East Clive Wastewater Treatment Plant - Annual Monitoring Report

2022 - 2023

October 2023 **Ref: 310003303**

PREPARED FOR:

Hastings District Council

PREPARED BY

Stantec

Revision Schedule

Revision No.	Date	Description	Prepared by	Quality Reviewer	Independent Reviewer	Project Manager Final Approval
1	8/9/2023	Draft for internal detailed review	O. Mothelesi	C. Wang	J. Grinter	
2	11/10/23	Draft for client review	-	J. Grinter	P. Loughran	
3	19/10/23	Draft for independent peer review	-	J. Grinter	P. Loughran	M. Lee
4	31/10/2023	Final	-	J. Grinter	P. Loughran	M. Lee

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Quality statement

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Executive summary

This Annual Monitoring Report for the East Clive Wastewater Treatment Plant (WWTP) has been prepared to satisfy the requirements of the resource consent under which the WWTP operates (consent number AUTH-120712-01/ CD130214W, issued by Hawke's Bay Regional Council (HRBC)). The consent provides for the discharge of treated wastewater from the WWTP via an offshore ocean outfall into Hawke Bay (Te Whanga a Ruawharo). This report has been developed in accordance with Condition 24 of the consent. It covers the reporting period between 1 July 2022 and 30 June 2023.

Hastings District Council are the holders of the resource consent, and as such are required to annually assess the following aspects of the WWTP operations and discharges to Hawke Bay (Te Whanga a Ruawharo):

- All routine and event-based monitoring undertaken.
- Results of monitoring, to determine whether Hawke Bay (Te Whanga a Ruawharo) has been affected as a result of the discharge.
- Compliance with all conditions of the resource consent
- Any measures taken during the year to reduce potential effects on the environment.
- Any operational problems experienced, including any non-compliances with the consent.
- Works undertaken to maintain the treatment system and improve performance.
- Overall trends in the quality of the discharge, and flows and volumes of wastewater discharged, compared with previous years dating back to 2014.
- Engagement with Tangata Whenua, the local community and other stakeholders with regards to operation of the WWTP and the discharge into Hawke Bay (Te Whanga a Ruawharo).

In addition, the report details events that have occurred during the reporting period which may have impacted on performance, such as the response to Cyclone Gabrielle from February 2023 onwards.

This year's report has found that HDC has been compliant with the conditions of the resource consent overall, with five minor non-compliances as an exception:

1. One non-compliance event occurred in June 2023, when untreated wastewater unexpectedly overflowed into a drain on Grey Street, within the bounds of the WWTP complex (**Condition 5(b)**). The issue was quickly remedied, and no further action was required.
2. Some changes in the colour and clarity of water in the vicinity of the outfall diffusers were observed in the early part of 2023, following Cyclone Gabrielle and subsequent heavy weather (**Condition 7**).
3. Water quality monitoring equipment was not calibrated at an appropriate frequency during the reporting period (**Condition 11).**
4. Surface currents in Hawke Bay (Te Whanga a Ruawharo) were not measured during one of the quarterly receiving environment water quality monitoring events, in August 2022 (**Condition 17**).
5. Submission of the resulting investigation report was slightly delayed beyond the stipulated period of one month after the overflow event (**Condition 31**).

In general, the WWTP is operating consistently when compared with previous years, with good performance maintained in that there has been no discernible increase in flow rate or volume of discharge from the WWTP via the ocean outfall, and the Rakahore passage continues to operate within design parameters. Contaminant loads and concentrations within the final combined wastewater discharge have remained fully compliant and generally either similar to the previous year or in some cases slightly reduced. However, fluctuations occurred in the first half of 2023 due to inclement weather and repair work on BTF2 which necessitated a temporary change to the treatment process. This has made it difficult to assess performance in comparison with previous years.

This report was independently reviewed by eCoast, at the request of the HDC and Tangata Whenua Joint Wastewater Committee. A copy of the comments from eCoast is appended.

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Abbreviations

Abbreviations	Full Name
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2018
AS	Acid Soluble
Avg	Average
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
BTF	Biological Trickling Filter
$cBOD_5$	5-day Carbonaceous Biochemical Oxygen Demand
CFU	Colony Forming Units (of Microorganisms)
COD	Chemical Oxygen Demand
DGV	Default Guideline Value
DNSI	Domestic and Non-Separable Industry
DRP	Dissolved Reactive Phosphorous
FCW	Final Combined Wastewater
HBRC	Hawke's Bay Regional Council
HDC	Hastings District Council
ISQG	Interim Sediment Quality Guideline
g/m^3	Grams per Cubic Metre (same as mg/l)
L/s	Litres per Second
LOEC	Lowest Observable Effect Concentration
MCC	Motor Control Centre
m	Metre
m^3	Cubic Metre
mg/L	Milligrams per Litre (same as g/m3)
MOU	Memorandum of Understanding
NH_3	Ammoniacal Nitrogen
NH_4+	Ammonium Ion
NIWA	National Institute of Water and Atmospheric Research
NOEC	No Observed Effect Concentration
NT	Not Tested – The sample was not tested for that parameter
PLC	Programmable Logic Controller
SCADA	Supervisory Control and Data Acquisition
TCD	Total Combined Discharge (same as Final Combined Wastewater)
TEC	Threshold Effect Concentration (Geometric mean of NOEC and LOEC)

Abbreviations	Full Name
TN	Total Nitrogen
TOG	Total Oil and Grease
TP	Total Phosphorous
TSS	Total Suspended Solids
UPS	Uninterruptible Power Supply

1 Introduction

Hastings District Council (HDC) has engaged Stantec to compile an Annual Monitoring Report for the East Clive Wastewater Treatment Plant (WWTP). The WWTP operates and discharges treated wastewater via an offshore ocean outfall into Hawke Bay (Te Whanga a Ruawharo) under Resource Consent No. AUTH-120712-01/ CD130214W issued by the Hawke's Bay Regional Council (HBRC). The Annual Monitoring Report has been prepared and is being submitted in accordance with Condition 24, which states that: "Before 1 October each year, the Consent Holder shall provide the Regional Council with an Annual Monitoring Report, covering the preceding 12-month period ending 30 June." This report covers the period from 1 July 2022 to 30 June 2023.

1.1 Background

The existing Resource Consent was granted in 2014, for a 35-year period ending on 31 May 2049. It includes 32 conditions covering requirements for the following:

- How much final combined wastewater can be discharged, and when;
- the way in which final combined wastewater can be discharged;
- where the discharge can occur;
- wastewater treatment and standards;
- monitoring requirements, and
- administration requirements (including reporting).

1.1.1 Overview of the East Clive WWTP and ocean outfall scheme

The WWTP treats wastewaters from the Hastings District urban area, Clive, and other areas along the conveyance route to the East Clive WWTP.

There are two wastewater streams that are delivered to the WWTP (a Domestic and Non-Separable Industry (DNSI) wastewater and a Separatable Industrial wastewater). Each stream is processed in a separate flow path and treatment process prior to discharge of the combined treated wastewater to the outfall.

The DNSI wastewater is treated through the Biological Trickling Filters (BTF) as a biological treatment process, and then through the Rakahore channel to remove the wastewater's cultural offensiveness linked to the human waste component (kūparu). Given its primarily organic nature and absence of human waste, industrial wastewater wasn't deemed culturally offensive at the time of consent granting.

The separable industrial wastewater is then passed through a milliscreen at the WWTP and combined with BTF treated wastewater before being discharged into Hawke Bay (Te Whanga a Ruawharo) via the 2.75km long ocean outfall and diffuser.

The components of the respective treatment processes are illustrated in Figure 1-1.

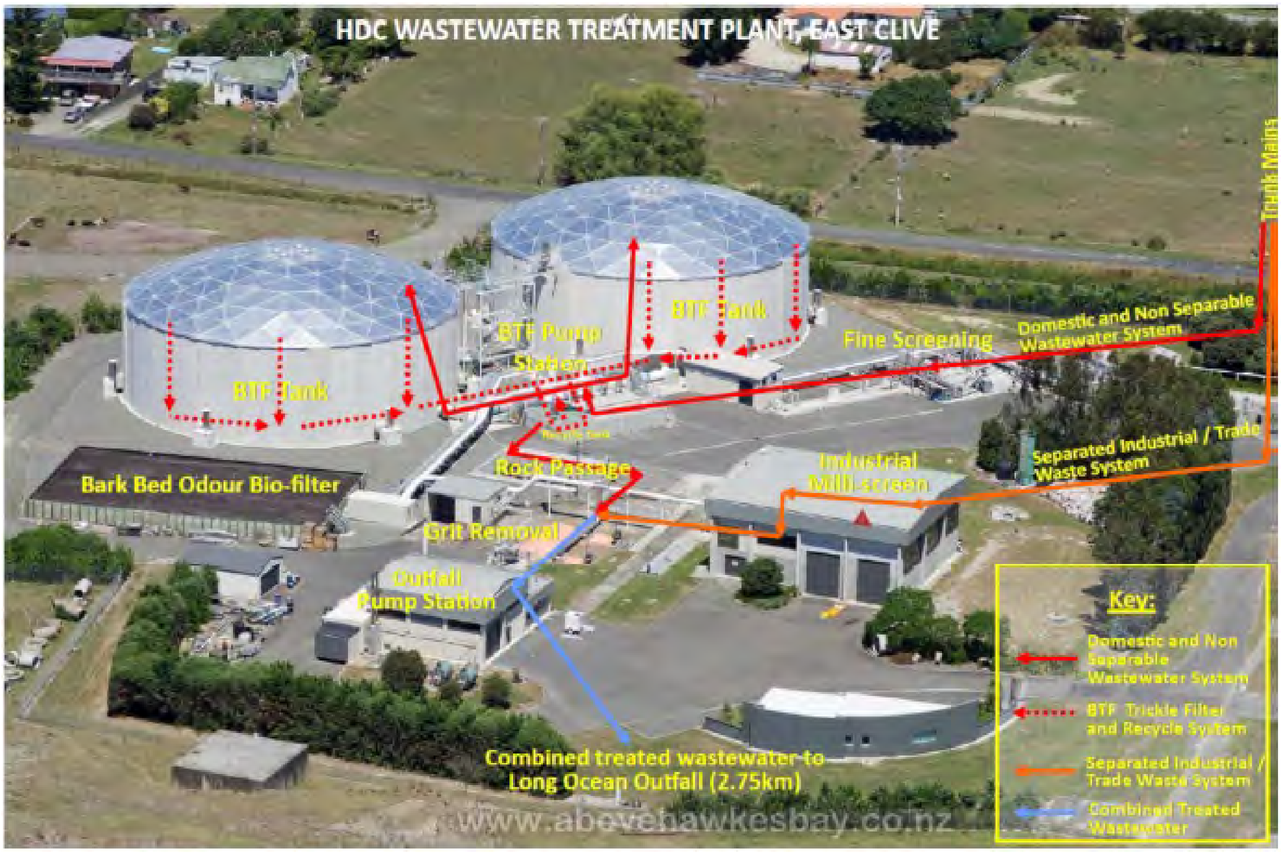


Figure 1-1: East Clive WWTP Flow and Flow Paths

1.2 Preparation of this Report

This report has been jointly prepared by Hastings District Council and Stantec. It has then been independently reviewed by eCoast Ltd. A summary of the roles and responsibilities of each organisation preparing this report has been outlined in Table 1-1 below.

Table 1-1: Organisations Involved and Their Roles in Preparation of the 2022 - 2023 Annual Monitoring Report

Organisation Name	Roles/Responsibility in Preparation of This Report
HDC	1. Provide all the tabulated sampling results, monitoring/testing information and reports. 2. Provide operational and event records. 3. Provide maintenance records and improvement action records. 4. Clarify information, and answer queries throughout the Report preparation. 5. Assure accountability of preparing and submitting this Report as the Consent Holder

Organisation Name	Roles/Responsibility in Preparation of This Report
Stantec	1. Review all the monitoring/testing information, records and reports provided. 2. Analyse and summarise the monitoring information provided. 3. Ensure the completeness of information and records necessary for this Report. 4. Physically compile this Report 5. Consult HDC for comments, and incorporate the review comments in the Report
eCoast Limited (eCoast)	1. Conduct an independent review of this report by referring to the Consent. 2. Compile the Peer Review Report (Appendix I).

1.3 Structure of this Report

This section outlines the background and purpose of the report, and briefly describes the wastewater treatment and discharge scheme. A compliance summary table has been prepared to enable interpretation of the report findings against each condition of the consent. The full version of this table is attached as **Appendix A** due to its size and level of detail.

Section 2 provides some context to the annual compliance assessment, outlining some of the circumstances and operational challenges experienced by HDC and the wider region during the reporting year as well as any additional information which cannot be directly attributed to a specific consent condition.

The summary table in Appendix A contains references to further content in this report (namely in **Section 3**) where details and evidence supporting the compliance assessment can be found, where such detail is necessary. Overall compliance with the consent for the current reporting period is then concluded in **Section 4.**

Various other appendices contain supporting evidence and reference documents which form the basis of this assessment.

All supporting reports prepared by relevant service providers are included as Appendices.

2 Reporting Period Overview

This section provides an overview of the conditions experienced and consent-related activities undertaken during the reporting period. This is intended to provide background information to the compliance assessment contained in the remainder of the report.

The 2022-23 reporting period has brought many challenges for HDC and the East Clive WWTP. The most significant of these was Cyclone Gabrielle; a severe Tropical Cyclone which hit New Zealand's North Island between 12-16 February 2023. The Hawke's Bay (Te Matau-a-Māui) and Tairāwhiti regions were severely impacted by intense, prolonged rainfall, high winds and flooding.

The impacts were intensified due to several weeks of wet weather preceding the cyclone (some of which was caused by Cyclone Hale in late January). Extensive flooding was seen within the Ngaruroro River catchment, which the East Clive WWTP is adjacent to. The river breached stopbanks in several locations.

HDC worked in partnership with HBRC and other agencies to respond to the emergency in the region following Cyclone Gabrielle. Much of the response work is still ongoing and will likely continue well into 2024. Due to the level of effort needed to coordinate and implement the response (led by the National Emergency Management Agency and HBRC), many of the key operational and management personnel who are usually responsible for the WWTP and/or wastewater network operations were diverted from their core routine tasks (except for vital services). This resulted in some delays with regards to administrative processes and routine receiving environment monitoring (for example).

One of the activities undertaken by HDC in March 2023 as a direct result of cyclone Gabrielle was a dive survey of the ocean outfall from East Clive WWTP. This was completed by New Zealand Diving and Salvage Ltd (NZDS) and HDC on 15 March 2023, one month after the cyclone hit. A Closed-Circuit Television (CCTV) inspection of the WYE junction on the outfall pipe was undertaken first, followed by the recovery and re-positioning of the inshore marker for the outfall. A submerged tree near the WYE junction was also removed. The following findings were recorded:

- No leaks were observed at the WYE junction during the survey. All anodes were seen and accounted for.
- Eighteen (18) diffusers were located along the pipeline, and all were flowing and clear of debris. Seabed levels around the pipeline and outfall were similar to those observe during a previous survey in November 2022.
- The inshore marker buoy for the outfall had migrated some 700 metres north-west of the outfall. This was recorded and cleared of debris. The offshore marker had not been affected.

Given the impact of Cyclone Gabrielle on the region and particularly on Hawke Bay (Te Whanga a Ruawharo), some of the results discussed in this report are anomalous when compared with past reports.

One non-compliant event took place on 27 June 2023, when approximately 50 m^3 of untreated (but heavily diluted) domestic wastewater overflowed from an inlet manhole within the WWTP into a roadside drain on Grey Street. The overflow occurred following a wet weather event in the preceding days, with increased stormwater flows infiltrating to the wastewater network and putting pressure on the urban stormwater network. At the time of the overflow, the WWTP was shut down and critical repairs were being made to a leaking air valve on the first section of the ocean outfall. The overflow from the inlet manhole occurred while these repairs were underway. The investigation report produced in response to the incident is attached as Appendix K. This event was considered a minor non-compliance with Condition 5(b). There was also a slight delay in providing the investigation report to HBRC (required within one month of a non-compliance) which is a minor non-compliance with Condition 31 of the consent.

On a more positive note, work has been underway for the majority of 2023 to complete the inaugural nine-yearly Trends, Technology, Discharge, Environmental and Monitoring Review Report for the East Clive WWTP treated wastewater discharge consent. This is a significant undertaking and has included consultation with the HDC and Tangata Whenua Joint Wastewater Committee (HDC-TWJWWC) on several occasions to confirm the scope of the review. It is intended that the review report will be published in early 2024 after it has been reviewed by the HDC-TWJWWC.

3 Information supporting the compliance assessment

This section provides evidence and other background information to support the conclusions reached regarding compliance for 2022/23, as set out in Appendix A.

3.1 Monitoring

Table 3-1 below summarises all the monitoring undertaken by HDC during this reporting period, in accordance with the resource consent requirements (Condition 24(a)).

In analysing the data collected during this reporting period, it became clear that some samples may not have been collected during periods that reflected 'normal operating conditions' for the WWTP. Given that monitoring is predominantly undertaken quarterly (only four samples per 12-month period), it is imperative that those quarterly samples are representative. This applies to both wastewater and receiving waters analyses. During this reporting period, the Q2 and Q3 sampling events were anomalous, and skewed by extreme weather events that preceded the sampling period. As such, it was necessary to exclude those samples from some of the analyses contained in Sections 3.3 and 3.4 of this report.

It is recommended that the sampling protocols applied for the WWTP (wastewater analyses) and receiving environment monitoring are reviewed and revised where necessary during the 2023/24 reporting period.

Table 3-1: Summary of All Monitoring Undertaken

Monitoring Requirement	Condition No.	Required frequency	Date/Period undertaken during 2022/23
Wastewater quality			
DNSI, before BTF, tested for: • Total Suspended Solids (TSS), • Total Oil and Grease (TOG), • Carbonaceous biochemical demand (cBOD5)	14(a)	Quarterly, with no less than 2 months between each sample. Over a minimum of seven consecutive days (24-hour periods) per quarter. Flow-proportional samples. Selected parameters are required to be tested annually **for final combined wastewater only** (on **one** of the quarterly sampling events).	Q1: 08/08 – 14/08/2022 Q2: 17/10 – 23/10/2022 Q3: 27/02 – 05/03/2023 Q4: 10/05 – 16/05/2023 The annual suite of parameters was also tested for during each quarterly event. This is beyond the consent requirements.
DNSI, immediately after BTF, tested for: TSS, TOG, $cBOD_5$	14(b)		
Final combined wastewater, tested for: • pH, conductivity, TOG • TSS • Ammoniacal nitrogen (NH_4-N) • $cBOD_5$ • Acid soluble zinc, arsenic, trivalent chromium (Cr III), hexavalent chromium (Cr VI), copper, nickel, lead, and mercury • Sulphide	14(c)		

Monitoring Requirement	Condition No.	Required frequency	Date/Period undertaken during 2022/23
• Dissolved Reactive Phosphorus (DRP) Annual only • Total solids • Total organic carbon • Nitrate and nitrite-nitrogen (NO3-N and NO2-N) • Chemical Oxygen Demand (COD) • Total Kjeldahl Nitrogen (TKN) • Total phosphorus (TP) • Total phenols • Total cyanide • Total metals (Zn, As, Cr III, Cr VI, Cu, Ni, Pb, Hg) • Volatile Organic Compounds (VOC; including Benzene, Toluene, Ethylene and Xylene (BTEX)) • Semi-volatile Organic Compounds (sVOC) • Polychlorinated phenols (PCP) • Organonitrogen and Organophoshorus (ON and OP) pesticides			
Wastewater quantity			
Rate of discharge (instantaneous flow rate) – Final combined wastewater discharged	12	Continuously in SCADA, with accuracy within plus or minus 5% (as per manufacturer's calibration records).	Recorded every 5 minutes
Daily volume – Final combined wastewater discharged	12		Recorded daily at midnight
Receiving environment and effects			
Toxicity of the final combined wastewater	15	Quarterly, with no less than 2 months between each sample.	Q1: 08/08 – 14/08/2022 Q2: 17/10 – 23/10/2022 Q3: 27/02 – 05/03/2023 Q4: 10/05 – 16/05/2023
Laboratory tests: Faecal coliform and enterococci – 10 locations as specified in Condition 16; and – 4 additional locations	16	Quarterly, with no less than 2 months between each sample. Samples collected from 10 sites: • North side of the diffuser, at 100 m, 250 m, 500m, 750m and 1000m from the centre of the diffuser (5 samples total) • South side of the diffuser, at 100 m, 250 m, 500m, 750m and 1000m	Q1: 08/08/2022 Q2: 17/10/2022 Q3: 03/03/2023 Q4: 11/05/2023

Monitoring Requirement	Condition No.	Required frequency	Date/Period undertaken during 2022/23
		from the centre of the diffuser (5 samples total)	
Field measurements: pH, salinity, turbidity, temperature, and dissolved oxygen – 10 locations as specified in Condition 16; and – 4 additional locations	16	As for Condition 16, but with four additional locations:	Q1: 08/08/2022 Q2: 17/10/2022 Q3: 03/03/2023 Q4: 11/05/2023
Surface currents measured via GPS drogue at centre of diffuser.	17	Quarterly. Measure surface currents for at least 30 mins during each quarterly receiving environment monitoring event.	Q1: Not completed. Q2: 17/10/2022 Q3: 03/03/2023 Q4: 11/05/2023
Grab samples of seabed sediment, analysed for total recoverable metals: Zinc, Arsenic, Cadmium, Chromium, Copper, Tin, Nickel, Lead, and Mercury	19	Twice a year (in summer and winter). Six locations: • North side of the diffuser, at 250m, 500m and 750m from the centre of the diffuser (3 locations) • South side of the diffuser, at 250m, 500m and 750m from the centre of the diffuser (3 locations)	1st: 08/08/2022 2nd: 17/10/2022 3rd: 03/03/2023 4th: 11/05/2023 (More frequent than specified)
Benthic surveys of marine sediments, benthic ecology, and trace metals in flatfish	18	In the 8th, 17th and 26th years after the commencement of the consent (2014).	First benthic survey undertaken in January 2023 (8 years after commencement)
Visual inspections			
Inspection of the ocean outfall pipeline and diffuser	9	At least annually, at intervals no more than 14 months apart and at any other time as necessary.	8/8/2022 17/10/2022 3/3/2023 11/5/2023
Visual assessment for gross pollutants, films/foams/scums/sheens at the diffuser	7	At all times (and formal visual inspection undertaken in conjunction with quarterly receiving environment sampling)	Dates as for Condition 9
Assessment of odour at diffuser	7	At all times (and formal visual inspection undertaken in conjunction with quarterly receiving environment sampling)	Dates as for Condition 9

3.2 Wastewater Quantity and Rainfall

As noted in Section 2, the East Clive WWTP (and HDC) has faced many challenges during the 2022/2034 reporting period as a result of extreme wet weather events (Cyclones, Hale: late-January and Gabrielle: mid-February) that have contributed to substantial increases in flow delivered to the WWTP. The variation in daily rainfall that has been observed throughout the reporting period is summarised in Figure 3-1 below.

The variation in instantaneous flow (data extracted at five-minute intervals) of the final combined wastewater (DNSI and separable industry) is shown in Figure 3-2. The influence of the extreme wet weather events is clear in Figure 3-2 where peak instantaneous flows of 1,955 L/s (Cyclone Hale) and 1,995 L/s (Cyclone Gabrielle) were recorded at the WWTP. The reported maximum instantaneous flow was lower than the consented limit of 2,800 L/s.

The increased flows observed during the reporting period are also evident when compared to flows in previous years. A comparison, based on the determination of average daily flows, of the 2022/2023 reporting period with historical observed daily flows from 2015 are presented in Figure 3-3. Data are shown to illustrate weekly (7d), monthly (30d), three monthly (90d) and annual average (365d) trends in the observed flow data together with a comparison with the Trigger Value (which is expressed as annual average daily flow) of Condition 24(d). Figure 3-3 also shows the timing of the quarterly and annual sampling events that have occurred relative to the flows discharged from the WWTP.

During the annual reporting period, the annual average daily volume of final combined wastewater discharged from the outfall was 52,600 m^3/day. This is substantially higher than that observed in previous reporting periods (2018/2019: 46,400 m^3/day, 2019/2020: 45,300 m^3/day, 2020/2021: 44,000 m^3/day, 2021/2022: 45,000 m^3/day) but lower than the consented limit of 66,000 m^3/day. It is important to note that this consent limit is a calculated annual average and not a daily limit to allow for some variance in daily volumes, particularly extreme wet weather events.

There was a considerable variation in the daily volumes to/from the WWTP throughout the year. The average daily flow exceeded 80,000 m^3/day on 17 occasions during the 2022/2023 reporting period and exceeded 100,000 m^3/day on 8 occasions. In contrast, during each of the previous four reporting periods (2018 to 2022), flows have exceeded 80,000 m^3/day on three or four occasions and have exceeded 100,000 m^3/day rarely (on four occasions over the four-year period).

The increase in flow is a direct result of the extreme wet weather that has occurred during the 2022/2023 reporting period particularly as seasonal high flows from separable industry (that are evident in previous reporting periods) have been somewhat subdued this year because of the widespread effects of Cyclones Hale and Gabrielle upon the local fruit and vegetable industry.

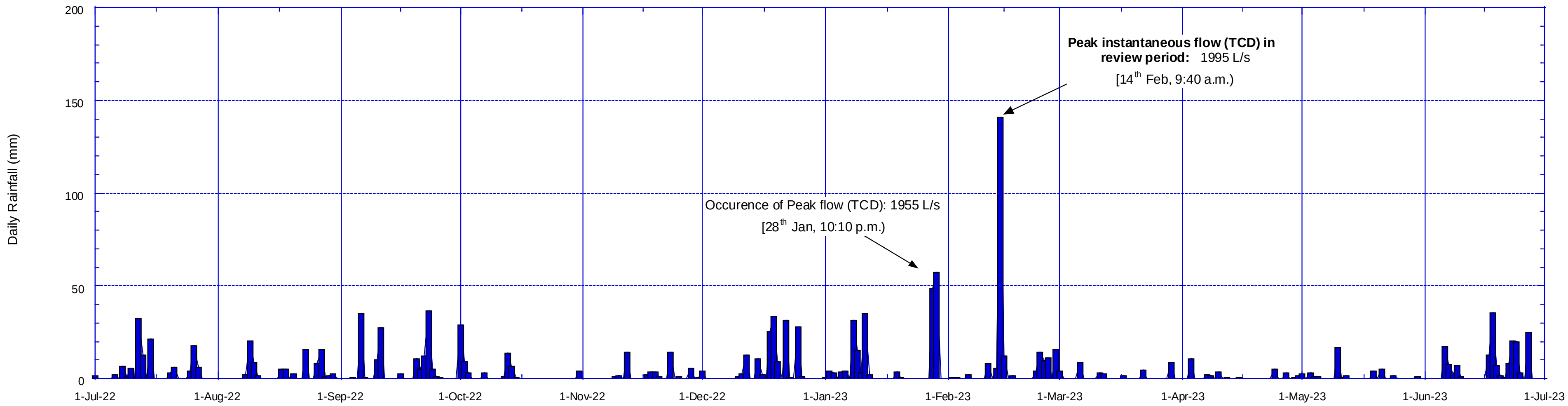


Figure 3-1: Variation in Daily Rainfall during the Annual Report Period.

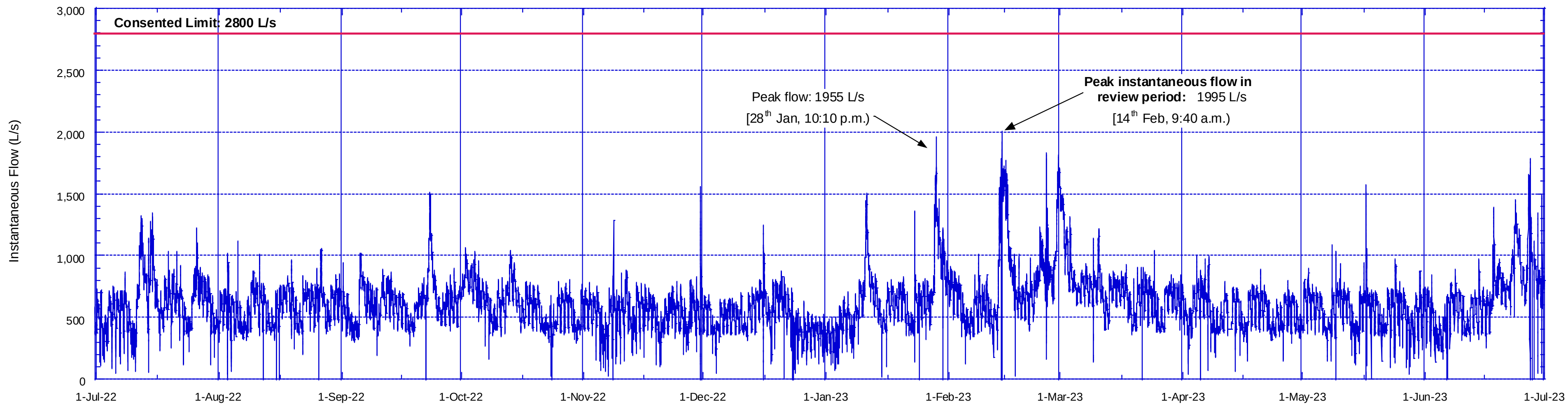


Figure 3-2: Variation in the Instantaneous Flow of Final Combined Wastewater during the Annual Report Period.

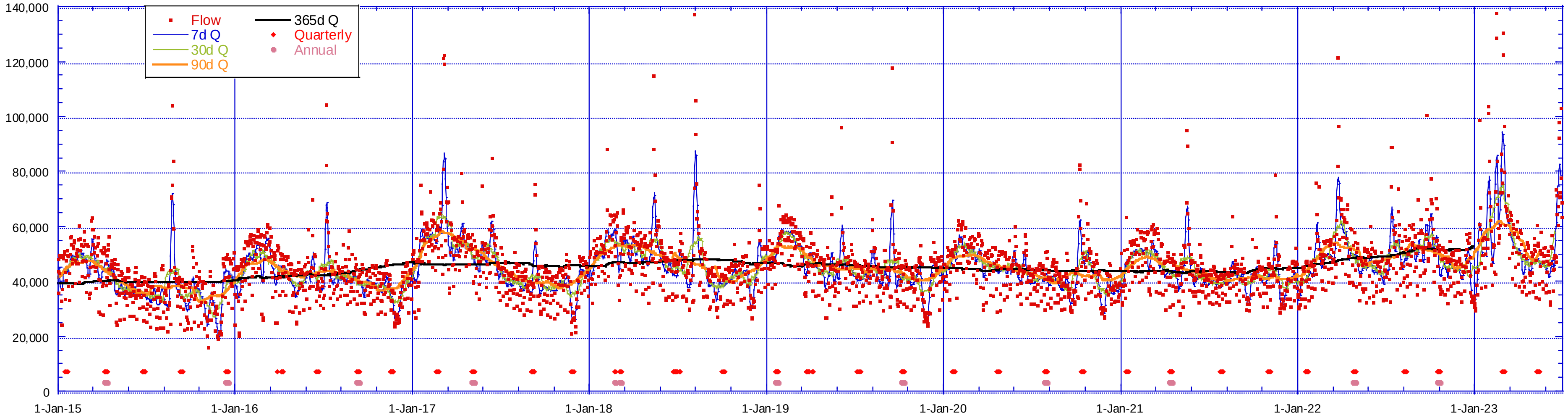


Figure 3-3: Variation in Average Daily Flow of Final Combined Wastewater (2015-2023).

3.3 Wastewater and receiving environment quality.

Wastewater and treated wastewater streams are monitored at the WWTP as detailed in Table 3-1. Wastewater is monitored at various stages throughout the treatment processes to determine how well the plant is performing (in transforming or removing certain constituents of the waste) and whether consent conditions are being complied with.

In summary these stages include:

1. **BTF influent** - Domestic and non-separable industrial (DNSI) wastewater as it arrives at the WWTP, before it is treated through the BTF.

2. **BTF effluent** – DNSI treated wastewater **after** it has been passed through the BTF, but before it is combined with other treated wastewater streams for discharge.

3. **Industry influent** – wastewater from separable industry as it arrives at the WWTP, before it is passed through the milliscreens. Whilst such monitoring is undertaken in parallel with that of DNSI and the final combined wastewater, it is not a consented requirement and not reported herein.

4. **Final combined wastewater** – BTF effluent and screened separable industrial wastewater are combined prior to the outfall pipeline and discharged to Hawke Bay (Te Whanga a Ruawharo).

In addition, monitoring (water quality and sediment) also takes place at and around the outfall in Hawke Bay (Te Whanga a Ruawharo), to determine whether any effects have occurred in the **receiving environment** that may be attributable to the WWTP discharge.

Results from monitoring for each of these aspects are discussed in this section, and provide an evidence base for the compliance assessment in Appendix A. Raw data are attached in Appendices D and E, with the exception of the instantaneous flow monitoring data (final combined wastewater).

3.3.1 BTF influent (DNSI)

The variation in the quality of the DNSI wastewater delivered to the WWTP and passed through to the BTF's for the annual reporting period and historically (from 2015) are presented in Figure 3-4. Data are presented for each sampling event (quarterly) in terms of the concentrations of suspended solids, carbonaceous BOD_5 and oils and grease (as required by Condition 14(a)). Data pertaining to the quality of other contaminants are available in Appendix D.

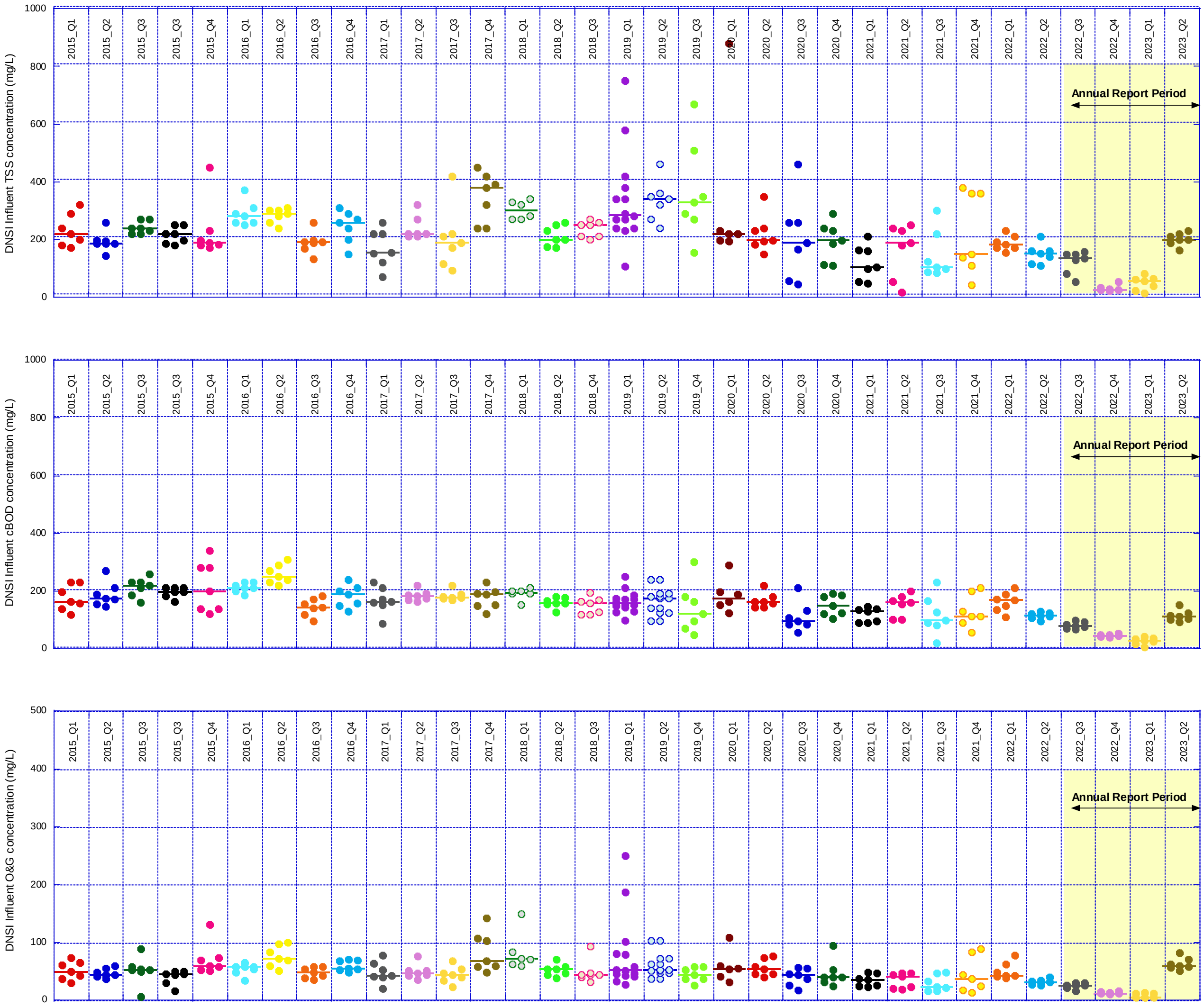


Figure 3-4: Variation in Contaminant Concentration in DNSI Wastewater to the WWTP (from top to bottom: TSS, $cBOD_5$, and TOG)

It is evident from Figure 3-4 that the concentrations of contaminants (TSS, $cBOD_5$) during the 2022/2023 reporting period were somewhat lower than the historical record, particularly 2022-Q4 and 2023-Q1. On a per capita basis, the observed values (16-26 and 21-31 g/hd.day, $cBOD_5$) are uncharacteristically low and cast doubt upon the validity and representativeness of the data.

As previously mentioned in Section 3.1, it is recommended that HDC undertake a review of sampling procedures at the WWTP to ensure the collection of representative data over the 2023/24 reporting period.

3.3.2 BTF effluent

The variation in the quality of the treated wastewater observed during the 2022/2023 reporting period and historically (from 2015) are presented in Figure 3-5. Data are presented for each sampling event (quarterly) in terms of the concentrations of suspended solids, carbonaceous BOD_5 and oils and grease (as required by Condition 14(b)). Data pertaining to the quality of other contaminants are available in Appendix D.

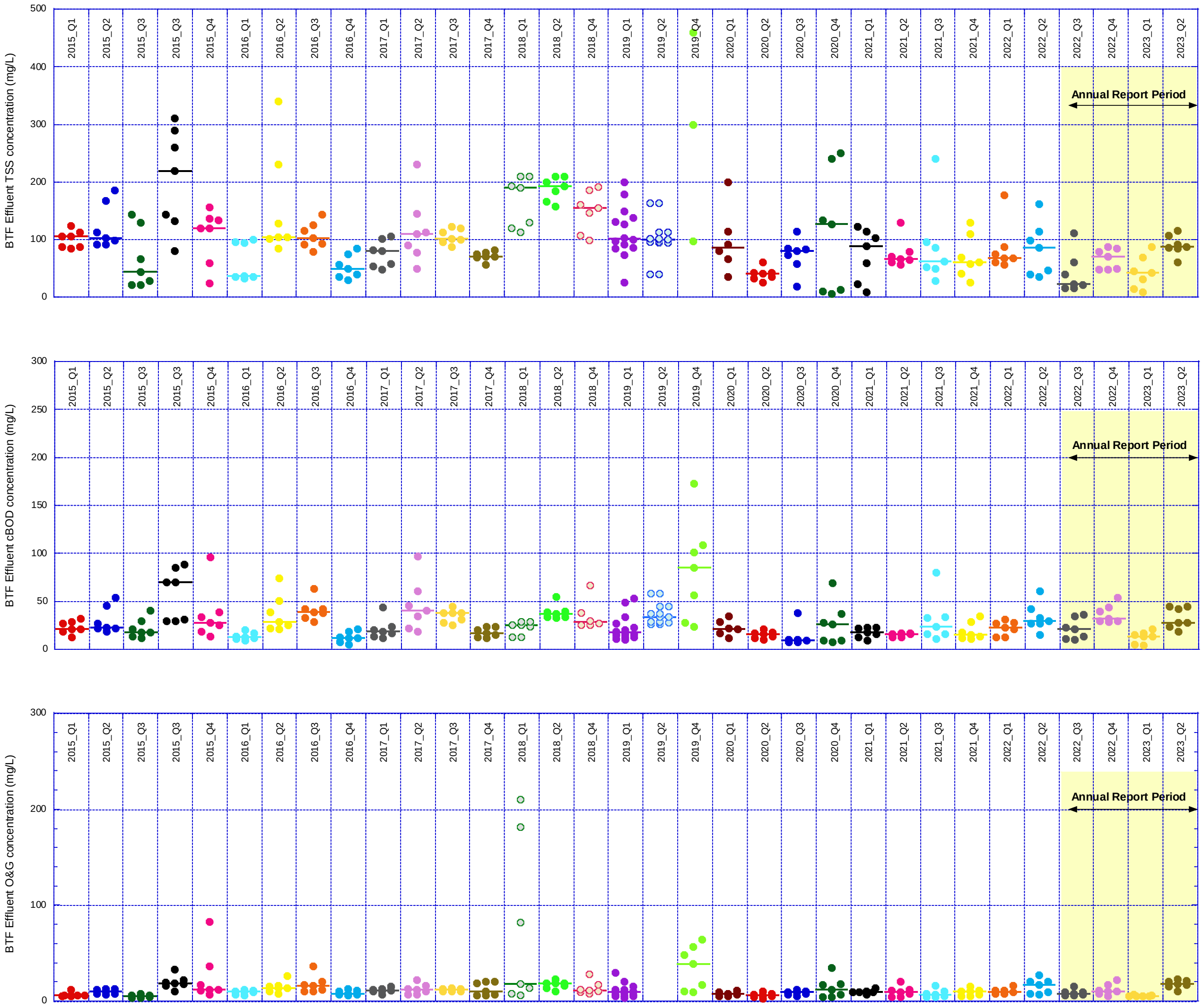


Figure 3-5: Variation in Contaminant Concentration in DNSI Treated Wastewater (from top to bottom: TSS, $cBOD_5$, and TOG).

The variation in treated wastewater quality from the BTFs during the 2022-2023 reporting period was generally consistent with what has been observed in the historical record. Over the reporting period, wastewater was irrigated to two BTFs until 5th May 2023 with BTF2 being irrigated with a stationary distributor as a result of a failure of the rotary distributor slewing ring bearing (failure occurred 3rd April 2022). Flow to BTF2 ceased temporarily on the 5th May 2023 to enable critical repair works. The final sampling event of the reporting period was undertaken one week after flow to BTF2 was stopped.

3.3.3 Removal of contaminants across BTF

The apparent performance of the BTF during the 2022/2023 reporting period is summarised in Table 3-2. Data are only presented for the first (Ev.1, occurring in Q3, 2022) and final (Ev. 4, occurring in Q2,2023) sampling events as influent data associated with the second and third events are not considered representative. Data for Ev.3 were significantly impacted by Cyclone Gabrielle and data for Ev.2 yielded atypical influent loads that are inconsistent with the reticulated population.

Table 3-2: Summary of Apparent BTF Performance (Conditions 14(a) and 14 (b))

	Statistic	TSS (g/m^3)	$cBOD_5$ ($g\ O_2/m^3$)	TOG (g/m^3)
Before BTF (DNSI Influent)	Maximum	230	151	81
	Ev.1 (Average ± 1 standard deviation)	128 ± 39	81 ± 11	25 ± 5
	Ev.4 (Average ± 1 standard deviation)	202 ± 22	114 ± 19	62 ± 10
After BTF (Treated DNSI Wastewater)	Maximum	115	54	23
	Ev.1 (Average ± 1 standard deviation)	29±18	21±11	8±3
	Ev.4 (Average ± 1 standard deviation)	90±18	38±11	18±4

Note 1: Monitoring data for Ev.2 and Ev.3 are not considered to be representative of plant performance for their respective period. Data for Ev.3 were significantly impacted by Cyclone Gabrielle and data for Ev.2 yield atypical influent loads that are inconsistent with the reticulated population.

Note 2: Operations for Ev.1 are based on two BTF in service. Flow to BTF2 ceased temporarily one week prior to collection of samples in Ev.4.

Based on the data presented in Table 3-2, the average reduction in the concentration of $cBOD_5$, TSS and TOG was 74%, 77% and 68% respectively over the 7-day period of the first sampling event and 67%, 55% and 71% over the 7-day period of the final sampling event. The difference in performance between the two sampling events is not unexpected as BTF1 was transitioning to an operation based on an increased applied organic loading (flow to BTF2 ceased temporarily one week prior to the final sampling event) in order to enable critical repair works on BTF2.

Overall, the BTF(s) have performed well over the 2022/2023 reporting period notwithstanding the operational issues experienced at the plant. The quality of the BTF treated wastewater was consistent with previous years.

3.3.4 BTF Organic Loading Rate

Condition 5(b) of the consent requires HDC to report the average daily BOD loading rate (OLR) applied to the BTF and to ensure that, as an annual average value, the OLR is maintained at less than 0.4 kg $cBOD_5$/day per cubic media of media. This value was considered appropriate at time of granting of the consent to demonstrate "a significant removal of kūparu" is being achieved in the treatment process.

The variation in organic loading rate applied to the BTFs over the 2022/2023 reporting period and historically (from 2015) are illustrated in Figure 3-6. Data are expressed in terms of the daily mass of carbonaceous BOD (5-day basis) per unit volume of media within the BTFs. Data that are considered unreliable (inconsistent within the sampling period, inconsistent with measurements of other contaminants or low derived per capita values) are also highlighted on Figure 3-6.

It should be noted that during the 2022/2023 reporting period, flows to BTF2 ceased temporarily on the 5th May 2023 (one week prior to the final sampling event) in order to enable repair works of the rotary distributor of BTF2. Thus, the applied organic loading rate to BTF1 increased as a result of a single filter being in use. However, a transition to a steady state operation at the increased loading rate is unlikely to have been achieved at the time of sample collection for Event 4.

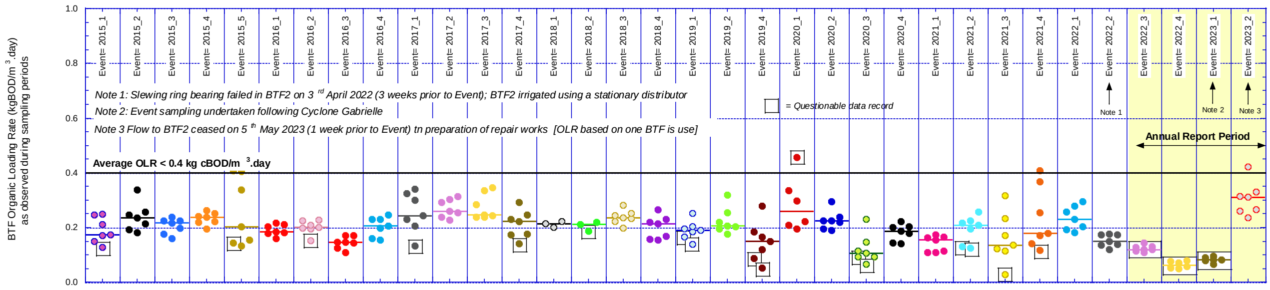


Figure 3-6: Variation in BTF Organic Loading Rate (kg $cBOD_5/m^3$.day)

Whilst it is clearly evident in Figure 3-6 that the organic loading rate is well below the annual average limit of 0.4 kg/m^3.day, it is equally evident that during the 2022/2023 reporting period there may have been issues associated with the collection of representative samples of the DNSI influent wastewaters as much of data (periods 1, 2 and 3) infers a very low per capita BOD contribution that is difficult to substantiate. Data associated with period 4 are consistent with the historic record when it is recognised that OLR's for this period are based on a single BTF in operation, in contrast to the historic record where two units are in service.

3.3.5 Final combined wastewater

The analysis of the quarterly sampling results for the final combined wastewater in accordance with condition 14(c) is provided in Table 3-3. The results demonstrate that **none of the consented limits for maximum concentration of constituents (where stipulated) were exceeded during the periods sampled**. As such, it was not necessary to undertake any further flow-proportional sampling as per Condition 6.

Table 3-3: Summary of Final Combined Wastewater Sampling Results (Condition 14(c))

Constituent (in g/m^3 unless otherwise stated)	Consented maximum concentration[1] (g/m^3)	Maximum value from each 7-day period			
		Q1	Q2[2]	Q3	Q4
Number of samples.		7	14	7	7
pH (pH units)	-	7.3	7.4	7.1	7.2
Conductivity (mS/m)	-	179	191	118	149
O&G	-	55	98	2	128
TSS	-	304	241	352	510
$cBOD_5$	-	498	533	300	580

[1] It should be noted that the consent (Condition 6) refers to the maximum concentrations as 'standards' for 'analytes' (metals) and Advice Note 2 confirms that these should be analysed as Acid Soluble Metals (for concentrations). However, the consent does not clarify that this also applies for loads analysis. Furthermore, samples that are taken quarterly are only analysed for acid soluble metal, whereas the "annual" sample is analysed for total, dissolved and acid soluble. Whilst, this may not be significant if the acid soluble determination represents a large fraction of the total metal and the maximum concentration relate to total metal, if the acid soluble fraction is low, then a direct comparison with a maximum concentration defined on the basis of total metal will be erroneous.

[2] In Q2, sets of seven primary samples and seven duplicate samples were taken (14 samples in total). This completed as an additional check in response to issues with lab testing during this quarter. The maximum values reported are from the entire dataset of 14 samples for that event.

Constituent (in g/m³ unless otherwise stated)	Consented maximum concentration [1] (g/m³)	Maximum value from each 7-day period			
		Q1	Q2 [2]	Q3	Q4
COD	-	1,040	1,069	1,027	1,660
Sulphide	-	2.2	8.5	4.8	6.5
NH_4-N	-	30	46	28	32
DRP	-	2.8	3.4	2.2	4.2
Acid Soluble Metal					
Arsenic	-	0.003	0.005	0.009	0.003
Chromium (III)	2.74	0.038	0.066	0.026	0.098
Chromium (VI)	0.44	ND	ND	ND	0.01
Copper	0.13	0.0103	0.0042	0.0141	0.0137
Nickel	0.70	0.0050	0.0050	0.0045	0.0052
Lead	0.44	0.0028	0.0019	0.0030	0.0027
Mercury	0.01	ND	ND	ND	ND
Cadmium	0.07	ND	ND	ND	ND
Zinc	1.50	0.099	0.159	0.115	0.420

Note:

'ND' indicates a constituent that was not detected above laboratory detection limits (as per Schedule 1 of the resource consent)

'-' indicates that the consent does not specify a limit for the constituent.

Condition 6 defines mass load limit values for the same metal contaminants as shown in Table 3-3 and also the mass load of ammoniacal nitrogen. The variation in mass loads of copper, nickel, lead, zinc and chromium (III), expressed in terms of acid soluble metal, during the 2022/2023 reporting period and historically (from 2015) are illustrated in Figure 3-7 and in Figure 3-8 for ammoniacal nitrogen (Condition 6). Variations in mass load for arsenic, cadmium, chromium (VI) and mercury are not presented as reported results as routinely below the limit of detection of the analytical test method and well below the limits defined in the consent.

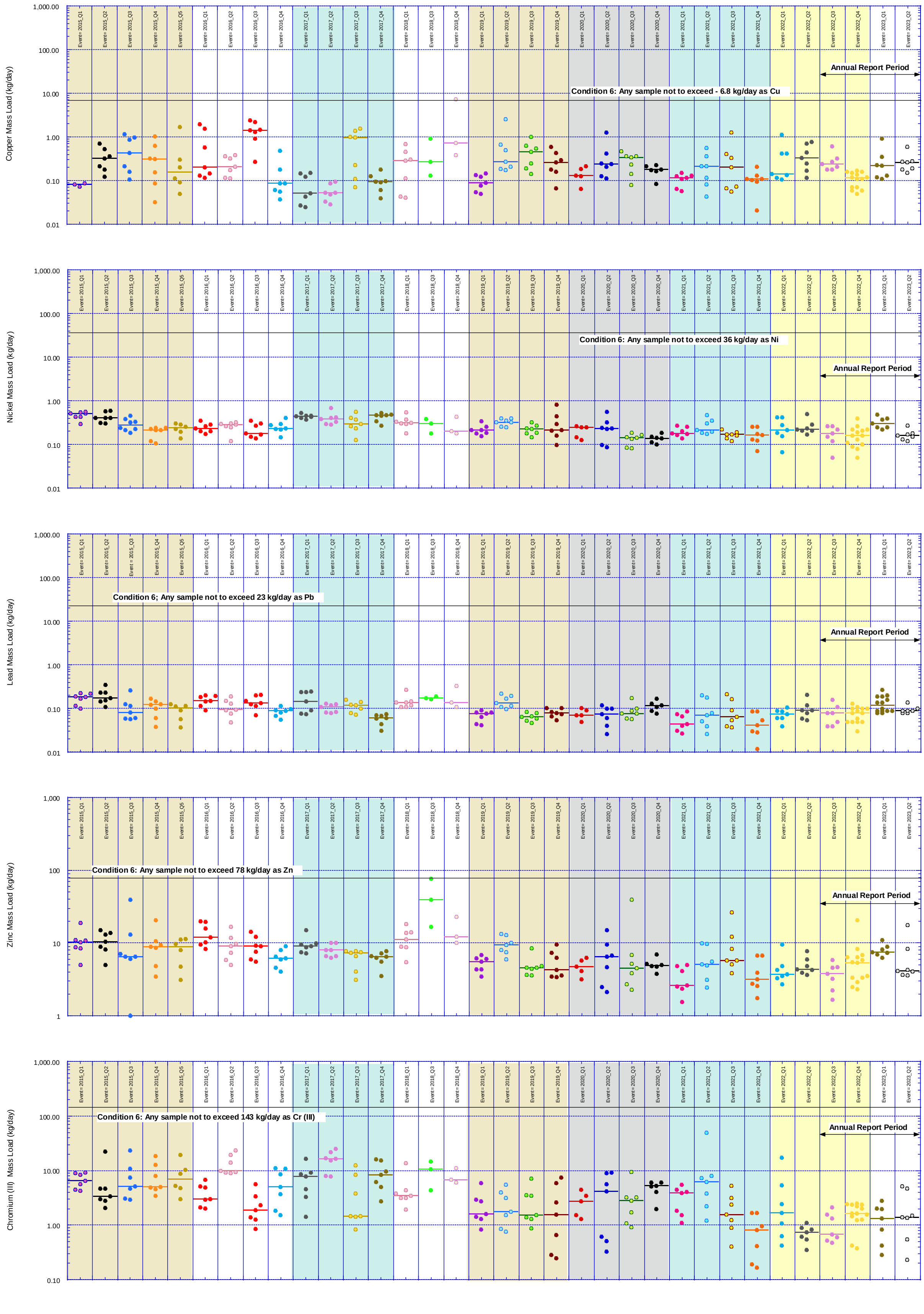


Figure 3-7: Variation in Mass Load of Acid Soluble Metal (top - copper, upper/mid - nickel, mid – lead, lower.mid – zinc, lower – chromium (III))

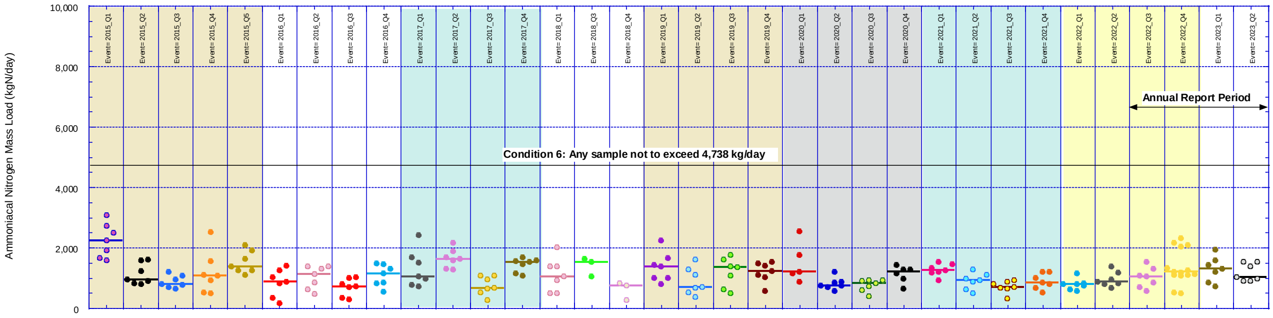


Figure 3-8: Variation in Mass Load of Ammoniacal Nitrogen

In reviewing Figure 3-7 and Figure 3-8, it is clear that the mass load of metal (copper, nickel, lead, zinc and chromium (III), as acid soluble metal) and the mass load of ammoniacal nitrogen observed during the 2022/2023 reporting period are substantially lower than the maximum values defined in the consent and are consistent with the observed historic record.

3.3.5.1 Total Oil and Grease

Condition 8 of the consent stipulates that the maximum concentration (average daily) of total oils and grease in the final combined wastewater shall be less than 200 mg/L. The variation in the concentration of total oils and grease observed during the reporting period and historically (from 2015) are presented in Figure 3-9.

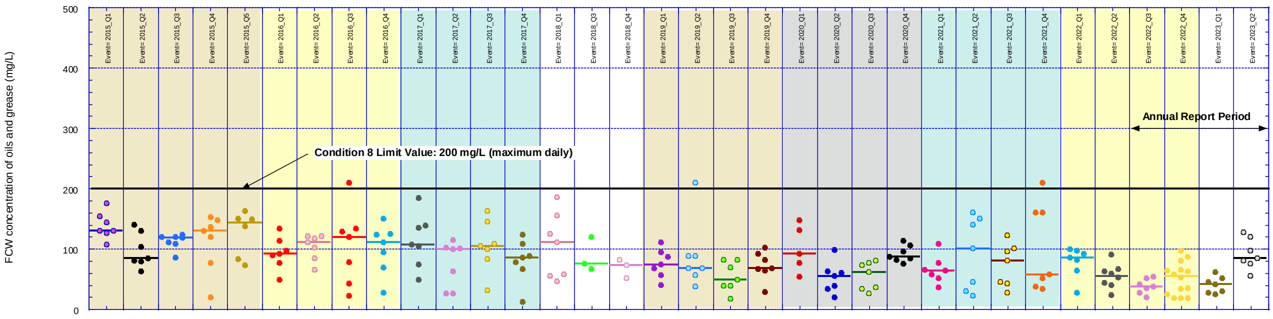


Figure 3-9 Comparison of the Observed Concentration of Total Oils and Grease in Final Combined Wastewater to the Consented Limit Value

The maximum TOG concentration in the final combined wastewater discharged observed during the reporting period was 128 g/m^3 (in May 2023, Event: Q2). The variation in the concentration of oils and grease in the final combined wastewater observed during the reporting period was consistent with that evident in the historical data for the WWTP.

3.3.5.2 Compliance with specific trigger values (Condition 24(d))

The consent requires that the loading of specific constituents within the final combined wastewater discharge to Hawke Bay (Te Whanga a Ruawharo) be compared with trigger values on an annual basis as per Condition 24(d). The variation in contaminant (volume, cBOD$_5$ and TSS) mass load is presented in Figure 3-8 both for the reported period and historically (from 2015) to illustrate the longer-term variation in contaminant load discharged to the receiving environment. Supporting data are documented in Appendix D.

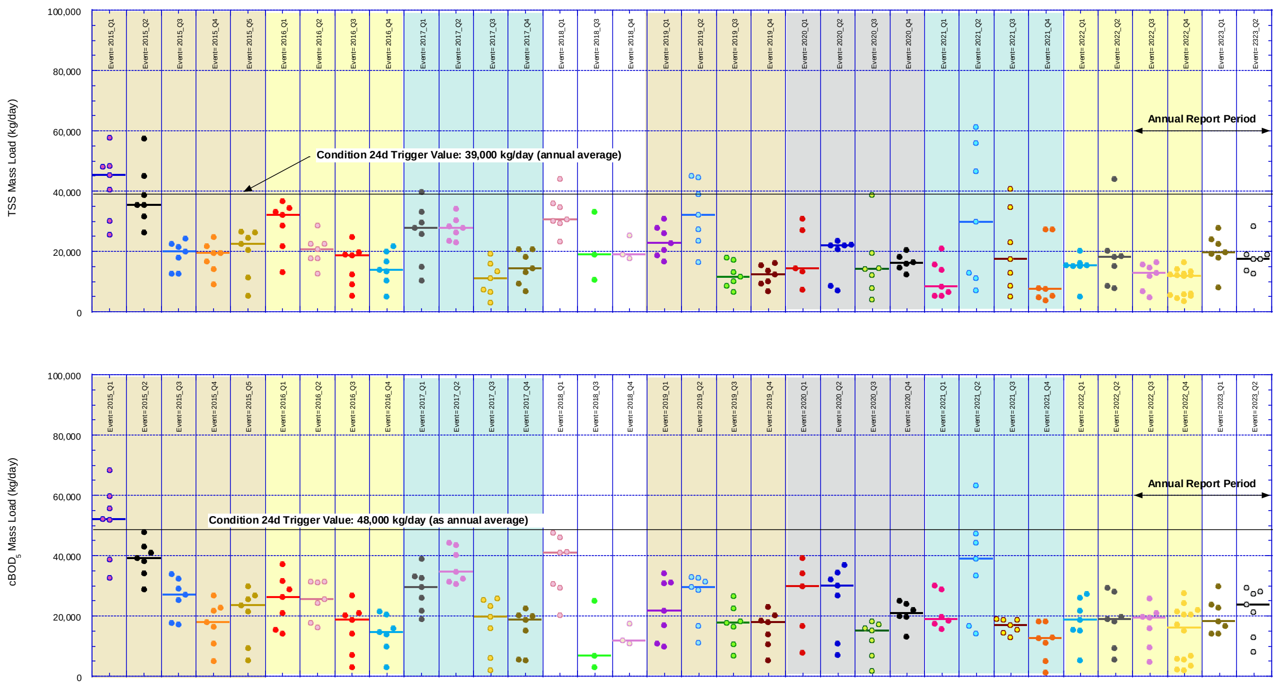


Figure 3-10: Comparison of Mass Loads to Consented Trigger Values (upper-TSS, lower-cBOD$_5$)

In considering Figure 3-10 it is evident that the contaminant loads (TSS and cBOD$_5$) observed during the 2022/2023 reporting period are well below the consented trigger values.

The annual average daily volume of final combined wastewater discharged from the outfall was 52,600 m^3/day, which was lower than the consented limit of 66,000 m^3/day. Trends in wastewater volume are detailed further in Section 3.2 above.

3.3.6 Receiving environment (Hawke Bay (Te Whanga a Ruawharo))

3.3.6.1 Water quality

HDC conducted quarterly sampling of the receiving water as detailed in Section 3.1 above (Table 3-1).

Raw water quality data are provided in Appendix E to this report. This section contains a summary of key patterns observed in the water quality of Hawke Bay (Te Whanga a Ruawharo) based on these results, which partly informs the assessment of effects contained in Section 3.4.

The figures below plot laboratory results for nutrients and suspended solids over the reporting period. The key patterns observed, particularly in relation to distance from the diffuser, were as follows:

- The samples collected from Hawke Bay (Te Whanga a Ruawharo) on 3 March 2023 all had considerably elevated concentrations of all parameters, compared with results from the other three quarters. TSS was particularly high (Figure 3-11).
- The March 2023 results indicate the effects of erosion / surface runoff from contributing catchments to the Ngaruroro, Tukituki and Clive as well as minor tributaries draining to the coast after Cyclone Gabrielle and subsequent wet weather in February/March 2023.
- There is a marked pattern of higher concentrations of total phosphorus (TP; see Figure 3-15) within 500 metres of the diffuser during the March 2023 sampling event, compared with samples taken further away. This is unusual as the same pattern is not as strongly evident for TSS, which is usually closely correlated with TP.

- During the three quarterly sampling events outside of March 2023, results were typically consistent across all locations. Concentrations of nutrients were not noticeably different at sites closest to the diffuser, compared with those further away (see Figure 3-12 through Figure 3-16).
- The advisory notes for consent Condition 6 call for consideration of the toxicity of wastewater constituents in the marine receiving environment. For example, Appendix 1 of the consent states that "the quality of the wastewater discharge to Hawke Bay (Te Whanga a Ruawharo) provides for 95% species protection (in accordance with ANZECC 2000 guidelines"). This is mainly accounted for by complying with trigger values for final combined wastewater quality, as well as regular toxicity testing on marine species. However, it's also useful to note that the ANZG 2018 default guideline value for toxicity of ammonia in marine waters (which has superseded ANZECC 2000) is 910 µg/L (0.91 g/m3)[3]. The results for 2022/23 show that this guideline value was not exceeded in the vicinity of the diffuser (and particularly, beyond 750 metres from the diffuser) during the reporting period. In fact, waters surrounding the diffuser were found to have concentrations of ammoniacal-nitrogen that were approximately 30 times less than the guideline value, even within 100 metres of the diffuser (Figure 3-14).
- The results indicated that the discharge was not having a discernible effect on water quality within Hawke Bay (Te Whanga a Ruawharo) on the dates when samples were collected.

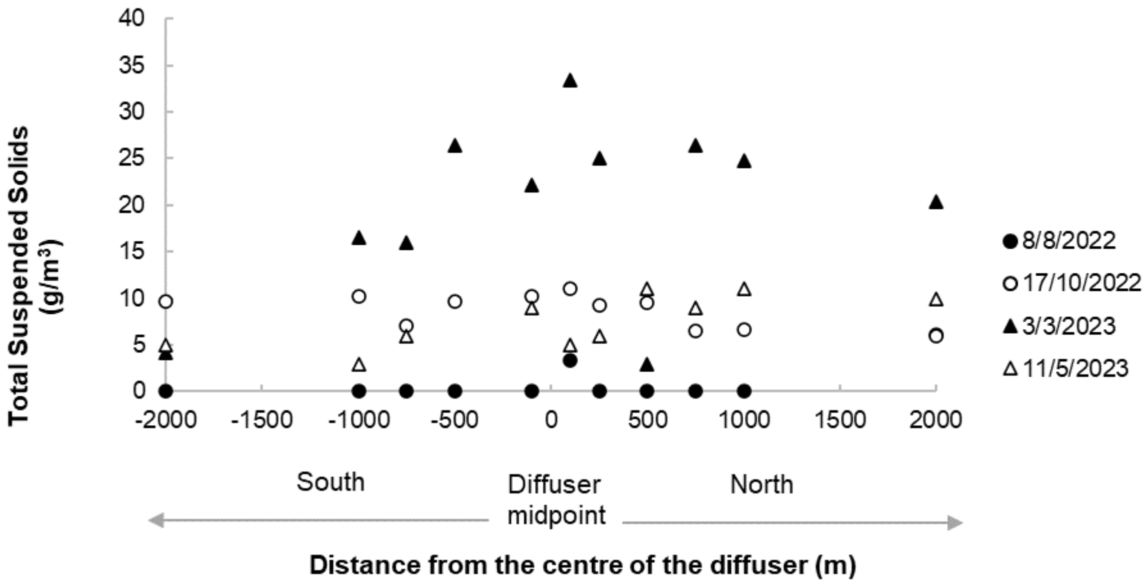


Figure 3-11 TSS measured in the receiving environment (Hawke Bay (Te Whanga a Ruawharo)) during 2022/23

[3] DGV for protection of 95% of species against toxic effects. pH within Hawke Bay (at the diffuser) was within the range of 8.1 – 8.2 based on field measurements during the reporting period. The DGV stated above is based on an assumed pH of 8.0. Ammonia toxicity can be affected by pH; as such, the threshold for toxic effects in Hawke Bay may be slightly lower than 910 µg/L, but would not likely be lower than 620 µg/L (as per Table 8.3.7 of the ANZECC 2000 guidelines, now available online as ANZG 2018 at https://www.waterquality.gov.au/anz-guidelines/guideline-values/default/water-quality-toxicants/toxicants/ammonia-2000).

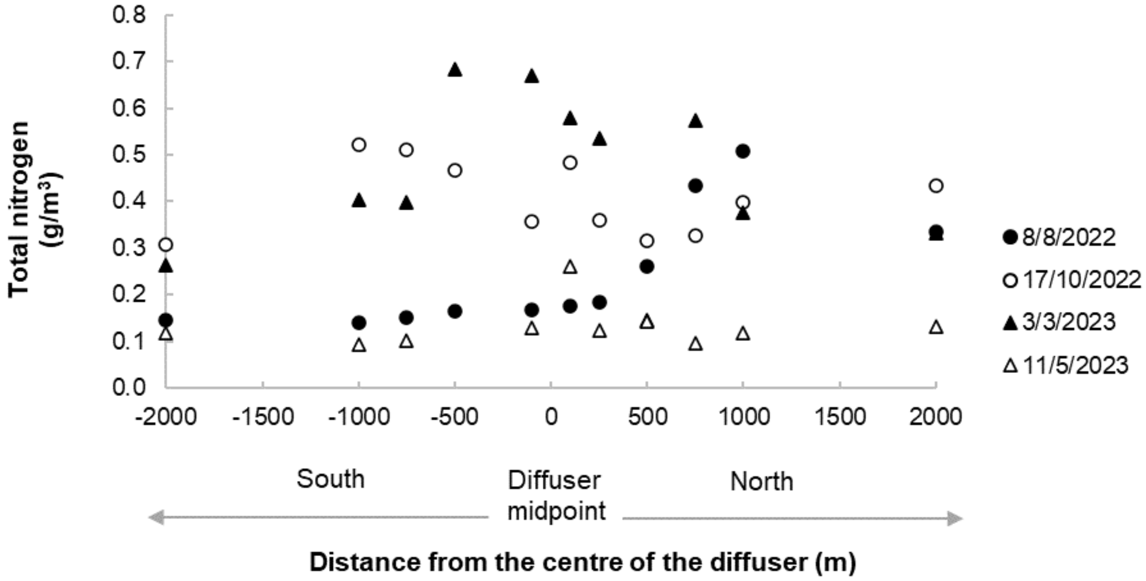


Figure 3-12 Total nitrogen measured in the receiving environment (Hawke Bay (Te Whanga a Ruawharo)) during 2022/23

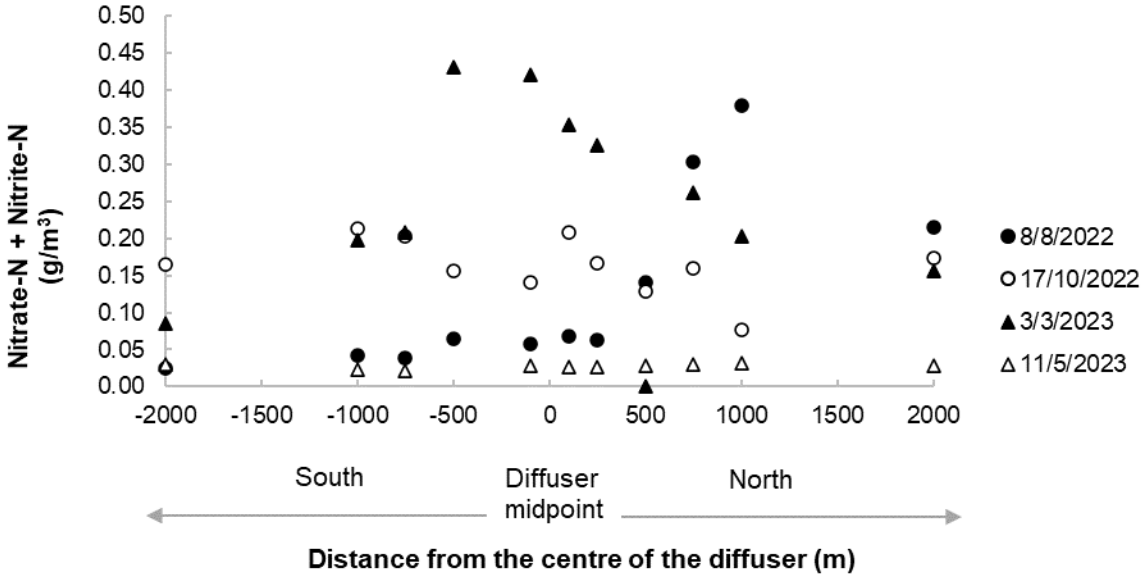


Figure 3-13 Oxidised nitrogen (Nitrate as NO_3-N and Nitrite as NO_2-N) measured in the receiving environment (Hawke Bay (Te Whanga a Ruawharo)) during 2022/23

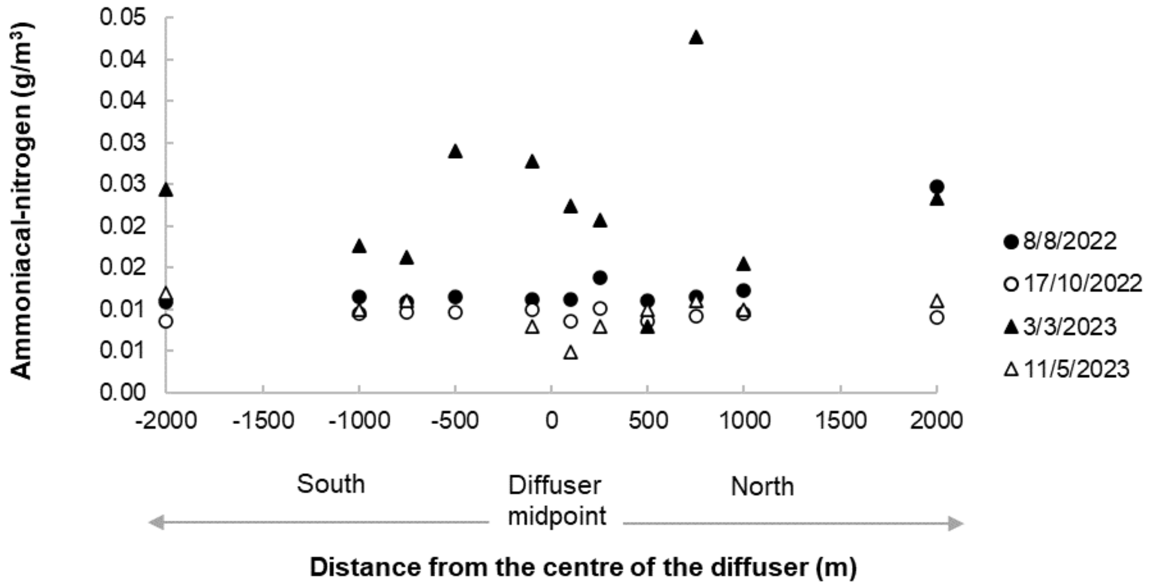


Figure 3-14 Ammoniacal-nitrogen (NH_4-N) measured in the receiving environment (Hawke Bay (Te Whanga a Ruawharo)) during 2022/23

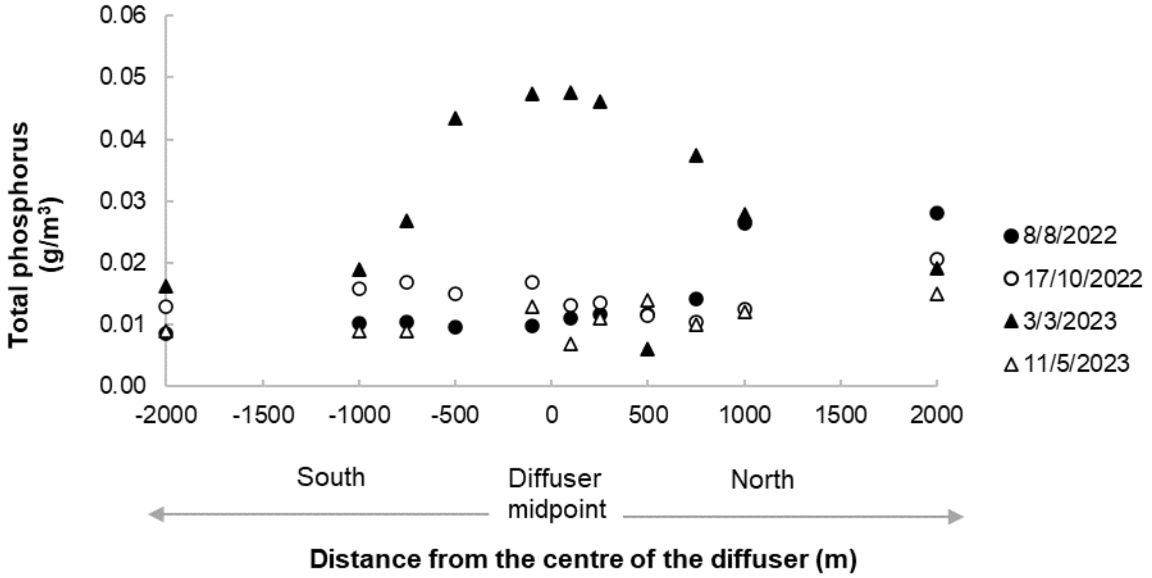


Figure 3-15 Total phosphorus measured in the receiving environment (Hawke Bay (Te Whanga a Ruawharo)) during 2022/23

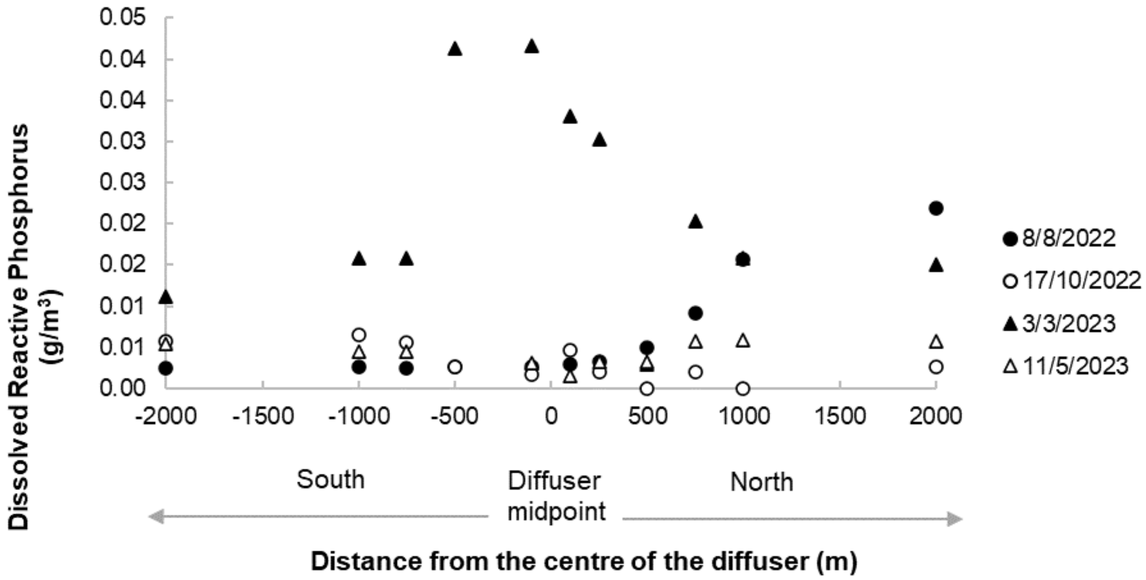


Figure 3-16 DRP measured in the receiving environment (Hawke Bay (Te Whanga a Ruawharo)) during 2022/23.

The following plots depict both spatial and temporal patterns in faecal coliforms (Figure 3-17) and Enterococci (Figure 3-18) in the receiving environment observed during the reporting period and historically (from 2015). The size of the dots represents a corresponding concentration of colony forming units per 100 mL of sample collected.

