PLANETARY

Marine Environmental Baseline Survey

May 2023

Final Report

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<tr><th>Rev</th><th>Date</th><th>Authors</th><th>Status</th></tr>
<tr><td>1</td><td>06/03/24</td><td rowspan="2">Dr Will Burt
Dr Yuanyuan Xu
Dr Robert Izett
Brenan Duhamel
Tim Cross
Marie Egert</td><td>Draft</td></tr>
<tr><td>2</td><td>28/03/24</td><td>Final</td></tr>
</table>

Executive Summary

Planetary Technologies, with support from Plymouth Marine Laboratory Applications (PMLA), carried out a marine environmental baseline survey in St Ives Bay. Surveys were undertaken between the 6th and 7th May 2023 using three sampling locations around the Hayle WWTW outfall diffusers and at a control site around ~ 5km to the west. Establishing these four survey sites was a key goal of this effort. The survey comprised a seawater column profiling study, a benthic marine ecology study and physicochemical sampling of marine water, plankton, seabed sediment and benthic invertebrate specimens, with subsequent laboratory analysis of various parameters including trace metals and total suspended solids.

This report focuses on sharing results and providing interpretations from Planetary's technical team.

- Seawater column profiling showed typical values for coastal UK waters in spring. The water column was well mixed with some minor stratification at certain sites, with strong tidal flows the chief driver behind observed variation. A minor pH and salinity signal possibly corresponding to the freshwater input from the diffuser was discernible in the southern mid-field mixing zone (MMZ-S).
- TSS samples showed no significant spatial pattern between sites. Substantial variability between triplicate samples highlights the need for repeat sampling at each station in future work, together with parallel turbidity monitoring.
- Water column and plankton results from this survey compare well to general patterns found at the long-term L4 monitoring station near Plymouth (approximately 95 km to the east), providing helpful validation while also highlighting the potential utility of the L4 station to contextualize results from St. Ives Bay going forward.
- Plankton data showed a diatom dominated phytoplankton community, indicating that sampling took place during a spring bloom period. No clear differences were found between the stations. Given the dynamic nature of the plankton community, this initial snapshot should be followed up with repeat surveys to understand, at minimum, seasonal and interannual variability.
- Most of the 18 metals parameters analysed were either undetected or presented detected values below UK and international guideline threshold values (including US EPA, Dutch, ANZ and Canadian standards), suggesting minimal risk of adverse environmental impact from metals loading. The exception to this was mercury, which presented concentrations exceeding UK MAC (0.07 µg/L) and Canadian long-term (0.016 µg/L) guideline values at the Diffuser and Control locations (two of three triplicate samples), and at the MMZ-NE station (one of three triplicate samples). Mercury concentrations did not exceed any of the other guideline threshold values in any samples.
- The overall metals loading in seawater did not appear to differ markedly between the Control and Diffuser locations, suggesting that the observed trends may be attributable to elevated background levels as opposed to point source contamination.
- Analyses for trace metals in marine sediment found that the majority of parameters were either undetected or presented detected values below UK and international guideline threshold values (including ANZ, Dutch, Canadian and ERL/ERM thresholds from Long et al. 1995). The exception to this was for zinc in all marine sediment samples from the Diffuser and MMZ-S stations, which ranged between 20.5 – 24.2 and 15.2 – 29.1 mg/kg, respectively. This slightly exceeds the Long et al. ERL threshold for Zn of 15 mg/kg. However, zinc levels did not exceed any of the other nine comparison thresholds used. Zinc levels at the control site were considerably lower, suggesting that proximity to either historical contamination sources (e.g. Hayle Estuary) or the wastewater diffuser, may play a role. More data will be needed to examine this in detail.
- There was minor indication of inter-station variability in overall metals loading, with the MMZ-S station, followed by the Diffuser station, presenting slightly higher values relative to the Control Station. This result, alongside the detectably lower pH and salinity at the MMZ-S site, suggests this station may be the most suitable to detect signals from the diffuser, which would be a valuable learning to inform future monitoring strategies.

- Analyses of crustacean and echinoderm invertebrate tissue samples for trace metals loading presented broadly similar results to a comparison study using the same taxonomic groups from Scottish waters. Chromium in crustacean tissue from the Diffuser location was the only exception to this, recording a value of 3.96 mg/kg dry weight. Neither UK nor international comparison standards for trace metals loading in biota are available for taxonomic groups sampled on this survey.
- A thorough literature review of trace metal data in and around St Ives Bay suggested that legacy mining contamination entering the bay through riverine flows from the Red River and Hayle Estuary has historically led to some level of elevated metals loading, particularly in sediments. The results from the nearshore waters on the current survey were generally far lower than those reported from previous studies, with the exception of the mercury in seawater results mentioned previously. Data from historical sampling further offshore in St. Ives Bay are fairly well-aligned with results found here.
- Results from the ecological dive survey at three stations (MMZ-S, Diffuser, Control) revealed similar seabed characteristics (rocky substrate interspersed with patches of sparse sediment), but some differences in the benthic community. At the Diffuser site, the three-dimensional structure of the diffusers themselves supported dense aggregations of benthic marine life, likely due to availability of hard substrate in an environment where suitable settlement space for the larvae of benthic marine organisms is limited. Some level of nutrient enrichment related to the wastewater from the diffuser is also possible.
- Overall, qualitative assessments suggested that the control site supported greater biodiversity, perhaps driven by greater structural complexity of the benthic environment which affords niche habitats for marine life.
- Semi-quantitative analyses of ecological data at the MMZ-S station showed that relative abundances were highest for gastropods (sea snails), ascidians (sea squirts), coralline sponges, red algae, ray-finned fishes, soft-shelled crustaceans, stony corals & anemones and bryozoans.

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1 Introduction

Planetary Technologies, Inc (referred to as Planetary from hereon) has undertaken marine environmental baseline survey work in St Ives Bay, as part of their wider project focusing on ocean alkalinity enhancement (OAE) at the Hayle Wastewater Treatment Works (WWTW).

Details regarding the objectives of the survey and the methods used were posted shortly after the completion of the survey in a blog on our website (https://www.planetarytech.com/survey-work-in-st-ives-bay/) on June 6th, 2023. This report provides some additional details on the methods in the survey, and shares the results found.

1.1 Project Background

1.1.1 The Importance of Marine Surveys

A critical component of Planetary's approach to an ocean alkalinity enhancement project is a good understanding of the local marine environment at and around the project location (i.e. the 'receiving waters' near an ocean outfall). This includes understanding the physics, chemistry, biology, and underlying geology of the area. This knowledge is collected through desktop reviews, marine surveys and ocean modelling studies, as well as through conversations and collaborations with local stakeholders and community members. These activities are initiated before any field trial begins but continue indefinitely in order to improve analyses and models, and to facilitate tracking temporal trends in the marine environment which might be linked to the project. The overarching goal is to create high-quality data that can inform all stakeholders about the efficacy and safety of our activities in a local ecosystem. An auxiliary benefit of this work is the establishment of a publicly shared database that can generate valuable scientific knowledge about a marine ecosystem with significant local interest.

1.1.2 The Cornwall Project: Context and History

The ocean outfall (operated by South West Water PLC) for Planetary's proposed Cornwall project terminates as a series of seabed diffusers (water depth approximately 20 meters) located near St. Ives Bay, approximately 3 km west of Godrevy Point. The project location can be seen in Figure 1-1, which shows St Ives Bay, its bathymetry, the outfall pipeline and the diffuser location.

In September 2022 a small-scale methods test was carried out at the Hayle WWTW, during which the marine system was surveyed for five full days (September 17 – 22). On three of these days (September 18th – 20th), magnesium hydroxide was released into the WWTW final effluent stream for eight hours, at a low concentration of approximately 0.02 % by volume. The Planetary team, with assistance from a team from Plymouth Marine Laboratory Applications, extensively sampled both the effluent pipe and the marine waters above and near the diffusers in the bay in an effort to collect valuable baseline data, while also understanding the measurability of the magnesium hydroxide signal during short dosing periods. The results of that study, and the lab experimentation that preceded it, have been submitted and peer-reviewed in the journal *Nature: Communications Earth and Environment*. Pending acceptance by the journal's editor, this manuscript should be published in the spring or summer of 2024. Results from that study show detectability of the OAE signal in both the effluent stream and marine water, alongside no evidence of increased suspended solids in the water column. The data collected are also used to calculate large effluent dilution rates that align well with those suggested by modelling work.

The focus of this report is the two-day baseline survey conducted in May 2023, which provides a 'spring' baseline that builds upon the findings from the initial study in autumn 2022.

1.2 Survey Objectives

The current survey was intended to document the ecological and physicochemical conditions around the diffusers and at a representative control location at the time of sampling. The report will describe existing conditions, detail any existing contamination, identify any sensitive benthic habitats and facilitate the analysis of temporal trends in future survey work.

The survey had three specific primary objectives:

(1) establish a set of sampling sites to revisit in future surveys;
(2) collect data on the physical, chemical, and biological characteristics of the water column;
(3) conduct a dive survey to collect samples of sediments and fauna for elemental analysis and assess benthic habitats in the project area, including community structure and composition

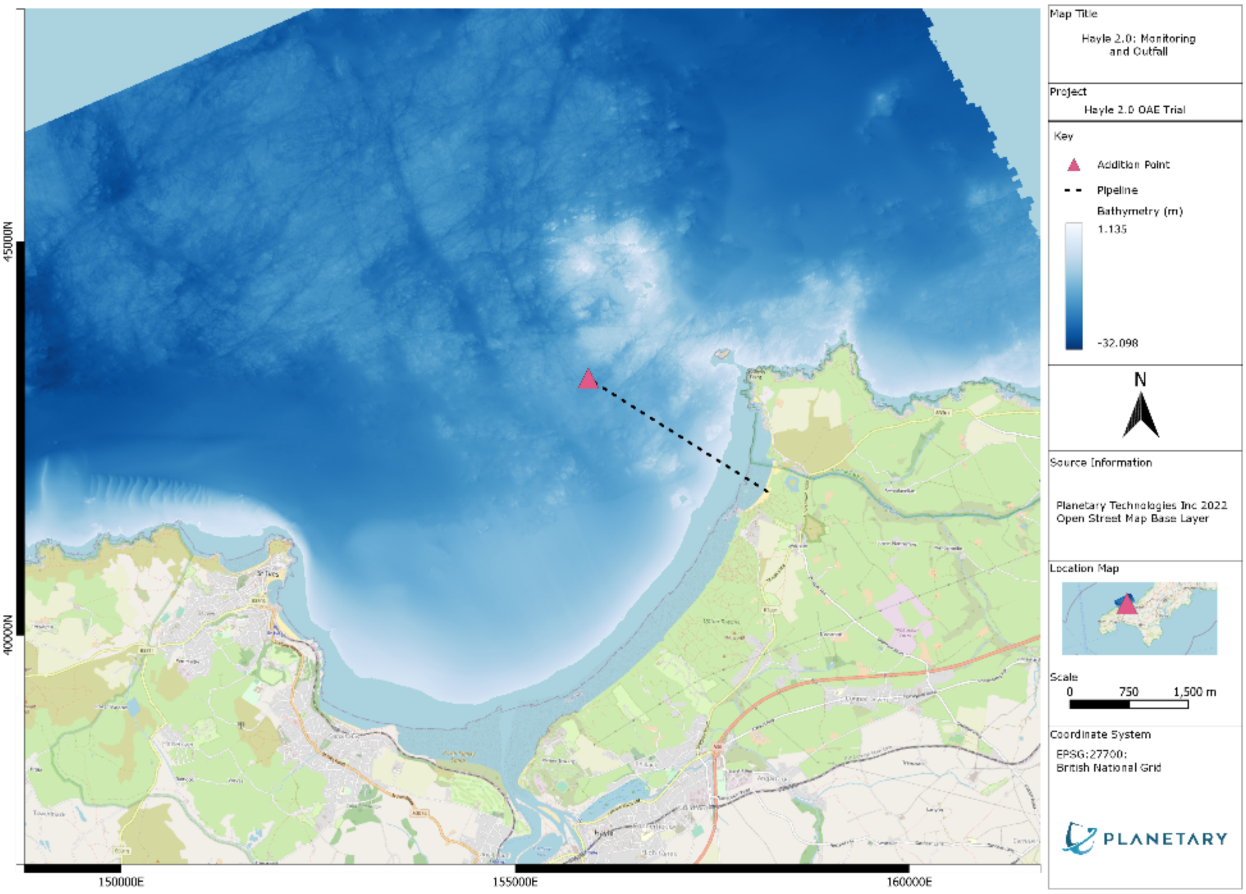

Figure 1-1. Project location and outfall pipeline in St Ives Bay, Cornwall

2 Legislation Review

A key component of the survey was the collection of seawater, sediment and invertebrate specimens for the analysis of trace metals. To provide context, these results have been compared to the following international standards and thresholds.

2.1 Seawater Quality Benchmarks

Trace metal concentrations in seawater are compared to several sets of aquatic water quality guidelines including the UK EQS guidelines derived from the Water Framework Directive (WFD), US EPA Aquatic Life Ambient Water Quality Criteria (AWQC), Australia & New Zealand Guidelines for Fresh and Marine Water Quality (ANZ), Dutch MPA and SRA_{eco} values and Canadian CCME and British Columbian guidelines for chronic and acute marine water quality. These are adopted as benchmarks against which the survey results can be compared against and contextualised. It should be noted that the Dutch SRA_{eco} represent analyte concentrations presenting a serious risk of environment harm and as such are not guideline upper limits but rather to be avoided.

Table 2-1 International ecotoxicology guideline values for trace metals in seawater

		US EPA		Dutch		ANZ Guidelines			Canadian		UK EQS	
Analyte	**Units**	**CCC[1]**	**CMC[1]**	**MPA[2]**	**SRA_{eco}[2]**	**TOX LOSP 95[3]**	**TOX LOSP 90[3]**	**TOX LOSP 80/Unknown[3]**	**Long term (chronic)[4]**	**Short term (acute)[4]**	**AA[5]**	**MAC[5]**
Aluminium (Al)	µg/L											1000#
Arsenic (As)	µg/L	36	69	24	890				12.5		25	
Boron (B)	µg/L										7000	
Cadmium (Cd)	µg/L	7.9	33	0.34	27	5.5	14	36	0.12		0.2	
Chromium (Cr) (III)	µg/L			36^{FW}	220^{FW}	27	49	91	56			
Chromium (Cr) (VI)	µg/L	50	1100	8.7	260	4.4	20	85	1.5		0.6	
Cobalt (Co)	µg/L			3	810	1	14	150			3	
Copper (Cu)	µg/L	3.1	4.8	1.1	18	1.3	3	8	2^{BC}	3^{BC}		
Iron (Fe)	µg/L										1000	
Lead (Pb)	µg/L	8.1	210	11	150	4.4	6.6	12	2^{BC}	140^{BC}	1.3	14
Manganese (Mn)	µg/L							80				
Mercury (Hg)	µg/L	0.94	1.8	0.23	2.7	0.4	0.7	1.4	0.016			0.07
Nickel (Ni)	µg/L	8.2	74	1.9^{FW}	500^{FW}	70	200	560			8.6	34
Silver (Ag)	µg/L		0.95			1.4	1.8	2.6	1.5^{BC}	3^{BC}	2.6	0.5
Tin (Sn)	µg/L										10	
Vanadium (V)	µg/L					100	160	280			100	
Zinc (Zn)	µg/L	81	90	7.3	89	8	12	21	10^{BC}	55^{BC}	6.8	

1 Criteria Chronic Concentration and Criteria Maximum Concentration, corresponding to 96-hour average and 1 hour average analyte concentrations - US EPA recommended Water Quality Criteria for Aquatic Life - Marine. * denotes threshold from National Academy of Sciences-National Academy of Engineering (NAS-NAE). 1972. Water Quality Criteria 1972.

2 Maximum Permitted Addition, based on added analyte concentration at which 95% of adverse effects on species or processes are avoided, and Serious Risk Addition for ecosystems, based on the added analyte concentration at which 50% of species or processes will experience adverse effects. As per Dutch Standards/Verbruggen et al., 2001. ^{FW} shows thresholds from freshwater ecotox data only, rather than combined freshwater/marine data.

3 Default guideline values for analyte concentrations corresponding to Toxicant Limit of Species Protection (LOSP) for 95%, 90% and 80% or unknown level of species protection, as per Australia and New Zealand Guidelines for Fresh and Marine Water Quality, revised 2018.

4 Long term (chronic) and short term (acute) Canadian Marine Quality Guidelines developed by Canadian Council for Ministers of the Environment (CCME). Where CCME guidelines are absent, Ambient Water Quality Guidelines (AWQG) from the British Columbia Ministry of Environment and Climate Change are used and are denoted by ^{BC}.

5 Annual Average and Maximum Allowable Concentration Environmental Quality Standards from UK Environment Agency Surface Water Pollution Risk Assessment. # only if pH ≥6.

2.2 Sediment Quality Benchmarks

In the absence of UK EQS standards for trace metal levels in marine sediments, data gathered on the current survey are compared to regionally and internationally recognised standards including the Canadian Council for Ministers of the Environment (CCME) Threshold Effect Level (TEL) and Probable Effect Level (PEL) values (also known as ISQG values), T20 and T50 values derived from amphipod toxicity studies after Field et al. (2002), Effect Range Low (ERL) and Effect Range Median (ERM) values from Long et al., (1995) and Australian and New Zealand's toxicant default and high guideline values (DGV and GV-High) for sediment quality, Dutch Intervention values and Apparent Effects Threshold values (AETs), after Buchman et al. (2008). Further information on each of these sets of guideline values is provided in the footnotes below Table 2-1. In many cases (e.g., for Long et al., 1995, ANZ and Canadian guidelines) a lower and upper threshold is presented. If analysis results for a given parameter in a sample fall below the lower threshold value, the risk of environmental harm is considered low. If the analysis results exceed the lower threshold, adverse environmental effects may begin to occur. If the upper threshold is exceeded, the risk of adverse environment effects is considered more likely. The Dutch intervention values also merit particular mention; these are not guideline upper limit values but rather analyte levels at which there is a serious risk of environmental harm.

Table 2-2 International ecotoxicology guideline values for trace metals in sediment

		Field et al. (2002)		ANZ		Dutch	Canadian		Long et al. (1995)		Buchman et al. (2008)	
Analyte	**Units**	**T20[1]**	**T50[1]**	**DGV[2]**	**GV-High[2]**	**Intervention[3]**	**TEL[4]**	**PEL[4]**	**ERL[5]**	**ERM[5]**	**AET[6]**	**Bioassay endpoint[7]**
Aluminium (Al)	%										1.8	N
Antimony (Sb)	mg/kg	0.63	2.4	2	25	15					9.3	E
Arsenic (As)	mg/kg	7.4	20	20	70	55	7.24	41.6	8.2	70	35	B
Barium (Ba)	mg/kg					625	130.1				48	A
Cadmium (Cd)	mg/kg	0.38	1.4	1.5	10	12	0.68	4.21	1.2	9.6	3	N
Chromium (Cr)	mg/kg	49	141	80	370	220	52.3	160	81	37	62	N
Cobalt (Co)	mg/kg					180					10	N
Copper (Cu)	mg/kg	32	9.4	65	270	96	18.7	108	34	270	390	M,O
Iron (Fe)	%										22	N
Lead (Pb)	mg/kg	30	9.4	50	220	530	30.24	112	46.7	218	400	B
Manganese (Mn)	mg/kg										260	N
Mercury (Hg)	mg/kg	0.14	0.48	0.15	1	10	0.13	0.7	0.15	0.71	0.41	M
Nickel (Ni)	mg/kg	15	47	21	52	10	15.9	42.80	20.9	51.6	110	E,L
Selenium (Se)	mg/kg					100					1	A
Silver (Ag)	mg/kg	0.23	1.1	1	4	15	0.73	1.77	0.73	3.7	3.1	A
Tin (Sn)	mg/kg					900					3.4	N
Vanadium (V)	mg/kg					250					57	N
Zinc (Zn)	mg/kg	94	245	200	410	350	124	271	15	410	410	I

1 T20/T50 = analyte conc. corresponding to 20 % & 50 % probability of toxicity for amphipods, as per Field et al. 2002
2 Default guideline value and guideline value – high = analyte concs. for low risk of toxic effects and potential commencement of toxic effects, respectively. From Australian and New Zealand Guidelines for Fresh and Marine Water Quality, 2000
3 Intervention values indicate levels where functional properties of sediments for ecosystems is or will be seriously impaired. As per Dutch Standards/Verbruggen et al., 2001 and Buchman et al., 2008
4 TEL = Threshold Effect Level (or ISQG) and PEL = Probable Effect Level from Canadian Sediment Quality Guidelines developed by Canadian Council for Ministers of the Environment. Analyte conc. < TEL adverse effects rarely occur; analyte conc. >TEL but < PEL adverse effects occasionally occur; analyte conc. > PEL adverse effects frequently occur
5 ERL = Effect Range Low, defined as analyte conc. corresponding to 10% percentile of adverse effects and ERM = Effect Range Median, corresponding to 50% percentile of adverse effects, from Long et al., 1995
6 Apparent Effects Threshold = highest analyte concentration associated with a non-toxic sample, as per Buchman et al., 2008
7 N = neanthes, E = echinoderm larvae, B = bivalve, A = amphipod, M = microbial ecotox, O = oyster larvae, E = echinoderm larvae, L = larval bioassay, I = infaunal community impacts, as per Buchman et al., 2008

2.3 Biota Tissue Quality Benchmarks

Due to the large variability in tissue metals levels between species, most countries have not adopted comprehensive standards or guidelines for metals in fish, shellfish and other benthic invertebrates. The Coordinated Environmental Monitoring Programme (CEMP) of the Oslo and Paris Commission (OSPARCOM) sets out Background Assessment Concentrations (BACs) – defined as an assessment threshold for testing whether contaminant concentrations are 'near background' – for cadmium, copper, lead, mercury and zinc in oysters, mussels and fish muscle. The Food and Agriculture Organisation of the United Nations (FAO) also compiled a series of guideline values for acceptable trace metal thresholds in fish and shellfish from member states in 1983; given that each participating member state supplied its own threshold value, the median value for each parameter has also been included in comparisons to provide context (FAO, 1983).

Given that both the FAO and OSPARCOM guidelines consider trace metals in fish or bivalve mollusc tissue samples and that there is significant variability in natural trace metal concentrations between different taxonomic groups, reference values for crustacean muscle, crustacean brown meat, bivalve and crustacean soft body, and echinoderm and polychaete homogenised whole body samples from Scottish waters have also been provided to provide context. These data were sampled from a mixture of 9 urbanised and industrialised estuarine locations around Scotland between 2015 and 2017 (Madgett et al. 2021). This reference is particularly pertinent because the organisms sampled for biota tissue analysis on the current survey were either echinoderms (common starfish: *Asterias rubens*) or decapod crustaceans (spider crab: *Maja brachydactyla*).

