total Phosphorus (Persulfate Digestion)									
Total Phosphorus as P	----	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	**0.008**
EK271A: Reactive Phosphorus									
Reactive Phosphorus as P	14265-44-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**2**	**2**	**2**	**2**	**2**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<1	<2	<1	<1	<1

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	DMPA-15-B	DMPA-15-C	DMPA-30-A	DMPA-30-B	DMPA-30-C
				Client sampling date / time	02-Dec-2018 14:12	02-Dec-2018 14:14	02-Dec-2018 14:25	02-Dec-2018 14:27	02-Dec-2018 14:29
					EB1829467-031	EB1829467-032	EB1829467-033	EB1829467-034	EB1829467-035
					Result	Result	Result	Result	Result
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		**23**	**14**	**8**	**20**	**17**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		<5	<5	<5	<5	<5
Arsenic	7440-38-2	0.5	µg/L		**1.7**	**1.7**	**1.6**	**1.6**	**1.7**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		<1	<1	<1	<1	<1
Iron	7439-89-6	5	µg/L		<5	<5	<5	<5	<5
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	7439-96-5	0.5	µg/L		**2.4**	**2.1**	**2.6**	**2.5**	**2.0**
Nickel	7440-02-0	0.5	µg/L		<0.5	**0.5**	<0.5	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	<5
EG093T: Total Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		**229**	**147**	**330**	**270**	**45**
Arsenic	7440-38-2	0.5	µg/L		**1.8**	**1.8**	**2.0**	**2.0**	**1.8**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		<1	<1	**2**	**1**	<1
Iron	7439-89-6	5	µg/L		**402**	**285**	**645**	**549**	**79**
Lead	7439-92-1	0.2	µg/L		**0.3**	**0.2**	**0.3**	**0.3**	<0.2
Manganese	7439-96-5	0.5	µg/L		**16.7**	**14.0**	**20.3**	**19.9**	**6.6**
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	**0.6**	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	<5
EK255A: Ammonia									
Ammonia as N	7664-41-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EK257A: Nitrite									
Nitrite as N	14797-65-0	0.002	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002
EK258A: Nitrate									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DMPA-15-B	DMPA-15-C	DMPA-30-A	DMPA-30-B	DMPA-30-C
				Client sampling date / time	02-Dec-2018 14:12	02-Dec-2018 14:14	02-Dec-2018 14:25	02-Dec-2018 14:27	02-Dec-2018 14:29
Compound	CAS Number	LOR	Unit		EB1829467-031	EB1829467-032	EB1829467-033	EB1829467-034	EB1829467-035
					Result	Result	Result	Result	Result
EK258A: Nitrate - Continued									
Nitrate as N	14797-55-8	0.002	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002
EK259A: Nitrite and Nitrate (NOx)									
Nitrite + Nitrate as N	----	0.002	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002
EK261A: Total Kjeldahl Nitrogen									
Total Kjeldahl Nitrogen as N	----	0.050	mg/L		**0.152**	**0.180**	**0.165**	**0.159**	**0.191**
EK262A: Total Nitrogen									
Total Nitrogen as N	----	0.050	mg/L		**0.152**	**0.180**	**0.165**	**0.159**	**0.191**
EK267A: Total Phosphorus (Persulfate Digestion)									
Total Phosphorus as P	----	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EK271A: Reactive Phosphorus									
Reactive Phosphorus as P	14265-44-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**2**	**2**	**2**	<1	**2**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DMPA-60-A	DMPA-60-B	DMPA-60-C	DMPA-60-D	DMPA-120-A
				Client sampling date / time	02-Dec-2018 14:55	02-Dec-2018 14:57	02-Dec-2018 14:59	02-Dec-2018 14:55	02-Dec-2018 15:55
Compound	CAS Number	LOR	Unit		EB1829467-036	EB1829467-037	EB1829467-038	EB1829467-039	EB1829467-040
					Result	Result	Result	Result	Result
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		**4**	**12**	**11**	**----**	**7**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		<5	<5	<5	<5	<5
Arsenic	7440-38-2	0.5	µg/L		**1.5**	**1.6**	**1.7**	**1.6**	**1.6**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		<1	<1	<1	<1	<1
Iron	7439-89-6	5	µg/L		<5	<5	<5	<5	<5
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	7439-96-5	0.5	µg/L		**1.9**	**2.3**	**2.1**	**1.9**	**2.0**
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	<5
EG093T: Total Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		**41**	**131**	**199**	**42**	**62**
Arsenic	7440-38-2	0.5	µg/L		**1.8**	**1.9**	**2.0**	**1.7**	**2.0**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		<1	<1	**1**	<1	<1
Iron	7439-89-6	5	µg/L		**69**	**218**	**323**	**62**	**93**
Lead	7439-92-1	0.2	µg/L		**0.3**	**0.2**	**0.2**	**0.3**	**0.3**
Manganese	7439-96-5	0.5	µg/L		**6.2**	**13.2**	**13.4**	**6.3**	**8.5**
Nickel	7440-02-0	0.5	µg/L		<0.5	**0.5**	<0.5	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	<5
EK255A: Ammonia									
Ammonia as N	7664-41-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EK257A: Nitrite									
Nitrite as N	14797-65-0	0.002	mg/L		<0.002	<0.002	<0.002	<0.002	<0.002
EK258A: Nitrate									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DMPA-60-A	DMPA-60-B	DMPA-60-C	DMPA-60-D	DMPA-120-A
				Client sampling date / time	02-Dec-2018 14:55	02-Dec-2018 14:57	02-Dec-2018 14:59	02-Dec-2018 14:55	02-Dec-2018 15:55
Compound	CAS Number	LOR	Unit		EB1829467-036	EB1829467-037	EB1829467-038	EB1829467-039	EB1829467-040
					Result	Result	Result	Result	Result
EK258A: Nitrate - Continued									
Nitrate as N	14797-55-8	0.002	mg/L		**0.004**	**0.002**	**0.002**	**0.004**	**0.014**
EK259A: Nitrite and Nitrate (NOx)									
Nitrite + Nitrate as N	----	0.002	mg/L		**0.004**	**0.002**	**0.002**	**0.004**	**0.014**
EK261A: Total Kjeldahl Nitrogen									
Total Kjeldahl Nitrogen as N	----	0.050	mg/L		**0.177**	**0.184**	**0.196**	**0.198**	**0.197**
EK262A: Total Nitrogen									
Total Nitrogen as N	----	0.050	mg/L		**0.181**	**0.186**	**0.198**	**0.202**	**0.211**
EK267A: Total Phosphorus (Persulfate Digestion)									
Total Phosphorus as P	----	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EK271A: Reactive Phosphorus									
Reactive Phosphorus as P	14265-44-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**2**	<1	**2**	**----**	**2**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<1	<1	<1	**----**	<1

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DMPA-120-B	DMPA-120-C	DMPA-120-D	GAT-Extra-A	----
				Client sampling date / time	02-Dec-2018 15:57	02-Dec-2018 15:59	02-Dec-2018 15:55	02-Dec-2018 10:40	----
Compound	CAS Number	LOR	Unit		EB1829467-041	EB1829467-042	EB1829467-043	EB1829467-044	--------
					Result	Result	Result	Result	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		**7**	**4**	**----**	**19**	**----**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	**----**
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	**----**
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		<5	<5	<5	<5	**----**
Arsenic	7440-38-2	0.5	µg/L		**1.3**	**1.2**	**1.5**	**1.0**	**----**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	**----**
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	**----**
Copper	7440-50-8	1	µg/L		<1	<1	<1	<1	**----**
Iron	7439-89-6	5	µg/L		<5	<5	<5	<5	**----**
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	**----**
Manganese	7439-96-5	0.5	µg/L		**2.0**	**2.0**	**1.8**	<0.5	**----**
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	**----**
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	**----**
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	**----**
EG093T: Total Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		**148**	**125**	**164**	**619**	**----**
Arsenic	7440-38-2	0.5	µg/L		**1.7**	**1.6**	**1.7**	**1.9**	**----**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	**----**
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	**2.0**	**----**
Copper	7440-50-8	1	µg/L		<1	<1	<1	<1	**----**
Iron	7439-89-6	5	µg/L		**247**	**173**	**248**	**1050**	**----**
Lead	7439-92-1	0.2	µg/L		**0.2**	**0.2**	**0.4**	**0.3**	**----**
Manganese	7439-96-5	0.5	µg/L		**9.3**	**8.4**	**8.5**	**24.5**	**----**
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	**1.6**	**----**
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	**----**
Zinc	7440-66-6	5	µg/L		<5	<5	<5	**6**	**----**
EK255A: Ammonia									
Ammonia as N	7664-41-7	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	**----**
EK257A: Nitrite									
Nitrite as N	14797-65-0	0.002	mg/L		<0.002	<0.002	<0.002	<0.002	**----**
EK258A: Nitrate									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DMPA-120-B	DMPA-120-C	DMPA-120-D	GAT-Extra-A	----
				Client sampling date / time	02-Dec-2018 15:57	02-Dec-2018 15:59	02-Dec-2018 15:55	02-Dec-2018 10:40	----
Compound	CAS Number	LOR	Unit		EB1829467-041	EB1829467-042	EB1829467-043	EB1829467-044	--------
					Result	Result	Result	Result	----
EK258A: Nitrate - Continued									
Nitrate as N	14797-55-8	0.002	mg/L		**0.002**	<0.002	**0.013**	**0.014**	**----**
EK259A: Nitrite and Nitrate (NOx)									
Nitrite + Nitrate as N	----	0.002	mg/L		**0.002**	<0.002	**0.013**	**0.014**	**----**
EK261A: Total Kjeldahl Nitrogen									
Total Kjeldahl Nitrogen as N	----	0.050	mg/L		**0.167**	**0.107**	**0.152**	<0.050	**----**
EK262A: Total Nitrogen									
Total Nitrogen as N	----	0.050	mg/L		**0.169**	**0.107**	**0.165**	<0.050	**----**
EK267A: Total Phosphorus (Persulfate Digestion)									
Total Phosphorus as P	----	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	**----**
EK271A: Reactive Phosphorus									
Reactive Phosphorus as P	14265-44-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**----**
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**2**	**2**	**----**	**3**	**----**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		<1	<1	**----**	<1	**----**

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1829356**	Page	: 1 of 10
Client	: **BMT EASTERN AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: DR DARREN RICHARDSON	Contact	: Customer Services EB
Address	: PO BOX 203 SPRING HILL BRISBANE QLD 4004	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3831 6744	Telephone	: +61-7-3243 7222
Project	: B23483	Date Samples Received	: 30-Nov-2018 09:30
Order number	: BN/293/18	Date Analysis Commenced	: 30-Nov-2018
C-O-C number	: ----	Issue Date	: 10-Dec-2018 11:51
Sampler	: CHRIS PIETSCH		
Site	: ----		
Quote number	: EN/222		
No. of samples received	: 18		
No. of samples analysed	: 18		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Diana Mesa	2IC Organic Chemist	Brisbane Organics, Stafford, QLD
Dianne Blane	Laboratory Coordinator (2IC)	Newcastle - Inorganics, Mayfield West, NSW
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD
Mark Hallas	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.
~ = Indicates an estimated value.