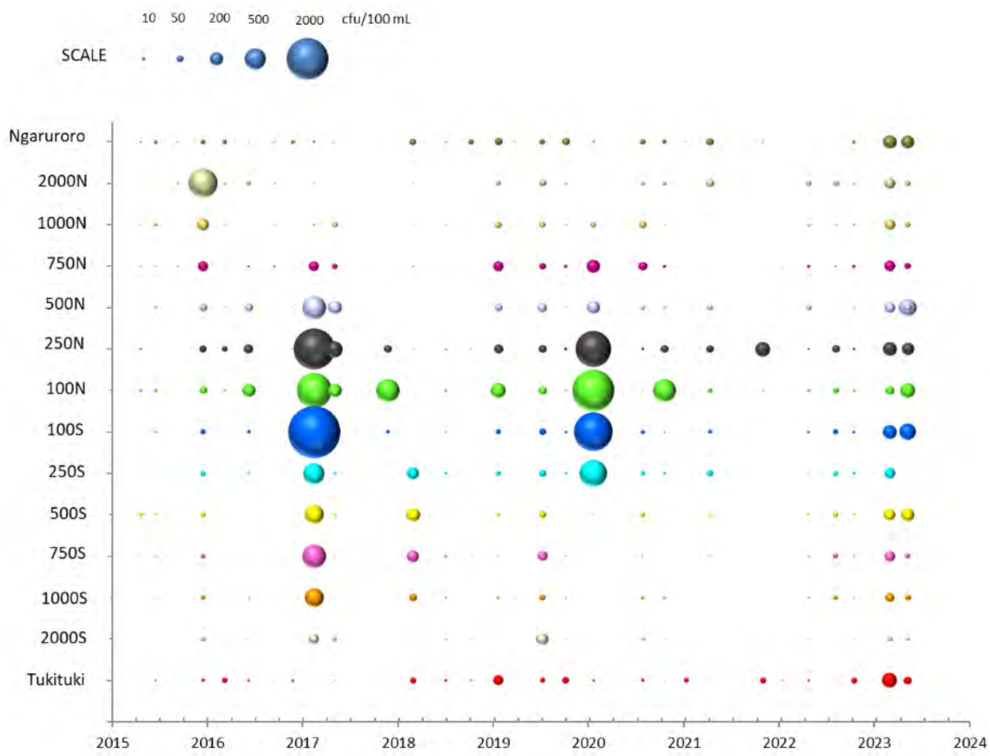


Figure 3-17: Temporal and spatial variation in the concentration of faecal coliforms in the receiving environment.

Faecal coliform concentrations were fairly uniform across all sampling locations and sampling events during the reporting period. Concentrations were slightly elevated during the first two events of 2023, which is to be expected given the intense rainfall in the region during that time (see Section 3.2 above for further detail). While concentrations within 100 metres of the diffuser midpoint were higher than those further away, they were still within the same range measured in samples from the Ngaruroro and Tukituki river mouths. This indicates that a similar level of faecal contamination was present in the wider catchment (from sources external to the WWTP discharge) during these events in early 2023.

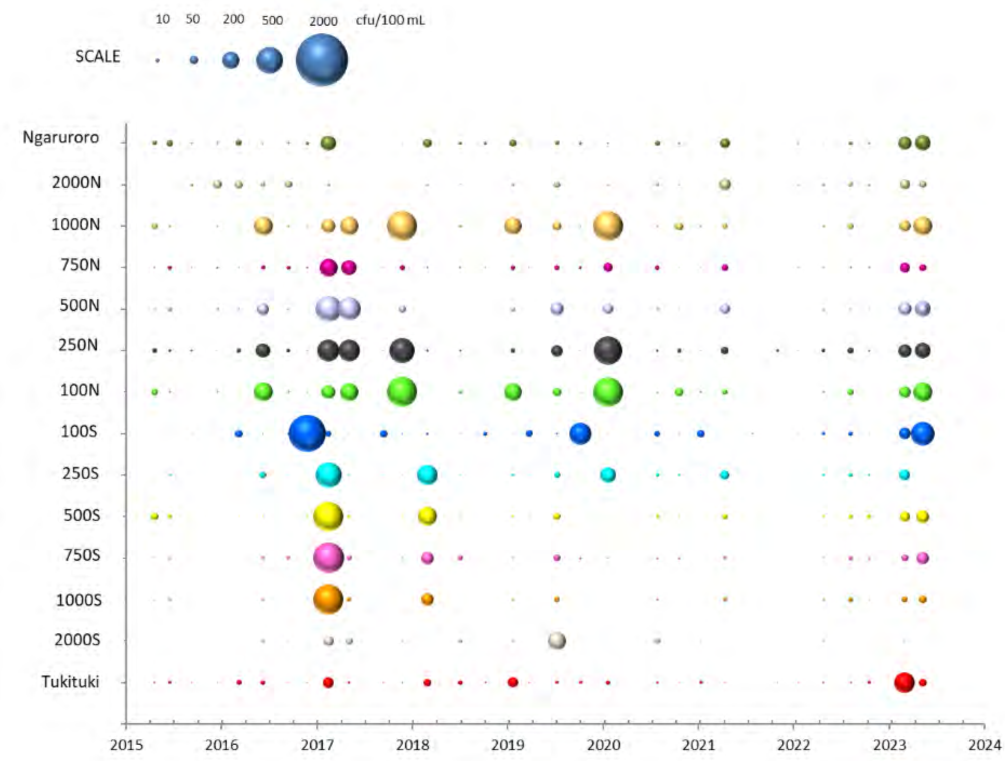


Figure 3-18: Temporal and spatial variation in the concentration of enterococci in the receiving environment.

Enterococci concentrations were similar to those for faecal coliforms, with higher concentrations measured during the first two sampling events in 2023. Again, concentrations were similarly elevated in the Ngaruroro and Tukituki river mouths.

3.3.6.2 Benthic sediment

HDC undertook quarterly sampling of benthic sediments in the vicinity of the outfall, which was more frequent than the twice-yearly sampling required by consent condition 19. Figure 3-19 and Figure 3-20 below provide an overview of the sampling results and compare them against the ANZG 2018 default guideline values for sediment quality (previously the ISQG-Low in ANZECC 2000, equivalent to the updated DGV from ANZG 2018).

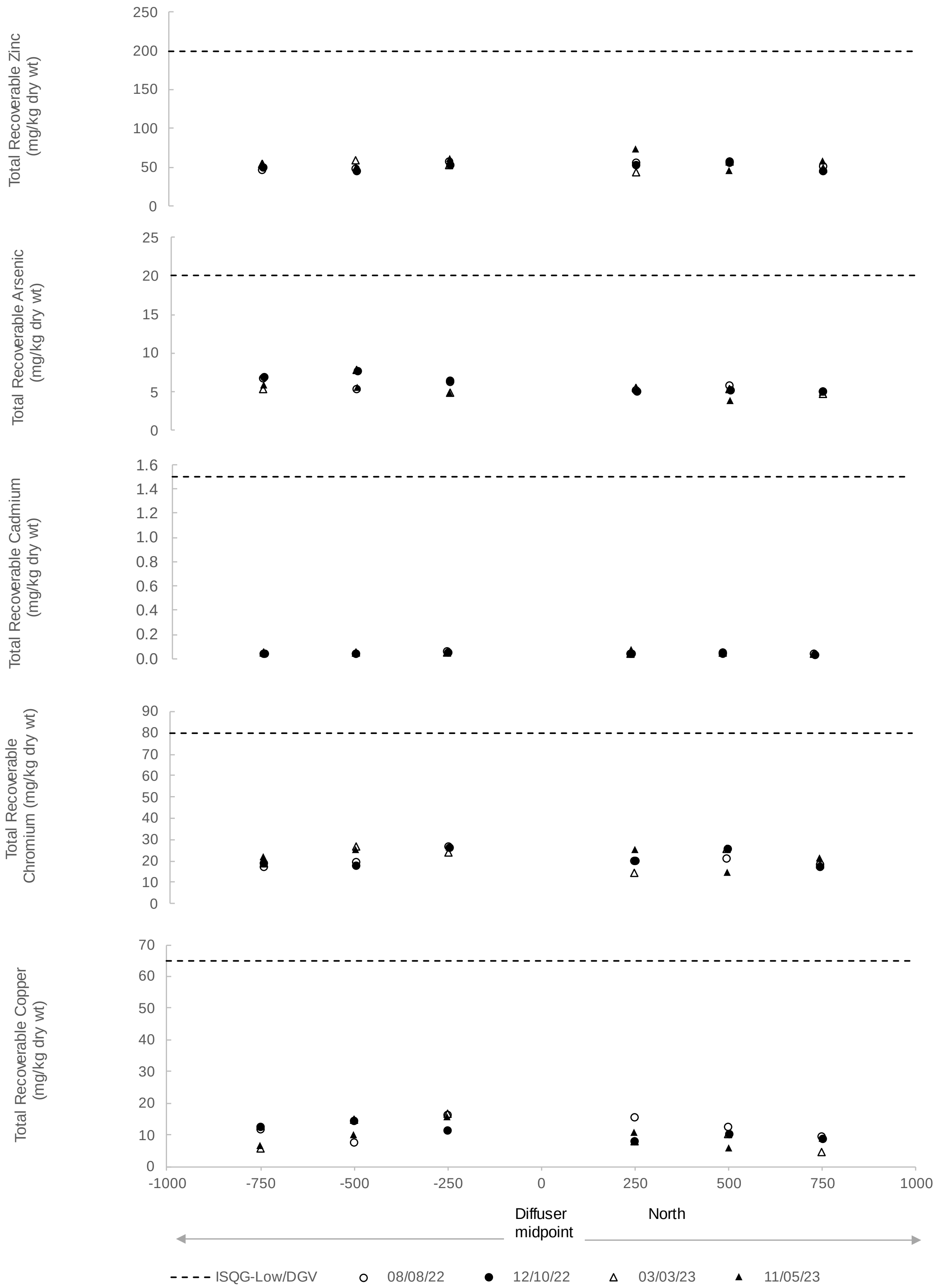


Figure 3-19 Sediment sampling results - Total Recoverable As, Cd, Cr, Cu

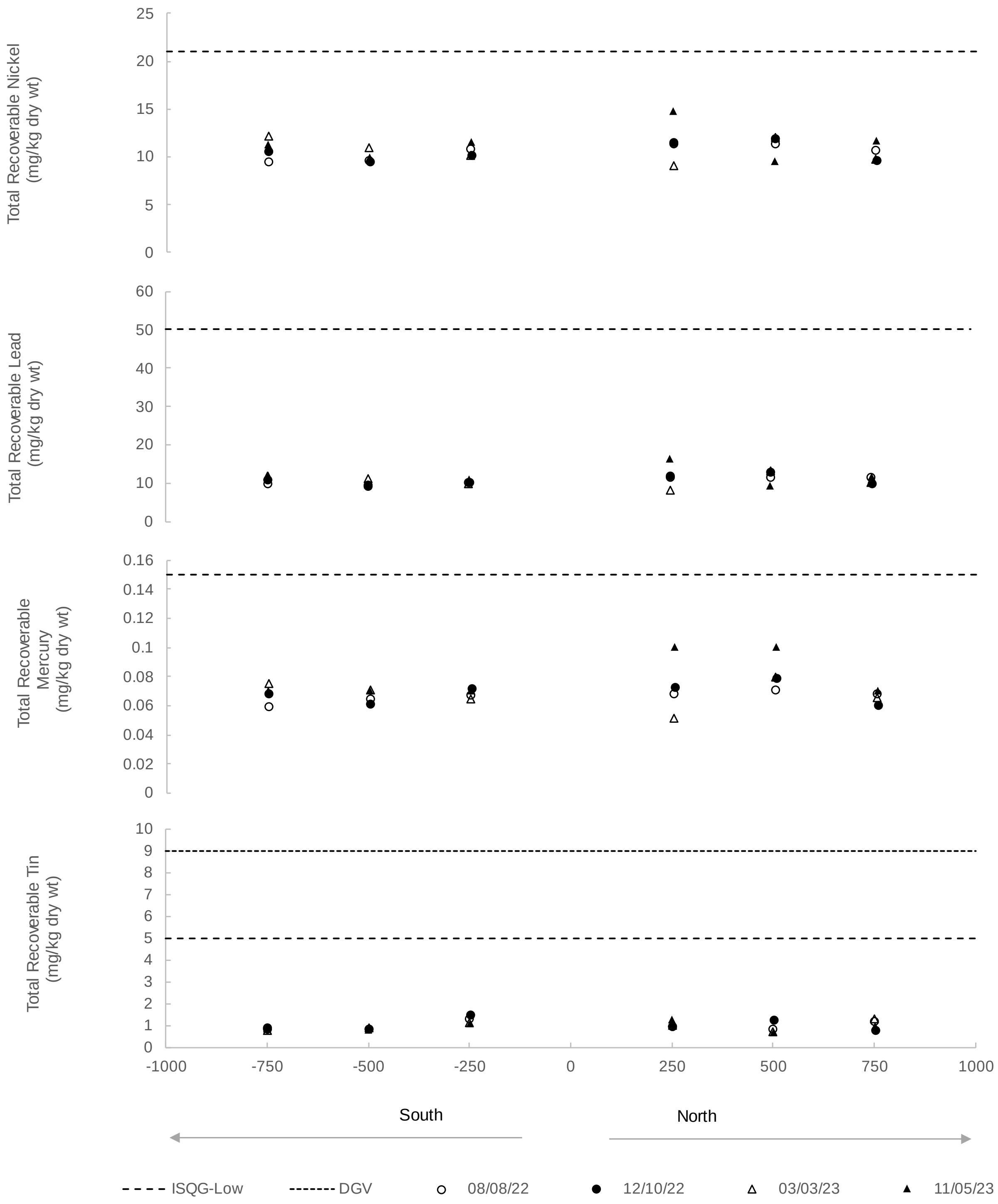


Figure 3-20 Sediment sampling results - Total Recoverable Ni, Pb, Hg, Sn

The can be a significant lag time between the introduction of a contaminant in water overlying sediments, and subsequent change(s) in sediment quality as a result. This lag can be lengthy when compared with the (often faster) rate of change seen in water quality as a result of a point source discharge. Bearing this in mind, in general the following spatial and temporal patterns in sediment quality were observed:

- Total recoverable metal concentrations were all within one order of magnitude, indicating a negligible difference between sampling locations.
- Concentrations of total recoverable zinc, chromium, nickel, lead and mercury were slightly elevated at the location 250 metres north of the diffuser midpoint (compared with other sampling events), for samples collected on 11 May 2023.
- Results were more consistent between sampling events for the other metals (i.e., concentrations in sediment did not change as much over time).

The results showed generally consistent concentrations of heavy metals in sediment samples collected. All results were well below the relevant DGVs. As such, no further action was required regarding sediment quality (as per condition 19). It is noted that the benthic survey discussed in Section 3.2.3.3 below also involved sediment sampling, which was completed in early 2023.

Overall, the sediment monitoring undertaken during the reporting year indicates that any adverse effects on aquatic life within benthic sediments beyond 500m from the diffuser would have been negligible.

3.3.6.3 Benthic fauna

The consent requires that a benthic survey be undertaken in the 8th, 17th, and 26th years after the commencement of the consent. The first of these was due in the summer of 2022/23. HDC engaged Bioresearches Ltd to conduct the first benthic survey in January 2023. The preliminary survey findings have been summarised in the draft report *Bioresearches (2023), Environmental monitoring of Clive outfall: sediment quality and benthic biota survey [DRAFT]. Report for Hastings District Council. pp 61*, which has been included in Appendix F

As of the time of writing, the survey report is still in draft form, so it has not formally been provided to HBRC; this will occur within 1 month after the report is received by HDC in its final form.

3.3.7 Toxicity

HDC engaged NIWA (National Institute of Water and Atmospheric Research) to undertake the quarterly toxicity testing for the final combined wastewater discharged from the East Clive Wastewater Treatment Plant. Each monitoring event involved collecting samples of final combined wastewater over two consecutive days. The following species were then exposed to the samples in the laboratory, to ascertain the level of toxicity (if any):

- For marine alga chronic toxicity – *Minutocellus polymorphus (*Alga)
- For marine bivalve acute toxicity – *Macomona liliana (*Wedge shell; hanikura)
- For marine bivalve acute toxicity – *Mytilus galloprovincialis* (Blue mussel; kuku / kutai)

Key findings of the NIWA reports are summarised in Table 3-6, and copies of the full reports are provided in Appendix G.

Table 3-4: Summary of findings reported by NIWA regarding toxicity of final combined wastewater, 2022/23

Sampling period	Summary of key findings (from NIWA quarterly reports)
8-9 August 2022	• The alga test showed detectable toxicity at a 200-fold dilution. The highest no-toxicity dilution was 556-fold derived from the alga test. The wedge shell and blue mussel tests did not show detectable toxicity at a 200-fold dilution. • The alga test had a Threshold Effect Concentration (TEC) < 0.5% effluent, however there was no further consecutive incidence of TEC < 0.25% effluent between quarters, so no further action was required.
17-18 October 2022	• The alga and blue mussel test showed detectable toxicity at a 200-fold dilution. The highest no-toxicity dilution was 286-fold derived from both the alga and blue mussel tests. The wedge shell did not show detectable toxicity at a 200-fold dilution. After application of the 200-fold dilution used for the 'no toxicity' criterion, the concentration of ammoniacal-N and total sulfide in the sample did not exceed ANZG (2018) default guideline values for 95% protection of species. • For the effluent sample in this quarter, the alga and blue mussel tests had a Threshold Effect Concentration (TEC) < 0.5% effluent, however neither species had a consecutive incidence of TEC < 0.25% effluent between quarters, so no further action was required.
27-28 February 2023	• The alga, wedge shell and blue mussel tests all showed no detectable toxicity at a 200-fold dilution. The highest no-toxicity dilution was 141-fold derived from the blue mussel tests. After application of the 200-fold dilution used for the 'no toxicity' criterion, the concentration of ammoniacal-N and total sulphide in the sample did not exceed ANZG (2018) default guideline values for 95% protection of species. • No further action was required, as no toxicity was determined.
8-9 May 2023	• The alga test showed detectable toxicity at a 200-fold dilution. The highest no-toxicity dilution was 141-fold derived from the alga test. The wedge shell and blue mussel tests did not show detectable toxicity at a 200-fold dilution. After application of the 200-fold dilution used for the 'no toxicity' criterion, the concentration of ammoniacal-N and total sulfide in the sample did not exceed ANZG (2018) default guideline values for 95% protection of species. • For the effluent sample in this quarter, the alga test had a Threshold Effect Concentration (TEC) < 0.5% effluent, however this species hasn't had two consecutive incidence of TEC < 0.25% effluent between quarters, so no further action was required.

3.4 Environmental effects

Based on the results of monitoring undertaken during the reporting period (detailed in Sections 3.2 and 3.3 above), and the high level of overall compliance with the resource consent, it is considered that **the discharge of final combined wastewater from the ocean outfall to Hawke Bay (Te Whanga a Ruawharo) had negligible adverse effects on the environment, if any**.

This is further supported by visual observations and records collected during the reporting period and summarised in Table 3-5 below. These observations were typically recorded at the same as water samples were collected (as per Section 3.1 above) and focused on whether effects were evident beyond the mixing zone for the diffuser (i.e., from 500 metres and 750 metres to the north and south of the discharge point).

Table 3-5: Assessment of effects in Hawke Bay (Te Whanga a Ruawharo) beyond 750m, 500m from midpoint of diffuser

Indicator/Parameter	Result/Answer	Supporting Information
Beyond 750m from the midpoint of the outfall diffuser (north and south)		
Production of any conspicuous suspended materials	Not observed	Observation records, see Appendix H
Any conspicuous change in the colour or visual clarity of receiving water	Change in colour observed at 750N, 750S and directly over diffuser on 3 Mar 2023. Noted to be likely due to river silt after heavy rain.	Observation records
Beyond 500m from the midpoint of the outfall diffuser (north and south)		
Production of any conspicuous oil or grease films, scums or foams, or floatable materials	Not observed	Observation records
Any emission of objectionable odour	Not observed	Observation records No public complaints relating to odour
Any significant adverse effects on aquatic life	Not observed	Toxicity testing results (Appendix G and Section 3.2.4) Analysis of receiving water and benthic sediment quality (Section 3.2.3)
A change of the natural temperature of the receiving water by more than 3°C	Not observed. The maximum change in temperature between the diffuser midpoint and 750N or 750S was within ±0.5°C.	Monitoring records in Section 3.1
The Dissolved Oxygen concentration is less than 80% of the saturation concentration[4]	Not observed. Minimum dissolved oxygen saturation was 85.6 % (recorded in May 2023 at	Field measurement records in Appendix E

[4] As part of the nine-yearly review of the resource consent, it is considered that the wording of Condition 7(g) is confusing and partly incorrect. The condition should read that dissolved oxygen does not fall below 80% saturation (in line with published guidelines, such as ANZG 2018).

Indicator/Parameter	Result/Answer	Supporting Information
	Tukituki River mouth, over 2 km from the outfall). Minimum result at 750 N was 96.1%, and 96.7% at 750 S.	
Undesirable biological growths	Not observed	Observation records Diffuser Inspection Report in Appendix H

In addition to the effects assessed in Table 3-5, the following conclusions can also be drawn based on additional monitoring information (see relevant sections for further detail):

- The discharge did not have any discernible effect on water quality (TSS and nutrients) within Hawke Bay (Te Whanga a Ruawharo) on the dates when samples were collected.
- The discharge did not contribute noticeably to faecal contamination in Hawke Bay (Te Whanga a Ruawharo).
- The sediment monitoring undertaken during the reporting year indicates that any adverse effects on aquatic life within benthic sediments beyond 500m from the diffuser would have been negligible.
- The discharge is unlikely to have had any toxic effects on marine organisms within the vicinity of the outfall, based on toxicity testing results (refer to Section 3.3.7).

3.5 Maintenance, inspections and improvement works

Both preventative and responsive maintenance has been undertaken to maintain and improve the serviceability and reliability of the WWTP and discharge outfall components. The serviced components include but are not limited to:

- Inlet screens, pumps, grit removal unit, valves, instruments, compactors, BTF equipment, etc.
- Automation control components, including hardware and software.
- Electrical components

The plant maintenance and service records and logs are available and can be provided upon request.

A YSI ProDSS Multiparameter Digital Water Quality Meter which is used to monitor electrical conductivity, dissolved oxygen, pH and turbidity was calibrated once during the reporting period, on 15 August 2022 (according to records). The manufacturer's specifications state that the instrument should be calibrated "periodically". Best practice is to clean and calibrate this meter at least once before starting any sampling round (i.e. quarterly) and ideally daily during sampling. It is recommended that in future, calibration is undertaken more frequently and at minimum before each sampling event is started. If the instrument is not used between each quarter, it should be prepared for 'long term storage' (> 4 weeks) as per the manufacturer's specifications (e.g. remove battery pack, all ports covered).

The calibration and verification records are available and can be provided upon request.

3.5.1 Diffuser and outfall structure inspections

The outfall was visually inspected by HDC Operations personnel from the WWTP on the following dates, and notes were recorded:

- 8 August 2022
- 17 October 2022
- 3 March 2023 (change in colour or clarity at 750m North and 750 m South of outfall, and directly over the diffuser (increased turbidity due to sediment from river mouths after Cyclone Gabrielle and subsequent heavy rainfall)

- 11 May 2023

On all occasions, except for March 2023, no issues were reported with regards to the diffuser, outfall structure, or visual effects on water quality from the discharge. The conditions on 3 March 2023 cannot be entirely attributed to the treated wastewater discharge and it is highly likely that sediment movement due to Cyclone Gabrielle was the cause.

3.6 Stakeholder engagement

3.6.1 Community Open Day 2022

An open day at the East Clive Wastewater Treatment Plant was held on 19 November 2022 in accordance with Consent Condition 26. The details of the open day are summarised in Table 3-6.

The invitation links and the visitor register can be provided upon request.

Table 3-6: Details regarding the community open day, 19 November 2022

Condition Requirements	Response
Date and time	19 November 2022, 10am to 1pm
Number of participants from the community	61 (increased of 10 compared to last year)
Advance notification/invitation to the community?	Yes. Via Hastings District Council's official website and Facebook page
Attendance by Hastings District Council staff?	Yes
Attendance by Regional Council Compliance Officer?	No
Written questions received?	None
Overall feedback from the community?	Positive

3.6.2 HDC and Tangata Whenua Joint Wastewater Committee

The Tangata Whenua Wastewater Joint Committee (constituted as a sub-committee of Council under the Local Government Act 2002) has been functioning well since it was established and complying with the Consent Condition.

- Committee meetings were held on 5 December 2022 and 6 June 2023.
- Meeting minutes for the meeting held on 5 December 2022 are attached in Appendix J.

Appendix J also contains papers issued in advance of each committee meeting held during this reporting period. Key issues covered during committee meetings within this reporting period included:

- Appointments of new committee members and elections for Chair and Deputy Chair
- Filming of the meetings for an upcoming documentary on the committee and its functions
- Discussion of the previous year's annual report findings (2021/22)
- The proposed scope of the inaugural 9-yearly Trends, Technology, Discharge, Environmental and Monitoring Review Report, and required inputs/reviews from the committee.

3.7 Overall trends compared with past records

A summary and analysis of the trends identified for this reporting period are included in Table 3-7. The following symbols are used to reflect the trends to visualise the interpretation:

———	Stable, or generally stable with negligible fluctuation
∿∿	Noticeable fluctuation but considered normal (e.g., seasonal changes)
↑	Generally increased (see comments)
↓	Generally decreased (see comments)

Table 3-7: Key trends observed in volumes, flows, toxicity and contaminant loads during 2022/23, compared with conditions observed since 2014

Analyte	Trend during 2022/23	Trend vs Previous Years (to 2014)	Comments
FCW – Loads: Annual Average Daily Volume	∿	∿	The annual Average daily volumes for the 2022/2023 reporting period were within a similar range to those for 2021/22, with the exception of increased loads during May 2023 after temporary changes to the treatment process (to enable critical repairs to BTF2).
FCW – Loads: Daily Volume	∿	—	The peak daily flow volume has remained largely similar to the previous year
FCW – Loads: Chromium-III, Chromium-VI, Zinc, Copper, Lead, Nickel	∿	—	The loads this year are very similar to those observed in previous years (to 2015).
FCW – Loads: Mercury, Cadmium	—	—	The loads this year are very similar to those observed in previous years (to 2015).
FCW – Loads: Ammonia, cBOD$_5$, TSS, TOG	∿	—	The loads this year are very similar to those observed in previous years (to 2015). TSS, TOG and cBOD5 loads were slightly lower compared with the previous three years (at least) until May 2023.
FCW – Loads: VOC, SVOC, ON & OP Pesticides, PCP	—	—	Consistently low with most concentrations below detection limits, which was also reflected in the corresponding loads.
Receiving Water Contaminants: Faecal Coliforms, Enterococci	∿	∿	Results from samples collected in Q2 and Q3 of the reporting period (i.e. after February 2023) were anomalous, and indicative of wider effects caused by severe wet weather and erosion after Cyclone Gabrielle. Faecal coliforms and Enterococci concentrations were slightly elevated compared with results for the 2021/22 reporting period, but also reflected contamination likely from external sources.
Sediments: Heavy metals	—	—	All samples had levels of heavy metals well below relevant guideline values. Results showed negligible differences between samples collected closer to the diffuser outlet, versus those farther away.

Analyte	Trend during 2022/23	Trend vs Previous Years (to 2014)	Comments
FCW – Toxicity	∿	∿	• Detectable toxicity was found for alga on 3 out of 4 sampling events, but threshold effect concentrations did not warrant further testing. • Detectable toxicity was found for blue mussels on two occasions and for wedge shell on one occasion (from four), however in these instances further testing was not warranted. • Overall, the TEC results for the species tested reached the first 'threshold' for decision-making (as stipulated in consent Condition 15) more frequently during this reporting period than in 2021/22. • However, despite this increased frequency, tests have demonstrated that the level of toxicity to the test species has not worsened.

4 Conclusions

On completion of this Annual Monitoring Report for the period between 1 July 2022 and 30 June 2023, it is concluded that the operation of the East Clive WWTP was generally compliant with the conditions of resource consent CD130214W for most of the period. There were five instances of non-compliance as follows:

Condition 5(b) – *MINOR Non-Compliance* – an accidental overflow of untreated (but highly diluted) wastewater from an inlet manhole into a roadside drain on Grey Street, at the WWTP on 27 June 2023.

Condition 7 – ***MINOR Non-Compliance* –** discharge of the final combined wastewater from the outfall into Hawke Bay (Te Whanga a Ruawharo) may have contributed to increased turbidity in waters beyond 750 m from the centre of the outfall, during the first half of 2023. However, it is not possible to definitively isolate the effects of the discharge from those caused by other sources in the catchment, given the effects of Cyclone Gabrielle and subsequent wet weather on the region during the same period.

Condition 11 – *MINOR Non-Compliance* – The YSI ProDSS meter used for monitoring water quality in Hawke Bay in the vicinity of the ocean outfall was only serviced and calibrated once during the reporting period, according to records. While the manufacturer's specifications of this equipment state that calibration should be completed 'periodically', given the nature of the receiving environment it is best practice to calibrate at least prior to each sampling event.

Condition 17 – *MINOR Non-Compliance* – Surface currents were not measured in Hawke Bay (Te Whanga a Ruawharo) during one of the four quarterly receiving environment water quality monitoring events (in August 2022).

Condition 31 – ***MINOR Non-Compliance* –** administrative non-compliance due to a slight delay in submitting a full investigation report of the overflow event (as per above) to HBRC within the required timeframe.

The assessment of effects, based on analysis of the final combined wastewater and receiving environment monitoring results, found that the discharge from East Clive WWTP to Hawke Bay (Te Whanga a Ruawharo) via the ocean outfall has had no discernible adverse environmental effects during this reporting period.

This reporting period has been an interesting one compared with previous years, with numerous challenges faced in the wake of Cyclone Gabrielle, and significant works underway with regards to the BTFs. The initiation of the first nine-yearly Trends, Technology, Discharge, Environmental and Monitoring Review has also provided an important opportunity to view the consent and associated activities from a more holistic perspective and identify ways to continuously improve management of the treatment system for the remainder of the consent term. One area which requires specific attention is that of monitoring, data management and reporting. While this report finds that HDC was compliant with all conditions relating to monitoring and reporting, in practice it was challenging to compile this report with ease. For example, it was difficult to verify that actions such as reporting to HBRC within the required period were undertaken, as in some cases documentation was not readily available. Data management and reporting practices are being reviewed in greater depth as part of the nine-yearly review mentioned above, therefore it was not considered necessary to recommend further actions as part of this report.

Given the challenges experienced in the wake of the COVID-19 pandemic and Cyclone Gabrielle, it is commendable that HDC have maintained overall compliance with the resource consent during this reporting period. This is a testament to the considerable efforts that have been made to continuously improve from previous years.

Appendices

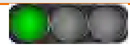
Appendix A Compliance summary

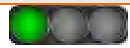
Note: The following symbols are used to indicate compliance status in the table below:

 *indicates Total Compliance*

 *indicates Minor Non-compliance*

 *indicates Significant Non-compliance*

Consent Condition No.	Condition summary	Compliance status, 2022/23	Commentary	Report Section Reference(s)
1	Discharge as per Resource Consent		No further comment	1.1
2	The rate of discharge of the final combined wastewater (see Advice Note 1) shall not exceed 2,800 litres per second.		The instantaneous flow rate for discharge of final combined wastewater from the ocean outfall did not exceed 2,800 L/s (maximum rate across reporting period was 1,995 L/s).	3.2
3	Discharge to ~2,450m and 2,750m offshore via the existing long offshore outfall structure		No further comment.	1.1
4	Final combined wastewater discharged shall pass through an ocean outfall diffuser to achieve a minimum dilution of 100:1 on slack water		It is assumed that the minimum dilution of 100:1 was achieved given that measured volume and rate of discharge was aligned with that stipulated in the consent.	1.1 3.2
5	a) All separable industrial wastewater to pass through a milli-screen with aperture slot width ≤ 1mm b) Minimum treatment processes for domestic and non-separable industrial water: 3mm screening ➔ biological trickling filter (BTF) to Rakahore channel • Average annual daily $cBOD_5$ loading to BTF media ≤ 0.4kg/m^3 • The specific surface area of BTF media ≥ 90m^2/m^3		$cBOD_5$ average annual daily loading to BTF was within the consented limit. Condition 5(b) was not complied with due to an accidental overflow of untreated (but highly diluted) wastewater from an inlet manhole into a roadside drain on Grey Street, at the WWTP on 27 June 2023. However, given the magnitude and location of the event it is considered to represent a minor non-compliance.	1.1 2 3.3.4

Consent Condition No.	Condition summary	Compliance status, 2022/23	Commentary	Report Section Reference(s)
6	Final combined wastewater discharged will meet the stipulated maximum concentration and loading standards.		Sampling results for final combined wastewater indicated that maximum concentrations and maximum daily loads were well below respective limits for all constituents tabulated in Condition 6.	3.3.2
7	The discharge of the final combined wastewater shall not cause any of the following effects beyond a distance of 750m from the midpoint of the outfall diffuser: a) Produce conspicuous suspended materials b) Conspicuous change in colour or visual clarity And shall not cause any of the following effects beyond a distance of 500 m from the midpoint of the outfall diffuser: c) Produce any conspicuous oil or grease films, scums or foams, or floatable d) materials e) Emit objectionable odour f) Any significant adverse effects on aquatic life g) A change of the natural temperature of the receiving water by more than 3°C h) The Dissolved Oxygen concentration to be less than 80% of the saturation concentration, or i) Undesirable biological growths.		Waters within the vicinity of the diffuser have been highly turbid (increased concentrations of suspended sediment) particularly during the first half of 2023. However it is difficult to isolate the effects of the discharge versus effects from other sources in the catchment related to wet weather events and consequent erosion, leading to sediment transport out into Hawke Bay (Te Whanga a Ruawharo) (via Ngaruroro, Clive and Tukituki Rivers).	3.3.5 3.4 (Table 3-5)
8	Average concentration of Total Oil and Grease in the final combined wastewater shall not exceed 200g/m^3 over any 24-hour period based on the sampling procedure set out in Conditions 13 and 14.		Limit was not exceeded.	3.3.5.1
9	Inspect the diffuser: • At least annually, and		The ocean outfall was visually inspected on four (4) occasions. A dive survey was undertaken of the outfall structure and diffuser ports in March	2 3.5.1

Consent Condition No.	Condition summary	Compliance status, 2022/23	Commentary	Report Section Reference(s)
	• When necessary recording and reporting blocked ports, if any		2023 following Cyclone Gabrielle, where some damage was recorded.	
10	Maintain WW treatment plant and outfall structures in good working order and in accordance with industry best practice guidelines.		No further comment	3.5
11	Maintain sampling equipment and records of calibration		YSI ProDSS meter was only serviced and calibrated once during the reporting period. This should be done at the start of every sampling round, at minimum. Frequent calibration is necessary given the sensitivity of measuring apparatus in dynamic marine environments.	3.5
12	Continuously monitor and record the rate of discharge and the daily volume of the final combined wastewater discharged. The flow meters used to record the discharge shall have an accuracy within plus or minus 5%, as per the manufacturer's calibration records.		No further comment	3.1 3.2
13	No longer relevant (since 2015)			
14	**Starting 12 months from the date of commencement of this consent**, at quarterly intervals (with not less than 2 months between each sample), take two flow proportional samples during each 24-hour period, on a minimum of 7 consecutive days. Samples shall be taken from the following waste streams and analysed for the constituents stated: a) The domestic and non-separable industrial wastewater prior to the biological trickling filter treatment. Analyse for: i) Total suspended solids; ii) Total oil and grease; and		Four quarterly sampling events were completed. There were at least two months between each event.	3.1 3.2.1 3.2.2

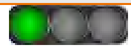
Consent Condition No.	Condition summary	Compliance status, 2022/23	Commentary	Report Section Reference(s)
	iii) $cBOD_5$. b) The domestic and non-separable industrial wastewater immediately after the biological trickling filter treatment. Analyse for: i) Total suspended solids; ii) Total oil and grease; and iii) cBOD5. c) The final combined wastewater. Samples shall be analysed for the analytes listed, at the detection limit shown, in Schedule 1 of the consent, for quarterly and annual sampling.			
15	Undertake toxicity testing of final combined wastewater quarterly, with no less than 2 months between each sample. Test the toxicity of the final combined wastewater to at least three species of marine organisms.		Quarterly toxicity testing was undertaken in August 2022, October 2022, February 2023 and May 2023 in accordance with the consent requirements. The adaptive management approach was followed correctly, and for each quarterly event it was determined that no further action was required by HDC based upon the initial findings.	3.1 3.3.7
16	At quarterly intervals, with not less than 2 months between each sample, take water quality samples at 10 sites perpendicular to the centre of the diffuser at distances of 100m, 250m, 500m, 750m and 1000m (on each side of the diffuser). Analyse for faecal coliform and enterococci. Take in-situ (field) measurements of pH, salinity, turbidity, temperature, and dissolved oxygen (%saturation) at each location.		Samples collected as required. No results that indicate an adverse effect on receiving water quality.	3.1 3.3.6.1

Consent Condition No.	Condition summary	Compliance status, 2022/23	Commentary	Report Section Reference(s)
17	Survey surface currents for ≥ 30 minutes with a GPS drogue at the diffuser centre while sampling as per Condition 16		Surface currents were monitored on the following dates: • 17 October 2022 • 3 March 2023 • 11 May 2023 • The survey was not completed during the August 2022 sampling event.	3.1 This table
18	Undertake surveys to show the impact of the discharge on benthic fauna [in the 8th year after commencement of this consent]. Flatfish of the same species as those collected at the time of the first benthic survey required by this consent shall also be tested for pathogenic bacteria and parasites. Provide the results of the survey to the Regional Council within 1 month of being received by the consent holder.		Benthic survey completed in December 2022 by Bioresearches. The resulting report was still in draft form at the time of this assessment. It shall be provided to HBRC within 1 month after HDC receives the final version.	3.3.6.3
19	Take seabed sediment grab samples at distances of approximately 250m, 500m and 750m to the north and 250m, 500m and 750m to the south of the midpoint of the outfall diffuser, twice a year (summer and winter). Analyse samples for the analytes listed, at the detection limit shown, in Schedule 2 of the consent.		Grab samples of benthic sediment were collected and analysed on the following dates: • 8 August 2022 • 12 October 2022 • 3 March 2023 • 11 May 2023 Appropriate detection limits were applied by the laboratory (between 0.01 – 0.8 mg/kg depending on the metal analysed).	3.3.6.2
20	Water quality analyses to be done by IANZ accredited or Regional Council approved laboratories.		Testing undertaken by Hill Laboratories (IANZ accredited)	3.1

Consent Condition No.	Condition summary	Compliance status, 2022/23	Commentary	Report Section Reference(s)
21	A Memorandum of Understanding (MOU) is in place and being followed		No further comment	3.1 Appendix C
22	Clear and visible signage including “Shellfish unfit for human consumption” on the buoys marking the diffuser ends		Signage checked during visual inspections as per Condition 9.	3.5
23	• Appointment of a person responsible for daily operation and to act as a contact person for Regional Council • Notifying Regional Council of appointment or change of the contact person		No personnel changes during this reporting period. Key contact is David Mackenzie.	1.1
24	Before 1 October each year, provide the Regional Council with an ‘Annual Monitoring Report’, covering the preceding 12 month period ending 30 June. The report shall be submitted together with a peer review completed by a suitably qualified and experienced professional expert. This monitoring report shall include content as stipulated in sub-conditions 24(a)-(k).		No further comment	This Report
24(a)	Summary of monitoring undertaken		Details provided in this report	3.1
24(b)	Critical analysis of sampling results		Details provided in this report	3.2 3.3 3.4
24(c)	Critical analysis of monitoring information in terms of compliance and adverse environmental effects		Details provided in this report	3.1 3.4
24(d)	• Assessment of compliance in relation to specified trigger values, for final combined wastewater. • Provide comment on the significance of any exceedance in terms of effects (if any) on the receiving environment,		Throughout this report	3.3 3.4

Consent Condition No.	Condition summary	Compliance status, 2022/23	Commentary	Report Section Reference(s)
	and any measures that may be appropriate to reduce the concentration of the relevant analyte. • Assess trends in $cBOD_5$, TSS and total daily discharge volume over the previous year and over the term of the consent.			
24(e)	Comment on non-compliances and operational problems, and any actions undertaken to address these.		Summarised in the conclusions of this report	2 4
24(f)	Detail any works undertaken or proposed to improve WWTP performance, including a timeframe for completion		Details provided in this report.	3.5
24(g)	Identify and comment on any trends in volumes, flows, toxicity and contaminant loads over the reporting period, and compared to previous years.		Commentary has been provided; a summary is contained in Section 4 of this report	3.2 3.3 3.3.7 4
24(h)	Recommend any alterations or additions to the monitoring programme.		It is recommended that the protocols for monitoring final combined wastewater and the receiving environment are reviewed and where necessary revised, as there have been issues with the timing and representativeness of sampling during this period.	3.1
24(i)	Detail any changes to consent conditions that may be applied for in the next 12 months		The wording of Condition 19 should be updated to refer to the ANZG 2018 Default guideline values (DGVs) for sediment quality, instead of the ISQG. Clarification or correction is needed for Condition 6 and Advice Note 2, with regards to the type of metal tested for/analysed for loads. It needs to be determined whether loads should also be	This table

Consent Condition No.	Condition summary	Compliance status, 2022/23	Commentary	Report Section Reference(s)
			calculated on the basis of Acid Soluble Metal content. Further changes may be necessary but will be identified during the 9-yearly review report which is due for completion in 2024.	
24(j)	Detail the date of the WWTP open day, numbers in attendance, and written questions submitted by the public and responses given.	Green	Details provided in this report.	3.6.1
24(k)	Provide tabulated results of laboratory analytical monitoring.	Green	Appendices D and E of this report	Appendix D Appendix E
25	Make each Annual Monitoring Report publicly available on HDC's website within one month of it being lodged with HBRC.	Green	The 2020/2021 Annual Monitoring Report was published on HDC's website. https://www.hastingsdc.govt.nz/assets/Document-Library/Reports/Annual-Wastewater-Discharge-Compliance-Report/2021.2022-Annual-Wastewater-Compliance-Report.pdf Timing of publication is dependent on receipt of final compliance report from HBRC.	3.6
26	• Organise a public open day at the East Clive Wastewater Treatment Plant in November each year • Report on the open day in the next Annual Monitoring Report	Green	Open Day was held on 19 November 2022.	3.6.1
27	Submit a Trends, Technology, Discharge, Environmental and Monitoring Review Report to HBRC not later than the 9th, 18th and 27th year anniversaries of the issue of this discharge permit.	Green	Nine-yearly review is currently underway (see more detail in Section 2).	2

Consent Condition No.	Condition summary	Compliance status, 2022/23	Commentary	Report Section Reference(s)
28	Log all complaints received relating to the discharge. Report any complaints received to HBRC within 24 hours of receipt. Any complaints relating to potential adverse health effects associated with exposure to the wastewater discharge shall be notified to the Hawke's Bay District Health Board [Te Whatu Ora] within 24 hours of receipt.		No public complaints were received specifically regarding the discharge of treated wastewater from the WWTP. One complaint was received via email in January 2023 regarding maintenance of land (long grass) adjacent to the WWTP which is owned by HDC, however as this is not directly relevant to the discharge it was not considered necessary to notify to HBRC under this consent. The complaint was logged on HDC's database and flagged as 'Medium' priority. It was assigned to a member of the WWTP operational team for action within 30 mins of receipt.	This table
29	Tangata Whenua engagement: • A Council Committee shall be established and retained; half of the members of which shall be Tangata Whenua representatives. • The Committee shall function as set out in the condition		Minutes of committee meetings provided in Appendix J, and further detail is summarised in the body of this report.	3.6.2 Appendix J
30	Immediately notifying Regional Council of any non-compliances that occurred or envisaged or unusual or extreme circumstances		Not relevant for this period as no complaints warranted this course of action	This table
31	Any unforeseen event leading to non-compliance: Investigating and reporting within one month		An accidental overflow occurred within the WWTP site on 27 June 2023. The incident was reported to HBRC the same day. An investigation report was provided to HBRC on 2 August 2023, which was 27 working days after the event, but not within one calendar month. The delayed reporting was due to operational	2 Appendix K

Consent Condition No.	Condition summary	Compliance status, 2022/23	Commentary	Report Section Reference(s)
			constraints relating to the Cyclone Gabrielle response at the time. See Section 2 for further summary of the event, and Appendix K for a copy of the investigation report submitted to HBRC.	
32	Keeping records related to the Consent and making them available to Regional Council upon request		No further comment	This table

Appendix B Copy of Resource Consent CD130214W

Connect with us

RESOURCE CONSENT

Coastal Permit

In accordance with the provisions of the Resource Management Act 1991 (RMA) and subject to the attached conditions, Hawke's Bay Regional Council (the Council) grants a resource consent for a discretionary activity to:

Hastings District Council
Private Bag 9002
Hastings 4156

to discharge final combined wastewater (see Advice Note 1) into Hawke Bay at East Clive via the long offshore outfall.

LOCATION

Address of site: 284 Richmond Road, Clive

Legal description: Seabed, adjacent to Sec 3 Blk II Clive SD

Map reference: NZMG: Between approximately 2850993 6173388-2850592 6173222
NZTM: Between approximately 1941039 5611758-1940638 5611592

CONSENT DURATION

This consent is granted for a period expiring on 31 May 2049.

LAPSING OF CONSENT

This consent shall lapse in accordance with section 125 of the RMA on the 31 May 2019, if it is not exercised before that date.

Iain Maxwell
Group Manager
RESOURCE MANAGEMENT GROUP
Under authority delegated by Hawke's Bay Regional Council
25th June 2014

CONDITIONS

1. The Consent Holder shall discharge the final combined wastewater as authorised by this Resource Consent generally in accordance with the information supplied with the application. Where a conflict exists between the application and the conditions of this Resource Consent, the conditions shall prevail.

2. The rate of discharge of the final combined wastewater (see Advice Note 1) shall not exceed 2,800 litres per second.

3. The discharge of the final combined wastewater as authorised by this Resource Consent shall be by way of the existing long offshore outfall structure located at the end of Richmond Road, East Clive, and shall take place between approximately 2,450m and 2,750m offshore, being approximately NZMG 2850993 6173388 - 2850592 6173222.

4. The final combined wastewater discharged to Hawke Bay via the long offshore outfall shall pass through an ocean outfall diffuser which has been designed to achieve a minimum average dilution over the boil of not less than 100:1 on slack water.

Wastewater treatment and standards

5. The final combined wastewater discharged shall meet the following requirements:

   a) All separable industrial wastewater shall pass through a milliscreen having a maximum aperture slot width of 1mm.

   b) All domestic and non-separable industrial wastewater shall pass through a 3mm diameter hole size screening device or equivalent, followed by treatment in a biological trickling filter, with an annual average daily loading of carbonaceous biochemical oxygen demand (5 day test) ($cBOD_5$) that shall not exceed 0.4 kg per cubic metre of media, with the treatment plant managed in accordance with best wastewater engineering practice and industry standards, and:

      i) the media in the biological trickling filters shall consist of randomly packed plastic material that provides a specific surface area of not less than $90m^2/m^3$, and

      ii) the wastewater remaining after that treatment, prior to being discharged, shall pass through the Rakahore channel.

6. The final combined wastewater discharged shall meet the following standards:

Analyte	Maximum concentration (g/m^3)	Maximum Loading (kg/day)*
Chromium III	2.74	143
Chromium VI	0.44	22.9
Copper	0.13	6.8
Zinc	1.5	78
Cadmium	0.07	3.6
Mercury	0.01	0.5
Lead	0.44	23
Nickel	0.7	36
Ammonia	91	4738

* The maximum daily loading limit is based on the maximum treated wastewater concentration limits multiplied by the 75%ile wastewater flow rate (52,070m^3/day) over 12 months in 1998 (a dry year).

In the event that a limit is exceeded for any analyte, an additional 24 hour flow proportional sample shall be collected and tested for that analyte within 5 working days of receipt of the laboratory result. An investigation shall also be undertaken into the cause of the exceedence, and the findings of the investigation recorded and provided to the Regional Council (Manager Resource Use) within one month of the exceedence occurring.

7. The discharge of the final combined wastewater as authorised by this Resource Consent shall not cause any of the following effects beyond a distance of 750m from the midpoint of the outfall diffuser:

   a) The production of any conspicuous suspended materials; or

   b) Any conspicuous change in the colour or visual clarity;

   and shall not cause any of the following effects beyond a distance of 500m from the midpoint of the outfall diffuser:

   c) The production of any conspicuous oil or grease films, scums or foams, or floatable materials; or

   d) Any emission of objectionable odour; or

   e) Any significant adverse effects on aquatic life, or

   f) A change of the natural temperature of the receiving water by more than 3 degrees Celsius, or

   g) The Dissolved Oxygen concentration to be less than 80% of the saturation concentration, or

   h) Undesirable biological growths.

8. The average concentration of Total Oil and Grease in the final combined wastewater shall not exceed 200g/m^3 over any 24 hour period based on the sampling procedure set out in Conditions 13 and 14.

9. The Consent Holder shall inspect the diffuser at least annually and at intervals not more than 14 months apart, and at any other time as necessary, at which time any ports blocked by mussels or other debris will be cleared. The number of blocked ports shall be recorded and reported in the Annual Monitoring Report required by Condition 24 of this consent.

10. The Consent Holder shall ensure that all components of the wastewater treatment plant and outfall structures (including the diffuser on the long offshore outfall) are maintained in good working order, and in accordance with industry best practice guidelines.

11. The Consent Holder shall ensure that all sampling equipment, including meters and field measurement devices are maintained in good working order by suitably qualified persons in accordance with the manufacturer's instructions and industry best practice guidelines. Records of calibration shall be kept and made available to the Council (Manager Resource Use) upon request.

Monitoring

12. The Consent Holder shall continuously monitor and record the rate of discharge and the daily volume of the final combined wastewater discharged. The flow meters used to record the discharge shall have an accuracy within plus or minus 5%, as per the manufacturer's calibration records.

13. For a period of 12 months, from the date of commencement of this consent, at quarterly intervals, with not less than 2 months between each sample, the Consent Holder shall take two flow proportional samples during each 24 hour period on a minimum of 7 consecutive days. The samples shall be taken from the following waste streams, and analysed for the constituents stated:

   a) The domestic and non-separable industrial wastewater prior to the biological trickling filter treatment. These samples shall be analysed for:

      i) Total suspended solids;

      ii) Total oil and grease; and

      iii) $cBOD_5$.

   b) The domestic and non-separable industrial wastewater immediately after the biological trickling filter treatment. These samples shall be split into 2 separate samples which will be analysed separately. One sample shall be taken during the 21 hours of normal operation. One sample shall be taken during the 3 hours of the biomass flushing cycle. These samples shall be analysed for:

      i) Total suspended solids;

      ii) Total oil and grease; and

      iii) $cBOD_{5.}$

   c) The final combined wastewater. These samples shall be analysed for the analytes listed, at the detection limit shown, in Schedule 1 (attached) for quarterly and annual sampling.

14. Starting 12 months from the date of commencement of this consent, at quarterly intervals, with not less than 2 months between each sample, the Consent Holder shall take 24 hour flow proportional samples on a minimum of 7 consecutive days of the following waste streams, and analyse them for the constituents stated:

   a) The domestic and non-separable industrial wastewater prior to the biological trickling filter treatment. These samples shall be analysed for:

      i) Total suspended solids;

      ii) Total oil and grease; and

      iii) $cBOD_5$.

   b) The domestic and non-separable industrial wastewater immediately after the biological trickling filter treatment. These samples shall be analysed for:

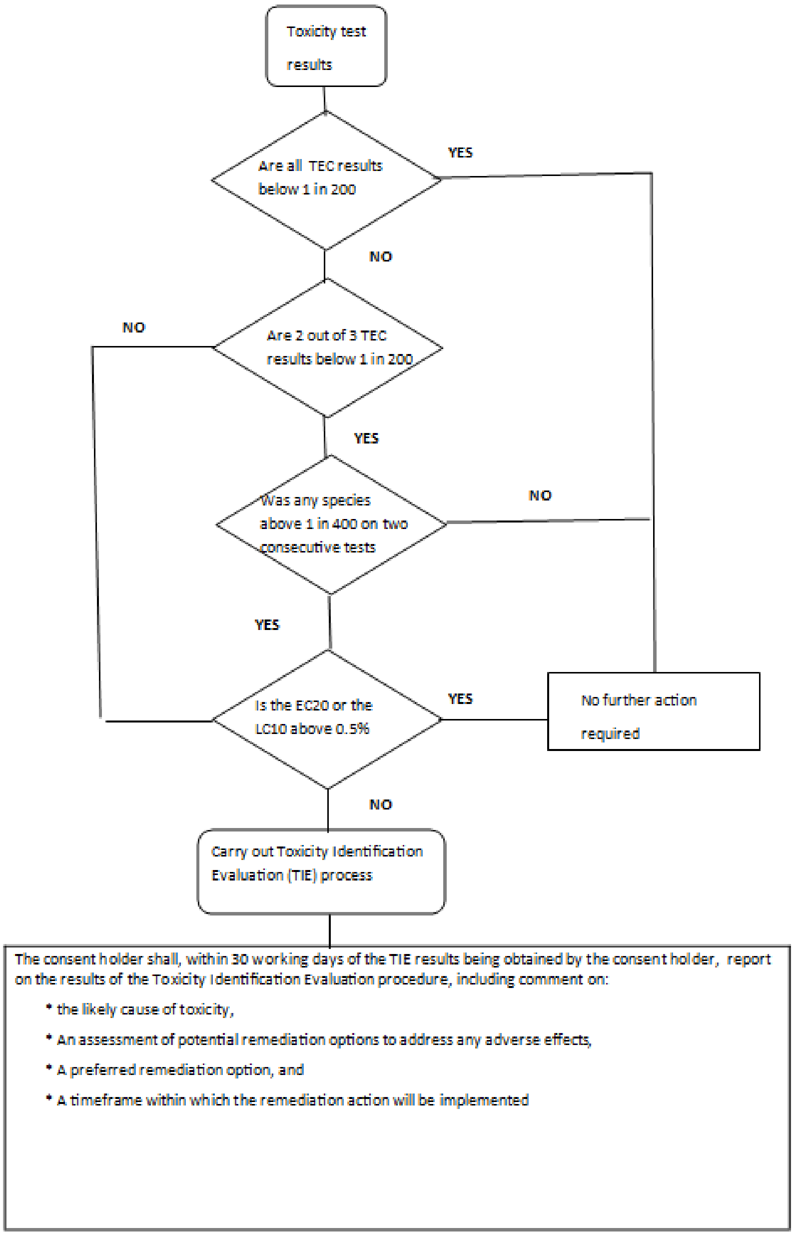
      i) Total suspended solids;

      ii) Total oil and grease; and

      iii) $cBOD_{5.}$

   c) The final combined wastewater. These samples shall be analysed for the analytes listed, at the detection limit shown, in Schedule 1 (attached) for quarterly and annual sampling.

15. At quarterly intervals, with not less than 2 months between each sample, the Consent Holder shall test the toxicity of the final combined wastewater to at least three species of marine organisms to determine if there is a statistically significant effect. A plan outlining the proposed testing method and the organisms to be tested shall be submitted to the Regional Council (Manager Science) for approval within 2 months of the commencement date of this consent. Changes to the plan (including changes to the organisms tested) can be made but must be submitted to the Regional Council for approval before the proposed changes can be made. The interpretation of results and the actions shall be undertaken using an adaptive management approach as is detailed in the figure below.



Advice Note

- Statistically significant effect is determined by the calculation of the Threshold Effect Concentration (TEC) and is the geometric mean of the No Observable Effect concentration (NOEC) and the Lowest Observable Effect Concentration (LOEC).
- EC20% is the effective concentration that causes the stated effect in 20% of the test organisms.
- LC10% is the lethal concentration that kills 10% of the test organisms.
- The TEC shall be expressed in terms of dilution (e.g. 1 in 200).
- The EC20 and LC10 shall be expressed in terms of percentage concentration (e.g. 0.5% equivalent to dilution 1 in 200).
- The decision tree above outlines the interpretation of the analysis and appropriate actions to be taken.

16. At quarterly intervals, with not less than 2 months between each sample, the Consent Holder shall take water quality samples at 10 sites perpendicular to the centre of the diffuser at distances of 100m, 250m, 500m, 750m and 1000m (on each side of the diffuser). These samples will be analysed for faecal coliform and enterococci. Field measurements are to be made of pH, salinity, turbidity, temperature, and dissolved oxygen (%saturation) at each location as well.

17. While samples are being taken in accordance with Condition 16, a GPS drogue shall be placed at the centre of the diffuser to measure the surface currents for at least 30 minutes.

18. The Consent Holder shall undertake surveys designed to show the impact of the discharge on the benthic fauna:

    a) The benthic survey shall include an assessment of marine sediments, benthic ecology, and trace metals in flatfish (comparable to that carried out by Golders Associates in 2012 and 2013) and shall be undertaken in the 8^{th}, 17^{th} and 26^{th} years after the commencement date of this Resource Consent. The final design of each survey shall be submitted to the Regional Council (Manager Science) for approval prior to each survey being undertaken. Flatfish of the same species as those collected at the time of the first benthic survey required by this consent shall also be tested for pathogenic bacteria and parasites (see Advice Note 3).

    The results of all benthic surveys shall be provided to the Regional Council (Manager Resource Use) within 1 month of being received by the Consent Holder.

19. Twice during the year (summer and winter) the Consent Holder shall take seabed sediment grab samples at distances of approximately 250m, 500m and 750m to the north and 250m, 500m and 750m to the south of the midpoint of the outfall diffuser. Those samples shall be analysed for the analytes listed, at the detection limit shown, in Schedule 2.

    In the event that sediment monitoring required by this condition, results in two or more exceedances of ANZECC 2000 (ISQG – Low) sediment guidelines on one occasion of sampling, then an additional benthic survey shall be undertaken within one year of the sediment sampling exceedance(s) occurring. However, no more than one additional survey shall be required by this condition to be undertaken within each 9 year period specified in Condition 18 a).

20. All quality analysis of the wastewater discharged other than field measurements as required by the conditions of this consent shall be undertaken by an independent laboratory accredited to IANZ or other laboratory approved by the Regional Council (Manager Resource Use). Field measurements shall be undertaken in accordance with best industry practice.

21. Within three months of the commencement date of this consent, the Consent Holder shall submit to the Regional Council (Manager Resource Use) a Memorandum of Understanding (MOU) which shall include, but is not limited to the following:

    a) Details of sampling methodologies and procedures to be followed;

    b) Protocols that will be observed;

    c) Details of sampling locations;

    d) Details of when information (including data and sampling results) needs to be provided to the Regional Council, and in what format.

    The MOU shall be prepared in consultation with the Regional Council (Manager Resource Use) and can be varied upon agreement between the two parties. All sampling shall be undertaken in accordance with the MOU. All records collected in accordance with the conditions of this Resource Consent shall be provided to the Regional Council (Manager Resource Use) at the times and in the formats specified in the MOU. Until the MOU is prepared, records shall be provided to the Regional Council (Manager Resource Use) no more than one month following the end of the month to which they relate, except for the flow data required in accordance with Condition 12 of this consent which shall be provided at quarterly intervals.

Administrative

22. The Consent Holder shall ensure that at all times clear and visible signage is placed on the buoys marking the two ends of the diffuser, incorporating the words "Shellfish unfit for human consumption".

23. The Consent Holder shall appoint a person to be responsible for the day-to-day operation of the treated wastewater disposal system and to act as a contact person for the Regional Council. The name and phone number of this contact person shall be advised to the Regional Council (Manager Resource Use) within 10 working days of the commencement date of this consent and within 10 days of any change.

Reporting

24. Before 1 October each year, the Consent Holder shall provide the Regional Council (Manager Resource Use) with an 'Annual Monitoring Report', covering the preceding 12 month period ending 30 June. The report shall be submitted together with a peer review completed by a suitably qualified and experienced professional expert. This monitoring report shall include, but not be limited to:

    a) A summary of all monitoring undertaken as required by this consent, and may include details of additional monitoring undertaken by the consent holder to better characterize the effects of the discharge on Hawke Bay;

    b) A critical analysis of the results of sampling required by Condition 13, in the Annual Monitoring Report completed the year following the collection of that data.

    c) A critical analysis of the monitoring information in terms of compliance and adverse environmental effects;

    d) An assessment of compliance in relation to the trigger values set out in the table below. Any exceedences of these trigger values shall be clearly identified and reasons for each exceedence (if known) provided. Comment shall also be provided about the significance of the exceedence in terms of effects (if any) on the receiving environment, and any measures that may be appropriate to reduce the concentration of the relevant analyte should that be necessary having regard to any adverse environmental effects. An assessment of trends in the concentrations of these parameters over the previous year, and also over the term of this Resource Consent must also be provided;

Analyte	Trigger Value[2]
$cBOD_5$[1]	48,000 kg/day
Total suspended solids[1]	39,000 kg/day
Total Daily (annual average)	66,000

volume	m^3/day

[1] The annual average mass load is calculated by multiplying the result for each day by the volume each day and then averaging the loads.

[2] The trigger value is calculated as an upper tolerance limit based on annual mean results from 1998 to 2013 inclusive.

e) Comment on any non-compliances and operational problems, and any actions undertaken to address these;

f) Details of any works undertaken or proposed to improve the performance of the treatment system, and the timeframe for completion of any proposed works;

g) Identification and comment on any trends in volumes, flows, toxicity (EC50 or LC50) and contaminant loads over the reporting period, and compared to previous years. This shall include any trends in water quality parameters/wastewater constituents including comment on the potential environmental implications of these trends; and

h) Recommendations regarding alterations or additions to the monitoring programme;

i) Details of any changes to the consent conditions that may be applied for within the next 12 month period;

j) Details of the date of the plant open day, numbers in attendance, and written questions submitted by members of the public, and responses given (except that this subsection cannot be addressed in the first Annual Monitoring Report completed in accordance with the conditions of this consent); and

k) The tabulated results of the laboratory analytical monitoring.

25. Each Annual Monitoring Report shall be made publicly available on the Consent Holder’s website within one month of it being lodged with the Regional Council (Manager Resource Use). Notification of the availability of this Report shall also be included in the Consent Holder’s next public newspaper general ratepayers’ notice and also the next ratepayer newsletter.

26. During the month of November each year, the Consent Holder shall have a public ‘open day’ at the Wastewater Treatment Plant site, located on Richmond Road. Notification of this open day shall be done via the Consent Holder’s website and in a Consent Holders public newspaper general ratepayers’ notice at least 10 working days before the open day. The open day shall be attended by Hastings District Council Staff as well as a Regional Council Compliance Officer. The purpose of the open day is to give the community an opportunity to view the treatment plant, and discuss the Annual Monitoring Report. It is also an opportunity for members of the public to submit written questions to which the Consent Holder shall respond in writing within one calendar month.

    Details of the date of the open day, numbers in attendance, written questions submitted and responses given shall be included in the next Annual Monitoring Report, as noted in Condition 24 (j) above.

27. The Consent Holder shall submit to the Regional Council (Manager Resource Use) a Trends, Technology, Discharge, Environmental and Monitoring Review Report not later than the 9^{th}, 18^{th} and 27^{th} year anniversaries of the issue of this discharge permit. Each Review Report shall be made publicly available on the Consent Holder’s website within one month of being lodged with the Regional Council. Notification of the availability of this Report shall be included in the

Consent Holder's next public newspaper general ratepayers' notice and also the next ratepayer newsletter.

The Review Report shall address as a minimum, but not be limited to, the following matters for the nine year period since the last review:

a) Comparisons of population and industrial changes and possible trends as compared to the Heretaunga Plains Urban Development Strategy (2010) (HPUDS), and then latest reports on the Hastings Urban Development Strategy and the Hastings Industrial Strategy;

b) Volumes, flows and loads profile and changes assessed against future projections and wastewater projections as set out in section 4.3 of the Hastings Wastewater Resource Consents Project: Assessment of Effects on the Environment and Resource Consent Applications copy dated June 2013;

c) Trade waste profiles, trends and any significant changes in the Consent Holder's trade waste management practices and the trade waste contaminant profile;

d) Any new changes to environmental guidelines and / or standards applicable to the discharge of treated wastewater into Hawke Bay;

e) Changes in asset management and operational matters that may have relevance to the on-going operation and development of the Consent Holder's Wastewater Scheme from the perspective of the treated wastewater discharge, water conservation and efficient energy management;

f) Changes in wastewater treatment technologies that may be relevant to the Hastings Wastewater Scheme for either the domestic and non-separable waste stream and / or the industrial waste stream;

g) The results of a recreational usage survey undertaken during the nine year period, which is comparable to the survey undertaken between the summers of 2011 and 2013 (See Advice Note 4), and comparison of those results with previous surveys;

h) Options for treated wastewater disposal / discharge and beneficial reuses that may be appropriate to the Wastewater Scheme;

i) Effects of the treated wastewater discharge into Hawke Bay as evident from the resource consent monitoring; and

j) Details of consultation undertaken with the community to ascertain their views of the effects of the current wastewater discharge (see Advice Note 5).

Consideration of this existing Resource Consents Project objectives, opportunities for improvement and Best Practicable Option (BPO) in terms of the interpretation of this term in the Resource Management Act 1991.

28. The Consent Holder shall log all complaints received relating to the discharge. The log shall include:

a) The date and time of the complaint;

b) The nature of the complaint;

c) The name, telephone number, and address of the complainant;

d) Weather and sea condition information (including an estimate of wind speed and direction, and description of sea condition);

e) Details of key operating parameters at the time of the complaint; and

f) Any remedial action taken to prevent further incidents.

Complaints shall be reported to the Regional Council (Manager Resource Use) within 24 hours of receipt, and the log of complaints shall be made available to the Regional Council (Manager Resource Use) on request. Any complaints relating to potential adverse health effects associated with exposure to the wastewater discharge shall be notified to the Hawke's Bay District Health Board within 24 hours of receipt also.

29. In accordance with the principles of the Treaty of Waitangi (especially those of partnership and consultation) and recognising the role of Tangata Whenua as kaitiaki, the Consent Holder shall establish, and retain, as a committee of the Hastings District Council under Clause 31, Schedule 7, Local Government Act 2002, a Council Committee, half of the members of which shall be Tangata Whenua representatives the functions of which shall include:

a) Developing the Hastings District Council's wastewater treatment and disposal system policies;

b) Receiving, reviewing and recommending action on reports concerning the operation and performance of the Council's wastewater disposal system, treatment plant and ocean discharge;

c) Receiving, reviewing and recommending from time to time the commissioning of reports and future Hastings District Council actions on wastewater issues including:

i) Options for further or other treatments;

ii) Options for alternative methods of disposal; and

iii) Monitoring effects on the environment;

d) Co-ordinating and overseeing education of the community including tangata whenua and trade waste dischargers on wastewater issues;

e) Not less than three months before each of the Trends, Technology, Discharge, Environmental and Monitoring Nine Yearly Review as required in accordance with Condition 27 is commenced by the Consent Holder, providing to the Consent Holder any further suggested input in respect to the scope of the review;

f) Advising the Consent Holder on the Condition 27 Trends, Technology, Discharge, Environmental and Monitoring Nine Yearly Review before it is finalised and submitted to the Regional Council (Manager Resource Use) (See Advice Note 6); and

g) Recognising the role of tangata whenua as kaitiaki and the need to recognise and seek to satisfy the cultural concerns of tangata whenua.

30. In the event of the Consent Holder becoming aware of:

a) unusual or extreme circumstances (not being circumstances such as would provide a defence under sections 341 – 341B, Resource Management Act 1991) that may lead to one or more of the conditions of this Resource Consent being breached, or

b) circumstances having occurred that have, or could, lead to non-compliance,

immediate notification of such problems shall be made to the Regional Council (Manager Resource Use). This notification shall include, but not be limited to, provision of the following information as far as such information is known to the Consent Holder at that time:

i) The extent of non-compliance if it has occurred, including the duration of non-compliance, volume discharged during that period, and the nature and quality of the discharge,

ii) The immediate and further planned measures being undertaken to minimise and mitigate any adverse effects of the non-compliance,

iii) The Consent Holder's assessment of public health risk arising from the event including advice received from the Hawke's Bay District Health Board Chief Executive Officer and Medical Officer of Health, and

iv) Updating the Regional Council (Manager Resource Use) at not greater than 24 hourly intervals of the current situation until the problems are rectified and the Consent Holder is compliant with the Resource Consent conditions.

31. Within one calendar month of any unforeseen event that resulted in non-compliance with the conditions of this Resource Consent, the Consent Holder shall provide a further report to the Regional Council (Manager Resource Use). This report shall include, but not be limited to the provision of any further information on the reasons for the non-compliance and the measures investigated and put in place or to be put in place to avoid or at least minimise the possibility of any similar problems in the future that may cause non-compliance.

32. The Consent Holder shall make available to the Regional Council (Manager Resource Use) upon request records kept in relation to the discharge, and its effects on the environment including sampling, testing, and analysis.

ADVICE NOTES

1. "Final combined wastewater" refers to the separate industrial wastewater stream, which is trade waste (excluding all human excreta) transported through a separate piped network to the East Clive Wastewater Treatment Plant, and the domestic and non-separable industrial wastewater (which has been treated in the biological trickling filter) which are combined immediately prior to discharge via the ocean outfall.

2. It relation to Condition 6, the maximum wastewater concentration limits are based on ANZECC (2000) Aquatic Ecosystem guideline limits multiplied by a factor of 100 (for 100:1 dilution). Concentrations are for the Acid Soluble Fraction.

3. In relation to Condition 18, the Consent Holder shall discuss and agree the design of the flatfish analysis required at the time of the first benthic survey with the Hawke's Bay District Health Board Chief Executive Officer and Medical Officer of Health.

4. The results and methodology used in the Coastal Recreational and Commercial Survey 2013 is detailed in Support Document 9 to the AEE which was lodged with the Regional Council on 1 July 2013.

5. For clarity, it is noted that the consultation required by Condition 27(j) is in addition to consultation that must be undertaken in accordance with other conditions of this Resource Consent, including Condition 29 which relates to the Tangata Whenua committee.

6. The reason for Condition 29(f) is that the Hastings District Council Tangata Whenua Wastewater Joint Committee established in accordance with Condition 30 of Resource Consent CD990260Wd, and Condition 29 of this Resource Consent, and the Hastings District Council requested this linkage between the Trends, Technology, Discharge, Environmental

and Monitoring Nine Yearly Reviews and the activities of a Hastings District Council and Tangata Whenua Committee formed and having the functions in accordance with Condition 29.

Review of Consent Conditions by the Council

The Council may review conditions of this consent pursuant to sections 128, 129, 130, 131 and 132 of the RMA. The actual and reasonable costs of any review undertaken will be charged to the Consent Holder, in accordance with section 36 of the RMA.

Times of service of notice of any review: During the month of May of any year.

Purposes of review:

To deal with any adverse effect on the environment arising from the exercise of this consent, which it is appropriate to deal with at that time or which became evident after the date of issue.

To require the adoption of the best practicable option to remove or reduce any effects on the environment.

To modify any monitoring programme, or to require additional monitoring if there is evidence that current monitoring requirements are inappropriate or inadequate.

Reasons for Decision

The effects of the activity on the environment will not be more than minor. Granting the consent is consistent with the purpose and principles of the RMA and with all relevant plans and policies.

Monitoring Note

Routine monitoring

Routine monitoring inspections will be undertaken by Council officers at a frequency of no more than once every year to check compliance with the conditions of the consent. The costs of **any** routine monitoring will be charged to the consent holder in accordance with the Council's Annual Plan of the time.

Non-routine monitoring

"Non-routine" monitoring will be undertaken if there is cause to consider (e.g. following a complaint from the public, or routine monitoring) that the Consent Holder is in breach of the conditions of this consent. The cost of non-routine monitoring will be charged to the Consent Holder in the event that non-compliance with conditions is determined, or if the Consent Holder is deemed not to be fulfilling the obligations specified in section 17(1) of the RMA shown below.

Section 17(1) of the RMA states:

Every person has a duty to avoid, remedy, or mitigate any adverse effect on the environment arising from an activity carried on by or on behalf of the person, whether or not the activity is carried on in accordance with

a) *any of sections 10, 10A, 10B, and 20A; or* *b) a national environmental standard, a rule, a resource consent, or a designation.*

Consent Impact Monitoring

In accordance with section 36 of the RMA (which includes the requirement to consult with the Consent Holder) the Council may levy additional charges for the cost of monitoring the environmental effects of this consent, either in isolation or in combination with other nearby consents. Any such charge would generally be set through the Council's Annual Plan process.

Debt Recovery

It is agreed by the Consent Holder that it is a term of the granting of this Resource Consent that all costs incurred by the Council for, and incidental to, the collection of any debt relating to this Resource Consent, whether as an individual or as a member of a group, and charged under section 36 of the RMA, shall be borne by the Consent Holder as a debt due to the Council, and for that purpose the Council reserves the right to produce this document in support of any claim for recovery.

Consent History

Consent No. (Version)	Date	Event	Relevant Rule Number	Plan
CD130214W	25/06/2014	Consent initially granted	157	Proposed Regional Coastal Environment Plan

Schedule 1

Test / Analyte	Quarterly	Annually	Units	Recommended Detection Limit**
pH	X	X		0.1
Conductivity	X	X	mS/m	0.1
Total Oil and Grease	X	X	g/m^3	4
Total Solids		X	g/m^3	10
Total Suspended Solids	X	X	g/m^3	3
Total organic carbon		X	g/m^3	0.5
NH_4-N	X	X	g/m^3	0.01
NO_3-N/NO_2-N		X	g/m^3	0.002
$cBOD_5$	X	X	g/m^3	10
COD		X	g/m^3	6
Zn (acid sol)	X	X	g/m^3	0.001
Sulphide	X	X	g/m^3	0.002
TKN		X	g/m^3	0.1
DRP	X	X	g/m^3	0.004
TP		X	g/m^3	0.004
Total Phenols		X	g/m^3	0.002
Total CN		X	g/m^3	0.001
As (acid sol)	X	X*	g/m^3	0.00005
Cr III (acid sol)	X	X*	g/m^3	0.001
Cr VI	X	X*	g/m^3	0.001
Cu (acid sol)	X	X*	g/m^3	0.0005
Ni (acid sol)	X	X*	g/m^3	0.0005
Pb (acid sol)	X	X*	g/m^3	0.0001
Hg (acid sol)	X	X*	g/m^3	0.00008
VOC (inc BTEX)		X	g/m^3	To trace
SVOC		X	g/m^3	To trace
PCP		X	g/m^3	To trace
ON & OP pesticides		X	g/m^3	To trace

*Both total and dissolved fractions to be tested in annual survey.
** The detection level quoted may not be applicable in all circumstances due to interferences within the sample.

Schedule 2

Test / Analyte	Units	Detection Limit*
Zn (total recoverable)	mg/kg	0.4
As (total recoverable)	mg/kg	0.2
Cd (total recoverable)	mg/kg	0.01
Cr (total recoverable)	mg/kg	0.2
Cu (total recoverable)	mg/kg	0.2
Sn (total recoverable)	mg/kg	0.1
Ni (total recoverable)	mg/kg	0.2
Pb (total recoverable)	mg/kg	0.04
Hg (total recoverable)	mg/kg	0.01

*The detection level quoted may not be applicable in all circumstances due to interferences within the sample.

APPENDIX 1. CONSENT CONDITION ANALYSIS

Condition No.	Reason for Condition
1	The effects of the proposed activity have been assessed based on the information provided by the applicant. It is important that the activity is undertaken as proposed because the effects of the activity may vary if the nature or intensity of the activity changes.
2	Rate of discharge influences the effects the proposed activity may have on the environment
3	The effects of the proposed activity have been assessed based on the environment surrounding the outfall. A discharge in another location may have different effects
4	The effects of the discharge have been assessed on the basis of a 100:1 dilution being achieved. It is important that this level of dilution continues to be achieved. Lower levels of dilution may result in adverse effects on the environment.
5	The effectiveness of BTF plants is closely linked to their loading rate (increased loading rate results in decreased levels of removal/treatment), therefore it is important that a loading rate is specified. The type of media installed in the tanks also has an effect on the quality of effluent produced and has therefore been specified. The Rakahore Channel (previously referred to as the Papatuanuku Channel) addresses tangata whenua concerns with the discharge and it is therefore important that it remains part of the treatment process.
6	The inclusion of end of pipe standards for metals and ammonia should ensure that quality of the wastewater discharged to Hawke Bay provides for 95% species protection (in accordance with ANZECC 2000 guidelines). End of pipe standards allow an easy assessment of the effects of the discharge, because they cannot be influenced by other possible sources of contamination that monitoring in the receiving environment can be.
7	In accordance with section 107, any discharge to the environment cannot result in the effects listed. Including this as a condition of consent ensures that the consent holder is aware of the effects it may not cause after reasonable mixing.
8	The inclusion of a Total Oil and Grease standard should ensure that the quality of the discharge to Hawke Bay is maintained.
9	Regular maintenance of the diffuser will ensure that the dilution rate in Condition 4 continues to be achieved.
10	Ongoing good practice in the operation of the outfall and diffuser will assist in ensuring compliance with the rest of the conditions of this consent.
11	Requiring the consent holder to regularly check and maintain sampling equipment should ensure that sampling results are accurate, and give confidence that the effects of the discharge are being correctly measured.
12	Allows compliance with Condition 2 to be assessed.
13	Allows compliance with Condition 8 to be assessed and also the nature of the discharge compared against the trigger values set out in Condition 24. Also will provide further information about the quality of the discharge during the flushing cycle. This condition was included to address a concern raised by the submitter who initially opposed the applications.
14	Allows compliance with Condition 8 to be assessed and also the nature of the discharge compared against the trigger values set out in Condition 24.
15	High toxicity levels can have an adverse effect on the environment. It is important that toxicity levels are assessed against criteria that will provide a level of protection that is appropriate to the sensitivity of the species found in it. This condition allows greater flexibility than the previous toxicity condition, which reflects the technical nature of toxicity assessments, and the difficulty in collecting meaningful data over a period of time.
16	High concentrations of faecal coliform and enterococci in the receiving environment can have an adverse effect on public health. It is important to sample these regularly to allow any trends in concentration to be identified. Sampling at a distance of 100 and 250 m also

	allows the adequacy of the mixing zone to be assessed and potentially decreased if the effects of the discharge are shown to be limited to a smaller radius around the diffuser.
17	The direction of current at the time of sampling can have an effect on the results of that sampling.
18	Benthic surveys will allow the effect of the discharge, particularly its solids component, to be assessed, and any adverse effect on the environment identified in a timely fashion. The requirement to sample flatfish at the time of the first survey reflected a request made in the HBDHB's submission.
19	Some constituents of wastewater discharges accumulate in sediments. Regular assessment of the concentrations of these constituents is important because they can bio accumulate and adversely affect other species that feed on them. The requirement for an additional benthic survey to be undertaken if two samples (taken during one sampling run) exceed the ANZECC guidelines provide further certainty that any adverse effects of the discharge will be identified in a timely fashion.
20	It is important that the analysis of sampling results is undertaken in accordance with industry best practice and in a manner that allows the results to be assessed with other sampling results. Use of an accredited laboratory and adherence to industry best practice guidelines ensures this.
21	To ensure the sampling results have integrity it is important that sampling methodologies and procedures are agreed and always followed, appropriate protocols are observed and the timing of the provision of information to Council is agreed. It is considered more appropriate to have this information set out in an MOU rather than consent conditions because is important that it can easily be amended to reflect industry best practice.
22	Signs indicate the presence of a potential public health risk as a result of the discharge.
23	It is important that the consent authority knows who the primary contact for the consent is, particularly in emergencies.
24	The requirement for an annual report ensures that the consent holder assesses the performance of the treatment plant over a 12 month period, and its effect on the receiving environment. The annual report also requires trends over time to be assessed, which ensures that the long term effect of the discharge is regularly reviewed, and necessary changes to the operation and/or design of the treatment plant made before the discharge has any adverse effect on the receiving environment. The specification of trigger values for the concentration of $cBOD_5$, TSS and total volume in this condition, and a requirement to assessment performance against these, ensures that the nature of the discharge remains within that which has been assessed, and historically observed to have no more than minor adverse effects on the environment. Increased loads will not necessarily have an adverse effect on the environment, but nominating these trigger values ensures that any higher concentrations are investigated. The requirement to submit a peer review together with the annual monitoring report provides an additional layer of transparency to the assessment of the WWTP's performance, and confidence that monitoring results are being thoroughly assessed, and any unusual trends identified.
25	It is important that the community has regular access to information about the quality and effects of the wastewater discharge. Making the annual monitoring report available is one way of ensuring that the public is regularly informed about the performance of the plant.
26	The facilitation of a public open day at the WWTP each year provides a further oportunity for members of the public to be regualarly updated on its performance, and also have an opportunity to ask questions of Council staff involved with it. This condition was developed to address a concern raised by one submitter about the lack of any regular formal engagement with the wider community.
27	The requirement for the consent holder to undertake a through review every nine years was one of the reasons on which a 35 year consent duration could be justified. It is important that at this interval the consent holder reviews the performance of the WWTP, and also engages with the community, and the Tangata Whenua Joint Committee to ensure that they are comfortable with the continuation of the current level of treatment, or

	whether there is a desire to increase the level of treatment that the plant provides. There are a number of other matters that the consent holder must assess also. The nine yearly review must also be made available to the public.
28	The consent holder needs to record and take action to address any complaints made by the public about the activity. This is a useful resource at the time of consent replacement also, as it helps gain an understanding of the effect of the activity on adjoining properties.
29	The applicant requested the inclusion of this particular consent condition as it had been discussed and agreed with the Tanagata Whenua Wastewater Joint Committee which as set up in accordance with the conditions of the previous consent. The condition ensures the ongoing engagement of the consent holder with tangata whenua over matters relating to the WWTP.
30	Discharge of an unusual nature have the potential to have adverse effects on both the enviornment and human health. It is therefore important that the Regional Council is aware of these as soon as possible, so that appropriate measures can be taken to ensure the protection of public health in the first instance.
31	It is important that the reason for any discharges of an unusual nature are identified so that hopefully they can be avoided in the future.
32	As the consent authority it is important that the Regional Council has the ability to obtain all relevant information from the consent holder relaing to this discharge, and its potential effects on the environment.