Table 2-3 International guideline values and reference data for trace metals in marine biota

Parameter	OSPAR BAC		FAO 1983 Median Value: Fish/Shellfish	Madgett et al., 2021.			
	Mussels	Oysters		Crustacean: muscle	Bivalve & crustacean: soft body	Echinoderm & polychaete: whole body	Crustacean: brown meat
Arsenic			1.5	4.59 – 26.2	1.91 – 35.3	2.28 – 17	8.99 – 11.7
Cadmium	0.96	3	0.5	0.0248 – 3	0.0317 - 6.92	0.1 – 0.486	0.713 – 3.34
Chromium			1	<0.03 – 0.368	0.06 –0.408	0.145 – 1.39	<0.030– 0.111
Copper	6	6	20	5.98 – 16.9	4.09 – 65.9	0.917 – 4.86	19.1 – 68.4
Lead	1.3	1.3	2	0.0136 – 0.183	0.157 – 7.58	0.194 – 8.87	0.0136 – 0.144
Mercury	0.09	0.18	0.5	0.023 – 0.273	0.035 – 0.129	0.0222 – 0.127	0.062 – 0.0804
Nickel				0.0089 – 0.299	0.183 – 3.66	0.131 – 1.76	0.191 – 1.14
Tin			150				
Zinc	63	63	50	12.2 – 79.2	23.5 – 341	3.8 – 105	16 – 55.8

All values mg/kg dry weight unless otherwise indicated

3 Methodology

3.1 Survey Design

The first key objective of the survey was to establish a set of stations for repeat sampling. Initial desktop analyses and ocean modelling of the diffusers and surrounding waters were initiated in 2021. These analyses concluded that the 'mixing zone' where effluent reaches the ocean surface is approximately 50 - 125m away from the outfall (shown as a green shaded area in inset map in Figure 3-2), and that within this area, the wastewater effluent waters will have diluted extensively (specifically by a factor of 473-2773).

A sampling station was established at the outermost SWW diffuser (labelled ‘Diffuser’) because both the 2022 study and the 2023 dive surveys suggest that it has the largest effluent discharge. To align closely with regulatory standards, whereby receiving waters are typically sampled within the ‘midfield mixing zone’, two stations were chosen within this area (labelled MMZ-S and MMZ-NE), on either side of the diffuser to consider tidal transport. The exact locations were chosen based on the seabed supporting similar benthic habitats as at the diffuser, specifically the presence of habitats with rocky substrates. Existing publicly available habitat mapping data (from JNCC EUNIS data: see Figure 3-1) was used to guide this.

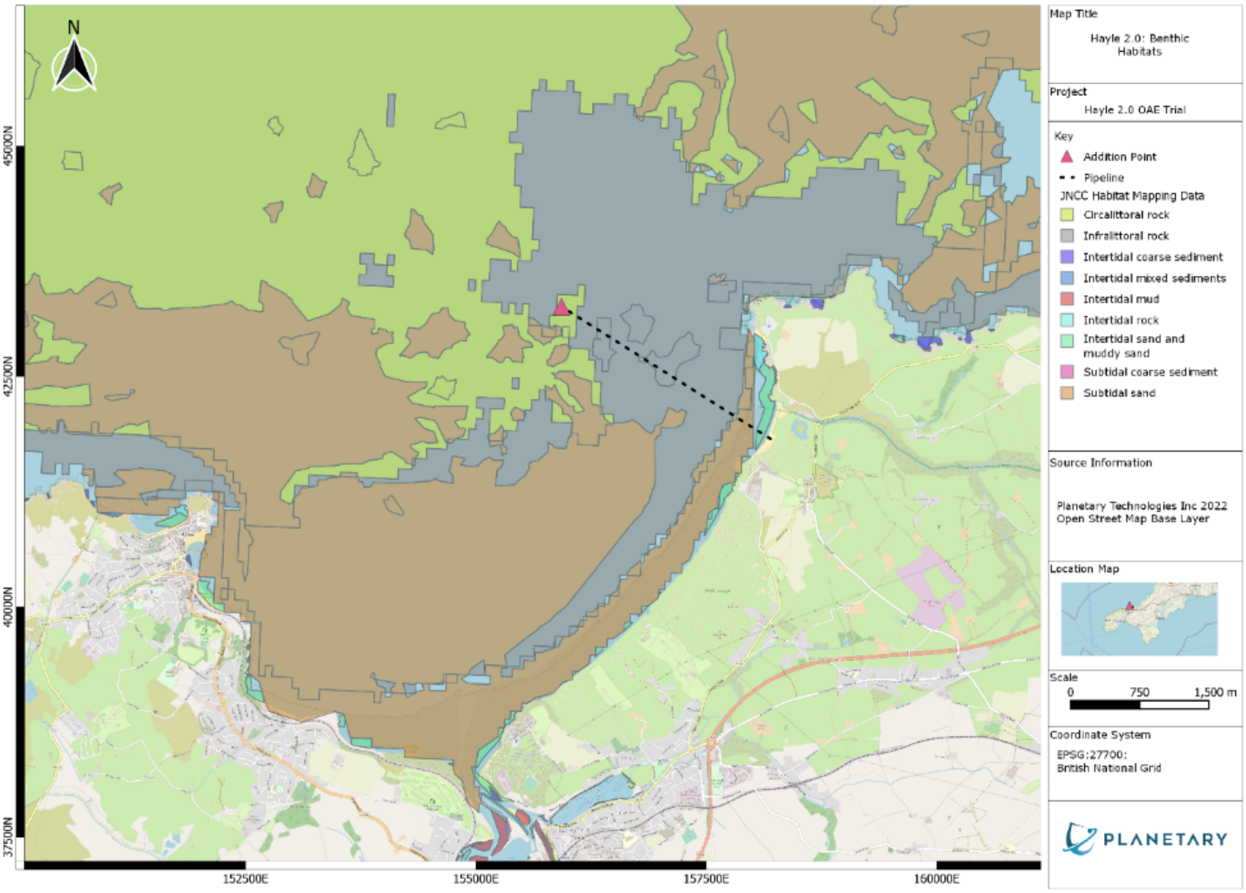

Figure 3-1 Benthic habitats in St Ives Bay (from JNCC EUNIS Data)

Significant efforts were taken to select an appropriate ‘Control’ site. Multiple sites were investigated, taking into account the following: adequate distance from the diffuser, ‘upstream’ location from the effluent’s general transport pathway, similarity of benthic habitat, similarly of water column characteristics (e.g. depth, wave exposure) and proximity to sensitive receptors or protected areas which might be disturbed by monitoring activities. The stations chosen are shown in Figure 3-2, which also shows significant local landmarks and the outfall pipeline alignment, and are summarised in Table 3-1 below.

Table 3-1. Location of sampling sites (WGS84)

Site	Latitude	Longitude	Depth (m)	Key Characteristics
Diffuser	50.23	-5.42	17.50	Adjacent to most seaward diffuser, hard substrate
MMZ-NE	50.23	-5.42	18.28	~60m NE of diffuser within midfield mixing zone, hard substrate
MMZ-S	50.23	-5.42	17.42	~60m S of diffuser within midfield mixing zone, hard substrate
Control	50.22	-5.49	21.55	~5 km W of diffuser, hard substrate

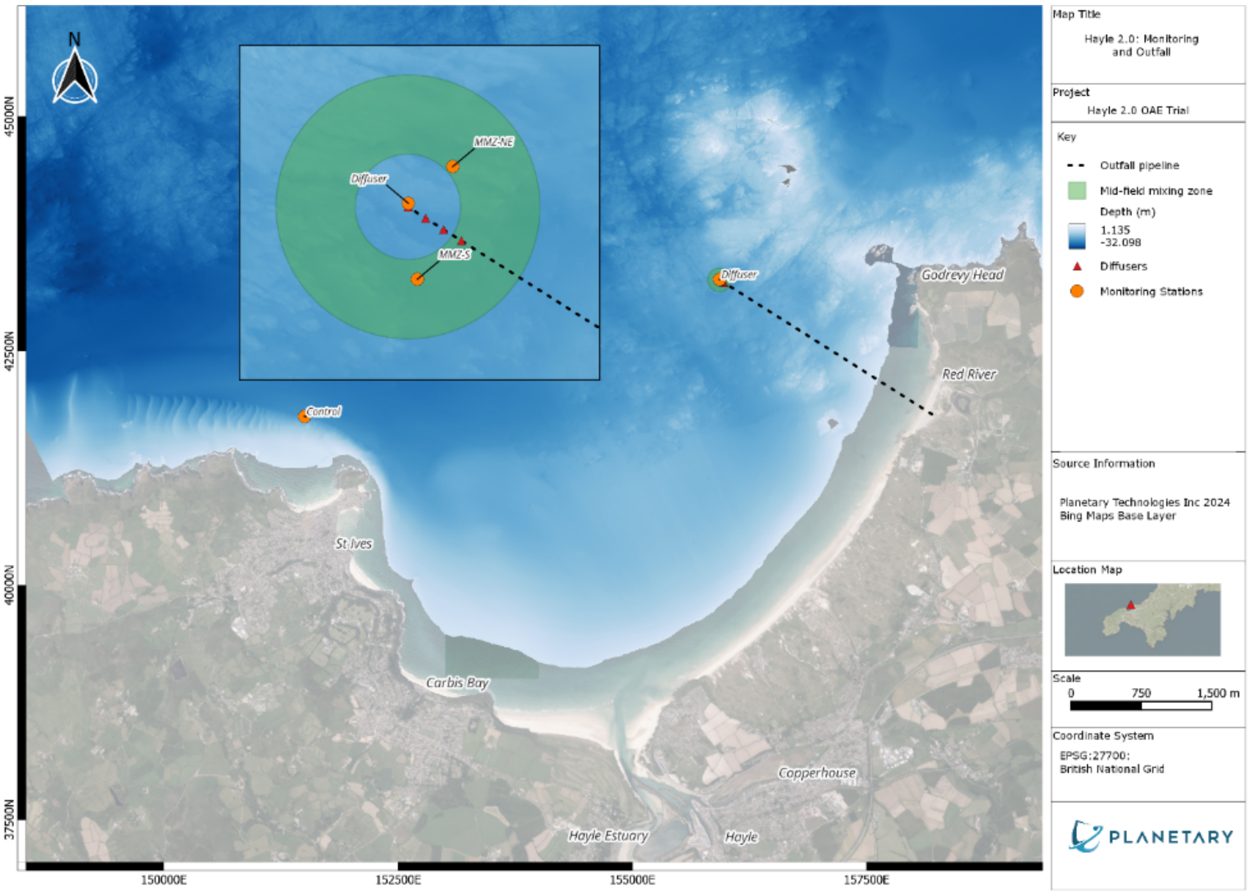

Figure 3-2 Monitoring sites and local features

3.2 Overview of Survey

The physical, chemical and biological parameters of the water column and benthos were assessed at all four stations by collecting water, plankton, sediment and biota samples. A summary of sample parameters and quantities is shown in Table 3-2.

Table 3-2 Overview of Surveys

Element	Method	Description
Benthic ecology survey	Dive survey	Species inventory & benthic habitat assessment – roughly 50 m^2
Water quality: Total suspended solids	Marine water sample	3 sets of triplicate samples at 3 locations + control (12 samples total)
Water quality: Trace metals: Ag, Al, As, B, Ca, Cd, Co, Cr, Cu, Fe, Hg, Mg, Mn, Ni, Pb, Sn, V, Zn	Marine water sample	3 sets of triplicate samples at 3 locations + control (12 samples total)
Water quality: Water column profiles for: temperature, pH, salinity, dissolved oxygen, specific conductivity, turbidity [TSS]	Water profile	3 locations + control (4 profiles)
Plankton: Phytoplankton bottle samples	Marine water sample	3 locations + control (4 samples total)
Plankton: Zooplankton net tows	Vertical trawls through water column	3 locations + control (4 trawls total)
Sediment quality: Trace metals: Ag, Al, As, B, Ca, Cd, Co, Cr, Cu, Fe, Hg, Mg, Mn, Ni, Pb, Sn, V, Zn	Sediment samples: diver collected	3 sets of triplicate samples at 3 locations + control (12 samples total)
Biota quality: Trace metals: Ag, Al, As, B, Ca, Cd, Co, Cr, Cu, Fe, Hg, Mg, Mn, Ni, Pb, Sn, V, Zn	Bivalve/crustacean biota tissue: diver collected	2 locations + control (6 samples total)

As Table 3-2 shows, sediment samples and dive surveys were completed at three of the four survey stations. Whilst the original survey plan called for full sampling at all four stations, strong tidal flows and deteriorating weather conditions at the worksite restricted the time available for safe diving work. As such, after dive surveys and sediment sampling at the Diffuser and Control stations, the decision was taken to prioritise sampling at the MMZ-S station – which according to modelling work should be positioned downstream of the prevailing outflows from the diffusers the majority of the time – and to omit the diving work from the MMZ-NE station.

3.3 Marine Water Quality

The physical, chemical and biological parameters of the water column were assessed at all four stations by collecting water samples and conducting vertical profiles.

Seawater quality monitoring was conducted using a calibrated RBR Maestro multi-channel oceanographic instrument with an attached pH logger to record vertical profiles of temperature, salinity, dissolved oxygen, turbidity, and pH through the water column every second (sensor specifications provided in Table 3-3). The instrument was lowered to just above the seabed (within 1 m), before being raised again slowly to the surface. The collected data were plotted against depth at each surveyed site in order to visualise the oceanographic conditions at the time of survey for each station.

Table 3-3 Specifications of the sensors on RBR Maestro

Parameter	Instrument	Unit	Accuracy	Resolution
Temperature	RBRmaestro^3	°C	±0.002°C	<0.00005°C
Conductivity	RBRmaestro^3	mS/cm	±0.003mS/cm	0.001mS/cm
Dissolved Oxygen	RBRmaestro^3	µmol/L	±2% O_2 saturation	1% of saturation
Turbidity	RBRmaestro^3	NTU	<2% deviation	
pH	HOBO		±0.10	0.01

Seawater samples for laboratory analysis were also taken from each site, using a trace-metal clean 1.7 L Niskin sampler with external spring and Teflon coated stopcock. Seawater samples were taken from mid water column at each sampling station, with separate triplicate samples collected for total trace metal analysis and for analysis of total suspended solids. Samples for trace metal analysis were decanted into pre-labelled, acid-washed, 250 ml sample bottles which had been provided by the analytical laboratory. Clean sampling techniques were enforced, such as the use of nitrile gloves during sampling, minimal air contact and sample fill directly from the trace metal approved Niskin sampler. All samples were stored in coolboxes for transport to the analytical laboratory and tested for the parameters listed in Table 3-4 below, using the methodologies indicated and with the Limit of Reporting (LOR) for each analysis as indicated.

Table 3-4. Summary of seawater quality sampling through Niskin sampler

Parameter	Units	LOR	Analytic Method(s)
Total Suspended Solids	mg/L	2	BS EN 872
Mercury	µg/L	0.002	AFS according to SS-EN ISO 17852:2008. Samples are acidified with 1 ml high purity nitric acid per 100 ml prior to analysis. No digestion.
Boron	µg/L	10	ICP-AES in accordance with SS-EN ISO 11885:2009 and US EPA Method 200.7:1994. Samples are acidified with 1 ml high purity nitric acid per 100 ml prior to analysis. No digestion.
Calcium	mg/L	0.1	
Magnesium	mg/L	0.09	
Aluminium	µg/L	0.70	ICP-SFMS according to SS-EN ISO 17294-2:2016 and US EPA Method 200.8:1994. Samples are acidified with 1 ml high purity nitric acid per 100 ml prior to analysis. No digestion.
Cadmium	µg/L	0.050	
Chromium	µg/L	0.1	
Cobalt	µg/L	0.050	
Copper	µg/L	0.5	
Iron	µg/L	0.004	
Lead	µg/L	0.3	
Manganese	µg/L	0.1	
Nickel	µg/L	0.5	
Zinc	µg/L	2.0	
Arsenic	µg/L	0.05	
Silver	µg/L	0.05	
Tin	µg/L	0.05	
Vanadium	µg/L	0.005	

3.4 Plankton

The plankton community was assessed at of the four sites using two distinct methods, for phytoplankton and zooplankton respectively.

For phytoplankton sampling, surface water was collected using the Niskin sampler and was decanted into 250 ml brown glass bottles. Lugol's iodine solution was then added for sample preservation. The phytoplankton samples were then analysed by a specialist laboratory using a FlowCam system, with diversity and abundance data reported to taxonomic group level.

For zooplankton sampling, a standard oceanographic zooplankton net was used, with a total volume of 2.51 m^3 and a mesh size of 100 μm, with associated cod-end. The net was lowered to a water depth of 10 m at each site, before being slowly raised to the surface at a speed not exceeding 0.5 m per second. The net was then suspended on the rear deck of the survey vessel and the retained organisms were rinsed down the inside of the net using seawater, into the cod-end, from which they were transferred into a sample bottle for preservation using Lugol's iodine. Two vertical hauls from 10 m depth were conducted at each site.

The zooplankton samples were then analysed by a specialist laboratory, with diversity and abundance data reported to indicator species level using a combination of the FlowCam system and microscopy, as required.

The FlowCam system allows for rapid analysis of plankton samples. As the sample is processed, images are taken rapidly and an algorithm within the instrument counts the particles and classifies them according to size and shape. A trained taxonomist can then assign these categories to taxonomic groups of phytoplankton. The result is a dataset of abundance across a range of functional and taxonomic groups, and given the total volume of water sampled either in the bottle or by the net is known, the unit is given as 'individuals per liter' of seawater sampled.

3.5 Marine Sediment Quality

Sediment samples were collected by the dive team from three of the four survey sites (Diffuser, MMZ-S, Control), with clean sampling techniques used to avoid sample contamination (e.g. avoidance of metal tools to collect sediment for trace metal samples). Triplicate sediment samples were collected from each of the survey locations in a spatially representative manner, with each sample gathered as far as possible from others. The sediment samples were stored in holding containers at the seabed, which were then separated into suitable volumes and containers for laboratory analysis once the dive team returned to the surface.

All samples were stored in coolboxes and transported to a fully accredited and certified laboratory for analysis. Once at the laboratory, the samples were pre-prepared by drying at 50°C, before being homogenised by grinding. The samples were then analysed as per Table 3-5, with the LOR for each analysis as indicated.

Table 3-5. Summary of sediment analysis

Parameter	Units	LOR	Analytic Method(s)
Arsenic	mg/kg DW	0.1	Determination of metals in soil, sludge, sediment and construction material by ICP -SFMS according to SS-EN ISO 17294-2:2016 and US EPA Method 200.8:1994. Prior to analysis the sample is digested according to: S-PM59-HB. Digestion in 7M nitric acid in hotblock according to SE-SOP-0021.
Calcium	mg/kg DW	20.0	
Cadmium	mg/kg DW	0.01	
Cobalt	mg/kg DW	0.03	
Copper	mg/kg DW	0.3	
Lead	mg/kg DW	0.1	
Magnesium	mg/kg DW	5.00	
Mercury	mg/kg DW	0.04	
Nickel	mg/kg DW	0.08	
Vanadium	mg/kg DW	0.2	
Zinc	mg/kg DW	1.00	
Aluminium	mg/kg	0.002	
Boron	mg/kg DW	2.00	
Chromium	mg/kg DW	0.1	
Iron	mg//kg	0.002	
Manganese	mg/kg	0.0001	
Silver	mg/kg DW	0.05	Determination of metals in soil, sludge, sediment and construction material by ICP -SFMS according to SS-EN ISO 17294-2:2016 and US EPA Method 200.8:1994. Prior to analysis the sample is digested according to: S-PAR53-HB. Aqua regia digestion in hotblock according to SE-SOP-0047 (SS-EN ISO 54321:2021 and SS-EN 16174:2012).
Tin	mg/kg DW	0.5	

3.6 Biota Tissue Quality

Specimens of benthic invertebrates (common starfish: *Asterias rubens*) or decapod crustaceans (spider crab: *Maja brachydactyla*) were collected from each of the three sites surveyed by the dive team (Diffuser, Control, MMZ – S), for analysis of trace metal levels in invertebrate tissues. One specimen of each taxon was collected from each of the sites surveyed, for a total of six specimens.

The specimens were frozen whole, stored in plastic containers and transported to the analytical laboratory as soon as possible. Upon arrival, the specimens were inspected, dissected as necessary (for crustaceans: exoskeleton discarded and muscle/soft body/brown meat extracted) and a representative sub-sample of 50 g prepared for analysis. The samples were then digested and analysed as per Table 3-6, with the LOR for each analysis as indicated.

Table 3-6. Summary of biota tissue sample analysis

Parameter	Units	LOR	Analytic Method(s)
Aluminium	mg/kg	2.0	Determination of metals in food according to SS-EN ISO 17294-2:2016 / US EPA Method 200.8:1994. Prior to analysis the sample is digested using: B-PF51HF-MW – Nitric acid/hydroperoxide digestion with trace of hydrofluoric acid in microwave oven according to SE -SOP-0128 (SS-EN 13805:2014).
Arsenic	mg/kg	0.02	
Boron	mg/kg	2.00	
Cadmium	mg/kg	0.005	
Calcium	mg/kg	30.0	
Chromium	mg/kg	0.05	
Cobalt	mg/kg	0.02	
Copper	mg/kg	0.2	
Iron	mg/kg	2.00	
Lead	mg/kg	0.03	
Magnesium	mg/kg	20.0	
Manganese	mg/kg	0.2	
Mercury	mg/kg	0.02	
Nickel	mg/kg	0.05	
Silver	mg//kg	0.003	
Tin	mg/kg	0.05	
Vanadium	mg/kg	0.02	
Zinc	mg/kg	0.5	

3.7 Benthic Ecology

Benthic surveys were conducted by a two-person scientific dive team at the Diffuser, MMZ-S, and Control sites (MMZ-NE was not surveyed by the dive team; see section 3.2). Using high-definition videos cameras, the surveyors documented the benthic environment along a series of circular transects, beginning ~10m on either side of the anchor line and spiralling towards the centre (see Figure 3-3 below). As such, the approximate total area surveyed at each station was 250 m^2. The video cameras recorded footage at an altitude of approximately 50 cm above the seabed, maintaining a known and constant field of view in order to facilitate semi-quantitative analysis of species abundance per unit area.

The video footage across all sites was first analysed qualitatively in order to assess the physical substrate, the type and status of any benthic habitats present and the presence of any disturbance indicators, as well as to identify all organisms observed to the lowest possible taxonomic level.

A representative subset of still frames was then extracted from the video at one station – MMZ-S – for semi-quantitative analysis in order to estimate the relative species abundance of each organism present. This preliminary analysis for a single site is one potential approach to providing an overview of the benthic community composition and assessing metrics of biodiversity at all sites over time.