- EA154: ALS does not hold NATA accreditation for Laser Particle Sizing.
- It is recognised that EG093-T (Total Metals in Saline Water by ORC-ICP-MS) is less than EG093-F (Dissolved Metals in Saline Water by ORC-ICP-MS) for some samples. However, the difference is within experimental variation of the methods.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	JC - B - A	JC - B - B	JC - B - C	JC - O - A	JC - O - B
				Client sampling date / time	29-Nov-2018 13:55	29-Nov-2018 14:15	29-Nov-2018 14:20	29-Nov-2018 15:10	29-Nov-2018 15:12
Compound	CAS Number	LOR	Unit		EB1829356-001	EB1829356-002	EB1829356-003	EB1829356-004	EB1829356-005
					Result	Result	Result	Result	Result
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		**13**	**16**	**11**	**20**	**15**
EA150: Particle Sizing									
ø +75µm	----	1	%		**----**	**-**	**----**	**-**	**----**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		<5	<5	<5	<5	<5
Arsenic	7440-38-2	0.5	µg/L		**1.2**	<0.5	**1.2**	**1.1**	**1.2**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		**2**	<1	<1	**1**	<1
Iron	7439-89-6	5	µg/L		<5	<5	<5	<5	<5
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	7439-96-5	0.5	µg/L		**1.4**	<0.5	**1.6**	**2.4**	**1.9**
Nickel	7440-02-0	0.5	µg/L		**0.7**	<0.5	<0.5	**0.6**	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		**7**	<5	**6**	**7**	<5
EG093T: Total Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		**299**	**479**	**397**	**730**	**386**
Arsenic	7440-38-2	0.5	µg/L		**1.5**	**1.6**	**1.6**	**1.8**	**1.5**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	**1.0**	<0.5	**1.3**	**1.2**
Copper	7440-50-8	1	µg/L		<1	**1**	<1	**2**	**1**
Iron	7439-89-6	5	µg/L		**363**	**603**	**462**	**998**	**531**
Lead	7439-92-1	0.2	µg/L		<0.2	**0.4**	<0.2	**0.5**	<0.2
Manganese	7439-96-5	0.5	µg/L		**11.2**	**15.2**	**12.1**	**21.3**	**17.6**
Nickel	7440-02-0	0.5	µg/L		<0.5	**3.0**	<0.5	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		**9**	**11**	**6**	**13**	<5
EK255A: Ammonia									
Ammonia as N	7664-41-7	0.005	mg/L		<0.005	**0.007**	<0.005	**0.014**	<0.005
EK257A: Nitrite									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	JC - B - A	JC - B - B	JC - B - C	JC - O - A	JC - O - B
				Client sampling date / time	29-Nov-2018 13:55	29-Nov-2018 14:15	29-Nov-2018 14:20	29-Nov-2018 15:10	29-Nov-2018 15:12
Compound	CAS Number	LOR	Unit		EB1829356-001	EB1829356-002	EB1829356-003	EB1829356-004	EB1829356-005
					Result	Result	Result	Result	Result
EK257A: Nitrite - Continued									
Nitrite as N	14797-65-0	0.002	mg/L		**0.004**	**0.003**	**0.002**	**0.003**	**0.003**
EK258A: Nitrate									
Nitrate as N	14797-55-8	0.002	mg/L		**0.014**	**0.015**	**0.014**	**0.022**	**0.009**
EK259A: Nitrite and Nitrate (NOx)									
Nitrite + Nitrate as N	----	0.002	mg/L		**0.018**	**0.018**	**0.016**	**0.025**	**0.012**
EK261A: Total Kjeldahl Nitrogen									
Total Kjeldahl Nitrogen as N	----	0.050	mg/L		**0.154**	**0.235**	**0.135**	**0.288**	**0.167**
EK262A: Total Nitrogen									
Total Nitrogen as N	----	0.050	mg/L		**0.172**	**0.253**	**0.151**	**0.313**	**0.179**
EK267A: Total Phosphorus (Persulfate Digestion)									
Total Phosphorus as P	----	0.005	mg/L		**0.011**	**0.013**	**0.012**	**0.022**	**0.019**
EK271A: Reactive Phosphorus									
Reactive Phosphorus as P	14265-44-2	0.001	mg/L		<0.001	<0.001	<0.001	**0.001**	<0.001
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**3**	**2**	**2**	**2**	**2**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**1**	**2**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	JC - O - C	JC - 15 - A	JC - 15 - B	JC - 15 - C	JC - 30 - A
				Client sampling date / time	29-Nov-2018 15:14	29-Nov-2018 15:30	29-Nov-2018 15:32	29-Nov-2018 15:34	29-Nov-2018 15:45
					EB1829356-006	EB1829356-007	EB1829356-008	EB1829356-009	EB1829356-010
					Result	Result	Result	Result	Result
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		**57**	**38**	**25**	**63**	**14**
EA150: Particle Sizing									
ø +75µm	----	1	%		**----**	**----**	**----**	**----**	**-**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		<5	<5	<5	<5	<5
Arsenic	7440-38-2	0.5	µg/L		**1.3**	**1.0**	**1.2**	**1.2**	**1.1**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		<1	<1	<1	<1	<1
Iron	7439-89-6	5	µg/L		<5	<5	<5	<5	<5
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	7439-96-5	0.5	µg/L		**7.4**	**5.0**	**3.3**	**12.4**	**2.0**
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	**0.5**
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	**6**	<5	<5
EG093T: Total Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		**1490**	**1070**	**809**	**2010**	**641**
Arsenic	7440-38-2	0.5	µg/L		**2.4**	**2.1**	**1.9**	**2.7**	**1.8**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		**2.4**	**1.6**	**1.5**	**2.7**	**0.6**
Copper	7440-50-8	1	µg/L		**2**	**2**	**2**	**3**	**1**
Iron	7439-89-6	5	µg/L		**2170**	**1590**	**1260**	**2870**	**682**
Lead	7439-92-1	0.2	µg/L		**0.7**	**0.3**	**0.2**	**0.8**	<0.2
Manganese	7439-96-5	0.5	µg/L		**43.6**	**31.4**	**26.1**	**60.5**	**13.9**
Nickel	7440-02-0	0.5	µg/L		**1.5**	**1.2**	**1.0**	**1.5**	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		**10**	<5	<5	**10**	<5
EK255A: Ammonia									
Ammonia as N	7664-41-7	0.005	mg/L		**0.006**	<0.005	<0.005	**0.015**	<0.005
EK257A: Nitrite									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	JC - O - C	JC - 15 - A	JC - 15 - B	JC - 15 - C	JC - 30 - A
				Client sampling date / time	29-Nov-2018 15:14	29-Nov-2018 15:30	29-Nov-2018 15:32	29-Nov-2018 15:34	29-Nov-2018 15:45
Compound	CAS Number	LOR	Unit		EB1829356-006	EB1829356-007	EB1829356-008	EB1829356-009	EB1829356-010
					Result	Result	Result	Result	Result
EK257A: Nitrite - Continued									
Nitrite as N	14797-65-0	0.002	mg/L		**0.003**	**0.003**	**0.003**	**0.003**	**0.003**
EK258A: Nitrate									
Nitrate as N	14797-55-8	0.002	mg/L		**0.009**	**0.010**	**0.012**	**0.010**	**0.008**
EK259A: Nitrite and Nitrate (NOx)									
Nitrite + Nitrate as N	----	0.002	mg/L		**0.012**	**0.013**	**0.015**	**0.013**	**0.011**
EK261A: Total Kjeldahl Nitrogen									
Total Kjeldahl Nitrogen as N	----	0.050	mg/L		**0.179**	**0.150**	**0.163**	**0.178**	**0.171**
EK262A: Total Nitrogen									
Total Nitrogen as N	----	0.050	mg/L		**0.191**	**0.163**	**0.178**	**0.191**	**0.182**
EK267A: Total Phosphorus (Persulfate Digestion)									
Total Phosphorus as P	----	0.005	mg/L		**0.049**	**0.035**	**0.031**	**0.098**	**0.014**
EK271A: Reactive Phosphorus									
Reactive Phosphorus as P	14265-44-2	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		<1	**3**	**2**	**3**	**2**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**1**	**1**	**2**	**2**	**2**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	JC - 30 - B	JC - 30 - C	JC - 60 - A	JC - 60 - B	JC - 60 - C
				Client sampling date / time	29-Nov-2018 15:47	29-Nov-2018 15:49	29-Nov-2018 16:15	29-Nov-2018 16:17	29-Nov-2018 16:19
					EB1829356-011	EB1829356-012	EB1829356-013	EB1829356-014	EB1829356-015
					Result	Result	Result	Result	Result
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		**13**	**22**	**12**	**15**	**26**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	<0.00004	<0.00004
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		<5	<5	<5	<5	<5
Arsenic	7440-38-2	0.5	µg/L		**1.0**	**0.9**	**1.1**	**1.1**	**1.2**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Copper	7440-50-8	1	µg/L		**2**	<1	<1	<1	<1
Iron	7439-89-6	5	µg/L		<5	<5	<5	<5	<5
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	7439-96-5	0.5	µg/L		**1.8**	**3.2**	**1.5**	**1.9**	**2.5**
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		**9**	<5	<5	<5	<5
EG093T: Total Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		**526**	**553**	**309**	**435**	**783**
Arsenic	7440-38-2	0.5	µg/L		**1.6**	**1.8**	**1.5**	**1.7**	**2.2**
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Chromium	7440-47-3	0.5	µg/L		<0.5	**0.7**	<0.5	**0.5**	**1.2**
Copper	7440-50-8	1	µg/L		**1**	**1**	**1**	**1**	**2**
Iron	7439-89-6	5	µg/L		**635**	**785**	**427**	**593**	**1160**
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	<0.2	<0.2
Manganese	7439-96-5	0.5	µg/L		**13.2**	**19.5**	**12.4**	**15.7**	**27.4**
Nickel	7440-02-0	0.5	µg/L		**0.7**	**0.7**	<0.5	<0.5	**0.7**
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	7440-66-6	5	µg/L		<5	<5	<5	<5	<5
EK255A: Ammonia									
Ammonia as N	7664-41-7	0.005	mg/L		**0.025**	<0.005	<0.005	<0.005	<0.005
EK257A: Nitrite									
Nitrite as N	14797-65-0	0.002	mg/L		**0.003**	**0.002**	**0.003**	**0.003**	**0.002**
EK258A: Nitrate									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	JC - 30 - B	JC - 30 - C	JC - 60 - A	JC - 60 - B	JC - 60 - C
				Client sampling date / time	29-Nov-2018 15:47	29-Nov-2018 15:49	29-Nov-2018 16:15	29-Nov-2018 16:17	29-Nov-2018 16:19
Compound	CAS Number	LOR	Unit		EB1829356-011	EB1829356-012	EB1829356-013	EB1829356-014	EB1829356-015
					Result	Result	Result	Result	Result
EK258A: Nitrate - Continued									
Nitrate as N	14797-55-8	0.002	mg/L		**0.019**	**0.008**	**0.011**	**0.012**	**0.009**
EK259A: Nitrite and Nitrate (NOx)									
Nitrite + Nitrate as N	----	0.002	mg/L		**0.022**	**0.010**	**0.014**	**0.015**	**0.011**
EK261A: Total Kjeldahl Nitrogen									
Total Kjeldahl Nitrogen as N	----	0.050	mg/L		**0.255**	**0.254**	**0.159**	**0.134**	**0.143**
EK262A: Total Nitrogen									
Total Nitrogen as N	----	0.050	mg/L		**0.277**	**0.264**	**0.173**	**0.149**	**0.154**
EK267A: Total Phosphorus (Persulfate Digestion)									
Total Phosphorus as P	----	0.005	mg/L		**0.017**	**0.018**	**0.010**	**0.014**	**0.021**
EK271A: Reactive Phosphorus									
Reactive Phosphorus as P	14265-44-2	0.001	mg/L		**0.002**	<0.001	**0.001**	<0.001	<0.001
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**3**	**3**	**2**	**3**	**3**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**1**	**2**	**1**	**2**	**1**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	JC - 120 - A	JC - 120 - B	JC - 120 - C	----	----
				Client sampling date / time	29-Nov-2018 17:05	29-Nov-2018 17:07	29-Nov-2018 17:09	----	----
Compound	CAS Number	LOR	Unit		EB1829356-016	EB1829356-017	EB1829356-018	--------	--------
					Result	Result	Result	----	----
EA025: Total Suspended Solids dried at 104 ± 2°C									
Suspended Solids (SS)	----	1	mg/L		**25**	**24**	**20**	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	----	----
EG035T: Total Mercury by FIMS									
Mercury	7439-97-6	0.00004	mg/L		<0.00004	<0.00004	<0.00004	----	----
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		<5	<5	<5	----	----
Arsenic	7440-38-2	0.5	µg/L		**1.1**	**1.0**	**1.0**	----	----
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	----	----
Chromium	7440-47-3	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Copper	7440-50-8	1	µg/L		<1	<1	<1	----	----
Iron	7439-89-6	5	µg/L		<5	<5	<5	----	----
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	----	----
Manganese	7439-96-5	0.5	µg/L		**3.1**	**2.8**	**2.1**	----	----
Nickel	7440-02-0	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	----	----
Zinc	7440-66-6	5	µg/L		<5	<5	<5	----	----
EG093T: Total Metals in Saline Water by ORC-ICPMS									
Aluminium	7429-90-5	5	µg/L		**762**	**815**	**534**	----	----
Arsenic	7440-38-2	0.5	µg/L		**2.0**	**1.8**	**1.6**	----	----
Cadmium	7440-43-9	0.2	µg/L		<0.2	<0.2	<0.2	----	----
Chromium	7440-47-3	0.5	µg/L		**0.9**	**1.2**	**0.8**	----	----
Copper	7440-50-8	1	µg/L		**1**	**2**	**1**	----	----
Iron	7439-89-6	5	µg/L		**1120**	**1110**	**770**	----	----
Lead	7439-92-1	0.2	µg/L		<0.2	<0.2	<0.2	----	----
Manganese	7439-96-5	0.5	µg/L		**26.2**	**24.8**	**19.3**	----	----
Nickel	7440-02-0	0.5	µg/L		**0.7**	**0.6**	**0.6**	----	----
Silver	7440-22-4	0.1	µg/L		<0.1	<0.1	<0.1	----	----
Zinc	7440-66-6	5	µg/L		<5	<5	<5	----	----
EK255A: Ammonia									
Ammonia as N	7664-41-7	0.005	mg/L		<0.005	<0.005	<0.005	----	----
EK257A: Nitrite									
Nitrite as N	14797-65-0	0.002	mg/L		**0.003**	**0.002**	**0.002**	----	----
EK258A: Nitrate									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	JC - 120 - A	JC - 120 - B	JC - 120 - C	----	----
				Client sampling date / time	29-Nov-2018 17:05	29-Nov-2018 17:07	29-Nov-2018 17:09	----	----
Compound	CAS Number	LOR	Unit		EB1829356-016	EB1829356-017	EB1829356-018	--------	--------
					Result	Result	Result	----	----
EK258A: Nitrate - Continued									
Nitrate as N	14797-55-8	0.002	mg/L		**0.008**	**0.009**	**0.009**	**----**	**----**
EK259A: Nitrite and Nitrate (NOx)									
Nitrite + Nitrate as N	----	0.002	mg/L		**0.011**	**0.011**	**0.011**	**----**	**----**
EK261A: Total Kjeldahl Nitrogen									
Total Kjeldahl Nitrogen as N	----	0.050	mg/L		**0.111**	**0.125**	**0.160**	**----**	**----**
EK262A: Total Nitrogen									
Total Nitrogen as N	----	0.050	mg/L		**0.122**	**0.136**	**0.171**	**----**	**----**
EK267A: Total Phosphorus (Persulfate Digestion)									
Total Phosphorus as P	----	0.005	mg/L		**0.021**	**0.024**	**0.022**	**----**	**----**
EK271A: Reactive Phosphorus									
Reactive Phosphorus as P	14265-44-2	0.001	mg/L		**0.001**	<0.001	<0.001	**----**	**----**
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**2**	**2**	**3**	**----**	**----**
EP008: Chlorophyll a & Pheophytin a									
Chlorophyll a	----	1	mg/m³		**1**	**1**	**1**	**----**	**----**