Appendix C Memorandum of Understanding

Connect with us

HASTINGS
DISTRICT COUNCIL

Memorandum of Understanding
Consent No. CD130214W

(Updated on 05 November 2020)

Prepared By:

R. McWilliams
Wastewater Treatment Manager
Hastings District Council

Contents

1. Introduction

The purpose of this Memorandum to provide the methodology of how Hastings District Council is going to comply with the Discharge Consent No. CD130214W (AUTH120712-01).

2. Conditions

2.1 Condition 2

Condition 2 specifies the maximum wastewater discharge rate. The final treated wastewater discharge rate is rounded to one decimal place.

The rate of discharge is governed by the speed of the pumps and the number of pumps running. The design of the pumps is that at the maximum revolutions of the pump and two duty pumps operating the outfall will discharge 2800 l/s. The instantaneous flow rate will depend on the state of the tide, swell and wet well levels but on average should not be capable of exceeding the maximum of 2800 l/s.

2.2 Condition 3

Condition 3 specifies the minimum dilution rate for the ocean outfall diffuser.

The current diffuser is located in the sea bed as in the consent document.

2.3 Condition 5

Condition 5 specifies the screening, biological trickling filter media, and Rakahore channel requirements.

The screens for the separated industrial influent wastewater are 1mm wedgewire ContraShear screens. The non-separated influent wastewater (DNSI) screens are 3mm diameter (hexagonal) Centre Flo band screens.

The current biological trickling filter has been designed for a daily loading rate of 0.3 Kg of carbonaceous biochemical oxygen demand (cBOD-5 day test) per cubic meter of media so it should not exceed the 0.4Kg limit. The loading rate is checked on each daily samples each quarter so increases will be readily identified long before the annual average is exceeded.

The loading rate is the average cBOD loading rate for the entire consent sampling period and calculate in kg/m3/day. The daily individual loading rates are calculated based on the influent flow rates (m3/day) and the cBOD (g/m3) for that day.

The final loading rates are rounded to 3 decimal places.

2.4 Condition 6

Condition 6 specifies the final combined wastewater discharge quality standards for heavy metals and ammonia.

The maximum daily loading/discharge calculation is based on the maximum treated wastewater (effluent) concentration limits multiplied by the average treated wastewater flow rate in m3/day over 12 months.

The analyte concentrations and the loading rates are rounded to 3 three decimal places.

This condition gives a procedure to be undertaken (another sample) if any analyte is exceeded for any test. Any exceedance will be reported to the HBRC compliance officer, as soon as practicable on receipt of the analyses, the compliance officer will determine non-compliance and notify the Hastings District Council of the decision.

2.5 Condition 7

Condition 7 specifies the adverse odour, visual, chemical, biological and ecological effects to be avoided as a result of the discharges.

Observations of these parameters will be made when carrying out the quarterly sampling around the outfall. Any exceptions will be reported to HBRC compliance Officer.

2.6 Condition 8

Condition 8 specifies the Total Oil and Grease limits in the final combined wastewater over a 24-hour period.

The total oil and grease in g/m3 will be calculated on a daily basis based on the final combined waste water flow (m3/day) during the sampling period. This calculated data is rounded to one decimal place.

Any exceedance will be reported to the HBRC compliance officer as soon as practicable on receipt of the analyses, the compliance officer will determine non-compliance and notify the Hastings District Council of the decision.

3. Monitoring

3.1 Condition 12

Condition 12 specifies the monitoring requirements for the discharge of final combined wastewater.

A Raven Eye^{R} flow meter is installed in the industrial outlet channel leading to the wet well (upstream of the grit removal system). The specification of the flow meter is stored in the HDC ID (Infrastructure Data Historian of the HDC).

This allows the comparison between the incoming flows and the outgoing flow (this is not required by the consent). The information from the flow meter is transferred to the local historian via the site SCADA system. The final combined wastewater flow rates are integrated to calculate the daily total combined effluent discharge volume.

Micronics Ultrasonic Doppler flow meters are installed on the outlet of each pump.

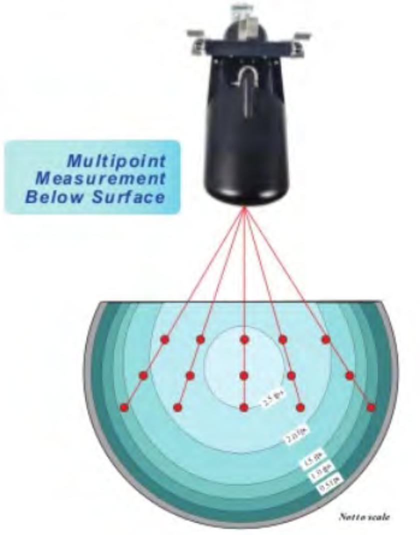
The accuracy of each meter is plus or minus 2%. This provides for a secondary measurement of the flow rate.

3.2 Condition 14 (Condition 13 no longer applies).

3.2.1 Condition 14a) and 14b)

Condition 14 specifies the sampling requirements of the DNSI wastewater.

A ”Laserflow” flow meter is installed in the domestic and non-separable (DNSI) sewer influent channel (Sewer 03). This flowmeter measures the height by an ultrasonic level meter and uses a laser to measure the depth at various points in the flow.



The specification for this instrument is stored in the HDC ID (Infrastructure Data Historian).

The control system at the site integrates the flow rates from the domestic laser flow meter and generates and historise daily volumetric flow data in an excel spread sheet through the SCADA.

In a steady state, the incoming flow to the Biological Trickling Filters will be the same as the flow exiting the filters and being discharged through the Rock Channel.

The sampler before the Biological Trickling Filter is located in an area of high turbulence at the exit of the screen structure and consists a peristaltic pump which is controlled by the plant control system to have flow proportional composite samples as required by consent. The operation sequence of the sample pumps are described in the sample pump Functional Description document.

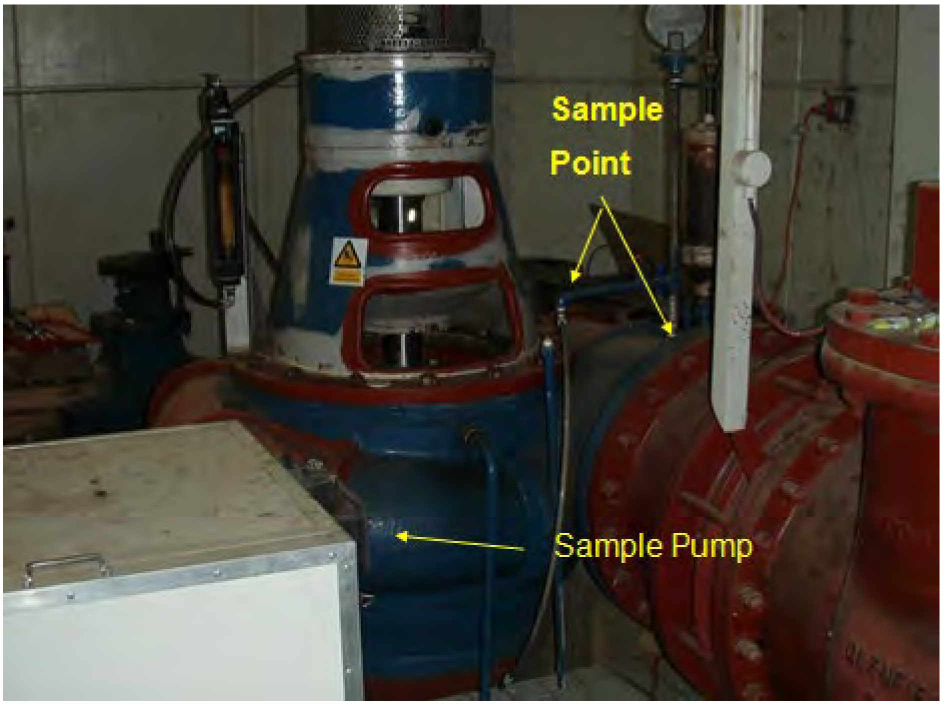
The sample is taken from 8am to 8am each day.

The sampler after the Biological Trickling Filter is located at the structure where the flow exits from both tanks prior to being conveyed to the recycle pump station, this is an area of high turbulence and sampler intake is in the centre of this structure.

The samples are refrigerated (maximum 4 days) and couriered overnight in chilly bins to Hills Laboratories in Hamilton for analysis. The BOD sample is frozen to preserve. The methods of analysis used are the standard methods of Hill Laboratories to achieve the required detection limits. Hill Laboratories is an IANZ Accredited Laboratory; they are accredited for a very wide range of tests on waters, effluents, soils, sediments, plants and biota. Copies of the Accreditation are available on request to Hill Laboratories.

3.2.2 Condition 14 c

The final combined wastewater is sampled at the outlet of the Duty 1 pump. At this point the wastewater will be turbulent and well mixed.



The peristaltic Watson Marlow sample pump sample pump is controlled by the control system which makes sure that the flow proportional sample is taken for analysis.

The sample pump operation sequence ensures that the fresh and representative samples are taken for testing purposes. The sample pump operation sequence is clearly described in the functional description (Refer the section 16 of the functional description FH-152-03-ENG-FDS-001_0.93).

The composite sample container is located in a refrigerated container. The sample is collected from 8am to 8am each day during the sampling period.

The sample pump operates for the full 7 days with containers being swapped at 8am for each day's sample. The composite sample is mixed and subsampled into containers provided by Hill Laboratories with the appropriate preservative added.

The samples are refrigerated (maximum 4 days) and couriered overnight in chilly bins to Hills Laboratories in Hamilton for analysis. The BOD sample is frozen to preserve. The methods of analysis used are the standard methods of Hill Laboratories to achieve the required detection limits. Hill Laboratories is an IANZ Accredited Laboratory; they are accredited for a very wide range of tests on waters, effluents, soils, sediments, plants and biota. Copies of the Accreditation are available on request to Hill Laboratories.

In case of any unforeseen failures in the sampling equipment or its control or operations during the sampling period, HBRC will be notified as soon as practicable and an alternative arrangement will be made to take more samples to compensate the lost samples as per the instructions from HBRC.

3.3 Condition 15

Condition 15 specifies the toxicity sampling & testing requirements of the final combined treated wastewater.

A 24 hour flow proportional sample of the final combined wastewater is taken (same as Condition 13c). The sample is sent to NIWA in Hamilton in a chilly bin (packed with ice or ice substitute) for testing. The current testing regime is:

- Marine algae (Mintocellus polymorphus) 48 hour growth test
- Wedge shell (Macomona liliana) 96 hour survival and burial test
- Blue mussel embryo (Mytilus gallprovincialis) 48 hour embryo development test.

These species have been approved by HBRC for measuring toxicity in our final combined discharge water.

The samples for the toxicity assessments do not need to be necessarily taken during the sampling for Hills Laboratory analysis.

3.4 Condition 16

Condition 16 specifies the sampling requirements in the receiving water (at the ocean outfall diffuser).

The 10 sites for sampling under this condition are:

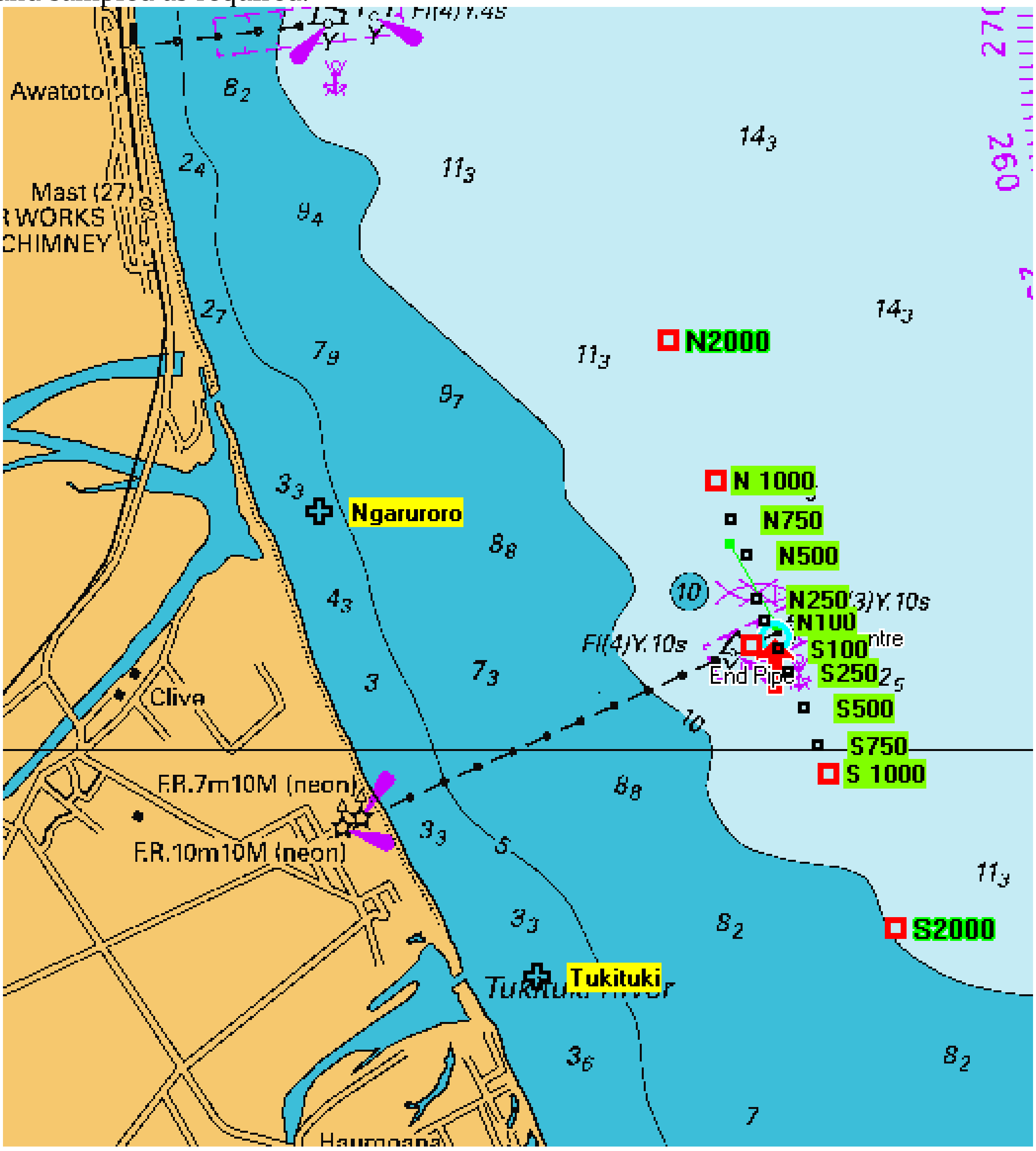
Site	Latitude S (WGS84)	Longitude E (WGS84)
1000m North	39.56785	176.96385
750m North	39.5702823	176.9650796
500m North	39.5723639	176.9662276
250m North	39.5748556	176.9669917
100m North	39.5760528	176.9675806
100m South	39.5777083	176.9686111
250m South	39.5790750	176.9694222
500m South	39.5811278	176.9705278
750m South	39.5832389	176.9715583
1000m South	39.5847338	176.9721880

Extra sites that are not required by the consent are also included in the sampling

Site	Latitude S (WGS84)	Longitude E (WGS84)
2000m North	39.5599111	176.9602111

2000m South	39.5937306	1769772333
Ngaruroro	39.5698861	176.9343917
Tukituki	39.5966444	176.9506306

These sites are depicted on the following chart along with two sites which are placed at the river outlets and sampled as required.



The field measurements will be taken using an YSI PRO DSS. The sample is taken 500mm to 1m below the surface to take the measurements for pH, Salinity, Turbidity, Temperature and Dissolved Oxygen. The instrument is calibrated according to the manufacturer's instructions prior to each use as follows:

pH – calibrated with standard pH 7 and pH 4 buffers

Turbidity – Calibrated Zero (filtered water) and 1000NTU standards

Salinity – Calibrated against conductivity standard 12.88mS/cm

Dissolved Oxygen – Calibrated in air saturated with water

All solutions used for calibration will be commercially sourced standard solutions. The standard will be diluted with deionised water to achieve the required strength as required. (E.g. turbidity standard).The microbiological samples are taken approximately 150mm below the surface using a polythene bottle and stored in a chilly bin (with an ice pack). On return the samples are transferred to bottles supplied by Hill Laboratories and packed into a Chilly Bin (with ice packs) and sent by overnight courier to Hill Laboratories.

These samples are sent the same day they are collected. In addition to the sampling required by the consent, the sample are analysed for Total Suspended Solids, Ammoniacal Nitrogen, Nitrate & Nitrite Nitrogen, Total Nitrogen, Dissolved Reactive Phosphorous and Total Phosphorous.

In case of any unforeseen failures in the sampling equipment or field measurement devices during sampling, HBRC will be notified as soon as practicable and an alternative arrangement will be made for sampling and measurements as required above and as per the instructions from HBRC.

3.5 Condition 17

Condition 17 specifies the requirement to measure surface currents at the ocean outfall diffuser

The surface currents are measured using a holey sock drogue with a Garmin Extrex10 GPS installed in the float. The GPS is set to log at 1 min intervals. For redundancy, two GPS devices will be used for surface current measurements.

The drogue with two GPS devices is released at the approximate centre of the outfall and left in the water while all the other sampling is carried out. The time and the position of the drogue at the start and the finish are recorded; this allows the calculation of the average current speed and direction, if required.

3.6 Condition 18

Condition 17 specifies the requirement for a Benthic Survey.

The Benthic Survey we will put out to tender at the appropriate time. The tender documents will include the requirements for consultation with the Hawkes Bay Regions Council and the Hawkes Bay District Health Board as required by the condition.

3.7 Condition 19

Condition 19 specifies the sampling requirements for seabed sediments.

The sediment samples will be taken the sites listed (see diagram Condition 16 for locations) using a mini ponar dredge.

The samples are placed in a sealed plastic container and stored in a chilly bin (with ice pack). On return the samples are subsampled into containers provided by Hill Laboratories, placed in a chilly bin (with ice packs) and sent to Hill Laboratories by overnight courier. If the samples cannot be sent the same day they will be refrigerated until they are sent.

3.8 Condition 20

Condition 20 specifies requirements of the laboratories undertaking analysis and field measurements.

All analyses other than field measurements and toxicity testing will be carried out by Hill Laboratories. The toxicity testing will be carried out by NIWA.

3.9 Condition 21

The results from the monitoring shall be sent to the HBRC (Manager Resource Use – via compliance officer) yearly unless there are any potential non-compliances in the sampling or analysis of samples. The results including a repeat analysis (if any) shall be sent with the final yearly consent report. .

However, the following data shall be readily made available to HBRC via HDC ID (Infrastructure Data Historian). ID access to HBRC shall be granted to view the following data from the day we receive the final analytical report for the quarter two (Q2) of the consent year.

- Daily Flow and Peak Flow
- Quarterly and Annual Analyses of the Total wastewater (excluding pesticides, VOC etc.)
- Domestic Analysis
- Sediments
- Receiving Water Quality
- Drogue
- Toxicity (Will record the “No toxicity” dilution)
- Odour Complaints

3.10 Condition 22

The buoys marking the outfall have recently been refurbished with new signage and lights. The photographs shows the signage.

3.11 Condition 23

The contact person is:

David McKenzie (Wastewater Manager) 06 871 5000 or 027 359 4494

3.12 Condition 28

Any odour complaints will be reported to HBRC as soon as practicable (and as per the WWTP Odour Management Plan), a list of the complaints will be forwarded along with the monitoring results. And also, all the odour complaints shall be logged in the ID with all the information (as per the Odour Management Plan) required by the ID form (WWATER-WWTP-ADHOC-Odour Investigation Report).

Appendix D Tabulated raw data - WWTP

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Final Combined Discharge at East Clive WWTP - Wastewater Quality Results (Raw Data output from Infrastructure Database)

	pH Hills [Lab]	Electrical Conductivity (EC - Lab)	Total Suspended Solids	Carbonaceous Biochemical Oxygen Demand ($cBOD_5$)	Chemical Oxygen Demand (COD), screen level	Oil and Grease - Soxhlet	Total Ammoniacal-N	Dissolved Reactive Phosphorus	Total Sulphide Screen	Acid Soluble Arsenic	Acid Soluble Cadmium	Acid Soluble Chromium	Hexavalent Chromium	Acid Soluble Copper	Acid Soluble Lead trace	Acid Soluble Mercury	Acid Soluble Nickel	Acid Soluble Zinc
Sample Date	**pH units**	**mS/m**	**g/m^3**	**$g\ O_2/m^3$**	**$g\ O_2/m^3$**	**g/m^3**	**g/m^3**	**mg/L**	**g/m^3**	**g/m^3**	**g/m^3**	**g/m^3**	**g/m^3**	**g/m^3**	**g/m^3**	**g/m^3**	**g/m^3**	**g/m^3**
8/08/2022	6.0	151	289	481	920	36	21	2.8	0.98	0.0028	0	0.0148	0	0.0043	0.0012	0	0.0037	0.0789
9/08/2022	6.6	133	232	283	561	28	13	0.7	0.30	0.0027	0	0.0378	0	0.0048	0.0020	0	0.0032	0.0837
10/08/2022	6.9	137	251	357	737	52	19	1.1	0.23	0.0025	0	0.0116	0	0.0103	0.0028	0	0.0044	0.0994
11/08/2022	6.7	157	300	356	880	55	24	1.1	1.01	0.0022	0	0.0242	0	0.0044	0.0015	0	0.0041	0.0687
12/08/2022	6.5	162	304	498	1040	42	30	2.4	2.24	0	0	0.0102	0	0.0040	0.0015	0	0.0050	0.0881
13/08/2022	7.0	179	165	229	540	38	25	1.4	0.19	0	0	0.0374	0	0.0043	0.0010	0	0.0028	0.0540
14/08/2022	7.3	99	127	130	270	21	15	1.4	0.12	0	0	0.0127	0	0.0084	0.0010	0	0.0013	0.0444
17/10/2022	6.7	147	225	328	854	54	25	3.0	1.34	0.0038	0	0.0237	0	0.0027	0.0019	0	0.0050	0.1589
17/10/2022	6.7	147	269	289	838	58	21	2.9	1.26	0.0038	0	0.0316	0	0.0030	0.0024	0	0.0074	0.3910
18/10/2022	6.5	152	238	389	950	65	23	2.7	2.67	0.0047	0	0.0380	0	0.0013	0.0019	0	0.0039	0.1006
18/10/2022	6.5	152	310	409	939	81	23	2.7	3.11	0.0050	0	0.0424	0	0.0020	0.0021	0	0.0041	0.1302
19/10/2022	6.6	191	241	476	974	66	46	3.1	5.52	0.0024	0	0.0467	0	0.0023	0.0015	0	0.0036	0.1139
19/10/2022	6.5	192	240	430	846	64	40	3.4	4.93	0.0023	0	0.0479	0	0.0024	0.0016	0	0.0043	0.1246
20/10/2022	6.8	178	240	533	1069	98	41	3.4	2.95	0.0024	0	0.0320	0	0.0031	0.0019	0	0.0031	0.1235
20/10/2022	6.8	181	262	399	1062	88	42	3.7	1.88	0.0023	0	0.0304	0	0.0033	0.0017	0	0.0031	0.1057
21/10/2022	7.3	189	155	91	549	34	30	2.8	1.59	0	0	0.0663	0	0.0019	0.0014	0	0.0026	0.0875
21/10/2022	7.1	188	149	181	514	36	30	2.8	0.47	0	0	0.0638	0	0.0016	0.0013	0	0.0024	0.0923
22/10/2022	7.4	161	167	155	455	19	35	1.9	8.46	0	0	0.0398	0	0.0017	0.0016	0	0.0035	0.0916
22/10/2022	7.3	161	146	158	435	26	30	1.9	8.40	0	0	0.0348	0	0.0014	0.0009	0	0.0030	0.0680
23/10/2022	7.3	100	100	60	204	19	14	1.7	0.18	0	0	0.0106	0	0.0042	0.0014	0	0.0015	0.0655
23/10/2022	7.4	100	132	68	236	19	15	1.7	0.28	0	0	0.0120	0	0.0031	0.0015	0	0.0023	0.0814
27/02/2023	6.8	100	87	153	415	26	9	1.2	1.06	0.0043	0.0001	0.0145	0	0.0038	0.0009	0	0.0032	0.0684
28/02/2023	6.9	82	183	155	379	30	7	0.8	0.49	0.0044	0	0.0263	0	0.0022	0.0025	0	0.0045	0.1011
1/03/2023	6.8	86	154	205	511	28	11	0.5	3.02	0.0029	0	0.0175	0	0.0019	0.0016	0	0.0035	0.0641
2/03/2023	6.7	102	243	300	754	42	16	1.2	4.79	0.0057	0	0.0201	0	0.0013	0.0021	0	0.0037	0.0902
3/03/2023	6.5	118	345	281	1027	62	18	2.2	3.41	0.0033	0.0001	0.0104	0	0.0014	0.0020	0	0.0031	0.0867
4/03/2023	6.9	113	278	266	785	52	28	1.1	4.11	0.0029	0.0001	0.0042	0	0.0015	0.0021	0	0.0036	0.1175
5/03/2023	7.1	96	352	222	723	46	19	1.0	0.34	0.0094	0.0001	0.0067	0	0.0141	0.0030	0	0.0034	0.1150
10/05/2023	6.4	125	340	380	1040	85	28	3.3	6.50	0.0010	0	0.0250	0	0.0049	0.0016	0.00007	0.0031	0.0740
11/05/2023	6.4	145	510	490	1070	76	25	3.8	3.10	0.0010	0	0.0920	0	0.0032	0.0015	0.00007	0.0033	0.0660
12/05/2023	6.5	143	360	580	1180	98	32	4.2	6.00	0.0010	0	0.0980	0	0.0030	0.0019	0.00007	0.0030	0.0840
13/05/2023	6.1	149	420	570	1660	121	24	4.1	0.10	0.0020	0.0001	0.0330	0.00998	0.0067	0.0018	0.00006	0.0039	0.4200
14/05/2023	6.7	142	350	330	760	81	23	2.2	0.94	0.0010	0	0.0140	0	0.0049	0.0024	0.00007	0.0032	0.1080
15/05/2023	7.2	102	290	186	660	56	21	2.2	0.09	0.0030	0	0.0053	0	0.0137	0.0024	0.00007	0.0027	0.0820
16/05/2023	6.5	129	370	570	1310	128	20	3.7	2.80	0.0010	0	0.0290	0	0.0050	0.0027	0.00007	0.0052	0.1610

NOTE: Yellow cells indicate where an analyte was not detected at concentrations above the relevant laboratory detection limit

Appendix E Tabulated raw data – receiving environment

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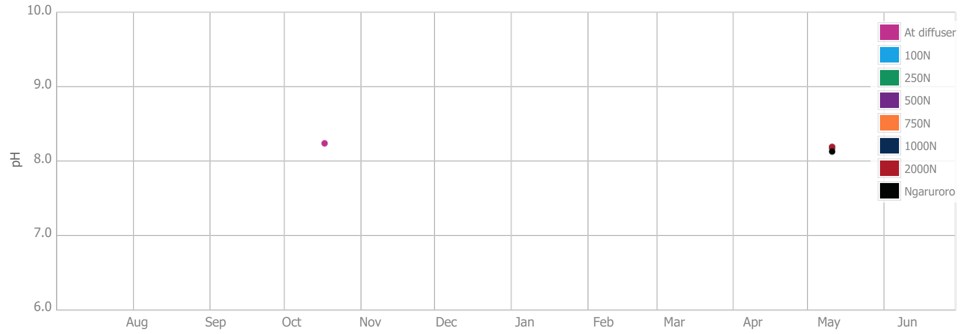
Receiving Environment (Hawke Bay) Water Quality Results (Raw Data output from Infrastructure Database)									
Sample Date	Location	Total Suspended Solids g/m^3	Total Nitrogen g/m^3	Total Ammoniacal-N g/m^3	Nitrate-N + Nitrite-N g/m^3	Dissolved Reactive Phosphorus g/m^3	Total Phosphorus g/m^3	Faecal Coliforms cfu/100mL	Enterococci cfu/100mL
8/08/2022	Ngaruroro	5	0.157	0.012	0.051	0.008	0.014	25	9
	2000N	6	0.335	0.025	0.215	0.022	0.028	39	16
	1000N	0	0.509	0.012	0.379	0.016	0.026	6	4
	750N	0	0.434	0.011	0.303	0.009	0.014	3	2
	500N	0	0.261	0.011	0.141	0.005	0.012	2	4
	250N	0	0.185	0.014	0.064	0.003	0.012	64	27
	100N	3	0.176	0.011	0.069	0.003	0.011	39	25
	100S	0	0.169	0.011	0.057	0.003	0.010	27	12
	250S	0	0.166	0.011	0.064	0.003	0.010	26	9
	500S	0	0.151	0.011	0.040	0.003	0.010	27	10
	750S	0	0.152	0.011	0.039	0.002	0.011	29	10
	1000S	0	0.141	0.011	0.042	0.003	0.010	24	16
	2000S	0	0.146	0.011	0.025	0.003	0.009	3	0
	TukiTuki	0	0.135	0.011	0.022	0.005	0.011	0	2
17/10/2022	Ngaruroro	7	0.532	0.010	0.262	0.009	0.016	12	3
	2000N	6	0.433	0.009	0.174	0.003	0.021	8	5
	1000N	7	0.398	0.009	0.077	0.000	0.013	8	1
	750N	7	0.326	0.009	0.160	0.002	0.010	11	2
	500N	10	0.317	0.009	0.128	0.000	0.011	8	3
	250N	9	0.361	0.010	0.167	0.002	0.013	7	2
	100N	11	0.484	0.009	0.208	0.005	0.013	8	1
	100S	10	0.356	0.010	0.142	0.002	0.017	9	1
	250S	10	0.467	0.010	0.156	0.003	0.015	11	3
	500S	10	0.397	0.008	0.211	0.005	0.017	7	10
	750S	7	0.512	0.010	0.203	0.006	0.017	5	3
	1000S	10	0.521	0.009	0.213	0.007	0.016	3	2
	2000S	10	0.308	0.009	0.165	0.006	0.013	2	1
	TukiTuki	29	0.689	0.011	0.409	0.015	0.032	36	7
3/03/2023	Ngaruroro	97	0.966	0.271	0.000	0.015	0.121	200	120
	2000N	20	0.333	0.023	0.157	0.015	0.019	120	70
	1000N	25	0.375	0.016	0.203	0.016	0.028	120	90
	750N	26	0.575	0.043	0.263	0.020	0.037	130	70
	500N	3	0.145	0.008	0.001	0.003	0.006	0.9	0.9
	250N	25	0.537	0.021	0.327	0.030	0.046	210	120
	100N	33	0.580	0.022	0.353	0.033	0.048	80	90
	100S	22	0.671	0.028	0.420	0.042	0.047	210	90
	250S	26	0.685	0.029	0.431	0.041	0.043	120	80
	500S	23	0.545	0.021	0.319	0.026	0.027	150	70
	750S	16	0.399	0.016	0.208	0.016	0.027	120	30
	1000S	17	0.404	0.018	0.198	0.016	0.019	90	23
	2000S	4	0.265	0.024	0.085	0.011	0.016	20	3
	TukiTuki	95	0.825	0.023	0.544	0.033	0.039	250	300
11/05/2023	Ngaruroro	156	0.180	0.012	0.083	0.011	0.072	180	170
	2000N	10	0.131	0.011	0.029	0.006	0.015	33	31
	1000N	11	0.119	0.010	0.031	0.006	0.012	34	37
	750N	9	0.097	0.011	0.030	0.006	0.010	38	31
	500N	11	0.143	0.010	0.028	0.003	0.014	340	180
	250N	6	0.124	0.008	0.027	0.003	0.011	170	170
	100N	5	0.260	0.005	0.026	0.002	0.007	9	4
	100S	9	0.130	0.008	0.028	0.003	0.013	310	400
	250S								
	500S	7	0.122	0.010	0.024	0.004	0.012	180	110
	750S	6	0.101	0.011	0.022	0.005	0.009	30	100
	1000S	3	0.094	0.010	0.024	0.005	0.009	36	40
	2000S	5	0.118	0.012	0.030	0.005	0.009	17	1
	TukiTuki	15	0.230	0.011	0.165	0.011	0.017	62	40

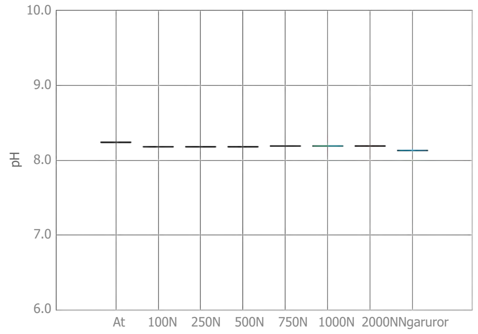
Note:
Yellow cells indicate where an analyte was not detected at concentrations above the relevant laboratory detection limit
Grey cells indicate missing data (or no sample taken)

Covers the period of 01/07/2022 to 30/06/2023

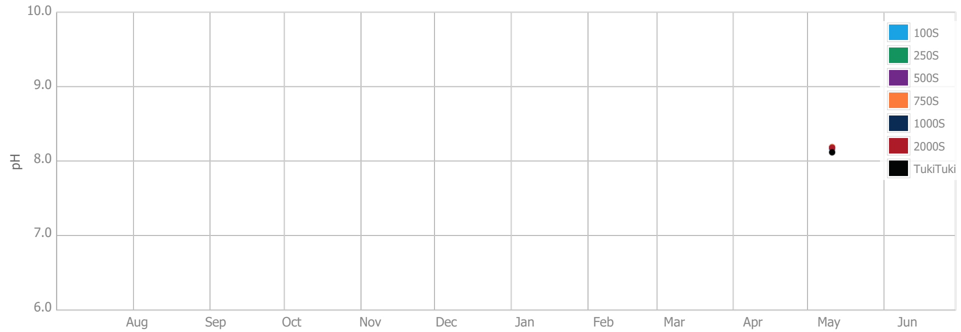
pH - Receiving Water - North Points



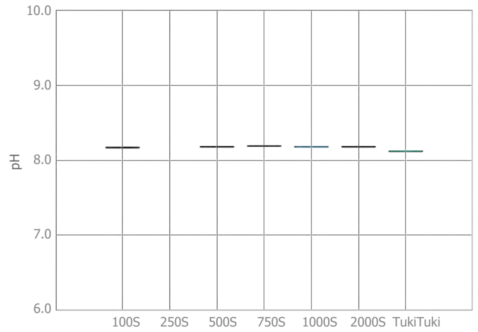
	Average	Minimum	Maximum	Standard Deviation
At diffuser	8.2	8.2	8.2	---
100N	8.2	8.2	8.2	---
250N	8.2	8.2	8.2	---
500N	8.2	8.2	8.2	---
750N	8.2	8.2	8.2	---
1000N	8.2	8.2	8.2	---
2000N	8.2	8.2	8.2	---
Ngaruroro	8.1	8.1	8.1	---



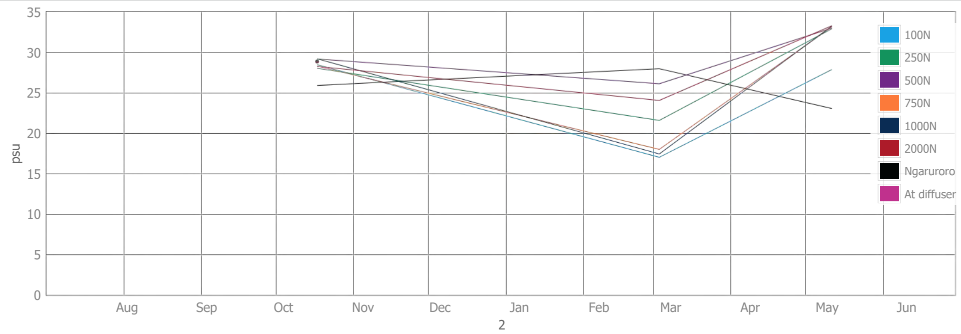
pH - Receiving Water - South Points



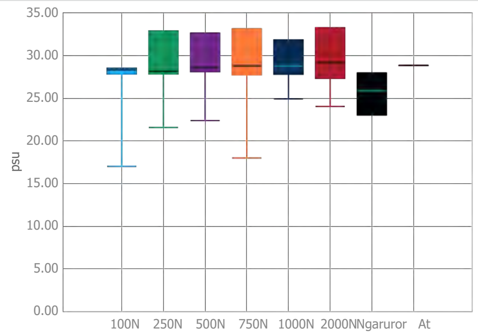
	Average	Minimum	Maximum	Standard Deviatio
100S	8.2	8.2	8.2	---
250S	---	---	---	---
500S	8.2	8.2	8.2	---
750S	8.2	8.2	8.2	---
1000S	8.2	8.2	8.2	---
2000S	8.2	8.2	8.2	---
TukiTuki	8.1	8.1	8.1	---



Salinity - Receiving Water - North Points

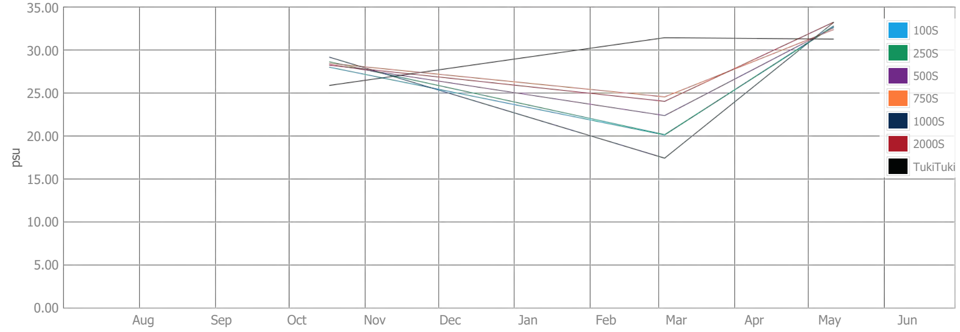


	Average	Minimum	Maximum	Standard Deviation
100N	25.45	17.02	28.54	5.63
250N	27.63	21.58	32.90	4.65
500N	29.42	26.11	32.99	3.45
750N	26.93	18.00	33.14	6.39
1000N	27.27	17.43	33.25	6.83
2000N	28.46	24.05	33.28	3.85
Ngaruroro	25.64	23.05	27.97	2.47
At diffuser	28.86	28.86	28.86	---

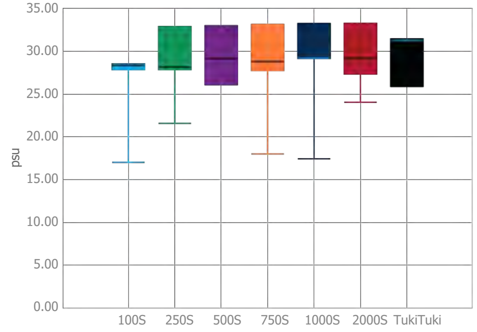


Covers the period of 01/07/2022 to 30/06/2023

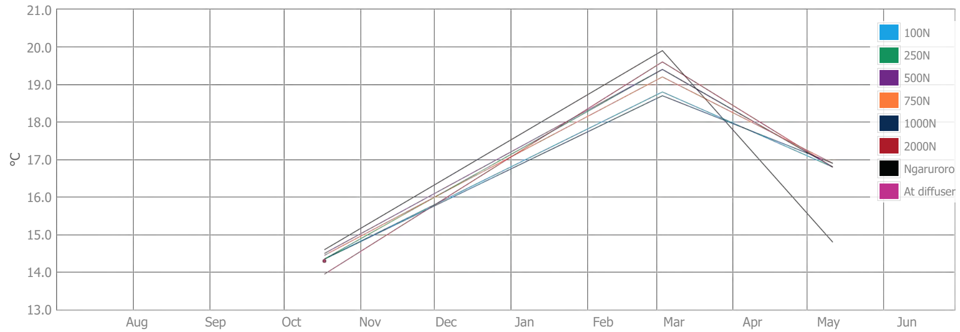
Salinity - Receiving Water - South Points



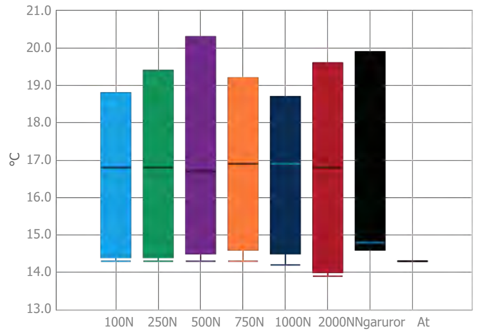
	Average	Minimum	Maximum	Standard Deviatio
100S	27.26	20.13	32.85	5.27
250S	27.63	21.58	32.90	4.65
500S	29.42	26.11	32.99	3.45
750S	26.93	18.00	33.14	6.39
1000S	28.35	24.94	31.85	2.85
2000S	28.46	24.05	33.28	3.85
TukiTuki	29.55	25.90	31.46	3.16



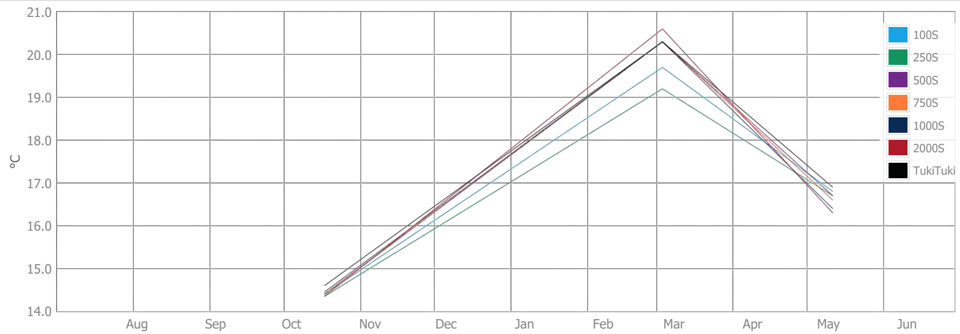
Temperature - Receiving Water - North Points



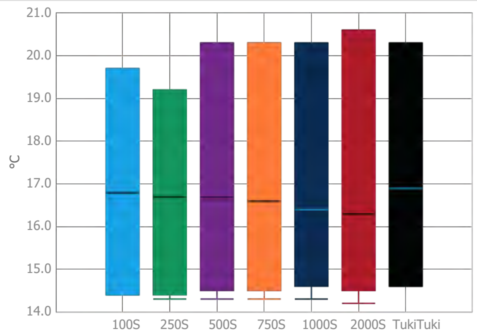
	Average	Minimum	Maximum	Standard Deviation
100N	16.1	14.3	18.8	2.2
250N	16.2	14.3	19.4	2.4
500N	16.9	14.5	19.4	2.5
750N	16.3	14.3	19.2	2.3
1000N	16.1	14.2	18.7	2.1
2000N	16.1	13.9	19.6	2.7
Ngaruroro	16.4	14.6	19.9	3.0
At diffuser	14.3	14.3	14.3	---



Temperature - Receiving Water - South Points

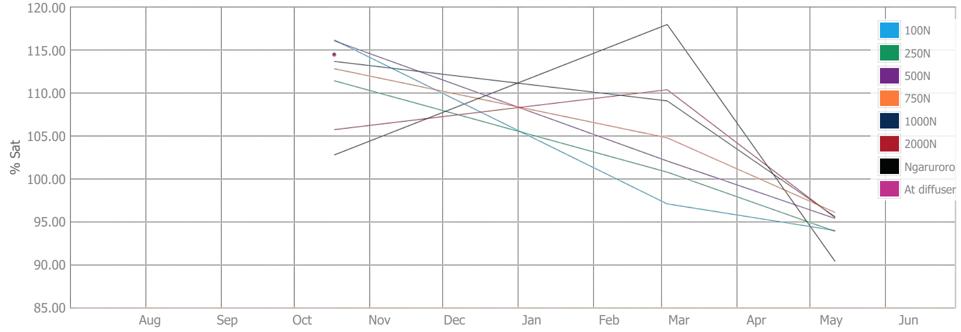


	Average	Minimum	Maximum	Standard Deviatio
100S	16.3	14.4	19.7	2.5
250S	16.2	14.3	19.2	2.3
500S	16.5	14.3	20.3	2.8
750S	16.4	14.3	20.3	2.8
1000S	16.4	14.3	20.3	2.8
2000S	16.4	14.2	20.6	2.9
TukiTuki	17.3	14.6	20.3	2.9

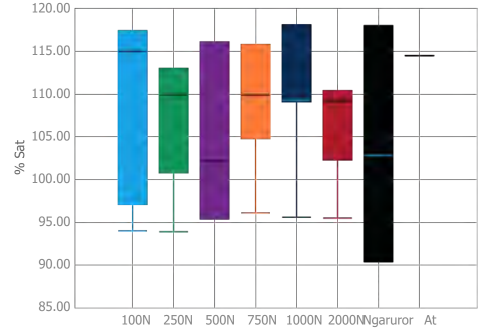


Covers the period of 01/07/2022 to 30/06/2023

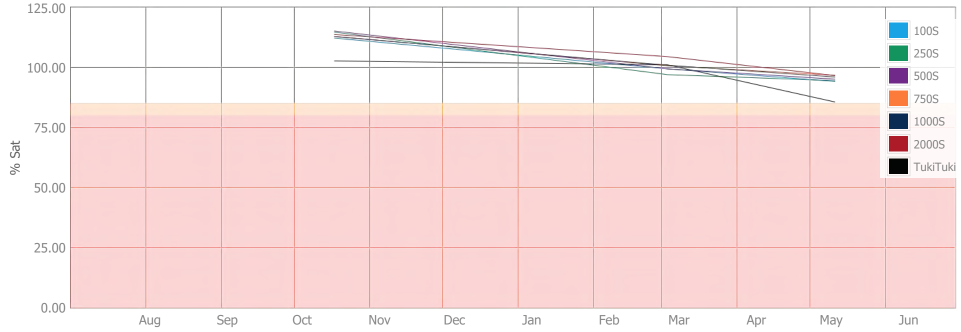
Dissolved oxygen - Receiving Water - North Points



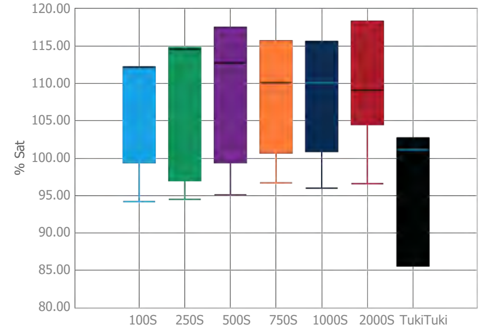
	Average	Minimum	Maximum	Standard Deviation
100N	105.88	94.00	117.40	12.03
250N	104.40	93.90	113.00	8.71
500N	104.53	95.40	116.10	10.56
750N	106.65	96.10	115.80	8.35
1000N	108.03	95.60	118.10	9.29
2000N	104.35	95.50	110.40	6.90
Ngaruroro	103.73	90.40	118.00	13.82
At	114.50	114.50	114.50	---



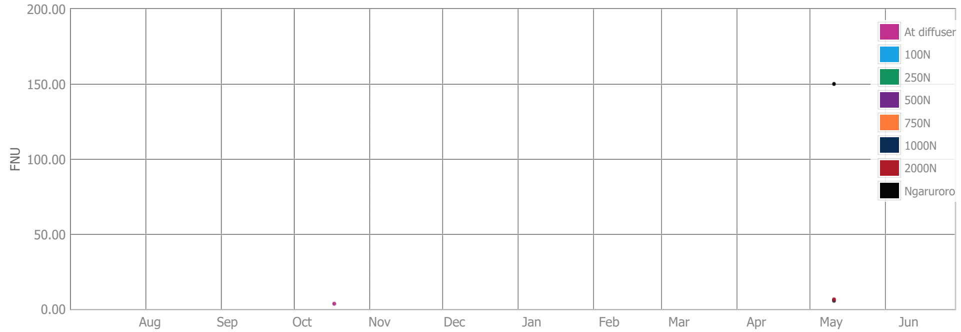
Dissolved oxygen - Receiving Water - South Points



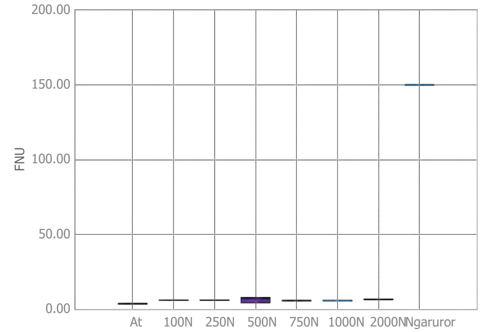
	Average	Minimum	Maximum	Standard Deviatio
100S	104.50	94.20	112.20	9.14
250S	105.23	94.50	114.80	10.99
500S	106.20	95.10	117.50	10.66
750S	105.80	96.70	115.70	8.67
1000S	105.65	96.00	115.60	8.84
2000S	107.13	96.60	118.30	9.06
TukiTuki	96.47	85.60	102.70	9.44



Turbidity- Receiving Water - North Points

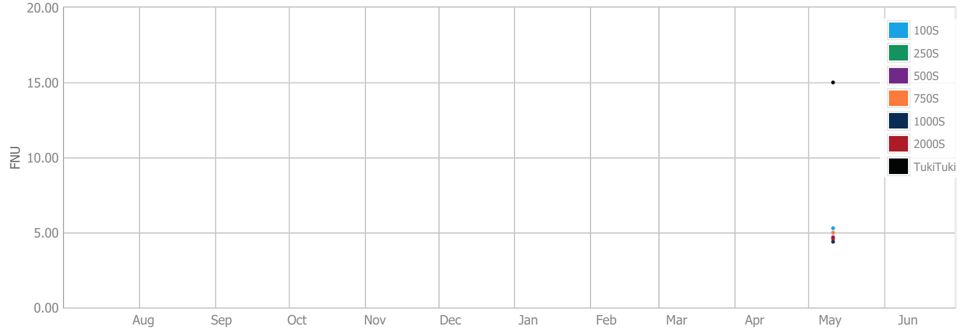


	Average	Minimum	Maximum	Standard Deviation
At diffuser	3.74	3.74	3.74	---
100N	6.10	6.10	6.10	---
250N	6.10	6.10	6.10	---
500N	6.15	4.50	7.80	2.33
750N	5.80	5.80	5.80	---
1000N	5.80	5.80	5.80	---
2000N	6.60	6.60	6.60	---
Ngaruroro	150.00	150.00	150.00	---

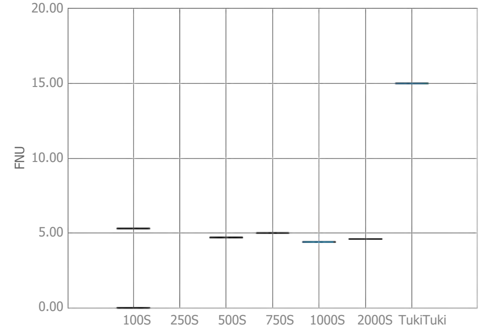


Covers the period of 01/07/2022 to 30/06/2023

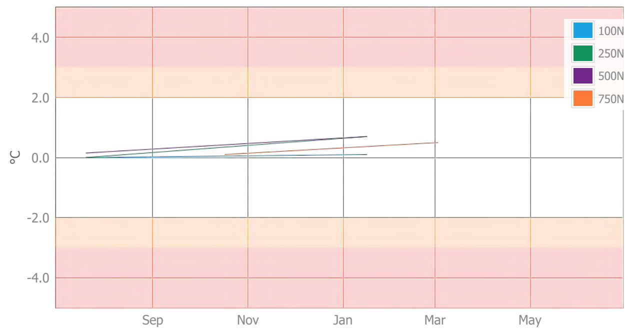
Turbidity - Receiving Water - South Points



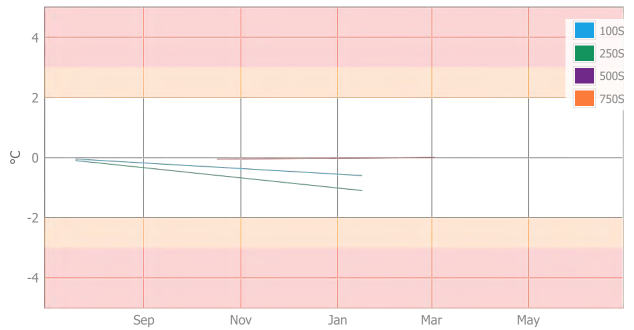
	Average	Minimum	Maximum	Standard Deviatio
100S	5.30	5.30	5.30	---
250S	---	---	---	---
500S	4.70	4.70	4.70	---
750S	5.00	5.00	5.00	---
1000S	4.40	4.40	4.40	---
2000S	4.60	4.60	4.60	---
TukiTuki	15.00	15.00	15.00	---



Temp Change (°C) - North Points compared to 1000N



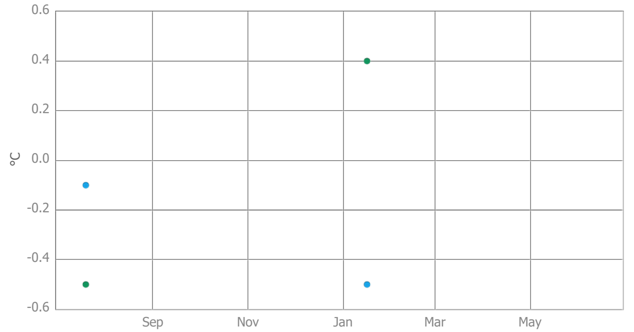
Temp Change (°C) - SouthPoints compared to 1000S



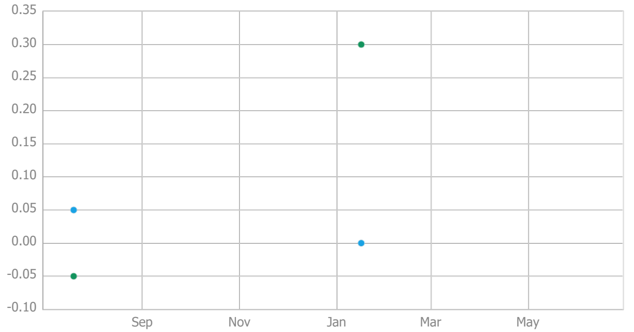
Notes:

CONSENT CD130214W - MAIN CLIVE WWTP
Condition 7
The discharge of the final combined wastewater as authorised by this Resource Consent shall not cause any of the following effects beyond a distance of 750m from the midpoint of the outfall diffuser:
a) The production of any conspicuous suspended materials; or
b) Any conspicuous change in the colour or visual clarity; and shall not cause any of the following effects beyond a distance of 500m from the midpoint of the outfall diffuser:
c) The production of any conspicuous oil or grease films, scums or foams, or floatable materials; or
d) Any emission of objectionable odour; or
e) Any significant adverse effects on aquatic life, or
f) A change of the natural temperature of the receiving water by more than 3 degrees Celsius, or
g) The Dissolved Oxygen concentration to be less than 80% of the saturation concentration, or
h) Undesirable biological growths.
Data Source:
Form.WQM-M3-YSI receiving water field sampling for WWTP
Form.WQM-M3-Outfall Surface current data (Drogue data)
Form.WQM-M3-WET testing

Temp Change (°C) - North Points compared to beyond 750N



Temp Change (°C) - South Points compared to beyond 750S



Appendix F Benthic Survey Report (*Draft*)

Connect with us

Quarterly Whole Effluent Toxicity testing for East Clive Wastewater Treatment Plant

August 2022

Prepared for Hastings District Council

September 2022

Prepared by:
Anathea Albert

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NIWA CLIENT REPORT No: 2022296HN
Report date: September 2022
NIWA Project: HCD22202

Quality Assurance Statement		
	Reviewed by:	Jennifer Gadd
	Formatting checked by:	Carli Nolan
	Approved for release by:	Michael Bruce

Contents

Tables

Executive summary

NIWA was engaged by Hastings District Council (HDC) to undertake quarterly Whole Effluent Toxicity (WET) testing of a treated effluent sample from East Clive Wastewater Treatment Plant to determine resource consent compliance. The sample, collected 8-9 August 2022, was tested with three marine organisms: a marine alga (*Minutocellus polymorphus* – 48-hour chronic growth test), and two bivalve species - wedge shell (*Macomona liliana* – 96-hour acute survival and burial test) and blue mussel (*Mytilus galloprovincialis* – 48-hour chronic embryo development test). The sample was also analysed for ammoniacal nitrogen (ammoniacal-N) and total sulfide.

This report documents the results of the toxicity testing. The algae, wedge shell, and blue mussel tests all met their respective test acceptability criteria based on control performance.

The algae and wedge shell did not show detectable toxicity at a 200-fold dilution. The blue mussel test showed detectable toxicity at a 200-fold dilution. The highest no-toxicity dilution was 282-fold from the blue mussel test. After application of the 200-fold dilution used for the 'no toxicity' criterion, the concentration of ammoniacal-N and total sulfide in the sample did not exceed ANZG (2018) default guideline values for 95% protection of species.

For the effluent sample in this quarter, the blue mussel test had a Threshold Effect Concentration (TEC) < 0.5% effluent, however no species had a consecutive incidence of TEC < 0.25% effluent between quarters and all species had EC_{10} (acute) or EC_{20} (chronic) > 0.5% effluent so no further action is required.

1 Introduction

East Clive Wastewater Treatment Plant treats both industrial and domestic wastewater and the treated effluent is discharged through an ocean outfall into Hawke Bay. NIWA was engaged by Hastings District Council (HDC) to undertake quarterly Whole Effluent Toxicity (WET) testing of effluent from the East Clive Wastewater Treatment Plant for compliance with Hawke's Bay Regional Council (HBRC) resource consent CD130214W condition 15. The effluent sample was tested with three organisms, a marine alga (*Minutocellus polymorphus* 48-hour chronic growth test), and 2 bivalve species: wedge shell (*Macomona liliana* 96-hour acute survival and burial test) and blue mussel (*Mytilus galloprovincialis* 48-hour chronic embryo development test).

Condition 15 states that there shall be no statistically detectable difference in toxicity between a water sample taken from uncontaminated near-shore water (from a location to be approved by Hawke's Bay Regional Council[1]), and treated wastewater when diluted 200-times with that water. No toxicity is defined as a no-toxicity dilution less than 200-fold. If the no-toxicity dilution is greater than 200-fold, the following three conditions must be examined:[2]

1. No more than one test species with a TEC[3] < 0.5% effluent in any given quarter.
2. No more than one consecutive incidence of TEC < 0.25% effluent within any given species between quarters.
3. EC_{20}[4] (chronic tests) and LC_{10} (acute tests) for all tests shall be greater than 0.5% effluent.

These conditions are described in a flow chart in Appendix A.

[1] Dilution water is 0.2 µm filtered offshore seawater collected by NIWA.
[2] These conditions interpret the flow chart in Appendix A describing the HBRC consent supplied to NIWA 25 Jun 2014.
[3] TEC=threshold effect concentration
[4] EC_x = dilution required to have an effect on X% of the test organisms. The lower the EC_x the greater the toxicity, indicating that a higher dilution was required to cause an X% effect on the test organisms.

2 Methods

2.1 Samples

A 2 L, single-use, food-grade high density polyethylene (HDPE) container was supplied by NIWA to HDC for collection of the 24 h composite effluent sample. The sample was collected by HDC staff on 8-9 August 2022 and a subsample was collected for total sulfide at the same time in a bottle supplied by Hill Laboratories. On arrival at NIWA Hamilton on 10 August 2022 the effluent sample was assigned a unique sample code (2682/TP4) and the physicochemical parameters measured. The effluent was subsampled for ammoniacal nitrogen (ammoniacal-N) and remaining sample was stored in the dark at 4°C until toxicity testing commenced (within 24 hours). The samples for ammoniacal-N and total sulfide were sent to Hill Laboratories for analysis.

2.2 Toxicity testing methods

Tests were completed according to NIWA Standard Operating Procedures (SOP):

- NIWA SOP 14.1–Marine algae chronic toxicity for *Minutocellus polymorphus.*
- NIWA SOP 58.0–Marine bivalve acute toxicity for *Macomona liliana.*
- NIWA SOP 21.2–Marine bivalve chronic toxicity for *Mytilus galloprovincialis.*

A summary of test conditions and test acceptability information specified in each of the SOP manuals is provided in Appendix B.

As well as a survival endpoint, the acute wedge shell test uses a sub-lethal endpoint (reburial, termed 'morbidity') to assess adverse effects on the test organisms because it is difficult to distinguish between live and recently dead juvenile bivalves. The reburial test is undertaken following 96 hours exposure to the effluent solutions and is a more sensitive and accurate endpoint than survival for this test species.

2.3 Sample dilutions

Each test included a range of sample dilutions. The diluent for all tests was NIWA's offshore seawater. The effluent sample was adjusted to the required test salinities, as specified by the standard operating procedures. For the wedge shell and blue mussel test, the sample was adjusted to the test salinity of 34 ppt using brine (made from frozen 0.2 µm filtered offshore seawater water) and tested at a maximum concentration of 20% effluent and 16% effluent respectively. For the algal test, the sample was adjusted to the required test salinity of 26 ppt using NIWA's offshore seawater for a maximum concentration of 32% effluent.

2.4 Reference toxicant

A reference toxicant test using zinc was undertaken concurrently using standard test procedures to measure the sensitivity and condition of the organisms in the current test. This is part of the quality control procedures and allows comparability between laboratory test results undertaken at different times by comparing results to the known sensitivity of the test organism to zinc (NIWA, unpublished long-term database). The zinc stock concentration was validated by chemical analysis (Hill Laboratories).

2.5 Test acceptability criteria

Each test has criteria that must be met for the test to be considered acceptable (Appendix B). For the alga test the increase in cell density in the control water must be greater than 16-fold and the coefficient of variation in the control replicates must be less than 20%. For the wedge shell test there must be at least 90% survival in control replicates and less than 10% morbidity in reburial control replicates. For the blue mussel test, at least 80% of the embryos in the control must have normal development.

2.6 Method detection limit

The method detection limit is a measure of the natural variability associated with each test calculated from the NIWA long-term database of test results. The current method detection limits were calculated in February 2021. If the percent effect is smaller than the method detection limit, then the effect may be due to natural variability in the test response—in this event, for compliance purposes, the NOEC and LOEC would be corrected to the concentrations at which the percent effect is greater than the method detection limit.

2.7 Statistics

Statistical analyses were completed using CETIS v1.9.7.7 (Comprehensive Environmental Toxicity Information System) by Tidepool Scientific.

3 Results

Results are summarized in this section (Tables 3-1 and 3-2). Raw data and detailed results from the statistical analyses are provided for all tests in Appendix C and chemistry results are provided in Appendix D.

Table 3-1: Measurements of municipal wastewater 24-hour composite sample after arrival at NIWA (10 August 2022) and results from analyses at Hill Laboratories. Temperature on arrival was measured as 11.2°C

Sample ID	NIWA Lab ID	pH	Temp (°C)	Salinity (ppt)	Ammoniacal-N (mg L^{-1})	Total Sulfide (S^{2-}) (mg L^{-1})
HDC 8-9/08/2022	2682/TP4	6.0	11	0.7	21	1.06

Table 3-2: Summary of key toxicity metrics for the test organisms exposed to HDC effluent collected 8-9 August 2022. Full results are provided in Appendix C.

Organism	EC_{10} [a] %	EC_{20} [a] %	EC_{50} [a] %	NOEC[b] %	LOEC[b] %	TEC[b] %	No-Toxicity dilution[c]	Complies Y/N[d]
Algae	0.3	0.8	2.8 (2.2–3.6)	0.5	1.0	**0.7**	141 x	**Y**
Wedge shell reburial[e]	-	-	>20.0	20.0	>20.0	**>20**	<5 x	**Y**
Wedge shell survival	-	-	>20.0	20.0	>20.0	**>20**	<5 x	**Y**
Blue mussel	0.6	0.9	1.9 (1.7–2.1)	0.25	0.5	**0.35**	282 x	**N**

[a] EC_x= dilution required to have an effect on X% of the test organisms. The lower the EC_x the greater the toxicity, indicating that a higher dilution was required to cause an effect on X% of test organisms. Values in parentheses indicate the 95% confidence intervals, [b] NOEC=No observed effect concentration, LOEC=Lowest observed effect concentration, TEC=threshold effect concentration (Geometric mean of NOEC and LOEC), [c] No-toxicity dilution is calculated as (1/TEC*100), [d] Bold indicates value used for compliance, [e] 60-minute reburial results (morbidity).

3.1 Algae – cell growth inhibition

The chronic algal growth test achieved the test acceptability criteria with a 194-fold increase in mean control cell density after 48 hours and a coefficient of variation (CV) < 20% (CV = 13.2%).

There was a statistically significant, 37% decrease in algal cell density at a concentration of 1% effluent (Appendix C), resulting in a LOEC of 1.0% and a NOEC of 0.5%. The no-toxicity dilution of 141-fold is within the compliance threshold of maximum 200-fold dilution.

3.2 Bivalve – wedge shell survival and morbidity

The wedge shell test achieved the test acceptability criterion with 100% survival and 98% reburial for the control treatments. Dissolved oxygen (DO) and pH were in the acceptable range for the test (Appendix D, Table D–2). The salinity at the end of the test (37-42 ppt) was higher than the acceptable range for the test (34 ± 2 ppt); this was likely due to evaporation of the solutions during the test because of insufficient covering of the test chambers. However, the higher salinity did not affect the survival or reburial of the wedge shells. There was no significant difference in mean survival (100%) and reburial (98%) between control and brine control replicates (data not shown).

There was no statistically significant decrease in survival or reburial at any effluent test concentration (maximum tested was 20% effluent), resulting in a no-toxicity dilution of <5-fold which is within the compliance threshold of maximum 200-fold dilution.

3.3 Bivalve - Blue Mussel embryo development

The chronic embryo development test achieved the test acceptability criterion of at least 80% controls with normal embryo development (mean 93%). Salinity and pH were in the acceptable range for the test (Appendix D, Table D-1), DO was in the acceptable range for the test except in the highest test concentration (16%). The brine solution did not affect normal embryo development at concentrations used in this test (data not shown).

There was a statistically significant 12.6% decrease in normal embryo development, at 0.5% effluent (Table 3-2, Appendix C), which is greater than the method detection limit of 5.1%. The no-toxicity dilution was 282-fold which is outside the compliance threshold of maximum 200-fold dilution.

3.4 Total sulfide

ANZG (2018) default guideline value for un-ionised sulfide: 0.001 mg L^{-1} H_2S.

The subsample for total sulfide was preserved at the time of sample collection. The total sulfide in the effluent sample collected 8-9 August 2022 was 1.06 mg L^{-1} which is equivalent to 0.04 mg L^{-1} of un-ionised sulfide[5], the more toxic form of sulfide in an aquatic ecosystem. The total sulfide concentration of the August 2022 effluent sample is similar to the long-term median value of 1.11 mg L^{-1} total sulfide for all HDC effluent samples analysed since 1992 (n=116).

After applying a 200-fold dilution, the resulting un-ionised sulfide concentration of 0.0002 mg L^{-1} was 5-fold lower than the ANZG (2018) default guideline value of 0.001 mg L^{-1} H_2S. Full results from the analysis of the effluent sample by Hill Laboratories are provided in Appendix D.

3.5 Ammoniacal-N

ANZG (2018) default guideline value: 0.910 mg L^{-1} ammoniacal-N, pH 8.

The ammoniacal-N concentration in the effluent sample was 21 mg L^{-1}, which is similar to the long-term median value of 16.1 mg L^{-1} for all HDC effluent samples analysed since 1992 (n=115). Applying a 200-fold dilution to the effluent sample resulted in a concentration of 0.1 mg L^{-1} ammoniacal-N, which is 9-fold lower than the ANZG (2018) default guideline value of 0.91 mg L^{-1} (at pH 8) for protection of 95% of marine species. Full results from the analysis of the effluent sample by Hill Laboratories are provided in Appendix D.

3.6 Reference toxicant

The EC_{50} for algae exposed to zinc sulfate (0.01 mg Zn L^{-1}) was within the expected range of the long-term mean of 0.011 ± 0.017 mg Zn^{2+} L^{-1} (±2 standard deviations (S.D.), n=20). The EC_{50} values for wedge shells exposed to zinc sulfate (survival 1.9, reburial 1.3 mg Zn L^{-1}) were within the expected range of the long-term mean for survival, xx ± xx mg Zn^{2+} L^{-1} (n=20), and reburial, xx ± xx mg Zn L^{-1} (n=20) respectively. The EC_{50} for blue mussel embryos exposed to zinc sulfate (0.17 mg Zn L^{-1}) was also within the expected range of the long-term mean is 0.17 ± 0.03 mg Zn L^{-1} (n=20).

[5] Calculated as 4.06% of total sulfide at pH 8.0, 20°C, 32.5 ppt (coastal waters) (ANZG 2018).

Based on chronic NOEC values derived from the zinc sulfate tests, the algae, blue mussels, wedge shell reburial, and wedge shell survival would rank within the 1st, 68th, 72nd and 83rd percentiles respectively of the most sensitive test organisms used for derivation of the ANZG (2021) guideline values for zinc in marine waters.

However, these sensitivity rankings are specific to zinc and care must be taken when extrapolating these results where other classes of contaminants (e.g., organics) may be present and for protection of all organisms present in a particular receiving water environment (e.g., Hawke's Bay).

4 Compliance Statement

Hawke's Bay Regional Council Resource Consent No. CD130214W condition 15 requires that there be no detectable toxicity at a 200-fold effluent dilution.

The blue mussel test showed detectable toxicity at a 200-fold dilution. The highest no-toxicity dilution was 282-fold from the blue mussel test. The algae and wedge shell tests did not show detectable toxicity at a 200-fold dilution.

If there is toxicity at a 200-fold dilution the following conditions must be examined: is there more than one test species with a TEC[6] < 0.5% effluent in any given quarter, is there a consecutive incidence of TEC < 0.25% effluent within any given species between quarters, and are EC_{20} (chronic tests) and LC_{10} (acute tests) for all tests greater than 0.5% effluent?

For the effluent sample in this quarter, only the blue mussel test had a TEC < 0.5% effluent, no species had a consecutive incidence of TEC < 0.25% effluent between quarters and all species had EC_{10} (acute) or EC_{20} (chronic) greater than 0.5% effluent, so no further action is required (Appendix A).

After application of the 200-fold dilution used for the ‘no toxicity’ criterion, the concentration of ammoniacal-N and total sulfide in the sample did not exceed ANZG (2018) default guideline values for 95% protection of species.

[6] TEC=threshold effect concentration

5 References

ANZG (2018) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Governments and Australian state and territory governments, Canberra, ACT, Australia. https://www.waterquality.gov.au/anz-guidelines

ANZG (2021) Toxicant default guideline values for aquatic ecosystem protection: Zinc in marine water. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. CC BY 4.0. Australian and New Zealand Governments and Australian state and territory governments, Canberra, ACT, Australia.

Environment Canada (1990) *Guidance document for control of toxicity test precision using reference toxicants.* No. EPS 1/RM12. Conservation and Protection, Environment Canada: 90.

NIWA (2013) Standard Operating Procedure Number 58. *Macomona liliana* 96-h Acute Toxicity Test Procedure. Hamilton, New Zealand, *NIWA Client Report:* 35.

NIWA (1996) Standard Operating Procedure Number *14.1*: Marine algal microplate method. Hamilton, New Zealand. *NIWA Client Report*: 13.

NIWA (2008) Standard Operating Procedure 21.2: Marine blue mussel embryo (Mytilus galloprovincialis). Short-term Chronic Toxicity Test Protocol. Hamilton, New Zealand, *NIWA Client Report*: 41.

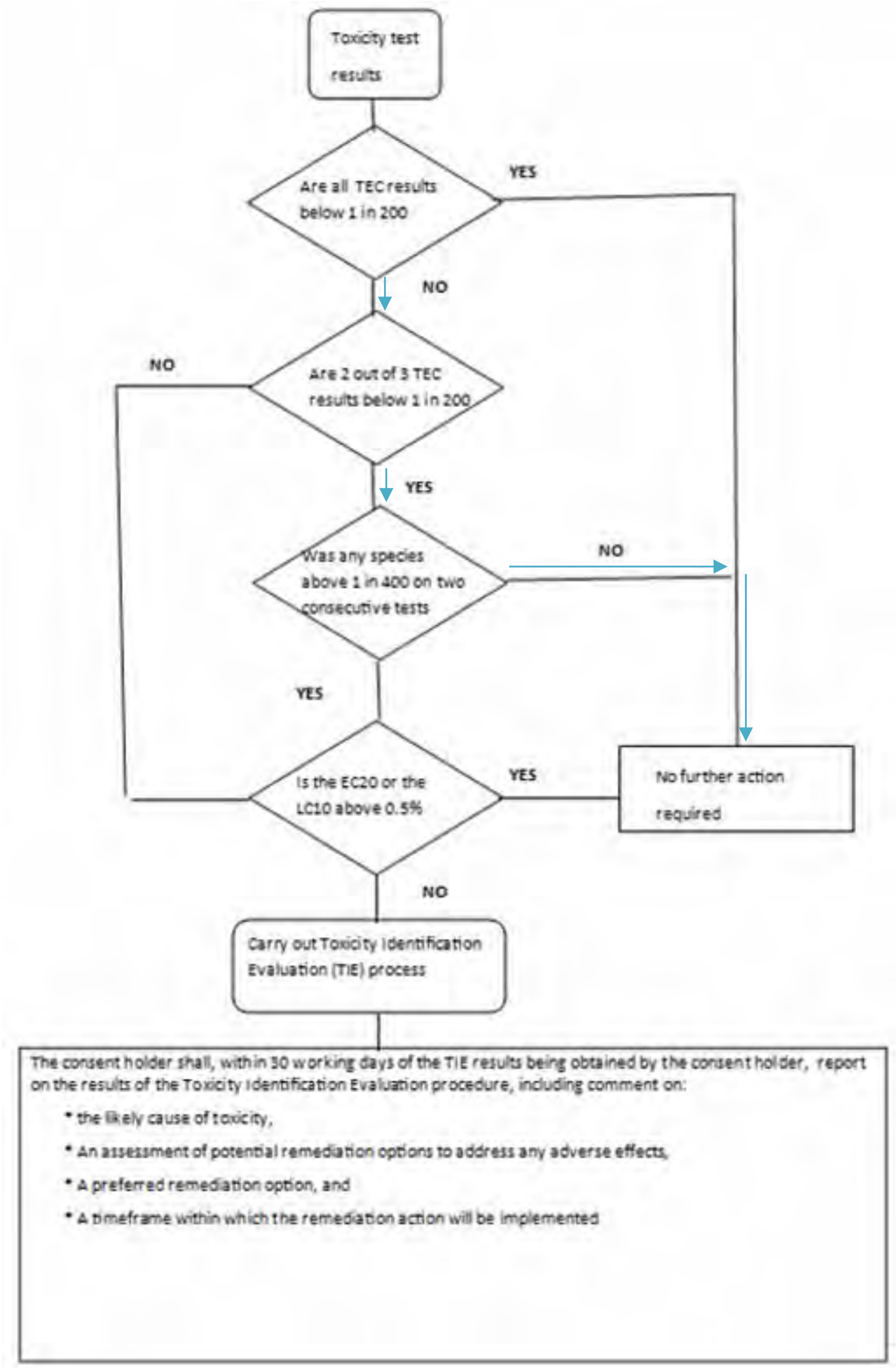
Roper, D.S., Hickey, C.W. (1994) Behavioural responses of the marine bivalve *Macomona liliana* exposed to copper- and chlordane-dosed sediments. *Marine Biology*, 118: 673–680.

Tidepool (2000-2020) CETIS™ Comprehensive Environmental Toxicity Information System. *CETIS Users Guide v.1.9.7.7* Tidepool Scientific Software, McKinleyville, CA, USA: 241

USEPA (1987) *Methods for toxicity tests of single substances and liquid complex wastes with marine unicellular algae. EPA-600-8/87/043*. US Environmental Protection Agency, Cincinnati, Ohio.

Williams, E.K., Hall, J.A. (1999) Seasonal and geographic variability in toxicant sensitivity of *Mytilus galloprovincialis* larvae. *Australasian Journal of Ecotoxicology*, 5(1): 1–10.