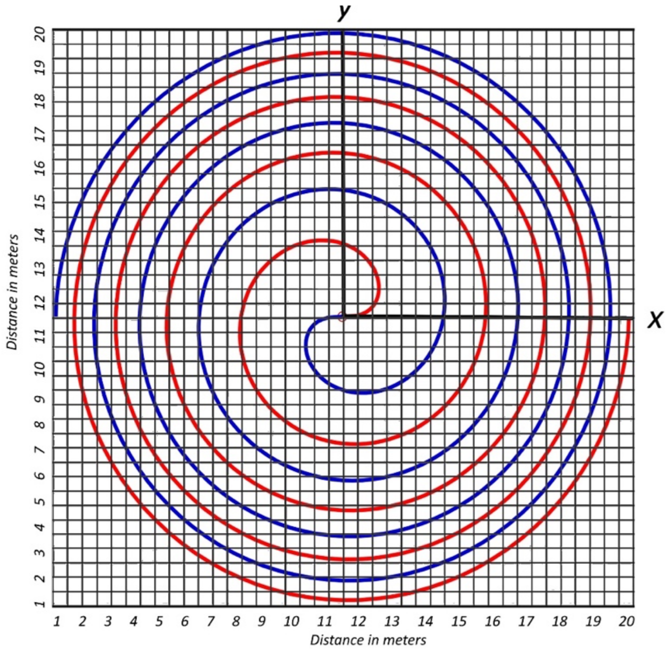

Figure 3-3 Spiral transect survey method

4 Results

4.1 Marine Water

4.1.1 Water column profile results

The physical characteristics of the water column at each station are shown by vertical profiles of temperature and salinity in Figure 4-1.

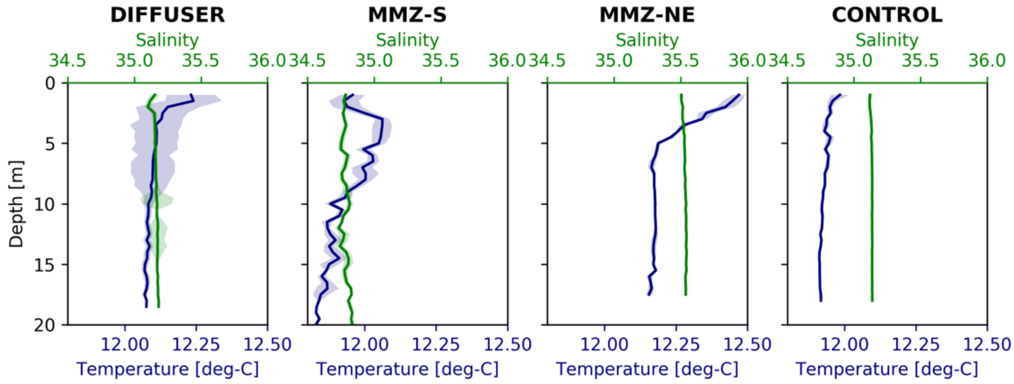

Figure 4-1. Seawater temperature and salinity recorded using multi-probe from the seabed to the surface at the surveyed locations

These profiles show very little variability with depth, especially in salinity, indicating that the water column is fully mixed. Slight increases in temperature found near the surface at most stations (particularly at MMZ-NE) are likely due to the fact that stations were sampled at or near slack tide, and that surveys were conducted on relatively warm and calm days. These conditions allow for brief surface temperature increases that likely dissipate once currents increase on the subsequent tide. Increased winds and wave action at the control site likely explains the lack of surface warming.

Dissolved oxygen content, pH, and turbidity showed no significant variability throughout the water column. As such, for simplicity, average water column values (± the standard deviation) are presented in Table 4-1, alongside temperature and salinity. Interestingly, the salinity (and to a lesser degree, temperature) at the Diffuser and two MMZ stations are all fairly different (each ~ 0.5 PSU salinity units apart), despite their close proximity to each other. The lower salinity at MMZ-S is accompanied by a lower pH, a very slightly elevated turbidity, and marginally lower dissolved oxygen, compared to nearby stations. The direction of these slight deviations in salinity, pH, oxygen and turbidity all align with a signal from the wastewater diffuser. Given that the wastewater pipe has multiple diffusers, all of which are located south of the main diffuser station, it is plausible that the MMZ-S station is better placed to try and measure wastewater effluent signals. This could be a significant finding given that Planetary's proposed monitoring strategy during a trial would include deployment of a moored sensor package in a fixed location. This data suggests that the MMZ-S station may be more suitable for this array than the diffuser site. Overall, these results align with our general understanding of the area; namely, that strong tidal flows create a well-mixed water column.

Table 4-1 Summary of water column characteristics for each station

Parameter	Station			
	Diffuser	MMZ-S	MMZ-NE	Control
Temperature (°C)	12.1 ± 0.03	11.9 ± 0.08	12.2 ± 0.07	11.9 ± 0.01
Salinity (PSU)	35.2 ± 0.02	34.8 ± 0.03	35.5 ± 0.01	35.1 ± 0.01
Dissolved Oxygen [%-saturation]	97.5 ± 0.16	96.6 ± 0.76	99.9 ± 0.39	93.7 ± 0.2
pH	8.23 ± 0.004	8.16 ± 0.087	8.27 ± 0.008	8.22 ± 0.005
Turbidity [NTU]	0.57 ± 0.011	0.62 ± 0.023	0.51 ± 0.012	0.23 ± 0.014

Average water column pH differs slightly between the stations. These small differences align with the changes in salinity noted above, which is logical given that freshwater, whether from wastewater or from rivers, typically has a lower pH compared to seawater. Slightly lower oxygen content and turbidity were measured at the control site relative to the other three stations.

4.1.2 Total suspended solids

TSS levels during the current survey were above the method detection limit (MDL) of 2 mg/L at all sites, ranging between an average of 7.7 mg/L at the Diffuser station to 12.3 mg/L at MMZ-NE (**Error! Reference source not found.**). It is worth noting that considerable variability was seen between the triplicate samples for TSS (e.g., at Control site, >100% difference between triplicates). This suggests that TSS loads in the area are heterogenous and supports continued TSS sampling at each station with triplicate or greater sample repeats in order to represent this variability. Furthermore, despite turbidity commonly being used as a real-time proxy for TSS, the trend in turbidity data across the four stations (shown in Table 4-1) did not align exactly with that shown for TSS in Table 4-2. The exact relationship between TSS and turbidity is site-specific, as turbidity measurements are typically determined optically through the scattering of a light beam as it encounters suspended particles in a solution. As the morphology and characteristics of suspended particles differ between locations, so does the degree of resulting light scattering and hence the turbidity. For the purposes of further monitoring, it is clear that direct measurements of TSS will be required alongside turbidity measurements, at least until such time as the relationship can be more conclusively determined for the project location.

Although few countries have specified threshold limits for TSS in ambient marine waters, values of <25 mg/L are generally considered to represent clear waters with minimal risk of environmental perturbation (as per CCME guidelines developed by Canadian Council of Ministers for the Environment). All values on the above survey fell below this threshold.

Table 4-2 Total suspended solids in water

Location	Sample	Value (mg/L)	Mean (mg/L)
Diffuser	A	10.6	7.7
	B	5.6	
	C	6.9	
MMZ-S	A	6.8	8.1
	B	10.3	
	C	7.1	
MMZ-NE	A	10.8	12.3
	B	14.8	
	C	11.4	
Control	A	13.9	9.7
	B	6.9	
	C	8.4	

4.1.3 Trace metals in marine water

Three trace metal parameters were not detected in any of the water samples from any of the sites (cadmium, cobalt, silver). There were a further four parameters (copper, iron, lead and nickel) which were only detected in up to three individual samples across the four survey stations, with all of these concentrations below all applicable reference standards.

The next group of parameters were detected at the majority or all of stations but did not exceed any of the applicable reference standards. This group comprised: aluminium, arsenic, boron, chromium, manganese, tin, vanadium and zinc.

There are no reference standards available for calcium and magnesium in seawater, as these are present at high background concentrations in the marine environment. On the current survey, calcium concentrations ranged between 368 and 406 mg/L, whilst magnesium concentrations varied between 1210 and 1350 mg/L.

Mercury was the only parameter to record an exceedance of any of the reference standards, with the results from the Diffuser A and C samples, the MMZ-NE B sample and the Control A and C samples exceeding the Canadian long-term threshold of 0.016 µg/L, and slightly exceeding the UK MAC of 0.07 µg/L. The results from all stations were within all other applicable reference standards. Of note is that the results from the control site (~ 5km to the west) were similar to those from the diffuser area, suggesting a more general trend of slightly elevated mercury levels in the bay, as opposed to any point source of contamination.

Given that there was relatively little variation in the trace metals results from seawater samples across the four stations, it is difficult to comment on spatial trends in background metals levels. However, in order to provide some indication, the mean detected concentrations for each parameter (i.e. metal) at each station were ranked from 1 (lowest) to 4 (highest). The sum of these ranks provides a simple holistic metric to assess overall metal loading across the four stations, with a higher rank sum score corresponding to greater metals loading. Overall, the Diffuser station recorded the highest rank sum score (36), followed by the Control site (34) and then the MMZ-S and MMZ-NE stations (both 22). This result suggests that metals loading between the Diffuser and Control sites is not markedly different. It is notable that the two mixing zone sites had markedly lower rank sum scores than the Diffuser and Control site. It is also notable that while the salinity and pH data above suggested a signal of the wastewater at the MMZ-S site, the metals loading there appears relatively low. Overall, more survey data would be needed to draw definitive conclusions from these results.

A summary of previous data on trace metals in seawater in and around St Ives Bay is presented in Section 5 of this report. The results recorded on the current survey were generally in alignment with previous data from the bay itself. The one exception to this was the mercury data recorded on the current survey, which was higher than previous data from the bay. However, given that seawater is an ephemeral medium by definition, it is challenging to draw conclusions on longer term trends from a single survey. This parameter in particular is suggested as a key focus for future monitoring.

Metal concentrations at surveyed sites can be seen in Table 4-3, whilst the original laboratory reports can be viewed in

Appendix 1 – Raw Laboratory Data – Seawater Quality.

Table 4-3. Comparison between metal levels acquired from seawater collected from surveyed sites and international guidelines.

			Lab Result												Reference Standards & Data										
Parameter	Unit	LOR	Diff			MMZ-S			MMZ-NE			CTRL			UK EQS		US EPA		Dutch		ANZ			Canadian	
			A	B	C	A	B	C	A	B	C	A	B	C	AA	MAC	CCC	CMC	MPA	SRA_{eco}	TOX LOSP 95	TOX LOSP 90	TOX LOSP 80	Long term	Short term
Aluminum	µg/L	0.7	2.42	1.81	4.33	2.34	1.47	1.54	1.03	0.718	1.25	1.12	1.65	1.71		1000									
Arsenic	µg/L	0.05	1.9	1.82	1.67	1.81	1.7	1.64	1.49	1.64	1.77	2.02	2.27	1.49	25		36	69	24	890				12.5	
Boron	µg/L	10	4380	4490	4380	4390	4340	4320	4420	4340	4370	4380	4370	4320	7000										
Cadmium	µg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.2		7.9	33	0.34	27	5.5	14	36	0.12	
Calcium	mg/L	0.1	381	406	387	376	387	379	383	364	373	379	382	378											
Chromium	µg/L	0.1	0.196	0.155	0.158	<0.1	0.167	0.179	0.224	0.259	0.156	0.296	0.146	0.172	0.6	32	50	1100	8.7	260	4.4	20	85	1.5	
Cobalt	µg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	3				3	810	1	14	150		
Copper	µg/L	0.5	0.613	<0.5	0.513	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.565	<0.5	<0.5			3.1	4.8	1.1	18	1.3	3	8	2	3
Iron	mg/L	0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.0112	<0.004	<0.004	1000										
Lead	µg/L	0.3	<0.3	<0.3	0.389	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	0.326	<0.3	0.341	1.3	14	8.1	210	11	150	4.4	6.6	12	2	140
Magnesium	mg/L	0.09	1260	1350	1290	1250	1280	1260	1260	1210	1250	1270	1270	1260											
Manganese	µg/L	0.1	0.744	0.537	0.334	0.807	1.04	0.557	0.667	0.795	0.497	0.671	0.776	0.744									80		
Mercury	µg/L	0.002	0.082	0.0694	0.0792	0.0532	0.0599	0.0617	0.066	0.0748	0.0684	0.0721	0.0694	0.071		0.07	0.9	1.8	0.23	2.7	0.4	0.7	1.4	0.016	
Nickel	µg/L	0.5	<0.5	0.638	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	8.6	34	8.2	74			70	200	560		
Silver	µg/L	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	2.6	0.5		0.95			1.4	1.8	2.6	1.5	3
Tin	µg/L	0.05	4.75	1.9	4.06	1.12	0.624	1.82	<0.5	<0.5	<0.5	3.54	6.26	14	10										
Vanadium	µg/L	0.005	1.69	1.67	1.58	1.7	1.59	1.51	1.65	1.63	1.71	1.69	1.74	1.62	100						100	160	280		
Zinc	µg/L	2	2.9	2.6	3.13	2.2	<2	2.92	3.38	<2	<2	2.5	2.32	<2	6.8		81	90	7.3	89	8	12	21	10	55

Above Threshold
Detected values

4.2 Plankton Sampling

Plankton represent the critical foundation for the marine ecosystem. The data shown here represent the beginning of an important dataset that over time will help understand the plankton community in St. Ives Bay.

The FlowCam results from the smaller plankton (less than 300 microns in diameter) are shown in Figure 4-2 (for bottle samples) and Figure 4-3 (for net-trawls). Although these graphs also contain some zooplankton classes, the phytoplankton community is generally dominated by diatoms. This is common during spring blooms in temperate ecosystems. Diatoms as r-selected opportunists are a widespread 'bloom and bust' algae with a very high growth rate that easily outcompete others during optimal nutrient supply (typical in spring, particularly in well-mixed waters).

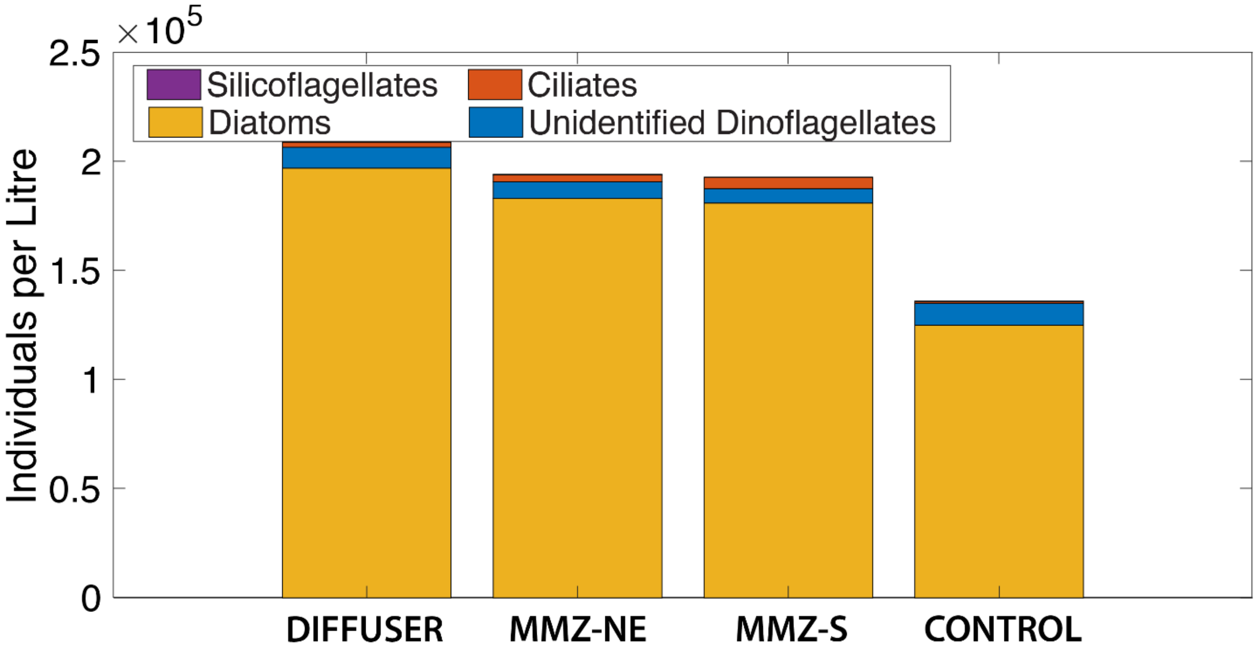

Figure 4-2. FlowCam results from bottle samples, showing relative abundances for plankton classes less than 100 microns in diameter.

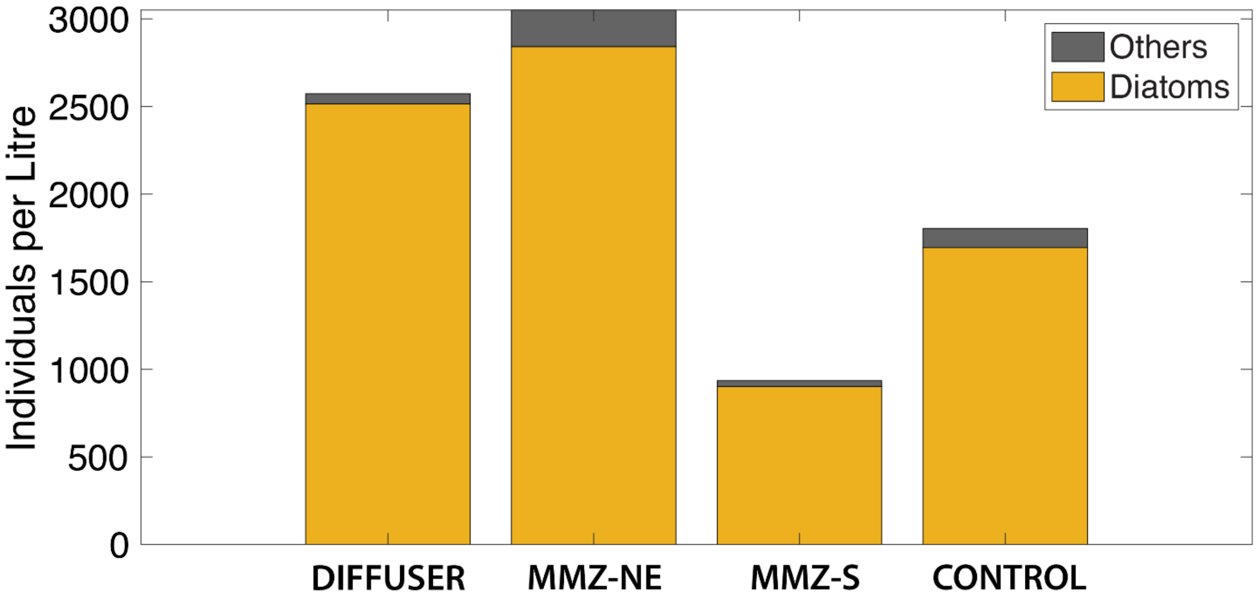

Figure 4-3. FlowCam results from the <300 microns net-tows, showing the relative abundances of plankton classes less than 300 microns in diameter. Similar to the image above, diatoms are the dominant class present.

The larger (>300 micron in diameter) zooplankton community sampled using the net tows is shown in Figure 4-4. The three dominant classes appear to be copepods, Appendicularia, and nauplii (various larval-stage crustaceans such as crabs). Across all different size classes, total plankton abundances vary between stations with no clear patterns emerging.

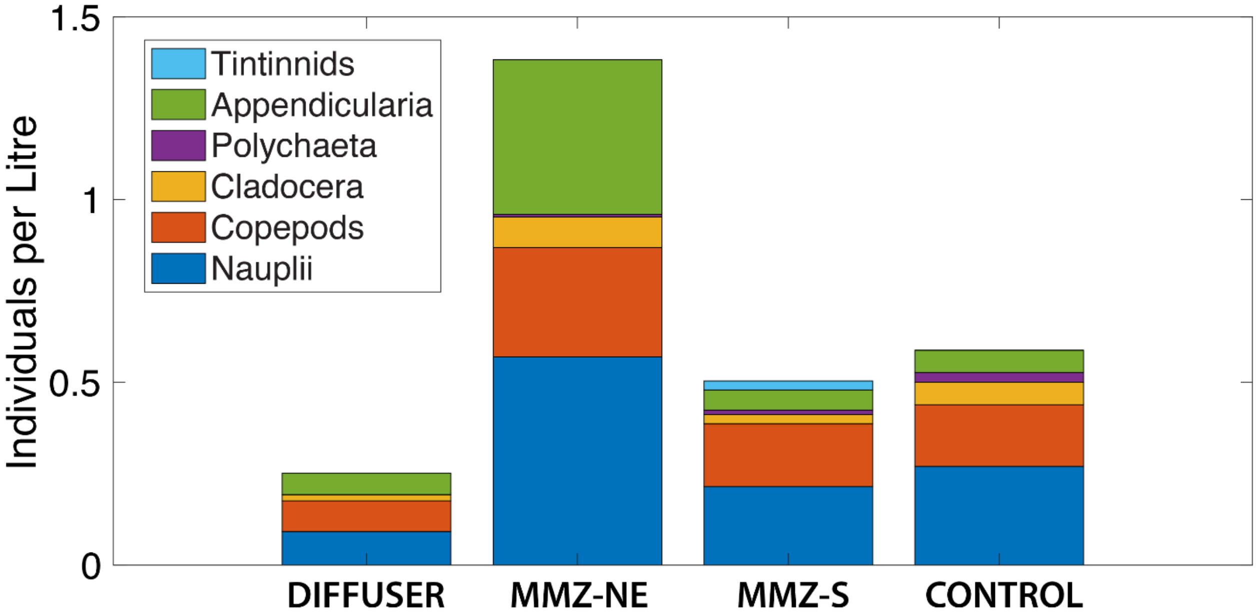

Figure 4-4. FlowCam results from the >300 microns net-tows. This shows the breakdown of the larger zooplankton classes.

A deeper analysis using the PRIMER-e (Plymouth Routines in Multivariate Ecological Research) software was conducted in part to better visualize this abundance data. In the shaded plot shown in Figure 4-5, abundance data across all stations and plankton classes are 4th root-transformed, dramatically lowering the very high abundances in the diatom data (e.g. 197000 small diatoms at the diffuser in a sample is shown as 21.1 when taking the 4th root). This is done to better visualize other less abundant but potentially important taxa in the presence of a dominant taxon, as was the case here. The shade plot also clarifies the division between phytoplankton and zooplankton, as well as the various size classes. This plot shows that for phytoplankton, small dinoflagellates also have significant abundances alongside the large and small diatoms.