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EB1829474**	Page	: 1 of 8
Client	: **BMT EASTERN AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: DR DARREN RICHARDSON	Contact	: Customer Services EB
Address	: PO BOX 203 SPRING HILL BRISBANE QLD 4004	Address	: 2 Byth Street Stafford QLD Australia 4053
Telephone	: +61 07 3831 6744	Telephone	: +61-7-3243 7222
Project	: B23483	Date Samples Received	: 04-Dec-2018
Order number	:	Date Analysis Commenced	: 05-Dec-2018
C-O-C number	: ----	Issue Date	: 13-Dec-2018
Sampler	: ----		
Site	: ----		
Quote number	: BN/293/18		
No. of samples received	: 12		
No. of samples analysed	: 12		

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Christopher Owler	Team Leader - Asbestos	Newcastle - Inorganics, Mayfield West, NSW
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics, Stafford, QLD
Kim McCabe	Senior Inorganic Chemist	WB Water Lab Brisbane, Stafford, QLD
Minh Wills	2IC Organic Chemist	Brisbane Organics, Stafford, QLD

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 2077952)									
EB1829467-026	Anonymous	EA025: Suspended Solids (SS)	----	1	mg/L	<1	<1	0.00	No Limit
EB1829467-036	Anonymous	EA025: Suspended Solids (SS)	----	1	mg/L	4	4	0.00	No Limit
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 2077953)									
EB1829474-007	WCC-B-A	EA025: Suspended Solids (SS)	----	1	mg/L	2	3	0.00	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 2075256)									
EB1829467-041	Anonymous	EG035F-LL: Mercury	7439-97-6	0.00004	mg/L	<0.00004	<0.00004	0.00	No Limit
EB1829474-009	WCC-B-C	EG035F-LL: Mercury	7439-97-6	0.00004	mg/L	<0.00004	<0.00004	0.00	No Limit
EG035T: Total Mercury by FIMS (QC Lot: 2075250)									
EB1829467-041	Anonymous	EG035T-LL: Mercury	7439-97-6	0.00004	mg/L	<0.00004	<0.00004	0.00	No Limit
EB1829474-009	WCC-B-C	EG035T-LL: Mercury	7439-97-6	0.00004	mg/L	<0.00004	<0.00004	0.00	No Limit
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS (QC Lot: 2075242)									
EB1829467-041	Anonymous	EG093A-F: Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	0.00	No Limit
		EG093A-F: Cadmium	7440-43-9	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EG093A-F: Lead	7439-92-1	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EG093A-F: Arsenic	7440-38-2	0.5	µg/L	1.3	1.4	8.23	No Limit
		EG093A-F: Chromium	7440-47-3	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG093A-F: Manganese	7439-96-5	0.5	µg/L	2.0	2.1	0.00	No Limit
		EG093A-F: Nickel	7440-02-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG093A-F: Copper	7440-50-8	1	µg/L	<1	<1	0.00	No Limit
		EG093A-F: Aluminium	7429-90-5	5	µg/L	<5	<5	0.00	No Limit
		EG093A-F: Zinc	7440-66-6	5	µg/L	<5	<5	0.00	No Limit
EB1829474-008	WCC-B-B	EG093A-F: Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	0.00	No Limit
		EG093A-F: Cadmium	7440-43-9	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EG093A-F: Lead	7439-92-1	0.2	µg/L	<0.2	<0.2	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS (QC Lot: 2075242) - continued									
EB1829474-008	WCC-B-B	EG093A-F: Arsenic	7440-38-2	0.5	µg/L	1.4	1.2	18.4	No Limit
		EG093A-F: Chromium	7440-47-3	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG093A-F: Manganese	7439-96-5	0.5	µg/L	1.0	1.0	0.00	No Limit
		EG093A-F: Nickel	7440-02-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG093A-F: Copper	7440-50-8	1	µg/L	<1	<1	0.00	No Limit
		EG093A-F: Aluminium	7429-90-5	5	µg/L	<5	<5	0.00	No Limit
		EG093A-F: Zinc	7440-66-6	5	µg/L	<5	<5	0.00	No Limit
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS (QC Lot: 2075243)									
EB1829467-041	Anonymous	EG093B-F: Iron	7439-89-6	5	µg/L	<5	<5	0.00	No Limit
EB1829474-008	WCC-B-B	EG093B-F: Iron	7439-89-6	5	µg/L	<5	<5	0.00	No Limit
EG093T: Total Metals in Saline Water by ORC-ICPMS (QC Lot: 2075223)									
EB1829467-041	Anonymous	EG093A-T: Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	0.00	No Limit
		EG093A-T: Cadmium	7440-43-9	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EG093A-T: Lead	7439-92-1	0.2	µg/L	0.2	0.2	0.00	No Limit
		EG093A-T: Arsenic	7440-38-2	0.5	µg/L	1.7	1.8	0.00	No Limit
		EG093A-T: Chromium	7440-47-3	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG093A-T: Manganese	7439-96-5	0.5	µg/L	9.3	9.9	6.66	0% - 50%
		EG093A-T: Nickel	7440-02-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG093A-T: Copper	7440-50-8	1	µg/L	<1	<1	0.00	No Limit
		EG093A-T: Aluminium	7429-90-5	5	µg/L	148	172	15.0	0% - 20%
		EG093A-T: Zinc	7440-66-6	5	µg/L	<5	<5	0.00	No Limit
EB1829474-008	WCC-B-B	EG093A-T: Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	0.00	No Limit
		EG093A-T: Cadmium	7440-43-9	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EG093A-T: Lead	7439-92-1	0.2	µg/L	0.7	0.7	0.00	No Limit
		EG093A-T: Arsenic	7440-38-2	0.5	µg/L	1.8	1.7	0.00	No Limit
		EG093A-T: Chromium	7440-47-3	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG093A-T: Manganese	7439-96-5	0.5	µg/L	5.2	5.3	1.90	0% - 50%
		EG093A-T: Nickel	7440-02-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG093A-T: Copper	7440-50-8	1	µg/L	<1	<1	0.00	No Limit
		EG093A-T: Aluminium	7429-90-5	5	µg/L	122	128	4.67	0% - 20%
		EG093A-T: Zinc	7440-66-6	5	µg/L	<5	<5	0.00	No Limit
EG093T: Total Metals in Saline Water by ORC-ICPMS (QC Lot: 2075224)									
EB1829467-041	Anonymous	EG093B-T: Iron	7439-89-6	5	µg/L	247	244	1.22	0% - 20%
EB1829474-008	WCC-B-B	EG093B-T: Iron	7439-89-6	5	µg/L	178	180	0.943	0% - 20%
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS (QC Lot: 2087452)									
EB1829467-001	Anonymous	EG094B-F: Iron	7439-89-6	2	µg/L	<2	<2	0.00	No Limit
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS (QC Lot: 2087453)									
EB1829467-001	Anonymous	EG094A-F: Cadmium	7440-43-9	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EG094A-F: Lead	7439-92-1	0.1	µg/L	<0.1	<0.1	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS (QC Lot: 2087453) - continued									
EB1829467-001	Anonymous	EG094A-F: Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	0.00	No Limit
		EG094A-F: Arsenic	7440-38-2	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EG094A-F: Chromium	7440-47-3	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EG094A-F: Copper	7440-50-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG094A-F: Manganese	7439-96-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG094A-F: Nickel	7440-02-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG094A-F: Zinc	7440-66-6	1	µg/L	<1	<1	0.00	No Limit
		EG094A-F: Aluminium	7429-90-5	5	µg/L	<5	<5	0.00	No Limit
EG094T: Total metals in Fresh water by ORC-ICPMS (QC Lot: 2087455)									
EB1829467-001	Anonymous	EG094B-T: Iron	7439-89-6	2	µg/L	<2	<2	0.00	No Limit
EG094T: Total metals in Fresh water by ORC-ICPMS (QC Lot: 2087456)									
EB1829467-001	Anonymous	EG094A-T: Cadmium	7440-43-9	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EG094A-T: Lead	7439-92-1	0.1	µg/L	<0.1	<0.1	0.00	No Limit
		EG094A-T: Silver	7440-22-4	0.1	µg/L	<0.1	<0.1	0.00	No Limit
		EG094A-T: Arsenic	7440-38-2	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EG094A-T: Chromium	7440-47-3	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EG094A-T: Copper	7440-50-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG094A-T: Manganese	7439-96-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG094A-T: Nickel	7440-02-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EG094A-T: Zinc	7440-66-6	1	µg/L	<1	<1	0.00	No Limit
		EG094A-T: Aluminium	7429-90-5	5	µg/L	<5	<5	0.00	No Limit
EK255A: Ammonia (QC Lot: 2078487)									
EB1829474-003	GC-B-A	EK255A-SW: Ammonia as N	7664-41-7	0.005	mg/L	<0.005	<0.005	0.00	No Limit
EK257A: Nitrite (QC Lot: 2078485)									
EB1829474-003	GC-B-A	EK257A-SW: Nitrite as N	14797-65-0	0.002	mg/L	<0.002	<0.002	0.00	No Limit
EK259A: Nitrite and Nitrate (NOx) (QC Lot: 2078484)									
EB1829474-003	GC-B-A	EK259A-SW: Nitrite + Nitrate as N	----	0.002	mg/L	0.008	0.006	22.0	No Limit
EK262A: Total Nitrogen (QC Lot: 2078491)									
EB1829474-003	GC-B-A	EK262PA-SW: Total Nitrogen as N	----	0.025	mg/L	0.185	0.184	0.542	No Limit
EK267A: Total Phosphorus (Persulfate Digestion) (QC Lot: 2078490)									
EB1829474-003	GC-B-A	EK267PA-SW: Total Phosphorus as P	----	0.005	mg/L	<0.005	<0.005	0.00	No Limit
EK271A: Reactive Phosphorus (QC Lot: 2078486)									
EB1829474-003	GC-B-A	EK271A-SW: Reactive Phosphorus as P	14265-44-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
EP005: Total Organic Carbon (TOC) (QC Lot: 2079231)									
EB1828570-003	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	6	5	20.3	No Limit
EB1829630-001	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	18	15	17.7	0% - 50%