Appendix A Flow chart describing HBRC consent CD130214W condition 15[a]



[a]Supplied to NIWA 25 Jun 2014

Appendix B Test Conditions

Test conditions and dilutions for sample 2682/TP4

Project Name:	Hastings DC Effluent Bioassays: 2021–2022		**Project Number**	HDC22202
Test Material:	Hastings District Council 8-9/08/2022		**Reference Toxicant:**	Zinc sulphate
Dilution Water:	0.2 µm filtered offshore seawater from Pacific Ocean			

	Algae	**Bivalve–wedge shell**	**Bivalve–blue mussel embryos**
Reference Method:	US EPA (1987) modified with Environment Canada (1992)	Adapted from Roper & Hickey (1994)	Williams & Hall (1999b)
Test Protocol:	NIWA SOP 14.1 NIWA (1996)	NIWA SOP 58.0 NIWA (2013)	NIWA SOP 21.2 (2008)
Test Organisms:	*Minutocellus polymorphus*	*Macomona liliana*	*Mytilus galloprovincialis*
Source:	Lab culture (500), imported from Bigelow Laboratories, USA	Manukau Harbour, Wiroa Island control site	Coromandel Harbour
Organisms/Container:	10,000 cells mL^{-1}	10	600 fertilised embryos
Test Concentrations	Control, 0.125, 0.25, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0, 32.0%	Control, 0.25, 0.5, 1.0, 2.0, 5.0, 10.0, 20.0%	Control, 0.25, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0%
Test Duration:	48 hours	96 hours	48 hours
Replicates:	10 for controls, 5 for treatments	5 for controls, 3 for treatments	10 for controls, 5 for treatments
Sample pre-treatment:	0.45 µm filtration	Brine added to adjust salinity	Brine added to adjust salinity
Salinity:	26‰	34 $\pm$ 2‰	34 $\pm$ 2‰
Brine:	Nil	Filtered (0.2 µm) offshore seawater, frozen and thawed for brine collection	Filtered (0.2 µm) offshore seawater, frozen and thawed for brine collection
Test Chambers:	96 well sterile microplates	55 ml polystyrene beakers	16x100 mm glass tubes
Lighting:	Continuous overhead lighting	Complete darkness	16:8 light dark
Temperature:	25 ± 1°C	20 ± 1°C	20 ± 1°C
Aeration:	Nil	Nil	Nil
Chemical Data:	Initial salinity	Initial and final salinity, final pH, temperature, dissolved oxygen	Initial and final salinity, temperature, dissolved oxygen, pH
Effect Measured:	Growth inhibition	Survival and morbidity (survival, reburial)	Abnormal embryo development
Zn sensitivity current test; long term mean (EC_{50}±2sd):	0.01; 0.01 (0.000–0.03) mg Zn L^{-1} (n=20)	Survival 1.9; Reburial 1.3; 3.4 (1.1–5.8) mg L^{-1} Zn^{2+} (n=20) (survival); 1.8 (0.6–2.9) mg L^{-1} Zn^{2+} (n=20) (reburial)	0.15; 0.17 (0.14–0.2) mg Zn L^{-1} (n=20)
Test Acceptability:	Control coefficient of variation within 20%; at least 16x cell growth increase in controls.	At least 90% survival in control and less than 10% morbidity in control reburial	80% of control embryos normally developed
Method Detection Limit (MDL):	12.4% reduction relative to controls	4.1% reduction relative to controls	5.1% reduction relative to controls
Percent Minimum Significant Difference (PMSD):	7.8%	Survival not calculated Reburial 16.1%	6.2%
Test Acceptability Compliance:	**Achieved**	**Achieved**	**Achieved**

Appendix C Statistics

Algae

CETIS Analytical Report

Report Date:	05 Sep-22 17:14 (p 3 of 4)
Test Code/ID:	2682/TP4 MP7 / 00-4155-1042

Phytoplankton Growth Inhibition Test — **NIWA Ecotoxicology**

Analysis ID:	20-7454-2688	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv1.9.7
Analyzed:	05 Sep-22 17:13	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1093556FF30499C4873BB53715E9E8BB	**Editor ID:**	

Batch ID:	16-2734-5628	**Test Type:**	Cell Growth	**Analyst:**	Ecotox Team
Start Date:	10 Aug-22	**Protocol:**	NIWA (1996)	**Diluent:**	Offshore seawater
Ending Date:	12 Aug-22	**Species:**	Minutocellus polymorphus	**Brine:**	Not Applicable
Test Length:	48h	**Taxon:**		**Source:**	CCMP Bigelow Laboratory f **Age:**

Sample ID:	08-6867-8196	**Code:**	2682/TP4 MP7	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	09 Aug-22	**Material:**	POTW Effluent	**Source:**	Client Supplied
Receipt Date:	10 Aug-22	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	24h	**Client:**	Hastings District Council		

Comments: SC is control plate control, L is sample plate control

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	TU	MSDu	PMSD
Untransformed	C > T	0.5	1	0.7071	200	298500	15.36%

Bonferroni Adj t Test

Control	vs	Conc-%	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
Lab Water		0.0625	0.6314	2.687	3E+05	12	CDF	1.0000	Non-Significant Effect
		0.125	0.8333	2.687	3E+05	13	CDF	1.0000	Non-Significant Effect
		0.25	-2.865	2.687	3E+05	12	CDF	1.0000	Non-Significant Effect
		0.5	-1.075	2.687	3E+05	13	CDF	1.0000	Non-Significant Effect
		1*	5.954	2.687	3E+05	12	CDF	<1.0E-05	Significant Effect
		2*	7.931	2.687	3E+05	13	CDF	<1.0E-05	Significant Effect
		4*	10.33	2.687	3E+05	13	CDF	<1.0E-05	Significant Effect
		8*	12.8	2.687	3E+05	13	CDF	<1.0E-05	Significant Effect
		16*	13.37	2.687	3E+05	13	CDF	<1.0E-05	Significant Effect
		32*	15.45	2.687	3E+05	13	CDF	<1.0E-05	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	2.760E+13	2.760E+12	10	67.11	<1.0E-05	Significant Effect
Error	1.892E+12	4.113E+10	46			
Total	2.95E+13		56			

ANOVA Assumptions Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variance	Bartlett Equality of Variance Test	11.12	23.21	0.3480	Equal Variances
	Levene Equality of Variance Test	0.6989	2.733	0.7203	Equal Variances
	Mod Levene Equality of Variance Test	0.482	2.814	0.8915	Equal Variances
Distribution	Anderson-Darling A2 Test	0.4783	3.878	0.2399	Normal Distribution
	D'Agostino Kurtosis Test	1.905	2.576	0.0568	Normal Distribution
	D'Agostino Skewness Test	1.218	2.576	0.2232	Normal Distribution
	D'Agostino-Pearson K2 Omnibus Test	5.111	9.21	0.0776	Normal Distribution
	Kolmogorov-Smirnov D Test	0.08777	0.1364	0.3135	Normal Distribution
	Shapiro-Wilk W Normality Test	0.972	0.9434	0.2075	Normal Distribution

Phytoplankton Growth Inhibition Test **NIWA Ecotoxicology**

Analysis ID:	20-7454-2688	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv1.9.7
Analyzed:	05 Sep-22 17:13	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1093556FF30499C4873BB53715E9E8BB	**Editor ID:**	

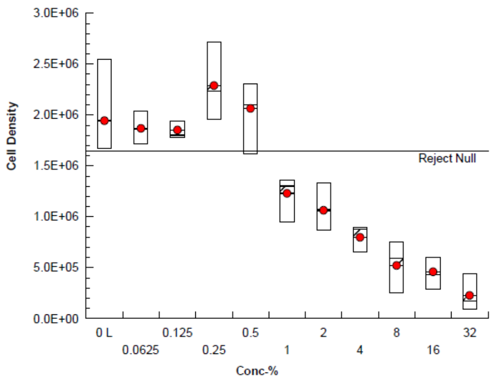
Cell Density Summary

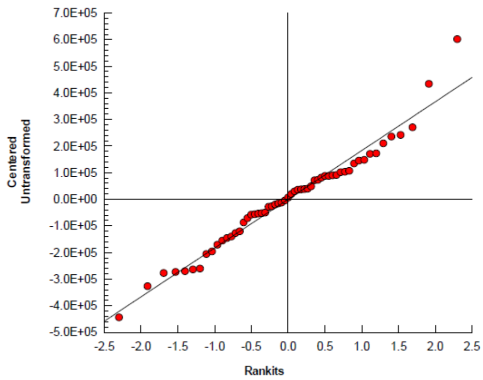
Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	L	10	1.944E+6	1.760E+6	2.127E+6	1.951E+6	1.673E+6	2.545E+6	8.094E+4	13.17%	0.00%
0.0625		4	1.868E+6	1.654E+6	2.081E+6	1.859E+6	1.712E+6	2.040E+6	6.712E+4	7.19%	3.90%
0.125		5	1.851E+6	1.749E+6	1.953E+6	1.801E+6	1.780E+6	1.942E+6	3.673E+4	4.44%	4.76%
0.25		4	2.287E+6	1.782E+6	2.793E+6	2.234E+6	1.961E+6	2.721E+6	1.588E+5	13.89%	-17.68%
0.5		5	2.063E+6	1.736E+6	2.390E+6	2.100E+6	1.619E+6	2.305E+6	1.179E+5	12.78%	-6.14%
1		4	1.229E+6	9.281E+5	1.530E+6	1.301E+6	9.523E+5	1.364E+6	9.462E+4	15.39%	36.75%
2		5	1.063E+6	8.409E+5	1.284E+6	1.069E+6	8.665E+5	1.333E+6	7.984E+4	16.80%	45.33%
4		5	7.965E+5	6.414E+5	9.516E+5	8.777E+5	6.507E+5	8.982E+5	5.586E+4	15.68%	59.02%
8		5	5.212E+5	2.389E+5	8.035E+5	5.941E+5	2.482E+5	7.568E+5	1.017E+5	43.62%	73.18%
16		5	4.587E+5	2.999E+5	6.175E+5	4.322E+5	2.876E+5	6.067E+5	5.720E+4	27.89%	76.40%
32		5	2.268E+5	6.147E+4	3.922E+5	1.746E+5	8.705E+4	4.368E+5	5.956E+4	58.71%	88.33%

Cell Density Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	L	1.973E+6	1.992E+6	2.015E+6	2.545E+6	1.915E+6	1.928E+6	1.683E+6	1.673E+6	2.031E+6	1.680E+6
0.0625		1.855E+6	1.863E+6	1.712E+6	2.040E+6						
0.125		1.793E+6	1.942E+6	1.780E+6	1.939E+6	1.801E+6					
0.25		2.200E+6	2.721E+6	1.961E+6	2.267E+6						
0.5		1.619E+6	2.100E+6	2.208E+6	2.083E+6	2.305E+6					
1		1.364E+6	1.336E+6	9.523E+5	1.265E+6						
2		1.333E+6	8.665E+5	1.102E+6	1.069E+6	9.422E+5					
4		6.507E+5	6.694E+5	8.982E+5	8.863E+5	8.777E+5					
8		2.482E+5	3.154E+5	5.941E+5	6.917E+5	7.568E+5					
16		2.876E+5	6.067E+5	4.322E+5	4.048E+5	5.620E+5					
32		4.368E+5	1.746E+5	2.650E+5	8.705E+4	1.708E+5					

Graphics





CETIS Analytical Report

Report Date: 05 Sep-22 17:14 (p 1 of 3)
Test Code/ID: 2682/TP4 MP7 / 00-4155-1042

Phytoplankton Growth Inhibition Test — **NIWA Ecotoxicology**

Analysis ID:	02-6953-4378	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv1.9.7
Analyzed:	05 Sep-22 17:13	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1093556FF30499C4873BB53715E9E8BB	**Editor ID:**	

Batch ID:	16-2734-5628	**Test Type:**	Cell Growth	**Analyst:**	Ecotox Team
Start Date:	10 Aug-22	**Protocol:**	NIWA (1996)	**Diluent:**	Offshore seawater
Ending Date:	12 Aug-22	**Species:**	Minutocellus polymorphus	**Brine:**	Not Applicable
Test Length:	48h	**Taxon:**		**Source:**	CCMP Bigelow Laboratory f **Age:**

Sample ID:	08-6867-8196	**Code:**	2682/TP4 MP7	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	09 Aug-22	**Material:**	POTW Effluent	**Source:**	Client Supplied
Receipt Date:	10 Aug-22	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	24h	**Client:**	Hastings District Council		

Comments: SC is control plate control, L is sample plate control

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Normal [ω=1]	Off [μ*=μ]	None	None

Regression Summary

Iters	LL	AICc	BIC	Adj R2	PMSD	Thresh	Optimize	F Stat	P-Value	Decision(α:5%)
17	-711.3	1429	1435	0.8643	6.56%	2024000	Yes	5.982	0.0000	Significant Lack-of-Fit

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
IC5	0.1697	0.004499	0.3426	589.2	291.9	22230
IC10	0.3469	0.1564	0.5559	288.3	179.9	639.2
IC15	0.5401	0.3053	0.8057	185.2	124.1	327.5
IC20	0.7537	0.4729	1.08	132.7	92.63	211.4
IC25	0.9924	0.6666	1.379	100.8	72.53	150
IC40	1.926	1.454	2.512	51.92	39.81	68.77
IC50	2.839	2.212	3.643	35.22	27.45	45.2

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	2024000	66240	1891000	2157000	30.56	<1.0E-05	Significant Parameter
γ	1.045	0.1413	0.7619	1.329	7.397	<1.0E-05	Significant Parameter
δ	2.839	0.428	1.981	3.697	6.634	<1.0E-05	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	1.266E+14	4.221E+13	3	590.4	<1.0E-05	Significant Effect
Lack of Fit	1.968E+12	2.461E+11	8	5.982	2.9E-05	Significant Lack-of-Fit
Pure Error	1.892E+12	4.113E+10	46			
Residual	3.86E+12	7.149E+10	54			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Variance	Bartlett Equality of Variance Test	11.12	18.31	0.3480	Equal Variances
	Mod Levene Equality of Variance	0.482	2.084	0.8915	Equal Variances
Distribution	Anderson-Darling A2 Test	0.6954	2.492	0.0694	Normal Distribution
	Shapiro-Wilk W Normality Test	0.9657	0.9588	0.1054	Normal Distribution

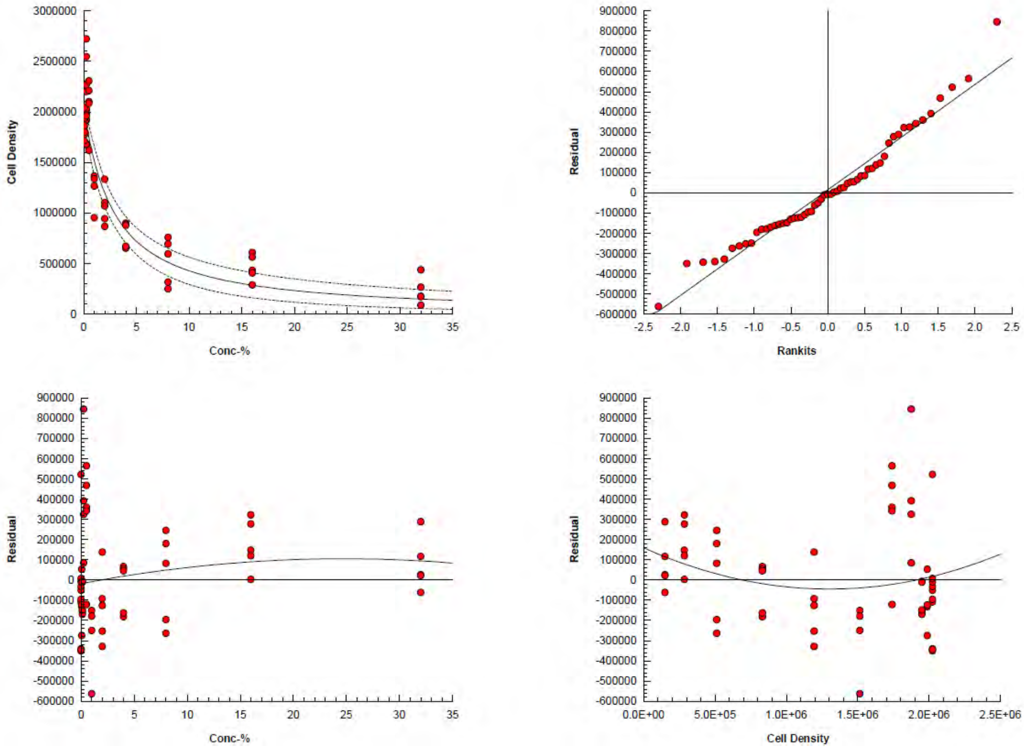
CETIS Analytical Report

Report Date: 05 Sep-22 17:14 (p 3 of 3)
Test Code/ID: 2682/TP4 MP7 / 00-4155-1042

Phytoplankton Growth Inhibition Test — **NIWA Ecotoxicology**

Analysis ID:	02-6953-4378	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv1.9.7
Analyzed:	05 Sep-22 17:13	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1093556FF30499C4873BB53715E9E8BB	**Editor ID:**	

Graphics — Model: 3P Log-Logistic: μ=α/[1+[x/δ]^γ] — Distribution: Normal [ω=1]



Wedge shell survival

CETIS Analytical Report

Report Date: 05 Sep-22 16:53 (p 3 of 4)
Test Code/ID: 2682/TP4 MAC / 09-1849-7826

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	10-1653-0958	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.7
Analyzed:	05 Sep-22 16:53	**Analysis:**	STP 2xK Contingency Tables	**Status Level:**	1
Edit Date:		**MD5 Hash:**	36106E84216150E38F99E9E82AC55705	**Editor ID:**	

Batch ID:	19-8718-6412	**Test Type:**	Survival-Reburial	**Analyst:**	Ecotox Team		
Start Date:	11 Aug-22	**Protocol:**	NIWA (1995)	**Diluent:**	Offshore seawater		
Ending Date:	15 Aug-22	**Species:**	Macomona liliana	**Brine:**	Frozen Coastal Seawater		
Test Length:	96h	**Taxon:**		**Source:**	Client Supplied	**Age:**	

Sample ID:	01-2830-3704	**Code:**	2682/TP4 MAC	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	09 Aug-22	**Material:**	POTW Effluent	**Source:**	Client Supplied
Receipt Date:	10 Aug-22	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	48h	**Client:**	Hastings District Council		

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	TU
Untransformed	C > T	20	>20	---	5

Fisher Exact/Bonferroni-Holm Test

Control	vs	Conc-%	Test Stat	P-Type	P-Value	Decision(α:5%)
SW Control		0.25	1.0000	Exact	1.0000	Non-Significant Effect
		0.5	1.0000	Exact	1.0000	Non-Significant Effect
		1	1.0000	Exact	1.0000	Non-Significant Effect
		2	1.0000	Exact	1.0000	Non-Significant Effect
		5	1.0000	Exact	1.0000	Non-Significant Effect
		10	0.1377	Exact	0.8259	Non-Significant Effect
		20	0.0173	Exact	0.1213	Non-Significant Effect

Survival Rate Frequencies

Conc-%	Code	NR	R	NR + R	Prop NR	Prop R	%Effect
0	SC	50	0	50	1.0000	0.0000	0.00%
0.25		30	0	30	1.0000	0.0000	0.00%
0.5		30	0	30	1.0000	0.0000	0.00%
1		30	0	30	1.0000	0.0000	0.00%
2		30	0	30	1.0000	0.0000	0.00%
5		30	0	30	1.0000	0.0000	0.00%
10		28	2	30	0.9333	0.0667	6.67%
20		26	4	30	0.8667	0.1333	13.33%

Survival Rate Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
0.25		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
0.5		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
1		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
2		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
5		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
10		3	0.9333	0.7899	1.0000	0.9000	0.9000	1.0000	0.0333	6.19%	6.67%
20		3	0.8667	0.7232	1.0000	0.9000	0.8000	0.9000	0.0333	6.66%	13.33%

Survival Rate Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	1.0000	1.0000	1.0000	1.0000	1.0000
0.25		1.0000	1.0000	1.0000		
0.5		1.0000	1.0000	1.0000		
1		1.0000	1.0000	1.0000		
2		1.0000	1.0000	1.0000		
5		1.0000	1.0000	1.0000		
10		1.0000	0.9000	0.9000		
20		0.9000	0.8000	0.9000		

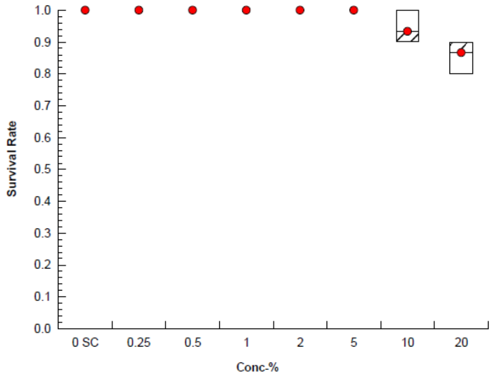
Macomona 96 h survival and reburial test | **NIWA Ecotoxicology**

Analysis ID:	10-1653-0958	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.7
Analyzed:	05 Sep-22 16:53	**Analysis:**	STP 2xK Contingency Tables	**Status Level:**	1
Edit Date:		**MD5 Hash:**	36106E84216150E38F99E9E82AC55705	**Editor ID:**	

Survival Rate Binomials

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	10/10	10/10	10/10	10/10	10/10
0.25		10/10	10/10	10/10		
0.5		10/10	10/10	10/10		
1		10/10	10/10	10/10		
2		10/10	10/10	10/10		
5		10/10	10/10	10/10		
10		10/10	9/10	9/10		
20		9/10	8/10	9/10		

Graphics



Wedge shell reburial

CETIS Analytical Report

Report Date: 05 Sep-22 16:53 (p 1 of 4)
Test Code/ID: 2682/TP4 MAC / 09-1849-7826

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	09-2634-1918	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv1.9.7
Analyzed:	05 Sep-22 16:52	**Analysis:**	STP 2xK Contingency Tables	**Status Level:**	1
Edit Date:		**MD5 Hash:**	BE61A9570C2C22275B4C26DCF4F11240	**Editor ID:**	

Batch ID:	19-8718-6412	**Test Type:**	Survival-Reburial	**Analyst:**	Ecotox Team
Start Date:	11 Aug-22	**Protocol:**	NIWA (1995)	**Diluent:**	Offshore seawater
Ending Date:	15 Aug-22	**Species:**	Macomona liliana	**Brine:**	Frozen Coastal Seawater
Test Length:	96h	**Taxon:**		**Source:**	Client Supplied **Age:**

Sample ID:	01-2830-3704	**Code:**	2682/TP4 MAC	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	09 Aug-22	**Material:**	POTW Effluent	**Source:**	Client Supplied
Receipt Date:	10 Aug-22	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	48h	**Client:**	Hastings District Council		

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	TU
Untransformed	C > T	20	>20	---	5

Fisher Exact/Bonferroni-Holm Test

Control	vs	Conc-%	Test Stat	P-Type	P-Value	Decision(α:5%)
SW Control		0.25	1.0000	Exact	1.0000	Non-Significant Effect
		0.5	1.0000	Exact	1.0000	Non-Significant Effect
		1	0.6123	Exact	1.0000	Non-Significant Effect
		2	0.3141	Exact	1.0000	Non-Significant Effect
		5	0.6123	Exact	1.0000	Non-Significant Effect
		10	0.1457	Exact	0.8741	Non-Significant Effect
		20	0.0257	Exact	0.1798	Non-Significant Effect

Eff. Survival Rate Frequencies

Conc-%	Code	NR	R	NR + R	Prop NR	Prop R	%Effect
0	SC	49	1	50	0.9800	0.0200	0.00%
0.25		30	0	30	1.0000	0.0000	-2.04%
0.5		30	0	30	1.0000	0.0000	-2.04%
1		29	1	30	0.9667	0.0333	1.36%
2		28	2	30	0.9333	0.0667	4.76%
5		29	1	30	0.9667	0.0333	1.36%
10		27	3	30	0.9000	0.1000	8.16%
20		25	5	30	0.8333	0.1667	14.97%

Eff. Survival Rate Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	5	0.9800	0.9245	1.0000	1.0000	0.9000	1.0000	0.0200	4.56%	0.00%
0.25		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	-2.04%
0.5		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	-2.04%
1		3	0.9667	0.8232	1.0000	1.0000	0.9000	1.0000	0.0333	5.97%	1.36%
2		3	0.9333	0.6465	1.0000	1.0000	0.8000	1.0000	0.0667	12.37%	4.76%
5		3	0.9667	0.8232	1.0000	1.0000	0.9000	1.0000	0.0333	5.97%	1.36%
10		3	0.9000	0.8996	0.9004	0.9000	0.9000	0.9000	0.0000	0.00%	8.16%
20		3	0.8333	0.3162	1.0000	0.9000	0.6000	1.0000	0.1202	24.98%	14.97%

Eff. Survival Rate Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	1.0000	1.0000	0.9000	1.0000	1.0000
0.25		1.0000	1.0000	1.0000		
0.5		1.0000	1.0000	1.0000		
1		0.9000	1.0000	1.0000		
2		1.0000	0.8000	1.0000		
5		0.9000	1.0000	1.0000		
10		0.9000	0.9000	0.9000		
20		0.9000	1.0000	0.6000		

CETIS Analytical Report

Report Date: 05 Sep-22 16:53 (p 2 of 4)
Test Code/ID: 2682/TP4 MAC / 09-1849-7826

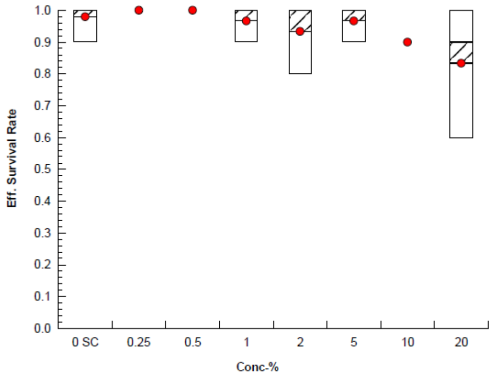
Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	09-2634-1918	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv1.9.7
Analyzed:	05 Sep-22 16:52	**Analysis:**	STP 2xK Contingency Tables	**Status Level:**	1
Edit Date:		**MD5 Hash:**	BE61A9570C2C22275B4C26DCF4F11240	**Editor ID:**	

Eff. Survival Rate Binomials

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	10/10	10/10	9/10	10/10	10/10
0.25		10/10	10/10	10/10		
0.5		10/10	10/10	10/10		
1		9/10	10/10	10/10		
2		10/10	8/10	10/10		
5		9/10	10/10	10/10		
10		9/10	9/10	9/10		
20		9/10	10/10	6/10		

Graphics



Blue mussel

CETIS Analytical Report

Report Date: 29 Sep-22 10:07 (p 1 of 3)
Test Code/ID: 2682/TP4 MyG / 10-8895-4817

Bivalve Larval Survival and Development Test — **NIWA Ecotoxicology**

Analysis ID:	12-4194-6428	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv1.9.7
Analyzed:	29 Sep-22 10:06	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:	28 Sep-22 16:54	**MD5 Hash:**	43CD7AE1F381F0A30A54336659F7B398	**Editor ID:**	001-024-732-2

Batch ID:	18-8287-7537	**Test Type:**	Development	**Analyst:**	Ecotox Team
Start Date:	10 Aug-22	**Protocol:**	NIWA (2008)	**Diluent:**	Seawater
Ending Date:	12 Aug-22	**Species:**	Mytilus galloprovincialis	**Brine:**	Frozen Coastal Seawater
Test Length:	48h	**Taxon:**		**Source:**	Coromandel **Age:**

Sample ID:	06-1549-9613	**Code:**	2682/TP4 MyG	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	09 Aug-22	**Material:**	POTW Effluent	**Source:**	Client Supplied
Receipt Date:	10 Aug-22	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	24h	**Client:**	Hastings District Council		

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	TU	MSDu	PMSD
Angular (Corrected)	C > T	0.25	0.5	0.3536	400	0.05428	6.16%

Bonferroni Adj t Test

Control	vs	Conc-%	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
SW Control		0.25	1.593	2.522	0.08	13	CDF	0.3620	Non-Significant Effect
		0.5*	4.676	2.522	0.08	13	CDF	0.0001	Significant Effect
		1*	7.915	2.522	0.08	13	CDF	<1.0E-05	Significant Effect
		2*	14.8	2.522	0.08	13	CDF	<1.0E-05	Significant Effect
		4*	27.01	2.522	0.08	13	CDF	<1.0E-05	Significant Effect
		8*	33.73	2.522	0.08	13	CDF	<1.0E-05	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	5.81067	0.968444	6	291.7	<1.0E-05	Significant Effect
Error	0.109559	0.00332	33			
Total	5.92023		39			

ANOVA Assumptions Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variance	Bartlett Equality of Variance Test	12.17	16.81	0.0582	Equal Variances
	Levene Equality of Variance Test	2.082	3.406	0.0822	Equal Variances
	Mod Levene Equality of Variance Test	1.318	3.558	0.2833	Equal Variances
Distribution	Anderson-Darling A2 Test	0.7206	3.878	0.0600	Normal Distribution
	D'Agostino Kurtosis Test	0.3288	2.576	0.7423	Normal Distribution
	D'Agostino Skewness Test	1.231	2.576	0.2182	Normal Distribution
	D'Agostino-Pearson K2 Omnibus Test	1.625	9.21	0.4438	Normal Distribution
	Kolmogorov-Smirnov D Test	0.164	0.1617	0.0084	Non-Normal Distribution
	Shapiro-Wilk W Normality Test	0.9579	0.9236	0.1418	Normal Distribution

Proportion Normal Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	10	0.8809	0.8597	0.9021	0.8744	0.8300	0.9400	0.0094	3.36%	0.00%
0.25		5	0.8462	0.7914	0.9011	0.8500	0.7800	0.8900	0.0198	5.22%	3.93%
0.5		5	0.7700	0.6945	0.8455	0.7800	0.6800	0.8500	0.0272	7.90%	12.59%
1		5	0.6800	0.6035	0.7565	0.6700	0.6300	0.7800	0.0276	9.07%	22.80%
2		5	0.4684	0.4516	0.4851	0.4700	0.4500	0.4818	0.0060	2.88%	46.83%
4		5	0.1303	0.1047	0.1559	0.1200	0.1100	0.1616	0.0092	15.81%	85.21%
8		5	0.0246	0.0000	0.0675	0.0000	0.0000	0.0722	0.0155	140.25%	97.20%

Proportion Normal Binomials

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	SC	87/100	87/100	87/100	94/100	87/99	89/100	86/100	89/100	91/100	83/100
0.25		89/100	85/100	83/100	89/101	78/100					
0.5		76/100	78/100	85/100	68/100	78/100					
1		78/100	69/100	63/100	63/100	67/100					
2		46/100	53/110	48/100	45/100	47/100					
4		12/100	11/100	16/99	12/100	14/100					
8		7/97	5/98	0/35	0/22	0/30					

CETIS Analytical Report		Report Date:	29 Sep-22 10:07 (p 3 of 3)
		Test Code/ID:	2682/TP4 MyG / 10-8895-4817

Bivalve Larval Survival and Development Test — **NIWA Ecotoxicology**

Analysis ID:	12-4194-6428	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv1.9.7
Analyzed:	29 Sep-22 10:06	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:	28 Sep-22 16:54	**MD5 Hash:**	43CD7AE1F381F0A30A54336659F7B398	**Editor ID:**	001-024-732-2

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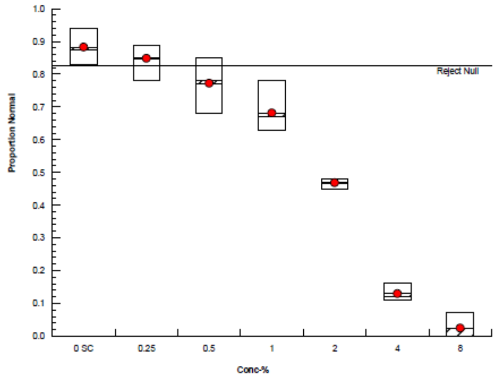

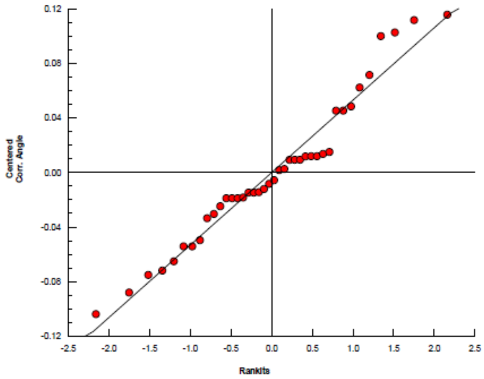

Linear Regression Options

Model Name	Link Function	Threshold Option	Thresh	PMSD	Optimize	Pooled	Het Corr	Weighted
Log-Normal (Probit)	η=inv Φ[π]	Control Threshold	0.135399	2.65%	Yes	No	Yes	Yes

Regression Summary

Iters	LL	AICc	BIC	Mu	Sigma	Cov	R2	F Stat	P-Value	Decision(α:5%)
12	-113.4	233.5	237.9	0.2810856	0.369332	-0.006351	0.9823	2.684	0.0484	Significant Lack-of-Fit

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
EC5	0.4716	0.3626	0.58	212	172.4	275.8
EC10	0.6423	0.5151	0.7654	155.7	130.6	194.1
EC15	0.7912	0.6521	0.9238	126.4	108.2	153.3
EC20	0.9338	0.7859	1.074	107.1	93.13	127.2
EC25	1.076	0.9216	1.223	92.9	81.8	108.5
EC40	1.54	1.369	1.705	64.94	58.66	73.02
EC50	1.91	1.727	2.095	52.35	47.73	57.91

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	Test Stat	P-Value	Decision(α:5%)
Intercept	-0.7611	0.07879	-0.9207	-0.6014	-9.659	<1.0E-05	Significant Parameter
Slope	2.708	0.1727	2.358	3.058	15.68	<1.0E-05	Significant Parameter
Threshold	0.1354	0.01129	0.1125	0.1583	11.99	<1.0E-05	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	3422	1711	2	1081	<1.0E-05	Significant Effect
Lack of Fit	14.38	3.595	4	2.684	0.0484	Significant Lack-of-Fit
Pure Error	44.2	1.339	33			
Residual	58.58	1.583	37			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Model Fit	Likelihood Ratio GOF Test	61.33	52.19	0.0072	Significant Heterogeneity
	Pearson Chi-Sq GOF Test	58.58	52.19	0.0134	Significant Heterogeneity
Variance	Bartlett Equality of Variance Test	11.16	12.59	0.0836	Equal Variances
	Mod Levene Equality of Variance	1.132	2.459	0.3707	Equal Variances
Distribution	Anderson-Darling A2 Test	0.4356	2.492	0.3032	Normal Distribution
	Shapiro-Wilk W Normality Test	0.973	0.9447	0.4462	Normal Distribution
Overdispersion	Tarone C(α) BinOverdispersion Te	1.492	1.645	0.0678	Non-Significant Overdispersion

Bivalve Larval Survival and Development Test **NIWA Ecotoxicology**

Analysis ID:	11-5510-5561	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv1.9.7
Analyzed:	29 Sep-22 10:06	**Analysis:**	Linear Regression (GLM)	**Status Level:**	1
Edit Date:	28 Sep-22 16:54	**MD5 Hash:**	43CD7AE1F381F0A30A54336659F7B398	**Editor ID:**	001-024-732-2

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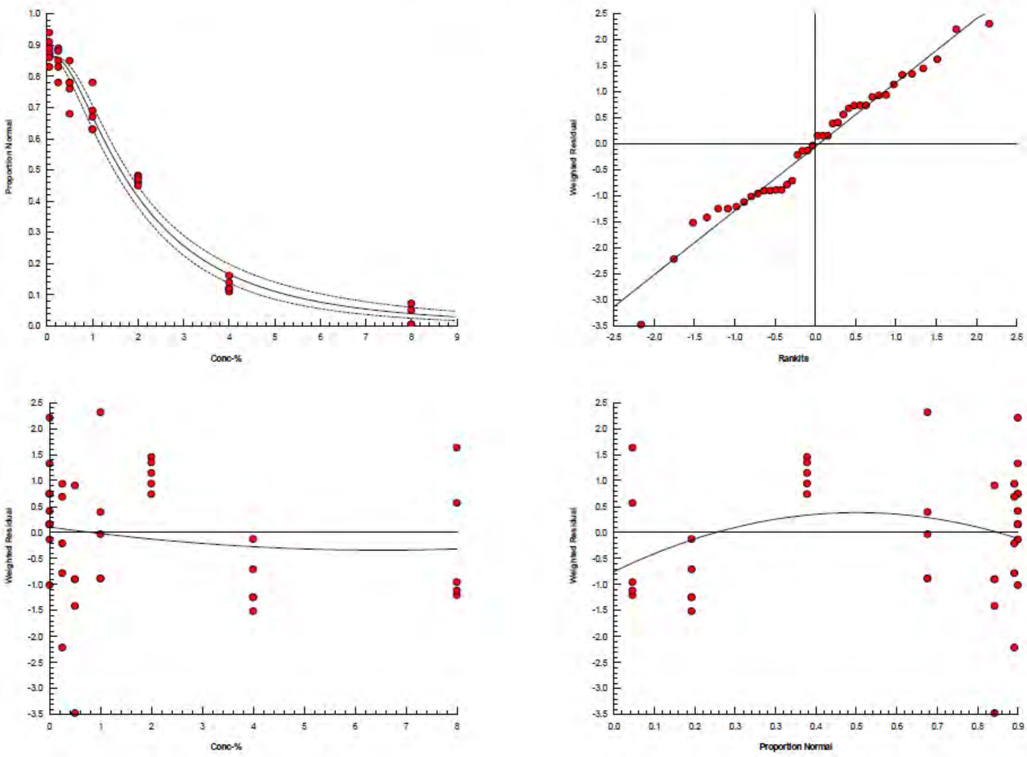

Appendix D Hill Laboratories results and bioassay physico-chemistry

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
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E mail@hill-labs.co.nz
W www.hill-laboratories.com

Certificate of Analysis

Page 1 of 1

Client:	NIWA Corporate	**Lab No:**	3052028 SPv1
Contact:	Anathea Albert C/- NIWA Corporate PO Box 11115 Hillcrest Hamilton 3251	**Date Received:**	10-Aug-2022
		Date Reported:	17-Aug-2022
		Quote No:	51353
		Order No:	11315078
		Client Reference:	
		Submitted By:	Anathea Albert

Sample Type: Aqueous

Sample Name:		TP4 10-Aug-2022
Lab Number:		3052028.1
Total Ammoniacal-N	g/m³	21
Total Sulphide	g/m³	1.06

Summary of Methods

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

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) 23rd ed. 2017.	0.010 g/m³	1
Total Sulphide Trace	In-line distillation, segmented flow colorimetry. APHA 4500-S^{2-} E (modified) 23rd ed. 2017.	0.002 g/m³	1

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

Testing was completed between 15-Aug-2022 and 17-Aug-2022. For completion dates of individual analyses please contact the laboratory.

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

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

Ara Heron BSc (Tech)
Client Services Manager - Environmental

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.
The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

Table D-1: Water quality measures from the blue mussel test. Grey shading indicates values that are outside the acceptable range for the test.

Date	Time (h)	Sample	Concentration (%)	Temp (°C)	pH	DO (mg L^{-1})	DO (%)	Salinity (ppt)
10/08/2022	0	Control	0	21	7.6	7.4	102	35
		TP4	0.25	21	8.0	7.2	99	35
			16	21	7.7	6.8	94	34
12/08/2022	48	Control	0	22	8.0	7.2	101	35
		TP4	0.25	22	8.4	6.9	97	34
			0.5	22	8.3	6.9	97	34
			1	22	8.3	7.0	98	34
			2	22	8.2	6.7	94	35
			4	22	8.2	6.6	93	34
			8	22	8.1	5.9	83	35
			16	22	8.0	2.7	38	34

Table D-2: Water quality measures from the wedge shell test. Grey shading indicates values that are outside the acceptable range for the test.

Date	Time (h)	Sample	Concentration (%)	Temp (°C)	pH	DO (mg L^{-1})	DO (%)	Salinity (ppt)
11/08/2022	0	Control	0	21	8.0	7.2	99	34
		TP4	0.25	20	8.1	8.8	119	34
			20	21	7.8	8.7	120	34
15/08/2022	96	Control	0	21	7.6	7.1	98	38
		TP4	0.25	21	8.0	7.1	98	42
			0.5	21	8.2	7.2	99	39
			1	21	8.2	7.2	99	37
			2	21	8.2	7.1	98	37
			5	21	8.2	7.0	97	37
			10	21	8.2	7.0	97	38
			20	21	8.2	6.8	94	39

Quarterly Whole Effluent Toxicity Testing of East Clive Wastewater Treatment Plant

February 2023

Prepared for Hastings District Council

May 2023

Prepared by:
Karen Thompson

For any information regarding this report please contact:

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Aquatic Ecology and Ecotoxicology Technician
Chemistry and Ecotoxicology
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NIWA CLIENT REPORT No:	2023108HN
Report date:	May 2023
NIWA Project:	HCD23201

Quality Assurance Statement		
	Reviewed by:	Dr C.W. Hickey, RMA Science
	Formatting checked by:	Jo Downey
	Approved for release by:	Michael Bruce

Contents

Tables

Figures

Executive summary

NIWA was engaged by Hastings District Council (HDC) to undertake quarterly Whole Effluent Toxicity (WET) testing of a treated effluent sample from East Clive Wastewater Treatment Plant to determine resource consent compliance. The sample, collected 27-28 February 2023, was tested with three marine organisms: an alga (*Minutocellus polymorphus* – 48-hour chronic growth test), and two bivalve species - wedge shell (*Macomona liliana* – 96-hour acute survival and burial test) and blue mussel (*Mytilus galloprovincialis* – 48-hour chronic embryo development test). The sample was also analysed for ammoniacal-nitrogen (ammoniacal-N) and total sulfide.

This report documents the results of the toxicity testing. The alga, wedge shell, and blue mussel tests all met their respective test acceptability criteria based on control performance.

The alga, wedge shell and blue mussel test showed no detectable toxicity at a 200-fold dilution. The highest no-toxicity dilution was 141-fold derived from the blue mussel tests. After application of the 200-fold dilution used for the 'no toxicity' criterion, the concentration of ammoniacal-N and total sulfide in the sample did not exceed ANZG (2018) default guideline values for 95% protection of species.

1 Introduction

East Clive Wastewater Treatment Plant treats both industrial and domestic wastewater and the treated effluent is discharged through an ocean outfall into Hawke Bay. NIWA was engaged by Hastings District Council (HDC) to undertake quarterly Whole Effluent Toxicity (WET) testing of effluent from the East Clive Wastewater Treatment Plant for compliance with Hawke's Bay Regional Council (HBRC) resource consent CD130214W condition 15. The effluent sample was tested with three marine organisms: an alga (*Minutocellus polymorphus* 48-hour chronic growth test), and 2 bivalve species: wedge shell (*Macomona liliana* 96-hour acute survival and burial test) and blue mussel (*Mytilus galloprovincialis* 48-hour chronic embryo development test).

Condition 15 states that there shall be no statistically detectable difference in toxicity between a water sample taken from uncontaminated near-shore water (from a location to be approved by Hawke's Bay Regional Council[1]) and treated wastewater when diluted 200-times with that water. No toxicity is defined as a no-toxicity dilution less than 200-fold. If the no-toxicity dilution is greater than 200-fold, the following three conditions must be examined:[2]

1. No more than one test species with a TEC[3] < 0.5% effluent in any given quarter.
2. No more than one consecutive incidence of TEC < 0.25% effluent within any given species between quarters.
3. EC_{20}[4] (chronic tests) and LC_{10} (acute tests) for all tests shall be greater than 0.5% effluent.

These conditions are described in a flow chart in Appendix A.

[1] Dilution water is 0.2 µm filtered offshore seawater collected by NIWA.
[2] These conditions interpret the flow chart in Appendix A describing the HBRC consent supplied to NIWA 25 Jun 2014.
[3] TEC = threshold effect concentration
[4] EC_x = dilution required to have an effect on X% of the test organisms. The lower the EC_x the greater the toxicity, indicating that a higher dilution was required to cause an X% effect on the test organisms.

2 Methods

2.1 Samples

A 2 L, single-use, food-grade high density polyethylene (HDPE) container was supplied by NIWA to HDC for collection of the 24 h composite effluent sample. The sample was collected by HDC staff on 27-28 February 2023 and a subsample was collected for total sulfide at the same time in a bottle supplied by Hill Laboratories via NIWA. On arrival at NIWA Hamilton on 1 March 2023 the effluent sample was assigned a unique sample code (23.003.1) and the physicochemical parameters measured. The effluent was subsampled for ammoniacal-nitrogen (ammoniacal-N) and the remaining sample was stored in the dark at 4°C until toxicity testing commenced (within 24 hours). The samples for ammoniacal-N and total sulfide were sent to Hill Laboratories for analysis.

2.2 Toxicity testing methods

Tests were completed according to NIWA Standard Operating Procedures (SOP):

- NIWA SOP 14.1–Marine alga chronic toxicity for *Minutocellus polymorphus.*
- NIWA SOP 58.0–Marine bivalve acute toxicity for *Macomona liliana.*
- NIWA SOP 21.2–Marine bivalve chronic toxicity for *Mytilus galloprovincialis.*

A summary of test conditions and test acceptability information specified in each of the SOP manuals is provided in Appendix B.

As well as a survival endpoint, the acute wedge shell test uses a sub-lethal endpoint (reburial, termed 'morbidity') to assess adverse effects on the test organisms because it is difficult to distinguish between live and recently dead juvenile bivalves. The reburial test is undertaken following 96 hours exposure to the effluent solutions and is a more sensitive and accurate endpoint than survival for this test species.

2.3 Sample dilutions

Each test included a range of sample dilutions. The diluent for all tests was NIWA's offshore seawater. The effluent sample was adjusted to the required test salinities, as specified by the standard operating procedures. For the wedge shell and blue mussel test, the sample was adjusted to the test salinity of 34 ppt using brine (made from frozen 0.2 µm filtered offshore seawater) and tested at a maximum concentration of 65% effluent and 16% effluent respectively. For the algal test, the sample was adjusted to the required test salinity of 26 ppt using NIWA's offshore seawater for a maximum concentration of 32% effluent.

2.4 Reference toxicant

Reference toxicant tests using zinc were undertaken concurrently to measure the sensitivity and condition of the organisms in the current test. This is part of the quality control procedures and allows comparability between laboratory test results undertaken at different times by comparing results to the known sensitivity of the test organism to zinc (NIWA, unpublished long-term database). NIWA uses zinc for all species as a reference toxicant because of the large amount of available toxicity data. Zinc was considered a suitable reference toxicant by Environment Canada (1990) for its solubility, stability and shelf-life. The zinc stock concentration was validated by chemical analysis (Hill Laboratories).

2.5 Test acceptability criteria

Each test has criteria that must be met for the test to be considered acceptable (Appendix B). For the alga test, the increase in cell density in the control replicates must be greater than 16-fold and the coefficient of variation in the control replicate cell density must be less than 20%. For the wedge shell test, there must be at least 90% survival of organisms in control replicates and less than 10% morbidity in reburial control replicates. For the blue mussel test, at least 80% of the embryos in the control must have normal development.

2.6 Method detection limit

The method detection limit is a measure of the natural variability associated with each test calculated from the NIWA long-term database of test results. If the percent effect is smaller than the method detection limit, then the effect may be due to natural variability in the test response—in this event, for compliance purposes, the NOEC and LOEC would be corrected to the concentrations at which the percent effect is greater than the method detection limit.

2.7 Statistics

Statistical analyses were completed using CETIS v2.1.4.5 (Comprehensive Environmental Toxicity Information System) software by Tidepool Scientific.

3 Results

Results are summarized in this section (Tables 3-1 and 3-2). Raw data and detailed results from the statistical analyses are provided for all tests in Appendix C and chemistry results are provided in Appendix D.

Table 3-1: Measurements of municipal wastewater 24-hour composite sample after arrival at NIWA (1 March 2023) and results from analyses at Hill Laboratories.

Sample ID	NIWA Lab ID	pH	Temp[a] (°C)	Salinity (ppt)	Ammoniacal-N (mg L^{-1})	Total Sulfide (S^{2-}) (mg L^{-1})
WWTP East Clive Discharge	23.003.1	7.61	21.2	0.54	6.67	0.060

[a] At time of measurements.

Table 3-2: Summary of key toxicity metrics for the test organisms exposed to HDC effluent collected 27-28 February 2023. Full results are provided in Appendix C.

Organism	EC_{10} [a] %	EC_{20}[a] %	EC_{50}[a] %	NOEC[b] %	LOEC[b] %	TEC[b] %	No-Toxicity dilution[c]	Complies Y/N[d]
Alga	-[f]	-[f]	9.8 (8.1-11.9)	4.0	8.0	**5.7**	18 x	**Y**
Wedge shell reburial[e]	5.1	8.3	19 (14-26)	3.2	10	**5.7**	18 x	**Y**
Wedge shell survival	8.9	14	29 (22-40)	10	32	**17.9**	5.6 x	**Y**
Blue mussel	2.7	3.6	5.6 (5.2–6.1)	0.5	1.0	**0.71**	141 x	**Y**

[a] EC_x= dilution required to have an effect on X% of the test organisms. The lower the EC_x the greater the toxicity, indicating that a higher dilution was required to cause an effect on X% of test organisms. Values in parentheses indicate the 95% confidence intervals, [b] NOEC=No observed effect concentration, LOEC=Lowest observed effect concentration, TEC=threshold effect concentration (Geometric mean of NOEC and LOEC), [c] No-toxicity dilution is calculated as (1/TEC*100), [d] Bold indicates value used for compliance, [e] 60-minute reburial results (morbidity). [f] EC_{10} and EC_{20} values excluded due to significant lack of fit with statistical model when derived.

3.1 Alga – cell growth inhibition

The chronic algal growth test achieved the test acceptability criteria with a 136-fold increase in mean control cell density after 48 hours and a coefficient of variation (CV) < 20% (CV = 6.2%).

The alga showed an anomalous concentration-response relationship with a decrease in cell density, becoming statistically significant at 0.0625% effluent (26% inhibition relative to the control) and continuing until a low point at 0.125% effluent (36% inhibition), followed by an increase in cell density up to 4% effluent (13% stimulation) and then a further statistically significant decrease at 8% with a progressive concentration-response inhibition through to 32% effluent (Figure 3-1). There was a statistically significant, 42% decrease in algal cell density at a concentration of 8% effluent (Appendix C), resulting in a LOEC of 4% and a NOEC of 8%.

The anomalous concentration-response relationship at high wastewater dilutions is likely caused by complex chemical reactions or algal/chemical interactions, which were not apparent at intermediate dilutions. Based on the clear concentration-response relationship observed at wastewater dilutions greater than 4% concentration, that portion of the exposure-response is considered the most definitive for the toxic threshold calculation.

This form of anomalous concentration-response relationship has been previously observed for the algal toxicity test for the Hastings wastewater (e.g., November 2021 (Albert 2021), January 2022 (Albert 2022b), May 2022 (Albert 2022a) and August 2022 (Albert 2022)). However, this type of response is not always observed (e.g., October 2022 (Thompson 2022)).

The statistically-derived no-toxicity dilution of 18-fold (i.e., TEC = 5.7%) does not exceed the compliance maximum threshold of 200-fold dilution (Table 3-2).

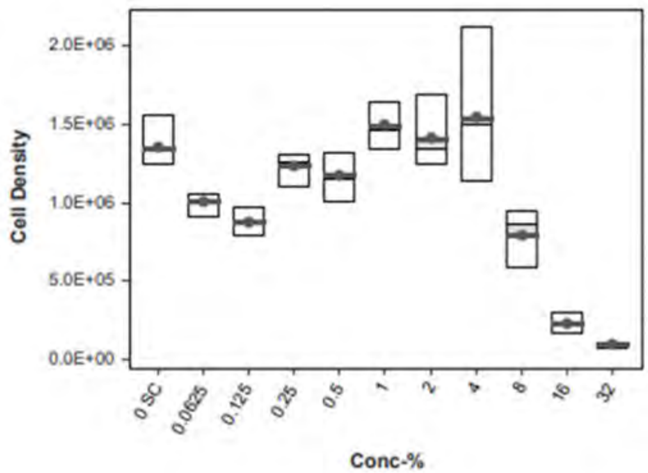


Figure 3-1: Concentration-response relationship for alga exposed to 27-28 February 2023 East Clive WWTP effluent sample diluted with oceanic water. SC = seawater control.

3.2 Bivalve – wedge shell survival and morbidity

The wedge shell test achieved the test acceptability criterion with 100% survival and 92% reburial for the control treatments. Dissolved oxygen (DO), temperature, pH and salinity were in the acceptable range for the test (Appendix E, Table E–1). There was no significant difference in mean survival (both 100%) and reburial (92% and 96%) between control and brine control replicates (data not shown).

There was a statistically significant decrease in survival at 32% effluent and reburial at 10% effluent with 43% and 24% effects respectively when compared to the control. This toxicity resulted in a minimum no-toxicity dilution of 18-fold which is within the compliance threshold of maximum 200-fold dilution.

3.3 Bivalve – blue mussel embryo development

The chronic embryo development test achieved the test acceptability criterion of at least 80% controls with normal embryo development (mean 94%). Salinity, temperature, DO and pH were in the acceptable range throughout the test (Appendix E, Table E-2). The brine solution did not affect normal embryo development at concentrations used in this test with 89% mean embryo development at 32% brine (data not shown).

There was a statistically significant (α=0.05) effect, an 8.7% decrease in normal embryo development, at 1% effluent when compared to the controls. There was a 100% effect on embryo development at the highest tested concentration (16%). For this sample, the NOEC and LOEC were 0.5% and 1% respectively resulting in a no-toxicity dilution of 141-fold which does not exceed the maximum compliance threshold of 200-fold dilution (Table 3-2 and Appendix C).

3.4 Total sulfide

ANZG (2018) default guideline value for un-ionised sulfide: 0.001 mg L^{-1} H_2S.

The subsample for total sulfide was preserved at the time of sample collection. The total sulfide in the effluent sample collected 27-28 February 2023 was 0.060 mg L^{-1} which is equivalent to 0.002 mg L^{-1} of un-ionised sulfide[5], the more toxic form of sulfide in an aquatic ecosystem. The total sulfide concentration of the February 2023 effluent sample is 1.6-fold lower than the long-term median value of 1.08 mg L^{-1} total sulfide for all HDC effluent samples analysed since 1992 (n=118).

After applying a 200-fold dilution, the resulting un-ionised sulfide concentration of 0.00001 mg L^{-1} was 100-fold lower than the ANZG (2018) default guideline value of 0.001 mg L^{-1} H_2S. Full results from the analysis of the effluent sample by Hill Laboratories are provided in Appendix D.

3.5 Ammoniacal-N

ANZG (2018) default guideline value: 0.910 mg L^{-1} ammoniacal-N, pH 8.

The ammoniacal-N concentration in the effluent sample was 6.67 mg L^{-1}, which is below the long-term median value of 16.1 mg L^{-1} for all HDC effluent samples analysed since 1992 (n=117). Applying a 200-fold dilution to the effluent sample resulted in a concentration of 0.03 mg L^{-1} ammoniacal-N, which is 30-fold lower than the ANZG (2018) default guideline value of 0.91 mg L^{-1} (at pH 8) for protection of 95% of marine species. Full results from the analysis of the effluent sample by Hill Laboratories are provided in Appendix D.

3.6 Reference toxicant

The EC_{50} for alga exposed to zinc sulfate (0.020 mg Zn L^{-1}) was within the expected range of the long-term mean of 0.012 ± 0.017 mg Zn^{2+} L^{-1} (±2 standard deviations (S.D.), n=24). The EC_{50} values for wedge shells exposed to zinc sulfate (survival 1.7, reburial 1.6 mg Zn L^{-1}) were within the expected range of the long-term mean for survival, 3.3 ± 2.4 mg Zn^{2+} L^{-1} (n=22), and reburial, 1.7 ± 1.1 mg Zn L^{-1} (n=22). The EC_{50} for blue mussel embryos exposed to zinc sulfate (0.13 mg Zn L^{-1}) was also within the expected range of the long-term mean is 0.16 ± 0.03 mg Zn L^{-1} (n=22).

Based on chronic NOEC values derived from the zinc sulfate tests, the algae, blue mussels, wedge shell reburial, and wedge shell survival would rank within the 1st, 68th, 81st and 82nd percentiles respectively of the most sensitive test organisms used for derivation of the ANZG (2021) guideline values for zinc in marine waters.

However, these sensitivity rankings are specific to zinc and care must be taken when extrapolating these results where other classes of contaminants (e.g., organics) may be present and for protection of all organisms present in a particular receiving water environment (e.g., Hawke Bay).

[5] Calculated as 4.06% of total sulfide at pH 8.0, 20°C, 32.5 ppt (coastal waters) (ANZG 2018).

4 Compliance Statement

Hawke's Bay Regional Council Resource Consent No. CD130214W condition 15 requires that there be no detectable toxicity at a 200-fold effluent dilution. The alga, wedge shell and blue mussel tests showed no detectable toxicity at a 200-fold dilution.

After application of the 200-fold dilution used for the ‘no toxicity’ criterion, the concentration of ammoniacal-N and total sulfide in the sample did not exceed ANZG (2018) default guideline values for 95% protection of species.

5 References

Albert, A. (2022) Quarterly Whole Effluent Toxicity Testing for East Clive Wastewater Treatment Plant – August 2022. *NIWA Client Report* 2022296HN, Hamilton, New Zealand: 28.

Albert, A. (2022a) Quarterly Whole Effluent Toxicity Testing for East Clive Wastewater Treatment Plant. *NIWA Client Report* 2022166HN, Hamilton, New Zealand: 29.

Albert, A. (2022b) Quarterly Whole Effluent Toxicity Testing for East Clive Wastewater Treatment Plant. *NIWA Client Report* 2022048HN, Hamilton, New Zealand: 24.

Albert, A. (2021) Quarterly Whole Effluent Toxicity Testing for East Clive Wastewater Treatment Plant. *NIWA Client Report* 2021393HN, Hamilton, New Zealand: 25.

ANZG (2018) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Governments and Australian state and territory governments, Canberra, ACT, Australia. https://www.waterquality.gov.au/anz-guidelines

ANZG (2021) Toxicant default guideline values for aquatic ecosystem protection: Zinc in marine water. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. CC BY 4.0. Australian and New Zealand Governments and Australian state and territory governments, Canberra, ACT, Australia.

Environment Canada (1990) *Guidance document for control of toxicity test precision using reference toxicants.* No. EPS 1/RM12. Conservation and Protection, Environment Canada: 90.

NIWA (2013) Standard Operating Procedure Number 58. *Macomona liliana* 96-h Acute Toxicity Test Procedure. Hamilton, New Zealand, *NIWA Client Report:* 35.

NIWA (2010) Standard Operating Procedure Number *14.1*: Marine algal microplate method. Hamilton, New Zealand. *NIWA Client Report*: 13.

NIWA (2008) Standard Operating Procedure 21.2: Marine blue mussel embryo (*Mytilus galloprovincialis*). Short-term Chronic Toxicity Test Protocol. Hamilton, New Zealand, *NIWA Client Report*: 41.

Roper, D.S., Hickey, C.W. (1994) Behavioural responses of the marine bivalve *Macomona liliana* exposed to copper- and chlordane-dosed sediments. *Marine Biology*, 118: 673–680.

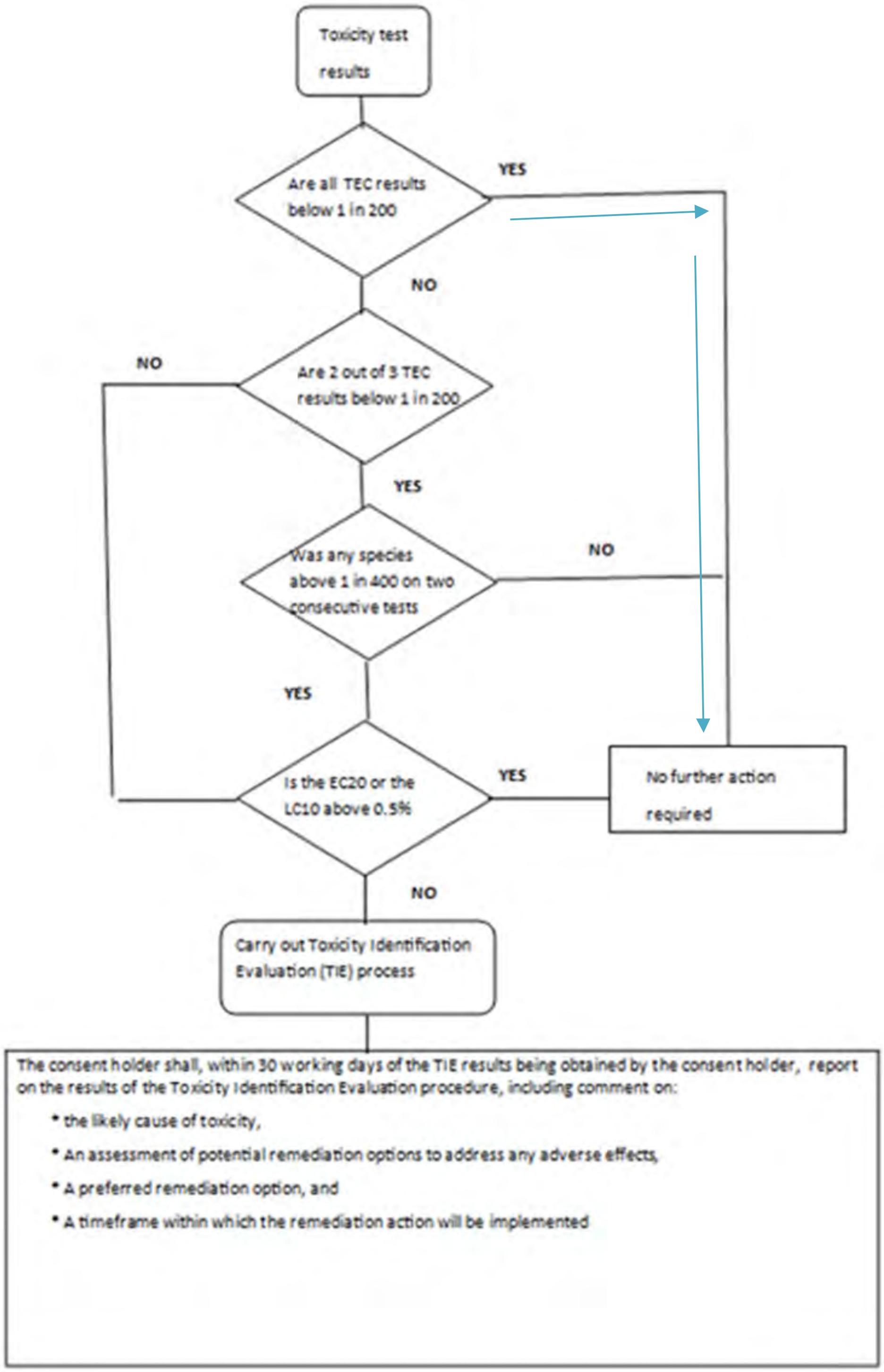
Thompson, K. (2022) Quarterly Whole Effluent Toxicity Testing of East Clive Wastewater Treatment Plant – October 2022. *NIWA Client Report* 2022371HN, Hamilton, New Zealand: 38.

Tidepool (2001-2022) CETIS -Comprehensive Environmental Toxicity Information System. CETIS Users Guide v2.1.3 Tidepool Scientific Software, MacKinleyville, Ca.: 305.

USEPA (1987) *Methods for toxicity tests of single substances and liquid complex wastes with marine unicellular algae. EPA-600-8/87/043*. US Environmental Protection Agency, Cincinnati, Ohio.

Williams, E.K., Hall, J.A. (1999) Seasonal and geographic variability in toxicant sensitivity of *Mytilus galloprovincialis* larvae. *Australasian Journal of Ecotoxicology*, 5(1): 1–10.

Appendix A Flow chart describing HBRC consent CD130214W condition 15[a]



[a]Supplied to NIWA 25 June 2014

Appendix B Test Conditions

Test conditions and dilutions for sample 23.003.1

Project Name:	Hastings DC Effluent Bioassays: 2022–2023	**Project Number**	HDC23201
Test Material:	Hastings District Council 27-28/2/2023	**Reference Toxicant:**	Zinc sulphate
Dilution Water:	0.2 µm filtered offshore seawater from South Pacific Ocean		

	Alga	**Bivalve–wedge shell**	**Bivalve–blue mussel embryos**
Reference Method:	US EPA (1987) modified with Environment Canada (1992)	Adapted from Roper & Hickey (1994)	Williams & Hall (1999b)
Test Protocol:	NIWA SOP 14.1 NIWA (2010)	NIWA SOP 58.0 NIWA (2013)	NIWA SOP 21.2 (2008)
Test Organisms:	*Minutocellus polymorphus*	*Macomona liliana*	*Mytilus galloprovincialis*
Source:	Lab culture (500), imported from Bigelow Laboratories, USA	Manukau Harbour, Wiroa Island control site	Coromandel Harbour
Organisms/Container:	10,000 cells mL^{-1}	10	600 fertilised embryos
Test Concentrations	Control, 0.125, 0.25, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0, 32.0%	Control, 0.25, 0.5, 1.0, 3.2, 10.0, 32.0, 65.0%	Control, 0.25, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0%
Test Duration:	48 hours	96 hours	48 hours
Replicates:	10 for controls, 5 for treatments	5 for controls, 3 for treatments	10 for controls, 5 for treatments
Sample pre-treatment:	0.45 µm filtration	Brine added to adjust salinity	Brine added to adjust salinity
Salinity:	26‰	34 $\pm$ 2‰	34 $\pm$ 2‰
Brine:	Nil	Filtered (0.2 µm) offshore seawater, frozen and thawed for brine collection	Filtered (0.2 µm) offshore seawater, frozen and thawed for brine collection
Test Chambers:	96 well sterile microplates	55 ml polystyrene beakers	16x100 mm glass tubes
Lighting:	Continuous overhead lighting	Complete darkness	16:8 light dark
Temperature:	25 ± 1°C	20 ± 1°C	20 ± 1°C
Aeration:	Nil	Nil	Nil
Chemical Data:	Initial salinity	Initial and final salinity, final pH, temperature, dissolved oxygen	Initial and final salinity, temperature, dissolved oxygen, pH
Effect Measured:	Growth inhibition	Survival and morbidity (survival, reburial)	Abnormal embryo development
Zn sensitivity current test; long term mean (EC_{50}±2sd):	0.020; 0.012 (0.000–0.029) mg Zn L^{-1} (n=24)	Survival 1.7; Reburial 1.6; 3.3 (0.9–5.7) mg L^{-1} Zn^{2+} (n=22) (survival); 1.7 (0.6–2.9) mg L^{-1} Zn^{2+} (n=22) (reburial)	0.13; 0.16 (0.13–0.19) mg Zn L^{-1} (n=22)
Test Acceptability:	Control coefficient of variation within 20%; at least 16x cell growth increase in controls.	At least 90% survival in control and less than 10% morbidity in control reburial	80% of control embryos normally developed
Method Detection Limit (MDL):	12.4% reduction relative to controls	4.1% reduction relative to controls	5.1% reduction relative to controls
Percent Minimum Significant Difference (PMSD):	15.6%	Survival 12.1% Reburial 16.4%	4.1%
Test Acceptability Compliance:	**Achieved**	**Achieved**	**Achieved**

Appendix C Statistics

Alga

CETIS Analytical Report

Report Date: 28 Apr-23 14:35 (p 1 of 2)
Test Code/ID: 23.003.1 MP7 / 06-6295-9229

Phytoplankton Growth Inhibition Test — **NIWA Ecotoxicology**

Analysis ID:	13-3391-5626	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv2.1.4
Analyzed:	28 Apr-23 14:31	**Analysis:**	Nonparametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	CF01BFAFFAF0C522892FD0615A70FEE7	**Editor ID:**	

Batch ID:	03-3564-3150	**Test Type:**	Cell Growth	**Analyst:**	K Thompson
Start Date:	01 Mar-23	**Protocol:**	NIWA (1996)	**Diluent:**	Offshore seawater
Ending Date:	03 Mar-23	**Species:**	Minutocellus polymorphus	**Brine:**	Not Applicable
Test Length:	48h	**Taxon:**		**Source:**	CCMP Bigelow Laboratory f **Age:**

Sample ID:	08-4330-9364	**Code:**	23.003.1 MP7	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	28 Feb-23	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	01 Mar-23	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	24h	**Client:**	Hastings District Council		

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	Tox Units	MSDu	PMSD
Untransformed	C > T	4	8	5.657	25	212600	15.61%

Wilcoxon/Bonferroni Adj Test

Control	vs	Conc-%	df	Test Stat	Critical	Ties	P-Type	P-Value	Decision(α:5%)
SW Control		0.0625*	13	15	---	0	Exact	0.0033	Significant Effect
		0.125*	13	15	---	0	Exact	0.0033	Significant Effect
		0.25	13	20	---	0	Exact	0.0633	Non-Significant Effect
		0.5*	13	19	---	0	Exact	0.0400	Significant Effect
		1	13	57	---	0	Exact	1.0000	Non-Significant Effect
		2	13	40	---	0	Exact	1.0000	Non-Significant Effect
		4	13	52	---	0	Exact	1.0000	Non-Significant Effect
		8*	13	15	---	0	Exact	0.0033	Significant Effect
		16*	13	15	---	0	Exact	0.0033	Significant Effect
		32*	13	15	---	0	Exact	0.0033	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	1.242E+13	1.242E+12	10	59.22	<1.0E-05	Significant Effect
Error	1.028E+12	2.098E+10	49			
Total	1.345E+13		59			

ANOVA Assumptions Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variance	Bartlett Equality of Variance Test	43.03	23.21	<1.0E-05	Unequal Variances
	Levene Equality of Variance Test	2.907	2.706	0.0062	Unequal Variances
	Mod Levene Equality of Variance Test	2.428	2.814	0.0234	Equal Variances
Distribution	Anderson-Darling A2 Test	1.658	3.878	<1.0E-05	Non-Normal Distribution
	D'Agostino Kurtosis Test	4.067	2.576	4.8E-05	Non-Normal Distribution
	D'Agostino Skewness Test	3.171	2.576	0.0015	Non-Normal Distribution
	D'Agostino-Pearson K2 Omnibus Test	26.59	9.21	<1.0E-05	Non-Normal Distribution
	Kolmogorov-Smirnov D Test	0.1196	0.1331	0.0325	Normal Distribution
	Shapiro-Wilk W Normality Test	0.8877	0.9459	4.8E-05	Non-Normal Distribution

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

Phytoplankton Growth Inhibition Test | **NIWA Ecotoxicology**

Analysis ID:	13-3391-5626	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv2.1.4
Analyzed:	28 Apr-23 14:31	**Analysis:**	Nonparametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	CF01BFAFFAF0C522892FD0615A70FEE7	**Editor ID:**	

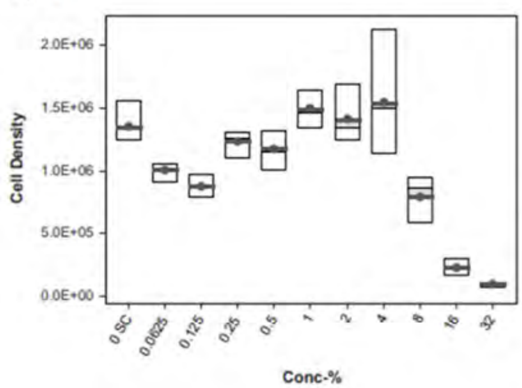
Cell Density Summary

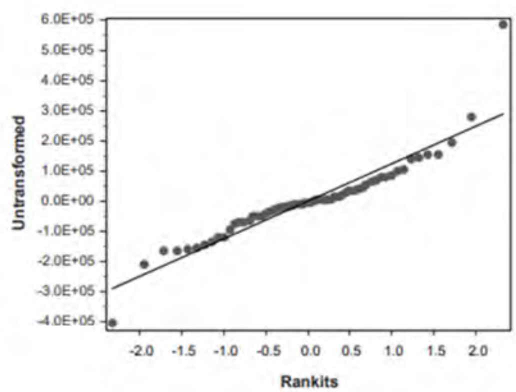
Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	10	1.362E+6	1.302E+6	1.422E+6	1.359E+6	1.244E+6	1.558E+6	2.660E+4	6.18%	0.00%
0.0625		5	1.006E+6	9.335E+5	1.079E+6	1.008E+6	9.115E+5	1.061E+6	2.619E+4	5.82%	26.13%
0.125		5	8.728E+5	7.920E+5	9.535E+5	8.610E+5	7.977E+5	9.773E+5	2.908E+4	7.45%	35.93%
0.25		5	1.236E+6	1.135E+6	1.337E+6	1.256E+6	1.098E+6	1.313E+6	3.636E+4	6.58%	9.27%
0.5		5	1.171E+6	1.023E+6	1.319E+6	1.155E+6	1.008E+6	1.315E+6	5.336E+4	10.19%	14.05%
1		5	1.497E+6	1.348E+6	1.646E+6	1.462E+6	1.339E+6	1.649E+6	5.365E+4	8.01%	-9.92%
2		5	1.416E+6	1.183E+6	1.650E+6	1.347E+6	1.253E+6	1.695E+6	8.418E+4	13.29%	-3.97%
4		5	1.542E+6	1.094E+6	1.991E+6	1.494E+6	1.137E+6	2.126E+6	1.615E+5	23.41%	-13.23%
8		5	7.965E+5	5.836E+5	1.009E+6	8.671E+5	5.869E+5	9.518E+5	7.668E+4	21.53%	41.53%
16		5	2.333E+5	1.683E+5	2.983E+5	2.140E+5	1.685E+5	2.961E+5	2.341E+4	22.44%	82.87%
32		5	1.016E+5	8.325E+4	1.200E+5	1.053E+5	7.766E+4	1.174E+5	6.617E+3	14.56%	92.54%

Cell Density Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	SC	1.354E+6	1.378E+6	1.290E+6	1.393E+6	1.365E+6	1.330E+6	1.398E+6	1.558E+6	1.312E+6	1.244E+6
0.0625		1.048E+6	1.061E+6	1.008E+6	1.002E+6	9.115E+5					
0.125		8.593E+5	8.685E+5	9.773E+5	8.610E+5	7.977E+5					
0.25		1.313E+6	1.269E+6	1.256E+6	1.243E+6	1.098E+6					
0.5		1.315E+6	1.254E+6	1.123E+6	1.155E+6	1.008E+6					
1		1.579E+6	1.457E+6	1.649E+6	1.462E+6	1.339E+6					
2		1.695E+6	1.518E+6	1.347E+6	1.269E+6	1.253E+6					
4		2.126E+6	1.532E+6	1.422E+6	1.494E+6	1.137E+6					
8		9.518E+5	9.373E+5	8.671E+5	6.394E+5	5.869E+5					
16		2.961E+5	2.772E+5	2.140E+5	2.106E+5	1.685E+5					
32		1.053E+5	1.076E+5	1.174E+5	1.001E+5	7.766E+4					

Graphics





Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

CETIS Analytical Report

Report Date: 28 Apr-23 14:35 (p 1 of 3)
Test Code/ID: 23.003.1 MP7 / 06-6295-9229

Phytoplankton Growth Inhibition Test — **NIWA Ecotoxicology**

Analysis ID:	12-8714-5817	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv2.1.4
Analyzed:	28 Apr-23 14:33	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	CF01BFAFFAF0C522892FD0615A70FEE7	**Editor ID:**	

Batch ID:	03-3564-3150	**Test Type:**	Cell Growth	**Analyst:**	K Thompson
Start Date:	01 Mar-23	**Protocol:**	NIWA (1996)	**Diluent:**	Offshore seawater
Ending Date:	03 Mar-23	**Species:**	Minutocellus polymorphus	**Brine:**	Not Applicable
Test Length:	48h	**Taxon:**		**Source:**	CCMP Bigelow Laboratory f **Age:**

Sample ID:	08-4330-9364	**Code:**	23.003.1 MP7	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	28 Feb-23	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	01 Mar-23	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	24h	**Client:**	Hastings District Council		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Normal [ω=1]	Off [μ*=μ]	None	None

Regression Summary

Iters	LL	AICc	BIC	Adj R2	PMSD	Thresh	Optimize	F Stat	P-Value	Decision(α:5%)
59	-741.9	1490	1496	0.7501	5.75%	1272000	Yes	13.23	0.0000	Significant Lack-of-Fit

Point Estimates

Level	%	95% LCL	95% UCL	Tox Units	95% LCL	95% UCL
IC5	4.617	---	6.135	21.7	16.3	---
IC10	5.594	---	7.107	17.9	14.1	---
IC15	6.299	2.959	7.821	15.9	12.8	33.8
IC20	6.888	4.548	8.413	14.5	11.9	22
IC25	7.416	5.443	8.947	13.5	11.2	18.4
IC40	8.86	7.236	10.54	11.3	9.5	13.8
IC50	9.832	8.137	11.88	10.2	8.4	12.3

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	1272000	36550	1199000	1345000	34.81	<1.0E-05	Significant Parameter
γ	3.896	1.145	1.604	6.188	3.404	0.0012	Significant Parameter
δ	9.832	0.9101	8.01	11.65	10.8	<1.0E-05	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	7.633E+13	2.544E+13	3	446.5	<1.0E-05	Significant Effect
Lack of Fit	2.22E+12	2.775E+11	8	13.23	<1.0E-05	Significant Lack-of-Fit
Pure Error	1.028E+12	2.098E+10	49			
Residual	3.248E+12	5.699E+10	57			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Variance	Mod Levene Equality of Variance	2.428	2.084	0.0234	Unequal Variances
Distribution	Anderson-Darling A2 Test	1.225	2.492	0.0032	Non-Normal Distribution
	Shapiro-Wilk W Normality Test	0.9375	0.9605	0.0042	Non-Normal Distribution

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

CETIS Analytical Report

Report Date:	28 Apr-23 14:35 (p 2 of 3)
Test Code/ID:	23.003.1 MP7 / 06-6295-9229

Phytoplankton Growth Inhibition Test — **NIWA Ecotoxicology**

Analysis ID:	12-8714-5817	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv2.1.4
Analyzed:	28 Apr-23 14:33	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	CF01BFAFFAF0C522892FD0615A70FEE7	**Editor ID:**	

Cell Density Summary

			Calculated Variate							
Conc-%	**Code**	**Count**	**Mean**	**Median**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**
0	SC	10	1.362E+6	1.359E+6	1.244E+6	1.558E+6	2.660E+4	8.412E+4	6.18%	0.00%
0.0625		5	1.006E+6	1.008E+6	9.115E+5	1.061E+6	2.619E+4	5.856E+4	5.82%	26.13%
0.125		5	8.728E+5	8.610E+5	7.977E+5	9.773E+5	2.908E+4	6.502E+4	7.45%	35.93%
0.25		5	1.236E+6	1.256E+6	1.098E+6	1.313E+6	3.636E+4	8.131E+4	6.58%	9.27%
0.5		5	1.171E+6	1.155E+6	1.008E+6	1.315E+6	5.336E+4	1.193E+5	10.19%	14.05%
1		5	1.497E+6	1.462E+6	1.339E+6	1.649E+6	5.365E+4	1.200E+5	8.01%	-9.92%
2		5	1.416E+6	1.347E+6	1.253E+6	1.695E+6	8.418E+4	1.882E+5	13.29%	-3.97%
4		5	1.542E+6	1.494E+6	1.137E+6	2.126E+6	1.615E+5	3.611E+5	23.41%	-13.23%
8		5	7.965E+5	8.671E+5	5.869E+5	9.518E+5	7.668E+4	1.715E+5	21.53%	41.53%
16		5	2.333E+5	2.140E+5	1.685E+5	2.961E+5	2.341E+4	5.235E+4	22.44%	82.87%
32		5	1.016E+5	1.053E+5	7.766E+4	1.174E+5	6.617E+3	1.480E+4	14.56%	92.54%