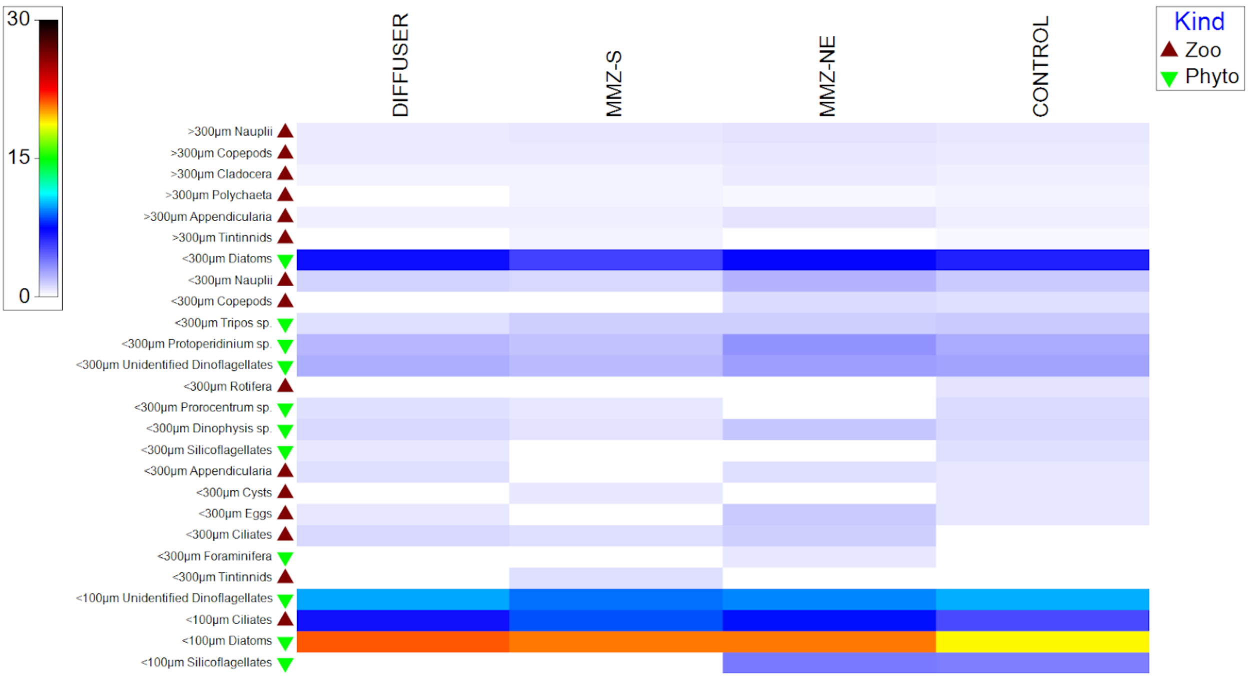

Figure 4-5. Shade plot generated by the PRIMER software, showing the relative abundances of all plankton classes counted by the FlowCam.

In an effort to differentiate the four stations in terms of the abundance data, a cluster analysis was performed, whereby the values shown in the shade plot were placed into a Bray-Curtis similarity matrix. The analysis showed that in terms of plankton community composition the stations were 86% similar (i.e., could not be significantly differentiated from one another).

To the best of our knowledge, no historical plankton information is available in St. Ives Bay to which these results can be directly compared. However, approximately 100 km east of St. Ives Bay, weekly phytoplankton and zooplankton data are collected (Harris, 2010) at a long-term time series station near Plymouth (Station L4, 50.25°N, 4.2167°W). The time-series data (available to view here, https://www.st.nmfs.noaa.gov/copepod/time-series/uk-30201/) suggest that the seasonal cycle of phytoplankton is characterized by a first peak in late April/early May corresponding to the spring diatom bloom and a second peak in late summer/early autumn corresponding to a dinoflagellate bloom. The seasonal cycle of zooplankton is also characterized by two peaks following phytoplankton blooms. Overall, the plankton results from our May survey in St. Ives Bay align well with generally seasonality found at station L4. Alignment can also be seen across other parameters, such as temperature and salinity, which points to the potential utility of the L4 station as a critical tool to help contextualize our growing dataset in St. Ives Bay.

It should be noted that analysis of this plankton data was made more complicated by the use of multiple sampling procedures, both of which have different biases on the resulting data. For example, surface water samples collected in bottles can bias towards smaller plankton, because larger plankton will more rapidly sink out of the surface. Also, plankton with flagella (e.g. dinoflagellates) can swim toward or away from sunlit surface waters, creating further bias when only collecting a surface sample. Future sampling strategies can include bottle samples of phytoplankton at multiple depths, and continuing zooplankton sampling using net tows.

These data provide a useful ‘spring’ baseline of the plankton community in St. Ives Bay. That said, it is important to note that this single snapshot must be accompanied by additional surveys at other times of year in order to begin formulating a strong understanding of this highly dynamic part of the marine food web. This is clarified by looking at the strong seasonality in both plankton and other parameters at the L4 station near Plymouth.

4.3 Marine Sediment

Table 4-3 shows the trace metal levels in marine sediments relative to the Australian and New Zealand (ANZG) guidelines, CCME Canadian Environmental Quality Guidelines (CEQGs), Long et al. (1995) weight of evidence methods, as well as other reference standards.

Concentrations of silver and mercury were undetected in sediment samples from all stations, whilst tin was undetected from all samples except samples B and C from the control site. All other trace metals with the exception of zinc were detected in all samples but recorded values below all their respective comparison standards.

Concentrations of zinc in all sediment samples from the diffuser and MMZ-S stations were greater than the Effect Range Low (ERL) threshold value from Long et al. (1995), of 15 mg/kg, yet were well below all other comparison thresholds. The ERL threshold from Long et al. (1995) corresponds to the 10th percentile of trace metal concentrations in sediment which are linked to some level of biological effect. It should be noted, however, that the ERL threshold for Zn is ~ 6x lower than the next comparison threshold value (94 mg/kg for T20 value from Field et al., 2002). A range of comparison standards are typically used when interpreting trace metal results and to form an overall assessment of contamination risk.

In terms of variation in the trace metals results between the three stations sampled, there were relatively few markedly pronounced trends. Levels of zinc, manganese, lead, cobalt, arsenic and copper were on average greater at the Diffuser and MMZ-S stations than at the Control station, whilst iron, nickel and aluminium were highest at the MMZ-S station relative to other stations. In contrast, tin was only detected at the Control station.

In order to provide some holistic interpretation, sediment metals values for each station were ranked from 1 (lowest) to 3 (highest). The sum of these ranks provides a simple holistic metric to assess overall metal loading across the three stations, with a higher rank sum score corresponding to greater metals loading. Overall, the MMZ-S station recorded the highest rank sum score (36), followed by the Diffuser site (31) and then the Control station (24). This high-level analysis gives some indication of elevated sediment metals loading at the MMZ-S station, and to a lesser extent the Diffuser station, relative to the Control site. If, on average, more wastewater is present at the MMZ-S site, as suggested (albeit as a single snapshot) by the water column data above, this could conceivably be linked to higher metals loading. Data from multiple surveys would be needed to draw further conclusions.

Sediments from the Control site might be expected to present the lowest metal loading, given the station is further from the Hayle Estuary and Red River, which according to historical data are the chief riverine sources of metal contamination in St. Ives Bay (see section 5 for more details). Nevertheless, it should be reiterated that all sediment metals values except for Zn at two sites were within the relevant comparison thresholds and are not therefore considered to present an ecological risk to marine organisms. Section 5 presents more detail on historical metals data in and around the bay; of note is that the results for sediment metals on the current survey were in alignment with, although generally lower than, the results from a 2005 survey (Halcrow Group, 2006).

Full laboratory results and reporting are shown in Appendix 2 – Raw Laboratory Data – Sediment Quality.

Table 4-3. Trace metals in Sediment

			Lab Result									Reference Standards & Data								
			Diff			MMZ-S			CTRL			Field et al. (2002)		ANZ		Dutch	Canadian		Long et al. (1995)		Buchman et al. (2008)
Parameter	Unit	LOR	A	B	C	A	B	C	A	B	C	T20	T50	DGV	GV-High	Intervention	TEL	PEL	ERL	ERM	AET
Aluminum	mg/kg	0.002	1150	1550	1240	2440	1550	2240	1090	1150	1440										18000
Arsenic	mg/kg	0.1	4.19	4.44	3.65	7.22	4.44	5.71	3.39	3.44	3.57	7.4	20	20	70	55	7.24	41.6	8.2	70	35
Boron	mg/kg	2	15.4	14.1	14.4	13	15.2	11.6	16.5	15.4	14.6										
Cadmium	mg/kg	0.01	0.0614	0.0358	0.0351	0.0362	0.0166	0.0433	0.067	0.0574	0.0526	0.38	1.4	1.5	10	12	0.68	4.21	1.2	9.6	3
Calcium	%	0.002	32.5	34.2	34.9	32.6	30.8	32.1	33	34.2	34.2										
Chromium	mg/kg	0.1	2.26	3.31	2.7	3.54	3.11	4.22	3.52	3.18	3.81	49	141	80	370	220	52.3	160	81	37	62
Cobalt	mg/kg	0.03	1.87	1.26	0.98	2.25	1.41	2.05	0.816	0.799	0.797					180					10
Copper	mg/kg	0.3	3.29	3.76	4.32	4.86	3.63	5.49	1.82	2.97	2.42	32	9.4	65	270	96	18.7	108	34	270	390
Iron	mg/kg	0.002	3820	3810	2750	6660	3890	5670	2280	2270	2340										220000
Lead	mg/kg	0.1	10.1	10.4	11.4	9.13	8.05	11	2.81	2.87	3.49	30	9.4	50	220	530	30.2	112	46.7	218	400
Magnesium	mg/kg	5	6740	8630	7990	6410	5380	5540	7840	7460	9040										
Manganese	mg/kg	0.0001	111	148	103	153	113	195	76	69.2	78										260
Mercury	mg/kg	0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.14	0.48	0.15	1	10	0.13	0.7	0.15	0.71	0.41
Nickel	mg/kg	0.08	2.71	3.32	2.24	5.77	4.06	5.4	2.15	2.26	2.44	15	47	21	52	10	15.9	42.8	20.9	51.6	110
Silver	mg/kg	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.23	1.1	1	4	15	0.73	1.77	0.73	3.7	3.1
Tin	mg/kg	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.689	0.641					900					3.4
Vanadium	mg/kg	0.2	5.55	6.93	5.13	7.64	5.66	7.99	4.96	5.52	5.24					250					57
Zinc	mg/kg	1	24.2	20.5	22.8	26	15.2	29.1	6.45	6.66	8.45	94	245	200	410	350	124	271	15	410	410

Above >1 comparison threshold
Detected values

4.4 Biota Tissue

Invertebrate specimens for tissue analysis were collected from three sites (Diffuser, MMZ-S, Control) with the results presented in Table 4-4. Comparison standards in the form of the OSPARCOM BAC values for bivalves and FAO median values for fish and shellfish are provided. However, care needs to be taken when interpreting these results as there are significant interspecific differences in the uptake and retention of trace metals. The sample organisms on the current survey were either echinoderms or crustaceans, rather than molluscs or fish. For this reason, contextual data is also provided from a study in Scotland, which assessed levels of tissue trace metals in benthic invertebrates, including starfish and crabs (Madgett et al., 2021).

Tin was not detected in tissue analysis of any of the specimens, whilst all of the remaining metals parameters – with the exception of arsenic, chromium, copper and zinc – were either undetected or detected but within the OSPAR BAC or FAO median comparison thresholds.

Arsenic was recorded at levels ranging from 13.2 to 19.9 mg/kg across the three crab specimens, and between 1.4 and 3.22 mg/kg in the starfish specimens. These values exceed the FAO median value for arsenic in fish and shellfish of 1.5 mg/kg; however, given the different taxa used it is also pertinent to consider the contextual data from Madgett et al. (2021). Comparison with these data show that arsenic levels both in crabs and starfish on the current survey were within the relevant ranges documented in the literature.

A similar trend is apparent for copper results in the crab specimens from the Diffuser and MMZ-S sites, where values of 8.03 mg/kg and 13.9 mg/kg respectively were recorded. These are in excess of the OSPAR BAC threshold value of 6 mg/kg for bivalves, yet within the FAO median value for fish and shellfish of 20 mg/kg. Furthermore, the Cu values in these crab specimens fell within the lower range of the contextual data from Madgett et al. (2021).

The zinc levels in the crab specimens from all three locations exceeded the FAO median value for fish and shellfish of 50 mg/kg, yet fell within the OSPAR BAC value of 63 mg/kg. Comparison with the contextual data shows that these zinc levels are within the ranges of values reported from other specimens in UK waters.

Chromium was the only trace metal parameter to display a notably elevated level (3.96 mg/kg), which was recorded in the crab specimen from the Diffuser site. This is roughly 4x the FAO median value for fish and shellfish, and also falls above all the ranges for chromium levels in crustacean tissue samples from the contextual data. This value is elevated by orders of magnitude compared to the nearby MMZ-S site, which suggests further sampling will be needed to assess its validity.

A rank score for each combination of specimen type, parameter and station was calculated, with the summed values then used to generate a holistic metric to inform variation between the sampling stations. For the crab specimens, the highest ranked sum score of 30 (corresponding to the highest metal load) occurred at the Diffuser station, followed by the MMZ-S station (rank sum score 26) and finally the Control station (score 21). For the starfish specimens, the highest ranked sum score of 39 (corresponding to the highest metal load) occurred at the Control station, followed by the MMZ-S station (rank sum score 31) and finally the lowest score at the Diffuser station (28). As such the two specimen types show contrasting trends in inter-station variation, with the crab specimens recording slightly higher metals loading at the Diffuser, then at the mixing zone, then at the Control station, whilst the starfish showed the inverse trend.

Full laboratory results and reporting are shown in

Appendix 3 – Raw Laboratory Data – Biota Tissue Quality.

Table 4-4 Trace metals in biota tissue

			Lab Result						Reference Standards			Contextual Data			
			Diff		MMZ-S		CTRL		OSPAR BAC		FAO 1983 Median Value Fish/Shellfish	Madgett et al., 2021: Benthic invertebrates			
Parameter	**Unit**	**LOR**	**Crab**	**Starfish**	**Crab**	**Starfish**	**Crab**	**Starfish**	**Mussels**	**Oysters**		**Crustacean: muscle**	**Bivalve & crustacean: soft body**	**Echinoderm & polychaete: whole body**	**Crustacean: brown meat**
Aluminum	mg/kg	2.0	7.94	2.57	2.29	4.2	12.8	3.96							
Arsenic	mg/kg	0.02	19.9	3.16	17.2	3.22	13.2	1.4			1.5	4.59 – 26.2	1.91 – 35.3	2.28 – 17	8.99 – 11.7
Boron	mg/kg	2.00	<2	14.8	<2	14.8	<2	18.8							
Cadmium	mg/kg	0.005	<0.005	0.344	0.0059	0.313	<0.005	0.478	0.96	3	0.5	0.0248 – 3	0.0317 - 6.92	0.1 – 0.486	0.713 – 3.34
Calcium	mg/kg	30.0	777	67900	914	54300	766	79900							
Chromium	mg/kg	0.05	3.96	0.212	<0.05	0.388	<0.05	0.306			1	<0.03 – 0.368	0.06 –0.408	0.145 – 1.39	<0.030– 0.111
Cobalt	mg/kg	0.02	0.119	0.0235	0.0873	0.0307	0.0338	<0.02							
Copper	mg/kg	0.2	8.03	2.9	13.9	3.04	5.26	1.08	6	6	20	5.98 – 16.9	4.09 – 65.9	0.917 – 4.86	19.1 – 68.4
Iron	mg/kg	2.00	20.4	12	2.87	13.3	16.9	16.8							
Lead	mg/kg	0.03	<0.03	0.222	0.0345	0.274	0.0387	0.302	1.3	1.3	2	0.0136 – 0.183	0.157 – 7.58	0.194 – 8.87	0.0136 – 0.144
Magnesium	mg/kg	20.0	743	6400	822	6580	718	9430							
Manganese	mg/kg	0.2	0.451	1.1	<0.2	0.925	0.252	1.14							
Mercury	mg/kg	0.02	0.0365	0.0364	0.0582	0.034	0.0436	0.0428	0.09	0.18	0.5	0.023 – 0.273	0.035 – 0.129	0.0222 – 0.127	0.062 – 0.0804
Nickel	mg/kg	0.05	2.08	0.479	0.0722	0.11	0.0679	0.24				0.0089 – 0.299	0.183 – 3.66	0.131 – 1.76	0.191 – 1.14
Silver	mg/kg	0.003	0.15	0.0345	0.216	0.041	0.046	0.0489							
Tin	mg/kg	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05			150				
Vanadium	mg/kg	0.02	0.0462	0.587	<0.02	0.326	0.0393	0.213							
Zinc	mg/kg	0.5	60.7	29.7	52.4	29.6	61.7	33.8	63	63	50	12.2 – 79.2	23.5 – 341	3.8 – 105	16 – 55.8

Outside reference range
Detected values

4.5 Benthic Ecology

4.5.1 Qualitative site descriptions

In general, the seafloor at all three sites can described as predominantly hard substrate (rock with overlying loose cobbles, pebbles and gravel) with small, interspersed patches of sandy sediment. Sites nearer to the diffuser were similar to one another, with the seafloor providing suitable habitat for a range of benthic species, such as algae, invertebrates, and small fish. These areas support a moderate level of species richness and abundance. One notable exception was evident at the diffuser site, where the hard, raised substrate provided by the concrete structure of the diffusers had been extensively colonised by benthic organisms, supporting greater species diversity and abundance than the other survey stations. Many artificial structures in marine environments are similarly colonised, as suitable recruitment space is typically a limiting factor for benthic organisms.

Still images from the site (shown in Figure 4-6), show dense aggregations of species such as sponges, ascidians, macroalgae and echinoderms at the Diffuser relative to the MMZ-S site (Figure 4-7). This trend is likely principally due to the settlement space provided by the physical structure of the diffuser itself, but nutrient input from the wastewater emanating from the diffuser may contribute to increased benthic productivity. The nearby MMZ-S site supports a more typical hard-substrate benthic community for the region.

Figure 4-6 Example images from the Diffuser site

Figure 4-7 Example images from MMZ-S site, showing more typical substrate

The seafloor at the control site, while still characterised as predominantly rocky substrate interspersed with patches of softer sediment, contained more complex three-dimensional structures which provided crevices and small rock formations. Based on qualitative assessment the control site appeared to support greater species diversity, with a richer assemblage of marine life compared to sites nearer the diffuser. Crustaceans such as crabs, and lobsters, together with various fish species, were observed. Benthic habitats with greater structural complexity provide niches, shelter, and foraging opportunities for a wide range of benthic species, and thus tend to support greater biodiversity.

Figure 4-8 Example images of the seafloor from the control site.

4.5.2 Semi-quantitative ecological analyses

As detailed in Section 3.7, the benthic ecology data from the MMS-Z station was subjected to semi-quantitative analysis and is presented below.

A species list was compiled of all organisms present at the MMZ-S site, which resulted in 122 taxa. A representative subset of still images was extracted from the transect video, using stratified random sampling. This resulted in a subset of 15 high quality, representative images for detailed analysis (Figure 4-8), which show a diverse assemblage of benthic organisms, including cnidarians, molluscs, echinoderms, crustaceans, sponges and ascidians.

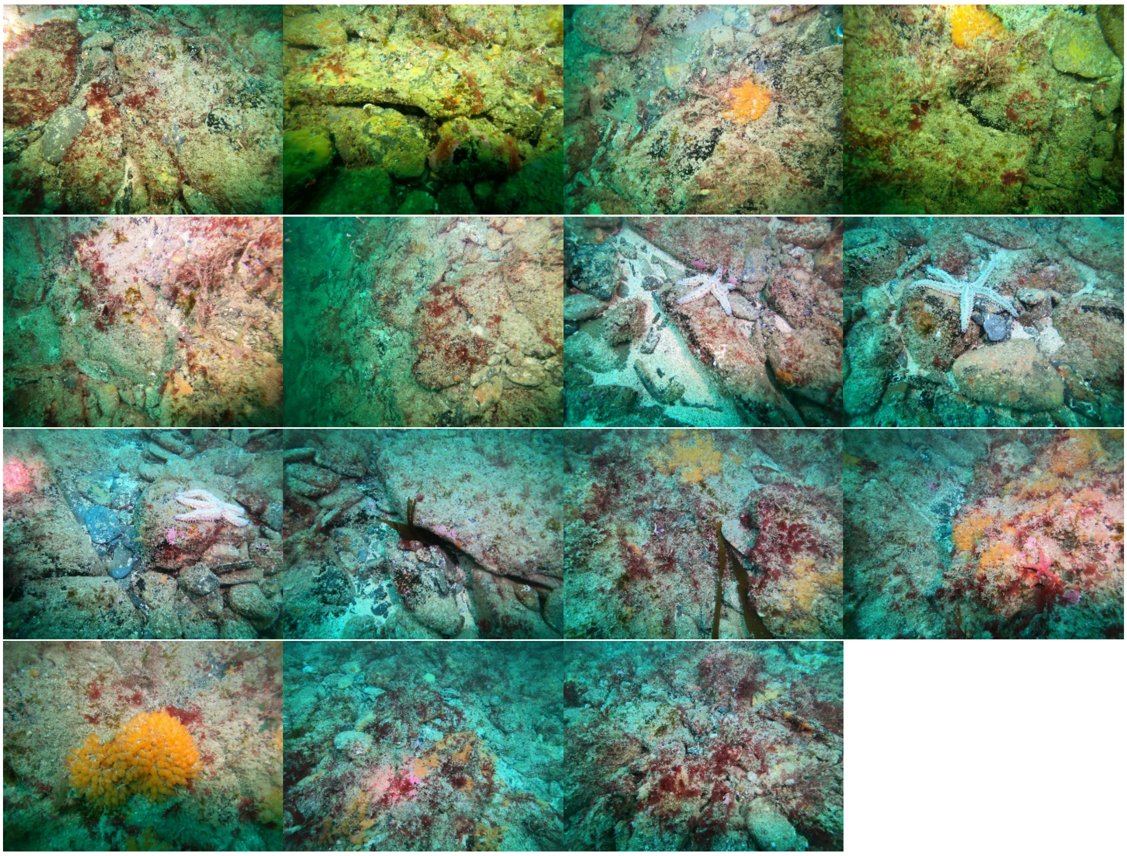

Figure 4-8. Images (frame) extracted from MMZ-S for preliminary ecological analysis.

The abundance of all organisms was recorded in each image, with individual counts for non-colonial organisms and estimates of percentage substrate cover for colonial organisms. The relative abundance was then calculated across the entire data set, in order to understand the most abundant benthic taxa at the site. A summary of the species list broken down by phylum and class is presented in

Table **4-5**, which also includes the species richness and relative abundance by taxonomic class.

Table 4-5 Species list by class at MMZ-S, with species richness and relative abundance

Kingdom	Phylum	Class	Common name	Species Richness	Relative Abundance (%)
Animalia	Annelida	Polychaeta	Segmented worms	5	3.73
	Arthropoda	Malacostraca	Soft-shell crustaceans	10	7.47
		Thecostraca	Includes barnacles	1	1.17
	Bryozoa	Gymnolaemata	Moss animals	6	5.30
		Stenolaemata		1	1.17
	Chordata	Ascidiacea	Sea squirts	17	12.00
		Elasmobranchii	Sharks and rays	1	1.55
		Teleostei	Ray-finned fish	9	7.55
	Cnidaria	Hexacorallia	Stony corals, anemones, zoanthids	4	6.12
		Hydrozoa	Hydroids	3	2.97
	Echinodermata	Asteroidea	Starfish	2	2.89
		Echinoidea	Sea urchins	1	1.08
		Holothuroidea	Sea cucumbers	3	2.80
		Ophiuroidea	Brittle stars	1	0.31
	Mollusca	Bivalvia	Clams, scallops, oysters, mussels	2	1.59
		Gastropoda	Slugs and snails	14	12.45
	Nemertea	Pilidiophora	Ribbon worms	1	0.72
	Porifera	Calcarea	Calcareous sponges	6	3.93
		Demospongiae	Coralline sponges	15	11.37
Chromista	Ochrophyta	Phaeophyceae	Brown algae	6	3.78
Plantae	Chlorophyta	Ulvophyceae	Green algae	1	1.34
	Rhodophyta	Florideophyceae	Red algae	12	8.71

The data highlight of a mix of organism types at the MMZ-S station, including algae (e.g., *Laminaria hyperborea*, *Palmaria palmata*), invertebrates (e.g., *Pagurus bernhardus*, *Polycarpa*), and fish species (e.g., *Pollachius pollachius*, *Scyliorhinus canicula*), highlighting the biodiversity present in the marine environment. The taxonomic classes presenting higher relative abundances (> 5 %) included gastropods (sea snails), ascidians (sea squirts), coralline sponges, red algae, ray-finned fishes, soft-shelled crustaceans, stony corals & anemones and bryozoans.