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Spike (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 2077952)								
EA025: Suspended Solids (SS)	----	1	mg/L	<1	150 mg/L	99.2	84	120
				<1	1000 mg/L	99.9	84	120
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 2077953)								
EA025: Suspended Solids (SS)	----	1	mg/L	<1	150 mg/L	107	84	120
				<1	1000 mg/L	96.6	84	120
EG035F: Dissolved Mercury by FIMS (QCLot: 2075256)								
EG035F-LL: Mercury	7439-97-6	0.00004	mg/L	<0.00004	0.002 mg/L	99.0	85	118
EG035T: Total Mercury by FIMS (QCLot: 2075250)								
EG035T-LL: Mercury	7439-97-6	0.00004	mg/L	<0.00004	0.002 mg/L	99.5	84	114
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS (QCLot: 2075242)								
EG093A-F: Aluminium	7429-90-5	5	µg/L	<5	50 µg/L	87.2	85	118
EG093A-F: Arsenic	7440-38-2	0.5	µg/L	<0.5	10 µg/L	90.2	87	116
EG093A-F: Cadmium	7440-43-9	0.2	µg/L	<0.2	10 µg/L	88.8	88	114
EG093A-F: Chromium	7440-47-3	0.5	µg/L	<0.5	10 µg/L	88.4	83	115
EG093A-F: Copper	7440-50-8	1	µg/L	<1	20 µg/L	89.5	81	117
EG093A-F: Lead	7439-92-1	0.2	µg/L	<0.2	10 µg/L	92.1	80	117
EG093A-F: Manganese	7439-96-5	0.5	µg/L	<0.5	10 µg/L	91.0	80	119
EG093A-F: Nickel	7440-02-0	0.5	µg/L	<0.5	10 µg/L	88.6	87	117
EG093A-F: Silver	7440-22-4	0.1	µg/L	<0.1	10 µg/L	93.8	80	127
EG093A-F: Zinc	7440-66-6	5	µg/L	<5	20 µg/L	83.6	81	120
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS (QCLot: 2075243)								
EG093B-F: Iron	7439-89-6	5	µg/L	<5	50 µg/L	84.3	78	123
EG093T: Total Metals in Saline Water by ORC-ICPMS (QCLot: 2075223)								
EG093A-T: Aluminium	7429-90-5	5	µg/L	<5	50 µg/L	85.9	85	120
EG093A-T: Arsenic	7440-38-2	0.5	µg/L	<0.5	10 µg/L	87.2	86	117
EG093A-T: Cadmium	7440-43-9	0.2	µg/L	<0.2	10 µg/L	86.1	84	115
EG093A-T: Chromium	7440-47-3	0.5	µg/L	<0.5	10 µg/L	89.7	84	120
EG093A-T: Copper	7440-50-8	1	µg/L	<1	20 µg/L	100	84	119
EG093A-T: Lead	7439-92-1	0.2	µg/L	<0.2	10 µg/L	93.7	84	120
EG093A-T: Manganese	7439-96-5	0.5	µg/L	<0.5	10 µg/L	89.7	86	124
EG093A-T: Nickel	7440-02-0	0.5	µg/L	<0.5	10 µg/L	89.3	80	120
EG093A-T: Silver	7440-22-4	0.1	µg/L	<0.1	10 µg/L	91.9	80	120
EG093A-T: Zinc	7440-66-6	5	µg/L	<5	20 µg/L	83.4	81	124

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EG093T: Total Metals in Saline Water by ORC-ICPMS (QCLot: 2075224)								
EG093B-T: Iron	7439-89-6	5	µg/L	<5	50 µg/L	94.2	80	128
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS (QCLot: 2087452)								
EG094B-F: Iron	7439-89-6	2	µg/L	<2	50 µg/L	96.7	80	120
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS (QCLot: 2087453)								
EG094A-F: Aluminium	7429-90-5	5	µg/L	<5	50 µg/L	104	80	120
EG094A-F: Arsenic	7440-38-2	0.2	µg/L	<0.2	10 µg/L	97.8	80	120
EG094A-F: Cadmium	7440-43-9	0.05	µg/L	<0.05	10 µg/L	96.8	80	120
EG094A-F: Chromium	7440-47-3	0.2	µg/L	<0.2	10 µg/L	93.8	80	120
EG094A-F: Copper	7440-50-8	0.5	µg/L	<0.5	20 µg/L	98.2	80	120
EG094A-F: Lead	7439-92-1	0.1	µg/L	<0.1	10 µg/L	100	80	120
EG094A-F: Manganese	7439-96-5	0.5	µg/L	<0.5	10 µg/L	100	80	120
EG094A-F: Nickel	7440-02-0	0.5	µg/L	<0.5	10 µg/L	98.2	80	120
EG094A-F: Silver	7440-22-4	0.1	µg/L	<0.1	10 µg/L	88.8	80	120
EG094A-F: Zinc	7440-66-6	1	µg/L	<1	20 µg/L	90.8	80	120
EG094T: Total metals in Fresh water by ORC-ICPMS (QCLot: 2087455)								
EG094B-T: Iron	7439-89-6	2	µg/L	<2	50 µg/L	104	80	120
EG094T: Total metals in Fresh water by ORC-ICPMS (QCLot: 2087456)								
EG094A-T: Aluminium	7429-90-5	5	µg/L	<5	50 µg/L	112	80	120
EG094A-T: Arsenic	7440-38-2	0.2	µg/L	<0.2	10 µg/L	97.0	80	120
EG094A-T: Cadmium	7440-43-9	0.05	µg/L	<0.05	10 µg/L	94.9	80	120
EG094A-T: Chromium	7440-47-3	0.2	µg/L	<0.2	10 µg/L	98.7	80	120
EG094A-T: Copper	7440-50-8	0.5	µg/L	<0.5	20 µg/L	104	80	120
EG094A-T: Lead	7439-92-1	0.1	µg/L	<0.1	10 µg/L	101	80	120
EG094A-T: Manganese	7439-96-5	0.5	µg/L	<0.5	10 µg/L	103	80	120
EG094A-T: Nickel	7440-02-0	0.5	µg/L	<0.5	10 µg/L	100	80	120
EG094A-T: Silver	7440-22-4	0.1	µg/L	<0.1	10 µg/L	88.8	80	120
EG094A-T: Zinc	7440-66-6	1	µg/L	<1	20 µg/L	92.9	80	120
EK255A: Ammonia (QCLot: 2078487)								
EK255A-SW: Ammonia as N	7664-41-7	0.005	mg/L	<0.005	0.1 mg/L	102	80	120
EK257A: Nitrite (QCLot: 2078485)								
EK257A-SW: Nitrite as N	14797-65-0	0.002	mg/L	<0.002	1 mg/L	91.7	80	120
EK259A: Nitrite and Nitrate (NOx) (QCLot: 2078484)								
EK259A-SW: Nitrite + Nitrate as N	----	0.002	mg/L	<0.002	0.1 mg/L	94.7	80	120
EK262A: Total Nitrogen (QCLot: 2078491)								
EK262PA-SW: Total Nitrogen as N	----	0.025	mg/L	<0.025	1 mg/L	96.6	80	120
EK267A: Total Phosphorus (Persulfate Digestion) (QCLot: 2078490)								
EK267PA-SW: Total Phosphorus as P	----	0.005	mg/L	<0.005	0.42 mg/L	97.9	80	120

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report: Result	Laboratory Control Spike (LCS) Report: Spike Concentration	Spike Recovery (%): LCS	Recovery Limits (%): Low	Recovery Limits (%): High
EK271A: Reactive Phosphorus (QCLot: 2078486)								
EK271A-SW: Reactive Phosphorus as P	14265-44-2	0.001	mg/L	<0.001	0.1 mg/L	94.5	84	120
EP005: Total Organic Carbon (TOC) (QCLot: 2079231)								
EP005: Total Organic Carbon	----	1	mg/L	<1	10 mg/L	99.4	79	113
				<1	100 mg/L	104	79	113
EP008: Chlorophyll (QCLot: 2077664)								
EP008: Chlorophyll a	----	1	mg/m³	<1	16 mg/m³	93.8	85	123

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%): MS	Recovery Limits (%): Low	Recovery Limits (%): High
EG035F: Dissolved Mercury by FIMS (QCLot: 2075256)							
EB1829467-042	Anonymous	EG035F-LL: Mercury	7439-97-6	0.002 mg/L	92.6	70	130
EG035T: Total Mercury by FIMS (QCLot: 2075250)							
EB1829467-042	Anonymous	EG035T-LL: Mercury	7439-97-6	0.002 mg/L	93.8	70	130
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS (QCLot: 2075242)							
EB1829467-042	Anonymous	EG093A-F: Arsenic	7440-38-2	50 µg/L	95.8	70	130
		EG093A-F: Cadmium	7440-43-9	50 µg/L	90.6	70	130
		EG093A-F: Chromium	7440-47-3	50 µg/L	96.2	70	130
		EG093A-F: Copper	7440-50-8	100 µg/L	95.0	70	130
		EG093A-F: Lead	7439-92-1	50 µg/L	91.9	70	130
		EG093A-F: Manganese	7439-96-5	50 µg/L	93.6	70	130
		EG093A-F: Nickel	7440-02-0	50 µg/L	91.9	70	130
		EG093A-F: Zinc	7440-66-6	100 µg/L	89.9	70	130
EG093T: Total Metals in Saline Water by ORC-ICPMS (QCLot: 2075223)							
EB1829467-042	Anonymous	EG093A-T: Arsenic	7440-38-2	50 µg/L	99.2	70	130
		EG093A-T: Cadmium	7440-43-9	50 µg/L	94.9	70	130
		EG093A-T: Chromium	7440-47-3	50 µg/L	95.8	70	130
		EG093A-T: Copper	7440-50-8	100 µg/L	110	70	130
		EG093A-T: Lead	7439-92-1	50 µg/L	110	70	130
		EG093A-T: Manganese	7439-96-5	50 µg/L	96.7	70	130
		EG093A-T: Nickel	7440-02-0	50 µg/L	94.3	70	130
		EG093A-T: Zinc	7440-66-6	100 µg/L	94.0	70	130
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS (QCLot: 2087453)							