Cell Density Detail

Conc-%	**Code**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**	**Rep 6**	**Rep 7**	**Rep 8**	**Rep 9**	**Rep 10**
0	SC	1.354E+6	1.378E+6	1.290E+6	1.393E+6	1.365E+6	1.330E+6	1.398E+6	1.558E+6	1.312E+6	1.244E+6
0.0625		1.048E+6	1.061E+6	1.008E+6	1.002E+6	9.115E+5					
0.125		8.593E+5	8.685E+5	9.773E+5	8.610E+5	7.977E+5					
0.25		1.313E+6	1.269E+6	1.256E+6	1.243E+6	1.098E+6					
0.5		1.315E+6	1.254E+6	1.123E+6	1.155E+6	1.008E+6					
1		1.579E+6	1.457E+6	1.649E+6	1.462E+6	1.339E+6					
2		1.695E+6	1.518E+6	1.347E+6	1.269E+6	1.253E+6					
4		2.126E+6	1.532E+6	1.422E+6	1.494E+6	1.137E+6					
8		9.518E+5	9.373E+5	8.671E+5	6.394E+5	5.869E+5					
16		2.961E+5	2.772E+5	2.140E+5	2.106E+5	1.685E+5					
32		1.053E+5	1.076E+5	1.174E+5	1.001E+5	7.766E+4					

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

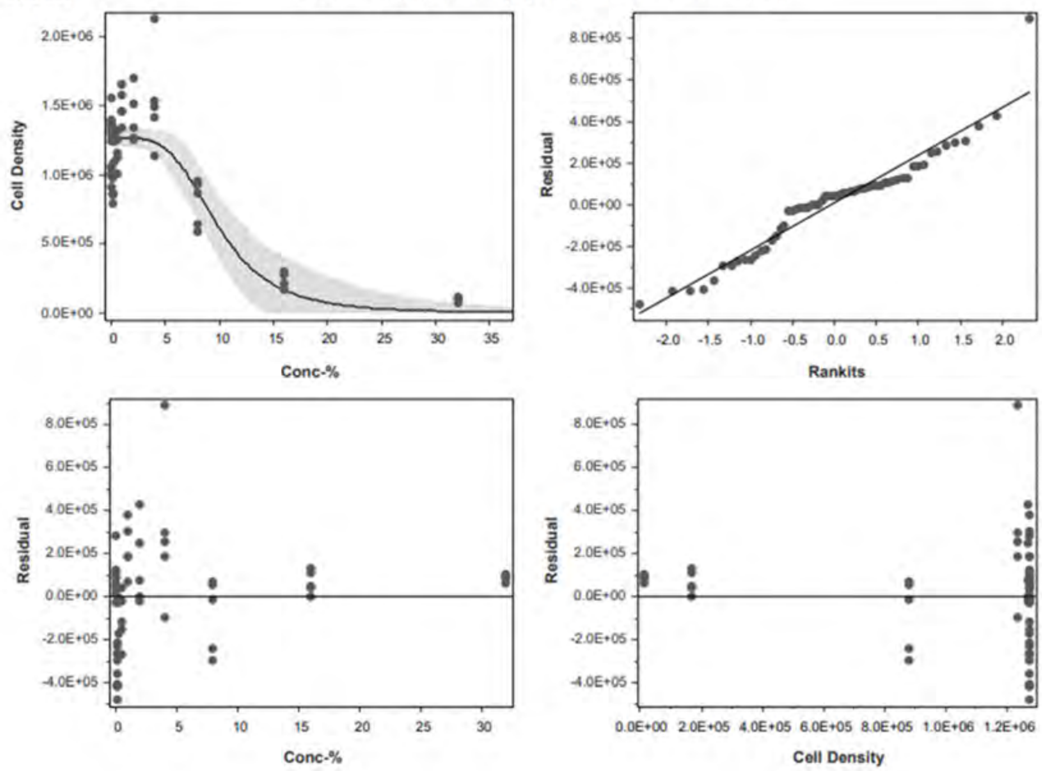
CETIS Analytical Report

		Report Date:	28 Apr-23 14:35 (p 3 of 3)
		Test Code/ID:	23.003.1 MP7 / 06-6295-9229

Phytoplankton Growth Inhibition Test — **NIWA Ecotoxicology**

Analysis ID: 12-8714-5817		**Endpoint:**	Cell Density	**CETIS Version:**	CETISv2.1.4
Analyzed: 28 Apr-23 14:33		**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	CF01BFAFFAF0C522892FD0615A70FEE7	**Editor ID:**	

Graphics Model: 3P Log-Logistic: μ=α/[1+[x/δ]^γ] Distribution: Normal [ω=1]



Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

Wedge shell reburial

CETIS Analytical Report

Report Date: 19 Apr-23 13:36 (p 1 of 6)
Test Code/ID: 23.003.1 MAC / 09-0876-2323

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	15-6221-2834	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:35	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:	19 Apr-23 13:33	**MD5 Hash:**	D3358A260E09EA36976698155D2EFEF6	**Editor ID:**	008-408-407-6

Batch ID:	01-1746-9341	**Test Type:**	Survival-Reburial	**Analyst:**	Ecotox Team
Start Date:	02 Mar-23	**Protocol:**	NIWA (1995)	**Diluent:**	Offshore seawater
Ending Date:	06 Mar-23	**Species:**	Macomona liliana	**Brine:**	Frozen Oceanic Seawater
Test Length:	96h	**Taxon:**		**Source:**	Client Supplied **Age:**

Sample ID:	14-0649-3713	**Code:**	23.003.1 MAC	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	28 Feb-23	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	01 Mar-23	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	48h	**Client:**	Hastings District Council		

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	Tox Units	MSDu	PMSD
Angular (Corrected)	C > T	3.2	10	5.657	31.2	0.1504	16.35%

Bonferroni Adj t Test

Control	vs	Conc-%	df	Test Stat	Critical	MSD	P-Type	P-Value	Decision(α:5%)
SW Control		0.25	6	-1.586	2.712	0.2158	CDF	1.0000	Non-Significant Effect
		0.5	6	0.3743	2.712	0.2158	CDF	1.0000	Non-Significant Effect
		1	6	-0.9029	2.712	0.2158	CDF	1.0000	Non-Significant Effect
		3.2	6	1.652	2.712	0.2158	CDF	0.4058	Non-Significant Effect
		10*	6	3.658	2.712	0.2158	CDF	0.0063	Significant Effect
		32*	6	8.014	2.712	0.2158	CDF	<1.0E-05	Significant Effect
		65*	6	13.45	2.712	0.2158	CDF	<1.0E-05	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	3.69322	0.527603	7	44.45	<1.0E-05	Significant Effect
Error	0.21365	0.0118694	18			
Total	3.90687		25			

ANOVA Assumptions Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variance	Bartlett Equality of Variance Test				Indeterminate
	Levene Equality of Variance Test	1.351	3.841	0.2841	Equal Variances
	Mod Levene Equality of Variance Test	0.5597	5.2	0.7729	Equal Variances
Distribution	Anderson-Darling A2 Test	0.5427	3.878	0.1672	Normal Distribution
	D'Agostino Kurtosis Test	1.096	2.576	0.2732	Normal Distribution
	D'Agostino Skewness Test	0.1691	2.576	0.8657	Normal Distribution
	D'Agostino-Pearson K2 Omnibus Test	1.229	9.21	0.5408	Normal Distribution
	Kolmogorov-Smirnov D Test	0.1538	0.1981	0.1141	Normal Distribution
	Shapiro-Wilk W Normality Test	0.9542	0.8912	0.2909	Normal Distribution

Eff. Survival Rate Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	5	0.9200	0.8161	1.0000	0.9000	0.8000	1.0000	0.0374	9.09%	0.00%
0.25		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	-8.70%
0.5		3	0.9000	0.6516	1.0000	0.9000	0.8000	1.0000	0.0577	11.11%	2.17%
1		3	0.9667	0.8232	1.0000	1.0000	0.9000	1.0000	0.0333	5.97%	-5.07%
3.2		3	0.8333	0.6899	0.9768	0.8000	0.8000	0.9000	0.0333	6.93%	9.42%
10		3	0.7000	0.4516	0.9484	0.7000	0.6000	0.8000	0.0577	14.29%	23.91%
32		3	0.3667	0.0798	0.6535	0.3000	0.3000	0.5000	0.0667	31.49%	60.14%
65		3	0.0333	0.0000	0.1768	0.0000	0.0000	0.1000	0.0333	173.21%	96.38%

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

Macomona 96 h survival and reburial test | **NIWA Ecotoxicology**

Analysis ID:	15-6221-2834	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:35	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:	19 Apr-23 13:33	**MD5 Hash:**	D3358A260E09EA36976698155D2EFEF6	**Editor ID:**	008-408-407-6

Angular (Corrected) Transformed Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	5	1.2860	1.1260	1.4460	1.2490	1.1070	1.4120	0.0577	10.03%	0.00%
0.25		3	1.4120	1.4110	1.4130	1.4120	1.4120	1.4120	0.0000	0.00%	-9.81%
0.5		3	1.2560	0.8771	1.6350	1.2490	1.1070	1.4120	0.0881	12.15%	2.32%
1		3	1.3580	1.1240	1.5910	1.4120	1.2490	1.4120	0.0543	6.93%	-5.59%
3.2		3	1.1540	0.9509	1.3580	1.1070	1.1070	1.2490	0.0473	7.10%	10.22%
10		3	0.9948	0.7201	1.2690	0.9912	0.8861	1.1070	0.0638	11.12%	22.64%
32		3	0.6482	0.3531	0.9433	0.5796	0.5796	0.7854	0.0686	18.33%	49.59%
65		3	0.2160	-0.0118	0.4438	0.1674	0.1588	0.3218	0.0529	42.45%	83.20%

Eff. Survival Rate Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	1.0000	1.0000	0.9000	0.9000	0.8000
0.25		1.0000	1.0000	1.0000		
0.5		0.9000	0.8000	1.0000		
1		1.0000	0.9000	1.0000		
3.2		0.8000	0.8000	0.9000		
10		0.8000	0.7000	0.6000		
32		0.3000	0.3000	0.5000		
65		0.0000	0.1000	0.0000		

Angular (Corrected) Transformed Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	1.4120	1.4120	1.2490	1.2490	1.1070
0.25		1.4120	1.4120	1.4120		
0.5		1.2490	1.1070	1.4120		
1		1.4120	1.2490	1.4120		
3.2		1.1070	1.1070	1.2490		
10		1.1070	0.9912	0.8861		
32		0.5796	0.5796	0.7854		
65		0.1674	0.3218	0.1588		

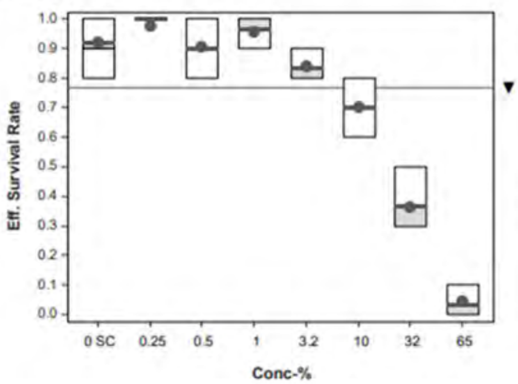
Eff. Survival Rate Binomials

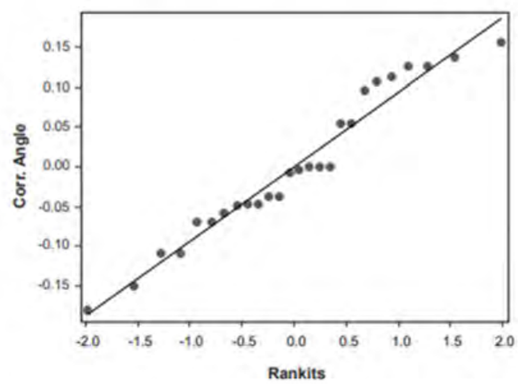
Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	10/10	10/10	9/10	9/10	8/10
0.25		10/10	10/10	10/10		
0.5		9/10	8/10	10/10		
1		10/10	9/10	10/10		
3.2		8/10	8/10	9/10		
10		8/10	7/10	6/10		
32		3/10	3/10	5/10		
65		0/9	1/10	0/10		

Macomona 96 h survival and reburial test **NIWA Ecotoxicology**

Analysis ID:	15-6221-2834	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:35	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:	19 Apr-23 13:33	**MD5 Hash:**	D3358A260E09EA36976698155D2EFEF6	**Editor ID:**	008-408-407-6

Graphics





CETIS Analytical Report

Report Date:	19 Apr-23 13:37 (p 1 of 6)
Test Code/ID:	23.003.1 MAC / 09-0876-2323

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID: 00-6540-8516		**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed: 19 Apr-23 13:36		**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date: 19 Apr-23 13:33		**MD5 Hash:**	D3358A260E09EA36976698155D2EFEF6	**Editor ID:**	008-408-407-6

Batch ID:	01-1746-9341	**Test Type:**	Survival-Reburial	**Analyst:**	Ecotox Team
Start Date:	02 Mar-23	**Protocol:**	NIWA (1995)	**Diluent:**	Offshore seawater
Ending Date:	06 Mar-23	**Species:**	Macomona liliana	**Brine:**	Frozen Oceanic Seawater
Test Length:	96h	**Taxon:**		**Source:**	Client Supplied **Age:**

Sample ID:	14-0649-3713	**Code:**	23.003.1 MAC	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	28 Feb-23	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	01 Mar-23	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	48h	**Client:**	Hastings District Council		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Binomial [ω=n/[p·q]]	Off [μ*=μ]	None	None

Regression Summary

Iters	LL	AICc	BIC	Adj R2	PMSD	Thresh	Optimize	F Stat	P-Value	Decision(α:5%)
9	-30.69	68.48	71.16	0.6704	4.35%	0.9377	Yes	2.08	0.1154	Non-Significant Lack-of-Fit

Point Estimates

Level	%	95% LCL	95% UCL	Tox Units	95% LCL	95% UCL
LC5	3.268	---	5.617	30.6	17.8	---
LC10	5.103	0.4852	8.212	19.6	12.2	206.1
LC15	6.725	2.366	10.47	14.9	9.6	42.3
LC20	8.278	3.868	12.56	12.1	8	25.9
LC25	9.827	5.336	14.6	10.2	6.8	18.7
LC40	14.86	9.986	21.07	6.7	4.7	10
LC50	18.93	13.54	26.46	5.3	3.8	7.4

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	0.9377	0.01971	0.8969	0.9785	47.58	<1.0E-05	Significant Parameter
γ	1.676	0.3273	0.9993	2.354	5.122	3.5E-05	Significant Parameter
δ	18.93	3.106	12.5	25.35	6.093	<1.0E-05	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	2372	790.6	3	898.8	<1.0E-05	Significant Effect
Lack of Fit	7.408	1.482	5	2.08	0.1154	Non-Significant Lack-of-Fit
Pure Error	12.83	0.7125	18			
Residual	20.23	0.8797	23			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Model Fit	Likelihood Ratio GOF Test	24.54	35.17	0.3745	Non-Significant Heterogeneity
	Pearson Chi-Sq GOF Test	20.23	35.17	0.6278	Non-Significant Heterogeneity
Variance	Mod Levene Equality of Variance	0.7628	3.135	0.6301	Equal Variances
Distribution	Anderson-Darling A2 Test	0.7739	2.492	0.0441	Non-Normal Distribution
	Shapiro-Wilk W Normality Test	0.9364	0.922	0.1099	Normal Distribution
Overdispersion	Tarone C(α) Overdispersion Test	1.084	1.645	0.1391	Non-Significant Overdispersion

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

Macomona 96 h survival and reburial test | **NIWA Ecotoxicology**

Analysis ID:	00-6540-8516	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:36	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:	19 Apr-23 13:33	**MD5 Hash:**	D3358A260E09EA36976698155D2EFEF6	**Editor ID:**	008-408-407-6

Eff. Survival Rate Summary

			Calculated Variate(A/B)								
Conc-%	**Code**	**Count**	**Mean**	**Median**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**ΣA/ΣB**
0	SC	5	0.9200	0.9000	0.8000	1.0000	0.0374	0.0837	9.09%	0.00%	46/50
0.25		3	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	-8.70%	30/30
0.5		3	0.9000	0.9000	0.8000	1.0000	0.0577	0.1000	11.11%	2.17%	27/30
1		3	0.9667	1.0000	0.9000	1.0000	0.0333	0.0577	5.97%	-5.07%	29/30
3.2		3	0.8333	0.8000	0.8000	0.9000	0.0333	0.0577	6.93%	9.42%	25/30
10		3	0.7000	0.7000	0.6000	0.8000	0.0577	0.1000	14.29%	23.91%	21/30
32		3	0.3667	0.3000	0.3000	0.5000	0.0667	0.1155	31.49%	60.14%	11/30
65		3	0.0333	0.0000	0.0000	0.1000	0.0333	0.0577	173.21%	96.38%	1/29

Eff. Survival Rate Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	1.0000	1.0000	0.9000	0.9000	0.8000
0.25		1.0000	1.0000	1.0000		
0.5		0.9000	0.8000	1.0000		
1		1.0000	0.9000	1.0000		
3.2		0.8000	0.8000	0.9000		
10		0.8000	0.7000	0.6000		
32		0.3000	0.3000	0.5000		
65		0.0000	0.1000	0.0000		

Eff. Survival Rate Binomials

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	10/10	10/10	9/10	9/10	8/10
0.25		10/10	10/10	10/10		
0.5		9/10	8/10	10/10		
1		10/10	9/10	10/10		
3.2		8/10	8/10	9/10		
10		8/10	7/10	6/10		
32		3/10	3/10	5/10		
65		0/9	1/10	0/10		

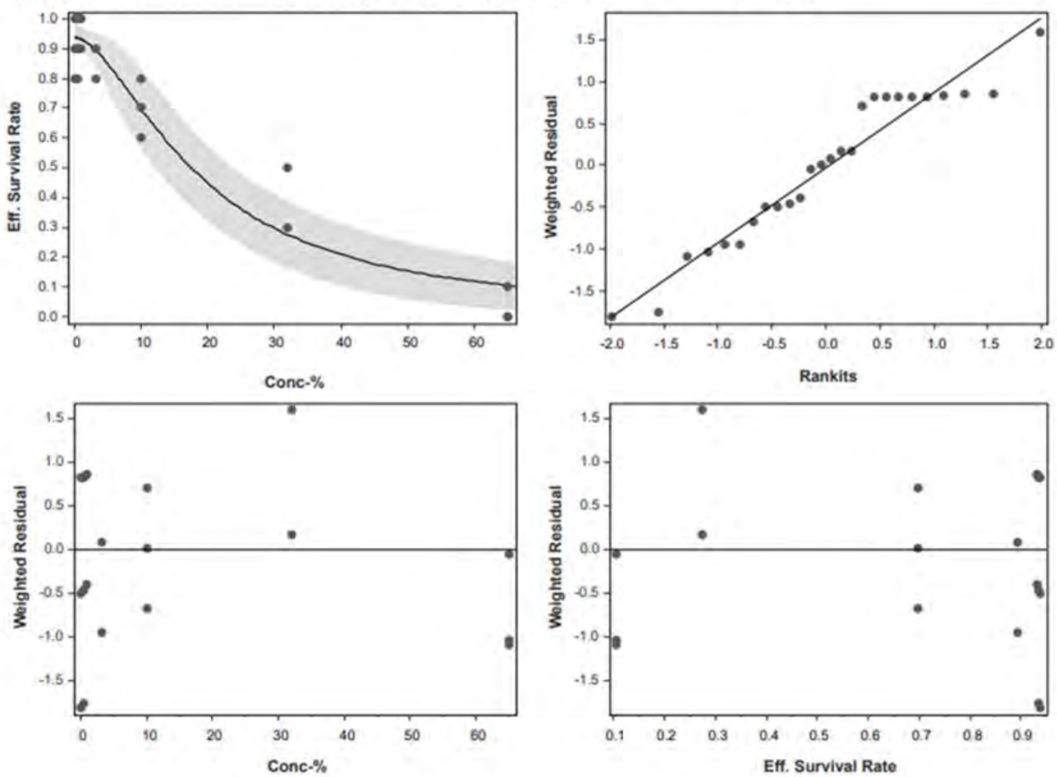
CETIS Analytical Report

Report Date:	19 Apr-23 13:37 (p 3 of 6)		
Test Code/ID:	23.003.1 MAC / 09-0876-2323		

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	00-6540-8516	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:36	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:	19 Apr-23 13:33	**MD5 Hash:**	D3358A260E09EA36976698155D2EFEF6	**Editor ID:**	008-408-407-6

Graphics Model: 3P Log-Logistic: μ=α/[1+[x/δ]^γ] Distribution: Binomial [ω=n/[p·q]]



Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

Wedge shell survival

CETIS Analytical Report

Report Date:	19 Apr-23 13:36 (p 4 of 6)
Test Code/ID:	23.003.1 MAC / 09-0876-2323

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	08-4869-3591	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:35	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:	19 Apr-23 13:33	**MD5 Hash:**	31A8D6CC807BA7AC2EC23028982027DD	**Editor ID:**	008-408-407-6

Batch ID:	01-1746-9341	**Test Type:**	Survival-Reburial	**Analyst:**	Ecotox Team
Start Date:	02 Mar-23	**Protocol:**	NIWA (1995)	**Diluent:**	Offshore seawater
Ending Date:	06 Mar-23	**Species:**	Macomona liliana	**Brine:**	Frozen Oceanic Seawater
Test Length:	96h	**Taxon:**		**Source:**	Client Supplied **Age:**

Sample ID:	14-0649-3713	**Code:**	23.003.1 MAC	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	28 Feb-23	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	01 Mar-23	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	48h	**Client:**	Hastings District Council		

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	Tox Units	MSDu	PMSD
Angular (Corrected)	C > T	10	32	17.89	10	0.1213	12.13%

Bonferroni Adj t Test

Control	vs	Conc-%	df	Test Stat	Critical	MSD	P-Type	P-Value	Decision(α:5%)
SW Control		0.25	6	0	2.712	0.1969	CDF	1.0000	Non-Significant Effect
		0.5	6	0	2.712	0.1969	CDF	1.0000	Non-Significant Effect
		1	6	0	2.712	0.1969	CDF	1.0000	Non-Significant Effect
		3.2	6	2.244	2.712	0.1969	CDF	0.1316	Non-Significant Effect
		10	6	0.7481	2.712	0.1969	CDF	1.0000	Non-Significant Effect
		32*	6	7.635	2.712	0.1969	CDF	<1.0E-05	Significant Effect
		65*	6	15.68	2.712	0.1969	CDF	<1.0E-05	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	3.63642	0.519488	7	52.55	<1.0E-05	Significant Effect
Error	0.177943	0.0098857	18			
Total	3.81436		25			

ANOVA Assumptions Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variance	Bartlett Equality of Variance Test				Indeterminate
	Levene Equality of Variance Test	6.03	3.841	0.0010	Unequal Variances
	Mod Levene Equality of Variance Test	6.596	5.2	0.0042	Unequal Variances
Distribution	Anderson-Darling A2 Test	4.082	3.878	<1.0E-05	Non-Normal Distribution
	D'Agostino Kurtosis Test	3.409	2.576	0.0007	Non-Normal Distribution
	D'Agostino Skewness Test	1.3	2.576	0.1935	Normal Distribution
	D'Agostino-Pearson K2 Omnibus Test	13.31	9.21	0.0013	Non-Normal Distribution
	Kolmogorov-Smirnov D Test	0.3846	0.1981	<1.0E-05	Non-Normal Distribution
	Shapiro-Wilk W Normality Test	0.6983	0.8912	<1.0E-05	Non-Normal Distribution

Survival Rate Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
0.25		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
0.5		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
1		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
3.2		3	0.9000	0.8996	0.9004	0.9000	0.9000	0.9000	0.0000	0.00%	10.00%
10		3	0.9667	0.8232	1.0000	1.0000	0.9000	1.0000	0.0333	5.97%	3.33%
32		3	0.5667	0.0000	1.0000	0.6000	0.3000	0.8000	0.1453	44.41%	43.33%
65		3	0.0704	0.0000	0.2224	0.1000	0.0000	0.1111	0.0353	86.96%	92.96%

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

CETIS Analytical Report

Report Date:	19 Apr-23 13:36 (p 5 of 6)
Test Code/ID:	23.003.1 MAC / 09-0876-2323

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	08-4869-3591	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:35	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:	19 Apr-23 13:33	**MD5 Hash:**	31A8D6CC807BA7AC2EC23028982027DD	**Editor ID:**	008-408-407-6

Angular (Corrected) Transformed Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	5	1.4120	1.4120	1.4120	1.4120	1.4120	1.4120	0.0000	0.00%	0.00%
0.25		3	1.4120	1.4110	1.4130	1.4120	1.4120	1.4120	0.0000	0.00%	0.00%
0.5		3	1.4120	1.4110	1.4130	1.4120	1.4120	1.4120	0.0000	0.00%	0.00%
1		3	1.4120	1.4110	1.4130	1.4120	1.4120	1.4120	0.0000	0.00%	0.00%
3.2		3	1.2490	1.2490	1.2490	1.2490	1.2490	1.2490	0.0000	0.00%	11.54%
10		3	1.3580	1.1240	1.5910	1.4120	1.2490	1.4120	0.0543	6.93%	3.85%
32		3	0.8576	0.1996	1.5160	0.8861	0.5796	1.1070	0.1529	30.89%	39.26%
65		3	0.2735	0.0257	0.5212	0.3218	0.1588	0.3398	0.0576	36.47%	80.63%

Survival Rate Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	1.0000	1.0000	1.0000	1.0000	1.0000
0.25		1.0000	1.0000	1.0000		
0.5		1.0000	1.0000	1.0000		
1		1.0000	1.0000	1.0000		
3.2		0.9000	0.9000	0.9000		
10		1.0000	1.0000	0.9000		
32		0.3000	0.8000	0.6000		
65		0.1111	0.1000	0.0000		

Angular (Corrected) Transformed Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	1.4120	1.4120	1.4120	1.4120	1.4120
0.25		1.4120	1.4120	1.4120		
0.5		1.4120	1.4120	1.4120		
1		1.4120	1.4120	1.4120		
3.2		1.2490	1.2490	1.2490		
10		1.4120	1.4120	1.2490		
32		0.5796	1.1070	0.8861		
65		0.3398	0.3218	0.1588		

Survival Rate Binomials

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	10/10	10/10	10/10	10/10	10/10
0.25		10/10	10/10	10/10		
0.5		10/10	10/10	10/10		
1		10/10	10/10	10/10		
3.2		9/10	9/10	9/10		
10		10/10	10/10	9/10		
32		3/10	8/10	6/10		
65		1/9	1/10	0/10		

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

CETIS Analytical Report

Report Date:	19 Apr-23 13:36 (p 6 of 6)
Test Code/ID:	23.003.1 MAC / 09-0876-2323

Macomona 96 h survival and reburial test **NIWA Ecotoxicology**

Analysis ID:	08-4869-3591	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:35	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:	19 Apr-23 13:33	**MD5 Hash:**	31A8D6CC807BA7AC2EC23028982027DD	**Editor ID:**	008-408-407-6

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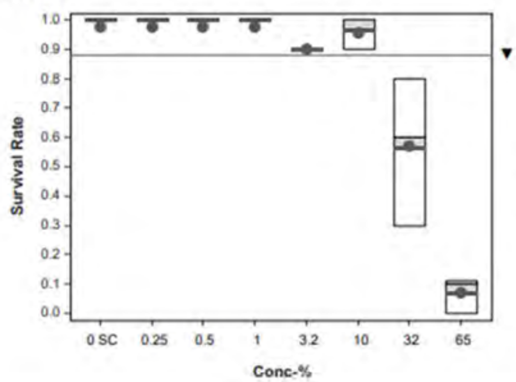

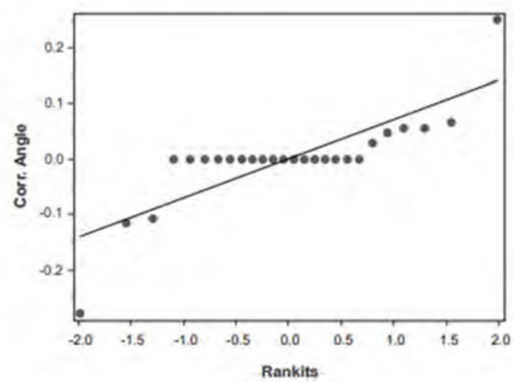

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	02-1123-9113	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:36	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:	19 Apr-23 13:33	**MD5 Hash:**	31A8D6CC807BA7AC2EC23028982027DD	**Editor ID:**	008-408-407-6

Batch ID:	01-1746-9341	**Test Type:**	Survival-Reburial	**Analyst:**	Ecotox Team
Start Date:	02 Mar-23	**Protocol:**	NIWA (1995)	**Diluent:**	Offshore seawater
Ending Date:	06 Mar-23	**Species:**	Macomona liliana	**Brine:**	Frozen Oceanic Seawater
Test Length:	96h	**Taxon:**		**Source:**	Client Supplied **Age:**

Sample ID:	14-0649-3713	**Code:**	23.003.1 MAC	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	28 Feb-23	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	01 Mar-23	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	48h	**Client:**	Hastings District Council		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Binomial [ω=n/[p·q]]	Off [μ*=μ]	None	None

Regression Summary

Iters	LL	AICc	BIC	Adj R2	PMSD	Thresh	Optimize	F Stat	P-Value	Decision(α:5%)
4	-21.2	49.48	52.17	0.9266	0.01%	1	Yes	11.12	0.0001	Significant Lack-of-Fit

Point Estimates

Level	%	95% LCL	95% UCL	Tox Units	95% LCL	95% UCL
LC5	5.945	---	9.296	16.8	10.8	---
LC10	8.912	2.825	13.21	11.2	7.6	35.4
LC15	11.45	5.55	16.43	8.7	6.1	18
LC20	13.83	7.925	19.38	7.2	5.2	12.6
LC25	16.16	10.18	22.25	6.2	4.5	9.8
LC40	23.52	16.85	31.64	4.3	3.2	5.9
LC50	29.3	21.57	39.8	3.4	2.5	4.6

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	1	4.697E-05	0.9999	1	21290	<1.0E-05	Significant Parameter
γ	1.846	0.3332	1.157	2.535	5.54	1.2E-05	Significant Parameter
δ	29.3	4.226	20.56	38.04	6.934	<1.0E-05	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	500300000	166800000	3	151100000	<1.0E-05	Significant Effect
Lack of Fit	19.18	3.835	5	11.12	5.3E-05	Significant Lack-of-Fit
Pure Error	6.21	0.345	18			
Residual	25.39	1.104	23			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Model Fit	Likelihood Ratio GOF Test	23.22	35.17	0.4478	Non-Significant Heterogeneity
	Pearson Chi-Sq GOF Test	25.39	35.17	0.3307	Non-Significant Heterogeneity
Variance	Mod Levene Equality of Variance	7.078	3.135	0.0032	Unequal Variances
Distribution	Anderson-Darling A2 Test	1.832	2.492	<1.0E-05	Non-Normal Distribution
	Shapiro-Wilk W Normality Test	0.8789	0.922	0.0055	Non-Normal Distribution
Overdispersion	Tarone C(α) Overdispersion Test	1.291	1.645	0.0984	Non-Significant Overdispersion

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	02-1123-9113	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:36	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:	19 Apr-23 13:33	**MD5 Hash:**	31A8D6CC807BA7AC2EC23028982027DD	**Editor ID:**	008-408-407-6

Survival Rate Summary

			Calculated Variate(A/B)								
Conc-%	**Code**	**Count**	**Mean**	**Median**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**ΣA/ΣB**
0	SC	5	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	50/50
0.25		3	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	30/30
0.5		3	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	30/30
1		3	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	0.00%	30/30
3.2		3	0.9000	0.9000	0.9000	0.9000	0.0000	0.0000	0.00%	10.00%	27/30
10		3	0.9667	1.0000	0.9000	1.0000	0.0333	0.0577	5.97%	3.33%	29/30
32		3	0.5667	0.6000	0.3000	0.8000	0.1453	0.2517	44.41%	43.33%	17/30
65		3	0.0704	0.1000	0.0000	0.1111	0.0353	0.0612	86.96%	92.96%	2/29

Survival Rate Detail

Conc-%	**Code**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**
0	SC	1.0000	1.0000	1.0000	1.0000	1.0000
0.25		1.0000	1.0000	1.0000		
0.5		1.0000	1.0000	1.0000		
1		1.0000	1.0000	1.0000		
3.2		0.9000	0.9000	0.9000		
10		1.0000	1.0000	0.9000		
32		0.3000	0.8000	0.6000		
65		0.1111	0.1000	0.0000		

Survival Rate Binomials

Conc-%	**Code**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**
0	SC	10/10	10/10	10/10	10/10	10/10
0.25		10/10	10/10	10/10		
0.5		10/10	10/10	10/10		
1		10/10	10/10	10/10		
3.2		9/10	9/10	9/10		
10		10/10	10/10	9/10		
32		3/10	8/10	6/10		
65		1/9	1/10	0/10		

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	02-1123-9113	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:36	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:	19 Apr-23 13:33	**MD5 Hash:**	31A8D6CC807BA7AC2EC23028982027DD	**Editor ID:**	008-408-407-6

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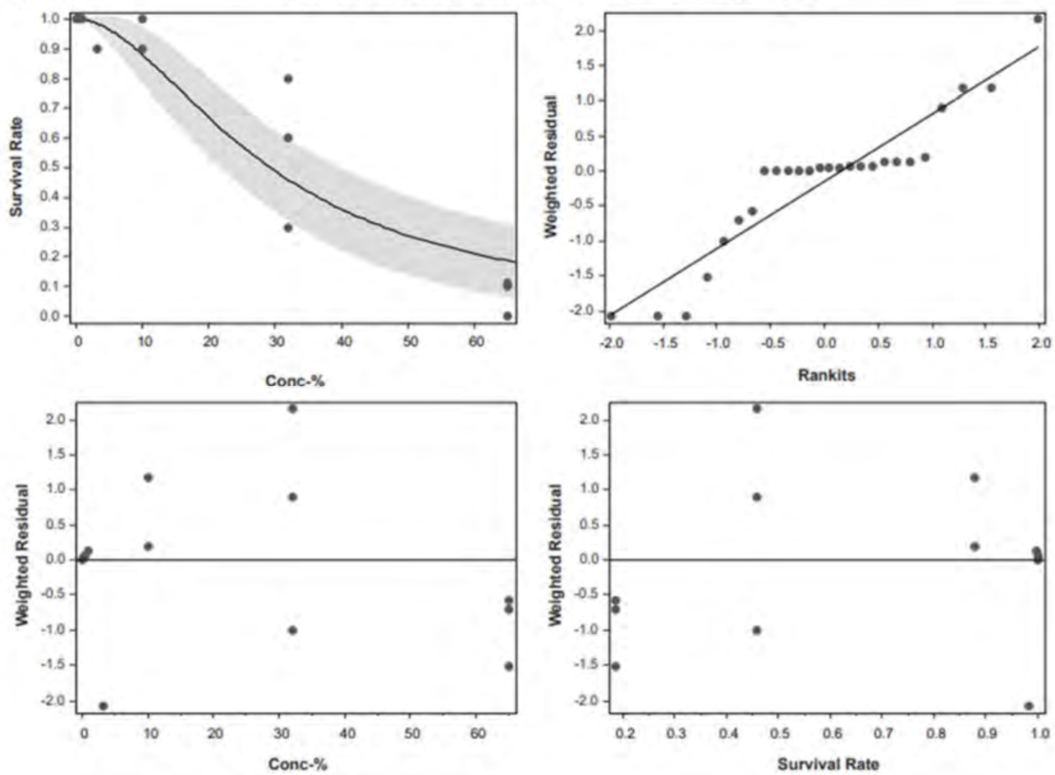

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

Blue mussel

CETIS Analytical Report

Report Date:	19 Apr-23 13:05 (p 1 of 3)
Test Code/ID:	23.003.1 MyG / 05-2656-2162

Bivalve Larval Survival and Development Test — **NIWA Ecotoxicology**

Analysis ID:	14-4790-2393	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:04	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1E150488AF42163C9AFAEA2B79B94085	**Editor ID:**	

Batch ID:	07-7899-7224	**Test Type:**	Development	**Analyst:**	Ecotox Team
Start Date:	01 Mar-23	**Protocol:**	NIWA (2008)	**Diluent:**	Offshore seawater
Ending Date:	03 Mar-23	**Species:**	Mytilus galloprovincialis	**Brine:**	Frozen Oceanic Seawater
Test Length:	48h	**Taxon:**		**Source:**	Coromandel **Age:**

Sample ID:	02-9846-3519	**Code:**	23.003.1 MyG	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	28 Feb-23	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	01 Mar-23	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	24h	**Client:**	Hastings District Council		

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	Tox Units	MSDu	PMSD
Angular (Corrected)	C > T	0.5	1	0.7071	200	0.03872	4.10%

Bonferroni Adj t Test

Control	vs	Conc-%	df	Test Stat	Critical	MSD	P-Type	P-Value	Decision(α:5%)
SW Control		0.25	13	1.265	2.579	0.06632	CDF	0.7498	Non-Significant Effect
		0.5	13	1.7	2.579	0.06632	CDF	0.3431	Non-Significant Effect
		1*	13	5.69	2.579	0.06632	CDF	<1.0E-05	Significant Effect
		2*	13	8.452	2.579	0.06632	CDF	<1.0E-05	Significant Effect
		4*	13	12.76	2.579	0.06632	CDF	<1.0E-05	Significant Effect
		8*	13	31.91	2.579	0.06632	CDF	<1.0E-05	Significant Effect
		16*	11	41.12	2.579	0.07971	CDF	<1.0E-05	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	5.89607	0.842296	7	382	<1.0E-05	Significant Effect
Error	0.0771737	0.002205	35			
Total	5.97325		42			

ANOVA Assumptions Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variance	Bartlett Equality of Variance Test	4.185	18.48	0.7582	Equal Variances
	Levene Equality of Variance Test	0.6631	3.2	0.7013	Equal Variances
	Mod Levene Equality of Variance Test	0.2585	3.358	0.9649	Equal Variances
Distribution	Anderson-Darling A2 Test	0.3944	3.878	0.3782	Normal Distribution
	D'Agostino Kurtosis Test	1.691	2.576	0.0909	Normal Distribution
	D'Agostino Skewness Test	1.237	2.576	0.2162	Normal Distribution
	D'Agostino-Pearson K2 Omnibus Test	4.387	9.21	0.1115	Normal Distribution
	Kolmogorov-Smirnov D Test	0.08551	0.1563	0.5779	Normal Distribution
	Shapiro-Wilk W Normality Test	0.9741	0.9281	0.4340	Normal Distribution

Proportion Normal Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	10	0.9440	0.9281	0.9599	0.9400	0.9100	0.9900	0.0070	2.35%	0.00%
0.25		5	0.9300	0.9068	0.9532	0.9300	0.9100	0.9600	0.0084	2.01%	1.48%
0.5		5	0.9240	0.8954	0.9526	0.9300	0.9000	0.9500	0.0103	2.49%	2.12%
1		5	0.8620	0.8299	0.8941	0.8700	0.8200	0.8900	0.0116	3.00%	8.69%
2		5	0.8100	0.7822	0.8378	0.8100	0.7800	0.8400	0.0100	2.76%	14.19%
4		5	0.7160	0.6682	0.7638	0.7000	0.6800	0.7800	0.0172	5.37%	24.15%
8		5	0.2460	0.1799	0.3121	0.2700	0.1600	0.2900	0.0238	21.63%	73.94%
16		3	0.0033	0.0000	0.0177	0.0000	0.0000	0.0100	0.0033	173.21%	99.65%

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

Bivalve Larval Survival and Development Test **NIWA Ecotoxicology**

Analysis ID:	14-4790-2393	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:04	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1E150488AF42163C9AFAEA2B79B94085	**Editor ID:**	

Angular (Corrected) Transformed Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	10	1.3380	1.2970	1.3780	1.3230	1.2660	1.4710	0.0179	4.24%	0.00%
0.25		5	1.3050	1.2570	1.3540	1.3030	1.2660	1.3690	0.0175	3.00%	2.43%
0.5		5	1.2940	1.2400	1.3480	1.3030	1.2490	1.3450	0.0195	3.37%	3.27%
1		5	1.1910	1.1460	1.2370	1.2020	1.1330	1.2330	0.0164	3.08%	10.94%
2		5	1.1200	1.0850	1.1560	1.1200	1.0830	1.1590	0.0128	2.55%	16.25%
4		5	1.0100	0.9553	1.0640	0.9912	0.9695	1.0830	0.0195	4.33%	24.53%
8		5	0.5169	0.4369	0.5968	0.5464	0.4115	0.5687	0.0288	12.46%	61.36%
16		3	0.0667	-0.0052	0.1387	0.0500	0.0500	0.1002	0.0167	43.38%	95.01%

Proportion Normal Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	SC	0.9300	0.9400	0.9400	0.9900	0.9600	0.9300	0.9300	0.9600	0.9100	0.9500
0.25		0.9300	0.9100	0.9600	0.9200	0.9300					
0.5		0.9400	0.9500	0.9000	0.9300	0.9000					
1		0.8900	0.8200	0.8700	0.8700	0.8600					
2		0.8000	0.7800	0.8100	0.8200	0.8400					
4		0.7800	0.7000	0.7200	0.7000	0.6800					
8		0.2900	0.1600	0.2300	0.2800	0.2700					
16		0.0000	0.0100	0.0000							

Angular (Corrected) Transformed Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	SC	1.3030	1.3230	1.3230	1.4710	1.3690	1.3030	1.3030	1.3690	1.2660	1.3450
0.25		1.3030	1.2660	1.3690	1.2840	1.3030					
0.5		1.3230	1.3450	1.2490	1.3030	1.2490					
1		1.2330	1.1330	1.2020	1.2020	1.1870					
2		1.1070	1.0830	1.1200	1.1330	1.1590					
4		1.0830	0.9912	1.0130	0.9912	0.9695					
8		0.5687	0.4115	0.5002	0.5576	0.5464					
16		0.0500	0.1002	0.0500							

Proportion Normal Binomials

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	SC	93/100	94/100	94/100	99/100	96/100	93/100	93/100	96/100	91/100	95/100
0.25		93/100	91/100	96/100	92/100	93/100					
0.5		94/100	95/100	90/100	93/100	90/100					
1		89/100	82/100	87/100	87/100	86/100					
2		80/100	78/100	81/100	82/100	84/100					
4		78/100	70/100	72/100	70/100	68/100					
8		29/100	16/100	23/100	28/100	27/100					
16		0/100	1/100	0/100							

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

Bivalve Larval Survival and Development Test — **NIWA Ecotoxicology**

Analysis ID:	14-4790-2393	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:04	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1E150488AF42163C9AFAEA2B79B94085	**Editor ID:**	

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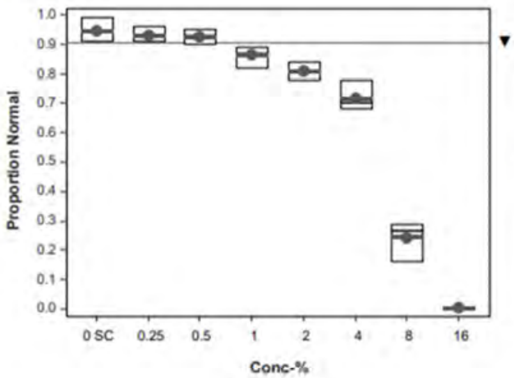

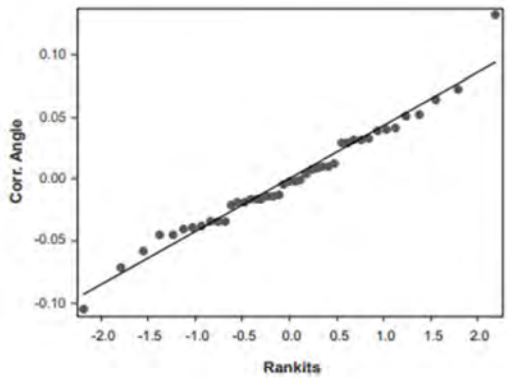

Convergent Rounding (4 sf) | CETIS™ v2.1.4.5 (008-408-407-6) | Analyst:________ QA:________

CETIS Analytical Report

Report Date: 19 Apr-23 13:05 (p 1 of 3)
Test Code/ID: 23.003.1 MyG / 05-2656-2162

Bivalve Larval Survival and Development Test — **NIWA Ecotoxicology**

Analysis ID:	11-8822-4385	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:04	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1E150488AF42163C9AFAEA2B79B94085	**Editor ID:**	

Batch ID:	07-7899-7224	**Test Type:**	Development	**Analyst:**	Ecotox Team
Start Date:	01 Mar-23	**Protocol:**	NIWA (2008)	**Diluent:**	Offshore seawater
Ending Date:	03 Mar-23	**Species:**	Mytilus galloprovincialis	**Brine:**	Frozen Oceanic Seawater
Test Length:	48h	**Taxon:**		**Source:**	Coromandel **Age:**

Sample ID:	02-9846-3519	**Code:**	23.003.1 MyG	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	28 Feb-23	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	01 Mar-23	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	24h	**Client:**	Hastings District Council		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Binomial [ω=n/[p·q]]	Off [μ*=μ]	None	None

Regression Summary

Iters	LL	AICc	BIC	Adj R2	PMSD	Thresh	Optimize	F Stat	P-Value	Decision(α:5%)
21	-130.7	268	272.7	0.8756	1.80%	0.9153	Yes	17.52	0.0000	Significant Lack-of-Fit

Point Estimates

Level	%	95% LCL	95% UCL	Tox Units	95% LCL	95% UCL
EC5	2.123	1.624	2.474	47.1	40.4	61.6
EC10	2.718	2.265	3.082	36.8	32.4	44.2
EC15	3.167	2.731	3.543	31.6	28.2	36.6
EC20	3.553	3.131	3.937	28.1	25.4	31.9
EC25	3.907	3.496	4.297	25.6	23.3	28.6
EC40	4.913	4.516	5.323	20.4	18.8	22.1
EC50	5.617	5.206	6.061	17.8	16.5	19.2

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	0.9153	0.008131	0.8989	0.9318	112.6	<1.0E-05	Significant Parameter
γ	3.026	0.2505	2.52	3.532	12.08	<1.0E-05	Significant Parameter
δ	5.617	0.2175	5.178	6.057	25.83	<1.0E-05	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	31420	10470	3	4862	<1.0E-05	Significant Effect
Lack of Fit	61.55	12.31	5	17.52	<1.0E-05	Significant Lack-of-Fit
Pure Error	24.59	0.7026	35			
Residual	86.15	2.154	40			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Model Fit	Likelihood Ratio GOF Test	95.44	55.76	<1.0E-05	Significant Heterogeneity
	Pearson Chi-Sq GOF Test	86.15	55.76	3.2E-05	Significant Heterogeneity
Variance	Bartlett Equality of Variance Test	4.363	14.07	0.7372	Equal Variances
	Mod Levene Equality of Variance	0.4394	2.359	0.8688	Equal Variances
Distribution	Anderson-Darling A2 Test	0.9076	2.492	0.0207	Non-Normal Distribution
	Shapiro-Wilk W Normality Test	0.9571	0.9479	0.1086	Normal Distribution
Overdispersion	Tarone C(α) Overdispersion Test	1.176	1.645	0.1198	Non-Significant Overdispersion

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

CETIS Analytical Report

Report Date: 19 Apr-23 13:05 (p 2 of 3)
Test Code/ID: 23.003.1 MyG / 05-2656-2162

Bivalve Larval Survival and Development Test — **NIWA Ecotoxicology**

Analysis ID:	11-8822-4385	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:04	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1E150488AF42163C9AFAEA2B79B94085	**Editor ID:**	

Proportion Normal Summary

			Calculated Variate(A/B)								
Conc-%	**Code**	**Count**	**Mean**	**Median**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**ΣA/ΣB**
0	SC	10	0.9440	0.9400	0.9100	0.9900	0.0070	0.0222	2.35%	0.00%	944/1000
0.25		5	0.9300	0.9300	0.9100	0.9600	0.0084	0.0187	2.01%	1.48%	465/500
0.5		5	0.9240	0.9300	0.9000	0.9500	0.0103	0.0230	2.49%	2.12%	462/500
1		5	0.8620	0.8700	0.8200	0.8900	0.0116	0.0259	3.00%	8.69%	431/500
2		5	0.8100	0.8100	0.7800	0.8400	0.0100	0.0224	2.76%	14.19%	405/500
4		5	0.7160	0.7000	0.6800	0.7800	0.0172	0.0385	5.37%	24.15%	358/500
8		5	0.2460	0.2700	0.1600	0.2900	0.0238	0.0532	21.63%	73.94%	123/500
16		3	0.0033	0.0000	0.0000	0.0100	0.0033	0.0058	173.21%	99.65%	1/300

Proportion Normal Detail

Conc-%	**Code**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**	**Rep 6**	**Rep 7**	**Rep 8**	**Rep 9**	**Rep 10**
0	SC	0.9300	0.9400	0.9400	0.9900	0.9600	0.9300	0.9300	0.9600	0.9100	0.9500
0.25		0.9300	0.9100	0.9600	0.9200	0.9300					
0.5		0.9400	0.9500	0.9000	0.9300	0.9000					
1		0.8900	0.8200	0.8700	0.8700	0.8600					
2		0.8000	0.7800	0.8100	0.8200	0.8400					
4		0.7800	0.7000	0.7200	0.7000	0.6800					
8		0.2900	0.1600	0.2300	0.2800	0.2700					
16		0.0000	0.0100	0.0000							

Proportion Normal Binomials

Conc-%	**Code**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**	**Rep 6**	**Rep 7**	**Rep 8**	**Rep 9**	**Rep 10**
0	SC	93/100	94/100	94/100	99/100	96/100	93/100	93/100	96/100	91/100	95/100
0.25		93/100	91/100	96/100	92/100	93/100					
0.5		94/100	95/100	90/100	93/100	90/100					
1		89/100	82/100	87/100	87/100	86/100					
2		80/100	78/100	81/100	82/100	84/100					
4		78/100	70/100	72/100	70/100	68/100					
8		29/100	16/100	23/100	28/100	27/100					
16		0/100	1/100	0/100							

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (008-408-407-6) Analyst:________ QA:________

Bivalve Larval Survival and Development Test | **NIWA Ecotoxicology**

Analysis ID:	11-8822-4385	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv2.1.4
Analyzed:	19 Apr-23 13:04	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1E150488AF42163C9AFAEA2B79B94085	**Editor ID:**	

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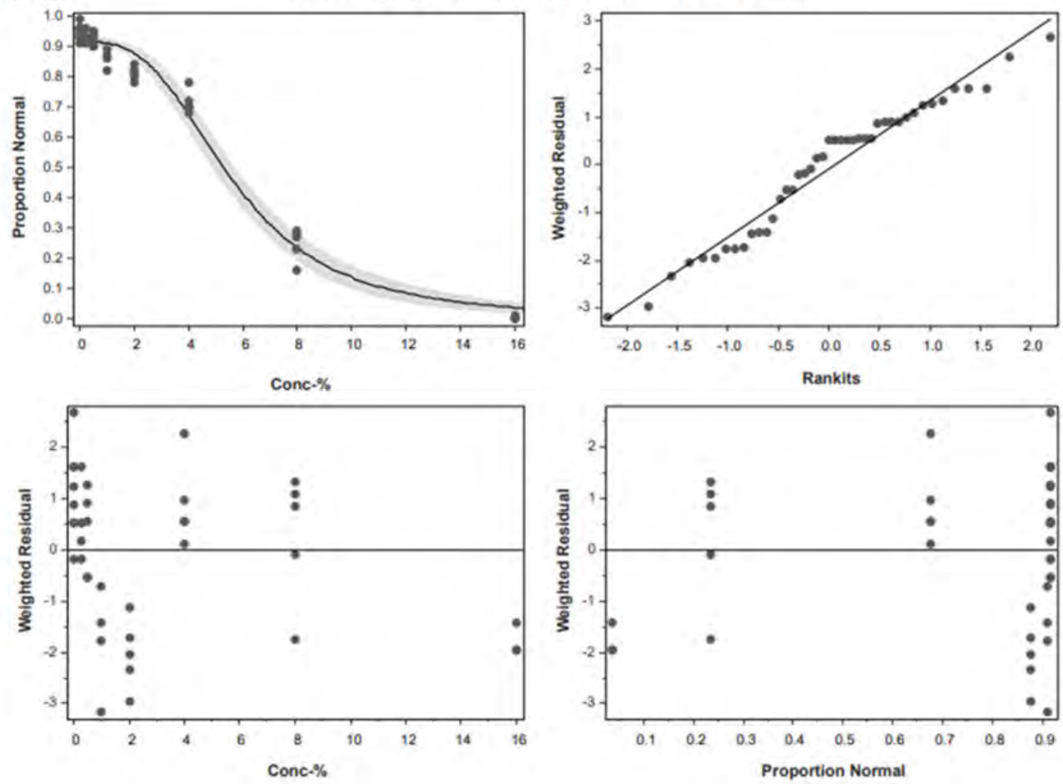

Appendix D Hill Laboratories Results

Hill Laboratories TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
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Hamilton 3240 New Zealand

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E mail@hill-labs.co.nz
W www.hill-laboratories.com

Certificate of Analysis

Page 1 of 1

Client:	NIWA Corporate	**Lab No:**	3187331
Contact:	K Thompson	**Date Received:**	02-Mar-2023
	C/- NIWA Corporate	**Date Reported:**	09-Mar-2023
	PO Box 11115	**Quote No:**	51353
	Hillcrest	**Order No:**	U321180
	Hamilton 3251	**Client Reference:**	Hastings Feb 23
		Add. Client Ref:	HDC23201
		Submitted By:	K Thompson

Sample Type: Aqueous

Sample Name:		Hastings 27-Feb-2023
Lab Number:		3187331.1
Total Ammoniacal-N	g/m^3	6.67 ± 0.24
Total Sulphide	g/m^3	0.060 ± 0.022

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

Summary of Methods

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

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) 23rd ed. 2017.	$0.010\ g/m^3$	1
Total Sulphide Trace	In-line distillation, segmented flow colorimetry. APHA 4500-S^{2-} E (modified) 23rd ed. 2017.	$0.002\ g/m^3$	1

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

Testing was completed between 06-Mar-2023 and 09-Mar-2023. For completion dates of individual analyses please contact the laboratory.

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

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

Ara Heron BSc (Tech)
Client Services Manager - Environmental

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised. The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

Appendix E Bioassay Physico-chemistry

Table E-1: Water quality measures from the wedge shell test.

Date	Time (h)	Sample	Concentration (%)	Temp (°C)	pH	DO (mg L^{-1})	DO (%)	Salinity (ppt)
2/03/2023	0	Control	0	21	7.2	6.1	83	35
		23.003.1	0.25	21	7.3	6.4	87	36
			65	21	7.3	5.4	72	33
6/03/2023	96	Control	0	20	7.1	6.6	89	36
		23.003.1	0.25	20	7.5	6.6	89	35
			0.5	20	7.5	6.6	89	35
			1	20	7.6	6.6	89	34
			3	20	7.6	6.5	88	35
			10	20	7.6	6.4	87	35
			32	20	7.6	6.1	83	35
			65	20	7.8	5.1	69	35

Table E-2: Water quality measures from the blue mussel test.

Date	Time (h)	Sample	Concentration (%)	Temp (°C)	pH	DO (mg L^{-1})	DO (%)	Salinity (ppt)
1/03/2023	0	Control	0	21	7.7	6.8	94	35
		23.003.1	0.25	21	7.7	6.8	94	35
			16	21	7.6	6.6	91	36
3/03/2023	48	Control	0	21	8.1	6.6	91	34
		23.003.1	0.25	21	7.6	6.7	92	35
			0.5	21	7.5	6.7	92	35
			1	21	7.6	6.7	92	35
			2	21	7.5	6.6	91	35
			4	21	7.5	6.5	90	35
			8	21	7.6	6.6	91	35
			16	21	7.5	5.9	81	35

NIWA
Taihoro Nukurangi

Quarterly Whole Effluent Toxicity Testing of East Clive Wastewater Treatment Plant

May 2023

Prepared for Hastings District Council

June 2023

Climate, Freshwater & Ocean Science

Prepared by:
Amelia Shepherd

For any information regarding this report please contact:

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National Institute of Water & Atmospheric Research Ltd
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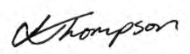
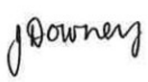
NIWA CLIENT REPORT No: 2023154HN
Report date: June 2023
NIWA Project: HDC23201

Quality Assurance Statement		
	Reviewed by:	Karen Thompson
	Formatting checked by:	Jo Downey
	Approved for release by:	Michael Bruce

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Executive summary

NIWA was engaged by Hastings District Council (HDC) to undertake quarterly Whole Effluent Toxicity (WET) testing of a treated effluent sample from East Clive Wastewater Treatment Plant to determine resource consent compliance. The sample, collected 8-9 May 2023, was tested with three marine organisms: an alga (*Minutocellus polymorphus* – 48-hour chronic growth test), and two bivalve species - wedge shell (*Macomona liliana* – 96-hour acute survival and burial test) and blue mussel (*Mytilus galloprovincialis* – 48-hour chronic embryo development test).

This report documents the results of the toxicity testing. The alga, wedge shell, and blue mussel tests all met their respective test acceptability criteria based on control performance.

The alga test showed detectable toxicity at a 200-fold dilution. The highest no-toxicity dilution was 556-fold derived from the alga test. The wedge shell and blue mussel tests did not show detectable toxicity at a 200-fold dilution. After application of the 200-fold dilution used for the 'no toxicity' criterion, the concentration of ammoniacal-N and total sulfide in the sample did not exceed ANZG (2018) default guideline values for 95% protection of species.

For the effluent sample in this quarter, the alga test had a Threshold Effect Concentration (TEC) < 0.5% effluent, however this species hasn't had two consecutive incidence of TEC < 0.25% effluent between quarters, so no further action is required.

1 Introduction

East Clive Wastewater Treatment Plant treats both industrial and domestic wastewater and the treated effluent is discharged through an ocean outfall into Hawke Bay. NIWA was engaged by Hastings District Council (HDC) to undertake quarterly Whole Effluent Toxicity (WET) testing of effluent from the East Clive Wastewater Treatment Plant for compliance with Hawke's Bay Regional Council (HBRC) resource consent CD130214W condition 15. The effluent sample was tested with three marine organisms: an alga (*Minutocellus polymorphus* 48-hour chronic growth test), and 2 bivalve species: wedge shell (*Macomona liliana* 96-hour acute survival and burial test) and blue mussel (*Mytilus galloprovincialis* 48-hour chronic embryo development test).

Condition 15 states that there shall be no statistically detectable difference in toxicity between a water sample taken from uncontaminated near-shore water (from a location to be approved by Hawke's Bay Regional Council[1]) and treated wastewater when diluted 200-times with that water. No toxicity is defined as a no-toxicity dilution less than 200-fold. If the no-toxicity dilution is greater than 200-fold, the following three conditions must be examined[2]:

1. No more than one test species with a TEC[3] < 0.5% effluent in any given quarter.
2. No more than one consecutive incidence of TEC < 0.25% effluent within any given species between quarters.
3. EC_{20}[4] (chronic tests) and LC_{10} (acute tests) for all tests shall be greater than 0.5% effluent.

These conditions are described in a flow chart in Appendix A.

[1] Dilution water is 0.2 µm filtered offshore seawater collected by NIWA.
[2] These conditions interpret the flow chart in Appendix A describing the HBRC consent supplied to NIWA 25 Jun 2014.
[3] TEC = threshold effect concentration
[4] EC_x = dilution required to have an effect on X% of the test organisms. The lower the EC_x the greater the toxicity, indicating that a higher dilution was required to cause an X% effect on the test organisms.

2 Methods

2.1 Samples

A 2 L, single-use, food-grade high density polyethylene (HDPE) container was supplied by NIWA to HDC for collection of the 24 h composite effluent sample. The sample was collected by HDC staff on 8-9 May 2023 and a subsample was collected for total sulfide at the same time in a bottle supplied by Hill Laboratories via NIWA. On arrival at NIWA Hamilton on 10 May 2023 the effluent sample was assigned a unique sample code (23.010.1) and the physicochemical parameters measured. The effluent was subsampled for ammoniacal-nitrogen (ammoniacal-N) and the remaining sample was stored in the dark at 4°C until toxicity testing commenced (within 24 hours). The samples for ammoniacal-N and total sulfide were sent to Hill Laboratories for analysis.

2.2 Toxicity testing methods

Tests were completed according to NIWA Standard Operating Procedures (SOP):

- NIWA SOP 14.4–Marine alga chronic toxicity for *Minutocellus polymorphus.*
- NIWA SOP 58.1–Marine bivalve acute toxicity for *Macomona liliana.*
- NIWA SOP 21.2–Marine bivalve chronic toxicity for *Mytilus galloprovincialis.*

A summary of test conditions and test acceptability information specified in each of the SOP manuals is provided in Appendix B.

As well as a survival endpoint, the acute wedge shell test uses a sub-lethal endpoint (reburial, termed 'morbidity') to assess adverse effects on the test organisms because it is difficult to distinguish between live and recently dead juvenile bivalves. The reburial test is undertaken following 96 hours exposure to the effluent solutions and is a more sensitive and accurate endpoint than survival for this test species.

2.3 Sample dilutions

Each test included a range of sample dilutions. The diluent for all tests was NIWA's offshore seawater. The effluent sample was adjusted to the required test salinities, as specified by the standard operating procedures. For the wedge shell and blue mussel test, the sample was adjusted to the test salinity of 34 ppt using brine (made from frozen 0.2 µm filtered offshore seawater) and tested at maximum concentrations of 65% effluent and 16% effluent respectively. For the algal test, the sample was adjusted to the required test salinity of 26 ppt using NIWA's offshore seawater for a maximum concentration of 32% effluent.

2.4 Reference toxicant

Reference toxicant tests using zinc were undertaken concurrently to measure the sensitivity and condition of the organisms in the current test. This is part of the quality control procedures and allows comparability between laboratory test results undertaken at different times by comparing results to the known sensitivity of the test organism to zinc (NIWA, unpublished long-term database). NIWA uses zinc for all species as a reference toxicant because of the large amount of available toxicity data. Zinc was considered a suitable reference toxicant by Environment Canada (1990) for its solubility, stability and shelf-life. The zinc stock concentration was validated by chemical analysis (Hill Laboratories).

2.5 Test acceptability criteria

Each test has criteria that must be met for the test to be considered acceptable (Appendix B). For the alga test, the increase in cell density in the control replicates must be greater than 16-fold and the coefficient of variation in the control replicate cell density must be less than 20%. For the wedge shell test, there must be at least 90% survival of organisms in control replicates and less than 10% morbidity in reburial control replicates. For the blue mussel test, at least 80% of the embryos in the control must have normal development.

2.6 Method detection limit

The method detection limit is a measure of the natural variability associated with each test calculated from the NIWA long-term database of test results. If the percent effect is smaller than the method detection limit, then the effect may be due to natural variability in the test response—in this event, for compliance purposes, the NOEC and LOEC would be corrected to the concentrations at which the percent effect is greater than the method detection limit. The method detection limits for each test have been updated as of February 2021 (Appendix B) according to the 23rd edition of Standard Methods for the Examination of Water and Wastewater (APHA, 2017).

2.7 Statistics

Statistical analyses were completed using CETIS v2.1.4.5 (Comprehensive Environmental Toxicity Information System) software by Tidepool Scientific.

3 Results

Results are summarized in this section (Tables 3-1 and 3-2). Raw data and detailed results from the statistical analyses are provided for all tests in Appendix C and chemistry results are provided in Appendix D.

Table 3-1: Measurements of municipal wastewater 24-hour composite sample after arrival at NIWA (10 May 2023) and results from analyses by Hill Laboratories.

Sample ID	NIWA Lab ID	pH	Temp.[a] (°C)	Salinity (ppt)	Ammoniacal-N (mg L^{-1})	Total Sulfide (S^{2-}) (mg L^{-1})
WWTP East Clive Discharge	23.010.1	3.75	19.0	0.72	19.7	3.5

[a] At time of measurements.

Table 3-2: Summary of key toxicity metrics for the test organisms exposed to HDC effluent collected 8-9 May 2023. Full results are provided in Appendix C.

Organism	EC_{10}[a] %	EC_{20}[a] %	EC_{50} % (±95% CI)[a]	NOEC[b] %	LOEC[b] %	TEC[b] %	No-Toxicity dilution[c]	Complies Y/N[d]
Alga	0.54	0.96	2.6 (2.2-3.2)	0.13[f]	0.25[f]	**0.18**	556 x	**N**
Wedge shell survival	N/A	16	30 (11-43)	10	32	**18**	5.6 x	**Y**
Wedge shell reburial[e]	N/A	14	25 (8.4-49)	10	32	**18**	5.6 x	**Y**
Blue mussel	2.1	2.4	3.2 (2.9-3.4)	0.5	1.0	**0.71**	141 x	**Y**

[a] EC_x= dilution required to have an effect on X% of the test organisms. The lower the EC_x the greater the toxicity, indicating that a higher dilution was required to cause an effect on X% of test organisms. Values in parentheses indicate the 95% confidence intervals, [b] NOEC=No observed effect concentration, LOEC=Lowest observed effect concentration, TEC=threshold effect concentration (Geometric mean of NOEC and LOEC), [c] No-toxicity dilution is calculated as (1/TEC*100), [d] Bold indicates value used for compliance, [e] 60-minute reburial results (morbidity). [f] Adjusted for the method detection limit.

3.1 Alga – cell growth inhibition

The chronic algal growth test achieved the test acceptability criteria with a 169-fold increase in mean control cell density after 48 hours and a coefficient of variation (CV) < 20% (CV = 4.5%).

There was a statistically significant effect, a 7.3% decrease in alga cell density at a concentration of 1% effluent (Appendix C). The 7.3% decrease in cell density was not greater than the method detection limit of 12.4% (Appendix B) so the NOEC and LOEC were adjusted to concentrations at which the percent effect was greater than the method detection limit. For this sample the NOEC and LOEC were adjusted to 0.125% and 0.25% respectively (Table 3-2) resulting in a no-toxicity dilution of 556-fold which exceeds the compliance threshold of maximum 200-fold dilution.

3.2 Bivalve – wedge shell survival and morbidity

Temperature was constant in all treatments, pH and salinity were in the acceptable range for the test (Appendix E, Table E-1). The dissolved oxygen (DO) in the highest concentration of effluent (65%) at the end of the test (2.4 mg L^{-1}, 33%) was below the test criterion of 60% saturation (at 20 °C and 35 ppt).

Toxicity was observed at 32% effluent where the DO was within the criterion at 61% saturation, therefore while it is possible that the DO of 33% saturation at the highest effluent concentration (65%) may have partially contributed to the observed toxicity at this concentration it was not the only cause. There was no significant difference in mean survival (both 100%) and reburial (both 96%) between control and brine control replicates (data not shown).

There was a statistically significant decrease in survival and reburial at 32% effluent with 53% and 62% effects respectively when compared to the control. This toxicity resulted in minimum no-toxicity dilutions of 5.6-fold which is within the compliance threshold of maximum 200-fold dilution.

3.3 Bivalve – blue mussel embryo development

The chronic embryo development test achieved the test acceptability criterion of at least 80% controls with normal embryo development (mean 96%). Salinity, temperature, DO and pH were in the acceptable range throughout the test (Appendix E, Table E-2). The brine solution did not affect normal embryo development at concentrations used in this test with 92% mean embryo development at 32% brine (data not shown).

There was a statistically significant (α=0.05) effect, a 6.2% decrease in normal embryo development, at 1% effluent when compared to the controls. There was a 98% effect on embryo development at the highest tested concentration (16%). For this sample, the NOEC and LOEC were 0.5% and 1% respectively resulting in a no-toxicity dilution of 141-fold which does not exceed the maximum compliance threshold of 200-fold dilution (Table 3-2 and Appendix C).

3.4 Total sulfide

ANZG (2018) default guideline value for un-ionised sulfide: 0.001 mg L^{-1} H_2S.

The subsample for total sulfide was preserved at the time of sample collection. The total sulfide in the effluent sample collected 8-9 May 2023 was 3.5 mg L^{-1} which is equivalent to 0.142 mg L^{-1} of un-ionised sulfide[5], the more toxic form of sulfide in an aquatic ecosystem. The total sulfide concentration of the May 2023 effluent sample is higher than the long-term median value of 1.08 mg L^{-1} total sulfide for all HDC effluent samples analysed since 1992 (n=119).

After applying a 200-fold dilution, the resulting un-ionised sulfide concentration of 0.0007 mg L^{-1} was lower than the ANZG (2018) default guideline value of 0.001 mg L^{-1} H_2S. Full results from the analysis of the effluent sample by Hill Laboratories are provided in Appendix D.

3.5 Ammoniacal-N

ANZG (2018) default guideline value: 0.910 mg L^{-1} ammoniacal-N, pH 8.

The ammoniacal-N concentration in the effluent sample was 19.7 mg L^{-1}, which is higher the long-term median value of 16.3 mg L^{-1} for all HDC effluent samples analysed since 1992 (n=118). Applying a 200-fold dilution to the effluent sample resulted in a concentration of 0.099 mg L^{-1} ammoniacal-N, which is approximately 9-fold lower than the ANZG (2018) default guideline value of 0.91 mg L^{-1} (at pH 8) for protection of 95% of marine species. Full results from the analysis of the effluent sample by Hill Laboratories are provided in Appendix D.

[5] Calculated as 4.06% of total sulfide at pH 8.0, 20°C, 32.5 ppt (coastal waters) (ANZG 2018).

3.6 Reference toxicant

The EC_{50} for alga exposed to zinc sulfate (0.008 mg Zn L^{-1}) was within the expected range of the long-term mean of 0.013 ± 0.016 mg Zn^{2+} L^{-1} (±2 standard deviations (S.D.), n=23). The EC_{50} values for wedge shells exposed to zinc sulfate (survival 2.9, reburial 1.5 mg Zn L^{-1}) were within the expected range of the long-term mean for survival, 3.3 ± 2.4 mg Zn^{2+} L^{-1} (n=23), and reburial, 1.7 ± 1.1 mg Zn L^{-1} (n=23). The EC_{50} for blue mussel embryos exposed to zinc sulfate (0.13 mg Zn L^{-1}) was also within the expected range of the long-term mean, 0.15 ± 0.03 mg Zn L^{-1} (n=23).

Based on chronic NOEC values derived from the zinc sulfate tests, the alga, wedge shell survival, wedge shell reburial, and blue mussels would rank within the 1^{st}, 87^{th}, 80^{th} and <68^{th} percentiles respectively of the most sensitive test organisms used for derivation of the ANZG (2021) guideline values for zinc in marine waters.

However, these sensitivity rankings are specific to zinc and care must be taken when extrapolating these results where other classes of contaminants (e.g., organics) may be present and for protection of all organisms present in a particular receiving water environment (e.g., Hawke Bay).

4 Compliance Statement

Hawke's Bay Regional Council Resource Consent No. CD130214W condition 15 requires that there be no detectable toxicity at a 200-fold effluent dilution.

The alga test showed detectable toxicity at a 200-fold dilution. The highest no-toxicity dilution was 556-fold derived from the alga test. The wedge shell and blue mussel tests did not show detectable toxicity at a 200-fold dilution.

If there is toxicity at a 200-fold dilution the following conditions must be examined: is there more than one test species with a TEC[6] < 0.5% effluent in any given quarter, is there a consecutive incidence of TEC < 0.25% effluent within any given species between quarters, and are EC_{20} (chronic tests) and LC_{10} (acute tests) for all tests greater than 0.5% effluent?

For the effluent sample in this quarter, the alga test had a TEC < 0.5% effluent however the species hasn't had two consecutive incidence of TEC < 0.25% effluent between quarters, so no further action is required (Appendix A).

After application of the 200-fold dilution used for the 'no toxicity' criterion, the concentration of ammoniacal-N and total sulfide in the sample did not exceed ANZG (2018) default guideline values for 95% protection of species.

[6] TEC=threshold effect concentration

5 Acknowledgements

I would like to thank Wakefield Harland-Baker of Hastings District Council for his co-operation with the administration and coordination of this project. Also, NIWA Ecotoxicology Principal Technician, Karen Thompson for her technical contribution to this project.

6 References

ANZG (2018) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Governments and Australian state and territory governments, Canberra, ACT, Australia. https://www.waterquality.gov.au/anz-guidelines

ANZG (2021) Toxicant default guideline values for aquatic ecosystem protection: Zinc in marine water. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. CC BY 4.0. Australian and New Zealand Governments and Australian state and territory governments, Canberra, ACT, Australia.

APHA (2017) Standard Methods for the Examination of Water and wastewater, 23rd edition. American Public Health Association, Washington, D.C. USA: 1-20.

Environment Canada (1990) *Guidance document for control of toxicity test precision using reference toxicants.* No. EPS 1/RM12. Conservation and Protection, Environment Canada: 90.

NIWA (2019) Standard Operating Procedure Number 58.1 *Macomona liliana* 96-h Acute Toxicity Test Procedure. *National Institute of Water and Atmospheric Research,* Hamilton, New Zealand:31.

NIWA (2021) Standard Operating Procedure. 14.4. Marine algae (*Minutocellus polymorphus*) chronic toxicity test procedure. *National Institute of Water and Atmospheric Research,* Hamilton, New Zealand: 47.

NIWA (2008) Standard Operating Procedure 21.2. Blue mussel embryo (*Mytilus galloprovincialis*) short-term chronic toxicity test protocol. *National Institute of Water and Atmospheric Research.* Hamilton, New Zealand: 29.

Roper, D.S., Hickey, C.W. (1994) Behavioural responses of the marine bivalve *Macomona liliana* exposed to copper- and chlordane-dosed sediments. *Marine Biology*, 118: 673–680.

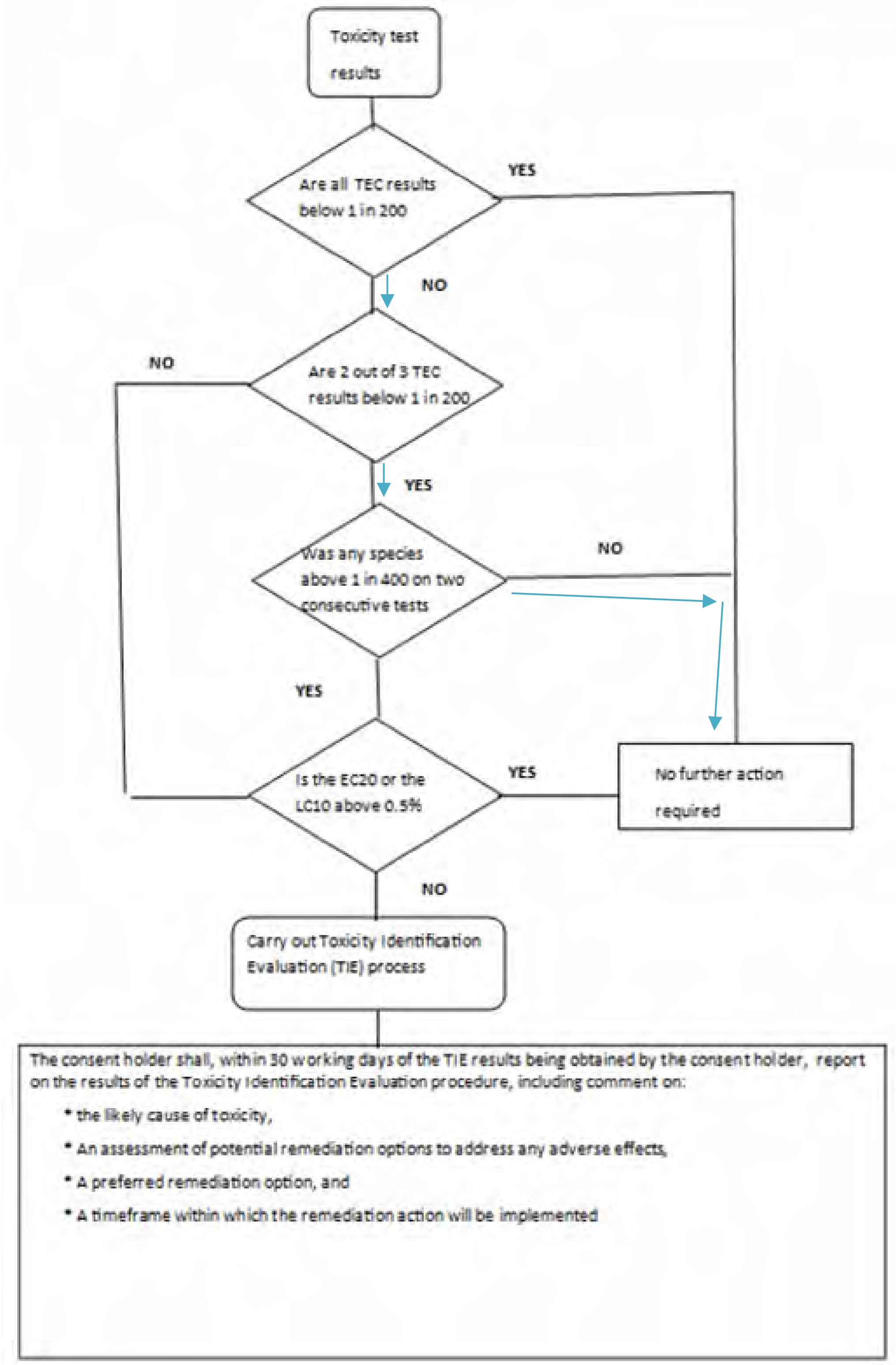
Thompson, K. (2022) Quarterly Whole Effluent Toxicity Testing of East Clive Wastewater Treatment Plant – October 2022. *NIWA Client Report* 2022371HN, Hamilton, New Zealand: 38.

Tidepool (2001-2022) CETIS -Comprehensive Environmental Toxicity Information System. *CETIS Users Guide v2.1.3* Tidepool Scientific Software, MacKinleyville, Ca.: 305.

USEPA (1987) *Methods for toxicity tests of single substances and liquid complex wastes with marine unicellular algae. EPA-600-8/87/043*. US Environmental Protection Agency, Cincinnati, Ohio.

Williams, E.K., Hall, J.A. (1999) Seasonal and geographic variability in toxicant sensitivity of *Mytilus galloprovincialis* larvae. *Australasian Journal of Ecotoxicology*, 5(1): 1–10.