In summary, the ecological surveys revealed a typical hard substrate benthic community for the marine waters of the north-eastern Atlantic, characterised by a moderate-high degree of species diversity and ecological interaction. The survey data provides useful baseline information to compare against future surveys of these sites.

5 Historical metals data

5.1 Metals in seawater

A literature search was carried out to better understand temporal trends in trace metal concentrations in seawater in and around St Ives Bay. The area has a long history of mining, which has resulted in some level of legacy metals contamination (Rainbow et al., 2020). This is particularly concentrated in some of the region's rivers – which received dewatering and waste streams from mining activities – and, by extension, the estuaries where these rivers discharge into coastal waters. St Ives Bay has two such riverine inputs which have received legacy mining contamination: these are the Red River, which discharges close to Godrevy Head in the north of the bay and the Hayle River, which discharges into the Hayle Estuary and then into the southern part of the bay (see Figure 5-1). All monitoring locations for previous trace metals data in and around St Ives Bay are shown on Figure 5-1, with details (e.g. analysis type and study) shown in the legend.

Results for previous data on trace metals in seawater are presented from three sources. These comprise an earlier study which analysed marine water samples in three locations in the bay (Bradfield et al., 1976), and two sets of data from the Environment Agency's monitoring programme, which were recorded at a sampling station close to the diffuser site and near the mouth of the Red River. These results are presented in Table 5-1, alongside the ranges of values recorded on the current survey. Generally speaking, the ranges of values recorded from the EA monitoring station at the mouth of the Red River are much higher than anything recorded within the bay itself, either in the past or on the current survey. This aligns with the trend mentioned above, of high levels of riverine metals inputs into the bay which then dilute rapidly in the coastal waters. The exception to this trend were the results for mercury on the current survey, which exceeded the ranges recorded in the literature. Further monitoring of Hg concentrations in seawater, in particular, is recommended in order to better understand temporal trends in the concentration of this parameter.

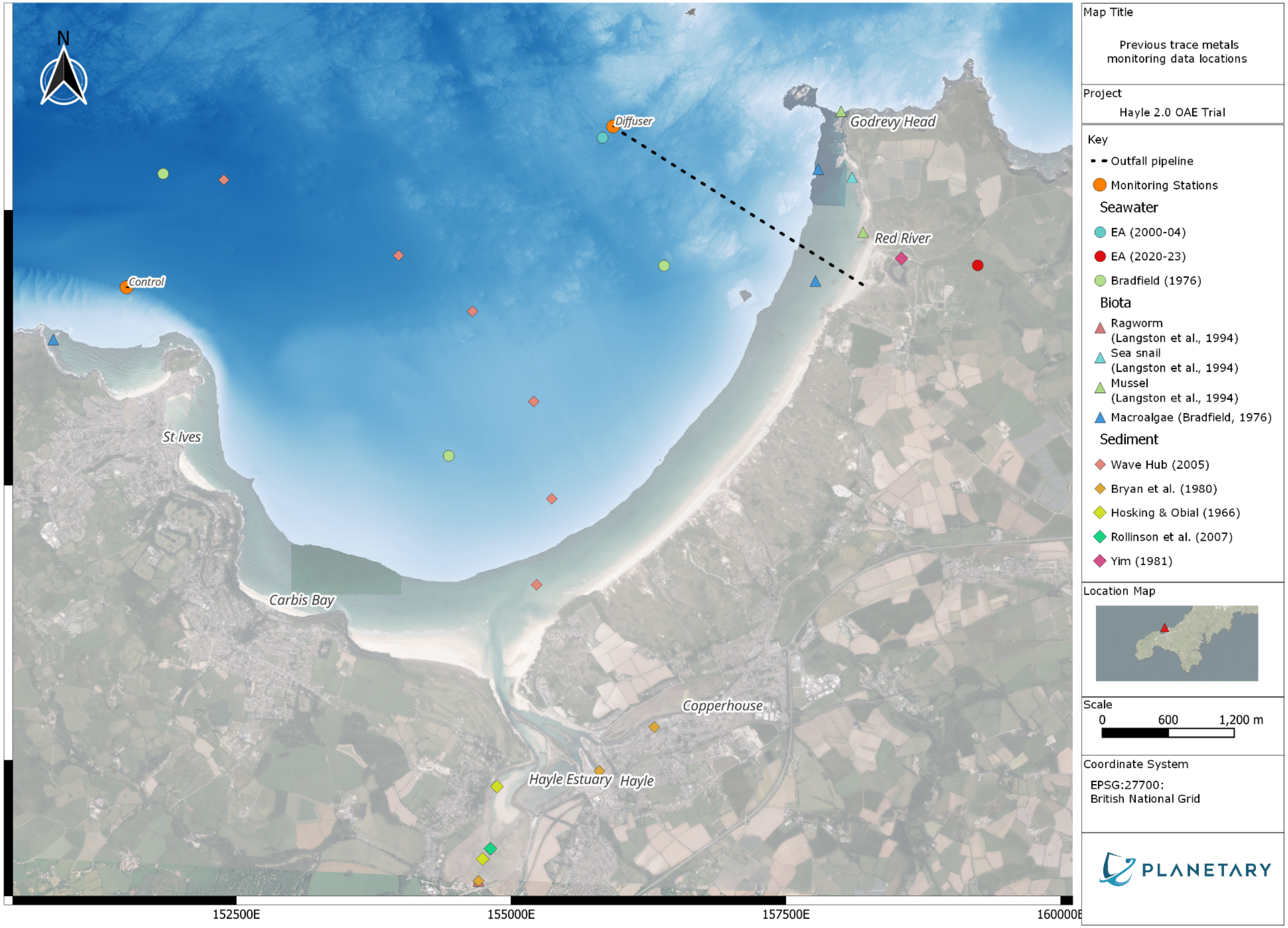

Figure 5-1 **Locations of previous monitoring data on trace metals in and around St Ives Bay**

Table 5-1 Historical data on metals in seawater in and around St Ives Bay

Parameter	Source	Location	Historical Range (µg/L)	Current Range (µg/L)
Aluminum	EA data: 2020 – 2023	Red River	56 - 500	0.72 – 4.33
Arsenic	Bradfield et al., 1976	St Ives Bay	<5	1.49 – 2.27
	EA data 2020 – 2023	Red River	41 - 69	
	EA data: 2000 – 2004	St Ives Bay – nr. Diffuser	1.2 – 1.8 (dissolved)	
Cadmium	Bradfield et al., 1976	St Ives Bay	<1	<0.05
	EA data 2020 – 2023	Red River	0.23 – 0.97	
	EA data: 2000 – 2004	St Ives Bay – nr. Diffuser	<0.25 (dissolved)	
Chromium	Bradfield et al. 1976	St Ives Bay	<1	<0.1 – 0.296
	EA data 2020 – 2023	Red River	0.68 – 1.9	
	EA data: 2000 – 2004	St Ives Bay – nr. Diffuser	<0.5 - 5.1 (dissolved)	
Cobalt	Bradfield et al., 1976	St Ives Bay	<1	<0.05
Copper	Bradfield et al., 1976	St Ives Bay	<1	<0.5 – 0.613
	EA data 2020 – 2023	Red River	17 - 410	
	EA data: 2000 – 2004	St Ives Bay – nr. Diffuser	<0.5 – 2.6 (dissolved)	
Iron	Bradfield et al., 1976	St Ives Bay	<5	<4 – 11.2
	EA data 2020 – 2023	Red River	660 - 1700	
Lead	Bradfield et al. 1976	St Ives Bay	<5	<0.3 – 0.389
	EA data 2020 – 2023	Red River	0.18 - 27	
	EA data: 2000 – 2004	St Ives Bay – nr. Diffuser	<2.5 (dissolved)	
Manganese	Bradfield et al., 1976	St Ives Bay	<5	0.33 – 1.04
Mercury	EA data: 2000 – 2004	St Ives Bay – nr. Diffuser	<0.01 (dissolved)	0.053 – 0.082
	EA data 2020 – 2023	Red River	0.013 – 0.016	
Nickel	Bradfield et al., 1976	St Ives Bay	<1	<0.5 – 0.638
	EA data: 2000 – 2004	St Ives Bay – nr. Diffuser	<3 (dissolved)	
	EA data 2020 – 2023	Red River	3 - 11	
Zinc	Bradfield et al., 1976	St Ives Bay	7 (average)	2.2 – 3.38
	EA data: 2000 – 2004	St Ives Bay – nr. Diffuser	<4 - 8.9 (dissolved)	
	EA data 2020 – 2023	Red River	110 - 360	

All total metals concentrations unless otherwise indicated

5.2 Metals in sediments

As with the trace metals in seawater, a literature review was carried out to compile data on trace metals in sediments from previous studies in and around St Ives Bay. Data is presented in Table 5-2 from five studies, three of which examined sediments in Hayle Estuary, one at the mouth of the Red River and one in the marine sediments of the bay itself (Wave Hub). Of these the Wave Hub results are the most comparable to those on the current survey, yet the other results provide context and support the overarching trend of high levels of riverine metals input to the bay from legacy mining activity. The locations for the data shown in Table 5-2 are presented in Figure 5-1.

The ranges of trace metals from previous studies clearly show that the sediments in the Hayle Estuary, and to a lesser extent the Red River, present elevated levels of many parameters. In comparison, the results from the seven stations sampled as part of the Wave Hub baseline survey in the bay are much lower. The Wave Hub results align fairly well with the data from the current survey, with the ranges of data from the current survey generally overlapping those from Wave Hub but falling slightly lower. This aligns with the supposition that riverine inputs from the Hayle Estuary account for much of the trace metal load in marine sediments in the bay, as the Wave Hub sampling stations are closer to the Hayle Estuary than the sampling stations on the current survey. Furthermore, a subset of the stations from the Wave Hub survey are roughly positioned on a transect moving away from the mouth of the Hayle Estuary. The concentrations of some metals parameters, such as arsenic, copper and tin, are elevated in stations closer to the estuary mouth and then decrease moving further offshore. This aligns with the trend of riverine metals inputs accounting for much of the trace metal loading in sediments of the bay.

Table 5-2 Historical data on metals in sediments in and around St Ives Bay

Parameter	Source	Location	Historical Range (mg/kg)	Current Survey (mg/kg)
Arsenic	Wave Hub, 2005	St Ives Bay	17.4 – 66.3	3.39 – 7.22
	Rollinson et al., 2007	Hayle Estuary	57 – 2290	
	Bryan et al., 1980	Hayle Estuary	550	
	Yim, 1981	Red River mouth	480	
Cadmium	Wave Hub, 2005	St Ives Bay	<0.1 – 0.1	0.017 – 0.067
	Bryan et al., 1980	Hayle Estuary	1.0	
Copper	Wave Hub, 2007	St Ives Bay	15.8 – 64.3	1.82 – 5.49
	Bryan et al., 1980	Hayle Estuary	782	
	Rollinson et al., 2007	Hayle Estuary	88 – 4139	
	Hosking and Obial, 1966	Hayle Estuary	up to 2000	
	Yim, 1981	Red River mouth	180	
Iron	Yim, 1981	Red River mouth	31700	2270 – 6660
	Bryan et al., 1980	Hayle Estuary	88 – 4140	
Lead	Wave Hub, 2005	St Ives Bay	6.8 – 16	2.81 – 11.4
	Yim, 1981	Red River mouth	7	
	Bryan et al., 1980	Hayle Estuary	218	
	Rollinson et al., 2007	Hayle Estuary	30 – 522	
Manganese	Yim, 1981	Red River mouth	408	69.2 – 195
	Bryan et al., 1980	Hayle Estuary	742	
Mercury	Wave Hub, 2005	St Ives Bay	<0.10	<0.04
Nickel	Wave Hub, 2005	St Ives Bay	3.6 – 12.5	2.15 – 5.77
Silver	Bryan et al., 1980	Hayle Estuary	1.3	<0.05
Tin	Wave Hub, 2007	St Ives Bay	2.7 – 12.6	<0.5 – 0.689
	Hosking and Obial, 1966	Hayle Estuary	up to 1000	
	Rollinson et al., 2007	Hayle Estuary	632 – 5455	
	Yim, 1981	Red River mouth	3300	
	Bryan et al., 1980	Hayle Estuary	1750	
Vanadium	Wave Hub, 2005	St Ives Bay	7 – 17.4	4.96 – 7.99
Zinc	Wave Hub, 2005	St Ives Bay	36.7 – 70.4	6.45 – 29.1
	Rollinson et al., 2007	Hayle Estuary	172 – 1194	
	Yim, 1981	Red River mouth	100	
	Bryan et al., 1980	Hayle Estuary	942	

5.3 Biota tissue sampling

As with seawater and sediment, a literature review was carried out to compile data on trace metals in marine biota from previous studies in and around St Ives Bay. Data is presented in Table 5-3 from three studies, which include results for trace metal levels in four different organisms from four locations. The organisms and locations were *Hediste diversicolor* (a polychaete ragworm sampled in the Hayle Estuary), *Mytilis edulis* (blue mussel, sampled at Red River mouth and Godrevy shoreline), *Littorina littorina* (common periwinkle, sampled at the Godrevy shoreline and *Fucus vesiculosus* (bladder wrack, sampled at three locations on the western side of St Ives bay). None of the four organisms from previous studies were the same as those sampled on the current survey and so a direct comparison is challenging, due to the inherent differences in trace metal levels between different taxonomic groups. For this reason, the results from biota samples on the current survey have not been presented alongside for direct comparison. Nonetheless, the historical studies can provide broad context and highlight some spatial trends in trace metal loading in biota.

The results for the ragworm specimens from Hayle Estuary generally presented high levels of trace metals, aligning with the pattern seen in sediment samples. The historical data on cadmium, copper, lead, mercury and zinc levels in the blue mussel specimens from the Red River and the Godrevy were generally elevated, exceeding the comparison thresholds for mussels set out by OSPAR and the FAO discussed previously and also significantly exceeding the ranges of values recorded for both the crab and starfish specimens recorded on the current survey. However, it should be noted that these historical data are now quite dated and thus may not be representative of current conditions.

The locations for the data shown in Table 5-3 are presented in Figure 5-1.

Table 5-3 Historical data on metals in biota in and around St Ives Bay

Parameter	Source	Location	Organism	Historical Range (mg/kg dry weight)
Arsenic	Bryan & Gibbs, 1983	Hayle Estuary	*Hediste diversicolor,*	84
Arsenic	Langston et al., 1994	Godrevy	*Mytulis edulis*	0.03
Arsenic	Langston et al., 1994	Red River mouth	*Mytulis edulis*	0.22
Cadmium	Bradfield et al.,1976	St Ives Bay	*Fucus vesiculosus*	1.0 – 4.6
Cadmium	Bryan & Gibbs, 1983	Hayle Estuary	*Hediste diversicolor*	0.47
Cadmium	Langston et al., 1994	Godrevy	*Littorina littorina*	2.9
Cadmium	Langston et al., 1994	Godrevy	*Mytulis edulis*	2.0
Cadmium	Langston et al., 1994	Red River mouth	*Mytulis edulis*	2.3
Chromium	Langston et al., 1994	Godrevy	*Mytulis edulis*	1.6
Chromium	Langston et al., 1994	Red River mouth	*Mytulis edulis*	0.9
Cobalt	Langston et al., 1994	Godrevy	*Littorina littorina*	1.6
Cobalt	Langston et al., 1994	Godrevy	*Mytulis edulis*	2.3
Cobalt	Langston et al., 1994	Red River mouth	*Mytulis edulis*	4.4
Copper	Bradfield et al., 1976	S Ives Bay	*Fucus vesiculosus*	6.6 - 141
Copper	Bryan & Gibbs, 1983	Hayle Estuary	*Hediste diversicolor,*	1210
Copper	Langston et al., 1994	Godrevy	*Littorina littorina*	372
Copper	Langston et al., 1994	Godrevy	*Mytulis edulis*	49
Copper	Langston et al., 1994	Red River mouth	*Mytulis edulis*	149
Iron	Bradfield et al.,1976	St Ives Bay.	*Fucus vesiculosus*	22 - 191
Iron	Bryan & Gibbs, 1983	Hayle Estuary	*Hediste diversicolor,*	734
Iron	Langston et al., 1994	Godrevy	*Littorina littorina*	332
Iron	Langston et al., 1994	Godrevy	*Mytulis edulis*	218
Iron	Langston et al., 1994	Red River mouth	*Mytulis edulis*	345
Lead	Bradfield et al.,1976	St Ives Bay.	*Fucus vesiculosus*	5.7 – 6.8
Lead	Bryan & Gibbs, 1983	Hayle Estuary	*Hediste diversicolor,*	4.2
Lead	Langston et al., 1994	Godrevy	*Littorina littorina*	1.7
Lead	Langston et al., 1994	Godrevy	*Mytulis edulis*	2.5
Lead	Langston et al., 1994	Red River mouth	*Mytulis edulis*	3.3
Manganese	Bradfield et al.,1976	St Ives Bay	*Fucus vesiculosus*	63 - 94
Manganese	Bryan & Gibbs, 1983	Hayle Estuary	*Hediste diversicolor,*	5.7
Manganese	Langston et al., 1994	Godrevy	*Mytulis edulis*	3.9
Manganese	Langston et al., 1994	Red River mouth	*Mytulis edulis*	6.9
Manganese	Langston et al., 1994	Godrevy	*Littorina littorina*	20
Mercury	Langston et al., 1994	Godrevy	*Mytulis edulis*	0.32
Mercury	Langston et al., 1994	Red River mouth	*Mytulis edulis*	0.48
Nickel	Bradfield et al.,1976	St Ives Bay.	*Fucus vesiculosus*	9.0 - 12
Nickel	Langston et al., 1994	Godrevy	*Mytulis edulis*	1.3
Nickel	Langston et al., 1994	Red River mouth	*Mytulis edulis*	2.4
Silver	Bryan & Gibbs, 1983	Hayle Estuary	*Hediste diversicolor,*	5.3
Silver	Langston et al., 1994	Godrevy	*Littorina littorina*	0.6
Silver	Langston et al., 1994	Godrevy	*Mytulis edulis*	0.03
Silver	Langston et al., 1994	Red River mouth	*Mytulis edulis*	0.22
Tin	Bryan & Gibbs, 1983	Hayle Estuary	*Hediste diversicolor,*	0.08
Tin	Langston et al., 1994	Godrevy	*Mytulis edulis*	0.04
Tin	Langston et al., 1994	Red River mouth	*Mytulis edulis*	0.28
Zinc	Bradfield et al.,1976	S Ives Bay.	*Fucus vesiculosus*	71 - 213
Zinc	Bryan & Gibbs, 1983	Hayle Estuary	*Hediste diversicolor,*	260
Zinc	Langston et al., 1994	Godrevy	*Mytulis edulis*	299
Zinc	Langston et al., 1994	Red River mouth	*Mytulis edulis*	453

All results in mg/kg dry weight

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Appendix 1 – Raw Laboratory Data – Seawater Quality

This certificate replaces any previous certificate with the same number.

CERTIFICATE OF ANALYSIS

Work Order	: **LE2307027**	Page	: 1 of 8
Amendment	: **2**		
Client	: **PML Applications Ltd**	Project	: PMA1907
Contact	: Invoice PML Applications	Purchase Number	: PMA1907
Address	: Prospect Place, The Hoe, Devon PL1 3DH United Kingdom United Kingdom	Sampler	: Planetary Tech
		Site	: ----
		Date Samples Received	: 2023-05-19 13:00
E-mail	: supplier@pml.ac.uk	Date Analysis Commenced	: 2023-05-22
Telephone	: ----	Issue Date	: 2023-07-06 13:45
C-O-C number	: ----	No. of samples received	: 12
Quote number	: LE2023SE-PML-LTD0001 (OF230300)	No. of samples analysed	: 12

General Comments

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This certificate represents the original certificate and may not be modified or reproduced other than in full, except with the prior written approval of the issuing lab. The results apply only to the material that has been identified, received, and tested. The laboratory has no responsibility for information in this certificate that has been provided by the customer, or results that may be affected by such information. Regarding the laboratory's liability in relation to assignment, please refer to our website http://www.alsglobal.se

Workorder Comments

Amendment 1 - the change only applies to changed company.
Amendment 2 - the change applies to add elements.