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS (QCLot: 2087453) - continued							
EB1829474-011	FB-B-A	EG094A-F: Arsenic	7440-38-2	50 µg/L	98.6	70	130
		EG094A-F: Cadmium	7440-43-9	50 µg/L	98.6	70	130
		EG094A-F: Chromium	7440-47-3	50 µg/L	100	70	130
		EG094A-F: Copper	7440-50-8	100 µg/L	99.3	70	130
		EG094A-F: Lead	7439-92-1	50 µg/L	97.8	70	130
		EG094A-F: Manganese	7439-96-5	50 µg/L	102	70	130
		EG094A-F: Nickel	7440-02-0	50 µg/L	98.8	70	130
		EG094A-F: Zinc	7440-66-6	100 µg/L	101	70	130
EG094T: Total metals in Fresh water by ORC-ICPMS (QCLot: 2087456)							
EB1829467-002	Anonymous	EG094A-T: Arsenic	7440-38-2	50 µg/L	100	70	130
		EG094A-T: Cadmium	7440-43-9	50 µg/L	98.9	70	130
		EG094A-T: Chromium	7440-47-3	50 µg/L	103	70	130
		EG094A-T: Copper	7440-50-8	100 µg/L	104	70	130
		EG094A-T: Lead	7439-92-1	50 µg/L	97.6	70	130
		EG094A-T: Manganese	7439-96-5	50 µg/L	104	70	130
		EG094A-T: Nickel	7440-02-0	50 µg/L	103	70	130
EK255A: Ammonia (QCLot: 2078487)							
EB1829474-004	GC-B-B	EK255A-SW: Ammonia as N	7664-41-7	0.1 mg/L	98.2	70	130
EK257A: Nitrite (QCLot: 2078485)							
EB1829474-005	GC-B-C	EK257A-SW: Nitrite as N	14797-65-0	0.1 mg/L	102	70	130
EK259A: Nitrite and Nitrate (NOx) (QCLot: 2078484)							
EB1829474-004	GC-B-B	EK259A-SW: Nitrite + Nitrate as N	----	0.1 mg/L	118	70	130
EK262A: Total Nitrogen (QCLot: 2078491)							
EB1829474-004	GC-B-B	EK262PA-SW: Total Nitrogen as N	----	0.5 mg/L	112	70	130
EK267A: Total Phosphorus (Persulfate Digestion) (QCLot: 2078490)							
EB1829474-004	GC-B-B	EK267PA-SW: Total Phosphorus as P	----	0.5 mg/L	93.8	70	130
EK271A: Reactive Phosphorus (QCLot: 2078486)							
EB1829474-004	GC-B-B	EK271A-SW: Reactive Phosphorus as P	14265-44-2	0.1 mg/L	92.5	70	130
EP005: Total Organic Carbon (TOC) (QCLot: 2079231)							
EB1829474-003	GC-B-A	EP005: Total Organic Carbon	----	100 mg/L	122	70	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EB1829474**	Page	: 1 of 10
Client	: **BMT EASTERN AUSTRALIA PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: DR DARREN RICHARDSON	Telephone	: +61-7-3243 7222
Project	: B23483	Date Samples Received	: 04-Dec-2018
Site	: ----	Issue Date	: 13-Dec-2018
Sampler	: ----	No. of samples received	: 12
Order number	:	No. of samples analysed	: 12

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EK262A: Total Nitrogen						
Clear Plastic Bottle - Natural						
GC-B-A, GC-B-B, GC-B-C, GC-B-D, WCC-B-A, WCC-B-B, WCC-B-C, WCC-B-D, FB-B-A, RB-B-A	06-Dec-2018	04-Dec-2018	**2**	06-Dec-2018	04-Dec-2018	**2**
EK267A: Total Phosphorus (Persulfate Digestion)						
Clear Plastic Bottle - Natural						
GC-B-A, GC-B-B, GC-B-C, GC-B-D, WCC-B-A, WCC-B-B, WCC-B-C, WCC-B-D, FB-B-A, RB-B-A	06-Dec-2018	04-Dec-2018	**2**	06-Dec-2018	04-Dec-2018	**2**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA025)							
GC-B-A, GC-B-B, GC-B-C, WCC-B-A, WCC-B-B, WCC-B-C	**03-Dec-2018**	**----**	----	----	**06-Dec-2018**	10-Dec-2018	✓
EA150: Particle Sizing							
Clear Plastic Bottle - Natural (EA154)							
GC-B-A, GC-O-A	**01-Dec-2018**	**----**	----	----	**07-Dec-2018**	30-May-2019	✓
Clear Plastic Bottle - Natural (EA154)							
WCC-B-A	**03-Dec-2018**	**----**	----	----	**07-Dec-2018**	01-Jun-2019	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035F: Dissolved Mercury by FIMS								
Clear Plastic Bottle - Filtered; Lab-acidified (EG035F-LL)								
GC-B-A,	GC-B-B,	**03-Dec-2018**	**----**	----	----	**05-Dec-2018**	31-Dec-2018	✓
GC-B-C,	GC-B-D,							
WCC-B-A,	WCC-B-B,							
WCC-B-C,	WCC-B-D,							
FB-B-A,	RB-B-A							
EG035T: Total Mercury by FIMS								
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG035T-LL)								
GC-B-A,	GC-B-B,	**03-Dec-2018**	**----**	----	----	**10-Dec-2018**	31-Dec-2018	✓
GC-B-C,	GC-B-D,							
WCC-B-A,	WCC-B-B,							
WCC-B-C,	WCC-B-D,							
FB-B-A,	RB-B-A							
EG093F: Dissolved Metals in Saline Water by ORC-ICPMS								
Clear Plastic Bottle - Filtered; Lab-acidified (EG093A-F)								
GC-B-A,	GC-B-B,	**03-Dec-2018**	**----**	----	----	**06-Dec-2018**	01-Jun-2019	✓
GC-B-C,	GC-B-D,							
WCC-B-A,	WCC-B-B,							
WCC-B-C,	WCC-B-D							
EG093T: Total Metals in Saline Water by ORC-ICPMS								
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG093B-T)								
GC-B-A,	GC-B-B,	**03-Dec-2018**	**07-Dec-2018**	01-Jun-2019	✓	**07-Dec-2018**	01-Jun-2019	✓
GC-B-C,	GC-B-D,							
WCC-B-A,	WCC-B-B,							
WCC-B-C,	WCC-B-D							
EG094F: Dissolved Metals in Fresh Water by ORC-ICPMS								
Clear Plastic Bottle - Filtered; Lab-acidified (EG094B-F)								
FB-B-A,	RB-B-A	**03-Dec-2018**	**----**	----	----	**11-Dec-2018**	01-Jun-2019	✓
EG094T: Total metals in Fresh water by ORC-ICPMS								
Clear Plastic Bottle - Unfiltered; Lab-acidified (EG094B-T)								
FB-B-A,	RB-B-A	**03-Dec-2018**	**11-Dec-2018**	01-Jun-2019	✓	**11-Dec-2018**	01-Jun-2019	✓
EK255A: Ammonia								
Clear Plastic - Filtered & Frozen (AS/ISO) - UT Nu (EK255A-SW)								
GC-B-A,	GC-B-B,	**03-Dec-2018**	**----**	----	----	**07-Dec-2018**	31-Dec-2018	✓
GC-B-C,	GC-B-D,							
WCC-B-A,	WCC-B-B,							
WCC-B-C,	WCC-B-D,							
FB-B-A,	RB-B-A							