Appendix A Flow chart describing HBRC consent CD130214W condition 15[a]



Appendix B Test Conditions

Test conditions and dilutions for sample 23.010.1

Project Name:	Hastings DC Effluent Bioassays: 2022–2023	**Project Number**	HDC23201
Test Material:	Hastings District Council 8-9/5/2023	**Reference Toxicant:**	Zinc sulphate
Dilution Water:	0.2 µm filtered offshore seawater from South Pacific Ocean		

	Alga	**Bivalve–wedge shell**	**Bivalve–blue mussel embryos**
Reference Method:	US EPA (1987) modified with Environment Canada (1992)	Adapted from Roper & Hickey (1994)	Williams & Hall (1999b)
Test Protocol:	NIWA SOP 14.4 NIWA (2021)	NIWA SOP 58.1 NIWA (2019)	NIWA SOP 21.2 (2008)
Test Organisms:	*Minutocellus polymorphus*	*Macomona liliana*	*Mytilus galloprovincialis*
Source:	Lab culture (500), imported from Bigelow Laboratories, USA	Manukau Harbour, Wiroa Island control site	Coromandel Harbour
Organisms/Container:	10,000 cells mL^{-1}	10	600 fertilised embryos
Test Concentrations	Control, 0.0625, 0.125, 0.25, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0, 32.0%	Control, 0.25, 0.5, 1.0, 3.2, 10,32, 65%	Control, 0.25, 0.5, 1.0, 2.0, 4.0, 8.0, 16%
Test Duration:	48 hours	96 hours	48 hours
Replicates:	10 for controls, 5 for treatments	5 for controls, 3 for treatments	10 for controls, 5 for treatments
Sample pre-treatment:	0.45 µm filtration	Brine added to adjust salinity	Brine added to adjust salinity
Salinity:	26‰	34 $\pm$ 2‰	34 $\pm$ 2‰
Brine:	Nil	Filtered (0.2 µm) offshore seawater, frozen and thawed for brine collection	Filtered (0.2 µm) offshore seawater, frozen and thawed for brine collection
Test Chambers:	96 well sterile microplates	55 ml polystyrene beakers	16x100 mm glass tubes
Lighting:	Continuous overhead lighting	Complete darkness	16:8 light dark
Temperature:	25 ± 1°C	20 ± 1°C	20 ± 1°C
Aeration:	Nil	Nil	Nil
Chemical Data:	Initial salinity	Initial and final salinity, final pH, temperature, dissolved oxygen	Initial and final salinity, temperature, dissolved oxygen, pH
Effect Measured:	Growth inhibition	Survival and morbidity (survival, reburial)	Abnormal embryo development
Zn sensitivity current test; long term mean (EC_{50}±2sd):	0.008; 0.013 (0.000–0.029) mg Zn L^{-1} (n=23)	Survival 2.9; Reburial 1.5; 3.3 (0.9–5.6) mg L^{-1} Zn^{2+} (n=23) (survival); 1.7 (0.6–2.8) mg L^{-1} Zn^{2+} (n=23) (reburial)	0.13; 0.15 (0.12–0.19) mg Zn L^{-1} (n=23)
Test Acceptability:	Control coefficient of variation within 20%; at least 16x cell growth increase in controls.	At least 90% survival in control and less than 10% morbidity in control reburial	80% of control embryos normally developed
Method Detection Limit (MDL):	12.4% reduction relative to controls	4.1% reduction relative to controls	5.1% reduction relative to controls
Percent Minimum Significant Difference (PMSD):	5.3%	Survival 11% Reburial 33%	5.7%
Test Acceptability Compliance:	**Achieved**	**Achieved**	**Achieved**

Appendix C Statistics

Alga

CETIS Analytical Report

Report Date: 31 May-23 10:55 (p 1 of 2)
Test Code/ID: 23.010.1 MP7 / 07-1612-5226

Phytoplankton Growth Inhibition Test — **NIWA Ecotoxicology**

Analysis ID:	03-6473-1280	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv2.1.4
Analyzed:	31 May-23 8:56	**Analysis:**	Nonparametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1F1E3087FE3056CC408C536E32C9D824	**Editor ID:**	
Batch ID:	17-6558-4013	**Test Type:**	Cell Growth	**Analyst:**	Ecotox Team
Start Date:	10 May-23	**Protocol:**	NIWA (1996)	**Diluent:**	Offshore seawater
Ending Date:	12 May-23	**Species:**	Minutocellus polymorphus	**Brine:**	Not Applicable
Test Length:	48h	**Taxon:**		**Source:**	CCMP Bigelow Laboratory f **Age:**
Sample ID:	11-7600-9311	**Code:**	23.010.1 MP7	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	09 May-23	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	10 May-23	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	24h (5.6 °C)	**Client:**	Hastings District Council		

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	Tox Units	MSDu	PMSD
Untransformed	C > T	<0.0625	0.0625	---	>1600	89220	5.27%

Wilcoxon/Bonferroni Adj Test

Control	vs	Conc-%	df	Test Stat	Critical	Ties	P-Type	P-Value	Decision(α:5%)
SW Control		0.0625*	13	18	---	0	Exact	0.0233	Significant Effect
		0.125*	13	18	---	0	Exact	0.0233	Significant Effect
		0.25*	13	15	---	0	Exact	0.0033	Significant Effect
		0.5*	13	15	---	0	Exact	0.0033	Significant Effect
		1*	13	15	---	0	Exact	0.0033	Significant Effect
		2*	13	15	---	0	Exact	0.0033	Significant Effect
		4*	13	15	---	0	Exact	0.0033	Significant Effect
		8*	13	15	---	0	Exact	0.0033	Significant Effect
		16*	13	15	---	0	Exact	0.0033	Significant Effect
		32*	13	15	---	0	Exact	0.0033	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	2.395E+13	2.395E+12	10	648.1	<1.0E-05	Significant Effect
Error	1.810E+11	3.695E+09	49			
Total	2.413E+13		59			

ANOVA Assumptions Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variance	Bartlett Equality of Variance Test	50.5	23.21	<1.0E-05	Unequal Variances
	Levene Equality of Variance Test	4.674	2.706	0.0001	Unequal Variances
	Mod Levene Equality of Variance Test	2.634	2.814	0.0148	Equal Variances
Distribution	Anderson-Darling A2 Test	0.3594	3.878	0.4543	Normal Distribution
	D'Agostino Kurtosis Test	0.06815	2.576	0.9457	Normal Distribution
	D'Agostino Skewness Test	0.5014	2.576	0.6161	Normal Distribution
	D'Agostino-Pearson K2 Omnibus Test	0.256	9.21	0.8798	Normal Distribution
	Kolmogorov-Smirnov D Test	0.06962	0.1331	0.6380	Normal Distribution
	Shapiro-Wilk W Normality Test	0.985	0.9459	0.6715	Normal Distribution

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (009-951-268-0) Analyst:________ QA:________

Phytoplankton Growth Inhibition Test | **NIWA Ecotoxicology**

Analysis ID:	03-6473-1280	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv2.1.4
Analyzed:	31 May-23 8:56	**Analysis:**	Nonparametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1F1E3087FE3056CC408C536E32C9D824	**Editor ID:**	

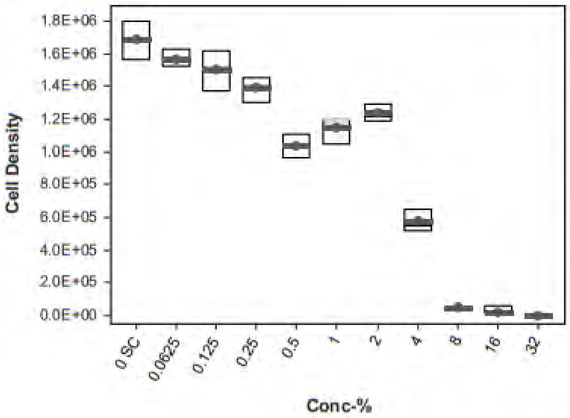
Cell Density Summary

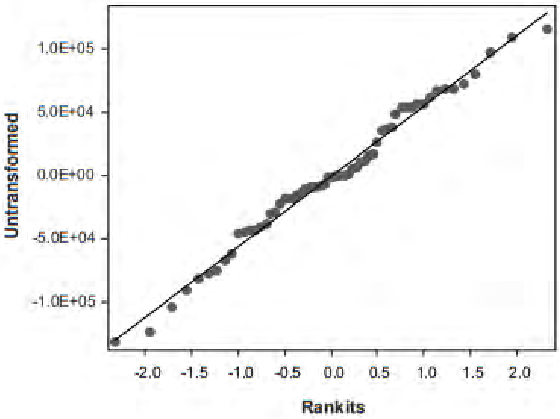
Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	10	1.693E+6	1.639E+6	1.746E+6	1.689E+6	1.569E+6	1.802E+6	2.381E+4	4.45%	0.00%
0.0625		5	1.569E+6	1.522E+6	1.616E+6	1.563E+6	1.529E+6	1.631E+6	1.701E+4	2.42%	7.29%
0.125		5	1.502E+6	1.372E+6	1.631E+6	1.514E+6	1.370E+6	1.618E+6	4.658E+4	6.94%	11.27%
0.25		5	1.389E+6	1.314E+6	1.464E+6	1.407E+6	1.298E+6	1.458E+6	2.699E+4	4.34%	17.93%
0.5		5	1.041E+6	9.644E+5	1.118E+6	1.034E+6	9.669E+5	1.110E+6	2.771E+4	5.95%	38.47%
1		5	1.147E+6	1.052E+6	1.243E+6	1.201E+6	1.044E+6	1.204E+6	3.439E+4	6.70%	32.22%
2		5	1.240E+6	1.185E+6	1.294E+6	1.221E+6	1.194E+6	1.294E+6	1.960E+4	3.53%	26.75%
4		5	5.833E+5	5.020E+5	6.646E+5	5.528E+5	5.164E+5	6.557E+5	2.928E+4	11.22%	65.53%
8		5	5.547E+4	3.863E+4	7.232E+4	6.070E+4	4.038E+4	7.184E+4	6.067E+3	24.46%	96.72%
16		5	2.097E+4	-4.678E+3	4.661E+4	1.190E+4	1.082E+4	5.790E+4	9.237E+3	98.50%	98.76%
32		5	7.120E+2	1.051E+2	1.319E+3	6.200E+2	2.000E+2	1.460E+3	2.186E+2	68.65%	99.96%

Cell Density Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	SC	1.569E+6	1.802E+6	1.741E+6	1.790E+6	1.655E+6	1.611E+6	1.649E+6	1.729E+6	1.704E+6	1.675E+6
0.0625		1.631E+6	1.551E+6	1.571E+6	1.529E+6	1.563E+6					
0.125		1.618E+6	1.370E+6	1.424E+6	1.582E+6	1.514E+6					
0.25		1.367E+6	1.298E+6	1.416E+6	1.458E+6	1.407E+6					
0.5		9.980E+5	9.669E+5	1.034E+6	1.110E+6	1.098E+6					
1		1.086E+6	1.044E+6	1.201E+6	1.202E+6	1.204E+6					
2		1.294E+6	1.194E+6	1.221E+6	1.211E+6	1.278E+6					
4		5.164E+5	5.403E+5	6.557E+5	6.515E+5	5.528E+5					
8		4.242E+4	4.038E+4	6.202E+4	6.070E+4	7.184E+4					
16		5.790E+4	1.174E+4	1.190E+4	1.082E+4	1.248E+4					
32		4.000E+2	8.800E+2	1.460E+3	2.000E+2	6.200E+2					

Graphics





Convergent Rounding (4 sf) | CETIS™ v2.1.4.5 (009-951-268-0) | Analyst:________ QA:________

CETIS Analytical Report

Report Date: 31 May-23 10:55 (p 1 of 3)
Test Code/ID: 23.010.1 MP7 / 07-1612-5226

Phytoplankton Growth Inhibition Test — **NIWA Ecotoxicology**

Analysis ID:	00-2941-5927	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv2.1.4
Analyzed:	31 May-23 8:58	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1F1E3087FE3056CC408C536E32C9D824	**Editor ID:**	

Batch ID:	17-6558-4013	**Test Type:**	Cell Growth	**Analyst:**	Ecotox Team
Start Date:	10 May-23	**Protocol:**	NIWA (1996)	**Diluent:**	Offshore seawater
Ending Date:	12 May-23	**Species:**	Minutocellus polymorphus	**Brine:**	Not Applicable
Test Length:	48h	**Taxon:**		**Source:**	CCMP Bigelow Laboratory f **Age:**

Sample ID:	11-7600-9311	**Code:**	23.010.1 MP7	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	09 May-23	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	10 May-23	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	24h (5.6 °C)	**Client:**	Hastings District Council		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Normal [ω=1]	Off [μ*=μ]	None	None

Regression Summary

Iters	LL	AICc	BIC	Adj R2	PMSD	Thresh	Optimize	F Stat	P-Value	Decision(α:5%)
58	-726.8	1460	1466	0.9160	5.26%	1542000	Yes	60.15	0.0000	Significant Lack-of-Fit

Point Estimates

Level	%	95% LCL	95% UCL	Tox Units	95% LCL	95% UCL
IC5	0.3126	0.07293	0.5064	319.9	197.5	1371.2
IC10	0.5366	0.3039	0.7576	186.3	132	329
IC15	0.7499	0.4917	1.01	133.3	99	203.4
IC20	0.9648	0.6817	1.262	103.7	79.2	146.7
IC25	1.188	0.8824	1.519	84.2	65.8	113.3
IC40	1.961	1.585	2.397	51	41.7	63.1
IC50	2.63	2.171	3.185	38	31.4	46.1

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	1542000	40480	1461000	1623000	38.09	<1.0E-05	Significant Parameter
γ	1.383	0.1781	1.026	1.739	7.761	<1.0E-05	Significant Parameter
δ	2.63	0.2868	2.055	3.204	9.17	<1.0E-05	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	8.151E+13	2.717E+13	3	790.6	<1.0E-05	Significant Effect
Lack of Fit	1.778E+12	2.222E+11	8	60.15	<1.0E-05	Significant Lack-of-Fit
Pure Error	1.81E+11	3.695E+09	49			
Residual	1.959E+12	3.437E+10	57			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Variance	Bartlett Equality of Variance Test	50.5	18.31	<1.0E-05	Unequal Variances
	Mod Levene Equality of Variance	2.634	2.084	0.0148	Unequal Variances
Distribution	Anderson-Darling A2 Test	0.3336	2.492	0.5182	Normal Distribution
	Shapiro-Wilk W Normality Test	0.9856	0.9605	0.6990	Normal Distribution

Convergent Rounding (4 sf)   CETIS™ v2.1.4.5 (009-951-268-0)   Analyst:________ QA:________

Phytoplankton Growth Inhibition Test — NIWA Ecotoxicology

Analysis ID:	00-2941-5927	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv2.1.4
Analyzed:	31 May-23 8:58	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1F1E3087FE3056CC408C536E32C9D824	**Editor ID:**	

Cell Density Summary

Conc-%	Code	Count	Mean	Median	Min	Max	Std Err	Std Dev	CV%	%Effect
0	SC	10	1.693E+6	1.689E+6	1.569E+6	1.802E+6	2.381E+4	7.529E+4	4.45%	0.00%
0.0625		5	1.569E+6	1.563E+6	1.529E+6	1.631E+6	1.701E+4	3.803E+4	2.42%	7.29%
0.125		5	1.502E+6	1.514E+6	1.370E+6	1.618E+6	4.658E+4	1.042E+5	6.94%	11.27%
0.25		5	1.389E+6	1.407E+6	1.298E+6	1.458E+6	2.699E+4	6.034E+4	4.34%	17.93%
0.5		5	1.041E+6	1.034E+6	9.669E+5	1.110E+6	2.771E+4	6.196E+4	5.95%	38.47%
1		5	1.147E+6	1.201E+6	1.044E+6	1.204E+6	3.439E+4	7.689E+4	6.70%	32.22%
2		5	1.240E+6	1.221E+6	1.194E+6	1.294E+6	1.960E+4	4.382E+4	3.53%	26.75%
4		5	5.833E+5	5.528E+5	5.164E+5	6.557E+5	2.928E+4	6.547E+4	11.22%	65.53%
8		5	5.547E+4	6.070E+4	4.038E+4	7.184E+4	6.067E+3	1.357E+4	24.46%	96.72%
16		5	2.097E+4	1.190E+4	1.082E+4	5.790E+4	9.237E+3	2.065E+4	98.50%	98.76%
32		5	7.120E+2	6.200E+2	2.000E+2	1.460E+3	2.186E+2	4.888E+2	68.65%	99.96%

Cell Density Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	SC	1.569E+6	1.802E+6	1.741E+6	1.790E+6	1.655E+6	1.611E+6	1.649E+6	1.729E+6	1.704E+6	1.675E+6
0.0625		1.631E+6	1.551E+6	1.571E+6	1.529E+6	1.563E+6					
0.125		1.618E+6	1.370E+6	1.424E+6	1.582E+6	1.514E+6					
0.25		1.367E+6	1.298E+6	1.416E+6	1.458E+6	1.407E+6					
0.5		9.980E+5	9.669E+5	1.034E+6	1.110E+6	1.098E+6					
1		1.086E+6	1.044E+6	1.201E+6	1.202E+6	1.204E+6					
2		1.294E+6	1.194E+6	1.221E+6	1.211E+6	1.278E+6					
4		5.164E+5	5.403E+5	6.557E+5	6.515E+5	5.528E+5					
8		4.242E+4	4.038E+4	6.202E+4	6.070E+4	7.184E+4					
16		5.790E+4	1.174E+4	1.190E+4	1.082E+4	1.248E+4					
32		4.000E+2	8.800E+2	1.460E+3	2.000E+2	6.200E+2					

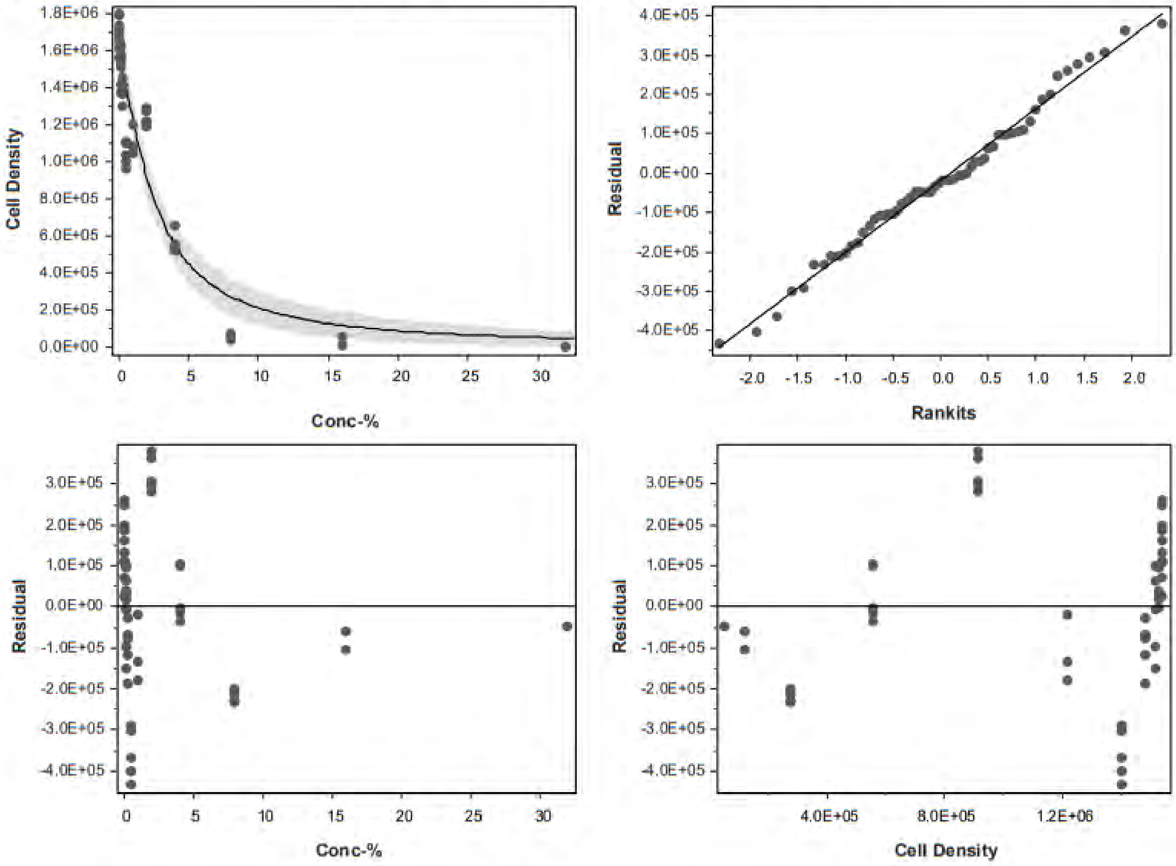
CETIS Analytical Report

Report Date:	31 May-23 10:55 (p 3 of 3)
Test Code/ID:	23.010.1 MP7 / 07-1612-5226

Phytoplankton Growth Inhibition Test NIWA Ecotoxicology

Analysis ID:	00-2941-5927	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv2.1.4
Analyzed:	31 May-23 8:58	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1F1E3087FE3056CC408C536E32C9D824	**Editor ID:**	

Graphics Model: 3P Log-Logistic: μ=α/[1+[x/δ]^γ] Distribution: Normal [ω=1]



Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (009-951-268-0) Analyst:________ QA:________

Wedge shell survival

CETIS Analytical Report

Report Date:	27 Jun-23 08:49 (p 1 of 3)
Test Code/ID:	23.010.1 MAC / 15-6527-1925

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	03-5832-1699	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	27 Jun-23 8:41	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	C9E0E86A536C6DCDE06E6D155A65C500	**Editor ID:**	

Batch ID:	18-0876-0192	**Test Type:**	Survival-Reburial	**Analyst:**	Ecotox Team	
Start Date:	11 May-23	**Protocol:**	NIWA (1995)	**Diluent:**	Offshore seawater	
Ending Date:	15 May-23	**Species:**	Macomona liliana	**Brine:**	Frozen Oceanic Seawater	
Test Length:	96h	**Taxon:**		**Source:**	Client Supplied	**Age:**

Sample ID:	12-5696-4688	**Code:**	23.010.1 MAC	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	09 May-23	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	10 May-23	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	48h (5.6 °C)	**Client:**	Hastings District Council		

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	Tox Units	MSDu	PMSD
Angular (Corrected)	C > T	10	32	17.89	10	0.1075	10.75%

Bonferroni Adj t Test

Control	vs	Conc-%	df	Test Stat	Critical	MSD	P-Type	P-Value	Decision(α:5%)
SW Control		0.25	6	0	2.694	0.1752	CDF	1.0000	Non-Significant Effect
		0.5	5	0	2.694	0.2007	CDF	1.0000	Non-Significant Effect
		1	6	0	2.694	0.1752	CDF	1.0000	Non-Significant Effect
		3.2	6	0	2.694	0.1752	CDF	1.0000	Non-Significant Effect
		10	6	0	2.694	0.1752	CDF	1.0000	Non-Significant Effect
		32*	6	10.25	2.694	0.1752	CDF	<1.0E-05	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	1.1518	0.191966	6	24.2	<1.0E-05	Significant Effect
Error	0.118964	0.007931	15			
Total	1.27076		21			

ANOVA Assumptions Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variance	Bartlett Equality of Variance Test				Indeterminate
	Levene Equality of Variance Test	17.27	4.318	<1.0E-05	Unequal Variances
	Mod Levene Equality of Variance Test	1.312	5.802	0.3424	Equal Variances
Distribution	Anderson-Darling A2 Test	6.233	3.878	<1.0E-05	Non-Normal Distribution
	D'Agostino Kurtosis Test	3.894	2.576	9.9E-05	Non-Normal Distribution
	D'Agostino Skewness Test	3.517	2.576	0.0004	Non-Normal Distribution
	D'Agostino-Pearson K2 Omnibus Test	27.53	9.21	<1.0E-05	Non-Normal Distribution
	Kolmogorov-Smirnov D Test	0.4545	0.214	<1.0E-05	Non-Normal Distribution
	Shapiro-Wilk W Normality Test	0.4798	0.8757	<1.0E-05	Non-Normal Distribution

Survival Rate Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
0.25		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
0.5		2	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
1		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
3.2		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
10		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
32		3	0.4667	0.0000	1.0000	0.6000	0.2000	0.6000	0.1333	49.49%	53.33%
64.7		3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	—	100.00%

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (009-951-268-0) Analyst:________ QA:________

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	03-5832-1699	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	27 Jun-23 8:41	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	C9E0E86A536C6DCDE06E6D155A65C500	**Editor ID:**	

Angular (Corrected) Transformed Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	5	1.4120	1.4120	1.4120	1.4120	1.4120	1.4120	0.0000	0.00%	0.00%
0.25		3	1.4120	1.4110	1.4130	1.4120	1.4120	1.4120	0.0000	0.00%	0.00%
0.5		2	1.4120	1.4090	1.4150	1.4120	1.4120	1.4120	0.0000	0.00%	0.00%
1		3	1.4120	1.4110	1.4130	1.4120	1.4120	1.4120	0.0000	0.00%	0.00%
3.2		3	1.4120	1.4110	1.4130	1.4120	1.4120	1.4120	0.0000	0.00%	0.00%
10		3	1.4120	1.4110	1.4130	1.4120	1.4120	1.4120	0.0000	0.00%	0.00%
32		3	0.7453	0.1394	1.3510	0.8861	0.4636	0.8861	0.1408	32.73%	47.22%
64.7		3	0.1588	0.1588	0.1588	0.1588	0.1588	0.1588	0.0000	0.00%	88.76%

Survival Rate Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	1.0000	1.0000	1.0000	1.0000	1.0000
0.25		1.0000	1.0000	1.0000		
0.5		1.0000	1.0000			
1		1.0000	1.0000	1.0000		
3.2		1.0000	1.0000	1.0000		
10		1.0000	1.0000	1.0000		
32		0.2000	0.6000	0.6000		
64.7		0.0000	0.0000	0.0000		

Angular (Corrected) Transformed Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	1.4120	1.4120	1.4120	1.4120	1.4120
0.25		1.4120	1.4120	1.4120		
0.5		1.4120	1.4120			
1		1.4120	1.4120	1.4120		
3.2		1.4120	1.4120	1.4120		
10		1.4120	1.4120	1.4120		
32		0.4636	0.8861	0.8861		
64.7		0.1588	0.1588	0.1588		

Survival Rate Binomials

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	10/10	10/10	10/10	10/10	10/10
0.25		10/10	10/10	10/10		
0.5		10/10	10/10			
1		10/10	10/10	10/10		
3.2		10/10	10/10	10/10		
10		10/10	10/10	10/10		
32		2/10	6/10	6/10		
64.7		0/10	0/10	0/10		

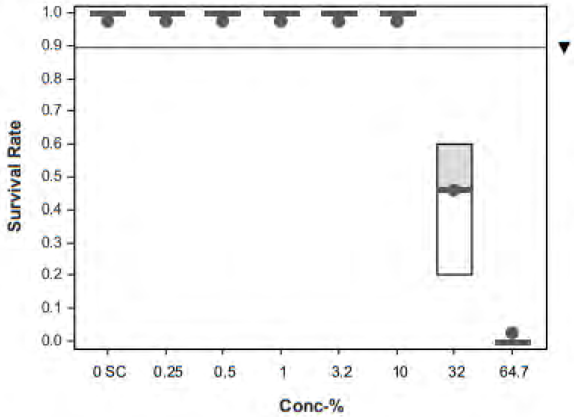
CETIS Analytical Report

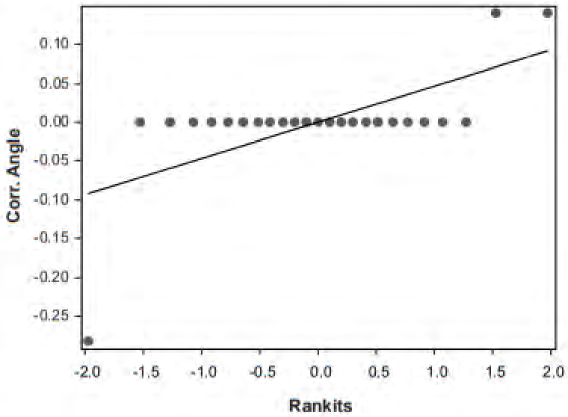
Report Date:	27 Jun-23 08:49 (p 3 of 3)
Test Code/ID:	23.010.1 MAC / 15-6527-1925

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	03-5832-1699	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	27 Jun-23 8:41	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	C9E0E86A536C6DCDE06E6D155A65C500	**Editor ID:**	

Graphics





Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (009-951-268-0) Analyst:________ QA:________

CETIS Analytical Report

Report Date: 27 Jun-23 08:49 (p 1 of 2)
Test Code/ID: 23.010.1 MAC / 15-6527-1925

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	08-1313-0362	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	27 Jun-23 8:43	**Analysis:**	Linear Interpolation (ICPIN)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	C9E0E86A536C6DCDE06E6D155A65C500	**Editor ID:**	

Batch ID:	18-0876-0192	**Test Type:**	Survival-Reburial	**Analyst:**	Ecotox Team
Start Date:	11 May-23	**Protocol:**	NIWA (1995)	**Diluent:**	Offshore seawater
Ending Date:	15 May-23	**Species:**	Macomona liliana	**Brine:**	Frozen Oceanic Seawater
Test Length:	96h	**Taxon:**		**Source:**	Client Supplied **Age:**

Sample ID:	12-5696-4688	**Code:**	23.010.1 MAC	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	09 May-23	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	10 May-23	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	48h (5.6 °C)	**Client:**	Hastings District Council		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	182027	200	Yes	Two-Point Interpolation

Point Estimates

Level	%	95% LCL	95% UCL	Tox Units	95% LCL	95% UCL
LC15	13.98	10.9	17.4	7.2	5.7	9.2
LC20	15.61	11.13	20.74	6.4	4.8	9
LC25	17.41	11.31	24.65	5.7	4.1	8.8
LC40	24.07	11.43	40.72	4.2	2.5	8.8
LC50	29.81	11.01	42.84	3.4	2.3	9.1

Survival Rate Summary

			Calculated Variate(A/B)							Isotonic Variate	
Conc-%	Code	Count	Mean	Median	Min	Max	CV%	%Effect	ΣA/ΣB	Mean	%Effect
0	SC	5	1.0000	1.0000	1.0000	1.0000	0.00%	0.00%	50/50	1.0000	0.00%
0.25		3	1.0000	1.0000	1.0000	1.0000	0.00%	0.00%	30/30	1.0000	0.00%
0.5		2	1.0000	1.0000	1.0000	1.0000	0.00%	0.00%	20/20	1.0000	0.00%
1		3	1.0000	1.0000	1.0000	1.0000	0.00%	0.00%	30/30	1.0000	0.00%
3.2		3	1.0000	1.0000	1.0000	1.0000	0.00%	0.00%	30/30	1.0000	0.00%
10		3	1.0000	1.0000	1.0000	1.0000	0.00%	0.00%	30/30	1.0000	0.00%
32		3	0.4667	0.6000	0.2000	0.6000	49.49%	53.33%	14/30	0.4667	53.33%
64.7		3	0.0000	0.0000	0.0000	0.0000	—	100.00%	0/30	0.0000	100.00%

Survival Rate Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	1.0000	1.0000	1.0000	1.0000	1.0000
0.25		1.0000	1.0000	1.0000		
0.5		1.0000	1.0000			
1		1.0000	1.0000	1.0000		
3.2		1.0000	1.0000	1.0000		
10		1.0000	1.0000	1.0000		
32		0.2000	0.6000	0.6000		
64.7		0.0000	0.0000	0.0000		

Survival Rate Binomials

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	10/10	10/10	10/10	10/10	10/10
0.25		10/10	10/10	10/10		
0.5		10/10	10/10			
1		10/10	10/10	10/10		
3.2		10/10	10/10	10/10		
10		10/10	10/10	10/10		
32		2/10	6/10	6/10		
64.7		0/10	0/10	0/10		

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (009-951-268-0) Analyst:________ QA:________

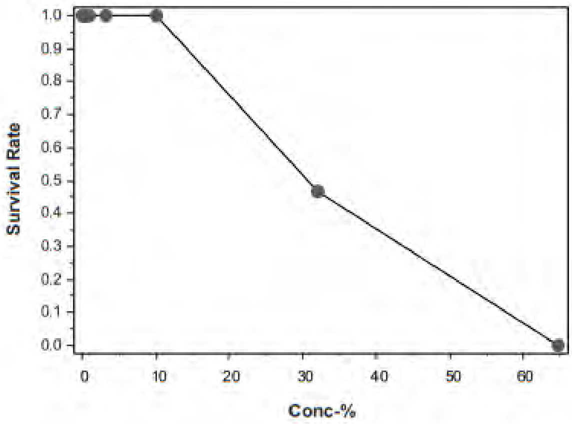
CETIS Analytical Report

Report Date:	27 Jun-23 08:49 (p 2 of 2)
Test Code/ID:	23.010.1 MAC / 15-6527-1925

Macomona 96 h survival and reburial test **NIWA Ecotoxicology**

Analysis ID:	08-1313-0362	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	27 Jun-23 8:43	**Analysis:**	Linear Interpolation (ICPIN)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	C9E0E86A536C6DCDE06E6D155A65C500	**Editor ID:**	

Graphics



Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (009-951-268-0) Analyst:________ QA:________

Wedge shell reburial

CETIS Analytical Report

Report Date:	27 Jun-23 08:50 (p 1 of 3)
Test Code/ID:	23.010.1 MAC / 15-6527-1925

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	17-7333-6405	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	27 Jun-23 8:41	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1F771B4761A41EEBF04C161B98DF1B3B	**Editor ID:**	

Batch ID:	18-0876-0192	**Test Type:**	Survival-Reburial	**Analyst:**	Ecotox Team		
Start Date:	11 May-23	**Protocol:**	NIWA (1995)	**Diluent:**	Offshore seawater		
Ending Date:	15 May-23	**Species:**	Macomona liliana	**Brine:**	Frozen Oceanic Seawater		
Test Length:	96h	**Taxon:**		**Source:**	Client Supplied	**Age:**	

Sample ID:	12-5696-4688	**Code:**	23.010.1 MAC	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	09 May-23	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	10 May-23	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	48h (5.6 °C)	**Client:**	Hastings District Council		

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	Tox Units	MSDu	PMSD
Angular (Corrected)	C > T	10	32	17.89	10	0.318	33.12%

Bonferroni Adj t Test

Control	vs	Conc-%	df	Test Stat	Critical	MSD	P-Type	P-Value	Decision(α:5%)
SW Control		0.25	6	0.5857	2.694	0.4174	CDF	1.0000	Non-Significant Effect
		0.5	5	0.8182	2.694	0.4782	CDF	1.0000	Non-Significant Effect
		1	6	-0.07012	2.694	0.4174	CDF	1.0000	Non-Significant Effect
		3.2	6	0.4846	2.694	0.4174	CDF	1.0000	Non-Significant Effect
		10	6	0.2351	2.694	0.4174	CDF	1.0000	Non-Significant Effect
		32*	6	4.755	2.694	0.4174	CDF	0.0008	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	1.28673	0.214455	6	4.763	0.0066	Significant Effect
Error	0.675312	0.0450208	15			
Total	1.96204		21			

ANOVA Assumptions Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variance	Bartlett Equality of Variance Test	7.099	16.81	0.3118	Equal Variances
	Levene Equality of Variance Test	4.26	4.318	0.0106	Equal Variances
	Mod Levene Equality of Variance Test	0.6203	5.802	0.7111	Equal Variances
Distribution	Anderson-Darling A2 Test	0.629	3.878	0.1019	Normal Distribution
	D'Agostino Kurtosis Test	0.6026	2.576	0.5468	Normal Distribution
	D'Agostino Skewness Test	1.673	2.576	0.0944	Normal Distribution
	D'Agostino-Pearson K2 Omnibus Test	3.161	9.21	0.2059	Normal Distribution
	Kolmogorov-Smirnov D Test	0.2099	0.214	0.0127	Normal Distribution
	Shapiro-Wilk W Normality Test	0.9402	0.8757	0.1999	Normal Distribution

Eff. Survival Rate Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	5	0.9600	0.8920	1.0000	1.0000	0.9000	1.0000	0.0245	5.71%	0.00%
0.25		3	0.9000	0.6516	1.0000	0.9000	0.8000	1.0000	0.0577	11.11%	6.25%
0.5		2	0.8500	0.0000	1.0000	0.8500	0.7000	1.0000	0.1500	24.96%	11.46%
1		3	0.9667	0.8232	1.0000	1.0000	0.9000	1.0000	0.0333	5.97%	-0.69%
3.2		3	0.9000	0.4697	1.0000	1.0000	0.7000	1.0000	0.1000	19.25%	6.25%
10		3	0.9333	0.6465	1.0000	1.0000	0.8000	1.0000	0.0667	12.37%	2.78%
32		3	0.3667	0.0000	1.0000	0.5000	0.0000	0.6000	0.1856	87.67%	61.81%
64.7		3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	---	100.00%

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (009-951-268-0) Analyst:________ QA:________

CETIS Analytical Report

Report Date: 27 Jun-23 08:50 (p 2 of 3)
Test Code/ID: 23.010.1 MAC / 15-6527-1925

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	17-7333-6405	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	27 Jun-23 8:41	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1F771B4761A41EEBF04C161B98DF1B3B	**Editor ID:**	

Angular (Corrected) Transformed Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	5	1.3470	1.2360	1.4580	1.4120	1.2490	1.4120	0.0399	6.63%	0.00%
0.25		3	1.2560	0.8771	1.6350	1.2490	1.1070	1.4120	0.0881	12.15%	6.74%
0.5		2	1.2020	-1.4720	3.8750	1.2020	0.9912	1.4120	0.2104	24.77%	10.78%
1		3	1.3580	1.1240	1.5910	1.4120	1.2490	1.4120	0.0543	6.93%	-0.81%
3.2		3	1.2720	0.6681	1.8750	1.4120	0.9912	1.4120	0.1403	19.11%	5.58%
10		3	1.3100	0.8731	1.7480	1.4120	1.1070	1.4120	0.1016	13.43%	2.71%
32		3	0.6101	-0.3688	1.5890	0.7854	0.1588	0.8861	0.2275	64.59%	54.70%
64.7		3	0.1588	0.1588	0.1588	0.1588	0.1588	0.1588	0.0000	0.00%	88.21%

Eff. Survival Rate Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	1.0000	1.0000	1.0000	0.9000	0.9000
0.25		0.9000	1.0000	0.8000		
0.5		0.7000	1.0000			
1		1.0000	0.9000	1.0000		
3.2		1.0000	1.0000	0.7000		
10		1.0000	0.8000	1.0000		
32		0.0000	0.5000	0.6000		
64.7		0.0000	0.0000	0.0000		

Angular (Corrected) Transformed Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	1.4120	1.4120	1.4120	1.2490	1.2490
0.25		1.2490	1.4120	1.1070		
0.5		0.9912	1.4120			
1		1.4120	1.2490	1.4120		
3.2		1.4120	1.4120	0.9912		
10		1.4120	1.1070	1.4120		
32		0.1588	0.7854	0.8861		
64.7		0.1588	0.1588	0.1588		

Eff. Survival Rate Binomials

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	10/10	10/10	10/10	9/10	9/10
0.25		9/10	10/10	8/10		
0.5		7/10	10/10			
1		10/10	9/10	10/10		
3.2		10/10	10/10	7/10		
10		10/10	8/10	10/10		
32		0/10	5/10	6/10		
64.7		0/10	0/10	0/10		

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (009-951-268-0) Analyst:________ QA:________

CETIS Analytical Report

Report Date:	27 Jun-23 08:50 (p 3 of 3)
Test Code/ID:	23.010.1 MAC / 15-6527-1925

Macomona 96 h survival and reburial test **NIWA Ecotoxicology**

Analysis ID:	17-7333-6405	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	27 Jun-23 8:41	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1F771B4761A41EEBF04C161B98DF1B3B	**Editor ID:**	

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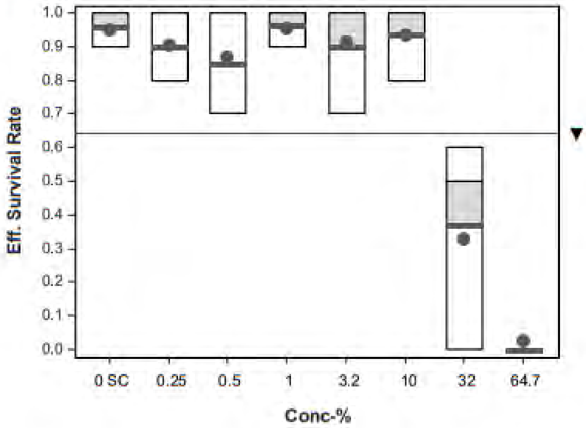
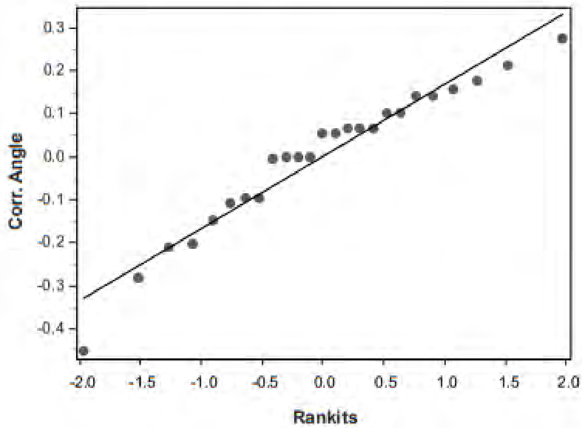




CETIS Analytical Report

Report Date:	27 Jun-23 09:08 (p 1 of 2)		
Test Code/ID:	23.010.1 MAC / 15-6527-1925		

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	12-0528-0257	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	27 Jun-23 9:08	**Analysis:**	Linear Interpolation (ICPIN)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1F771B4761A41EEBF04C161B98DF1B3B	**Editor ID:**	

Batch ID:	18-0876-0192	**Test Type:**	Survival-Reburial	**Analyst:**	Ecotox Team		
Start Date:	11 May-23	**Protocol:**	NIWA (1995)	**Diluent:**	Offshore seawater		
Ending Date:	15 May-23	**Species:**	Macomona liliana	**Brine:**	Frozen Oceanic Seawater		
Test Length:	96h	**Taxon:**		**Source:**	Client Supplied	**Age:**	

Sample ID:	12-5696-4688	**Code:**	23.010.1 MAC	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	09 May-23	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	10 May-23	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	48h (5.6 °C)	**Client:**	Hastings District Council		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	1590150	200	Yes	Two-Point Interpolation

Point Estimates

Level	%	95% LCL	95% UCL	Tox Units	95% LCL	95% UCL
LC15	12.3	---	17.2	8.1	5.8	---
LC20	13.66	7.294	20.89	7.3	4.8	13.7
LC25	15.15	8.146	25.52	6.6	3.9	12.3
LC40	20.61	9.173	45.49	4.9	2.2	10.9
LC50	25.24	8.367	48.76	4	2.1	12

Eff. Survival Rate Summary

			Calculated Variate(A/B)							Isotonic Variate	
Conc-%	Code	Count	Mean	Median	Min	Max	CV%	%Effect	ΣA/ΣB	Mean	%Effect
0	SC	5	0.9600	1.0000	0.9000	1.0000	5.71%	0.00%	48/50	0.9600	0.00%
0.25		3	0.9000	0.9000	0.8000	1.0000	11.11%	6.25%	27/30	0.9100	5.21%
0.5		2	0.8500	0.8500	0.7000	1.0000	24.96%	11.46%	17/20	0.9100	5.21%
1		3	0.9667	1.0000	0.9000	1.0000	5.97%	-0.69%	29/30	0.9100	5.21%
3.2		3	0.9000	1.0000	0.7000	1.0000	19.25%	6.25%	27/30	0.9100	5.21%
10		3	0.9333	1.0000	0.8000	1.0000	12.37%	2.78%	28/30	0.9100	5.21%
32		3	0.3667	0.5000	0.0000	0.6000	87.67%	61.81%	11/30	0.3667	61.80%
64.7		3	0.0000	0.0000	0.0000	0.0000	---	100.00%	0/30	0.0000	100.00%

Eff. Survival Rate Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	1.0000	1.0000	1.0000	0.9000	0.9000
0.25		0.9000	1.0000	0.8000		
0.5		0.7000	1.0000			
1		1.0000	0.9000	1.0000		
3.2		1.0000	1.0000	0.7000		
10		1.0000	0.8000	1.0000		
32		0.0000	0.5000	0.6000		
64.7		0.0000	0.0000	0.0000		

Eff. Survival Rate Binomials

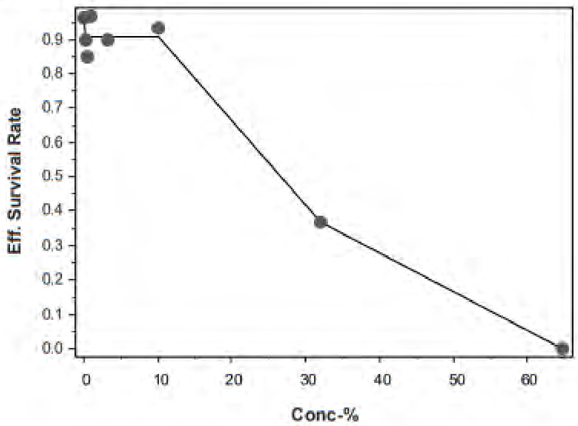
Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5
0	SC	10/10	10/10	10/10	9/10	9/10
0.25		9/10	10/10	8/10		
0.5		7/10	10/10			
1		10/10	9/10	10/10		
3.2		10/10	10/10	7/10		
10		10/10	8/10	10/10		
32		0/10	5/10	6/10		
64.7		0/10	0/10	0/10		

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (009-951-268-0) Analyst:________ QA:________

Macomona 96 h survival and reburial test | **NIWA Ecotoxicology**

Analysis ID:	12-0528-0257	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv2.1.4
Analyzed:	27 Jun-23 9:08	**Analysis:**	Linear Interpolation (ICPIN)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	1F771B4761A41EEBF04C161B98DF1B3B	**Editor ID:**	

Graphics



Blue mussel

CETIS Analytical Report

Report Date:	31 May-23 12:10 (p 1 of 3)
Test Code/ID:	23.010.1 MyG / 18-9771-6935

Bivalve Larval Survival and Development Test — **NIWA Ecotoxicology**

Analysis ID:	03-6994-6033	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv2.1.4
Analyzed:	31 May-23 12:08	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	FF0D8D4BE0B2E65E1D2CAAE0F10FD41	**Editor ID:**	

Batch ID:	11-5065-3350	**Test Type:**	Development	**Analyst:**	K Thompson		
Start Date:	10 May-23	**Protocol:**	NIWA (2008)	**Diluent:**	Offshore seawater		
Ending Date:	12 May-23	**Species:**	Mytilus galloprovincialis	**Brine:**	Frozen Oceanic Seawater		
Test Length:	48h	**Taxon:**		**Source:**	Coromandel	**Age:**	

Sample ID:	09-6478-1621	**Code:**	23.010.1 MyG	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	09 May-23	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	10 May-23	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	24h (5.6 °C)	**Client:**	Hastings District Council		

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	Tox Units	MSDu	PMSD
Angular (Corrected)	C > T	0.5	1	0.7071	200	0.05525	5.74%

Bonferroni Adj t Test

Control	vs	Conc-%	df	Test Stat	Critical	MSD	P-Type	P-Value	Decision(α:5%)
SW Control		0.25	13	1.349	2.462	0.1223	CDF	0.4692	Non-Significant Effect
		0.5	13	1.805	2.462	0.1223	CDF	0.2035	Non-Significant Effect
		1*	13	2.528	2.462	0.1223	CDF	0.0429	Significant Effect
		2*	13	3.724	2.462	0.1223	CDF	0.0021	Significant Effect
		4*	13	18.67	2.462	0.1223	CDF	<1.0E-05	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	3.22337	0.644675	5	78.41	<1.0E-05	Significant Effect
Error	0.23844	0.0082221	29			
Total	3.46181		34			

ANOVA Assumptions Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variance	Bartlett Equality of Variance Test	11.05	15.09	0.0504	Equal Variances
	Levene Equality of Variance Test	4.001	3.725	0.0070	Unequal Variances
	Mod Levene Equality of Variance Test	6.082	3.895	0.0009	Unequal Variances
Distribution	Anderson-Darling A2 Test	0.5046	3.878	0.2072	Normal Distribution
	D'Agostino Kurtosis Test	1.448	2.576	0.1476	Normal Distribution
	D'Agostino Skewness Test	0.7673	2.576	0.4429	Normal Distribution
	D'Agostino-Pearson K2 Omnibus Test	2.685	9.21	0.2612	Normal Distribution
	Kolmogorov-Smirnov D Test	0.09468	0.1723	0.5822	Normal Distribution
	Shapiro-Wilk W Normality Test	0.9706	0.9146	0.4591	Normal Distribution

Proportion Normal Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	10	0.9619	0.9448	0.9791	0.9633	0.9100	0.9900	0.0076	2.50%	0.00%
0.25		5	0.9340	0.9005	0.9675	0.9300	0.9000	0.9700	0.0121	2.89%	2.90%
0.5		5	0.9220	0.8778	0.9662	0.9400	0.8700	0.9500	0.0159	3.87%	4.15%
1		5	0.9020	0.8528	0.9512	0.9200	0.8500	0.9400	0.0177	4.39%	6.23%
2		5	0.8640	0.7962	0.9318	0.8800	0.7700	0.9100	0.0244	6.32%	10.18%
4		5	0.2100	0.0357	0.3843	0.2000	0.0500	0.3800	0.0628	66.84%	78.17%
8		1	0.0200			0.0200	0.0200	0.0200	---	---	97.92%

Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (009-951-268-0) Analyst:________ QA:________

Analysis ID:	03-6994-6033	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv2.1.4
Analyzed:	31 May-23 12:08	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	FF0D8D4BE0B2E65E1D2CAAE0F10FD41	**Editor ID:**	

Angular (Corrected) Transformed Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	10	1.3830	1.3390	1.4260	1.3790	1.2660	1.4710	0.0193	4.40%	0.00%
0.25		5	1.3160	1.2450	1.3870	1.3030	1.2490	1.3970	0.0255	4.34%	4.85%
0.5		5	1.2930	1.2130	1.3730	1.3230	1.2020	1.3450	0.0288	4.98%	6.48%
1		5	1.2570	1.1750	1.3390	1.2840	1.1730	1.3230	0.0294	5.23%	9.08%
2		5	1.1980	1.1050	1.2910	1.2170	1.0710	1.2660	0.0335	6.25%	13.38%
4		5	0.4553	0.2266	0.6839	0.4636	0.2255	0.6642	0.0824	40.45%	67.07%
8		1	0.1419			0.1419	0.1419	0.1419	—	—	89.74%

Proportion Normal Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	SC	0.9900	0.9600	0.9500	0.9800	0.9800	0.9394	0.9800	0.9700	0.9600	0.9100
0.25		0.9300	0.9000	0.9200	0.9700	0.9500					
0.5		0.9400	0.9500	0.9500	0.8700	0.9000					
1		0.8700	0.9300	0.9200	0.9400	0.8500					
2		0.8700	0.8800	0.7700	0.8900	0.9100					
4		0.2000	0.0500	0.1000	0.3800	0.3200					
8		0.0200									

Angular (Corrected) Transformed Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	SC	1.4710	1.3690	1.3450	1.4290	1.4290	1.3220	1.4290	1.3970	1.3690	1.2660
0.25		1.3030	1.2490	1.2840	1.3970	1.3450					
0.5		1.3230	1.3450	1.3450	1.2020	1.2490					
1		1.2020	1.3030	1.2840	1.3230	1.1730					
2		1.2020	1.2170	1.0710	1.2330	1.2660					
4		0.4636	0.2255	0.3218	0.6642	0.6013					
8		0.1419									

Proportion Normal Binomials

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	SC	99/100	96/100	95/100	98/100	98/100	93/99	98/100	97/100	96/100	91/100
0.25		93/100	90/100	92/100	97/100	95/100					
0.5		94/100	95/100	95/100	87/100	90/100					
1		87/100	93/100	92/100	94/100	85/100					
2		87/100	88/100	77/100	89/100	91/100					
4		20/100	5/100	10/100	38/100	32/100					
8		2/100									

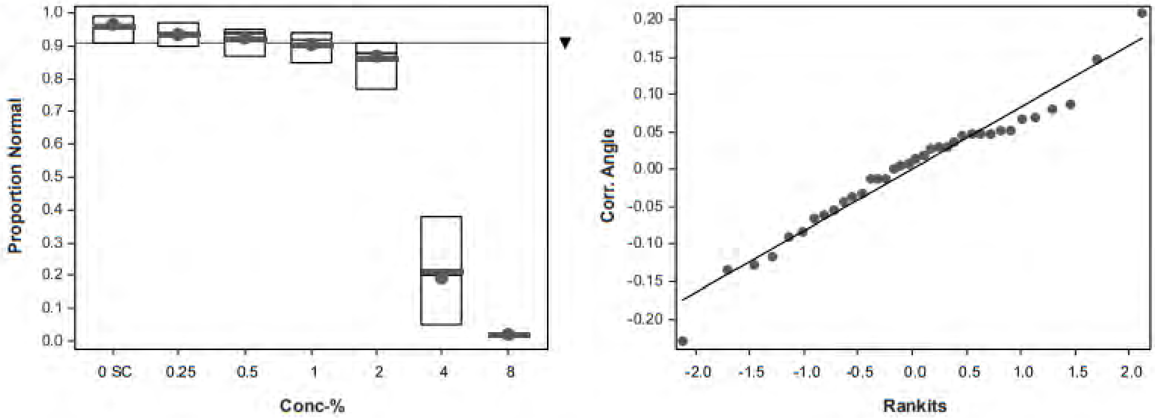
CETIS Analytical Report

Report Date:	31 May-23 12:10 (p 3 of 3)
Test Code/ID:	23.010.1 MyG / 18-9771-6935

Bivalve Larval Survival and Development Test — **NIWA Ecotoxicology**

Analysis ID:	03-6994-6033	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv2.1.4
Analyzed:	31 May-23 12:08	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	FF0D8D4BE0B2E65E1D2CAAE0F10FD41	**Editor ID:**	

Graphics



Convergent Rounding (4 sf) CETIS™ v2.1.4.5 (009-951-268-0) Analyst:________ QA:________

Appendix D Hill Laboratories Results

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22)
T +64 7 858 2000
E mail@hill-labs.co.nz
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Certificate of Analysis

Client:	NIWA Corporate	**Lab No:**	3272183	SPv1
Contact:	K Thompson	**Date Received:**	10-May-2023	
	C/- NIWA Corporate	**Date Reported:**	17-May-2023	
	PO Box 11115	**Quote No:**	51353	
	Hillcrest	**Order No:**	U322941	
	Hamilton 3251	**Client Reference:**	Hastings DC	
		Submitted By:	K Thompson	

Sample Type: Aqueous

	Sample Name:	East Clive WWTP 09-May-2023
	Lab Number:	3272183.1
Total Ammoniacal-N	g/m^3	19.7
Total Sulphide	g/m^3	3.5

Summary of Methods

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

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) 23rd ed. 2017.	0.010 g/m^3	1
Total Sulphide Trace	In-line distillation, segmented flow colorimetry. APHA 4500-S^{2-} E (modified) 23rd ed. 2017.	0.002 g/m^3	1

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

Testing was completed between 16-May-2023 and 17-May-2023. For completion dates of individual analyses please contact the laboratory.

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

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

Martin Cowell - BSc
Client Services Manager - Environmental

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised.
The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

Appendix E Bioassay Physico-chemistry

Table E-1: Water quality measures from the wedge shell test.

Date	Time (h)	Sample	Concentration (%)	Temp (°C)	pH	DO (mg L^{-1})	DO (%)	Salinity (ppt)
	0	Control	0	20	8.1	7.2	98	34
		23.010.1	0.25	20	8.1	7.1	96	35
			65	20	5.3	6.7	91	33
	96	Control	0	21	8.1	7.1	98	36
		23.010.1	0.25	20	8.1	7.1	96	36
			0.5	20	8.1	7.1	96	36
			1	20	8.1	7.0	95	36
			3	20	8.1	7.0	95	36
			10	20	8.0	6.7	91	36
			32	20	7.9	4.5	61	36
			65	20	7.7	2.4	33	36

Table E-2: Water quality measures from the blue mussel test.

Date	Time (h)	Sample	Concentration (%)	Temp (°C)	pH	DO (mg L^{-1})	DO (%)	Salinity (ppt)
	0	Control	0	19	8.1	7.0	93	35
		23.010.1	0.25	19	8.1	7.0	93	35
			16	19	6.7	6.8	90	34
	48	Control	0	20	8.0	7.3	99	34
		23.010.1	0.25	20	8.0	7.3	99	34
			0.5	20	8.0	7.2	98	35
			1	20	8.0	7.2	98	35
			2	20	8.0	7.1	96	35
			4	20	8.0	7.0	95	35
			8	20	7.9	6.4	87	35
			16	20	7.8	4.5	61	34

Quarterly Whole Effluent Toxicity Testing of East Clive Wastewater Treatment Plant

October 2022

Prepared for Hastings District Council

December 2022

Prepared by:
Karen Thompson

For any information regarding this report please contact:

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NIWA CLIENT REPORT No: 2022371HN
Report date: December 2022
NIWA Project: HCD23201

Quality Assurance Statement		
	Reviewed by:	Jennifer Gadd
	Formatting checked by:	Carole Evans
	Approved for release by:	Michael Bruce

Contents

Tables

Executive summary

NIWA was engaged by Hastings District Council (HDC) to undertake quarterly Whole Effluent Toxicity (WET) testing of a treated effluent sample from East Clive Wastewater Treatment Plant to determine resource consent compliance. The sample, collected 17-18 October 2022, was tested with three marine organisms: a marine alga (*Minutocellus polymorphus* – 48-hour chronic growth test), and two bivalve species - wedge shell (*Macomona liliana* – 96-hour acute survival and burial test) and blue mussel (*Mytilus galloprovincialis* – 48-hour chronic embryo development test). The sample was also analysed for ammoniacal nitrogen (ammoniacal-N) and total sulfide.

This report documents the results of the toxicity testing. The alga, wedge shell, and blue mussel tests all met their respective test acceptability criteria based on control performance.

The alga and blue mussel test showed detectable toxicity at a 200-fold dilution. The highest no-toxicity dilution was 286-fold derived from both the alga and blue mussel tests. The wedge shell did not show detectable toxicity at a 200-fold dilution. After application of the 200-fold dilution used for the 'no toxicity' criterion, the concentration of ammoniacal-N and total sulfide in the sample did not exceed ANZG (2018) default guideline values for 95% protection of species.

For the effluent sample in this quarter, the alga and blue mussel tests had a Threshold Effect Concentration (TEC) < 0.5% effluent, however neither species had a consecutive incidence of TEC < 0.25% effluent between quarters, so no further action is required.

1 Introduction

East Clive Wastewater Treatment Plant treats both industrial and domestic wastewater and the treated effluent is discharged through an ocean outfall into Hawke Bay. NIWA was engaged by Hastings District Council (HDC) to undertake quarterly Whole Effluent Toxicity (WET) testing of effluent from the East Clive Wastewater Treatment Plant for compliance with Hawke's Bay Regional Council (HBRC) resource consent CD130214W condition 15. The effluent sample was tested with three marine organisms: an alga (*Minutocellus polymorphus* 48-hour chronic growth test), and 2 bivalve species: wedge shell (*Macomona liliana* 96-hour acute survival and burial test) and blue mussel (*Mytilus galloprovincialis* 48-hour chronic embryo development test).

Condition 15 states that there shall be no statistically detectable difference in toxicity between a water sample taken from uncontaminated near-shore water (from a location to be approved by Hawke's Bay Regional Council[1]) and treated wastewater when diluted 200-times with that water. No toxicity is defined as a no-toxicity dilution less than 200-fold. If the no-toxicity dilution is greater than 200-fold, the following three conditions must be examined:[2]

1. No more than one test species with a TEC[3] < 0.5% effluent in any given quarter.
2. No more than one consecutive incidence of TEC < 0.25% effluent within any given species between quarters.
3. EC_{20}[4] (chronic tests) and LC_{10} (acute tests) for all tests shall be greater than 0.5% effluent.

These conditions are described in a flow chart in Appendix A.

[1] Dilution water is 0.2 µm filtered offshore seawater collected by NIWA.
[2] These conditions interpret the flow chart in Appendix A describing the HBRC consent supplied to NIWA 25 Jun 2014.
[3] TEC=threshold effect concentration
[4] EC_x = dilution required to have an effect on X% of the test organisms. The lower the EC_x the greater the toxicity, indicating that a higher dilution was required to cause an X% effect on the test organisms.

2 Methods

2.1 Samples

A 2 L, single-use, food-grade high density polyethylene (HDPE) container was supplied by NIWA to HDC for collection of the 24 h composite effluent sample. The sample was collected by HDC staff on 17-18 October 2022 and a subsample was collected for total sulfide at the same time in a bottle supplied by Hill Laboratories via NIWA. On arrival at NIWA Hamilton on 19 October 2022 the effluent sample was assigned a unique sample code (2699/UG1) and the physicochemical parameters measured. The effluent was subsampled for ammoniacal nitrogen (ammoniacal-N) and the remaining sample was stored in the dark at 4°C until toxicity testing commenced (within 24 hours). The samples for ammoniacal-N and total sulfide were sent to Hill Laboratories for analysis.

2.2 Toxicity testing methods

Tests were completed according to NIWA Standard Operating Procedures (SOP):

- NIWA SOP 14.1–Marine alga chronic toxicity for *Minutocellus polymorphus.*
- NIWA SOP 58.0–Marine bivalve acute toxicity for *Macomona liliana.*
- NIWA SOP 21.2–Marine bivalve chronic toxicity for *Mytilus galloprovincialis.*

A summary of test conditions and test acceptability information specified in each of the SOP manuals is provided in Appendix B.

As well as a survival endpoint, the acute wedge shell test uses a sub-lethal endpoint (reburial, termed 'morbidity') to assess adverse effects on the test organisms because it is difficult to distinguish between live and recently dead juvenile bivalves. The reburial test is undertaken following 96 hours exposure to the effluent solutions and is a more sensitive and accurate endpoint than survival for this test species.

2.3 Sample dilutions

Each test included a range of sample dilutions. The diluent for all tests was NIWA's offshore seawater. The effluent sample was adjusted to the required test salinities, as specified by the standard operating procedures. For the wedge shell and blue mussel test, the sample was adjusted to the test salinity of 34 ppt using brine (made from frozen 0.2 µm filtered offshore seawater water) and tested at a maximum concentration of 10% effluent and 16% effluent respectively. For the algal test, the sample was adjusted to the required test salinity of 26 ppt using NIWA's offshore seawater for a maximum concentration of 32% effluent.

2.4 Reference toxicant

A reference toxicant test using zinc was undertaken concurrently using standard test procedures to measure the sensitivity and condition of the organisms in the current test. This is part of the quality control procedures and allows comparability between laboratory test results undertaken at different times by comparing results to the known sensitivity of the test organism to zinc (NIWA, unpublished long-term database). The zinc stock concentration was validated by chemical analysis (Hill Laboratories).

2.5 Test acceptability criteria

Each test has criteria that must be met for the test to be considered acceptable (Appendix B). For the alga test, the increase in cell density in the control replicates must be greater than 16-fold and the coefficient of variation in the control replicate cell density must be less than 20%. For the wedge shell test, there must be at least 90% survival of organisms in control replicates and less than 10% morbidity in reburial control replicates. For the blue mussel test, at least 80% of the embryos in the control must have normal development.

2.6 Method detection limit

The method detection limit is a measure of the natural variability associated with each test calculated from the NIWA long-term database of test results. The current method detection limits were calculated in February 2021. If the percent effect is smaller than the method detection limit, then the effect may be due to natural variability in the test response—in this event, for compliance purposes, the NOEC and LOEC would be corrected to the concentrations at which the percent effect is greater than the method detection limit.

2.7 Statistics

Statistical analyses were completed using CETIS v1.9.7.7 (Comprehensive Environmental Toxicity Information System) by Tidepool Scientific.

3 Results

Results are summarized in this section (Tables 3-1 and 3-2). Raw data and detailed results from the statistical analyses are provided for all tests in Appendix C and chemistry results are provided in Appendix D.

Table 3-1: Measurements of municipal wastewater 24-hour composite sample after arrival at NIWA (19 October 2022) and results from analyses at Hill Laboratories. Temperature on arrival was measured as 4.9°C

Sample ID	NIWA Lab ID	pH	Temp (°C)	Salinity (ppt)	Ammoniacal-N (mg L^{-1})	Total Sulfide (S^{2-}) (mg L^{-1})
HDC 17-18/10/2022	2699/UG1	7.33	19.1	0.69	21	0.67

Table 3-2: Summary of key toxicity metrics for the test organisms exposed to HDC effluent collected 17-18 October 2022. Full results are provided in Appendix C.

Organism	EC_{10} [a] %	EC_{20} [a] %	EC_{50} [a] %	NOEC[b] %	LOEC[b] %	TEC[b] %	No-Toxicity dilution[c]	Complies Y/N[d]
Alga	1.1	1.9	4.9 (3.3–7.2)	0.25	0.5	**0.35**	286 x	**N**
Wedge shell reburial[e]	2.4	2.9	4.3	2.0	5.0	**3.2**	31 x	**Y**
Wedge shell survival	2.4	3.0	7.1	2.0	5.0	**3.2**	31 x	**Y**
Blue mussel	0.7	1.0	1.6 (1.5–1.6)	0.25[f]	0.5[f]	**0.35**[f]	286 x	**N**

[a] EC_x= dilution required to have an effect on X% of the test organisms. The lower the EC_x the greater the toxicity, indicating that a higher dilution was required to cause an effect on X% of test organisms. Values in parentheses indicate the 95% confidence intervals, [b] NOEC=No observed effect concentration, LOEC=Lowest observed effect concentration, TEC=threshold effect concentration (Geometric mean of NOEC and LOEC), [c] No-toxicity dilution is calculated as (1/TEC*100), [d] Bold indicates value used for compliance, [e] 60-minute reburial results (morbidity). [f] Adjusted for the method detection limit.

3.1 Algae – cell growth inhibition

The chronic algal growth test achieved the test acceptability criteria with a 145-fold increase in mean control cell density after 48 hours and a coefficient of variation (CV) < 20% (CV = 3.6%).

There was a statistically significant, 14% decrease in algal cell density at a concentration of 0.5% effluent (Appendix C), resulting in a LOEC of 0.5% and a NOEC of 0.25%. The no-toxicity dilution of 286-fold exceeds the compliance maximum threshold of 200-fold dilution.

3.2 Bivalve – wedge shell survival and morbidity

The wedge shell test achieved the test acceptability criterion with 100% survival and 95% reburial for the control treatments. Dissolved oxygen (DO), pH and salinity were in the acceptable range for the test (Appendix E, Table E–1). There was no significant difference in mean survival (both 100%) and reburial (95% and 100%) between control and brine control replicates (data not shown).

There was a statistically significant decrease in survival and reburial at 5% effluent with 47% and 72% effects respectively when compared to the control. This toxicity resulted in a no-toxicity dilution of 31-fold which is within the compliance threshold of maximum 200-fold dilution.

3.3 Bivalve – blue mussel embryo development

The chronic embryo development test achieved the test acceptability criterion of at least 80% controls with normal embryo development (mean 93%). Salinity, DO and pH were in the acceptable range for the test at initiation, however, DO in the highest tested concentration (16%) dropped to 52% saturation by test completion (Appendix E, Table E-2). The brine solution did not affect normal embryo development at concentrations used in this test with 95% mean embryo development at 32% brine (data not shown).

There was a statistically significant effect, a 4.0% decrease in normal embryo development, at 0.25% effluent (Table 3-2 and Appendix C). The 4.0% decrease in normal embryo development was not greater than the method detection limit of 5.1% so the NOEC and LOEC were adjusted to concentrations at which the percent effect was greater than the method detection limit. For this sample, the NOEC and LOEC were adjusted to 0.25% and 0.5% respectively (Table 3-2) resulting in a no-toxicity dilution of 286-fold which exceeds the maximum compliance threshold of 200-fold dilution. There was a statistically significant 7.6% decrease in normal embryo development at 0.5% effluent.

3.4 Total sulfide

ANZG (2018) default guideline value for un-ionised sulfide: 0.001 mg L^{-1} H_2S.

The subsample for total sulfide was preserved at the time of sample collection. The total sulfide in the effluent sample collected 17-18 October 2022 was 0.67 mg L^{-1} which is equivalent to 0.03 mg L^{-1} of un-ionised sulfide[5], the more toxic form of sulfide in an aquatic ecosystem. The total sulfide concentration of the October 2022 effluent sample is 1.6-fold lower than the long-term median value of 1.08 mg L^{-1} total sulfide for all HDC effluent samples analysed since 1992 (n=117).

After applying a 200-fold dilution, the resulting un-ionised sulfide concentration of 0.0001 mg L^{-1} was 10-fold lower than the ANZG (2018) default guideline value of 0.001 mg L^{-1} H_2S. Full results from the analysis of the effluent sample by Hill Laboratories are provided in Appendix D.

3.5 Ammoniacal-N

ANZG (2018) default guideline value: 0.910 mg L^{-1} ammoniacal-N, pH 8.

The ammoniacal-N concentration in the effluent sample was 21 mg L^{-1}, which is slightly higher than the long-term median value of 16.3 mg L^{-1} for all HDC effluent samples analysed since 1992 (n=116). Applying a 200-fold dilution to the effluent sample resulted in a concentration of 0.1 mg L^{-1} ammoniacal-N, which is 9-fold lower than the ANZG (2018) default guideline value of 0.91 mg L^{-1} (at pH 8) for protection of 95% of marine species. Full results from the analysis of the effluent sample by Hill Laboratories are provided in Appendix D.

3.6 Reference toxicant

The EC_{50} for alga exposed to zinc sulfate (0.017 mg Zn L^{-1}) was within the expected range of the long-term mean of 0.012 ± 0.017 mg Zn^{2+} L^{-1} (±2 standard deviations (S.D.), n=21). The EC_{50} values for wedge shells exposed to zinc sulfate (survival 2.1, reburial 1.3 mg Zn L^{-1}) were within the expected range of the long-term mean for survival, 3.4 ± 2.4 mg Zn^{2+} L^{-1} (n=21), and reburial, 1.7 ± 1.2 mg Zn L^{-1}

[5] Calculated as 4.06% of total sulfide at pH 8.0, 20°C, 32.5 ppt (coastal waters) (ANZG 2018).

(n=21). The EC_{50} for blue mussel embryos exposed to zinc sulfate (0.17 mg Zn L^{-1}) was also within the expected range of the long-term mean is 0.17 ± 0.03 mg Zn L^{-1} (n=21).

Based on chronic NOEC values derived from the zinc sulfate tests, the algae, blue mussels, wedge shell reburial, and wedge shell survival would rank within the 1st, 68th, 72nd and 85th percentiles respectively of the most sensitive test organisms used for derivation of the ANZG (2021) guideline values for zinc in marine waters.

However, these sensitivity rankings are specific to zinc and care must be taken when extrapolating these results where other classes of contaminants (e.g., organics) may be present and for protection of all organisms present in a particular receiving water environment (e.g., Hawke's Bay).

4 Compliance Statement

Hawke's Bay Regional Council Resource Consent No. CD130214W condition 15 requires that there be no detectable toxicity at a 200-fold effluent dilution.

The alga and blue mussel test showed detectable toxicity at a 200-fold dilution. The highest no-toxicity dilution was 286-fold derived from both the alga and blue mussel tests. The wedge shell test did not show detectable toxicity at a 200-fold dilution.

If there is toxicity at a 200-fold dilution the following conditions must be examined: is there more than one test species with a TEC[6] < 0.5% effluent in any given quarter, is there a consecutive incidence of TEC < 0.25% effluent within any given species between quarters, and are EC_{20} (chronic tests) and LC_{10} (acute tests) for all tests greater than 0.5% effluent?

For the effluent sample in this quarter, both the alga and blue mussel tests had a TEC < 0.5% effluent however neither species had two consecutive incidence of TEC < 0.25% effluent between quarters so no further action is required (Appendix A).

After application of the 200-fold dilution used for the 'no toxicity' criterion, the concentration of ammoniacal-N and total sulfide in the sample did not exceed ANZG (2018) default guideline values for 95% protection of species.

[6] TEC=threshold effect concentration

5 References

ANZG (2018) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Governments and Australian state and territory governments, Canberra, ACT, Australia. https://www.waterquality.gov.au/anz-guidelines

ANZG (2021) Toxicant default guideline values for aquatic ecosystem protection: Zinc in marine water. Australian and New Zealand Guidelines for Fresh and Marine Water Quality. CC BY 4.0. Australian and New Zealand Governments and Australian state and territory governments, Canberra, ACT, Australia.

Environment Canada (1990) *Guidance document for control of toxicity test precision using reference toxicants.* No. EPS 1/RM12. Conservation and Protection, Environment Canada: 90.

NIWA (2013) Standard Operating Procedure Number 58. *Macomona liliana* 96-h Acute Toxicity Test Procedure. Hamilton, New Zealand, *NIWA Client Report:* 35.

NIWA (1996) Standard Operating Procedure Number *14.1*: Marine algal microplate method. Hamilton, New Zealand. *NIWA Client Report*: 13.

NIWA (2008) Standard Operating Procedure 21.2: Marine blue mussel embryo (*Mytilus galloprovincialis*). Short-term Chronic Toxicity Test Protocol. Hamilton, New Zealand, *NIWA Client Report*: 41.

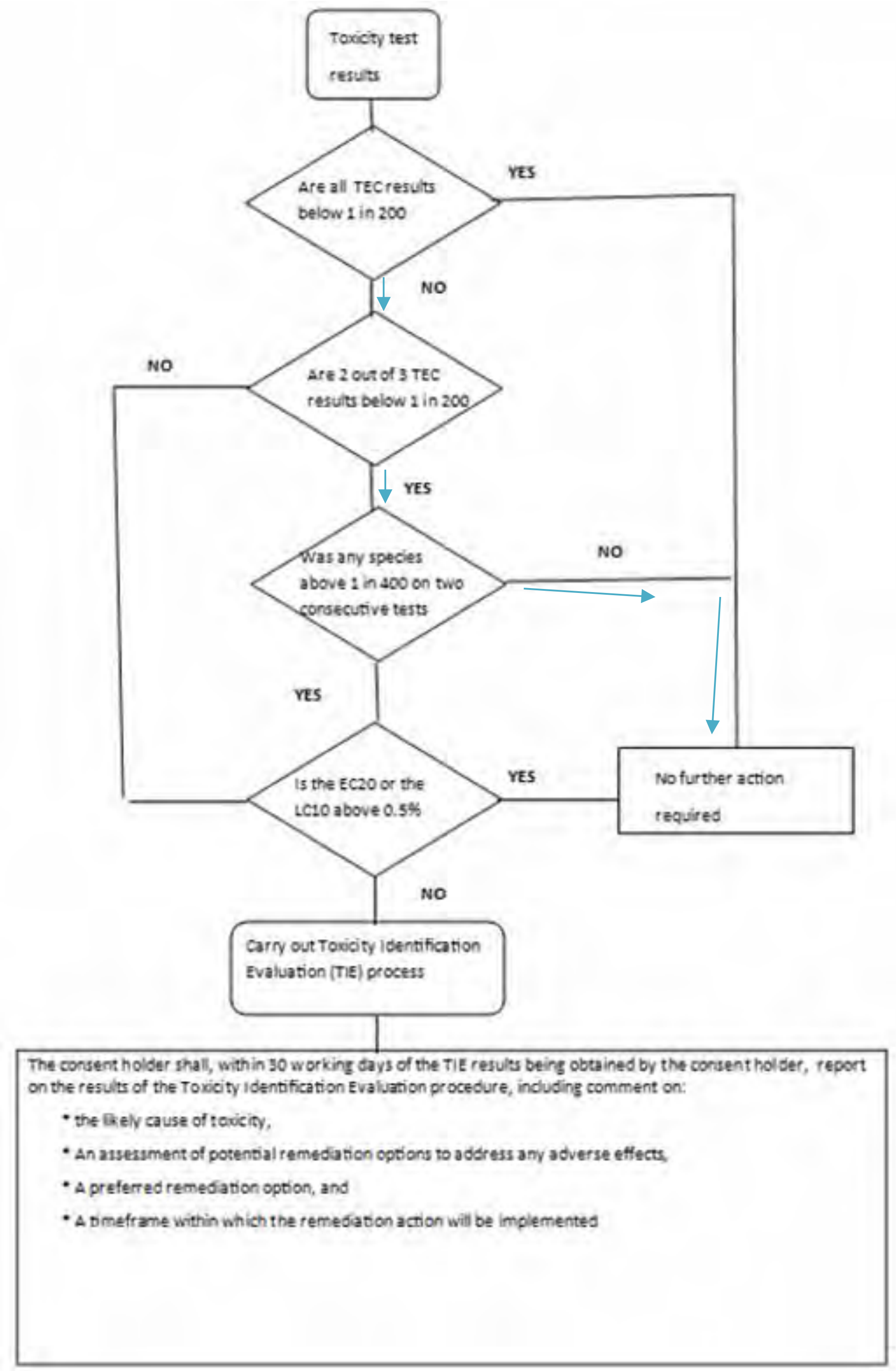
Roper, D.S., Hickey, C.W. (1994) Behavioural responses of the marine bivalve *Macomona liliana* exposed to copper- and chlordane-dosed sediments. *Marine Biology*, 118: 673–680.

Tidepool (2000-2020) CETIS™ Comprehensive Environmental Toxicity Information System. *CETIS Users Guide v.1.9.7.7* Tidepool Scientific Software, McKinleyville, CA, USA: 241

USEPA (1987) *Methods for toxicity tests of single substances and liquid complex wastes with marine unicellular algae. EPA-600-8/87/043*. US Environmental Protection Agency, Cincinnati, Ohio.

Williams, E.K., Hall, J.A. (1999) Seasonal and geographic variability in toxicant sensitivity of *Mytilus galloprovincialis* larvae. *Australasian Journal of Ecotoxicology*, 5(1): 1–10.