Signatories	*Position*
Ilia Rodushkin	Laboratory Manager

Ilia Rodushkin

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Provning
ISO/IEC 17025

ilac-MRA

Laboratory	: ALS Scandinavia AB Luleå	Webpage	: www.alsglobal.se
Address	: Aurorum 10 977 75 Luleå Sweden	E-mail	: info.lu@alsglobal.com
		Telephone	: +46 920 28 99 00

Analytical Results

Sub-Matrix: **SEAWATER**

	Client sample ID	TM A CTRL					
	Laboratory sample ID	LE2307027-001					
	Client sampling date / time	2023-05-07					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Filtration	Yes	----	-	-	PP-FILTR045	W-PP-filt	LE
Total Metals/Major Cations							
Aluminum	1.12	± 0.44	µg/L	0.70	V-5	W-SFMS-5C	LE
Cadmium	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Chromium	0.296	± 0.069	µg/L	0.10	V-5	W-SFMS-5C	LE
Cobalt	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Copper	0.565	± 0.151	µg/L	0.50	V-5	W-SFMS-5C	LE
Iron	0.0112	± 0.0016	mg/L	0.0040	V-5	W-SFMS-5C	LE
Lead	0.326	± 0.050	µg/L	0.30	V-5	W-SFMS-5C	LE
Manganese	0.671	± 0.119	µg/L	0.10	V-5	W-SFMS-5C	LE
Mercury	0.0721	± 0.0099	µg/L	0.002	V-5	W-AFS-17V2	LE
Nickel	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Zinc	2.50	± 0.75	µg/L	2.0	V-5	W-SFMS-5C	LE
Arsenic	2.02	± 0.27	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Boron	4380	± 510	µg/L	10	V-5-ADD	W-AES-1A	LE
Silver	<0.5	----	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Tin	3.54	± 0.54	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Vanadium	1.69	± 0.27	µg/L	0.005	V-5-ADD	W-SFMS-5C	LE

Sub-Matrix: **SEAWATER**

	Client sample ID	TM A S					
	Laboratory sample ID	LE2307027-002					
	Client sampling date / time	2023-05-07					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Filtration	Yes	----	-	-	PP-FILTR045	W-PP-filt	LE
Total Metals/Major Cations							
Aluminum	2.34	± 0.54	µg/L	0.70	V-5	W-SFMS-5C	LE
Cadmium	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Chromium	<0.1	----	µg/L	0.10	V-5	W-SFMS-5C	LE
Cobalt	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Copper	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Iron	<0.004	----	mg/L	0.0040	V-5	W-SFMS-5C	LE
Lead	<0.3	----	µg/L	0.30	V-5	W-SFMS-5C	LE
Manganese	0.807	± 0.138	µg/L	0.10	V-5	W-SFMS-5C	LE
Mercury	0.0532	± 0.0073	µg/L	0.002	V-5	W-AFS-17V2	LE
Nickel	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Zinc	2.20	± 0.72	µg/L	2.0	V-5	W-SFMS-5C	LE
Arsenic	1.81	± 0.25	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Boron	4390	± 510	µg/L	10	V-5-ADD	W-AES-1A	LE
Silver	<0.5	----	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Tin	1.12	± 0.23	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Vanadium	1.70	± 0.28	µg/L	0.005	V-5-ADD	W-SFMS-5C	LE

Sub-Matrix: **SEAWATER**

	Client sample ID	TM A NE					
	Laboratory sample ID	LE2307027-003					
	Client sampling date / time	2023-05-07					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Filtration	Yes	----	-	-	PP-FILTR045	W-PP-filt	LE
Total Metals/Major Cations							
Aluminum	1.03	± 0.43	µg/L	0.70	V-5	W-SFMS-5C	LE
Cadmium	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Chromium	0.224	± 0.062	µg/L	0.10	V-5	W-SFMS-5C	LE
Cobalt	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Copper	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Iron	<0.004	----	mg/L	0.0040	V-5	W-SFMS-5C	LE
Lead	<0.3	----	µg/L	0.30	V-5	W-SFMS-5C	LE
Manganese	0.667	± 0.118	µg/L	0.10	V-5	W-SFMS-5C	LE
Mercury	0.0660	± 0.0091	µg/L	0.002	V-5	W-AFS-17V2	LE
Nickel	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Zinc	3.38	± 0.84	µg/L	2.0	V-5	W-SFMS-5C	LE
Arsenic	1.49	± 0.22	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Boron	4420	± 514	µg/L	10	V-5-ADD	W-AES-1A	LE
Silver	<0.5	----	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Tin	<0.5	----	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Vanadium	1.65	± 0.27	µg/L	0.005	V-5-ADD	W-SFMS-5C	LE

Sub-Matrix: **SEAWATER**

	Client sample ID	TM A Diff					
	Laboratory sample ID	LE2307027-004					
	Client sampling date / time	2023-05-07					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Filtration	Yes	----	-	-	PP-FILTR045	W-PP-filt	LE
Total Metals/Major Cations							
Aluminum	2.42	± 0.55	µg/L	0.70	V-5	W-SFMS-5C	LE
Cadmium	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Chromium	0.196	± 0.060	µg/L	0.10	V-5	W-SFMS-5C	LE
Cobalt	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Copper	0.613	± 0.156	µg/L	0.50	V-5	W-SFMS-5C	LE
Iron	<0.004	----	mg/L	0.0040	V-5	W-SFMS-5C	LE
Lead	<0.3	----	µg/L	0.30	V-5	W-SFMS-5C	LE
Manganese	0.744	± 0.129	µg/L	0.10	V-5	W-SFMS-5C	LE
Mercury	0.0820	± 0.0113	µg/L	0.002	V-5	W-AFS-17V2	LE
Nickel	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Zinc	2.90	± 0.79	µg/L	2.0	V-5	W-SFMS-5C	LE
Arsenic	1.90	± 0.26	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Boron	4380	± 510	µg/L	10	V-5-ADD	W-AES-1A	LE
Silver	<0.5	----	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Tin	4.75	± 0.71	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Vanadium	1.69	± 0.27	µg/L	0.005	V-5-ADD	W-SFMS-5C	LE

Sub-Matrix: **SEAWATER**

	Client sample ID	TM B CTRL					
	Laboratory sample ID	LE2307027-005					
	Client sampling date / time	2023-05-07					

Parameter	Result	MU	Unit	LOR	Package	Method	Issuer
Sample Pre-Preparation							
Filtration	Yes	----	-	-	PP-FILTR045	W-PP-filt	LE
Total Metals/Major Cations							
Aluminum	1.65	± 0.48	µg/L	0.70	V-5	W-SFMS-5C	LE
Cadmium	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Chromium	0.146	± 0.056	µg/L	0.10	V-5	W-SFMS-5C	LE
Cobalt	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Copper	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Iron	<0.004	----	mg/L	0.0040	V-5	W-SFMS-5C	LE
Lead	<0.3	----	µg/L	0.30	V-5	W-SFMS-5C	LE
Manganese	0.776	± 0.134	µg/L	0.10	V-5	W-SFMS-5C	LE
Mercury	0.0694	± 0.0096	µg/L	0.002	V-5	W-AFS-17V2	LE
Nickel	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Zinc	2.32	± 0.73	µg/L	2.0	V-5	W-SFMS-5C	LE
Arsenic	2.27	± 0.30	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Boron	4370	± 508	µg/L	10	V-5-ADD	W-AES-1A	LE
Silver	<0.5	----	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Tin	6.26	± 0.92	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Vanadium	1.74	± 0.28	µg/L	0.005	V-5-ADD	W-SFMS-5C	LE

Sub-Matrix: **SEAWATER**

	Client sample ID	TM B S					
	Laboratory sample ID	LE2307027-006					
	Client sampling date / time	2023-05-07					

Parameter	Result	MU	Unit	LOR	Package	Method	Issuer
Sample Pre-Preparation							
Filtration	Yes	----	-	-	PP-FILTR045	W-PP-filt	LE
Total Metals/Major Cations							
Aluminum	1.47	± 0.46	µg/L	0.70	V-5	W-SFMS-5C	LE
Cadmium	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Chromium	0.167	± 0.058	µg/L	0.10	V-5	W-SFMS-5C	LE
Cobalt	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Copper	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Iron	<0.004	----	mg/L	0.0040	V-5	W-SFMS-5C	LE
Lead	<0.3	----	µg/L	0.30	V-5	W-SFMS-5C	LE
Manganese	1.04	± 0.17	µg/L	0.10	V-5	W-SFMS-5C	LE
Mercury	0.0599	± 0.0083	µg/L	0.002	V-5	W-AFS-17V2	LE
Nickel	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Zinc	<2	----	µg/L	2.0	V-5	W-SFMS-5C	LE
Arsenic	1.70	± 0.24	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Boron	4340	± 504	µg/L	10	V-5-ADD	W-AES-1A	LE
Silver	<0.5	----	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Tin	0.624	± 0.180	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Vanadium	1.59	± 0.26	µg/L	0.005	V-5-ADD	W-SFMS-5C	LE

Sub-Matrix: **SEAWATER**	*Client sample ID*	**TM B NE**					
	Laboratory sample ID	*LE2307027-007*					
	Client sampling date / time	*2023-05-07*					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Filtration	Yes	----	-	-	PP-FILTR045	W-PP-filt	LE
Total Metals/Major Cations							
Aluminum	0.718	± 0.415	µg/L	0.70	V-5	W-SFMS-5C	LE
Cadmium	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Chromium	0.259	± 0.066	µg/L	0.10	V-5	W-SFMS-5C	LE
Cobalt	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Copper	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Iron	<0.004	----	mg/L	0.0040	V-5	W-SFMS-5C	LE
Lead	<0.3	----	µg/L	0.30	V-5	W-SFMS-5C	LE
Manganese	0.795	± 0.136	µg/L	0.10	V-5	W-SFMS-5C	LE
Mercury	0.0748	± 0.0103	µg/L	0.002	V-5	W-AFS-17V2	LE
Nickel	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Zinc	<2	----	µg/L	2.0	V-5	W-SFMS-5C	LE
Arsenic	1.64	± 0.23	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Boron	4340	± 505	µg/L	10	V-5-ADD	W-AES-1A	LE
Silver	<0.5	----	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Tin	<0.5	----	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Vanadium	1.63	± 0.26	µg/L	0.005	V-5-ADD	W-SFMS-5C	LE

Sub-Matrix: **SEAWATER**	*Client sample ID*	**TM B DIFF**					
	Laboratory sample ID	*LE2307027-008*					
	Client sampling date / time	*2023-05-07*					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Filtration	Yes	----	-	-	PP-FILTR045	W-PP-filt	LE
Total Metals/Major Cations							
Aluminum	1.81	± 0.49	µg/L	0.70	V-5	W-SFMS-5C	LE
Cadmium	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Chromium	0.155	± 0.057	µg/L	0.10	V-5	W-SFMS-5C	LE
Cobalt	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Copper	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Iron	<0.004	----	mg/L	0.0040	V-5	W-SFMS-5C	LE
Lead	<0.3	----	µg/L	0.30	V-5	W-SFMS-5C	LE
Manganese	0.537	± 0.101	µg/L	0.10	V-5	W-SFMS-5C	LE
Mercury	0.0694	± 0.0096	µg/L	0.002	V-5	W-AFS-17V2	LE
Nickel	0.638	± 0.155	µg/L	0.50	V-5	W-SFMS-5C	LE
Zinc	2.60	± 0.76	µg/L	2.0	V-5	W-SFMS-5C	LE
Arsenic	1.82	± 0.25	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Boron	4490	± 522	µg/L	10	V-5-ADD	W-AES-1A	LE
Silver	<0.5	----	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Tin	1.90	± 0.32	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Vanadium	1.67	± 0.27	µg/L	0.005	V-5-ADD	W-SFMS-5C	LE

Sub-Matrix: **SEAWATER**	*Client sample ID*	**TM C CTRL**					
	Laboratory sample ID	*LE2307027-009*					
	Client sampling date / time	*2023-05-07*					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Filtration	Yes	----	-	-	PP-FILTR045	W-PP-filt	LE
Total Metals/Major Cations							
Aluminum	1.71	± 0.48	µg/L	0.70	V-5	W-SFMS-5C	LE
Cadmium	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Chromium	0.172	± 0.058	µg/L	0.10	V-5	W-SFMS-5C	LE
Cobalt	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Copper	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Iron	<0.004	----	mg/L	0.0040	V-5	W-SFMS-5C	LE
Lead	0.341	± 0.052	µg/L	0.30	V-5	W-SFMS-5C	LE
Manganese	0.744	± 0.129	µg/L	0.10	V-5	W-SFMS-5C	LE
Mercury	0.0710	± 0.0098	µg/L	0.002	V-5	W-AFS-17V2	LE
Nickel	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Zinc	<2	----	µg/L	2.0	V-5	W-SFMS-5C	LE
Arsenic	1.49	± 0.22	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Boron	4320	± 502	µg/L	10	V-5-ADD	W-AES-1A	LE
Silver	<0.5	----	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Tin	14.0	± 2.0	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Vanadium	1.62	± 0.26	µg/L	0.005	V-5-ADD	W-SFMS-5C	LE

Sub-Matrix: **SEAWATER**	*Client sample ID*	**TM C S**					
	Laboratory sample ID	*LE2307027-010*					
	Client sampling date / time	*2023-05-07*					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Filtration	Yes	----	-	-	PP-FILTR045	W-PP-filt	LE
Total Metals/Major Cations							
Aluminum	1.54	± 0.47	µg/L	0.70	V-5	W-SFMS-5C	LE
Cadmium	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Chromium	0.179	± 0.058	µg/L	0.10	V-5	W-SFMS-5C	LE
Cobalt	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Copper	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Iron	<0.004	----	mg/L	0.0040	V-5	W-SFMS-5C	LE
Lead	<0.3	----	µg/L	0.30	V-5	W-SFMS-5C	LE
Manganese	0.557	± 0.104	µg/L	0.10	V-5	W-SFMS-5C	LE
Mercury	0.0617	± 0.0085	µg/L	0.002	V-5	W-AFS-17V2	LE
Nickel	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Zinc	2.92	± 0.79	µg/L	2.0	V-5	W-SFMS-5C	LE
Arsenic	1.64	± 0.23	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Boron	4320	± 502	µg/L	10	V-5-ADD	W-AES-1A	LE
Silver	<0.5	----	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Tin	1.82	± 0.31	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Vanadium	1.51	± 0.24	µg/L	0.005	V-5-ADD	W-SFMS-5C	LE

Sub-Matrix: **SEAWATER**

Client sample ID	**TM C Diff**						
Laboratory sample ID	*LE2307027-011*						
Client sampling date / time	*2023-05-07*						
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Filtration	Yes	----	-	-	PP-FILTR045	W-PP-filt	LE
Total Metals/Major Cations							
Aluminum	4.33	± 0.79	µg/L	0.70	V-5	W-SFMS-5C	LE
Cadmium	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Chromium	0.158	± 0.057	µg/L	0.10	V-5	W-SFMS-5C	LE
Cobalt	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Copper	0.513	± 0.146	µg/L	0.50	V-5	W-SFMS-5C	LE
Iron	<0.004	----	mg/L	0.0040	V-5	W-SFMS-5C	LE
Lead	0.389	± 0.058	µg/L	0.30	V-5	W-SFMS-5C	LE
Manganese	0.334	± 0.077	µg/L	0.10	V-5	W-SFMS-5C	LE
Mercury	0.0792	± 0.0109	µg/L	0.002	V-5	W-AFS-17V2	LE
Nickel	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Zinc	3.13	± 0.81	µg/L	2.0	V-5	W-SFMS-5C	LE
Arsenic	1.67	± 0.23	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Boron	4380	± 509	µg/L	10	V-5-ADD	W-AES-1A	LE
Silver	<0.5	----	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Tin	4.06	± 0.61	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Vanadium	1.58	± 0.26	µg/L	0.005	V-5-ADD	W-SFMS-5C	LE

Sub-Matrix: **SEAWATER**

Client sample ID	**TM C NE**						
Laboratory sample ID	*LE2307027-012*						
Client sampling date / time	*2023-05-07*						
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Filtration	Yes	----	-	-	PP-FILTR045	W-PP-filt	LE
Total Metals/Major Cations							
Aluminum	1.25	± 0.45	µg/L	0.70	V-5	W-SFMS-5C	LE
Cadmium	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Chromium	0.156	± 0.057	µg/L	0.10	V-5	W-SFMS-5C	LE
Cobalt	<0.05	----	µg/L	0.050	V-5	W-SFMS-5C	LE
Copper	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Iron	<0.004	----	mg/L	0.0040	V-5	W-SFMS-5C	LE
Lead	<0.3	----	µg/L	0.30	V-5	W-SFMS-5C	LE
Manganese	0.497	± 0.096	µg/L	0.10	V-5	W-SFMS-5C	LE
Mercury	0.0684	± 0.0094	µg/L	0.002	V-5	W-AFS-17V2	LE
Nickel	<0.5	----	µg/L	0.50	V-5	W-SFMS-5C	LE
Zinc	<2	----	µg/L	2.0	V-5	W-SFMS-5C	LE
Arsenic	1.77	± 0.25	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Boron	4370	± 508	µg/L	10	V-5-ADD	W-AES-1A	LE
Silver	<0.5	----	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Tin	<0.5	----	µg/L	0.05	V-5-ADD	W-SFMS-5C	LE
Vanadium	1.71	± 0.28	µg/L	0.005	V-5-ADD	W-SFMS-5C	LE

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Reference*
W-AES-1A	Determination of metals in fresh water, pool and drinking water by ICP-AES according to SS-EN ISO 11885:2009 and US EPA Method 200.7:1994. Samples are acidified with 1 ml high purity nitric acid per 100 ml prior to analysis. No digestion.
W-AFS-17V2	Determination of mercury (Hg) in natural water by AFS according to SS-EN ISO 17852:2008. Samples are acidified with 1 ml high purity nitric acid per 100 ml prior to analysis. No digestion.
W-PP-filt	Filtration (SE-SOP-0259, SS-EN ISO 5667-3:2018)
W-SFMS-5C	Determination of metals in seawater by ICP-SFMS according to SS-EN ISO 17294-2:2016 and US EPA Method 200.8:1994. Samples are acidified with 1 ml high purity nitric acid per 100 ml prior to analysis. No digestion.

Key: **LOR** = Limit of reporting represents the standard LOR for the respective parameters in each method. Note that limits of reporting may be affected if, e.g. additional dilution was required because of matrix effects, or the sample quantity was limited.

MU = Measurement Uncertainty

***** = Symbol succeding any result indicates laboratory or subcontractor non-accredited test.

Measurement Uncertainty:

The uncertainty is given as extended uncertainty (according to the definition in "Guide to the Expression of Measurement", JCGM 100:2008 Corrected version 2010) calculated with a coverage factor of 2, which give level of approximately 95%. Measurement of uncertainty is reported only for detected substances with levels above the reporting limits.

The uncertainty from subcontractors is often given as extended uncertainty calculated with a coverage factor of 2. Contact the laboratory for further information.

Issuing lab

	Issuer
LE	*The analysis is provided by* ALS Scandinavia AB Luleå, Aurorum 10 Luleå Sweden 977 75 Accredited by: SWEDAC Accreditation Number: 2030, ISO/IEC 17025

CERTIFICATE OF ANALYSIS

Work Order	: **LE2310490**	Page	: 1 of 4
Client	: **PML Applications Ltd**	Project	: PMA1907
Contact	: Sam Fawcett	Purchase Number	: PMA1907
Address	: Prospect Place, The Hoe, Devon PL1 3DH	Sampler	: Planetary Tech
	United Kingdom	Site	: ----
	United Kingdom	Date Samples Received	: 2023-07-11 13:35
E-mail	: saf@pml.ac.uk	Date Analysis Commenced	: 2023-07-24
Telephone	: ----	Issue Date	: 2023-07-25 16:08
C-O-C number	: ----	No. of samples received	: 12
Quote number	: LE2023SE-PML-LTD0001 (OF230300)	No. of samples analysed	: 12

General Comments

This certificate represents the original certificate and may not be modified or reproduced other than in full, except with the prior written approval of the issuing lab. The results apply only to the material that has been identified, received, and tested. The laboratory has no responsibility for information in this certificate that has been provided by the customer, or results that may be affected by such information. Regarding the laboratory's liability in relation to assignment, please refer to our website http://www.alsglobal.se

Workorder Comments

Amendment 1 - the change only applies to changed company.
Amendment 2 - the change applies to add elements.

Signatories	***Position***
Ilia Rodushkin	Laboratory Manager

Ackred. nr 2030
Provning
ISO/IEC 17025

Laboratory	: ALS Scandinavia AB Luleå	Webpage	: www.alsglobal.se
Address	: Aurorum 10	E-mail	: info.lu@alsglobal.com
	977 75 Luleå	Telephone	: +46 920 28 99 00
	Sweden		

Analytical Results

Sub-Matrix: **SEAWATER**

	Client sample ID	TM A CTRL					
	Laboratory sample ID	LE2310490-001					
	Client sampling date / time	2023-05-07					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Total Metals/Major Cations							
Calcium	379	± 47	mg/L	0.1	V-5	W-AES-1A	LE
Magnesium	1270	± 149	mg/L	0.09	V-5	W-AES-1A	LE

Sub-Matrix: **SEAWATER**

	Client sample ID	TM A S					
	Laboratory sample ID	LE2310490-002					
	Client sampling date / time	2023-05-07					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Total Metals/Major Cations							
Calcium	376	± 47	mg/L	0.1	V-5	W-AES-1A	LE
Magnesium	1250	± 147	mg/L	0.09	V-5	W-AES-1A	LE

Sub-Matrix: **SEAWATER**

	Client sample ID	TM A NE					
	Laboratory sample ID	LE2310490-003					
	Client sampling date / time	2023-05-07					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Total Metals/Major Cations							
Calcium	383	± 48	mg/L	0.1	V-5	W-AES-1A	LE
Magnesium	1260	± 148	mg/L	0.09	V-5	W-AES-1A	LE

Sub-Matrix: **SEAWATER**

	Client sample ID	TM A Diff					
	Laboratory sample ID	LE2310490-004					
	Client sampling date / time	2023-05-07					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Total Metals/Major Cations							
Calcium	381	± 47	mg/L	0.1	V-5	W-AES-1A	LE
Magnesium	1260	± 148	mg/L	0.09	V-5	W-AES-1A	LE

Sub-Matrix: **SEAWATER**

	Client sample ID	TM B CTRL					
	Laboratory sample ID	LE2310490-005					
	Client sampling date / time	2023-05-07					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Total Metals/Major Cations							
Calcium	382	± 48	mg/L	0.1	V-5	W-AES-1A	LE
Magnesium	1270	± 149	mg/L	0.09	V-5	W-AES-1A	LE

Sub-Matrix: **SEAWATER**

		Client sample ID	**TM B S**				
		Laboratory sample ID	*LE2310490-006*				
		Client sampling date / time	2023-05-07				
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Total Metals/Major Cations							
Calcium	387	± 48	mg/L	0.1	V-5	W-AES-1A	LE
Magnesium	1280	± 150	mg/L	0.09	V-5	W-AES-1A	LE

Sub-Matrix: **SEAWATER**

		Client sample ID	**TM B NE**				
		Laboratory sample ID	*LE2310490-007*				
		Client sampling date / time	2023-05-07				
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Total Metals/Major Cations							
Calcium	364	± 45	mg/L	0.1	V-5	W-AES-1A	LE
Magnesium	1210	± 142	mg/L	0.09	V-5	W-AES-1A	LE

Sub-Matrix: **SEAWATER**

		Client sample ID	**TM B DIFF**				
		Laboratory sample ID	*LE2310490-008*				
		Client sampling date / time	2023-05-07				
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Total Metals/Major Cations							
Calcium	406	± 50	mg/L	0.1	V-5	W-AES-1A	LE
Magnesium	1350	± 158	mg/L	0.09	V-5	W-AES-1A	LE

Sub-Matrix: **SEAWATER**

		Client sample ID	**TM C CTRL**				
		Laboratory sample ID	*LE2310490-009*				
		Client sampling date / time	2023-05-07				
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Total Metals/Major Cations							
Calcium	378	± 47	mg/L	0.1	V-5	W-AES-1A	LE
Magnesium	1260	± 147	mg/L	0.09	V-5	W-AES-1A	LE

Sub-Matrix: **SEAWATER**

		Client sample ID	**TM C S**				
		Laboratory sample ID	*LE2310490-010*				
		Client sampling date / time	2023-05-07				
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Total Metals/Major Cations							
Calcium	379	± 47	mg/L	0.1	V-5	W-AES-1A	LE
Magnesium	1260	± 147	mg/L	0.09	V-5	W-AES-1A	LE

Sub-Matrix: **SEAWATER**	Client sample ID	**TM C Diff**					
	Laboratory sample ID	LE2310490-011					
	Client sampling date / time	2023-05-07					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Total Metals/Major Cations							
Calcium	387	± 48	mg/L	0.1	V-5	W-AES-1A	LE
Magnesium	1290	± 151	mg/L	0.09	V-5	W-AES-1A	LE

Sub-Matrix: **SEAWATER**	Client sample ID	**TM C NE**					
	Laboratory sample ID	LE2310490-012					
	Client sampling date / time	2023-05-07					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Total Metals/Major Cations							
Calcium	373	± 46	mg/L	0.1	V-5	W-AES-1A	LE
Magnesium	1250	± 147	mg/L	0.09	V-5	W-AES-1A	LE

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Reference*
W-AES-1A	Determination of metals in fresh water, pool and drinking water by ICP-AES according to SS-EN ISO 11885:2009 and US EPA Method 200.7:1994. Samples are acidified with 1 ml high purity nitric acid per 100 ml prior to analysis. No digestion.