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK257A: Nitrite							
Clear Plastic - Filtered & Frozen (AS/ISO) - UT Nu (EK257A-SW)							
GC-B-A, GC-B-B, GC-B-C, GC-B-D, WCC-B-A, WCC-B-B, WCC-B-C, WCC-B-D, FB-B-A, RB-B-A	**03-Dec-2018**	**----**	----	----	**07-Dec-2018**	07-Dec-2018	✓
EK259A: Nitrite and Nitrate (NOx)							
Clear Plastic - Filtered & Frozen (AS/ISO) - UT Nu (EK259A-SW)							
GC-B-A, GC-B-B, GC-B-C, GC-B-D, WCC-B-A, WCC-B-B, WCC-B-C, WCC-B-D, FB-B-A, RB-B-A	**03-Dec-2018**	**----**	----	----	**07-Dec-2018**	31-Dec-2018	✓
EK262A: Total Nitrogen							
Clear Plastic Bottle - Natural (EK262PA-SW)							
GC-B-A, GC-B-B, GC-B-C, GC-B-D, WCC-B-A, WCC-B-B, WCC-B-C, WCC-B-D, FB-B-A, RB-B-A	**03-Dec-2018**	**06-Dec-2018**	04-Dec-2018	×	**06-Dec-2018**	04-Dec-2018	×
EK267A: Total Phosphorus (Persulfate Digestion)							
Clear Plastic Bottle - Natural (EK267PA-SW)							
GC-B-A, GC-B-B, GC-B-C, GC-B-D, WCC-B-A, WCC-B-B, WCC-B-C, WCC-B-D, FB-B-A, RB-B-A	**03-Dec-2018**	**06-Dec-2018**	04-Dec-2018	×	**06-Dec-2018**	04-Dec-2018	×
EK271A: Reactive Phosphorus							
Clear Plastic - Filtered & Frozen (AS/ISO) - UT Nu (EK271A-SW)							
GC-B-A, GC-B-B, GC-B-C, GC-B-D, WCC-B-A, WCC-B-B, WCC-B-C, WCC-B-D, FB-B-A, RB-B-A	**03-Dec-2018**	**----**	----	----	**07-Dec-2018**	31-Dec-2018	✓
EP005: Total Organic Carbon (TOC)							
Amber TOC Vial - Sulfuric Acid (EP005)							
GC-B-A, GC-B-B, GC-B-C, WCC-B-A, WCC-B-B, WCC-B-C	**03-Dec-2018**	**----**	----	----	**06-Dec-2018**	31-Dec-2018	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP008: Chlorophyll a & Pheophytin a							
White Plastic Bottle - Unpreserved (EP008)							
GC-B-A, GC-B-B, GC-B-C, WCC-B-A, WCC-B-B, WCC-B-C	**03-Dec-2018**	**----**	----	----	**05-Dec-2018**	05-Dec-2018	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N - Ultra-Trace in Saline Waters	EK255A-SW	1	10	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS - Low Level	EG035F-LL	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Fresh Water -Suite A by ORC-ICPMS	EG094A-F	1	6	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Fresh Water -Suite B by ORC-ICPMS	EG094B-F	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Saline Water -Suite A by ORC-ICPMS	EG093A-F	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Saline Water -Suite B by ORC-ICPMS	EG093B-F	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N - Ultra-Trace in Saline Waters	EK259A-SW	1	10	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Ultra-Trace in Saline Waters	EK257A-SW	1	10	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P - Ultra-Trace in Saline Water	EK271A-SW	1	10	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids	EA025	3	23	**13.04**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS - Low Level	EG035T-LL	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Fresh Water -Suite A by ORC-ICPMS	EG094A-T	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Fresh Water -Suite B by ORC-ICPMS	EG094B-T	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Saline Water Suite A by ORC-ICPMS	EG093A-T	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Saline Water -Suite B by ORC-ICPMS	EG093B-T	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Nitrogen/Persulfate Digestion/Ultra-Trace/Saline	EK262PA-SW	1	10	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus/Persulfate Digestion/ Ultra Trace /Saline	EK267PA-SW	1	10	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia as N - Ultra-Trace in Saline Waters	EK255A-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorophyll a and Pheophytin a	EP008	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS - Low Level	EG035F-LL	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Fresh Water -Suite A by ORC-ICPMS	EG094A-F	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Fresh Water -Suite B by ORC-ICPMS	EG094B-F	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Saline Water -Suite A by ORC-ICPMS	EG093A-F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Saline Water -Suite B by ORC-ICPMS	EG093B-F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N - Ultra-Trace in Saline Waters	EK259A-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Ultra-Trace in Saline Waters	EK257A-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P - Ultra-Trace in Saline Water	EK271A-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids	EA025	4	23	**17.39**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS - Low Level	EG035T-LL	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Fresh Water -Suite A by ORC-ICPMS	EG094A-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Fresh Water -Suite B by ORC-ICPMS	EG094B-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Saline Water Suite A by ORC-ICPMS	EG093A-T	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Saline Water -Suite B by ORC-ICPMS	EG093B-T	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Nitrogen/Persulfate Digestion/Ultra-Trace/Saline	EK262PA-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Control Samples (LCS) - Continued							
Total Organic Carbon	EP005	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus/Persulfate Digestion/ Ultra Trace /Saline	EK267PA-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N - Ultra-Trace in Saline Waters	EK255A-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorophyll a and Pheophytin a	EP008	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS - Low Level	EG035F-LL	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Fresh Water -Suite A by ORC-ICPMS	EG094A-F	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Fresh Water -Suite B by ORC-ICPMS	EG094B-F	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Saline Water -Suite A by ORC-ICPMS	EG093A-F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Saline Water -Suite B by ORC-ICPMS	EG093B-F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N - Ultra-Trace in Saline Waters	EK259A-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Ultra-Trace in Saline Waters	EK257A-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P - Ultra-Trace in Saline Water	EK271A-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids	EA025	2	23	**8.70**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS - Low Level	EG035T-LL	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Fresh Water -Suite A by ORC-ICPMS	EG094A-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Fresh Water -Suite B by ORC-ICPMS	EG094B-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Saline Water Suite A by ORC-ICPMS	EG093A-T	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Saline Water -Suite B by ORC-ICPMS	EG093B-T	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Nitrogen/Persulfate Digestion/Ultra-Trace/Saline	EK262PA-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus/Persulfate Digestion/ Ultra Trace /Saline	EK267PA-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N - Ultra-Trace in Saline Waters	EK255A-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS - Low Level	EG035F-LL	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Fresh Water -Suite A by ORC-ICPMS	EG094A-F	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals in Saline Water -Suite A by ORC-ICPMS	EG093A-F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N - Ultra-Trace in Saline Waters	EK259A-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N - Ultra-Trace in Saline Waters	EK257A-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P - Ultra-Trace in Saline Water	EK271A-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS - Low Level	EG035T-LL	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Fresh Water -Suite A by ORC-ICPMS	EG094A-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals in Saline Water Suite A by ORC-ICPMS	EG093A-T	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Nitrogen/Persulfate Digestion/Ultra-Trace/Saline	EK262PA-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus/Persulfate Digestion/ Ultra Trace /Saline	EK267PA-SW	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Suspended Solids	EA025	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Particle Sizing in Water by Laser Diffraction Analysis	* EA154	WATER	Particle Size Analysis of Particulates in Water by Laser Diffraction Analysis according to APHA Method 2560D
Dissolved Mercury by FIMS - Low Level	EG035F-LL	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS - Low Level	EG035T-LL	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals in Saline Water -Suite A by ORC-ICPMS	EG093A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020 Samples are 0.45µm filtered prior to analysis. The ORC-ICPMS technique removes interfering species through a series of chemical reactions prior to ion detection. Ions are passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to measurement by a discrete dynode ion detector. This method is compliant with NEPM (2013) Schedule B(3)
Total Metals in Saline Water Suite A by ORC-ICPMS	EG093A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020. The ORC-ICPMS technique removes interfering species through a series of chemical reactions prior to ion detection. Ions are passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to measurement by a discrete dynode ion detector. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals in Saline Water -Suite B by ORC-ICPMS	EG093B-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020 Samples are 0.45µm filtered prior to analysis. The ORC-ICPMS technique removes interfering species through a series of chemical reactions prior to ion detection. Ions are passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to measurement by a discrete dynode ion detector. This method is compliant with NEPM (2013) Schedule B(3)
Total Metals in Saline Water -Suite B by ORC-ICPMS	EG093B-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020. The ORC-ICPMS technique removes interfering species through a series of chemical reactions prior to ion detection. Ions are passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to measurement by a discrete dynode ion detector. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Metals in Fresh Water -Suite A by ORC-ICPMS	EG094A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020 Samples are 0.45µm filtered prior to analysis. The ORC-ICPMS technique removes interfering species through a series of chemical reactions prior to ion detection. Ions are passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to measurement by a discrete dynode ion detector. This method is compliant with NEPM (2013) Schedule B(3)
Total Metals in Fresh Water -Suite A by ORC-ICPMS	EG094A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020. The ORC-ICPMS technique removes interfering species through a series of chemical reactions prior to ion detection. Ions are passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to measurement by a discrete dynode ion detector. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals in Fresh Water -Suite B by ORC-ICPMS	EG094B-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020 Samples are 0.45µm filtered prior to analysis. The ORC-ICPMS technique removes interfering species through a series of chemical reactions prior to ion detection. Ions are passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to measurement by a discrete dynode ion detector. This method is compliant with NEPM (2013) Schedule B(3)
Total Metals in Fresh Water -Suite B by ORC-ICPMS	EG094B-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020. The ORC-ICPMS technique removes interfering species through a series of chemical reactions prior to ion detection. Ions are passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to measurement by a discrete dynode ion detector. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N - Ultra-Trace in Saline Waters	EK255A-SW	WATER	In house: Referenced to APHA 4500-NH3 H. Ammonia is determined by direct colorimetry by FIA. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N - Ultra-Trace in Saline Waters	EK257A-SW	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by FIA.
Nitrate as N - Ultra-Trace in Saline Waters	EK258A-SW	WATER	In house: Referenced to APHA 4500-NO3- I. Nitrate is reduced to nitrite by way of a cadmium reduction column followed by quantification by FIA. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results.
Nitrite and Nitrate as N - Ultra-Trace in Saline Waters	EK259A-SW	WATER	In house: Referenced to APHA 4500-NO3- I. Combined oxidised Nitrogen (NO2+NO3) is determined by Cadmium Reduction and direct colourimetry by FIA.
TKN (Total N - NOx-N). (FIA - UT) in Saline Waters	EK261PA-SW	WATER	In house: Referenced to APHA 4500-P J. & 4500-NO3- I. Calculated by difference from total Nitrogen and NOx. Contributing method parameters are determined by FIA. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen/Persulfate Digestion/Ultra-Trace/Saline	EK262PA-SW	WATER	In house: Referenced to APHA 4500-P J. Persulfate Method for Simultaneous Determination of Total Nitrogen and Total Phosphorus. As sample is digested with persulfate under alkaline conditions yielding orthophosphate and nitrate. Following digestion, analytes are determined by flow injection analysis. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus/Persulfate Digestion/ Ultra Trace /Saline	EK267PA-SW	WATER	In house: Referenced to APHA 4500-P J. Persulfate Method for Simultaneous Determination of Total Nitrogen and Total Phosphorus. As sample is digested with persulfate under alkaline conditions yielding orthophosphate and nitrate. Following digestion, analytes are determined by flow injection analysis. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Reactive Phosphorus as P - Ultra-Trace in Saline Water	EK271A-SW	WATER	In house: Referenced to APHA 4500-P E Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by FIA. This method is compliant with NEPM (2013) Schedule B(3)
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM (2013) Schedule B(3)
Chlorophyll a and Pheophytin a	EP008	WATER	In house: Referenced to APHA 10200 H. The pigments are extracted into aqueous acetone. The optical density of the extract before and after acidification at both 664 nm and 665 nm is determined spectrometrically.

Preparation Methods	Method	Matrix	Method Descriptions
Persulfate Digestion for UT Dissolved TN and TP for FIA fin	EK262/267PA-SW Prep	WATER	In house: Referenced to APHA 4500 P - J. This method is compliant with NEPM (2013) Schedule B(3)
Digestion for Total Recoverable Metals - ORC	EN25-ORC	WATER	In house: Referenced to USEPA SW846-3005. This is an Ultrapure Nitric acid digestion procedure used to prepare surface and ground water samples for analysis by ORC- ICPMS. This method is compliant with NEPM (2013) Schedule B(3)

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CERTIFICATE OF ANALYSIS 207221

Client Details

Client	BMT
Attention	Darren Richardson
Address	Lvl 8, 200 Creek St, Brisbane, QLD, 4000

Sample Details

Your Reference	**B23483 - BMT**
Number of Samples	12 Water
Date samples received	04/12/2018
Date completed instructions received	04/12/2018

Analysis Details

Please refer to the following pages for results, methodology summary and quality control data.

Samples were analysed as received from the client. Results relate specifically to the samples as received.

Results are reported on a dry weight basis for solids and on an as received basis for other matrices.

Please refer to the last page of this report for any comments relating to the results.

Report Details

Date results requested by	11/12/2018
Date of Issue	11/12/2018

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Results Approved By
Leon Ow, Chemist
Nick Sarlamis, Inorganics Supervisor

Authorised By

Jacinta Hurst, Laboratory Manager

HM in water - dissolved						
Our Reference		207221-1	207221-2	207221-3	207221-4	207221-5
Your Reference	UNITS	GAT-B-A	DMPA-B-A	DMPA-B-B	GAT-30-A	GAT-60-A
Date Sampled		02/12/2018	02/12/2018	02/12/2018	02/12/2018	02/12/2018
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	06/12/2018	06/12/2018	06/12/2018	06/12/2018	06/12/2018
Date analysed	-	06/12/2018	06/12/2018	06/12/2018	06/12/2018	06/12/2018
Aluminium-Dissolved	µg/L	<10	<10	<10	<10	<10
Arsenic-Dissolved	µg/L	1	1	1	1	1
Cadmium-Dissolved	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium-Dissolved	µg/L	<1	<1	<1	<1	<1
Copper-Dissolved	µg/L	<1	<1	<1	<1	<1
Iron-Dissolved	µg/L	<10	<10	<10	<10	<10
Lead-Dissolved	µg/L	<1	<1	<1	<1	<1
Manganese-Dissolved	µg/L	<5	<5	<5	<5	<5
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel-Dissolved	µg/L	<1	<1	<1	<1	<1
Silver-Dissolved	µg/L	<1	<1	<1	<1	<1
Zinc-Dissolved	µg/L	5	1	1	2	2