Appendix A Flow chart describing HBRC consent CD130214W condition 15[a]



[a]Supplied to NIWA 25 Jun 2014

Appendix B Test Conditions

Test conditions and dilutions for sample 2699/UG1

Project Name:	Hastings DC Effluent Bioassays: 2022–2023		**Project Number**	HDC23201
Test Material:	Hastings District Council 17-18/10/2022		**Reference Toxicant:**	Zinc sulphate
Dilution Water:	0.2 µm filtered offshore seawater from Pacific Ocean			

	Alga	**Bivalve–wedge shell**	**Bivalve–blue mussel embryos**
Reference Method:	US EPA (1987) modified with Environment Canada (1992)	Adapted from Roper & Hickey (1994)	Williams & Hall (1999b)
Test Protocol:	NIWA SOP 14.1 NIWA (1996)	NIWA SOP 58.0 NIWA (2013)	NIWA SOP 21.2 (2008)
Test Organisms:	*Minutocellus polymorphus*	*Macomona liliana*	*Mytilus galloprovincialis*
Source:	Lab culture (500), imported from Bigelow Laboratories, USA	Manukau Harbour, Wiroa Island control site	Coromandel Harbour
Organisms/Container:	10,000 cells mL^{-1}	7 for controls, 10 for treatments	600 fertilised embryos
Test Concentrations	Control, 0.125, 0.25, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0, 32.0%	Control, 0.25, 0.5, 1.0, 2.0, 5.0, 10.0%	Control, 0.25, 0.5, 1.0, 2.0, 4.0, 8.0, 16.0%
Test Duration:	48 hours	96 hours	48 hours
Replicates:	10 for controls, 5 for treatments	3	10 for controls, 5 for treatments
Sample pre-treatment:	0.45 µm filtration	Brine added to adjust salinity	Brine added to adjust salinity
Salinity:	26‰	34 ± 2‰	34 ± 2‰
Brine:	Nil	Filtered (0.2 µm) offshore seawater, frozen and thawed for brine collection	Filtered (0.2 µm) offshore seawater, frozen and thawed for brine collection
Test Chambers:	96 well sterile microplates	55 ml polystyrene beakers	16x100 mm glass tubes
Lighting:	Continuous overhead lighting	Complete darkness	16:8 light dark
Temperature:	25 ± 1°C	20 ± 1°C	20 ± 1°C
Aeration:	Nil	Nil	Nil
Chemical Data:	Initial salinity	Initial and final salinity, final pH, temperature, dissolved oxygen	Initial and final salinity, temperature, dissolved oxygen, pH
Effect Measured:	Growth inhibition	Survival and morbidity (survival, reburial)	Abnormal embryo development
Zn sensitivity current test; long term mean (EC_{50}±2sd):	0.017; 0.012 (0.000–0.03) mg Zn L^{-1} (n=21)	Survival 2.1; Reburial 1.3; 3.4 (1.0–5.7) mg L^{-1} Zn^{2+} (n=21) (survival); 1.7 (0.6–2.9) mg L^{-1} Zn^{2+} (n=21) (reburial)	0.17; 0.17 (0.14–0.2) mg Zn L^{-1} (n=21)
Test Acceptability:	Control coefficient of variation within 20%; at least 16x cell growth increase in controls.	At least 90% survival in control and less than 10% morbidity in control reburial	80% of control embryos normally developed
Method Detection Limit (MDL):	12.4% reduction relative to controls	4.1% reduction relative to controls	5.1% reduction relative to controls
Percent Minimum Significant Difference (PMSD):	10.4%	Survival 8.1% Reburial 15.6%	3.6%
Test Acceptability Compliance:	**Achieved**	**Achieved**	**Achieved**

Appendix C Statistics

Alga

CETIS Analytical Report

Report Date: 06 Dec-22 19:35 (p 1 of 2)
Test Code/ID: 2699/UG1 MP7 / 02-2372-8208

Phytoplankton Growth Inhibition Test — **NIWA Ecotoxicology**

Analysis ID:	09-4844-3353	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 19:30	**Analysis:**	Parametric-Control vs Treatments	**Status Level:**	1
Edit Date:		**MD5 Hash:**	DAFF0B159C75A197E9131C0742B4D541	**Editor ID:**	

Batch ID:	10-2077-5373	**Test Type:**	Cell Growth	**Analyst:**	K Thompson
Start Date:	19 Oct-22	**Protocol:**	NIWA (1996)	**Diluent:**	Offshore seawater
Ending Date:	21 Oct-22	**Species:**	Minutocellus polymorphus	**Brine:**	Not Applicable
Test Length:	48h	**Taxon:**		**Source:**	CCMP Bigelow Laboratory f **Age:**

Sample ID:	12-2651-8214	**Code:**	2699/UG1 MP7	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	18 Oct-22	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	19 Oct-22	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	24h	**Client:**	Hastings District Council		

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	TU	MSDu	PMSD
Untransformed	C > T	0.25	0.5	0.3536	400	151600	10.44%

Dunnett Multiple Comparison Test

Control	vs	Conc-%	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
SW Control		0.0625	-1.526	2.61	2E+05	12	CDF	1.0000	Non-Significant Effect
		0.125	0.361	2.61	2E+05	10	CDF	0.8963	Non-Significant Effect
		0.25	-0.3374	2.61	2E+05	13	CDF	0.9881	Non-Significant Effect
		0.5*	3.443	2.61	2E+05	13	CDF	0.0058	Significant Effect
		1*	6.764	2.61	2E+05	13	CDF	<1.0E-05	Significant Effect
		2*	6.924	2.61	2E+05	13	CDF	<1.0E-05	Significant Effect
		4*	9.422	2.61	2E+05	13	CDF	<1.0E-05	Significant Effect
		8*	16.75	2.61	2E+05	13	CDF	<1.0E-05	Significant Effect
		16*	24.28	2.61	2E+05	13	CDF	<1.0E-05	Significant Effect
		32*	24.67	2.61	2E+05	13	CDF	<1.0E-05	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	1.586E+13	1.586E+12	10	140.9	<1.0E-05	Significant Effect
Error	5.064E+11	1.125E+10	45			
Total	1.636E+13		55			

ANOVA Assumptions Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variance	Bartlett Equality of Variance Test	51.8	23.21	<1.0E-05	Unequal Variances
	Levene Equality of Variance Test	10.29	2.743	<1.0E-05	Unequal Variances
	Mod Levene Equality of Variance Test	3.016	2.843	0.0069	Unequal Variances
Distribution	Anderson-Darling A2 Test	1.228	3.878	0.0032	Non-Normal Distribution
	D'Agostino Kurtosis Test	2.253	2.576	0.0243	Normal Distribution
	D'Agostino Skewness Test	1.643	2.576	0.1004	Normal Distribution
	D'Agostino-Pearson K2 Omnibus Test	7.776	9.21	0.0205	Normal Distribution
	Kolmogorov-Smirnov D Test	0.1238	0.1376	0.0322	Normal Distribution
	Shapiro-Wilk W Normality Test	0.9429	0.9426	0.0103	Normal Distribution

007-273-703-6 CETIS™ v1.9.7.7 Analyst:________ QA:________

Phytoplankton Growth Inhibition Test | **NIWA Ecotoxicology**

Analysis ID:	09-4844-3353	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 19:30	**Analysis:**	Parametric-Control vs Treatments	**Status Level:**	1
Edit Date:		**MD5 Hash:**	DAFF0B159C75A197E9131C0742B4D541	**Editor ID:**	

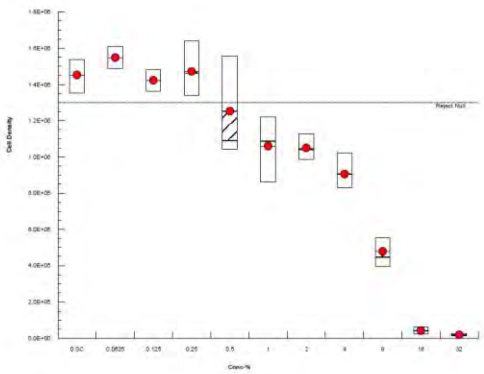
Cell Density Summary

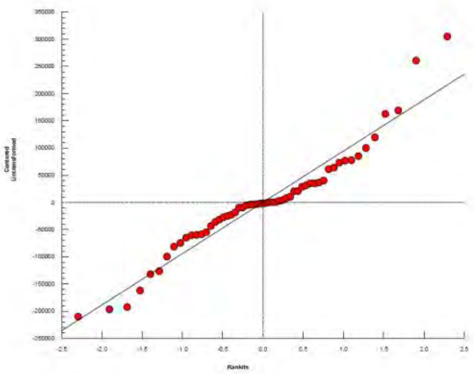
Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	10	1.452E+6	1.415E+6	1.490E+6	1.452E+6	1.353E+6	1.537E+6	1.671E+4	3.64%	0.00%
0.0625		4	1.548E+6	1.451E+6	1.645E+6	1.546E+6	1.488E+6	1.612E+6	3.050E+4	3.94%	-6.59%
0.125		2	1.423E+6	6.517E+5	2.194E+6	1.423E+6	1.362E+6	1.483E+6	6.067E+4	6.03%	2.04%
0.25		5	1.472E+6	1.305E+6	1.639E+6	1.462E+6	1.340E+6	1.641E+6	6.004E+4	9.12%	-1.35%
0.5		5	1.252E+6	9.308E+5	1.574E+6	1.090E+6	1.042E+6	1.557E+6	1.158E+5	20.67%	13.78%
1		5	1.059E+6	8.980E+5	1.221E+6	1.088E+6	8.625E+5	1.222E+6	5.810E+4	12.26%	27.06%
2		5	1.050E+6	9.839E+5	1.116E+6	1.041E+6	9.847E+5	1.127E+6	2.378E+4	5.06%	27.70%
4		5	9.048E+5	8.109E+5	9.988E+5	9.046E+5	8.303E+5	1.024E+6	3.385E+4	8.36%	37.70%
8		5	4.791E+5	3.910E+5	5.671E+5	4.474E+5	3.975E+5	5.555E+5	3.172E+4	14.80%	67.01%
16		5	4.164E+4	2.431E+4	5.898E+4	3.948E+4	2.310E+4	6.176E+4	6.243E+3	33.52%	97.13%
32		5	1.859E+4	1.233E+4	2.484E+4	1.668E+4	1.432E+4	2.622E+4	2.252E+3	27.10%	98.72%

Cell Density Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	SC	1.452E+6	1.353E+6	1.394E+6	1.487E+6	1.425E+6	1.447E+6	1.487E+6	1.537E+6	1.452E+6	1.489E+6
0.0625		1.488E+6	1.505E+6	1.612E+6	1.588E+6						
0.125		1.483E+6	1.362E+6								
0.25		1.572E+6	1.462E+6	1.345E+6	1.641E+6	1.340E+6					
0.5		1.557E+6	1.042E+6	1.060E+6	1.090E+6	1.512E+6					
1		1.034E+6	8.625E+5	1.088E+6	1.222E+6	1.090E+6					
2		1.041E+6	1.070E+6	9.847E+5	1.127E+6	1.027E+6					
4		8.303E+5	8.501E+5	9.150E+5	9.046E+5	1.024E+6					
8		3.975E+5	5.555E+5	5.520E+5	4.430E+5	4.474E+5					
16		2.310E+4	3.948E+4	3.831E+4	4.556E+4	6.176E+4					
32		2.622E+4	2.104E+4	1.468E+4	1.668E+4	1.432E+4					

Graphics





CETIS Analytical Report

Report Date: 14 Dec-22 14:13 (p 1 of 3)
Test Code/ID: 2699/UG1 MP7 / 02-2372-8208

Phytoplankton Growth Inhibition Test — **NIWA Ecotoxicology**

Analysis ID:	12-6180-5237	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv1.9.7
Analyzed:	14 Dec-22 14:09	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	E09E5A4BA97F47B0742621FAACAC53AA	**Editor ID:**	

Batch ID:	10-2077-5373	**Test Type:**	Cell Growth	**Analyst:**	K Thompson
Start Date:	19 Oct-22	**Protocol:**	NIWA (1996)	**Diluent:**	Offshore seawater
Ending Date:	21 Oct-22	**Species:**	Minutocellus polymorphus	**Brine:**	Not Applicable
Test Length:	48h	**Taxon:**		**Source:**	CCMP Bigelow Laboratory f **Age:**

Sample ID:	12-2651-8214	**Code:**	2699/UG1 MP7	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	18 Oct-22	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	19 Oct-22	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	24h	**Client:**	Hastings District Council		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Normal [ω=1]	Off [μ*=μ]	None	None

Regression Summary

Iters	LL	AICc	BIC	Adj R2	PMSD	Thresh	Optimize	F Stat	P-Value	Decision(α:5%)
17	-764.4	1535	1541	0.6669	9.97%	1357000	Yes	0.9455	0.4887	Non-Significant Lack-of-Fit

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
IC5	0.686	---	1.455	145.8	68.74	---
IC10	1.127	---	2.05	88.73	48.77	---
IC15	1.533	0.3053	2.631	65.25	38.01	327.6
IC20	1.932	0.7143	3.188	51.77	31.36	140
IC25	2.339	1.102	3.738	42.76	26.75	90.78
IC40	3.707	2.338	5.546	26.98	18.03	42.77
IC50	4.853	3.258	7.228	20.61	13.84	30.69

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	1357000	67600	1222000	1493000	20.08	<1.0E-05	Significant Parameter
γ	1.505	0.425	0.6539	2.356	3.541	0.0008	Significant Parameter
δ	4.853	1.04	2.77	6.936	4.665	1.9E-05	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	7.206E+13	2.402E+13	3	199.2	<1.0E-05	Significant Effect
Lack of Fit	9.193E+11	1.149E+11	8	0.9455	0.4887	Non-Significant Lack-of-Fit
Pure Error	5.955E+12	1.215E+11	49			
Residual	6.874E+12	1.206E+11	57			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Variance	Mod Levene Equality of Variance	9.776	2.084	<1.0E-05	Unequal Variances
Distribution	Anderson-Darling A2 Test	5.153	2.492	<1.0E-05	Non-Normal Distribution
	Shapiro-Wilk W Normality Test	0.7059	0.9605	<1.0E-05	Non-Normal Distribution

008-408-407-6 CETIS™ v1.9.7.7 Analyst:________ QA:________

CETIS Analytical Report

Report Date: 14 Dec-22 14:13 (p 1 of 3)
Test Code/ID: 2699/UG1 MP7 / 02-2372-8208

Phytoplankton Growth Inhibition Test — **NIWA Ecotoxicology**

Analysis ID:	12-6180-5237	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv1.9.7
Analyzed:	14 Dec-22 14:09	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	E09E5A4BA97F47B0742621FAACAC53AA	**Editor ID:**	

Batch ID:	10-2077-5373	**Test Type:**	Cell Growth	**Analyst:**	K Thompson
Start Date:	19 Oct-22	**Protocol:**	NIWA (1996)	**Diluent:**	Offshore seawater
Ending Date:	21 Oct-22	**Species:**	Minutocellus polymorphus	**Brine:**	Not Applicable
Test Length:	48h	**Taxon:**		**Source:**	CCMP Bigelow Laboratory f **Age:**

Sample ID:	12-2651-8214	**Code:**	2699/UG1 MP7	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	18 Oct-22	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	19 Oct-22	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	24h	**Client:**	Hastings District Council		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Normal [ω=1]	Off [μ*=μ]	None	None

Regression Summary

Iters	LL	AICc	BIC	Adj R2	PMSD	Thresh	Optimize	F Stat	P-Value	Decision(α:5%)
17	-764.4	1535	1541	0.6669	9.97%	1357000	Yes	0.9455	0.4887	Non-Significant Lack-of-Fit

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
IC5	0.686	---	1.455	145.8	68.74	---
IC10	1.127	---	2.05	88.73	48.77	---
IC15	1.533	0.3053	2.631	65.25	38.01	327.6
IC20	1.932	0.7143	3.188	51.77	31.36	140
IC25	2.339	1.102	3.738	42.76	26.75	90.78
IC40	3.707	2.338	5.546	26.98	18.03	42.77
IC50	4.853	3.258	7.228	20.61	13.84	30.69

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	1357000	67600	1222000	1493000	20.08	<1.0E-05	Significant Parameter
γ	1.505	0.425	0.6539	2.356	3.541	0.0008	Significant Parameter
δ	4.853	1.04	2.77	6.936	4.665	1.9E-05	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	7.206E+13	2.402E+13	3	199.2	<1.0E-05	Significant Effect
Lack of Fit	9.193E+11	1.149E+11	8	0.9455	0.4887	Non-Significant Lack-of-Fit
Pure Error	5.955E+12	1.215E+11	49			
Residual	6.874E+12	1.206E+11	57			

Residual Analysis

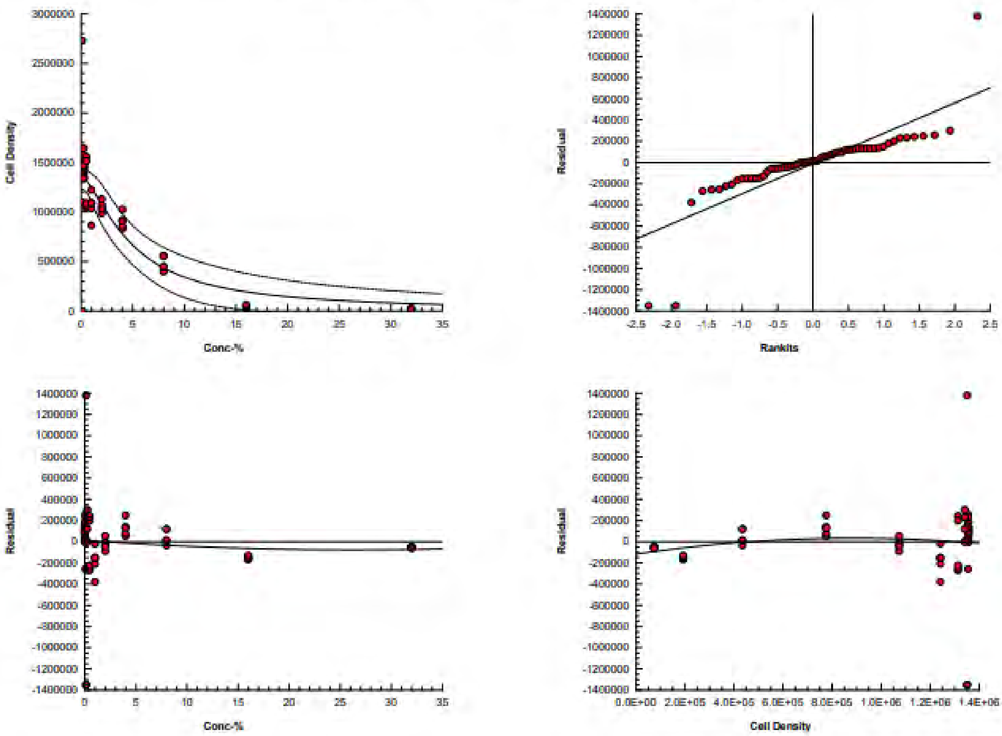
Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Variance	Mod Levene Equality of Variance	9.776	2.084	<1.0E-05	Unequal Variances
Distribution	Anderson-Darling A2 Test	5.153	2.492	<1.0E-05	Non-Normal Distribution
	Shapiro-Wilk W Normality Test	0.7059	0.9605	<1.0E-05	Non-Normal Distribution

008-408-407-6 CETIS™ v1.9.7.7 Analyst:________ QA:________

Phytoplankton Growth Inhibition Test | **NIWA Ecotoxicology**

Analysis ID:	12-6180-5237	**Endpoint:**	Cell Density	**CETIS Version:**	CETISv1.9.7
Analyzed:	14 Dec-22 14:09	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	E09E5A4BA97F47B0742621FAACAC53AA	**Editor ID:**	

Graphics Model: 3P Log-Logistic: μ=α/[1+[x/δ]^γ] Distribution: Normal [ω=1]



Wedge shell survival

CETIS Analytical Report

Report Date: 06 Dec-22 21:34 (p 1 of 3)
Test Code/ID: 2699/UG1 MAC / 10-0797-1059

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	05-8958-5296	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 21:34	**Analysis:**	Parametric-Control vs Treatments	**Status Level:**	1
Edit Date:	12 Jun-22 21:20	**MD5 Hash:**	71F8FFBB69AB51690050BA6A657BBC9E	**Editor ID:**	007-273-703-6

Batch ID:	05-7857-4275	**Test Type:**	Survival-Reburial	**Analyst:**	Ecotox Team
Start Date:	21 Oct-22	**Protocol:**	NIWA (1995)	**Diluent:**	Offshore seawater
Ending Date:	25 Oct-22	**Species:**	Macomona liliana	**Brine:**	Frozen Oceanic Seawater
Test Length:	96h	**Taxon:**		**Source:**	Client Supplied **Age:**

Sample ID:	04-8262-3632	**Code:**	2699/UG1 MAC	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	18 Oct-22	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	19 Oct-22	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	72h	**Client:**	Hastings District Council		

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	TU	MSDu	PMSD
Angular (Corrected)	C > T	2	5	3.162	50	0.08055	8.05%

Dunnett Multiple Comparison Test

Control	vs	Conc-%	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
SW Control		0.25	-0.8129	2.532	0.098	4	CDF	0.9776	Non-Significant Effect
		0.5	-0.8129	2.532	0.098	4	CDF	0.9776	Non-Significant Effect
		1	-0.8129	2.532	0.098	4	CDF	0.9776	Non-Significant Effect
		2	0.5959	2.532	0.098	4	CDF	0.6403	Non-Significant Effect
		5*	13.7	2.532	0.098	4	CDF	<1.0E-05	Significant Effect
		10*	17.18	2.532	0.098	4	CDF	<1.0E-05	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	1.62645	0.271074	6	121.6	<1.0E-05	Significant Effect
Error	0.0312212	0.0022301	14			
Total	1.65767		20			

ANOVA Assumptions Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variance	Bartlett Equality of Variance Test				Indeterminate
	Levene Equality of Variance Test	11.11	4.456	0.0001	Unequal Variances
	Mod Levene Equality of Variance Test	0.6943	7.191	0.6637	Equal Variances
Distribution	Anderson-Darling A2 Test	1.786	3.878	<1.0E-05	Non-Normal Distribution
	D'Agostino Kurtosis Test	1.798	2.576	0.0721	Normal Distribution
	D'Agostino Skewness Test	1.724	2.576	0.0847	Normal Distribution
	D'Agostino-Pearson K2 Omnibus Test	6.205	9.21	0.0449	Normal Distribution
	Kolmogorov-Smirnov D Test	0.3095	0.2186	1.3E-05	Non-Normal Distribution
	Shapiro-Wilk W Normality Test	0.8528	0.871	0.0048	Non-Normal Distribution

Survival Rate Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
0.25		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
0.5		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
1		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	0.00%
2		3	0.9667	0.8232	1.0000	1.0000	0.9000	1.0000	0.0333	5.97%	3.33%
5		3	0.5667	0.4232	0.7101	0.6000	0.5000	0.6000	0.0333	10.19%	43.33%
10		3	0.4333	0.2899	0.5768	0.4000	0.4000	0.5000	0.0333	13.32%	56.67%

007-273-703-6 CETIS™ v1.9.7.7 Analyst:________ QA:________

Macomona 96 h survival and reburial test — NIWA Ecotoxicology

Analysis ID:	05-8958-5296	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 21:34	**Analysis:**	Parametric-Control vs Treatments	**Status Level:**	1
Edit Date:	12 Jun-22 21:20	**MD5 Hash:**	71F8FFBB69AB51690050BA6A657BBC9E	**Editor ID:**	007-273-703-6

Angular (Corrected) Transformed Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	3	1.3810	1.3800	1.3810	1.3810	1.3810	1.3810	0.0000	0.00%	0.00%
0.25		3	1.4120	1.4110	1.4130	1.4120	1.4120	1.4120	0.0000	0.00%	-2.27%
0.5		3	1.4120	1.4110	1.4130	1.4120	1.4120	1.4120	0.0000	0.00%	-2.27%
1		3	1.4120	1.4110	1.4130	1.4120	1.4120	1.4120	0.0000	0.00%	-2.27%
2		3	1.3580	1.1240	1.5910	1.4120	1.2490	1.4120	0.0543	6.93%	1.66%
5		3	0.8525	0.7081	0.9969	0.8861	0.7854	0.8861	0.0336	6.82%	38.25%
10		3	0.7183	0.5739	0.8627	0.6847	0.6847	0.7854	0.0336	8.09%	47.98%

Survival Rate Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3
0	SC	1.0000	1.0000	1.0000
0.25		1.0000	1.0000	1.0000
0.5		1.0000	1.0000	1.0000
1		1.0000	1.0000	1.0000
2		1.0000	0.9000	1.0000
5		0.5000	0.6000	0.6000
10		0.4000	0.5000	0.4000

Angular (Corrected) Transformed Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3
0	SC	1.3810	1.3810	1.3810
0.25		1.4120	1.4120	1.4120
0.5		1.4120	1.4120	1.4120
1		1.4120	1.4120	1.4120
2		1.4120	1.2490	1.4120
5		0.7854	0.8861	0.8861
10		0.6847	0.7854	0.6847

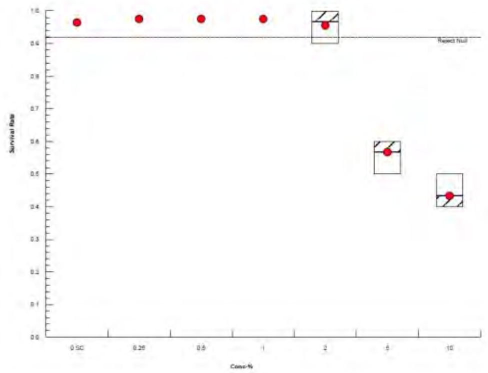
Survival Rate Binomials

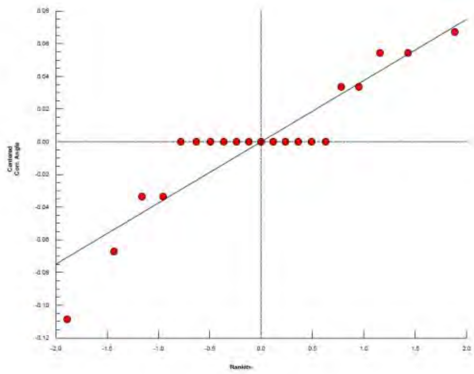
Conc-%	Code	Rep 1	Rep 2	Rep 3
0	SC	7/7	7/7	7/7
0.25		10/10	10/10	10/10
0.5		10/10	10/10	10/10
1		10/10	10/10	10/10
2		10/10	9/10	10/10
5		5/10	6/10	6/10
10		4/10	5/10	4/10

Macomona 96 h survival and reburial test	**NIWA Ecotoxicology**

Analysis ID:	05-8958-5296	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 21:34	**Analysis:**	Parametric-Control vs Treatments	**Status Level:**	1
Edit Date:	12 Jun-22 21:20	**MD5 Hash:**	71F8FFBB69AB51690050BA6A657BBC9E	**Editor ID:**	007-273-703-6

Graphics





CETIS Analytical Report

Report Date:	06 Dec-22 21:46 (p 1 of 2)
Test Code/ID:	2699/UG1 MAC / 10-0797-1059

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	15-3788-0284	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 21:45	**Analysis:**	Linear Interpolation (ICPIN)	**Status Level:**	1
Edit Date:	12 Jun-22 21:20	**MD5 Hash:**	71F8FFBB69AB51690050BA6A657BBC9E	**Editor ID:**	007-273-703-6

Batch ID:	05-7857-4275	**Test Type:**	Survival-Reburial	**Analyst:**	Ecotox Team
Start Date:	21 Oct-22	**Protocol:**	NIWA (1995)	**Diluent:**	Offshore seawater
Ending Date:	25 Oct-22	**Species:**	Macomona liliana	**Brine:**	Frozen Oceanic Seawater
Test Length:	96h	**Taxon:**		**Source:**	Client Supplied **Age:**

Sample ID:	04-8262-3632	**Code:**	2699/UG1 MAC	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	18 Oct-22	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	19 Oct-22	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	72h	**Client:**	Hastings District Council		

Linear Interpolation Options

X Transform	Y Transform	Seed	Resamples	Exp 95% CL	Method
Log(X+1)	Linear	249949	200	Yes	Two-Point Interpolation

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
LC10	2.367	1.596	2.788	42.24	35.87	62.66
LC15	2.672	2.032	3.131	37.42	31.94	49.21
LC20	3.005	2.393	3.505	33.28	28.53	41.79
LC25	3.367	2.802	3.912	29.7	25.56	35.68
LC40	4.663	3.739	5.37	21.44	18.62	26.74
LC50	7.124	2.664	13.16	14.04	7.597	37.54

Survival Rate Summary

			Calculated Variate(A/B)							Isotonic Variate	
Conc-%	Code	Count	Mean	Median	Min	Max	CV%	%Effect	A/B	Mean	%Effect
0	SC	3	1.0000	1.0000	1.0000	1.0000	0.00%	0.00%	21/21	1.0000	0.00%
0.25		3	1.0000	1.0000	1.0000	1.0000	0.00%	0.00%	30/30	1.0000	0.00%
0.5		3	1.0000	1.0000	1.0000	1.0000	0.00%	0.00%	30/30	1.0000	0.00%
1		3	1.0000	1.0000	1.0000	1.0000	0.00%	0.00%	30/30	1.0000	0.00%
2		3	0.9667	1.0000	0.9000	1.0000	5.97%	3.33%	29/30	0.9667	3.33%
5		3	0.5667	0.6000	0.5000	0.6000	10.19%	43.33%	17/30	0.5667	43.33%
10		3	0.4333	0.4000	0.4000	0.5000	13.32%	56.67%	13/30	0.4333	56.67%

Survival Rate Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3
0	SC	1.0000	1.0000	1.0000
0.25		1.0000	1.0000	1.0000
0.5		1.0000	1.0000	1.0000
1		1.0000	1.0000	1.0000
2		1.0000	0.9000	1.0000
5		0.5000	0.6000	0.6000
10		0.4000	0.5000	0.4000

Survival Rate Binomials

Conc-%	Code	Rep 1	Rep 2	Rep 3
0	SC	7/7	7/7	7/7
0.25		10/10	10/10	10/10
0.5		10/10	10/10	10/10
1		10/10	10/10	10/10
2		10/10	9/10	10/10
5		5/10	6/10	6/10
10		4/10	5/10	4/10

007-273-703-6 CETIS™ v1.9.7.7 Analyst:________ QA:________

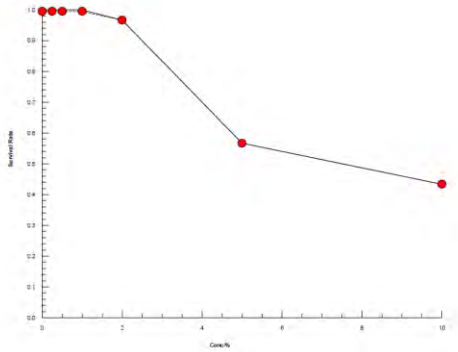
CETIS Analytical Report

Report Date:	06 Dec-22 21:46 (p 2 of 2)		
Test Code/ID:	2699/UG1 MAC / 10-0797-1059		

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	15-3788-0284	**Endpoint:**	Survival Rate	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 21:45	**Analysis:**	Linear Interpolation (ICPIN)	**Status Level:**	1
Edit Date:	12 Jun-22 21:20	**MD5 Hash:**	71F8FFBB69AB51690050BA6A657BBC9E	**Editor ID:**	007-273-703-6

Graphics



007-273-703-6 CETIS™ v1.9.7.7 Analyst:________ QA:________

Wedge shell reburial

CETIS Analytical Report

Report Date: 06 Dec-22 21:28 (p 1 of 3)
Test Code/ID: 2699/UG1 MAC / 10-0797-1059

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	00-7230-1580	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 21:27	**Analysis:**	Parametric-Control vs Treatments	**Status Level:**	1
Edit Date:	12 Jun-22 21:20	**MD5 Hash:**	C4602C48B5617F3014D234BE301552E1	**Editor ID:**	007-273-703-6

Batch ID:	05-7857-4275	**Test Type:**	Survival-Reburial	**Analyst:**	Ecotox Team	
Start Date:	21 Oct-22	**Protocol:**	NIWA (1995)	**Diluent:**	Offshore seawater	
Ending Date:	25 Oct-22	**Species:**	Macomona liliana	**Brine:**	Frozen Oceanic Seawater	
Test Length:	96h	**Taxon:**		**Source:**	Client Supplied	**Age:**

Sample ID:	04-8262-3632	**Code:**	2699/UG1 MAC	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	18 Oct-22	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	19 Oct-22	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	72h	**Client:**	Hastings District Council		

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	TU	MSDu	PMSD
Angular (Corrected)	C > T	2	5	3.162	50	0.1484	15.59%

Dunnett Multiple Comparison Test

Control vs	Conc-%	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
SW Control	0.25	-0.5351	2.532	0.203	4	CDF	0.9549	Non-Significant Effect
	0.5	-0.5351	2.532	0.203	4	CDF	0.9549	Non-Significant Effect
	1	-1.214	2.532	0.203	4	CDF	0.9925	Non-Significant Effect
	2	-0.5351	2.532	0.203	4	CDF	0.9549	Non-Significant Effect
	5*	9.665	2.532	0.203	4	CDF	<1.0E-05	Significant Effect
	10*	12.49	2.532	0.203	4	CDF	<1.0E-05	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	3.81484	0.635806	6	66.12	<1.0E-05	Significant Effect
Error	0.134631	0.0096165	14			
Total	3.94947		20			

ANOVA Assumptions Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variance	Bartlett Equality of Variance Test				Indeterminate
	Levene Equality of Variance Test	1.933	4.456	0.1451	Equal Variances
	Mod Levene Equality of Variance Test	0.4394	7.191	0.8321	Equal Variances
Distribution	Anderson-Darling A2 Test	1.412	3.878	0.0006	Non-Normal Distribution
	D'Agostino Kurtosis Test	0.6126	2.576	0.5401	Normal Distribution
	D'Agostino Skewness Test	1.125	2.576	0.2608	Normal Distribution
	D'Agostino-Pearson K2 Omnibus Test	1.64	9.21	0.4405	Normal Distribution
	Kolmogorov-Smirnov D Test	0.2143	0.2186	0.0128	Normal Distribution
	Shapiro-Wilk W Normality Test	0.8817	0.871	0.0157	Normal Distribution

Eff. Survival Rate Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	3	0.9524	0.7475	1.0000	1.0000	0.8571	1.0000	0.0476	8.66%	0.00%
0.25		3	0.9667	0.8232	1.0000	1.0000	0.9000	1.0000	0.0333	5.97%	-1.50%
0.5		3	0.9667	0.8232	1.0000	1.0000	0.9000	1.0000	0.0333	5.97%	-1.50%
1		3	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	0.0000	0.00%	-5.00%
2		3	0.9667	0.8232	1.0000	1.0000	0.9000	1.0000	0.0333	5.97%	-1.50%
5		3	0.2667	0.1232	0.4101	0.3000	0.2000	0.3000	0.0333	21.65%	72.00%
10		3	0.1000	0.0000	0.3484	0.1000	0.0000	0.2000	0.0577	100.00%	89.50%

007-273-703-6 CETIS™ v1.9.7.7 Analyst:________ QA:________

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	00-7230-1580	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 21:27	**Analysis:**	Parametric-Control vs Treatments	**Status Level:**	1
Edit Date:	12 Jun-22 21:20	**MD5 Hash:**	C4602C48B5617F3014D234BE301552E1	**Editor ID:**	007-273-703-6

Angular (Corrected) Transformed Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	3	1.3150	1.0320	1.5980	1.3810	1.1830	1.3810	0.0658	8.67%	0.00%
0.25		3	1.3580	1.1240	1.5910	1.4120	1.2490	1.4120	0.0543	6.93%	-3.26%
0.5		3	1.3580	1.1240	1.5910	1.4120	1.2490	1.4120	0.0543	6.93%	-3.26%
1		3	1.4120	1.4110	1.4130	1.4120	1.4120	1.4120	0.0000	0.00%	-7.39%
2		3	1.3580	1.1240	1.5910	1.4120	1.2490	1.4120	0.0543	6.93%	-3.26%
5		3	0.5410	0.3746	0.7073	0.5796	0.4636	0.5796	0.0387	12.38%	58.86%
10		3	0.3147	-0.0642	0.6937	0.3218	0.1588	0.4636	0.0881	48.47%	76.06%

Eff. Survival Rate Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3
0	SC	0.8571	1.0000	1.0000
0.25		1.0000	1.0000	0.9000
0.5		0.9000	1.0000	1.0000
1		1.0000	1.0000	1.0000
2		1.0000	0.9000	1.0000
5		0.3000	0.2000	0.3000
10		0.2000	0.1000	0.0000

Angular (Corrected) Transformed Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3
0	SC	1.1830	1.3810	1.3810
0.25		1.4120	1.4120	1.2490
0.5		1.2490	1.4120	1.4120
1		1.4120	1.4120	1.4120
2		1.4120	1.2490	1.4120
5		0.5796	0.4636	0.5796
10		0.4636	0.3218	0.1588

Eff. Survival Rate Binomials

Conc-%	Code	Rep 1	Rep 2	Rep 3
0	SC	6/7	7/7	7/7
0.25		10/10	10/10	9/10
0.5		9/10	10/10	10/10
1		10/10	10/10	10/10
2		10/10	9/10	10/10
5		3/10	2/10	3/10
10		2/10	1/10	0/10

CETIS Analytical Report

Report Date: 06 Dec-22 21:28 (p 3 of 3)
Test Code/ID: 2699/UG1 MAC / 10-0797-1059

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	00-7230-1580	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 21:27	**Analysis:**	Parametric-Control vs Treatments	**Status Level:**	1
Edit Date:	12 Jun-22 21:20	**MD5 Hash:**	C4602C48B5617F3014D234BE301552E1	**Editor ID:**	007-273-703-6

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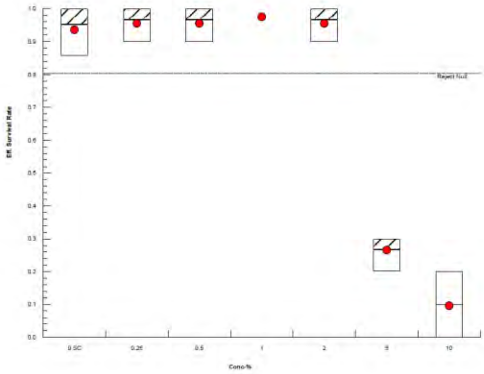
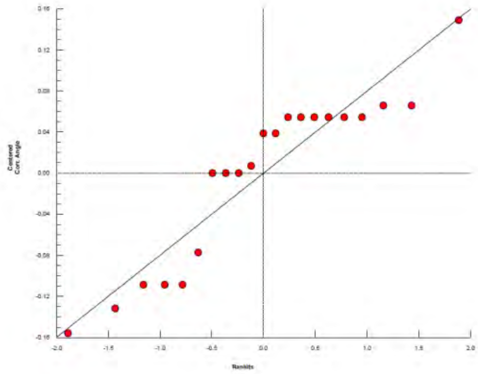




007-273-703-6 CETIS™ v1.9.7.7 Analyst:________ QA:________

CETIS Analytical Report

Report Date:	06 Dec-22 21:46 (p 1 of 3)		
Test Code/ID:	2699/UG1 MAC / 10-0797-1059		

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	13-6580-8756	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 21:40	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:	12 Jun-22 21:20	**MD5 Hash:**	C4602C48B5617F3014D234BE301552E1	**Editor ID:**	007-273-703-6

Batch ID:	05-7857-4275	**Test Type:**	Survival-Reburial	**Analyst:**	Ecotox Team
Start Date:	21 Oct-22	**Protocol:**	NIWA (1995)	**Diluent:**	Offshore seawater
Ending Date:	25 Oct-22	**Species:**	Macomona liliana	**Brine:**	Frozen Oceanic Seawater
Test Length:	96h	**Taxon:**		**Source:**	Client Supplied **Age:**

Sample ID:	04-8262-3632	**Code:**	2699/UG1 MAC	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	18 Oct-22	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	19 Oct-22	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	72h	**Client:**	Hastings District Council		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Log-Logistic: μ=α/[1+[x/δ]^γ]	Binomial [ω=n/[p·q]]	Off [μ*=μ]	None	None

Regression Summary

Iters	LL	AICc	BIC	Adj R2	PMSD	Thresh	Optimize	F Stat	P-Value	Decision(α:5%)
29	-19.14	45.7	47.42	0.9806	3.58%	0.9763	Yes	1.307	0.3150	Non-Significant Lack-of-Fit

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
LC5	1.918	---	2.605	52.14	38.39	---
LC10	2.357	---	3.132	42.43	31.92	---
LC15	2.678	---	3.516	37.35	28.44	---
LC20	2.948	1.066	3.836	33.92	26.07	93.79
LC25	3.191	1.832	4.122	31.34	24.26	54.6
LC40	3.864	2.879	4.908	25.88	20.38	34.74
LC50	4.321	3.416	5.465	23.14	18.3	29.27

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	0.9763	0.01663	0.9414	1.011	58.72	<1.0E-05	Significant Parameter
γ	3.625	0.8973	1.74	5.51	4.04	0.0008	Significant Parameter
δ	4.321	0.465	3.344	5.298	9.291	<1.0E-05	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	4697	1566	3	1305	<1.0E-05	Significant Effect
Lack of Fit	5.871	1.468	4	1.307	0.3150	Non-Significant Lack-of-Fit
Pure Error	15.72	1.123	14			
Residual	21.59	1.2	18			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Model Fit	Likelihood Ratio GOF Test	18.77	28.87	0.4059	Non-Significant Heterogeneity
	Pearson Chi-Sq GOF Test	21.59	28.87	0.2505	Non-Significant Heterogeneity
Variance	Mod Levene Equality of Variance T	0.4941	3.866	0.7957	Equal Variances
Distribution	Anderson-Darling A2 Test	1.061	2.492	0.0089	Non-Normal Distribution
	Shapiro-Wilk W Normality Test	0.916	0.9079	0.0723	Normal Distribution
Overdispersion	Tarone C(α) BinOverdispersion Te	1.144	1.645	0.1263	Non-Significant Overdispersion

CETIS Analytical Report

Report Date: 06 Dec-22 21:46 (p 2 of 3)
Test Code/ID: 2699/UG1 MAC / 10-0797-1059

Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	13-6580-8756	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 21:40	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:	12 Jun-22 21:20	**MD5 Hash:**	C4602C48B5617F3014D234BE301552E1	**Editor ID:**	007-273-703-6

Eff. Survival Rate Summary

			Calculated Variate(A/B)								
Conc-%	**Code**	**Count**	**Mean**	**Median**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**A/B**
0	SC	3	0.9524	1.0000	0.8571	1.0000	0.0476	0.0825	8.66%	0.00%	20/21
0.25		3	0.9667	1.0000	0.9000	1.0000	0.0333	0.0577	5.97%	-1.50%	29/30
0.5		3	0.9667	1.0000	0.9000	1.0000	0.0333	0.0577	5.97%	-1.50%	29/30
1		3	1.0000	1.0000	1.0000	1.0000	0.0000	0.0000	0.00%	-5.00%	30/30
2		3	0.9667	1.0000	0.9000	1.0000	0.0333	0.0577	5.97%	-1.50%	29/30
5		3	0.2667	0.3000	0.2000	0.3000	0.0333	0.0577	21.65%	72.00%	8/30
10		3	0.1000	0.1000	0.0000	0.2000	0.0577	0.1000	100.00%	89.50%	3/30

Eff. Survival Rate Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3
0	SC	0.8571	1.0000	1.0000
0.25		1.0000	1.0000	0.9000
0.5		0.9000	1.0000	1.0000
1		1.0000	1.0000	1.0000
2		1.0000	0.9000	1.0000
5		0.3000	0.2000	0.3000
10		0.2000	0.1000	0.0000

007-273-703-6 CETIS™ v1.9.7.7 Analyst:________ QA:________

CETIS Analytical Report

Report Date: 06 Dec-22 21:46 (p 3 of 3)
Test Code/ID: 2699/UG1 MAC / 10-0797-1059

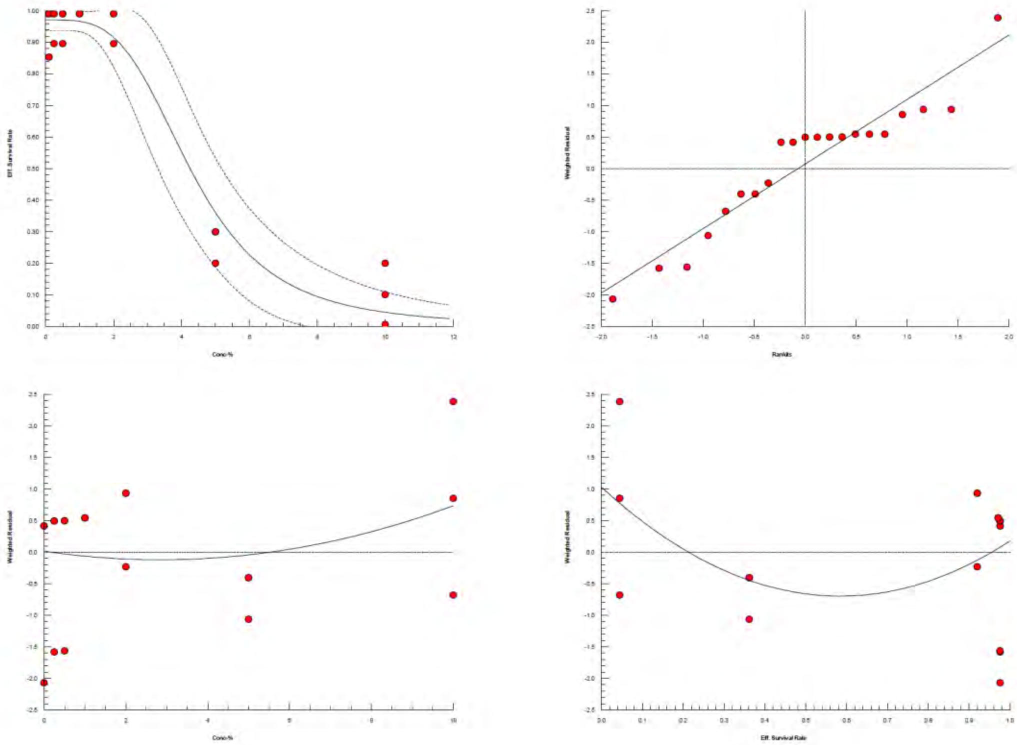
Macomona 96 h survival and reburial test — **NIWA Ecotoxicology**

Analysis ID:	13-6580-8756	**Endpoint:**	Eff. Survival Rate	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 21:40	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:	12 Jun-22 21:20	**MD5 Hash:**	C4602C48B5617F3014D234BE301552E1	**Editor ID:**	007-273-703-6

Eff. Survival Rate Binomials

Conc-%	Code	Rep 1	Rep 2	Rep 3
0	SC	6/7	7/7	7/7
0.25		10/10	10/10	9/10
0.5		9/10	10/10	10/10
1		10/10	10/10	10/10
2		10/10	9/10	10/10
5		3/10	2/10	3/10
10		2/10	1/10	0/10

Graphics Model: 3P Log-Logistic: μ=α/[1+[x/δ]^γ] Distribution: Binomial [ω=n/[p·q]]



007-273-703-6 CETIS™ v1.9.7.7 Analyst:________ QA:________

Blue mussel

CETIS Analytical Report

Report Date:	06 Dec-22 17:23 (p 1 of 2)
Test Code/ID:	2699/UG1 MyG / 04-9393-8984

Bivalve Larval Survival and Development Test — **NIWA Ecotoxicology**

Analysis ID:	21-2347-3959	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 17:16	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	A1F43B77EA11CE39EC78D6821C864183	**Editor ID:**	

Batch ID:	15-6963-9082	**Test Type:**	Development	**Analyst:**	Ecotox Team		
Start Date:	19 Oct-22	**Protocol:**	NIWA (2008)	**Diluent:**	Offshore seawater		
Ending Date:	21 Oct-22	**Species:**	Mytilus galloprovincialis	**Brine:**	Frozen Oceanic Seawater		
Test Length:	48h	**Taxon:**		**Source:**	Coromandel	**Age:**	

Sample ID:	06-1882-3379	**Code:**	2699/UG1 MyG	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	18 Oct-22	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	19 Oct-22	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	24h	**Client:**	Hastings District Council		

Data Transform	Alt Hyp	NOEL	LOEL	TOEL	TU	MSDu	PMSD
Angular (Corrected)	C > T	<0.25	0.25	---	>400	0.03362	3.61%

Bonferroni Adj t Test

Control	vs	Conc-%	Test Stat	Critical	MSD	DF	P-Type	P-Value	Decision(α:5%)
SW Control		0.25*	2.65	2.462	0.065	13	CDF	0.0322	Significant Effect
		0.5*	4.634	2.462	0.065	13	CDF	0.0002	Significant Effect
		1*	9.207	2.462	0.065	13	CDF	<1.0E-05	Significant Effect
		2*	30.83	2.462	0.065	13	CDF	<1.0E-05	Significant Effect
		4*	46.93	2.462	0.065	13	CDF	<1.0E-05	Significant Effect

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Between	6.86942	1.37388	5	599.1	<1.0E-05	Significant Effect
Error	0.0665055	0.0022933	29			
Total	6.93593		34			

ANOVA Assumptions Tests

Attribute	Test	Test Stat	Critical	P-Value	Decision(α:1%)
Variance	Bartlett Equality of Variance Test	6.274	15.09	0.2805	Equal Variances
	Levene Equality of Variance Test	2.093	3.725	0.0950	Equal Variances
	Mod Levene Equality of Variance Test	0.7169	3.895	0.6170	Equal Variances
Distribution	Anderson-Darling A2 Test	0.8605	3.878	0.0270	Normal Distribution
	D'Agostino Kurtosis Test	0.2047	2.576	0.8378	Normal Distribution
	D'Agostino Skewness Test	1.763	2.576	0.0779	Normal Distribution
	D'Agostino-Pearson K2 Omnibus Test	3.151	9.21	0.2069	Normal Distribution
	Kolmogorov-Smirnov D Test	0.165	0.1723	0.0169	Normal Distribution
	Shapiro-Wilk W Normality Test	0.9426	0.9146	0.0671	Normal Distribution

Proportion Normal Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	10	0.9310	0.9121	0.9499	0.9300	0.8900	0.9600	0.0084	2.84%	0.00%
0.25		5	0.8940	0.8752	0.9128	0.9000	0.8700	0.9100	0.0068	1.70%	3.97%
0.5		5	0.8600	0.8404	0.8796	0.8600	0.8400	0.8800	0.0071	1.84%	7.63%
1		5	0.7660	0.7074	0.8246	0.7500	0.7400	0.8500	0.0211	6.16%	17.72%
2		5	0.2320	0.1638	0.3002	0.2100	0.1900	0.3200	0.0246	23.69%	75.08%
4		5	0.0060	0.0000	0.0171	0.0000	0.0000	0.0200	0.0040	149.07%	99.36%

Angular (Corrected) Transformed Summary

Conc-%	Code	Count	Mean	95% LCL	95% UCL	Median	Min	Max	Std Err	CV%	%Effect
0	SC	10	1.3090	1.2720	1.3470	1.3040	1.2330	1.3690	0.0167	4.02%	0.00%
0.25		5	1.2400	1.2100	1.2700	1.2490	1.2020	1.2660	0.0108	1.95%	5.31%
0.5		5	1.1880	1.1590	1.2160	1.1870	1.1590	1.2170	0.0102	1.92%	9.28%
1		5	1.0680	0.9943	1.1410	1.0470	1.0360	1.1730	0.0265	5.54%	18.45%
2		5	0.5006	0.4216	0.5796	0.4760	0.4510	0.6013	0.0284	12.71%	61.77%
4		5	0.0784	0.0268	0.1301	0.0500	0.0500	0.1419	0.0186	53.04%	94.01%

007-273-703-6 CETIS™ v1.9.7.7 Analyst:________ QA:________

CETIS Analytical Report

Report Date:	06 Dec-22 17:23 (p 2 of 2)
Test Code/ID:	2699/UG1 MyG / 04-9393-8984

Bivalve Larval Survival and Development Test — **NIWA Ecotoxicology**

Analysis ID:	21-2347-3959	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 17:16	**Analysis:**	Parametric-Multiple Comparison	**Status Level:**	1
Edit Date:		**MD5 Hash:**	A1F43B77EA11CE39EC78D6821C864183	**Editor ID:**	

Proportion Normal Detail

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	SC	0.9200	0.9400	0.9100	0.9600	0.8900	0.9000	0.9500	0.9200	0.9600	0.9600
0.25		0.9000	0.9000	0.8700	0.9100	0.8900					
0.5		0.8700	0.8800	0.8400	0.8500	0.8600					
1		0.7500	0.7400	0.8500	0.7400	0.7500					
2		0.1900	0.2500	0.3200	0.1900	0.2100					
4		0.0200	0.0000	0.0100	0.0000	0.0000					

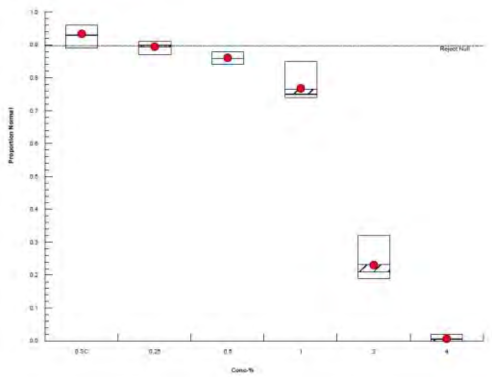
Angular (Corrected) Transformed Detail

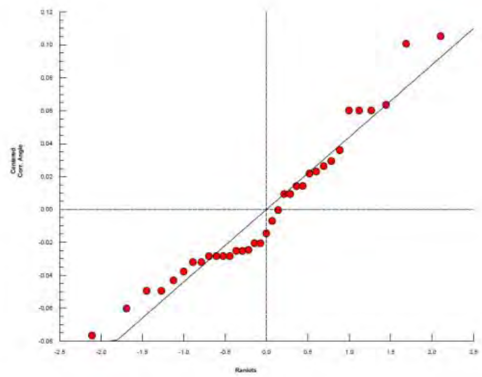
Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	SC	1.2840	1.3230	1.2660	1.3690	1.2330	1.2490	1.3450	1.2840	1.3690	1.3690
0.25		1.2490	1.2490	1.2020	1.2660	1.2330					
0.5		1.2020	1.2170	1.1590	1.1730	1.1870					
1		1.0470	1.0360	1.1730	1.0360	1.0470					
2		0.4510	0.5236	0.6013	0.4510	0.4760					
4		0.1419	0.0500	0.1002	0.0500	0.0500					

Proportion Normal Binomials

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	SC	92/100	94/100	91/100	96/100	89/100	90/100	95/100	92/100	96/100	96/100
0.25		90/100	90/100	87/100	91/100	89/100					
0.5		87/100	88/100	84/100	85/100	86/100					
1		75/100	74/100	85/100	74/100	75/100					
2		19/100	25/100	32/100	19/100	21/100					
4		2/100	0/100	1/100	0/100	0/100					

Graphics





007-273-703-6 CETIS™ v1.9.7.7 Analyst:________ QA:________

CETIS Analytical Report

Report Date:	06 Dec-22 17:23 (p 1 of 3)
Test Code/ID:	2699/UG1 MyG / 04-9393-8984

Bivalve Larval Survival and Development Test — **NIWA Ecotoxicology**

Analysis ID:	13-8346-0351	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 17:19	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	A1F43B77EA11CE39EC78D6821C864183	**Editor ID:**	

Batch ID:	15-6963-9082	**Test Type:**	Development	**Analyst:**	Ecotox Team
Start Date:	19 Oct-22	**Protocol:**	NIWA (2008)	**Diluent:**	Offshore seawater
Ending Date:	21 Oct-22	**Species:**	Mytilus galloprovincialis	**Brine:**	Frozen Oceanic Seawater
Test Length:	48h	**Taxon:**		**Source:**	Coromandel **Age:**

Sample ID:	06-1882-3379	**Code:**	2699/UG1 MyG	**Project:**	Effluent Characterization (Quarterly)
Sample Date:	18 Oct-22	**Material:**	WWTP discharge	**Source:**	Client Supplied
Receipt Date:	19 Oct-22	**CAS (PC):**		**Station:**	Hastings DC Outfall
Sample Age:	24h	**Client:**	Hastings District Council		

Non-Linear Regression Options

Model Name and Function	Weighting Function	PTBS Function	X Trans	Y Trans
3P Logistic: μ=α/[1+exp[-γ[x-δ]]]	Binomial [ω=n/[p·q]]	Off [μ*=μ]	None	None

Regression Summary

Iters	LL	AICc	BIC	Adj R2	PMSD	Thresh	Optimize	F Stat	P-Value	Decision(α:5%)
4	-82.51	171.8	175.7	0.9932	3.01%	0.9252	Yes	1.633	0.2032	Non-Significant Lack-of-Fit

Point Estimates

Level	%	95% LCL	95% UCL	TU	95% LCL	95% UCL
EC5	0.4662	0.348	0.5619	214.5	178	287.3
EC10	0.7035	0.5919	0.7968	142.2	125.5	169
EC15	0.8705	0.7636	0.9623	114.9	103.9	131
EC20	1.003	0.9027	1.093	99.66	91.53	110.8
EC25	1.117	1.022	1.203	89.54	83.15	97.82
EC40	1.399	1.319	1.477	71.48	67.72	75.81
EC50	1.568	1.492	1.644	63.77	60.82	67.01

Regression Parameters

Parameter	Estimate	Std Error	95% LCL	95% UCL	t Stat	P-Value	Decision(α:5%)
α	0.9509	0.01366	0.9231	0.9787	69.62	<1.0E-05	Significant Parameter
γ	-2.32	0.1683	-2.663	-1.978	-13.79	<1.0E-05	Significant Parameter
δ	1.545	0.04349	1.456	1.633	35.52	<1.0E-05	Significant Parameter

ANOVA Table

Source	Sum Squares	Mean Square	DF	F Stat	P-Value	Decision(α:5%)
Model	22240	7414	3	6275	<1.0E-05	Significant Effect
Lack of Fit	5.465	1.822	3	1.633	0.2032	Non-Significant Lack-of-Fit
Pure Error	32.35	1.115	29			
Residual	37.81	1.182	32			

Residual Analysis

Attribute	Method	Test Stat	Critical	P-Value	Decision(α:5%)
Model Fit	Likelihood Ratio GOF Test	34.67	46.19	0.3419	Non-Significant Heterogeneity
	Pearson Chi-Sq GOF Test	37.81	46.19	0.2210	Non-Significant Heterogeneity
Variance	Mod Levene Equality of Variance T	0.7347	2.621	0.6047	Equal Variances
Distribution	Anderson-Darling A2 Test	1.056	2.492	0.0091	Non-Normal Distribution
	Shapiro-Wilk W Normality Test	0.9152	0.9384	0.0104	Non-Normal Distribution
Overdispersion	Tarone C(α) BinOverdispersion Te	1.325	1.645	0.0926	Non-Significant Overdispersion

007-273-703-6 CETIS™ v1.9.7.7 Analyst:________ QA:________

CETIS Analytical Report

Report Date:	06 Dec-22 17:23 (p 2 of 3)
Test Code/ID:	2699/UG1 MyG / 04-9393-8984

Bivalve Larval Survival and Development Test — **NIWA Ecotoxicology**

Analysis ID:	13-8346-0351	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 17:19	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	A1F43B77EA11CE39EC78D6821C864183	**Editor ID:**	

Proportion Normal Summary

			Calculated Variate(A/B)								
Conc-%	**Code**	**Count**	**Mean**	**Median**	**Min**	**Max**	**Std Err**	**Std Dev**	**CV%**	**%Effect**	**A/B**
0	SC	10	0.9310	0.9300	0.8900	0.9600	0.0084	0.0264	2.84%	0.00%	931/1000
0.25		5	0.8940	0.9000	0.8700	0.9100	0.0068	0.0152	1.70%	3.97%	447/500
0.5		5	0.8600	0.8600	0.8400	0.8800	0.0071	0.0158	1.84%	7.63%	430/500
1		5	0.7660	0.7500	0.7400	0.8500	0.0211	0.0472	6.16%	17.72%	383/500
2		5	0.2320	0.2100	0.1900	0.3200	0.0246	0.0550	23.69%	75.08%	116/500
4		5	0.0060	0.0000	0.0000	0.0200	0.0040	0.0089	149.07%	99.36%	3/500

Proportion Normal Detail

Conc-%	**Code**	**Rep 1**	**Rep 2**	**Rep 3**	**Rep 4**	**Rep 5**	**Rep 6**	**Rep 7**	**Rep 8**	**Rep 9**	**Rep 10**
0	SC	0.9200	0.9400	0.9100	0.9600	0.8900	0.9000	0.9500	0.9200	0.9600	0.9600
0.25		0.9000	0.9000	0.8700	0.9100	0.8900					
0.5		0.8700	0.8800	0.8400	0.8500	0.8600					
1		0.7500	0.7400	0.8500	0.7400	0.7500					
2		0.1900	0.2500	0.3200	0.1900	0.2100					
4		0.0200	0.0000	0.0100	0.0000	0.0000					

007-273-703-6 CETIS™ v1.9.7.7 Analyst:________ QA:________

CETIS Analytical Report

Report Date: 06 Dec-22 17:23 (p 3 of 3)
Test Code/ID: 2699/UG1 MyG / 04-9393-8984

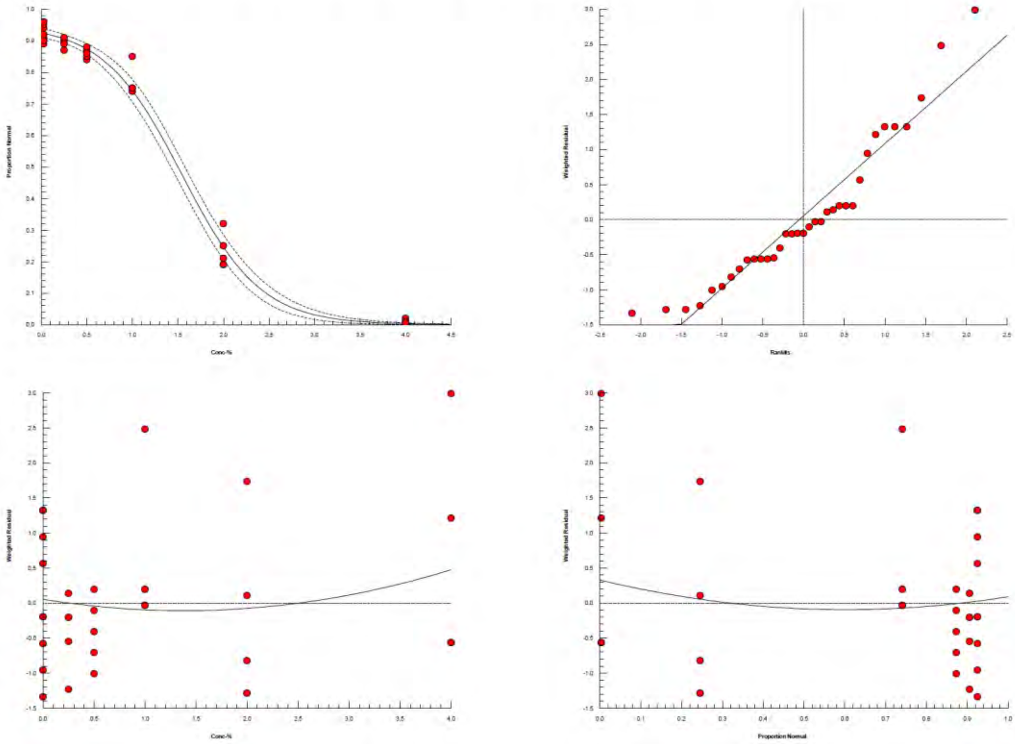
Bivalve Larval Survival and Development Test — **NIWA Ecotoxicology**

Analysis ID:	13-8346-0351	**Endpoint:**	Proportion Normal	**CETIS Version:**	CETISv1.9.7
Analyzed:	06 Dec-22 17:19	**Analysis:**	Nonlinear Regression (NLR)	**Status Level:**	1
Edit Date:		**MD5 Hash:**	A1F43B77EA11CE39EC78D6821C864183	**Editor ID:**	

Proportion Normal Binomials

Conc-%	Code	Rep 1	Rep 2	Rep 3	Rep 4	Rep 5	Rep 6	Rep 7	Rep 8	Rep 9	Rep 10
0	SC	92/100	94/100	91/100	96/100	89/100	90/100	95/100	92/100	96/100	96/100
0.25		90/100	90/100	87/100	91/100	89/100					
0.5		87/100	88/100	84/100	85/100	86/100					
1		75/100	74/100	85/100	74/100	75/100					
2		19/100	25/100	32/100	19/100	21/100					
4		2/100	0/100	1/100	0/100	0/100					

Graphics Model: 3P Logistic: μ=α/[1+exp[-γ[x-δ]]] Distribution: Binomial [ω=n/[p·q]]



007-273-703-6 CETIS™ v1.9.7.7 Analyst:________ QA:________

Appendix D Hill Laboratories Results

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

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T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Certificate of Analysis

Page 1 of 1

Client:	NIWA Corporate	**Lab No:**	3099451 SUPv1
Contact:	K Thompson C/- NIWA Corporate PO Box 11115 Hillcrest Hamilton 3251	**Date Received:**	19-Oct-2022
		Date Reported:	31-Oct-2022
		Quote No:	51353
		Order No:	U317642
		Client Reference:	Hastings DC
		Submitted By:	K Thompson

Sample Type: Aqueous

Sample Name:		HDC WWTP 17-Oct-2022
Lab Number:		3099451.1
Total Ammoniacal-N	g/m^3	21.36 ± 0.77
Total Sulphide	g/m^3	0.67 ± 0.25

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

Summary of Methods

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

Sample Type: Aqueous

Test	Method Description	Default Detection Limit	Sample No
Filtration, Unpreserved	Sample filtration through 0.45µm membrane filter.	-	1
Total Ammoniacal-N	Phenol/hypochlorite colourimetry. Flow injection analyser. (NH_4-N = NH_4^+-N + NH_3-N). APHA 4500-NH_3 H (modified) 23rd ed. 2017.	0.010 g/m^3	1
Total Sulphide Trace	In-line distillation, segmented flow colorimetry. APHA 4500-S^{2-} E (modified) 23rd ed. 2017.	0.002 g/m^3	1

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

Testing was completed between 21-Oct-2022 and 25-Oct-2022. For completion dates of individual analyses please contact the laboratory.

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

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

Ara Heron BSc (Tech)
Client Services Manager - Environmental

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised. The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked * or any comments and interpretations, which are not accredited.

Appendix E Bioassay Physico-chemistry

Table E-1: Water quality measures from the wedge shell test.

Date	Time (h)	Sample	Concentration (%)	Temp (°C)	pH	DO (mg L^{-1})	DO (%)	Salinity (ppt)
21/10/2022	0	Control	0	20	8.1	7.2	98	35
		UG1	0.25	20	8.1	7.3	99	34
			10	19	8.0	7.3	97	33
25/10/2022	96	Control	0	20	8.0	7.4	100	36
		UG1	0.25	19	8.2	7.1	94	36
			0.5	19	8.2	7.1	94	36
			1	19	8.2	7.1	94	36
			2	19	8.2	7.1	94	36
			5	19	8.2	7.1	94	36
			10	19	8.1	6.9	92	36

Table E-2: Water quality measures from the blue mussel test. Grey shading indicates values that are outside the acceptable range for the test.

Date	Time (h)	Sample	Concentration (%)	Temp (°C)	pH	DO (mg L^{-1})	DO (%)	Salinity (ppt)
19/10/2022	0	Control	0	21	8.1	7.3	101	35
		UG1	0.25	21	8.0	7.2	99	35
			16	21	7.7	6.8	94	34
21/10/2022	48	Control	0	22	7.7	7.3	101	36
		UG1	0.25	21	8.0	7.1	98	33
			0.5	21	8.0	7.1	98	35
			1	21	8.0	6.9	95	35
			2	21	8.0	6.9	95	35
			4	21	8.0	6.7	92	35
			8	21	8.0	5.4	74	34
			16	21	8.0	3.8	52	34

Appendix G Toxicity Testing Reports

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Environmental monitoring of Clive outfall: sediment quality and benthic biota survey

January 2023

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Environmental monitoring of Clive outfall: sediment quality and benthic biota survey January 2023

DOCUMENT APPROVAL

Document title:	Environmental monitoring of Clive outfall: sediment quality and benthic biota survey
Prepared for:	Hastings District Council
Version:	Draft 1
Date:	3 July 2023
Document name:	CON2022073 Clive Outfall Benthic Ecology Survey 2023-draft 1.docx

Authors:	Laureline Meynier, PhD Marine Ecologist
Reviewer:	Simon West, M.Sc. (Hons) Technical Director Marine Ecology
Approved for Release:	Simon West, M.Sc. (Hons) Technical Director Marine Ecology

REVISION HISTORY

Rev. No.	Date	Description	Author(s)	Reviewer	Approved
1	July 2023	Draft 1	L. Meynier	S. West	S. West
2					
3					

Reference: Bioresearches (2023). Environmental monitoring of Clive outfall: sediment quality and benthic biota survey. Report for Hastings District Council. pp 62

Cover Illustration: Aerial view of the Marine Parade, Napier, with the beach continuing to the left of the photo towards Clive (from Learninghawkesbay.nz)

CONTENTS

EXECUTIVE SUMMARY

Hastings District Council engaged Bioresearches in December 2022 to conduct the benthic survey around the Clive outfall in January/February 2023 to assess potential effects of the treated wastewater on the receiving environment. This report presents the results of the environmental monitoring carried out in January 2023. The methodology matched the previous 2012 survey from Golder Associates.

Sediment Quality: grain size

The percentage of mud in the 2023 survey was high, representing more than 70% of the total weight at each site. On the north and south transects, the mud content increased with distance from the outfall. On the east transect, grain size profiles consisted of mud at 96% while the west transect presented the least mud percentages at 500m and 750m distances. During the 2012 survey, most of the sites showed significantly less mud in the grain size compositions than was found in January 2023.

Input of fine sediments from the catchments forming Hawke's Bay is a key stressor for the regional coastal ecosystem. Large river systems from Tukituki, Ngaruroro and Tūtaekurī rivers greatly influence the sediment dynamics in the Bay after heavy rainfall events. The sampling locations around the outfall are situated in front of the coastline delimited by the estuaries of these large rivers. The grain size distribution around the outfall is likely to be more affected by the river systems during heavy rainfall events than the outfall effluent. The mud increase in the subtidal sediment over time is consistent with the general trend recorded by the State of the environment in Hawke Bay.

Sediment Quality: organic content

Organic content was assessed by two different measures: total organic carbon, and total volatile solids. There was no detected trend of organic content in sediment with distance from the outfall except on the south transect. Hydrodynamic modelling of the Bay in a previous study showed modelled particles going predominately south, highlighting a dominant north to south current parallel to the shore in that part of Hawke Bay. The north site at a distance of 2500m from the outfall had high organic content, suggesting that other factors are at play in the distribution of particulate matter in the Bay such as the influence of the river systems into the Bay.

Sediment Quality: metal and arsenic concentrations

Out of the eight metals/metalloids tested in the sediments around the Clive outfall, only mercury showed values higher than the ANZG DGV guideline at two sites. The concentrations were however lower than the ANZG DV-high guideline, at levels which adverse effects on the biota could possibly occur (ANZG 2018).

The seven metals tested (Cadmium, Chromium, Copper, Lead, Mercury, Nickel and Zinc) all showed a similar pattern of distribution around the outfall diffuser. The aluminium-adjusted concentrations revealed a clear metal enrichment at the sites closest to the outfall (50m north and south), and further south to a 100m or 250m distance. The decreasing gradient of metal concentrations with distance going south could indicate an effect from the outfall effluent. This hypothesis is consistent with the movement of water particles modelled in a previous study showing a predominant southern current.

When compared to earlier surveys from 2006 and 2012, the bulk of the metal concentrations in sediment were in similar range to that found previously. There were few exceptions such as cadmium and mercury at the 50m sites with concentrations higher than previously recorded in 2006 and 2012.

Subtidal Benthic Ecology Monitoring

The polychaetes were the dominant taxa group with 98% of the total number of counted individuals with *Heteromastus filiformis*, *Prionospio aucklandica*, *Paraprionospio* sp. and *Cossura consimilis* being the most abundant ones. *Diopatra akarana*, an oniphid polychaete building large tubes, formed dense patches around the outfall and in the southern transect.

A combination of univariate tests on diversity measures and multivariate tests on benthic communities revealed significant differences between sites. The western region gave the highest taxa diversity and the highest abundance of polychaetes, in contrast to the eastern region with the least number of taxa and abundance. *Heteromastus filiformis* was encountered in significant numbers at all sites, but its highest contribution was found in the west samples. Sites within 100m of the outfall were characterised by a high contribution of the spionid polychaete *Prionospio aucklandica* and *Diopatra akarana.* The benthic composition in the north and east of the outfall showed similarities with high contribution of *Heteromastus* and *Cossura consimilis*.

Despite a low relationship between contaminant levels and the distribution of the biota communities, *Diopatra* was present at sites with the highest levels of contaminants, i.e. near the outfall and on the southern transect up to 250m, suggesting a link between that species and pollution levels. However, no literature reference was found to corroborate that hypothesis.

When compared with the 2012 dataset, large differences in benthic assemblages and diversity indices were obvious. The mean number of taxa identified in 2023 and mean abundance were six times lower and 10 times lower respectively than that found in 2012. Also, a significant proportion of the infauna assemblage in 2012 consisted of molluscs, a rare find in the 2023 survey. The major differences observed between the surveys in 2012 and 2023 could be explained by a methodology bias (different sampler), a change in the sediment texture (mud content higher in 2023), a natural seasonal variation (autumn in 2012 versus summer in 2023), or a combination of all the above. The differences are most likely explained by the differences in sediment grain size composition and minor difference in sampling season.

1. INTRODUCTION

1.1 Background

Hastings District Council (HDC) holds a resource consent to discharge treated wastewater into Hawke Bay. The current resource consent CD130214W allows the discharge of sewage and industrial wastewater from part of the Hastings District (including Hastings City, Havelock North and various industrial areas) into Hawke Bay at a maximum rate of 2,800 L/s via a 2,750m long outfall. The combined sewage and wastewater flow passes through a screening plant located at 284 Richmond Road, East Clive, before being pumped to the outfall. The screening plant comprises a milli-screen, removing material with dimensions greater than 1 mm, with a biological trickling filter providing additional treatment along the Papatuanuku Channel prior to wastewater entering the Clive Outfall pipe.

Wastewater from the Hastings area has been discharged into the sea between the Tukituki and Clive Rivers in Hawke Bay for much of the last century. Following extensions to the sewer system in 1960, effluent was discharged some 50m from the shore. The outfall consisted of a 175 cm diameter, open-ended pipe discharging (in 1973) 1,614 L/s of effluent (Knox & Fenwick 1981).

In 1981, the present long outfall was constructed and is still in use today. The 2,750m long outfall lies between the mouths of the Ngaruroro and Tukituki rivers and discharges at a depth of approximately 13 m. The seafloor slopes steadily out from the shore to the outfall and for over about one-third of its length, the outfall is buried 1 m beneath the seabed. Discharge of wastewater occurs between 2,450m and 2,750m from the shoreline via a 300m long diffuser. The diffuser has 100 ports – of these, 52 are routinely open.

Wastewater discharges have the potential to affect benthic communities through:

- the organic enrichment of sediments that increases diversity and abundance of benthic infauna (low levels of enrichment) or reduces diversity and abundance (high levels of enrichment)
- altering the benthic light regime with increasing water turbidity due to particulate substances in wastewater
- the effects of toxic contaminants

To assess the extent of potential effects highlighted above, monitoring of benthic communities affected by wastewater outfalls involves the measurement of:

- **sediment quality parameters**—grain size, total organic carbon, total volatile solids;
- **toxic contaminants**—heavy metals, and
- **benthic infauna**—abundance and diversity of animals that live in the sediment.

Condition 18 of the coastal permit stated that benthic surveys "shall include an assessment of marine sediments, benthic ecology and trace metals in flatfish (comparable to that carried out by Golders Associates in 2012 and 2013) and shall be undertaken in the 8th, 17th and 26th years after the commencement date of this Resource Consent". Hastings District Council engaged Bioresearches in December 2022 to conduct the benthic survey in January/February 2023, representing the 8th year since the start of the current consent.

This report presents the results of the environmental monitoring carried out in January 2023. The methodology matched the 2012 survey from Golder Associates.

1.2 Variation to the project: flatfish survey postponed

The benthic survey was planned into two phases: sampling of sediment samples in January 2023 followed by sampling of flatfish in February 2023. However, extreme weather conditions end of January until the second week of February impeded fish to be collected in Hawke Bay. Cyclone Gabrielle hit the North Island the 12th of February. The Hawke's Bay catchment and coastal environment were highly impacted by the resulting flooding. Moreover, flatfish fishery was closed for an undetermined period due to large debris accumulating on the seafloor. It was decided after discussion with Hastings District Council to postpone the fish survey to February 2024 to assess effects under normal WWTP operating conditions.

1.3 Previous environmental surveys

Under the previous consent CD990260Wc, Hastings District Council has undertaken environmental surveys around the Clive outfall in 2002, 2006 and 2012. Sediment samples were collected along a north-to-south transect parallel to the shore, and a west-to-east transect, both transects intersecting in the midpoint of the outfall diffuser. The methodology for the 2012 survey was the result of refinements overtime but kept a similar approach to that used in the 2002 and 2006 surveys. For each section of the present report, data collected in January 2023 were compared to that of previous surveys, sourced from Golder Associates report (2013).

In addition to these environmental surveys, Hastings District Council samples twice a year seabed sediment for quality testing at distances 250m, 500m, 750m to the north and 250m, 500m, and 750m to the south of the midpoint of the outfall diffuser. Metals tested are Zinc, Arsenic, Cadmium, Chromium, Copper, Selenium, Nickel, Lead, and Mercury. Results were not provided to Bioresearches for this project, therefore were not discussed in this report.

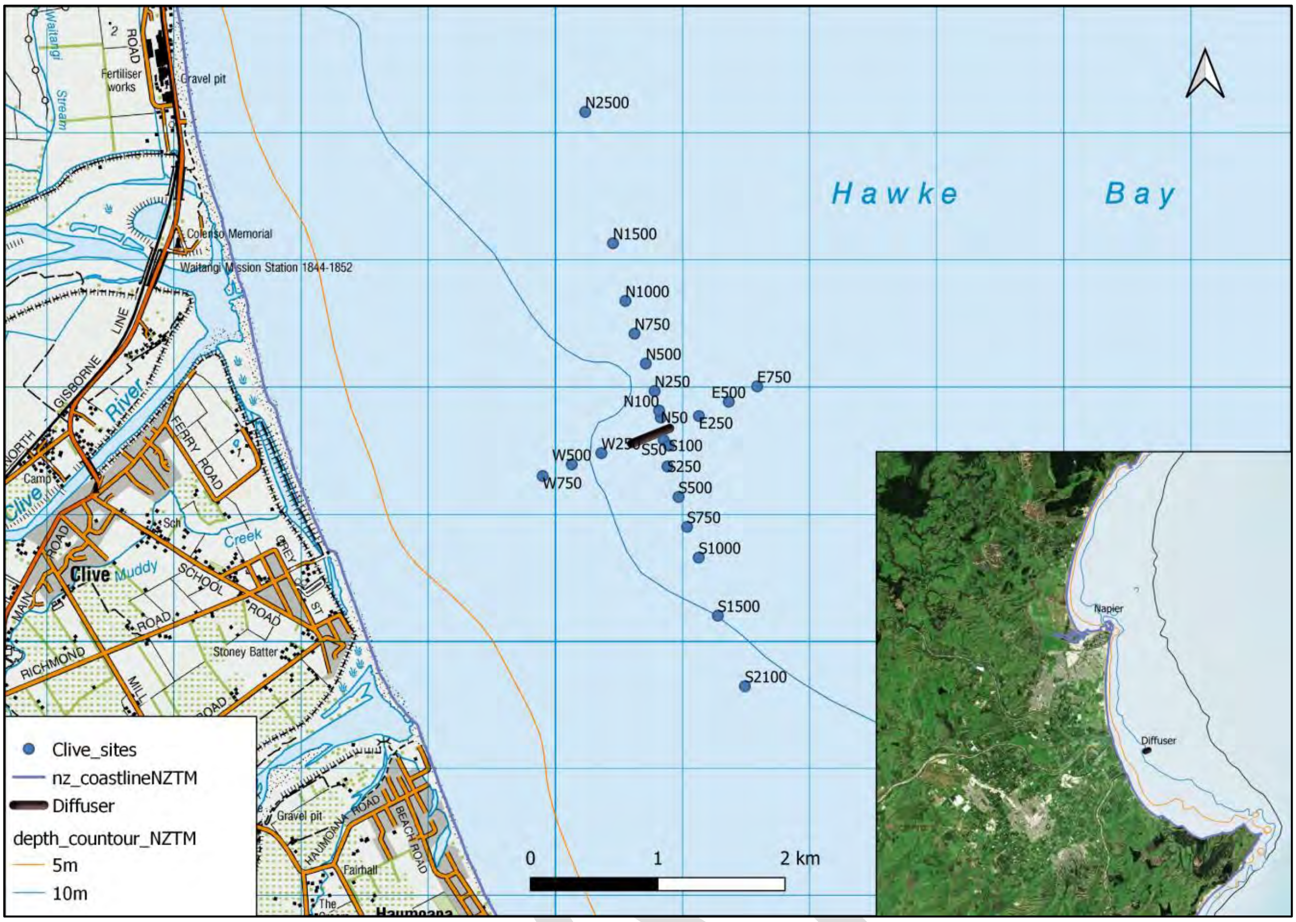

Figure 1.1 Map of Hawke Bay with the outfall diffuser and sediment sampling sites.

2. SEDIMENT QUALITY MONITORING

2.1 Sediment quality methodology

2.1.1 Sampling methodology

In January 2023, eighteen sites located along two transects were sampled for sediment (Figure 1.1). The first transect ran parallel to the shore on the same depth contour as the centre point of the outfall diffuser, at distances of 50, 100, 250, 500, and 2,500 m to the NNW (referred hereafter as "north") and at distances of 50, 100, 250, 500, 750, 1,000, 1,500 and 2,100 m SSE (referred hereafter as "south"). The second transect ran inshore from the diffuser at distances of 250 and 500 m inshore ("west") and 250, 500 and 750 m offshore from the diffuser ("east"). These sites are the same as sampled during the 2012 survey and coordinates are listed in Appendix 1.