Key: **LOR** = Limit of reporting represents the standard LOR for the respective parameters in each method. Note that limits of reporting may be affected if, e.g. additional dilution was required because of matrix effects, or the sample quantity was limited.

MU = Measurement Uncertainty

***** = Symbol succeding any result indicates laboratory or subcontractor non-accredited test.

Measurement Uncertainty:

The uncertainty is given as extended uncertainty (according to the definition in "Guide to the Expression of Measurement", JCGM 100:2008 Corrected version 2010) calculated with a coverage factor of 2, which give level of approximately 95%. Measurement of uncertainty is reported only for detected substances with levels above the reporting limits.

The uncertainty from subcontractors is often given as extended uncertainty calculated with a coverage factor of 2. Contact the laboratory for further information.

Issuing lab

	Issuer
LE	*The analysis is provided by* ALS Scandinavia AB Luleå, Aurorum 10 Luleå Sweden 977 75 Accredited by: SWEDAC Accreditation Number: 2030, ISO/IEC 17025

Appendix 2 – Raw Laboratory Data – Sediment Quality

This certificate replaces any previous certificate with the same number.

CERTIFICATE OF ANALYSIS

Work Order	: **LE2307184**	Page	: 1 of 11
Amendment	: **3**		

Client	: **PML Applications Ltd**	Project	: ----
Contact	: Sam Fawcett	Purchase Number	: ----
Address	: Prospect Place, The Hoe, Devon PL1 3DH United Kingdom United Kingdom	Sampler	: Planetary Tech
		Site	: ----
		Date Samples Received	: 2023-05-19 10:27
E-mail	: saf@pml.ac.uk	Date Analysis Commenced	: 2023-05-23
Telephone	: ----	Issue Date	: 2023-07-12 12:28
C-O-C number	: ----	No. of samples received	: 9
Quote number	: LE2023SE-PML-LTD0001 (OF230300)	No. of samples analysed	: 9

General Comments

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This certificate represents the original certificate and may not be modified or reproduced other than in full, except with the prior written approval of the issuing lab. The results apply only to the material that has been identified, received, and tested. The laboratory has no responsibility for information in this certificate that has been provided by the customer, or results that may be affected by such information. Regarding the laboratory's liability in relation to assignment, please refer to our website http://www.alsglobal.se

Workorder Comments

Amendment 1 - the change only applies to changed company.

Signatories	Position
Ilia Rodushkin	Laboratory Manager

Ackred. nr 2030
Provning
ISO/IEC 17025

Laboratory	: ALS Scandinavia AB Luleå	Webpage	: www.alsglobal.se
Address	: Aurorum 10 977 75 Luleå Sweden	E-mail	: info.lu@alsglobal.com
		Telephone	: +46 920 28 99 00

Analytical Results

Sub-Matrix: **SEDIMENT**

	Client sample ID						
	Client sample ID	**Sediment TM A S**					
	Laboratory sample ID	*LE2307184-001*					
	Client sampling date / time	*2023-05-07*					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE
Sample Preparation							
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE
Digestion AR	Yes	----	-	-	M-AR	S-PAR53-HB	LE
Total Metals/Major Cations							
Arsenic	7.22	± 0.96	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Cadmium	0.0362	± 0.0069	mg/kg DW	0.0100	M-2	S-SFMS-59	LE
Chromium	3.54	± 0.50	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Cobalt	2.25	± 0.30	mg/kg DW	0.0300	M-2	S-SFMS-59	LE
Copper	4.86	± 0.70	mg/kg DW	0.300	M-2	S-SFMS-59	LE
Lead	9.13	± 1.14	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Mercury	<0.04	----	mg/kg DW	0.0400	M-2	S-SFMS-59	LE
Nickel	5.77	± 0.83	mg/kg DW	0.0800	M-2	S-SFMS-59	LE
Vanadium	7.64	± 0.95	mg/kg DW	0.200	M-2	S-SFMS-59	LE
Zinc	26.0	± 3.7	mg/kg DW	1.00	M-2	S-SFMS-59	LE
Aluminum	2440	± 283	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Boron	13.0	± 1.6	mg/kg DW	2.00	M-2-ADD	S-SFMS-59	LE
Iron	6660	± 1160	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Manganese	153	± 18	mg/kg	0.0001	M-2-ADD	S-SFMS-59	LE
Silver	<0.05	----	mg/kg DW	0.0500	M-AR	S-SFMS-53	LE
Tin	<0.5	----	mg/kg DW	0.500	M-AR	S-SFMS-53	LE
Physical Parameters							
Dry matter @ 105°C	79.0	± 2.00	%	1.00	M-2-ADD	TS-105	LE

Sub-Matrix: **SEDIMENT**	*Client sample ID*	**Sediment TM A CTRL**					
	Laboratory sample ID	*LE2307184-002*					
	Client sampling date / time	*2023-05-07*					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE
Sample Preparation							
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE
Digestion AR	Yes	----	-	-	M-AR	S-PAR53-HB	LE
Total Metals/Major Cations							
Arsenic	3.39	± 0.45	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Cadmium	0.0670	± 0.0106	mg/kg DW	0.0100	M-2	S-SFMS-59	LE
Cobalt	0.816	± 0.110	mg/kg DW	0.0300	M-2	S-SFMS-59	LE
Copper	1.82	± 0.32	mg/kg DW	0.300	M-2	S-SFMS-59	LE
Lead	2.81	± 0.35	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Mercury	<0.04	----	mg/kg DW	0.0400	M-2	S-SFMS-59	LE
Nickel	2.15	± 0.31	mg/kg DW	0.0800	M-2	S-SFMS-59	LE
Vanadium	4.96	± 0.62	mg/kg DW	0.200	M-2	S-SFMS-59	LE
Zinc	6.45	± 0.97	mg/kg DW	1.00	M-2	S-SFMS-59	LE
Aluminum	1090	± 126	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Boron	16.5	± 2.1	mg/kg DW	2.00	M-2-ADD	S-SFMS-59	LE
Chromium	3.52	± 0.49	mg/kg DW	0.100	M-2-ADD	S-SFMS-59	LE
Iron	2280	± 398	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Manganese	76.0	± 9.1	mg/kg	0.0001	M-2-ADD	S-SFMS-59	LE
Silver	<0.05	----	mg/kg DW	0.0500	M-AR	S-SFMS-53	LE
Tin	<0.5	----	mg/kg DW	0.500	M-AR	S-SFMS-53	LE
Physical Parameters							
Dry matter @ 105°C	70.3	± 2.00	%	1.00	M-2-ADD	TS-105	LE

Sub-Matrix: **SEDIMENT**	*Client sample ID*	**Sediment TM A DIFF**						
	Laboratory sample ID	*LE2307184-003*						
	Client sampling date / time	*2023-05-07*						
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE
Sample Preparation							
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE
Digestion AR	Yes	----	-	-	M-AR	S-PAR53-HB	LE
Total Metals/Major Cations							
Arsenic	4.19	± 0.56	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Cadmium	0.0614	± 0.0098	mg/kg DW	0.0100	M-2	S-SFMS-59	LE
Cobalt	1.87	± 0.25	mg/kg DW	0.0300	M-2	S-SFMS-59	LE
Copper	3.29	± 0.49	mg/kg DW	0.300	M-2	S-SFMS-59	LE
Lead	10.1	± 1.3	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Mercury	<0.04	----	mg/kg DW	0.0400	M-2	S-SFMS-59	LE
Nickel	2.71	± 0.39	mg/kg DW	0.0800	M-2	S-SFMS-59	LE
Vanadium	5.55	± 0.69	mg/kg DW	0.200	M-2	S-SFMS-59	LE
Zinc	24.2	± 3.5	mg/kg DW	1.00	M-2	S-SFMS-59	LE
Aluminum	1150	± 134	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Boron	15.4	± 1.9	mg/kg DW	2.00	M-2-ADD	S-SFMS-59	LE
Chromium	2.26	± 0.32	mg/kg DW	0.100	M-2-ADD	S-SFMS-59	LE
Iron	3820	± 666	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Manganese	111	± 13	mg/kg	0.0001	M-2-ADD	S-SFMS-59	LE
Silver	<0.05	----	mg/kg DW	0.0500	M-AR	S-SFMS-53	LE
Tin	<0.5	----	mg/kg DW	0.500	M-AR	S-SFMS-53	LE
Physical Parameters							
Dry matter @ 105°C	74.5	± 2.00	%	1.00	M-2-ADD	TS-105	LE

Sub-Matrix: **SEDIMENT**	*Client sample ID*	**Sediment TM B S**					
	Laboratory sample ID	*LE2307184-004*					
	Client sampling date / time	*2023-05-07*					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE
Sample Preparation							
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE
Digestion AR	Yes	----	-	-	M-AR	S-PAR53-HB	LE
Total Metals/Major Cations							
Arsenic	4.44	± 0.59	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Cadmium	0.0166	± 0.0052	mg/kg DW	0.0100	M-2	S-SFMS-59	LE
Cobalt	1.41	± 0.19	mg/kg DW	0.0300	M-2	S-SFMS-59	LE
Copper	3.63	± 0.54	mg/kg DW	0.300	M-2	S-SFMS-59	LE
Lead	8.05	± 1.00	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Mercury	<0.04	----	mg/kg DW	0.0400	M-2	S-SFMS-59	LE
Nickel	4.06	± 0.58	mg/kg DW	0.0800	M-2	S-SFMS-59	LE
Vanadium	5.66	± 0.71	mg/kg DW	0.200	M-2	S-SFMS-59	LE
Zinc	15.2	± 2.2	mg/kg DW	1.00	M-2	S-SFMS-59	LE
Aluminum	1550	± 180	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Boron	15.2	± 1.9	mg/kg DW	2.00	M-2-ADD	S-SFMS-59	LE
Chromium	3.11	± 0.44	mg/kg DW	0.100	M-2-ADD	S-SFMS-59	LE
Iron	3890	± 679	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Manganese	113	± 14	mg/kg	0.0001	M-2-ADD	S-SFMS-59	LE
Silver	<0.05	----	mg/kg DW	0.0500	M-AR	S-SFMS-53	LE
Tin	<0.5	----	mg/kg DW	0.500	M-AR	S-SFMS-53	LE
Physical Parameters							
Dry matter @ 105°C	81.2	± 2.00	%	1.00	M-2-ADD	TS-105	LE

Sub-Matrix: **SEDIMENT**

		Client sample ID		**Sediment TM B CTRL**			
		Laboratory sample ID		LE2307184-005			
		Client sampling date / time		2023-05-07			
Parameter	Result	MU	Unit	LOR	Package	Method	Issuer
Sample Pre-Preparation							
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE
Sample Preparation							
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE
Digestion AR	Yes	----	-	-	M-AR	S-PAR53-HB	LE
Total Metals/Major Cations							
Arsenic	3.44	± 0.46	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Cadmium	0.0574	± 0.0093	mg/kg DW	0.0100	M-2	S-SFMS-59	LE
Cobalt	0.799	± 0.108	mg/kg DW	0.0300	M-2	S-SFMS-59	LE
Copper	2.97	± 0.45	mg/kg DW	0.300	M-2	S-SFMS-59	LE
Lead	2.87	± 0.36	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Mercury	<0.04	----	mg/kg DW	0.0400	M-2	S-SFMS-59	LE
Nickel	2.26	± 0.33	mg/kg DW	0.0800	M-2	S-SFMS-59	LE
Vanadium	5.52	± 0.69	mg/kg DW	0.200	M-2	S-SFMS-59	LE
Zinc	6.66	± 1.00	mg/kg DW	1.00	M-2	S-SFMS-59	LE
Aluminum	1150	± 134	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Boron	15.4	± 1.9	mg/kg DW	2.00	M-2-ADD	S-SFMS-59	LE
Chromium	3.18	± 0.45	mg/kg DW	0.100	M-2-ADD	S-SFMS-59	LE
Iron	2270	± 396	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Manganese	69.2	± 8.2	mg/kg	0.0001	M-2-ADD	S-SFMS-59	LE
Silver	<0.05	----	mg/kg DW	0.0500	M-AR	S-SFMS-53	LE
Tin	0.689	± 0.181	mg/kg DW	0.500	M-AR	S-SFMS-53	LE
Physical Parameters							
Dry matter @ 105°C	78.2	± 2.00	%	1.00	M-2-ADD	TS-105	LE

Sub-Matrix: **SEDIMENT**		*Client sample ID*		**Sediment TM B DIFF**				
		Laboratory sample ID		*LE2307184-006*				
		Client sampling date / time		*2023-05-07*				
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*	
Sample Pre-Preparation								
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE	
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE	
Sample Preparation								
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE	
Digestion AR	Yes	----	-	-	M-AR	S-PAR53-HB	LE	
Total Metals/Major Cations								
Arsenic	4.44	± 0.59	mg/kg DW	0.100	M-2	S-SFMS-59	LE	
Cadmium	0.0358	± 0.0069	mg/kg DW	0.0100	M-2	S-SFMS-59	LE	
Cobalt	1.26	± 0.17	mg/kg DW	0.0300	M-2	S-SFMS-59	LE	
Copper	3.76	± 0.55	mg/kg DW	0.300	M-2	S-SFMS-59	LE	
Lead	10.4	± 1.3	mg/kg DW	0.100	M-2	S-SFMS-59	LE	
Mercury	<0.04	----	mg/kg DW	0.0400	M-2	S-SFMS-59	LE	
Nickel	3.32	± 0.48	mg/kg DW	0.0800	M-2	S-SFMS-59	LE	
Vanadium	6.93	± 0.87	mg/kg DW	0.200	M-2	S-SFMS-59	LE	
Zinc	20.5	± 2.9	mg/kg DW	1.00	M-2	S-SFMS-59	LE	
Aluminum	1550	± 179	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE	
Boron	14.1	± 1.8	mg/kg DW	2.00	M-2-ADD	S-SFMS-59	LE	
Chromium	3.31	± 0.47	mg/kg DW	0.100	M-2-ADD	S-SFMS-59	LE	
Iron	3810	± 664	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE	
Manganese	148	± 18	mg/kg	0.0001	M-2-ADD	S-SFMS-59	LE	
Silver	<0.05	----	mg/kg DW	0.0500	M-AR	S-SFMS-53	LE	
Tin	<0.5	----	mg/kg DW	0.500	M-AR	S-SFMS-53	LE	
Physical Parameters								
Dry matter @ 105°C	75.9	± 2.00	%	1.00	M-2-ADD	TS-105	LE	

Sub-Matrix: **SEDIMENT**

Client sample ID	**Sediment TM C S**						
Laboratory sample ID	*LE2307184-007*						
Client sampling date / time	*2023-05-07*						
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE
Sample Preparation							
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE
Digestion AR	Yes	----	-	-	M-AR	S-PAR53-HB	LE
Total Metals/Major Cations							
Arsenic	5.71	± 0.76	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Cadmium	0.0433	± 0.0077	mg/kg DW	0.0100	M-2	S-SFMS-59	LE
Cobalt	2.05	± 0.27	mg/kg DW	0.0300	M-2	S-SFMS-59	LE
Copper	5.49	± 0.78	mg/kg DW	0.300	M-2	S-SFMS-59	LE
Lead	11.0	± 1.4	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Mercury	<0.04	----	mg/kg DW	0.0400	M-2	S-SFMS-59	LE
Nickel	5.40	± 0.77	mg/kg DW	0.0800	M-2	S-SFMS-59	LE
Vanadium	7.99	± 1.00	mg/kg DW	0.200	M-2	S-SFMS-59	LE
Zinc	29.1	± 4.2	mg/kg DW	1.00	M-2	S-SFMS-59	LE
Aluminum	2240	± 259	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Boron	11.6	± 1.5	mg/kg DW	2.00	M-2-ADD	S-SFMS-59	LE
Chromium	4.22	± 0.59	mg/kg DW	0.100	M-2-ADD	S-SFMS-59	LE
Iron	5670	± 989	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Manganese	195	± 23	mg/kg	0.0001	M-2-ADD	S-SFMS-59	LE
Silver	<0.05	----	mg/kg DW	0.0500	M-AR	S-SFMS-53	LE
Tin	<0.5	----	mg/kg DW	0.500	M-AR	S-SFMS-53	LE
Physical Parameters							
Dry matter @ 105°C	75.8	± 2.00	%	1.00	M-2-ADD	TS-105	LE

Sub-Matrix: **SEDIMENT**	Client sample ID	Sediment TM C DIFF					
	Laboratory sample ID	LE2307184-008					
	Client sampling date / time	2023-05-07					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE
Sample Preparation							
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE
Digestion AR	Yes	----	-	-	M-AR	S-PAR53-HB	LE
Total Metals/Major Cations							
Arsenic	3.65	± 0.48	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Cadmium	0.0351	± 0.0068	mg/kg DW	0.0100	M-2	S-SFMS-59	LE
Cobalt	0.980	± 0.131	mg/kg DW	0.0300	M-2	S-SFMS-59	LE
Copper	4.32	± 0.63	mg/kg DW	0.300	M-2	S-SFMS-59	LE
Lead	11.4	± 1.4	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Mercury	<0.04	----	mg/kg DW	0.0400	M-2	S-SFMS-59	LE
Nickel	2.24	± 0.32	mg/kg DW	0.0800	M-2	S-SFMS-59	LE
Vanadium	5.13	± 0.64	mg/kg DW	0.200	M-2	S-SFMS-59	LE
Zinc	22.8	± 3.3	mg/kg DW	1.00	M-2	S-SFMS-59	LE
Aluminum	1240	± 143	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Boron	14.4	± 1.8	mg/kg DW	2.00	M-2-ADD	S-SFMS-59	LE
Chromium	2.70	± 0.38	mg/kg DW	0.100	M-2-ADD	S-SFMS-59	LE
Iron	2750	± 480	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Manganese	103	± 12	mg/kg	0.0001	M-2-ADD	S-SFMS-59	LE
Silver	<0.05	----	mg/kg DW	0.0500	M-AR	S-SFMS-53	LE
Tin	<0.5	----	mg/kg DW	0.500	M-AR	S-SFMS-53	LE
Physical Parameters							
Dry matter @ 105°C	65.5	± 2.00	%	1.00	M-2-ADD	TS-105	LE

Sub-Matrix: **SEDIMENT**	Client sample ID	**Sediment TM C CTRL**					
	Laboratory sample ID	LE2307184-009					
	Client sampling date / time	2023-05-07					
Parameter	**Result**	MU	Unit	LOR	Package	Method	Issuer
Sample Pre-Preparation							
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE
Sample Preparation							
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE
Digestion AR	Yes	----	-	-	M-AR	S-PAR53-HB	LE
Total Metals/Major Cations							
Arsenic	3.57	± 0.47	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Cadmium	0.0526	± 0.0088	mg/kg DW	0.0100	M-2	S-SFMS-59	LE
Cobalt	0.797	± 0.107	mg/kg DW	0.0300	M-2	S-SFMS-59	LE
Copper	2.42	± 0.38	mg/kg DW	0.300	M-2	S-SFMS-59	LE
Lead	3.49	± 0.44	mg/kg DW	0.100	M-2	S-SFMS-59	LE
Mercury	<0.04	----	mg/kg DW	0.0400	M-2	S-SFMS-59	LE
Nickel	2.44	± 0.35	mg/kg DW	0.0800	M-2	S-SFMS-59	LE
Vanadium	5.24	± 0.65	mg/kg DW	0.200	M-2	S-SFMS-59	LE
Zinc	8.45	± 1.24	mg/kg DW	1.00	M-2	S-SFMS-59	LE
Aluminum	1440	± 166	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Boron	14.6	± 1.8	mg/kg DW	2.00	M-2-ADD	S-SFMS-59	LE
Chromium	3.81	± 0.53	mg/kg DW	0.100	M-2-ADD	S-SFMS-59	LE
Iron	2340	± 407	mg/kg	0.002	M-2-ADD	S-SFMS-59	LE
Manganese	78.0	± 9.3	mg/kg	0.0001	M-2-ADD	S-SFMS-59	LE
Silver	<0.05	----	mg/kg DW	0.0500	M-AR	S-SFMS-53	LE
Tin	0.641	± 0.168	mg/kg DW	0.500	M-AR	S-SFMS-53	LE
Physical Parameters							
Dry matter @ 105°C	79.6	± 2.00	%	1.00	M-2-ADD	TS-105	LE

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Reference*
S-PP-dry50	Sample dried at 50°C.
S-PP-siev/grind	Soil samples are sieved <2mm according to ISO 11464:2006. Sediment and sludge are homogenized by grinding.
S-SFMS-53	Determination of metals in soil, sludge, sediment and construction material by ICP-SFMS according to SS-EN ISO 17294-2:2016 and US EPA Method 200.8:1994. Prior to analysis the sample is digested according to S-PAR53-HB.
S-SFMS-59	Determination of metals in soil, sludge, sediment and construction material by ICP-SFMS according to SS-EN ISO 17294-2:2016 and US EPA Method 200.8:1994. Prior to analysis the sample is digested according to S-PM59-HB.
TS-105	Determination of dry weight (DW) according to SS-EN 15934:2012 ed 1.

Preparation Methods	*Method Reference*
S-EU-not*	Sample from outside EU
S-PAR53-HB	Aqua regia digestion in hotblock according to SE-SOP-0047 (SS-EN ISO 54321:2021 and SS-EN 16174:2012).
S-PM59-HB	Digestion in 7M nitric acid in hotblock according to SE-SOP-0021.

Key: **LOR** = Limit of reporting represents the standard LOR for the respective parameters in each method. Note that limits of reporting may be affected if, e.g. additional dilution was required because of matrix effects, or the sample quantity was limited.

MU = Measurement Uncertainty

***** = Symbol succeding any result indicates laboratory or subcontractor non-accredited test.

Measurement Uncertainty:

The uncertainty is given as extended uncertainty (according to the definition in "Guide to the Expression of Measurement", JCGM 100:2008 Corrected version 2010) calculated with a coverage factor of 2, which give level of approximately 95%. Measurement of uncertainty is reported only for detected substances with levels above the reporting limits.

The uncertainty from subcontractors is often given as extended uncertainty calculated with a coverage factor of 2. Contact the laboratory for further information.