HM in water - dissolved						
Our Reference		207221-6	207221-7	207221-8	207221-9	207221-10
Your Reference	UNITS	GAT-60-B	GAT-120-A	DMPA-30-A	DMPA-60-A	DMPA-60-B
Date Sampled		02/12/2018	02/12/2018	02/12/2018	02/12/2018	02/12/2018
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	06/12/2018	06/12/2018	06/12/2018	06/12/2018	06/12/2018
Date analysed	-	06/12/2018	06/12/2018	06/12/2018	06/12/2018	06/12/2018
Aluminium-Dissolved	µg/L	<10	<10	<10	<10	<10
Arsenic-Dissolved	µg/L	1	1	1	2	1
Cadmium-Dissolved	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium-Dissolved	µg/L	<1	<1	<1	<1	<1
Copper-Dissolved	µg/L	<1	<1	<1	<1	<1
Iron-Dissolved	µg/L	<10	<10	<10	<10	<10
Lead-Dissolved	µg/L	<1	<1	<1	<1	<1
Manganese-Dissolved	µg/L	<5	<5	<5	<5	<5
Mercury-Dissolved	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel-Dissolved	µg/L	<1	<1	<1	<1	<1
Silver-Dissolved	µg/L	<1	<1	<1	<1	<1
Zinc-Dissolved	µg/L	1	1	2	1	<1

HM in water - dissolved			
Our Reference		207221-11	207221-12
Your Reference	UNITS	DMPA-120-A	DMPA-120-B
Date Sampled		02/12/2018	02/12/2018
Type of sample		Water	Water
Date prepared	-	06/12/2018	06/12/2018
Date analysed	-	06/12/2018	06/12/2018
Aluminium-Dissolved	µg/L	<10	<10
Arsenic-Dissolved	µg/L	1	1
Cadmium-Dissolved	µg/L	<0.1	<0.1
Chromium-Dissolved	µg/L	<1	<1
Copper-Dissolved	µg/L	<1	<1
Iron-Dissolved	µg/L	<10	<10
Lead-Dissolved	µg/L	<1	<1
Manganese-Dissolved	µg/L	<5	<5
Mercury-Dissolved	µg/L	<0.05	<0.05
Nickel-Dissolved	µg/L	<1	<1
Silver-Dissolved	µg/L	<1	<1
Zinc-Dissolved	µg/L	2	<1

HM in water - total						
Our Reference		207221-1	207221-2	207221-3	207221-4	207221-5
Your Reference	UNITS	GAT-B-A	DMPA-B-A	DMPA-B-B	GAT-30-A	GAT-60-A
Date Sampled		02/12/2018	02/12/2018	02/12/2018	02/12/2018	02/12/2018
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	07/12/2018	07/12/2018	07/12/2018	07/12/2018	07/12/2018
Date analysed	-	07/12/2018	07/12/2018	07/12/2018	07/12/2018	07/12/2018
Aluminium-Total	µg/L	60	10	10	100	80
Arsenic-Total	µg/L	2	2	2	2	2
Cadmium-Total	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium-Total	µg/L	<1	<1	<1	<1	<1
Copper-Total	µg/L	<1	<1	<1	<1	<1
Iron-Total	µg/L	93	12	13	190	140
Lead-Total	µg/L	<1	<1	<1	<1	<1
Manganese-Total	µg/L	<5	<5	<5	10	7
Mercury-Total	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel-Total	µg/L	<1	<1	<1	<1	<1
Silver-Total	µg/L	<1	<1	<1	<1	<1
Zinc-Total	µg/L	8	3	2	4	3

HM in water - total						
Our Reference		207221-6	207221-7	207221-8	207221-9	207221-10
Your Reference	UNITS	GAT-60-B	GAT-120-A	DMPA-30-A	DMPA-60-A	DMPA-60-B
Date Sampled		02/12/2018	02/12/2018	02/12/2018	02/12/2018	02/12/2018
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	07/12/2018	07/12/2018	07/12/2018	07/12/2018	07/12/2018
Date analysed	-	07/12/2018	07/12/2018	07/12/2018	07/12/2018	07/12/2018
Aluminium-Total	µg/L	80	70	220	50	140
Arsenic-Total	µg/L	2	2	2	2	2
Cadmium-Total	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chromium-Total	µg/L	<1	<1	<1	<1	<1
Copper-Total	µg/L	<1	<1	<1	<1	<1
Iron-Total	µg/L	160	140	560	82	370
Lead-Total	µg/L	<1	<1	<1	<1	<1
Manganese-Total	µg/L	7	6	23	7	16
Mercury-Total	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Nickel-Total	µg/L	<1	<1	<1	<1	<1
Silver-Total	µg/L	<1	<1	<1	<1	<1
Zinc-Total	µg/L	2	2	3	2	2

HM in water - total			
Our Reference	UNITS	207221-11	207221-12
Your Reference		DMPA-120-A	DMPA-120-B
Date Sampled		02/12/2018	02/12/2018
Type of sample		Water	Water
Date prepared	-	07/12/2018	07/12/2018
Date analysed	-	07/12/2018	07/12/2018
Aluminium-Total	µg/L	80	90
Arsenic-Total	µg/L	2	2
Cadmium-Total	µg/L	<0.1	<0.1
Chromium-Total	µg/L	<1	<1
Copper-Total	µg/L	<1	<1
Iron-Total	µg/L	160	210
Lead-Total	µg/L	<1	<1
Manganese-Total	µg/L	11	13
Mercury-Total	µg/L	<0.05	<0.05
Nickel-Total	µg/L	<1	<1
Silver-Total	µg/L	<1	<1
Zinc-Total	µg/L	3	3

Miscellaneous Inorganics						
Our Reference		207221-1	207221-2	207221-3	207221-4	207221-5
Your Reference	UNITS	GAT-B-A	DMPA-B-A	DMPA-B-B	GAT-30-A	GAT-60-A
Date Sampled		02/12/2018	02/12/2018	02/12/2018	02/12/2018	02/12/2018
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	05/12/2018	05/12/2018	05/12/2018	05/12/2018	05/12/2018
Date analysed	-	05/12/2018	05/12/2018	05/12/2018	05/12/2018	05/12/2018
Total Nitrogen in water	mg/L	0.3	<0.1	<0.1	<0.1	<0.1
Nitrate as N in water	mg/L	0.006	0.008	<0.005	0.006	0.006
Nitrite as N in water	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Ammonia as N in water	mg/L	0.019	0.012	0.015	0.017	0.016
Phosphate as P in water	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005

Miscellaneous Inorganics						
Our Reference		207221-6	207221-7	207221-8	207221-9	207221-10
Your Reference	UNITS	GAT-60-B	GAT-120-A	DMPA-30-A	DMPA-60-A	DMPA-60-B
Date Sampled		02/12/2018	02/12/2018	02/12/2018	02/12/2018	02/12/2018
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	05/12/2018	05/12/2018	05/12/2018	05/12/2018	05/12/2018
Date analysed	-	05/12/2018	05/12/2018	05/12/2018	05/12/2018	05/12/2018
Total Nitrogen in water	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate as N in water	mg/L	0.005	0.007	<0.005	<0.005	<0.005
Nitrite as N in water	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005
Ammonia as N in water	mg/L	0.018	0.016	0.010	0.01	0.010
Phosphate as P in water	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005

Miscellaneous Inorganics			
Our Reference		207221-11	207221-12
Your Reference	UNITS	DMPA-120-A	DMPA-120-B
Date Sampled		02/12/2018	02/12/2018
Type of sample		Water	Water
Date prepared	-	05/12/2018	05/12/2018
Date analysed	-	05/12/2018	05/12/2018
Total Nitrogen in water	mg/L	<0.1	<0.1
Nitrate as N in water	mg/L	0.01	<0.005
Nitrite as N in water	mg/L	<0.005	<0.005
Ammonia as N in water	mg/L	0.010	0.015
Phosphate as P in water	mg/L	<0.005	<0.005

Metals in Waters - Total						
Our Reference		207221-1	207221-2	207221-3	207221-4	207221-5
Your Reference	UNITS	GAT-B-A	DMPA-B-A	DMPA-B-B	GAT-30-A	GAT-60-A
Date Sampled		02/12/2018	02/12/2018	02/12/2018	02/12/2018	02/12/2018
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	06/12/2018	06/12/2018	06/12/2018	06/12/2018	06/12/2018
Date analysed	-	07/12/2018	07/12/2018	07/12/2018	07/12/2018	07/12/2018
Phosphorus - Total	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05

Metals in Waters - Total						
Our Reference		207221-6	207221-7	207221-8	207221-9	207221-10
Your Reference	UNITS	GAT-60-B	GAT-120-A	DMPA-30-A	DMPA-60-A	DMPA-60-B
Date Sampled		02/12/2018	02/12/2018	02/12/2018	02/12/2018	02/12/2018
Type of sample		Water	Water	Water	Water	Water
Date prepared	-	06/12/2018	06/12/2018	06/12/2018	06/12/2018	06/12/2018
Date analysed	-	07/12/2018	07/12/2018	07/12/2018	07/12/2018	07/12/2018
Phosphorus - Total	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05

Metals in Waters - Total			
Our Reference		207221-11	207221-12
Your Reference	UNITS	DMPA-120-A	DMPA-120-B
Date Sampled		02/12/2018	02/12/2018
Type of sample		Water	Water
Date prepared	-	06/12/2018	06/12/2018
Date analysed	-	07/12/2018	07/12/2018
Phosphorus - Total	mg/L	<0.05	<0.05

Method ID	Methodology Summary
Inorg-055	Nitrate - determined colourimetrically. Soils are analysed following a water extraction.
Inorg-055	Nitrite - determined colourimetrically based on APHA latest edition NO2- B. Soils are analysed following a water extraction.
Inorg-055/062	Total Nitrogen - Calculation sum of TKN and oxidised Nitrogen.
Inorg-057	Ammonia - determined colourimetrically, based on APHA latest edition 4500-NH3 F. Soils are analysed following a KCl extraction.
Inorg-060	Phosphate determined colourimetrically based on EPA365.1 and APHA latest edition 4500 P E. Soils are analysed following a water extraction.
Metals-020	Determination of various metals by ICP-AES.
Metals-021	Determination of Mercury by Cold Vapour AAS.
Metals-022	Determination of various metals by ICP-MS.

QUALITY CONTROL: HM in water - dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	207221-2
Date prepared	-			06/12/2018	1	06/12/2018	06/12/2018		06/12/2018	06/12/2018
Date analysed	-			06/12/2018	1	06/12/2018	06/12/2018		06/12/2018	06/12/2018
Aluminium-Dissolved	µg/L	10	Metals-022	<10	1	<10	<10	0	119	116
Arsenic-Dissolved	µg/L	1	Metals-022	<1	1	1	1	0	108	107
Cadmium-Dissolved	µg/L	0.1	Metals-022	<0.1	1	<0.1	<0.1	0	107	94
Chromium-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	112	102
Copper-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	104	85
Iron-Dissolved	µg/L	10	Metals-022	<10	1	<10	<10	0	109	99
Lead-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	109	91
Manganese-Dissolved	µg/L	5	Metals-022	<5	1	<5	<5	0	113	106
Mercury-Dissolved	µg/L	0.05	Metals-021	<0.05	1	<0.05	<0.05	0	90	84
Nickel-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	108	91
Silver-Dissolved	µg/L	1	Metals-022	<1	1	<1	<1	0	110	90
Zinc-Dissolved	µg/L	1	Metals-022	<1	1	5	4	22	108	95

QUALITY CONTROL: HM in water - dissolved						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	11	06/12/2018	06/12/2018		[NT]	[NT]
Date analysed	-			[NT]	11	06/12/2018	06/12/2018		[NT]	[NT]
Aluminium-Dissolved	µg/L	10	Metals-022	[NT]	11	<10	<10	0	[NT]	[NT]
Arsenic-Dissolved	µg/L	1	Metals-022	[NT]	11	1	1	0	[NT]	[NT]
Cadmium-Dissolved	µg/L	0.1	Metals-022	[NT]	11	<0.1	<0.1	0	[NT]	[NT]
Chromium-Dissolved	µg/L	1	Metals-022	[NT]	11	<1	<1	0	[NT]	[NT]
Copper-Dissolved	µg/L	1	Metals-022	[NT]	11	<1	<1	0	[NT]	[NT]
Iron-Dissolved	µg/L	10	Metals-022	[NT]	11	<10	<10	0	[NT]	[NT]
Lead-Dissolved	µg/L	1	Metals-022	[NT]	11	<1	<1	0	[NT]	[NT]
Manganese-Dissolved	µg/L	5	Metals-022	[NT]	11	<5	<5	0	[NT]	[NT]
Mercury-Dissolved	µg/L	0.05	Metals-021	[NT]	11	<0.05	<0.05	0	[NT]	[NT]
Nickel-Dissolved	µg/L	1	Metals-022	[NT]	11	<1	<1	0	[NT]	[NT]
Silver-Dissolved	µg/L	1	Metals-022	[NT]	11	<1	<1	0	[NT]	[NT]
Zinc-Dissolved	µg/L	1	Metals-022	[NT]	11	2	1	67	[NT]	[NT]

QUALITY CONTROL: HM in water - total						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W2	207221-2
Date prepared	-			07/12/2018	1	07/12/2018	07/12/2018		07/12/2018	07/12/2018
Date analysed	-			07/12/2018	1	07/12/2018	07/12/2018		07/12/2018	07/12/2018
Aluminium-Total	µg/L	10	Metals-022	<10	1	60	70	15	108	101
Arsenic-Total	µg/L	1	Metals-022	<1	1	2	2	0	99	98
Cadmium-Total	µg/L	0.1	Metals-022	<0.1	1	<0.1	<0.1	0	99	87
Chromium-Total	µg/L	1	Metals-022	<1	1	<1	<1	0	106	97
Copper-Total	µg/L	1	Metals-022	<1	1	<1	<1	0	106	103
Iron-Total	µg/L	10	Metals-022	<10	1	93	100	7	105	94
Lead-Total	µg/L	1	Metals-022	<1	1	<1	<1	0	100	89
Manganese-Total	µg/L	5	Metals-022	<5	1	<5	<5	0	109	102
Mercury-Total	µg/L	0.05	Metals-021	<0.05	1	<0.05	<0.05	0	98	87
Nickel-Total	µg/L	1	Metals-022	<1	1	<1	<1	0	101	84
Silver-Total	µg/L	1	Metals-022	<1	1	<1	<1	0	102	84
Zinc-Total	µg/L	1	Metals-022	<1	1	8	8	0	101	86

QUALITY CONTROL: HM in water - total						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	11	07/12/2018	07/12/2018		[NT]	[NT]
Date analysed	-			[NT]	11	07/12/2018	07/12/2018		[NT]	[NT]
Aluminium-Total	µg/L	10	Metals-022	[NT]	11	80	80	0	[NT]	[NT]
Arsenic-Total	µg/L	1	Metals-022	[NT]	11	2	2	0	[NT]	[NT]
Cadmium-Total	µg/L	0.1	Metals-022	[NT]	11	<0.1	<0.1	0	[NT]	[NT]
Chromium-Total	µg/L	1	Metals-022	[NT]	11	<1	<1	0	[NT]	[NT]
Copper-Total	µg/L	1	Metals-022	[NT]	11	<1	<1	0	[NT]	[NT]
Iron-Total	µg/L	10	Metals-022	[NT]	11	160	170	6	[NT]	[NT]
Lead-Total	µg/L	1	Metals-022	[NT]	11	<1	<1	0	[NT]	[NT]
Manganese-Total	µg/L	5	Metals-022	[NT]	11	11	11	0	[NT]	[NT]
Mercury-Total	µg/L	0.05	Metals-021	[NT]	11	<0.05	<0.05	0	[NT]	[NT]
Nickel-Total	µg/L	1	Metals-022	[NT]	11	<1	<1	0	[NT]	[NT]
Silver-Total	µg/L	1	Metals-022	[NT]	11	<1	<1	0	[NT]	[NT]
Zinc-Total	µg/L	1	Metals-022	[NT]	11	3	3	0	[NT]	[NT]

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W1	207221-2
Date prepared	-			05/12/2018	1	05/12/2018	05/12/2018		05/12/2018	05/12/2018
Date analysed	-			05/12/2018	1	05/12/2018	05/12/2018		05/12/2018	05/12/2018
Total Nitrogen in water	mg/L	0.1	Inorg-055/062	<0.1	1	0.3	0.2	40	112	102
Nitrate as N in water	mg/L	0.005	Inorg-055	<0.005	1	0.006	0.005	18	99	#
Nitrite as N in water	mg/L	0.005	Inorg-055	<0.005	1	<0.005	<0.005	0	113	103
Ammonia as N in water	mg/L	0.005	Inorg-057	<0.005	1	0.019	0.019	0	102	116
Phosphate as P in water	mg/L	0.005	Inorg-060	<0.005	1	<0.005	<0.005	0	117	109

QUALITY CONTROL: Miscellaneous Inorganics						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	11	05/12/2018	05/12/2018		[NT]	[NT]
Date analysed	-			[NT]	11	05/12/2018	05/12/2018		[NT]	[NT]
Total Nitrogen in water	mg/L	0.1	Inorg-055/062	[NT]	11	<0.1	<0.1	0	[NT]	[NT]
Nitrate as N in water	mg/L	0.005	Inorg-055	[NT]	11	0.01	0.01	0	[NT]	[NT]
Nitrite as N in water	mg/L	0.005	Inorg-055	[NT]	11	<0.005	<0.005	0	[NT]	[NT]
Ammonia as N in water	mg/L	0.005	Inorg-057	[NT]	11	0.010	0.011	10	[NT]	[NT]
Phosphate as P in water	mg/L	0.005	Inorg-060	[NT]	11	<0.005	<0.005	0	[NT]	[NT]

QUALITY CONTROL: Metals in Waters - Total						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	LCS-W3	207221-2
Date prepared	-			06/12/2018	1	06/12/2018	06/12/2018		06/12/2018	06/12/2018
Date analysed	-			07/12/2018	1	07/12/2018	07/12/2018		07/12/2018	07/12/2018
Phosphorus - Total	mg/L	0.05	Metals-020	<0.05	1	<0.05	<0.05	0	103	114

QUALITY CONTROL: Metals in Waters - Total						Duplicate			Spike Recovery %	
Test Description	Units	PQL	Method	Blank	#	Base	Dup.	RPD	[NT]	[NT]
Date prepared	-			[NT]	11	06/12/2018	06/12/2018		[NT]	[NT]
Date analysed	-			[NT]	11	07/12/2018	07/12/2018		[NT]	[NT]
Phosphorus - Total	mg/L	0.05	Metals-020	[NT]	11	<0.05	<0.05	0	[NT]	[NT]

Result Definitions

NT	Not tested
NA	Test not required
INS	Insufficient sample for this test
PQL	Practical Quantitation Limit
<	Less than
>	Greater than
RPD	Relative Percent Difference
LCS	Laboratory Control Sample
NS	Not specified
NEPM	National Environmental Protection Measure
NR	Not Reported

Quality Control Definitions

Blank	This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.
Duplicate	This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.
Matrix Spike	A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.
LCS (Laboratory Control Sample)	This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.
Surrogate Spike	Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.

Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.

Spikes for Physical and Aggregate Tests are not applicable.

For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: >10xPQL - RPD acceptance criteria will vary depending on the analytes and the analytical techniques but is typically in the range 20%-50% – see ELN-P05 QA/QC tables for details; <10xPQL - RPD are higher as the results approach PQL and the estimated measurement uncertainty will statistically increase.

Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

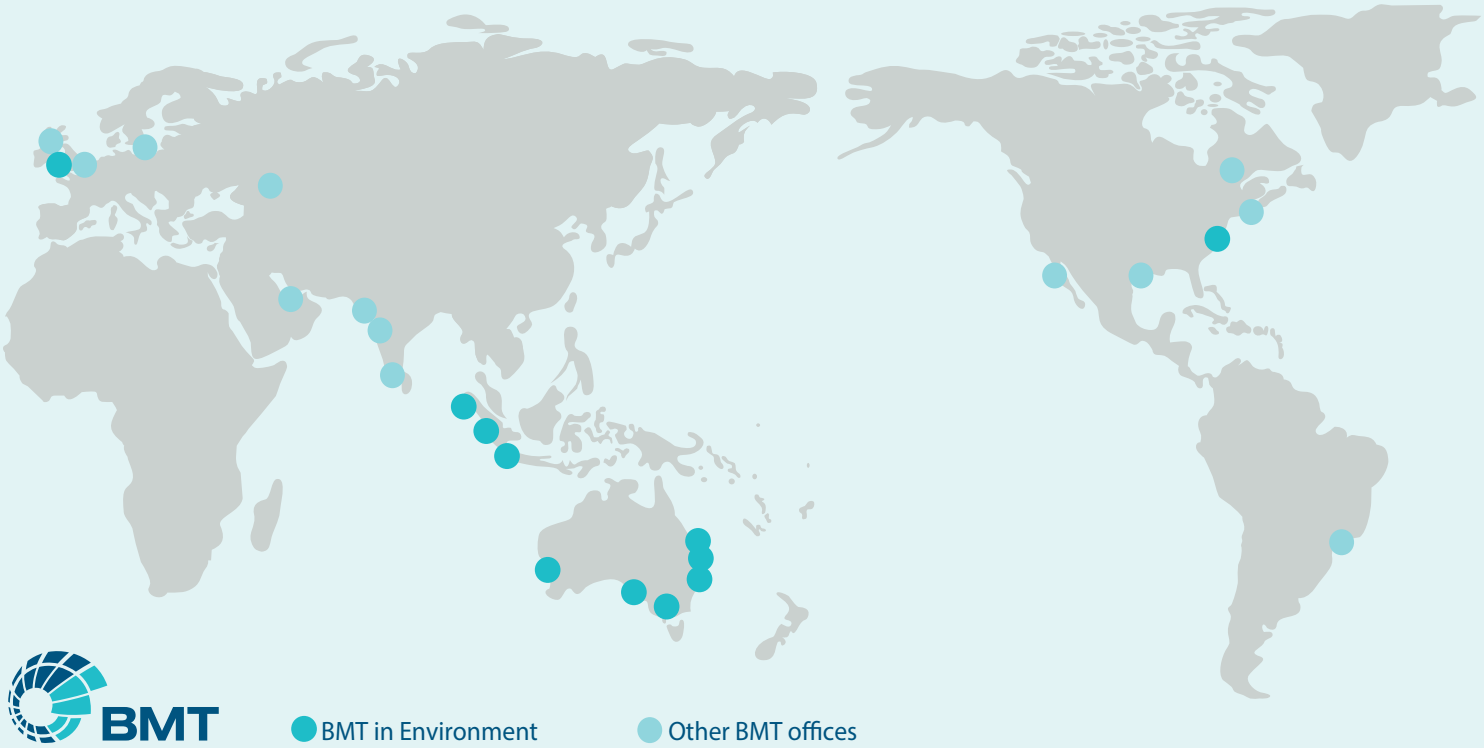
Measurement Uncertainty estimates are available for most tests upon request.

Report Comments

MISC_INORG: Nitrate # Percent recovery is not possible to report due to matrix interference. . However an acceptable recovery was obtained for the LCS.

BMT has a proven record in addressing today's engineering and environmental issues.

Our dedication to developing innovative approaches and solutions enhances our ability to meet our client's most challenging needs.



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