Issuing lab

	Issuer
LE	*The analysis is provided by* ALS Scandinavia AB Luleå, Aurorum 10 Luleå Sweden 977 75 Accredited by: SWEDAC Accreditation Number: 2030, ISO/IEC 17025

CERTIFICATE OF ANALYSIS

Work Order	: **LE2310332**	Page	: 1 of 5
Client	: **PML Applications Ltd**	Project	: PMA1907
Contact	: Sam Fawcett	Purchase Number	: ----
Address	: Prospect Place, The Hoe, Devon PL1 3DH United Kingdom United Kingdom	Sampler Site Date Samples Received	: Planetary Tech : ---- : 2023-07-12 16:00
E-mail	: saf@pml.ac.uk	Date Analysis Commenced	: 2023-07-17
Telephone	: ----	Issue Date	: 2023-07-19 08:52
C-O-C number	: ----	No. of samples received	: 9
Quote number	: LE2023SE-PML-LTD0002 (OF231215)	No. of samples analysed	: 9

General Comments

This certificate represents the original certificate and may not be modified or reproduced other than in full, except with the prior written approval of the issuing lab. The results apply only to the material that has been identified, received, and tested. The laboratory has no responsibility for information in this certificate that has been provided by the customer, or results that may be affected by such information. Regarding the laboratory's liability in relation to assignment, please refer to our website http://www.alsglobal.se

Signatories	***Position***
Ilia Rodushkin	Laboratory Manager

Ilia Rodushkin

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Laboratory	: ALS Scandinavia AB Luleå	Webpage	: www.alsglobal.se
Address	: Aurorum 10 977 75 Luleå Sweden	E-mail Telephone	: info.lu@alsglobal.com : +46 920 28 99 00

Analytical Results

Sub-Matrix: **SEDIMENT**	Client sample ID	**Sediment TM A S**						
	Laboratory sample ID	LE2310332-001						
	Client sampling date / time	2023-05-07						
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*	
Sample Pre-Preparation								
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE	
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE	
Sample Preparation								
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE	
Total Metals/Major Cations								
Calcium	326000	± 56500	mg/kg DW	20.0	M-2-ADD	S-SFMS-59	LE	
Magnesium	6410	± 781	mg/kg DW	5.00	M-2-ADD	S-SFMS-59	LE	
Physical Parameters								
Dry matter @ 105°C	79.0	± 2.00	%	1.00	M-2-ADD	TS-105	LE	

Sub-Matrix: **SEDIMENT**	Client sample ID	**Sediment TM A CTRL**						
	Laboratory sample ID	LE2310332-002						
	Client sampling date / time	2023-05-07						
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*	
Sample Pre-Preparation								
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE	
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE	
Sample Preparation								
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE	
Total Metals/Major Cations								
Calcium	330000	± 57200	mg/kg DW	20.0	M-2-ADD	S-SFMS-59	LE	
Magnesium	7840	± 956	mg/kg DW	5.00	M-2-ADD	S-SFMS-59	LE	
Physical Parameters								
Dry matter @ 105°C	70.3	± 2.00	%	1.00	M-2-ADD	TS-105	LE	

Sub-Matrix: **SEDIMENT**	Client sample ID	**Sediment TM A DIFF**						
	Laboratory sample ID	LE2310332-003						
	Client sampling date / time	2023-05-07						
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*	
Sample Pre-Preparation								
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE	
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE	
Sample Preparation								
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE	
Total Metals/Major Cations								
Calcium	325000	± 56300	mg/kg DW	20.0	M-2-ADD	S-SFMS-59	LE	
Magnesium	6740	± 822	mg/kg DW	5.00	M-2-ADD	S-SFMS-59	LE	
Physical Parameters								
Dry matter @ 105°C	74.5	± 2.00	%	1.00	M-2-ADD	TS-105	LE	

Sub-Matrix: **SEDIMENT**	*Client sample ID*	**Sediment TM B S**					
	Laboratory sample ID	*LE2310332-004*					
	Client sampling date / time	*2023-05-07*					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE
Sample Preparation							
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE
Total Metals/Major Cations							
Calcium	308000	± 53500	mg/kg DW	20.0	M-2-ADD	S-SFMS-59	LE
Magnesium	5380	± 656	mg/kg DW	5.00	M-2-ADD	S-SFMS-59	LE
Physical Parameters							
Dry matter @ 105°C	81.2	± 2.00	%	1.00	M-2-ADD	TS-105	LE

Sub-Matrix: **SEDIMENT**	*Client sample ID*	**Sediment TM B CTRL**					
	Laboratory sample ID	*LE2310332-005*					
	Client sampling date / time	*2023-05-07*					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE
Sample Preparation							
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE
Total Metals/Major Cations							
Calcium	342000	± 59200	mg/kg DW	20.0	M-2-ADD	S-SFMS-59	LE
Magnesium	7460	± 910	mg/kg DW	5.00	M-2-ADD	S-SFMS-59	LE
Physical Parameters							
Dry matter @ 105°C	78.2	± 2.00	%	1.00	M-2-ADD	TS-105	LE

Sub-Matrix: **SEDIMENT**	*Client sample ID*	**Sediment TM B DIFF**					
	Laboratory sample ID	*LE2310332-006*					
	Client sampling date / time	*2023-05-07*					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE
Sample Preparation							
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE
Total Metals/Major Cations							
Calcium	342000	± 59300	mg/kg DW	20.0	M-2-ADD	S-SFMS-59	LE
Magnesium	8630	± 1050	mg/kg DW	5.00	M-2-ADD	S-SFMS-59	LE
Physical Parameters							
Dry matter @ 105°C	75.9	± 2.00	%	1.00	M-2-ADD	TS-105	LE

Sub-Matrix: **SEDIMENT**		*Client sample ID*	**Sediment TM C S**					
		Laboratory sample ID	*LE2310332-007*					
		Client sampling date / time	*2023-05-07*					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE
Sample Preparation							
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE
Total Metals/Major Cations							
Calcium	321000	± 55600	mg/kg DW	20.0	M-2-ADD	S-SFMS-59	LE
Magnesium	5540	± 676	mg/kg DW	5.00	M-2-ADD	S-SFMS-59	LE
Physical Parameters							
Dry matter @ 105°C	75.8	± 2.00	%	1.00	M-2-ADD	TS-105	LE

Sub-Matrix: **SEDIMENT**		*Client sample ID*	**Sediment TM C DIFF**				
		Laboratory sample ID	*LE2310332-008*				
		Client sampling date / time	*2023-05-07*				
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE
Sample Preparation							
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE
Total Metals/Major Cations							
Calcium	349000	± 60600	mg/kg DW	20.0	M-2-ADD	S-SFMS-59	LE
Magnesium	7990	± 974	mg/kg DW	5.00	M-2-ADD	S-SFMS-59	LE
Physical Parameters							
Dry matter @ 105°C	65.5	± 2.00	%	1.00	M-2-ADD	TS-105	LE

Sub-Matrix: **SEDIMENT**		*Client sample ID*	**Sediment TM C CTRL**				
		Laboratory sample ID	*LE2310332-009*				
		Client sampling date / time	*2023-05-07*				
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Pre-Preparation							
Drying	Yes	----	-	-	M-2-ADD	S-PP-dry50	LE
Sieving/grinding	Yes	----	-	-	M-2-ADD	S-PP-siev/grind	LE
Sample Preparation							
Digestion	Yes	----	-	-	M-2-ADD	S-PM59-HB	LE
Total Metals/Major Cations							
Calcium	342000	± 59300	mg/kg DW	20.0	M-2-ADD	S-SFMS-59	LE
Magnesium	9040	± 1100	mg/kg DW	5.00	M-2-ADD	S-SFMS-59	LE
Physical Parameters							
Dry matter @ 105°C	79.6	± 2.00	%	1.00	M-2-ADD	TS-105	LE

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	Method Reference
S-PP-dry50	Sample dried at 50°C.
S-PP-siev/grind	Soil samples are sieved <2mm according to ISO 11464:2006. Sediment and sludge are homogenized by grinding.
S-SFMS-59	Determination of metals in soil, sludge, sediment and construction material by ICP-SFMS according to SS-EN ISO 17294-2:2016 and US EPA Method 200.8:1994. Prior to analysis the sample is digested according to S-PM59-HB.
TS-105	Determination of dry weight (DW) according to SS-EN 15934:2012 ed 1.

Preparation Methods	Method Reference
S-PM59-HB	Digestion in 7M nitric acid in hotblock according to SE-SOP-0021.

Key: **LOR** = Limit of reporting represents the standard LOR for the respective parameters in each method. Note that limits of reporting may be affected if, e.g. additional dilution was required because of matrix effects, or the sample quantity was limited.

MU = Measurement Uncertainty

***** = Symbol succeding any result indicates laboratory or subcontractor non-accredited test.

Measurement Uncertainty:

The uncertainty is given as extended uncertainty (according to the definition in "Guide to the Expression of Measurement", JCGM 100:2008 Corrected version 2010) calculated with a coverage factor of 2, which give level of approximately 95%. Measurement of uncertainty is reported only for detected substances with levels above the reporting limits.

The uncertainty from subcontractors is often given as extended uncertainty calculated with a coverage factor of 2. Contact the laboratory for further information.

Issuing lab

	Issuer
LE	*The analysis is provided by* ALS Scandinavia AB Luleå, Aurorum 10 Luleå Sweden 977 75 Accredited by: SWEDAC Accreditation Number: 2030, ISO/IEC 17025

Appendix 3 – Raw Laboratory Data – Biota Tissue Quality

This certificate replaces any previous certificate with the same number.

CERTIFICATE OF ANALYSIS

Work Order	: **LE2307155**	Page	: 1 of 5
Amendment	: **3**		
Client	: **PML Applications Ltd**	Project	: PMA1907
Contact	: Sam Fawcett	Purchase Number	: ----
Address	: Prospect Place, The Hoe, Devon PL1 3DH United Kingdom United Kingdom	Sampler	: Planetary Tech
		Site	: ----
		Date Samples Received	: 2023-05-19 14:42
E-mail	: saf@pml.ac.uk	Date Analysis Commenced	: 2023-05-22
Telephone	: ----	Issue Date	: 2023-07-27 13:06
C-O-C number	: ----	No. of samples received	: 5
Quote number	: LE2023SE-PML-LTD0001 (OF230300)	No. of samples analysed	: 5

General Comments

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This certificate represents the original certificate and may not be modified or reproduced other than in full, except with the prior written approval of the issuing lab. The results apply only to the material that has been identified, received, and tested. The laboratory has no responsibility for information in this certificate that has been provided by the customer, or results that may be affected by such information. Regarding the laboratory's liability in relation to assignment, please refer to our website http://www.alsglobal.se

Workorder Comments

Amendment 1 - the change only applies to changed company.
Version 3 avser tillägg Ca och Mg.

Signatories	Position
Ilia Rodushkin	Laboratory Manager

Ackred. nr 2030
Provning
ISO/IEC 17025

Laboratory	: ALS Scandinavia AB Luleå	Webpage	: www.alsglobal.se
Address	: Aurorum 10 977 75 Luleå Sweden	E-mail	: info.lu@alsglobal.com
		Telephone	: +46 920 28 99 00

Analytical Results

Sub-Matrix: **BIOTA**

Client sample ID	**Fauna Diffuser Crab**						
Laboratory sample ID	*LE2307155-001*						
Client sampling date / time	*2023-05-07*						
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Preparation							
Digestion	Yes	----	-	-	F-15HF-sol2	B-PF51HF-MW	LE
Total Metals/Major Cations							
Aluminum	7.94	± 1.42	mg/kg	2.00	F-15HF-sol2	B-SFMS-51	LE
Arsenic	19.9	± 2.5	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Boron	<2	----	mg/kg	2.00	F-15HF-sol2	B-SFMS-51	LE
Cadmium	<0.005	----	mg/kg	0.00500	F-15HF-sol2	B-SFMS-51	LE
Calcium	777	± 105	mg/kg	30.0	F-15HF-sol2	B-SFMS-51	LE
Chromium	3.96	± 1.03	mg/kg	0.0500	F-15HF-sol2	B-SFMS-51	LE
Cobalt	0.119	± 0.017	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Copper	8.03	± 1.12	mg/kg	0.200	F-15HF-sol2	B-SFMS-51	LE
Iron	20.4	± 3.0	mg/kg	2.00	F-15HF-sol2	B-SFMS-51	LE
Lead	<0.03	----	mg/kg	0.0300	F-15HF-sol2	B-SFMS-51	LE
Magnesium	743	± 102	mg/kg	20.0	F-15HF-sol2	B-SFMS-51	LE
Manganese	0.451	± 0.062	mg/kg	0.200	F-15HF-sol2	B-SFMS-51	LE
Mercury	0.0365	± 0.0046	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Nickel	2.08	± 0.41	mg/kg	0.0500	F-15HF-sol2	B-SFMS-51	LE
Silver	0.150	± 0.026	mg/kg	0.00300	F-15HF-sol2	B-SFMS-51	LE
Tin	<0.05	----	mg/kg	0.0500	F-15HF-sol2	B-SFMS-51	LE
Vanadium	0.0462	± 0.0063	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Zinc	60.7	± 8.3	mg/kg	0.500	F-15HF-sol2	B-SFMS-51	LE

Sub-Matrix: **BIOTA**

Client sample ID	**Fauna Diffuser Starfish**						
Laboratory sample ID	*LE2307155-002*						
Client sampling date / time	*2023-05-07*						
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Preparation							
Digestion	Yes	----	-	-	P-F-HNO3HF-MW	B-PF51HF-MW	LE
Total Metals/Major Cations							
Aluminum	2.57	± 0.46	mg/kg	2.00	F-15HF-sol2	B-SFMS-51	LE
Arsenic	3.16	± 0.40	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Boron	14.8	± 1.8	mg/kg	2.00	F-15HF-sol2	B-SFMS-51	LE
Cadmium	0.344	± 0.046	mg/kg	0.00500	F-15HF-sol2	B-SFMS-51	LE
Calcium	67900	± 9180	mg/kg	30.0	F-15HF-sol2	B-SFMS-51	LE
Chromium	0.212	± 0.055	mg/kg	0.0500	F-15HF-sol2	B-SFMS-51	LE
Cobalt	0.0235	± 0.0033	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Copper	2.90	± 0.40	mg/kg	0.200	F-15HF-sol2	B-SFMS-51	LE
Iron	12.0	± 1.8	mg/kg	2.00	F-15HF-sol2	B-SFMS-51	LE
Lead	0.222	± 0.031	mg/kg	0.0300	F-15HF-sol2	B-SFMS-51	LE
Magnesium	6400	± 882	mg/kg	20.0	F-15HF-sol2	B-SFMS-51	LE
Manganese	1.10	± 0.15	mg/kg	0.200	F-15HF-sol2	B-SFMS-51	LE
Mercury	0.0364	± 0.0046	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Nickel	0.479	± 0.095	mg/kg	0.0500	F-15HF-sol2	B-SFMS-51	LE
Silver	0.0345	± 0.0061	mg/kg	0.00300	F-15HF-sol2	B-SFMS-51	LE
Tin	<0.05	----	mg/kg	0.0500	F-15HF-sol2	B-SFMS-51	LE
Vanadium	0.587	± 0.080	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Zinc	29.7	± 4.0	mg/kg	0.500	F-15HF-sol2	B-SFMS-51	LE

Sub-Matrix: **BIOTA**

Client sample ID		**Fauna S Diffuser Crab**					
Laboratory sample ID		*LE2307155-003*					
Client sampling date / time		*2023-05-07*					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Preparation							
Digestion	Yes	----	-	-	P-F-HNO3HF-MW	B-PF51HF-MW	LE
Total Metals/Major Cations							
Aluminum	2.29	± 0.41	mg/kg	2.00	F-15HF-sol2	B-SFMS-51	LE
Arsenic	17.2	± 2.2	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Boron	<2	----	mg/kg	2.00	F-15HF-sol2	B-SFMS-51	LE
Cadmium	0.00594	± 0.00080	mg/kg	0.00500	F-15HF-sol2	B-SFMS-51	LE
Calcium	914	± 123	mg/kg	30.0	F-15HF-sol2	B-SFMS-51	LE
Chromium	<0.05	----	mg/kg	0.0500	F-15HF-sol2	B-SFMS-51	LE
Cobalt	0.0873	± 0.0122	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Copper	13.9	± 1.9	mg/kg	0.200	F-15HF-sol2	B-SFMS-51	LE
Iron	2.87	± 0.43	mg/kg	2.00	F-15HF-sol2	B-SFMS-51	LE
Lead	0.0345	± 0.0048	mg/kg	0.0300	F-15HF-sol2	B-SFMS-51	LE
Magnesium	822	± 113	mg/kg	20.0	F-15HF-sol2	B-SFMS-51	LE
Manganese	<0.2	----	mg/kg	0.200	F-15HF-sol2	B-SFMS-51	LE
Mercury	0.0582	± 0.0073	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Nickel	0.0722	± 0.0145	mg/kg	0.0500	F-15HF-sol2	B-SFMS-51	LE
Silver	0.216	± 0.038	mg/kg	0.00300	F-15HF-sol2	B-SFMS-51	LE
Tin	<0.05	----	mg/kg	0.0500	F-15HF-sol2	B-SFMS-51	LE
Vanadium	<0.02	----	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Zinc	52.4	± 7.1	mg/kg	0.500	F-15HF-sol2	B-SFMS-51	LE

Sub-Matrix: **BIOTA**

Client sample ID		**Fauna S Diffuser Starfish**					
Laboratory sample ID		*LE2307155-004*					
Client sampling date / time		*2023-05-07*					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*
Sample Preparation							
Digestion	Yes	----	-	-	P-F-HNO3HF-MW	B-PF51HF-MW	LE
Total Metals/Major Cations							
Aluminum	4.20	± 0.75	mg/kg	2.00	F-15HF-sol2	B-SFMS-51	LE
Arsenic	3.22	± 0.40	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Boron	14.8	± 1.8	mg/kg	2.00	F-15HF-sol2	B-SFMS-51	LE
Cadmium	0.313	± 0.042	mg/kg	0.00500	F-15HF-sol2	B-SFMS-51	LE
Calcium	54300	± 7340	mg/kg	30.0	F-15HF-sol2	B-SFMS-51	LE
Chromium	0.388	± 0.101	mg/kg	0.0500	F-15HF-sol2	B-SFMS-51	LE
Cobalt	0.0307	± 0.0043	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Copper	3.04	± 0.42	mg/kg	0.200	F-15HF-sol2	B-SFMS-51	LE
Iron	13.3	± 2.0	mg/kg	2.00	F-15HF-sol2	B-SFMS-51	LE
Lead	0.274	± 0.038	mg/kg	0.0300	F-15HF-sol2	B-SFMS-51	LE
Magnesium	6580	± 908	mg/kg	20.0	F-15HF-sol2	B-SFMS-51	LE
Manganese	0.925	± 0.128	mg/kg	0.200	F-15HF-sol2	B-SFMS-51	LE
Mercury	0.0340	± 0.0043	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Nickel	0.110	± 0.022	mg/kg	0.0500	F-15HF-sol2	B-SFMS-51	LE
Silver	0.0410	± 0.0072	mg/kg	0.00300	F-15HF-sol2	B-SFMS-51	LE
Tin	<0.05	----	mg/kg	0.0500	F-15HF-sol2	B-SFMS-51	LE
Vanadium	0.326	± 0.044	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE
Zinc	29.6	± 4.0	mg/kg	0.500	F-15HF-sol2	B-SFMS-51	LE

Sub-Matrix: **BIOTA**	Client sample ID		**Fauna Control Crab**					
	Laboratory sample ID		*LE2307155-005*					
	Client sampling date / time		*2023-05-07*					
Parameter	**Result**	MU	*Unit*	*LOR*	*Package*	*Method*	*Issuer*	
Sample Preparation								
Digestion	Yes	----	-	-	P-F-HNO3HF-MW	B-PF51HF-MW	LE	
Total Metals/Major Cations								
Aluminum	12.8	± 2.3	mg/kg	2.00	F-15HF-sol2	B-SFMS-51	LE	
Arsenic	13.2	± 1.7	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE	
Boron	<2	----	mg/kg	2.00	F-15HF-sol2	B-SFMS-51	LE	
Cadmium	<0.005	----	mg/kg	0.00500	F-15HF-sol2	B-SFMS-51	LE	
Calcium	766	± 104	mg/kg	30.0	F-15HF-sol2	B-SFMS-51	LE	
Chromium	<0.05	----	mg/kg	0.0500	F-15HF-sol2	B-SFMS-51	LE	
Cobalt	0.0338	± 0.0047	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE	
Copper	5.26	± 0.73	mg/kg	0.200	F-15HF-sol2	B-SFMS-51	LE	
Iron	16.9	± 2.5	mg/kg	2.00	F-15HF-sol2	B-SFMS-51	LE	
Lead	0.0387	± 0.0053	mg/kg	0.0300	F-15HF-sol2	B-SFMS-51	LE	
Magnesium	718	± 99	mg/kg	20.0	F-15HF-sol2	B-SFMS-51	LE	
Manganese	0.252	± 0.035	mg/kg	0.200	F-15HF-sol2	B-SFMS-51	LE	
Mercury	0.0436	± 0.0055	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE	
Nickel	0.0679	± 0.0136	mg/kg	0.0500	F-15HF-sol2	B-SFMS-51	LE	
Silver	0.0460	± 0.0081	mg/kg	0.00300	F-15HF-sol2	B-SFMS-51	LE	
Tin	<0.05	----	mg/kg	0.0500	F-15HF-sol2	B-SFMS-51	LE	
Vanadium	0.0393	± 0.0053	mg/kg	0.0200	F-15HF-sol2	B-SFMS-51	LE	
Zinc	61.7	± 8.4	mg/kg	0.500	F-15HF-sol2	B-SFMS-51	LE	

The end of result part of the certificate of analysis

Brief Method Summaries

Analytical Methods	*Method Reference*
B-PF51HF-MW	Nitric acid/hydroperoxide digestion with trace of hydrofluoric acid in microwave oven according to SE -SOP-0128 (SS-EN 13805:2014).
B-SFMS-51	Determination of metals in food according to SS-EN ISO 17294-2:2016, US EPA Method 200.8:1994. Prior to analysis the sample is digested according to B-PF51HF-MW or B-PF51-MW.

Preparation Methods	*Method Reference*
B-EU-not*	Sample from outside EU

Key: **LOR** = Limit of reporting represents the standard LOR for the respective parameters in each method. Note that limits of reporting may be affected if, e.g. additional dilution was required because of matrix effects, or the sample quantity was limited.

MU = Measurement Uncertainty

***** = Symbol succeding any result indicates laboratory or subcontractor non-accredited test.

Measurement Uncertainty:

The uncertainty is given as extended uncertainty (according to the definition in "Guide to the Expression of Measurement", JCGM 100:2008 Corrected version 2010) calculated with a coverage factor of 2, which give level of approximately 95%. Measurement of uncertainty is reported only for detected substances with levels above the reporting limits.

The uncertainty from subcontractors is often given as extended uncertainty calculated with a coverage factor of 2. Contact the laboratory for further information.

Issuing lab

	Issuer
LE	*The analysis is provided by* ALS Scandinavia AB Luleå, Aurorum 10 Luleå Sweden 977 75 Accredited by: SWEDAC Accreditation Number: 2030, ISO/IEC 17025