Golder Associates (2013) used a Standard Ponar grab sampler. This equipment was not available prior to fieldwork and was replaced by a Petite Ponar grab sampler. The Petite Ponar has a maximum volume capacity of 2.4 L compared to a maximum capacity of 8.2 L for the Standard Ponar. To compensate for a smaller grab volume, two Petite Ponar grabs were used to replace one Standard Ponar grab, or repeated until approximately 600mL made by 5 sediment cores of 50mm diameter to 50mm depth was achieved, to represent one replicate, as stated in Golder Associates 2012 survey.

At each site, three replicate samples for sediment quality were collected from a boat, with each replicate consisting of approximately 600mL of sediment. The sediment was thoroughly mixed and a sub-sample of approximately 400ml was retained and analysed for sediment chemistry, while a second subsample of approximately 100ml was retained and analysed for particle size. The sub samples were collected with an inert plastic scoop into a zip lock plastic bag. All samples were kept cool after collection and were chilled on return to the shore.

2.1.2 Aluminium normalisation

To assess the anthropogenic effects from a potential pollution source such as a WWTP outfall, understanding the importance of natural variability is fundamental to differentiate contaminants originating from natural processes and contaminants originating from anthropogenic processes.

Contaminant loads in sediment are highly dependent on the grain size distribution and the geological origin of the substrate (Clark *et al.* 2008). Normalisation of contaminant concentrations allows to compensate for some natural processes and gives a better visibility of anthropogenic effects. There are two types of normalisations: granulometric and geochemical types (Clark *et al.* 2008, Ho *et al.* 2012).

For the granulometry approach, the finer fraction is separated, generally mud, prior to chemical analysis. It however does not take into account the full metal variability by natural processes.

For the geochemical approach, metal concentrations are normalised by a conservative element such as aluminium. The conditions for a normalizer are that it is insensitive to anthropogenic inputs, it is stable, and it is not subject to environmental influences. In the 2012 study, Golder Associates reviewed the normalisation by aluminium and concluded it was a good candidate for a normaliser in Hawke Bay in order to minimise the confounding effects of natural processes on the contaminant concentrations.

The 2012 survey used a granulometry approach by analysing metal concentrations (total recoverable) on the mud fraction only (<63µm), and a geochemical approach by normalising contaminant concentrations by aluminium concentrations. The same approach was followed with the analysis of the 2023 samples.

2.1.3 Analytical procedures

Sediment samples were sent to Hill Laboratories for sediment texture analyses by wet sieving samples through 2mm and 63µm mesh sieves. This method partitioned sediments into gravel (>2mm), sand (≤2mm, >63µm), and silt and clay (≤63µm, referred hereafter as "mud") fractions. Each fraction was dried to constant weight at 60°C and the percentage of each fraction was calculated on a dry weight basis. Coarser fractions (gravels and sands) were also inspected for the presence of man-made objects.

Hill laboratories conducted organic testing on a sediment sub-sample sieved to <2mm for the purposes of total volatile solids (TVS) and total organic carbon (TOC) analyses.

Another sub-sample was wet-sieved to <63µm and then digested in aqua regia (hydrochloric and nitric acids) for the analysis of nine elements by ICP-MS: Aluminium (Al), Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), Zinc (Zn). Results were compared with the 2018 ANZECC sediment quality guidelines. The Australian and New Zealand guidelines presented in ANZECC (2000) were revised in 2013 (Simpson *et al.* 2013) and updated in 2018 (ANZG 2018).

2.1.4 Statistical procedures

Statistical differences on percentages are commonly tested with a chi-square test of homogeneity. This is however not recommended with a small sample size, therefore no statistical test was run on the grain size percentages. Instead, notable percentage differences between sites were visually assessed from the figures. A similar approach was conducted with TVS and TOC. Standard errors were reported with the means and were noted "se".

Arsenic and metal concentrations between sites for the 2023 survey were compared using two sets of data: raw data, and aluminium (Al)-normalised data. Before being used as a normaliser, aluminium concentrations were assessed visually between sites for the degree of "major element stability" in the area. Then, correlations between this major element and the other trace elements were explored. These diagnostics on aluminium allowed to determine its suitability as a normaliser. The Draftsman plot function on PRIMER PRIMER 7 (PRIMER-e, Quest Research Ltd) was used to plot Aluminium data against the other elements and to calculate Pearson correlation coefficients between all pairs. Al-normalised data were obtained by dividing arsenic and metals by aluminium and by multiplying this ratio by 10000. The multiplying factor allowed to visualize both data sets (raw data and Al-norm. data) on the same scale on the figures.

An exploratory analysis was performed with a Principal Component Analysis (PCA) on PRIMER 7 (PRIMER-e, Quest Research Ltd). It allowed to visualise in a multivariable space (all contaminants at once) the similarity between sites based on the concentration of metals/metalloids (environmental variables).

Al-normalised metal/metalloid concentrations were compared between distances from the outfall with Kruskal-Wallis tests, as the data sets did not follow normal distributions. Kruskal-Wallis tests were followed by pairwise comparison Dunn's tests when the null hypothesis was rejected. All univariate tests were performed in R (version R 4.3.0, R Core Team 2023) with an alpha value of 0.05. The Al-normalised concentrations were assigned an "Al" symbol after the concentration unit "mg/kg" to avoid confusion with raw data.

2.2 Grain size

Three replicates of sediment for each of the 18 sites around the outfall were collected for grain size. The grain size percentages are summarised in Table 2.1 and compared visually between sites in Figure 2.2. Raw results are available in Appendix 2.

Overall, the percentage of mud was high, representing more than 70% of the total weight in each site (Table 2.1). Most sites did not contain any gravel. Two south sites were notable exceptions with the gravel portion weighing 7% and 10% of the total at S100 and S50 respectively.

On the south transect, the mud content increased with distance from the outfall, from 72% at S50 to 91% at S1000, but decreased by 5 % further away (Figure 2.2, Table 2.1). On the north transect, a same trend was visible with mud content increasing from 81% at N50 to 95% at N250.

On the west-east axis, the closest sites from the outfall diffuser are 250m away in each direction. On the east transect, grain size profiles were very similar from a site to another with an elevated mud proportion (96%). The west transect, with two sites only at 250m and 500m from the outfall, presented the least mud percentages at these distances (Figure 2.2).

During the last survey conducted by Golder Associates (2013), most of the sites showed significantly less mud in the grain size compositions than that found in January 2023 (Figure 2.2). The 2012 grain size profiles were in fact lower than the surveys in 2006 and before (Golder Associates 2013, see figure 2). The mud proportions found in January 2023 matched the grain size profiles found in surveys prior to 2012.

Table 2.1 Grain size summary percentages by weight (mean from 3 replicates) – January 2023

Transect	Site	Gravel (>2mm)	Sand (< 2mm - >63 µm)	Mud (<63 µm)
NORTH	N50	< 0.1	19.4	80.5
	N100	< 0.1	11.5	88.5
	N250	< 0.1	4.2	95.2
	N500	0.4	13.1	86.6
	N2500	< 0.1	6.3	93.7
SOUTH	S50	12.5	15.8	71.7
	S100	7.4	19.5	73.1
	S250	1.8	11.9	86.2
	S500	0.4	14.4	85.3
	S750	0.7	9.2	90.1
	S1000	0.6	8.6	90.8
	S1500	< 0.1	14.9	85.0
	S2100	0.2	12.9	86.9
EAST	E250	< 0.1	3.8	96.2
	E500	< 0.1	3.3	96.7
	E750	< 0.1	3.3	96.6
WEST	W250	< 0.1	25.2	74.6
	W500	0.5	30.5	69.2

Input of fine sediments from the catchments surrounding Hawke's Bay is a key stressor for the regional coastal ecosystem. Large river systems from Tukituki, Ngaruroro and Tūtaekurī rivers greatly influence the sediment dynamics in the Bay after heavy rainfall events. In the State of the Environment document for Hawke's Bay (2022), it was reported that the Waitangi estuary (common mouth of Tūtaekurī, Ngaruroro and Clive rivers) showed a shift from sandy to muddy sediments, reflecting the land-based inputs. These muddy sediments are flushed to the Bay during floods, such as in November 2020 for which the extent of sediment transport from the rivers was captured by satellite imagery (Figure 2.1). The sampling locations around the outfall are situated in front of the coastline delimited by the Waitangi estuary in the north and by the Tukituki mouth in the south (Figure 1.1). This surveyed area is the first to be impacted by the material transported by the river flows. In the long term, river systems combined with the tidal currents are likely to have a higher influence on the sediment texture distribution of the coastal area than the outfall wastewater.

Figure 2.1 Satellite imagery of the south of Hawke Bay (Napier to Cape Kidnappers) before and after the flood in November 2020. Sourced from SOP (2022)

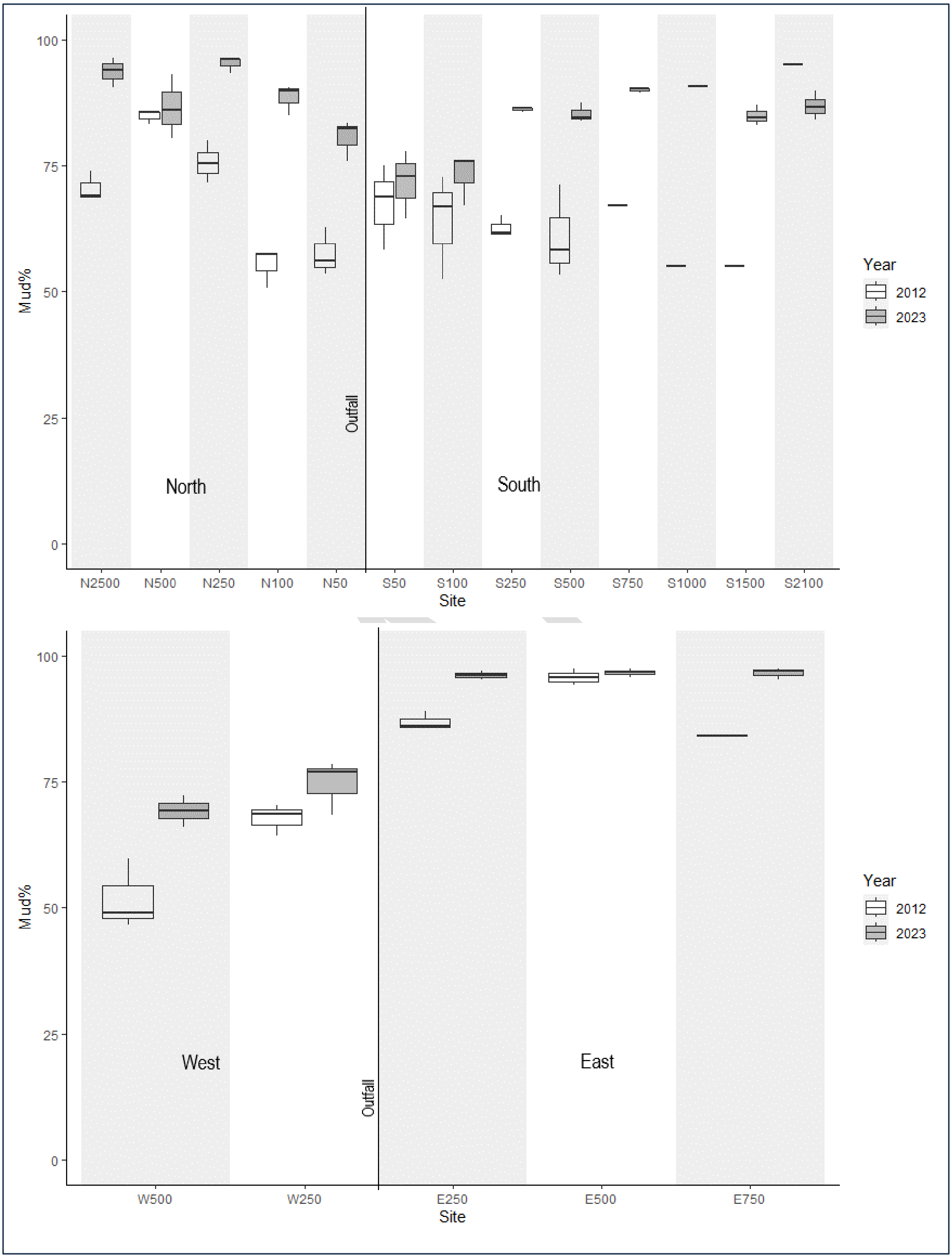

Figure 2.2 Comparison of mud percentages (boxplots) between sites around the outfall diffuser.

2.3 Organic content

Treated wastewater contains particulate matter with high organic content, thus sedimentation of that matter on the seabed increases the organic content of sediments. Organic content was tested with two parameters: Total Volatile Solids (TVS) and Total Organic Carbon (TOC). As they were highly correlated between each other (Figure A3.1 in Appendix 3), they are analysed together. Mean results are displayed in Table 2.2.

The mud proportion of the sediment did not show an influence on TOC or TVS, therefore a normalisation to mud content was not necessary to compare sites (Figure A3.2 in Appendix 3).

Table 2.2 Means (± se) of Total Organic Carbon (% dry weight) and Total Volatile Solids (% dry weight) – January 2023

Transect	Site	TOC (% dw)	TVS (% dw)
NORTH	N50	0.87 ± 0.21	5 ± 0.4
	N100	0.74 ± 0.01	4.9 ± 0.1
	N250	0.77 ± 0.01	4.7 ± 0.1
	N500	0.58 ± 0.09	4.5 ± 0.2
	N2500	1.15 ± 0.05	5.8 ± 0
SOUTH	S50	1.5 ± 0.14	5.9 ± 0
	S100	1.05 ± 0.14	5.5 ± 0.3
	S250	0.98 ± 0.06	4.9 ± 0
	S500	0.63 ± 0.02	4.4 ± 0
	S750	0.66 ± 0.07	5.1 ± 0.1
	S1000	0.73 ± 0.05	5.2 ± 0
	S1500	0.63 ± 0.06	4.4 ± 0.2
	S2100	0.46 ± 0.07	4.1 ± 0.2
EAST	E250	0.76 ± 0.07	4.8 ± 0.2
	E500	0.93 ± 0.03	5.3 ± 0.1
	E750	0.87 ± 0.03	4.7 ± 0.2
WEST	W250	0.73 ± 0.06	4.3 ± 0.1
	W500	0.67 ± 0.02	4.1 ± 0

Along the north transect, there was no trend of TVS or TOC percentages with distance from the outfall. The site with the highest percentages of organic content was N2500, while the site with the lowest percentages was N500 (Figure 2.3). Along the south transect, organic content showed a decrease with distance with the highest values close to the outfall diffuser (S50) and the lowest values at the site at 2100m away (Figure 2.3).

Looking at the west-east axis, distance from the outfall did not show any pattern (Table 2.2). E500 gave high organic values while the contents of W500 replicates were in the lowest range.

The values of TOC and TVS are in general higher than the 2012 survey but lower than the 2006 survey. The exception to that pattern is for the west sites where the 2023 survey gave the highest values for both TVS and TOC (Figure A3.3 and Figure A3.4 in Appendix 3).

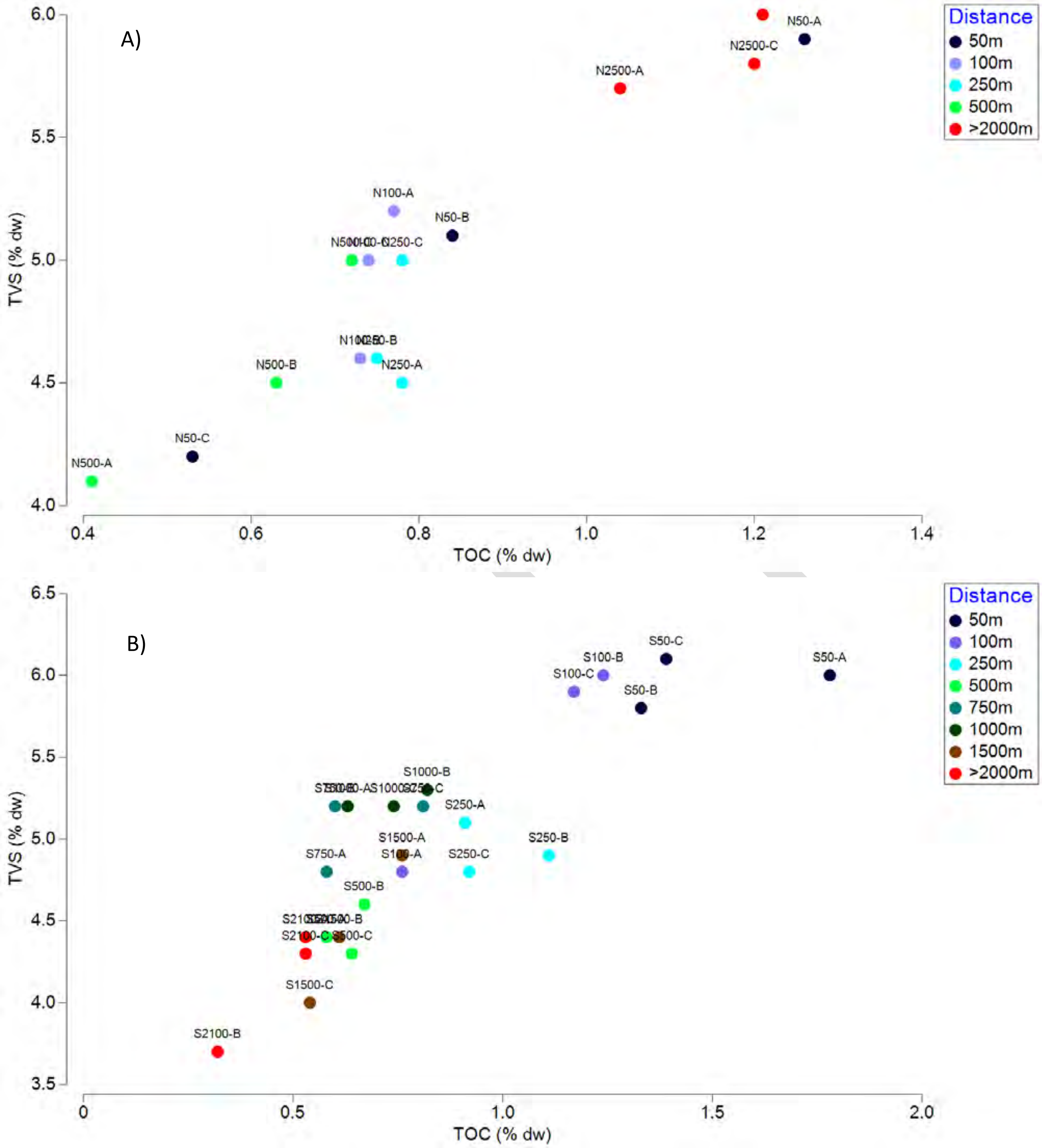

Figure 2.3 TOC and TVS variation in relation to sites along the north transect (A) and the south transect (B)

The south transect was the only transect with a visible gradient with distance, from high organic content 50m south of the outfall to lower organic content further away. Metocean and Cawthron (2010) modelled the dynamic of particles from the outfall into the Bay. It showed modelled particles going predominately south, highlighting a dominant north to south current parallel to the shore in that part of Hawke Bay (see figures 30 and 31 in Golder Associates 2013).

The fact that N2500 had high organic content suggests that other factors are at play in the distribution of particulate matter in the Bay.

2.4 Metal and metalloids

2.4.1 Aluminium

From the Draftsman plot with PRIMER (not represented), there were good correlations between aluminium and arsenic, copper, lead, nickel and zinc. Cadmium, chromium and mercury were not correlated with aluminium due to highly skewed distributions.

In 2023, aluminium showed lower concentrations in sediment near the outfall (50m) than at sites further away (Figure 2.4) (Kruskal-Wallis test with Tukey tests in Appendix 4). Sites beyond 50m from the outfall showed no statistical differences between each other in 2023. When compared with the three previous studies, concentrations in 2023 were within similar ranges, with the exception of sites S1500 and W500 for which the 2023 concentrations were higher (Figure 2.4).

Overall, aluminium seemed to be a good candidate to act as normaliser and to buffer variation due to geochemical processes.

2.4.2 Overall contaminant pattern

Raw concentrations of arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc are reported in Appendix 2. The PCAs integrated the variation of the seven heavy metals plus arsenic in a multivariate space. The north-south sites and the west-east sites were analysed separately, and for each group of samples, a PCA was run on raw data, and another one on the aluminium normalised data. To minimise the number of figures in the core of the report, only PCAs for the north-south sites were represented in Figure 2.5. The west-east PCAs are presented in Appendix 5 (Figure A5.5).

With raw contaminant concentrations, the north-south PCA showed a clear segregation on PC1 between the group N50, S50, S100 and the other sites further away from the outfall (Figure 2.5). The 50m sites were highly correlated with mercury, chromium and cadmium. S1000 replicates were distinct from the rest on PC2 with a negative correlation to contaminant loads. When data were normalised with aluminium, the sites closest to the outfall were even more segregated from the rest of the samples.

On the west-east axis, the PCA on the raw data did not reveal any contaminant pattern with distance. The site W500 was positively correlated to the contaminant loads (Figure A5.5 in Appendix 5). However, that trend disappeared with Al-normalised data.

This general trend over all contaminants was assessed at a finer scale by looking at each contaminant separately.

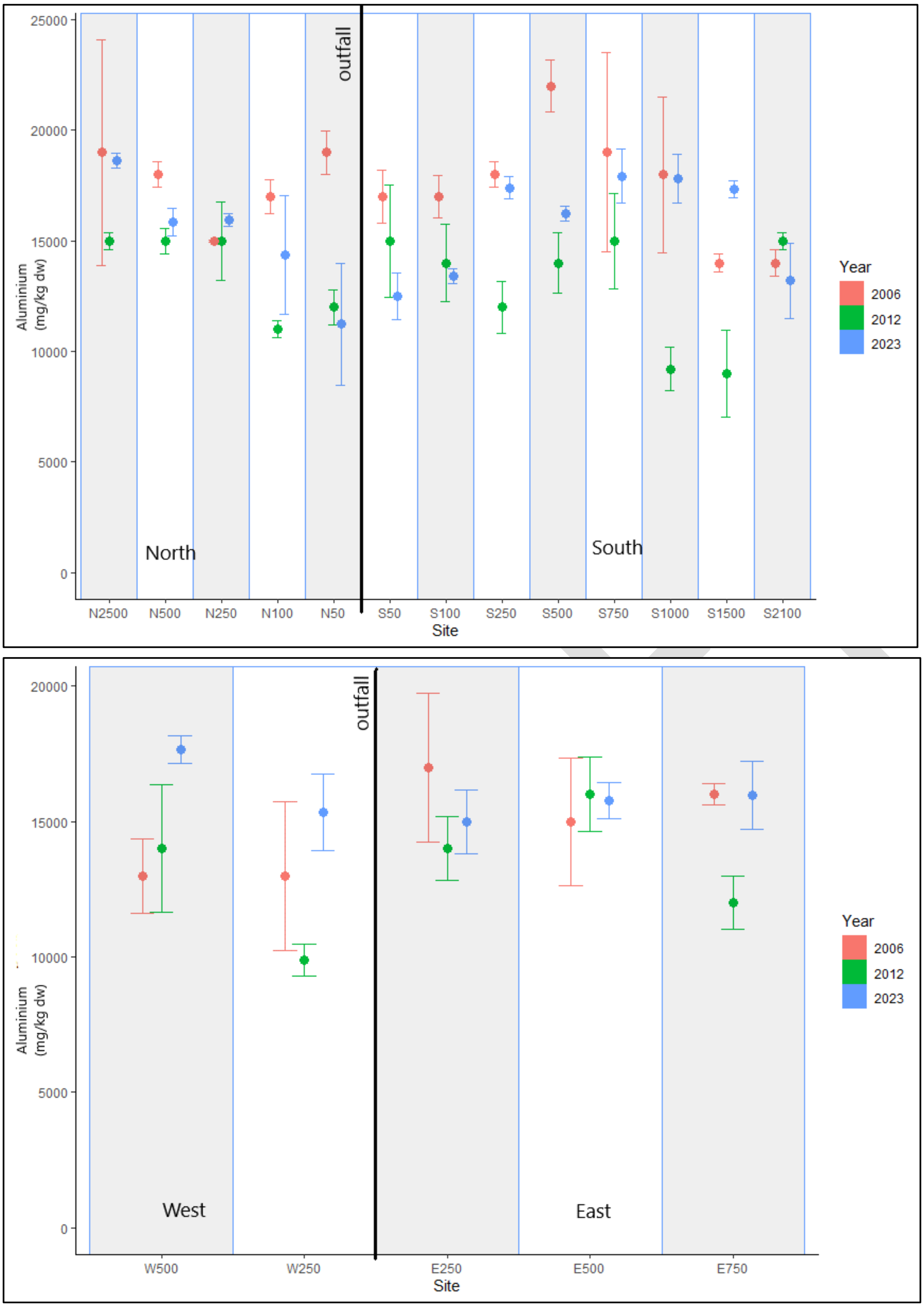

Figure 2.4 Aluminium concentrations (mean mg/kg dry weight ± 95%CI) at each site

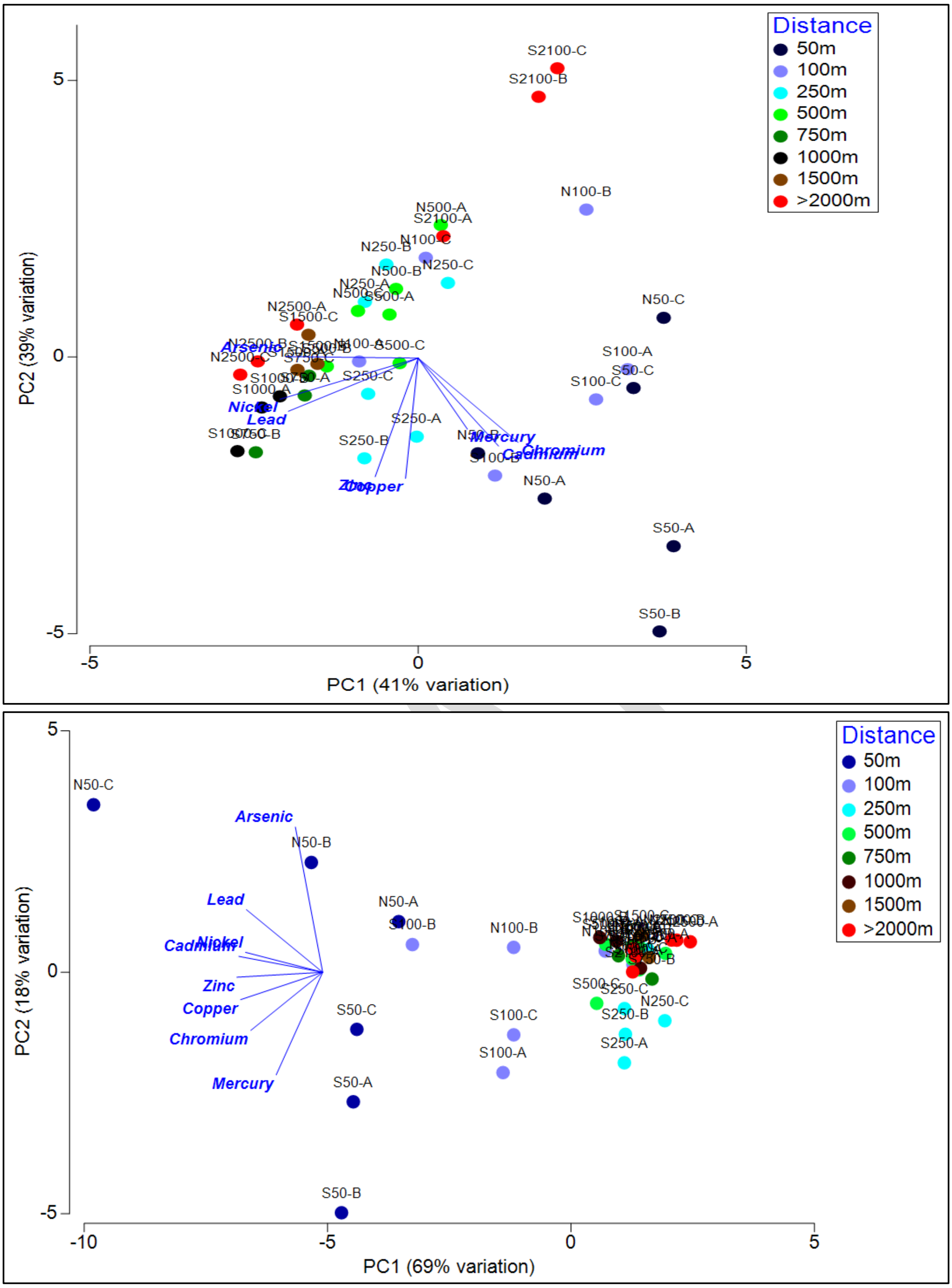

Figure 2.5 Principal Component Analyses based on metal/metalloid concentrations along the north-south sampling axis. Top: PCA with raw data; bottom: PCA with Al-normalised data

2.4.3 Arsenic

All arsenic concentrations recorded in sediments around the Clive outfall were lower than the ANZG 2018 DGV of 20 mg/kg dry weight.

Looking at Al-normalised data, there was no statistical difference between distances (H=2.034, p=0.958; Appendix 4), but at a finer scale, arsenic on each site of the outfall diffuser (100m apart) have different concentrations with N50 enriched at 5 mg/kgAl, and S50 depleted at 3 mg/kgAl (mean values across sites at 4 mg/kgAl) (Figure 2.6). There was no indication that the outfall effluent could have an influence on the 2023 concentrations.

Raw data from 2023 were compared with the previous surveys conducted by Golder Associates (Appendix 5 Figure A5.6). The concentrations recorded in 2023 were closer to those recorded during the 2006 survey than those recorded during the 2012 survey. Most sites had similar concentrations over time except S50, S250, and S500 where the 2023 survey recorded significantly less arsenic than measured before.

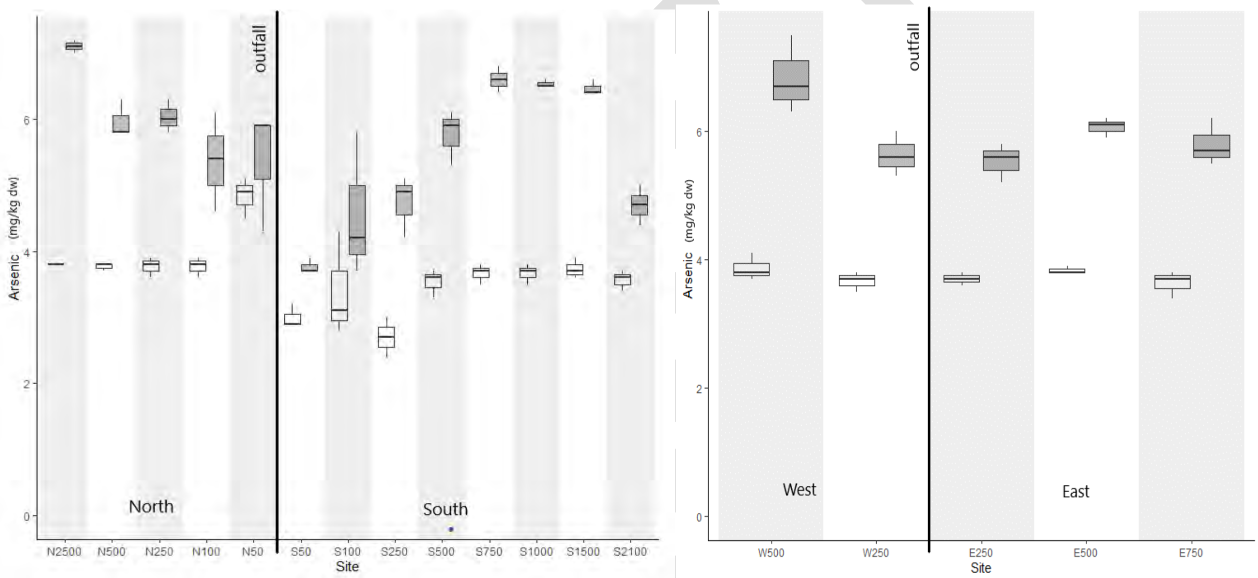

Figure 2.6 Arsenic concentrations (mg/kg dry weight) for each site. Grey boxplot = raw data, white boxplot = Al-normalised data.

2.4.4 Cadmium

All cadmium concentrations recorded in sediments around the Clive outfall were lower than the ANZG 2018 DGV of 1.5 mg/kg dry weight.

Looking at Al-normalised data, a Kruskal-Wallis test gave a significant difference between the north-south sites at different distances (H = 26.082, p<0.001; Appendix 4). N50 (0.08 mg/kgAl) had the highest concentration of cadmium followed by S50, both significantly higher than concentrations found at 250m or further (mean values of 0.03 mg/kgAl) (Figure 2.7). The decreasing gradient of cadmium concentrations with distance from the outfall in the south could indicate an effect from the outfall effluent.

Raw data from 2023 were compared with the previous surveys conducted by Golder Associates (Appendix 5 Figure A5.7). The concentrations recorded in 2023 were similar to those of the 2012 survey for most sites. N50, S50, and W250 however were more enriched with cadmium in 2023 than in 2012. The trend of cadmium with distance found in 2023 was consistent with the findings of the 2012 survey.

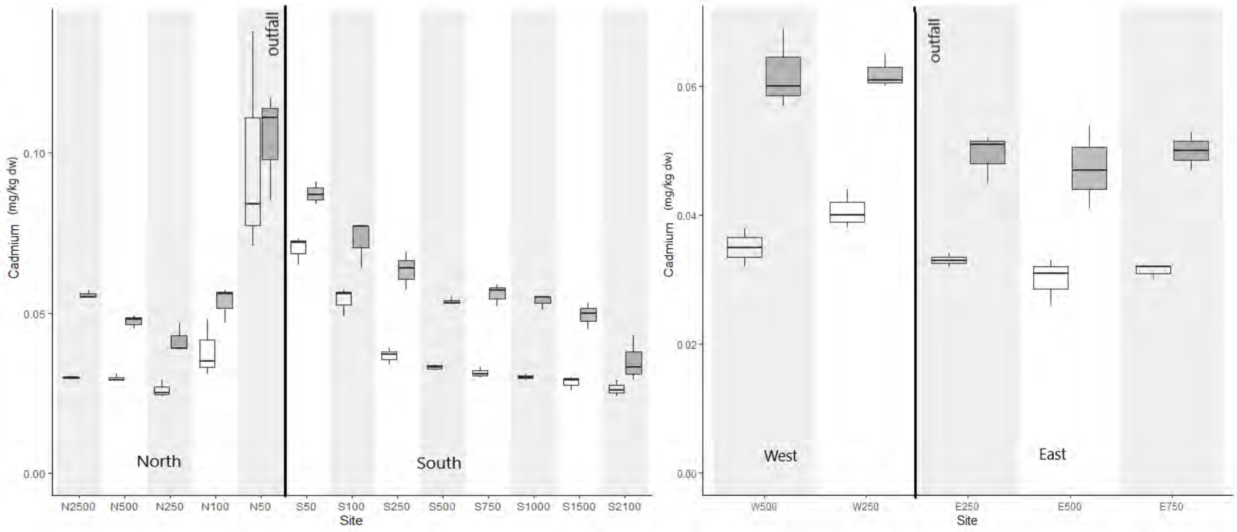

Figure 2.7 Cadmium concentrations (mg/kg dry weight) for each site. Grey boxplot = raw data, white boxplot = Al-normalised data.

2.4.5 Chromium

All chromium concentrations recorded in sediments around the Clive outfall were lower than the ANZG 2018 DGV of 80 mg/kg dry weight.

Looking at Al-normalised data, a Kruskal-Wallis test gave a significant difference between the north-south sites at different distances (H = 24.097, p=0.001, Appendix 4). Both N50 and S50 were enriched in chromium (~29 mg/kgAl) and showed significantly higher concentrations than that found at distances further than 100m (mean values of 10 mg/kgAl) (Figure 2.8). The decreasing gradient of chromium concentrations with distance from the outfall in the north and south could indicate an effect from the outfall effluent.

Raw data from 2023 were compared with the previous surveys conducted by Golder Associates (Appendix 5 Figure A5.8). The concentrations recorded in 2023 had similar concentrations to those of the 2012 survey for the south and west sites, while lower chromium loads were detected in the north and east transects. The trend of chromium with distance found in 2023 was consistent with the findings of the 2012 survey.

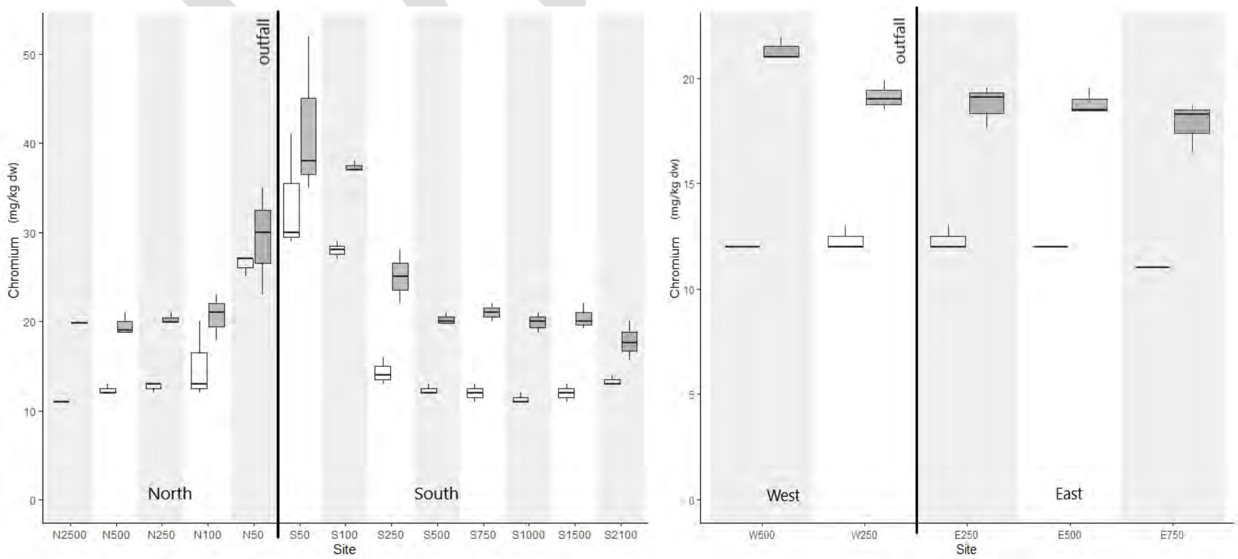

Figure 2.8 Chromium concentrations (mg/kg dry weight) for each site. Grey boxplot = raw data, white boxplot = Al-normalised data.

2.4.6 Copper

All copper concentrations recorded in sediments around the Clive outfall were lower than the ANZG 2018 DGV of 65 mg/kg dry weight.

Looking at Al-normalised data, a Kruskal-Wallis test gave a significant difference between the north-south sites at different distances (H = 28.576, p<0.001, Appendix 4). Both N50 and S50 were enriched in copper (~12 mg/kgAl) and showed significantly higher concentrations than that found at distances further than 250m (mean values of 8 mg/kgAl) (Figure 2.9). The decreasing gradient of copper concentrations with distance from the outfall in the north and south could indicate an effect from the outfall effluent.

Raw data from 2023 were compared with the previous surveys conducted by Golder Associates (Appendix 5 Figure A5.9). Overall, concentrations recorded in 2023 were between those found in the 2006 survey and those found in the 2012 survey. The trend of copper with distance found in 2023 was consistent with the findings of the 2012 survey.

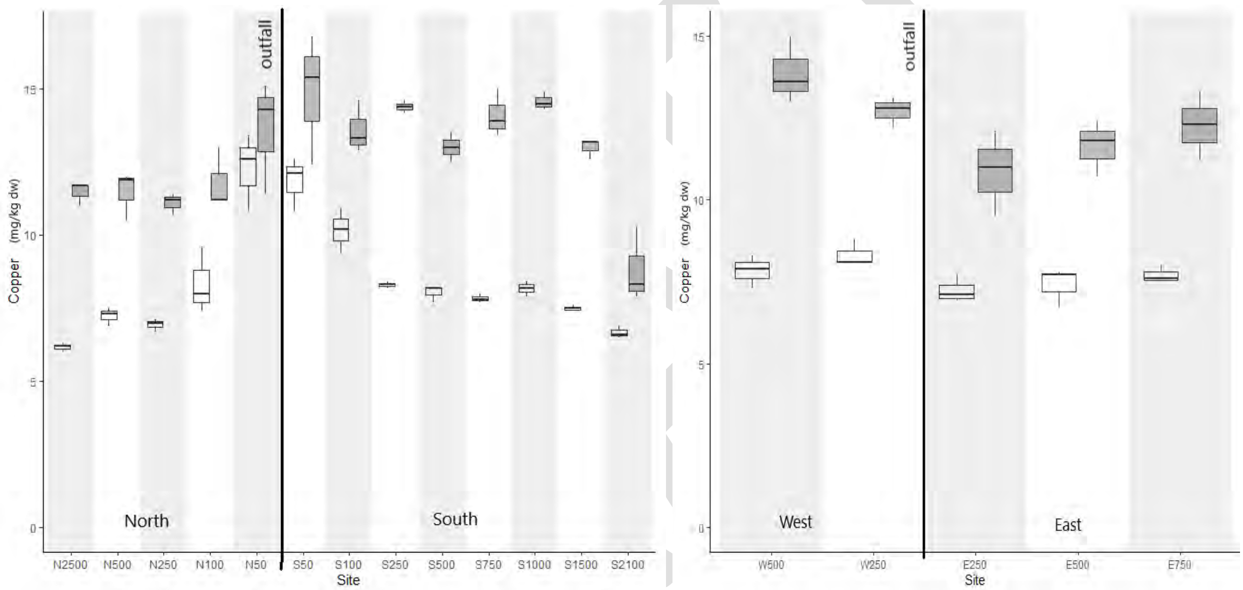

Figure 2.9 Copper concentrations (mg/kg dry weight) for each site. Grey boxplot = raw data, white boxplot = Al-normalised data.

2.4.7 Lead

All lead concentrations recorded in sediments around the Clive outfall were lower than the ANZG 2018 DGV of 50 mg/kg dry weight.

Looking at Al-normalised data, a Kruskal-Wallis test gave a significant difference between the north-south sites at different distances (H = 26.459, p<0.001, Appendix 4). N50 was enriched in lead (12 mg/kgAl) and showed significantly higher concentrations than that found at distances further than 250m (mean values of 8 mg/kgAl) (Figure 2.10). The decreasing gradient of lead concentrations with distance from the outfall in the north and south could indicate an effect from the outfall effluent.

Raw data from 2023 were compared with the previous surveys conducted by Golder Associates (Appendix 5 Figure A5.10). Overall, the concentrations recorded in 2023 were between those found in the 2006 survey and those found in the 2012 survey.

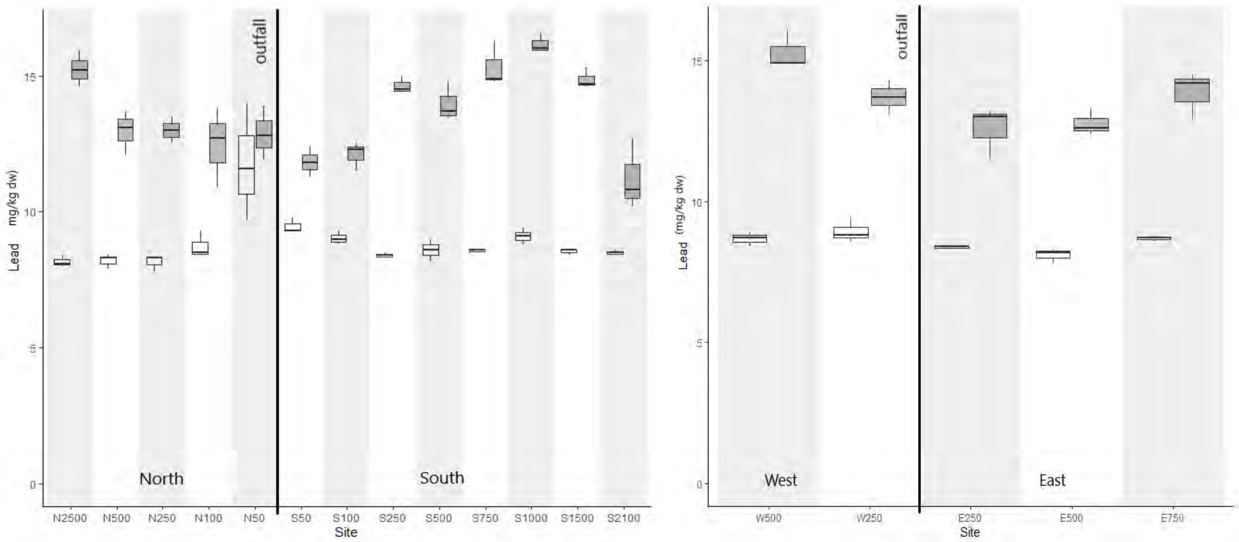

Figure 2.10 Lead concentrations (mg/kg dry weight) for each site. Grey boxplot = raw data, white boxplot = Al-normalised data.

2.4.8 Mercury

Mercury concentrations recorded in sediments around the Clive outfall were lower than the ANZG 2018 DGV of 0.15 mg/kg dry weight, except at the site S50 with a replicate at 0.48 mg/kg and at the site N250 with a replicate at 0.23 mg/kg (Table A2.2 in Appendix 2).

Looking at Al-normalised data, a Kruskal-Wallis test gave a significant difference between the north-south sites at different distances ($H = 24.552$, $p<0.001$, Appendix 4). S50 was enriched in mercury (0.12 mg/kgAl) and showed significantly higher concentrations than that found at distances further than 250m (mean values of 0.05 mg/kgAl) (Figure 2.11). The decreasing gradient of mercury concentrations with distance from the outfall in the north and south could indicate an effect from the outfall effluent.

Raw data from 2023 were compared with the previous surveys conducted by Golder Associates (Appendix 5 Figure A5.11). The concentrations recorded in 2023 were similar to previous surveys. A notable exception is the high load of mercury in one sample at S50, four times higher than the other replicates sampled at the same site.

2.4.9 Nickel

All Nickel concentrations recorded in sediments around the Clive outfall were lower than the ANZG 2018 DGV of 21 mg/kg dry weight.

Looking at Al-normalised data, a Kruskal-Wallis test gave a significant difference between the north-south sites at different distances ($H = 19.243$, $p=0.007$; Appendix 4). Both N50 and S50 were enriched in nickel (~10 mg/kgAl) and showed significantly higher concentrations than that found at distances further than 250m (mean values of 8 mg/kgAl) (Figure 2.12). The decreasing gradient of nickel concentrations with distance from the outfall in the north and south could indicate an effect from the outfall effluent.

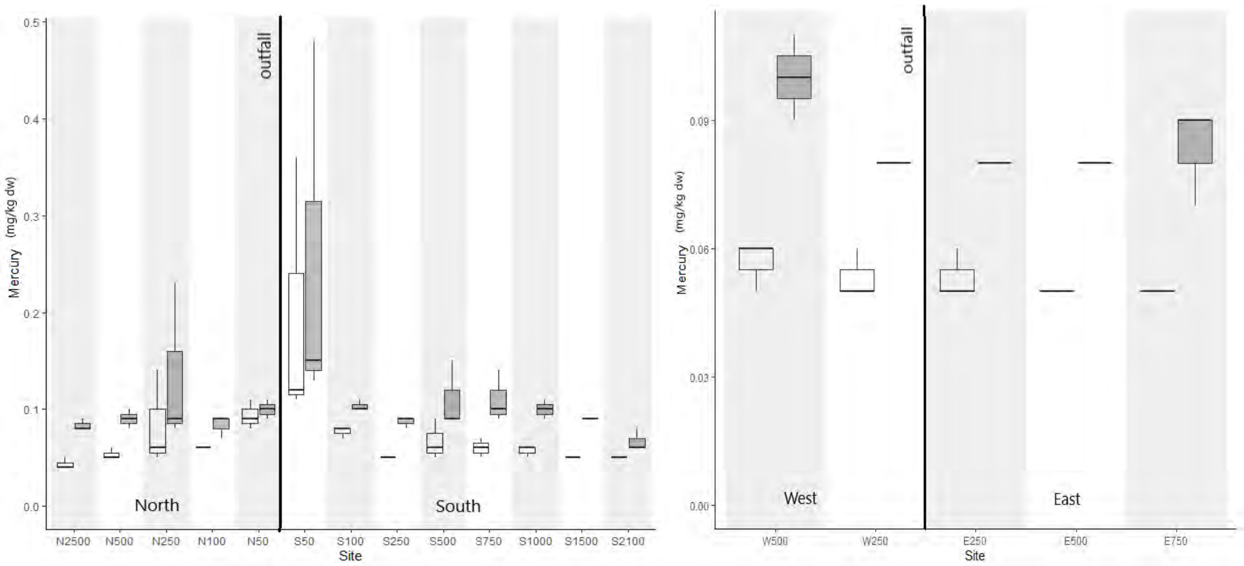

Figure 2.11 Mercury concentrations (mg/kg dry weight) for each site. Grey boxplot = raw data, white boxplot = Al-normalised data.

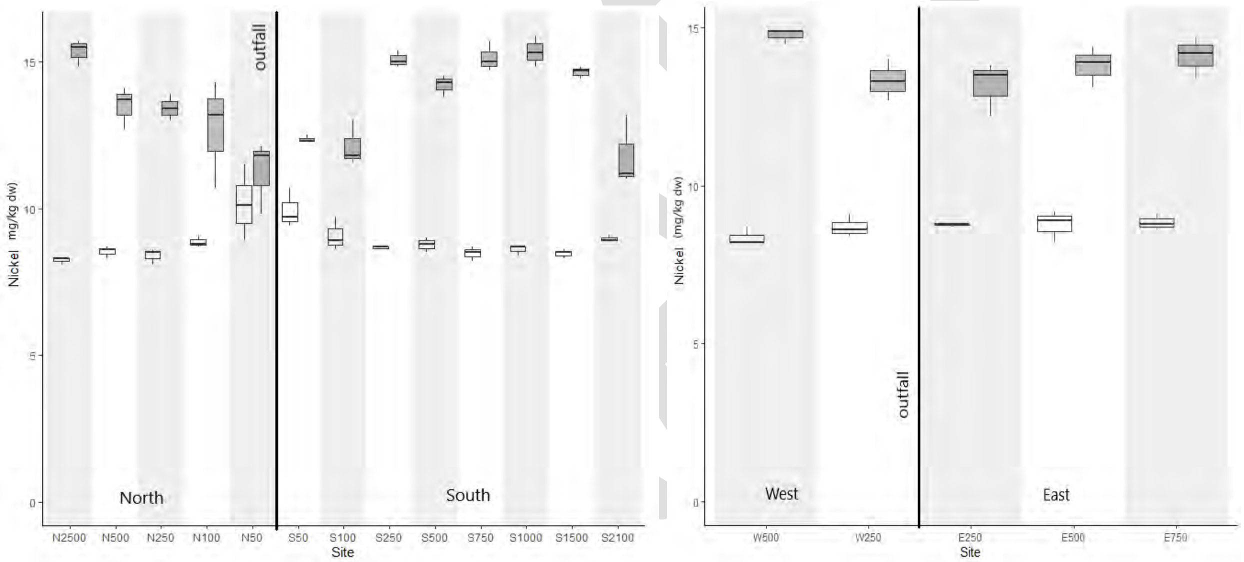

Figure 2.12 Nickel concentrations (mg/kg dry weight) for each site. Grey boxplot = raw data, white boxplot = Al-normalised data.

Raw data from 2023 were compared with the previous surveys conducted by Golder Associates (Appendix 5 Figure A5.12). The concentrations recorded in 2023 were between those found in the 2006 survey and those found in the 2012 survey.

2.4.10 Zinc

All Zinc concentrations recorded in sediments around the Clive outfall were lower than the ANZG 2018 DGV of 200 mg/kg dry weight.

Looking at Al-normalised data, a Kruskal-Wallis test gave a significant difference between the north-south sites at different distances (H = 25.378, p<0.001; Appendix 4). Both N50 and S50 were enriched in zinc (~60 mg/kgAl), followed by S100 (52 mg/kgAl), and showed significantly higher concentrations than that found at distances further than 250m (mean values of 41 mg/kgAl) (Figure 2.13). The decreasing gradient of zinc concentrations with distance from the outfall in the north and south could indicate an effect from the outfall effluent.

Raw data from 2023 were compared with the previous surveys conducted by Golder Associates (Appendix 5 Figure A5.13). The concentrations recorded in 2023 were between those found in the 2006 survey and those found in the 2012 survey, except for the west sites where the 2023 results were higher than that previously measured. The trend of zinc with distance found in 2023 was consistent with the findings of the 2012 survey.

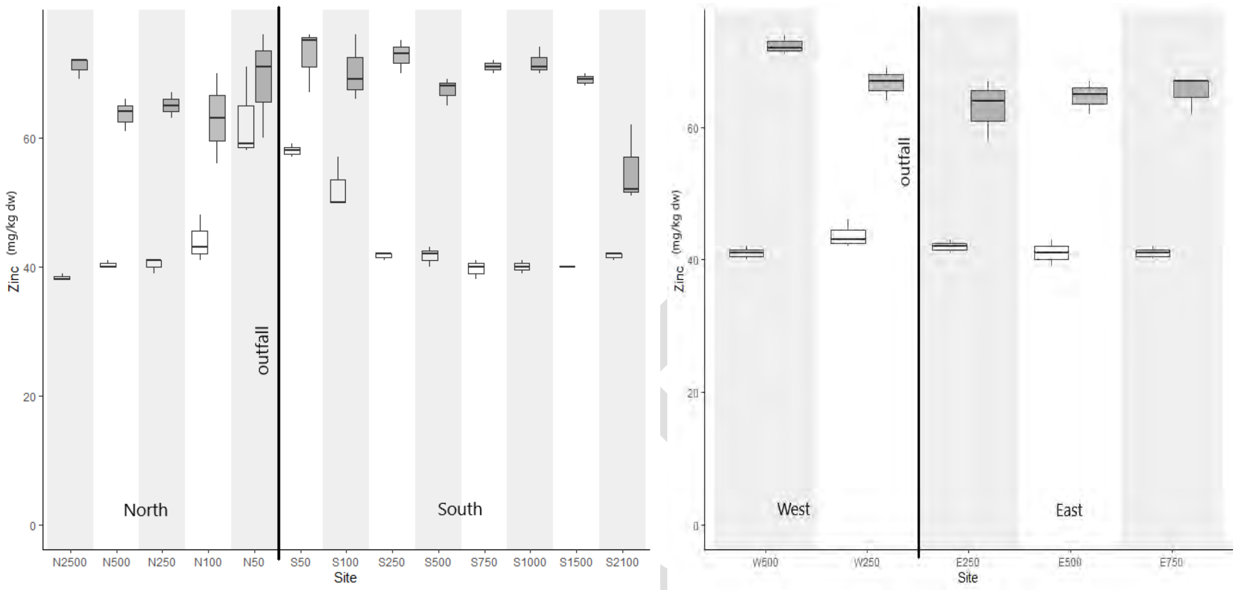

Figure 2.13 Zinc concentrations (mg/kg dry weight) for each site. Grey boxplot = raw data, white boxplot = Al-normalised data.

2.5 Summary of Sediment Quality

The sampling methodology applied in January 2023 was similar to that described in the Golder Associates report (2013) to allow comparisons between surveys.

Grain size

The percentage of mud in the 2023 survey was high, representing more than 70% of the total weight at each site. On the north and south transects, the mud content increased with distance from the outfall. On the east transect, grain size profiles consisted of mud at 96% while the west transect presented the least mud percentages at 500m and 750m distances. During the 2012 survey, most of the sites showed significantly less mud in the grain size compositions than that found in January 2023.

Input of fine sediments from the catchments forming Hawke's Bay is a key stressor for the regional coastal ecosystem. Large river systems from Tukituki, Ngaruroro and Tūtaekurī rivers greatly influence the sediment dynamics in the Bay after heavy rainfall events. The sampling locations around the outfall are situated in front of the coastline delimited by the estuaries of these large rivers. The grain size distribution around the outfall is likely to be more affected by the river systems during heavy rainfall events than the outfall effluent. The mud increase in the subtidal sediment over time is consistent with the general trend recorded by the State of the environment in Hawke Bay.

TVS and TOC

There was no detected trend of organic content in sediment with distance from the outfall except on the south transect. Hydrodynamic modelling of the Bay in a previous study showed modelled particles moving predominately south, highlighting a dominant north to south current parallel to the shore in that part of Hawke Bay.

N2500 had high organic content, suggesting that factors other than the outfall are at play in the distribution of particulate matter in the Bay.

Aluminium normalisation

The 2012 survey used a granulometry approach by analysing metal concentrations (total recoverable) on the mud fraction only (<63µm), and a geochemical approach by normalising contaminant concentrations by aluminium concentrations. The same approach was followed with the analysis of the 2023 samples. It allowed to compensate for some natural processes and gives a better visibility of anthropogenic effects.

Metal and arsenic concentrations

Out of the eight metals/metalloids tested in the sediments around the Clive outfall, only mercury showed values higher than the ANZG DGV guidelines at two sites: S50, and N250. The concentrations were however lower than the ANZG DV-high guideline, at levels which adverse effects on the biota could possibly occur (ANZG 2018).

The seven metals tested (Cadmium, Chromium, Copper, Lead, Mercury, Nickel and Zinc) all showed a similar pattern of distribution around the outfall diffuser. The aluminium-adjusted concentrations revealed a clear metal enrichment at the sites closest to the outfall (50m north and south), and further south to a 100m or 250m distance. The decreasing gradient of metal concentrations with distance going south could indicate an effect from the outfall effluent. This hypothesis is consistent with the movement of water particles modelled in a previous study showing a predominant southern current.

When compared to earlier surveys from 2006 and 2012, the bulk of the metal concentrations in sediment were in similar range to that found previously. There were few exceptions such as cadmium and mercury at the 50m sites with concentrations higher than previously recorded in 2006 and 2012.

3. BENTHIC ECOLOGY MONITORING

3.1 Benthic biota methodology

3.1.1 Sampling methodology

In January 2023, eighteen sites located along two transects were sampled for benthic biota (Figure 1.1). These sites are the same sites described in the sediment quality chapter above.

The sampling methodology matches that presented in Golder Associates (2013) for the 2012 survey. There was however a difference in the equipment used to collect the sediment. Golder Associates (2013) used a Standard Ponar grab sampler (0.05m² surface area). This equipment was not available prior to fieldwork and was replaced by a Petite Ponar grab sampler (0.023m² surface area). To have similar results to the 2012 survey, one replicate consisted of two Petite Ponar grab contents to roughly match the surface area sampled by a Standard Ponar. If a sample volume retrieved per grab was less than half the maximum volume capacity of 2.4L for the Petite Ponar, it was assumed not to have sampled the surface sediment correctly and that grab was discarded and resampled.

At each site, three replicate samples were collected for benthic biota. The sediment in each replicate was washed through a 0.5mm mesh sieve and the residual animals and debris were fixed in 5% glyoxal, 70% ethanol, sea water solution. In the laboratory, samples were rinsed after a minimum of one week of fixing in glyoxal and sorted for biota. Individuals were identified to the lowest practicable level, and enumerated, by an experienced benthic taxonomist (Rod Asher, Biolive, Nelson).

3.1.2 Statistical procedures

The ecological data were analysed using a mix of data plots, univariate and multivariate statistical methods to identify spatial trends in key species and indices of biodiversity and abundance. The biota matrix was examined in relation to the sediment quality matrix, to determine if contaminants or grain size influenced the benthic biota community around the outfall.

Three diversity parameters were considered: number of taxa S (species richness), number of individuals N (abundance), and the inverse of the Berger-Parker Diversity index 1/*d* (species diversity). *d* equals the abundance of the most abundant species divided by the total abundance. An increase of 1/*d* indicates an increase in diversity and a reduction in dominance.

The diversity parameters were compared between distances and regions using a combined factor to better reflect the contaminant patterns observed in the previous section. Six groups were created:

- "Near outfall" consisted of the sites up to 100m distance (N50, S50, N100, and S100);
- "North" consisted of sites north of the outfall between 250m and 2000m (N250, N500, N750, N1000, N1500);
- "South" consisted of sites south of the outfall between 250m and 2000m (S250, S500, S750, S1000, S1500);
- "West" consisted of all sites west of the outfall (W250, and W500);
- "East" consisted of all sites east of the outfall (E250, and E750);
- ">2000" consisted of sites further than 2000m from the outfall (N2500, and S2100).

As normality of data was not reached, Kruskal-Wallis tests were used with subsequent pairwise comparison Dunn's tests (version R 4.3.0, R Core Team 2023). All univariate tests were performed with an alpha value of 0.05.

A multivariate approach was used to test differences in species assemblages between groups. Multivariate tests were conducted with the software PRIMER-E (version 7.0.13, Quest Research Ltd). Bray-Curtis (B-C) similarity matrices were created on square-root transformed density data. The data transformation down-weights the importance of abundant species and gives more influence of the rare taxa. Non-metric multidimensional scaling (nMDS) allowed to visualise the degree of similarity among samples of different groups on a two-dimensional plot. One-way analysis of similarities ANOSIM (maximum permutations = 999) were performed on the B-C similarity matrices to test the null hypothesis "no difference between groups". The ANOSIM test is the multivariate analogue of the univariate ANOVA test. In the case of significant differences between groups, a one-way similarity percentage analysis SIMPER is needed to determine the taxa responsible for the differences between the groups. The multivariate procedure "data transform – Bray-Curtis – nMDS – ANOSIM – SIMPER" has become a common statistical methodology for communities' structure in the past 10 years (Clarke *et al.*, 2014).

The role of sediment quality on the benthic community composition was investigated by linking biological variables on the nMDS plot with the physicochemical variables in the contaminant matrix. BIO-ENV routine in PRIMER assesses the "match" between the biota similarity matrix and the environmental variables by calculating Spearman's rank correlations with different subsets of environmental data.

3.2 Benthic biota 2023

3.2.1 General Biota composition

Taxa composition of benthic biota around the outfall is summarised in Table 3.1 with raw data presented in Appendix 6. A total of 36 taxa were identified from the benthic samples with a total of 3,066 individual invertebrates counted. The polychaetes were the dominant taxa group with 98% of the total number of counted individuals in the sediment samples. That included 21 polychaete species/group with *Heteromastus filiformis* (34%), *Prionospio aucklandica* (19.2%), *Paraprionospio* sp. (12.2%) and *Cossura consimilis* (11.5%) being the most abundant ones with more than 300 individuals (Table 3.1). Outside the polychaetes, the other taxa such as the Mollusca Bivalvia or the Echinoderm Holothuroidea were represented by a couple of individuals only.

Diopatra akarana was a significant species in the composition of some sites (personal observation), but its role in the infauna composition was underestimated when looking at its abundance, as each individual was large. *Diopatra* is an oniphid polychaete building large and robust tubes in the sediment (Berke 2022). It was present in large densities around the outfall, such as some samples consisted only of tubes agglomerated together with empty tubes filled with thick black mud. The empty tubes as well as the shells glued to the external wall provides refugia for other species.

3.2.2 Benthic community distribution around the outfall

3.2.2.1 Diversity measures

The results of the statistical tests performed between regions and distances (combined factor) are detailed in Appendix 7. There were significant differences in the species richness S and the abundance N between the six groups distance-region (Kruskal-Wallis tests, p<0.05). No difference was detected with the “1/d” diversity index (Table 3.2).

The number of benthic taxa across the whole survey was low, ranging from four taxa east of the outfall to nine taxa west of the outfall. The western region gave the highest taxa diversity (9 ± 0.5 se) and the highest abundance (158 ± 42 se), in contrast to the eastern region with the least number of taxa (4 ± 0.7 se) and abundance (16 ± 5 se) (Table 3.2, Figure 3.1). The diversity measures of groups “East”, “North”, “South” and “Near outfall” showed no statistical difference between each other (Appendix 7). The biota number and diversity at N50 was highly variable between the three replicates with more than 600 polychaetes found in one while less than 10 was found in the others.

Table 3.1 Summary of densities (number/0.05 m²) and percentages for the 2023 taxa

Phylum	Taxa group	Name	All samples		Near outfall	North	South	West	East	>2000
			Total No.	% total	%	%	%	%	%	%
Hydrozoa	Hydrozoa	Hydroid athecate	2	0.1				0.1		0.4
Anthozoa	Anthozoa	Burrowing anemone	13	0.4		1.1	1.2	0.4		
Nemertea	Nemertea	Proboscis worms	2	0.1						0.8
Sipuncula	Sipuncula	Peanut worm	1	0.0						0.4
Mollusca	Bivalvia	*Arthritica bifurca*	6	0.2	0.2		0.6	0.1		
		Leptomya retiaria retiaria	4	0.1				0.1		1.2
		Ruditapes largillierti	1	0.0	0.1					
		Theora lubrica	4	0.1	0.1		0.4	0.1		
		Varinucula gallinacea	9	0.3	0.1		0.4	0.1		2.0
Annelida	Oligochaeta	Oligochaete worms	2	0.1				0.2		
	Polychaeta	Paraonidae	3	0.1				0.2	0.7	
		Cossura consimilis	352	11.5	2.4	41.0	11.2	6.0	60.7	7.9
		Paraprionospio sp.	375	12.2	0.4	4.8	28.9	15.7	4.3	23.2
		Polydora sp.	152	5.0	15.8			0.1		
		Prionospio aucklandica	589	19.2	45.3		22.9	3.9		2.0
		Prionospio yuriel	24	0.8	0.1	0.7	1.2	1.2	0.7	1.2
		Magelona dakini	43	1.4				4.4		0.4
		Capitella sp.	16	0.5	1.4		0.2	0.2		
		Heteromastus filiformis	1042	34.0	19.8	47.2	9.6	58.6	25.7	33.5
		Sigalionidae	1	0.0						0.4
		Hesionidae	2	0.1	0.1					0.4
		Glyceridae	3	0.1	0.1					0.8
		Aglaophamus sp.	6	0.2		0.4			0.7	1.6
		Diopatra akarana	191	6.2	12.4		10.6	1.6	2.1	0.4
		Onuphis aucklandensis	2	0.1			0.2			0.4
		Lumbrineridae	6	0.2	0.1		0.6			0.8
		Dorvilleidae	9	0.3	0.2		1.4			
		Owenia petersenae	97	3.2	0.1	3.7	3.4	5.3	5.0	4.7
		Ampharetidae	55	1.8			1.0	1.1		15.7
		Cirratulidae	6	0.2	0.2		0.8			
		Pectinaria australis	35	1.1	0.6		4.4	0.4		1.2
Arthropoda	Amphipoda	Phoxocephalidae	2	0.1	0.2					
	Ostracoda	Ostracoda	1	0.0						0.4
Phoronida		Horseshoe worms	5	0.2		1.1	0.2	0.1		
Echinodermata	Holothuroidea	*Heterothyone alba*	1	0.0	0.1					
		Paracaudina chilensis	4	0.1	0.1		0.2	0.1		0.4

Note: *light orange for 150<x<300 total individuals, and dark orange for >300 total individuals*

Near outfall *= 12 samples;* ***North*** *= 6 samples;* ***South*** *= 15 samples;* ***West*** *= 6 samples;* ***East*** *= 9 samples;* ***>2000m*** *= 6 samples*

Table 3.2 Mean diversity measures (± se) by combined distance-region

	Near outfall	North	South	West	East	>2000m
S – No. of taxa	**5** ± 1.2	**5** ± 0.3	**5** ± 0.6	**9** ± 0.5	**4** ± 0.7	**8** ± 1.5
N – No. of individuals	**88** ± 53	**45** ± 5	**33** ± 12	**158** ± 42	**16** ± 5	**42** ± 11
1/d – reciprocal of Berger-Parker Diversity index	**1.7** ± 0.2	**1.8** ± 0.1	**2.0** ± 0.2	**2.2** ± 0.3	**1.5** ± 0.1	**2.3** ± 0.3

Note: *Mean per site available in Appendix 6*

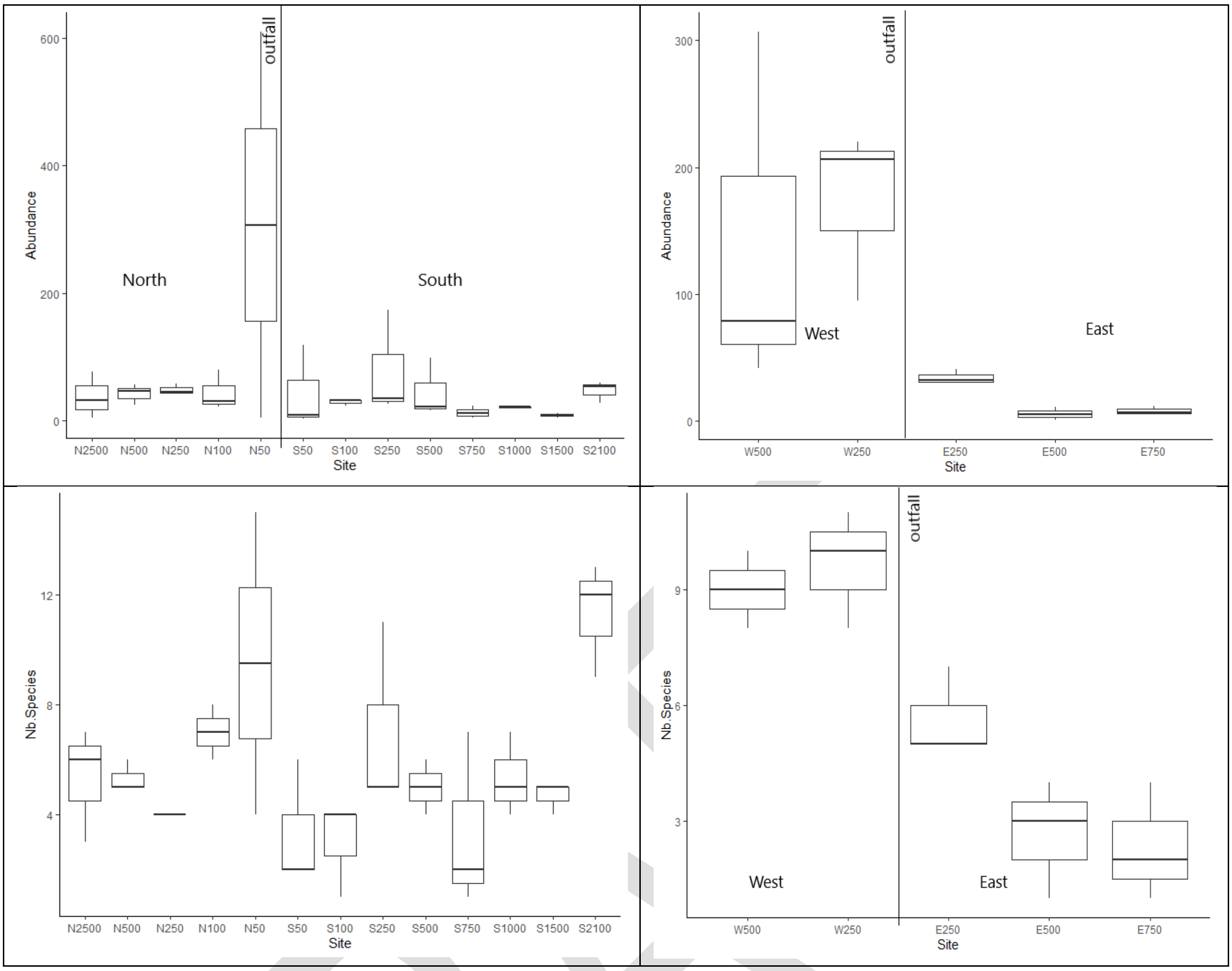

Figure 3.1 ***Diversity parameters (box plots) for each site: abundance at the top, number of species at the bottom.***

3.2.2.1 Multivariate analysis

Species represented by only few individuals in the whole dataset create noise in multivariate statistical analysis. Therefore, the taxa with a total count of less than five individuals were discarded for the multivariate analysis, leaving a total of 19 species in the taxa matrix. The nMDS plot showed that benthic communities were different between groups (Figure 3.2). The “Near outfall” sites formed a distinct group from the other sites on the horizontal axis, showing a high correlation with the oniphid polychaete *Diopatra akarana*. The “West” and “East” groups were differentiated along the vertical axis. West samples were correlated with all main polychaete groups as their contribution in western communities occurred in high numbers. The “North”, “South” and “>2000” groups did not show a clear distinction between themselves.

The ANOSIM tests corroborated the visual grouping on the nMDS plot (Appendix 7 Table A7.3). SIMPER tests highlighted the taxa responsible for the differences in communities (Appendix 7 Table A7.4). For instance, the sites within 100m of the outfall (“near outfall” group) were characterised by a high contribution of the spionid polychaete *Prionospio aucklandica (*45%), and *Diopatra* (12%), which drove the variation with the other groups (Table 3.1, Figure 3.2). *Heteromastus filiformis* was encountered in significant numbers at all sites, but its highest contribution was found in the west samples (59%). *Paraprionospio*, another major polychaete species in the area, was present in significant numbers west of the outfall (16%), but also south (29%) and in sites further than 2000m (23%) (Table 3.1). The benthic composition in the north and east of the outfall showed similarities with high contribution of *Heteromastus* (47% and 26% respectively) and *Cossura consimilis* (41% and 61% respectively). The contribution of species by number can be seen over the whole matrix in Appendix 8.

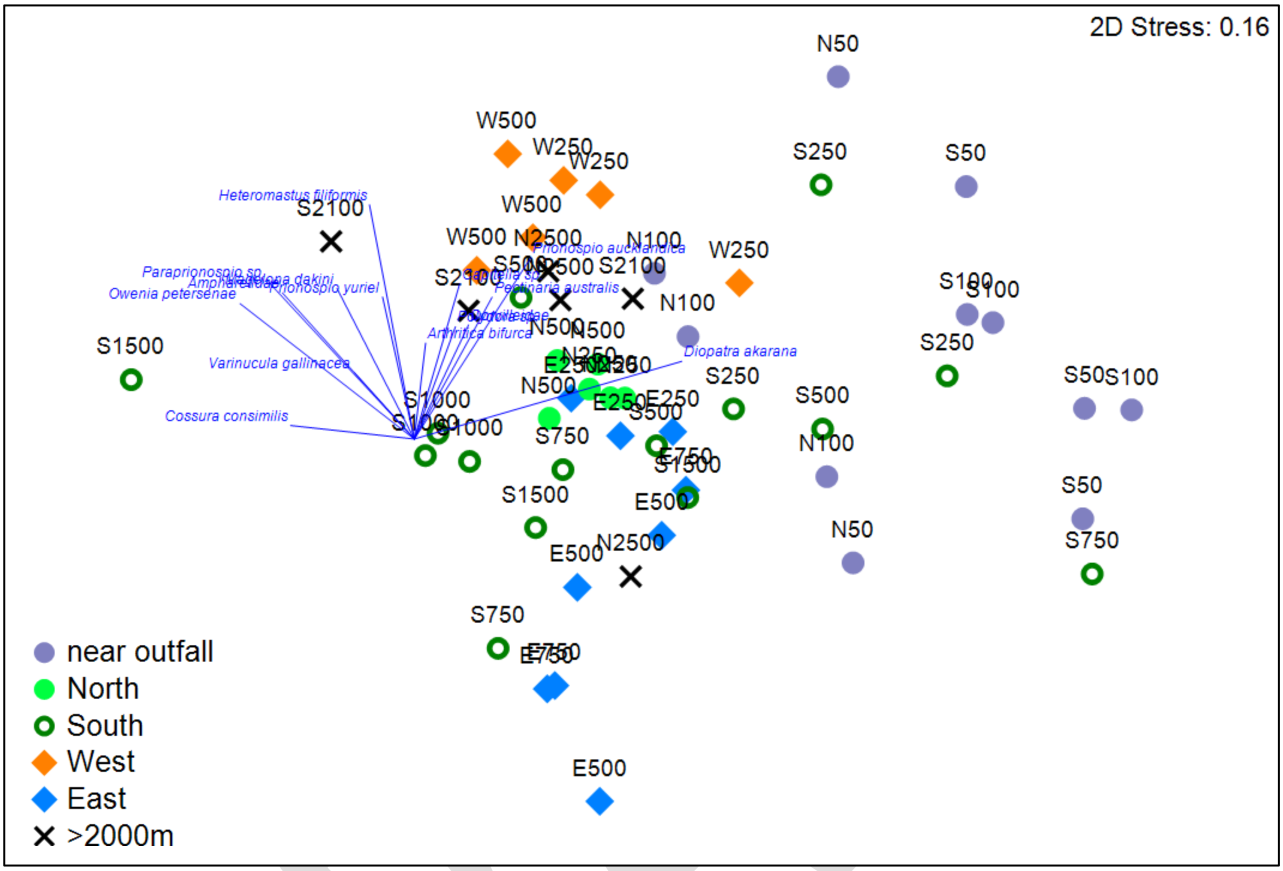

Figure 3.2 nMDS plot of benthic communities around Clive outfall highlighting differences between groups – January 2023

The Primer BIO-ENV routine aims to find the best match between the multivariate among-sample patterns of biota assemblage and that from environmental variables associated with those samples. The extent to which these two patterns match reflects the degree to which the chosen environmental data 'explains' the biotic pattern. BIO-ENV carries out a complete search of all possible combinations of variables (metals and %mud) from the data. The best calculated correlations were low (maximum of 0.360 over the combinations), and the best match was achieved with cadmium alone (rank of 0.360). When other variables were added to the tests, the best correlations with benthic assemblages were found with cadmium, chromium, nickel and zinc. However, all correlations were very low, therefore there was no evidence that the distribution of benthic communities was affected by the contaminants. This result is consistent with the low levels of contaminants overall which are well below concentrations that are likely to affect organisms. Benthic habitat structure (polychaete tubes), current and depth are likely to play a more significant role around the Clive outfall.

Despite the low relationship between contaminant levels and the distribution of the biota communities, *Diopatra* was present at sites with the highest levels of contaminants, *i.e.* near the outfall and on the southern transect up to 250m, suggesting a link between that species and pollution levels. However, at this stage, no literature reference was found to corroborate that hypothesis.

Table 3.3 Results from the BIO-ENV routine on the combined distance-region factor

Number of variables	Correlation (Spearman's rank)	Variable combination
Between groups (general rank = 0.360)		
1	0.360	Cadmium
2	0.341	Cadmium, Zinc
3	0.346	Cadmium, Chromium, Nickel
4	0.335	Cadmium, Chromium, Nickel, Zinc
5	0.333	%Mud, Cadmium, Chromium, Nickel, Zinc

Note: Variables in the model were %Mud, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, and Zinc

3.3 Benthic biota: changes over time

Golder Associates compared the 2012 survey with those carried out in 1995 and 2006 (Golder Associates 2013). They reported large fluctuations in abundance and diversity between surveys: in 1995 and 2006, infauna species and abundance around the outfall was low or dominated by few polychaete species, while in 2012, infauna was sampled in larger numbers from a wide range of species. The 2023 survey showed a low diversity and abundance, matching the biota pattern described for 1995 and 2006.

No statistical analysis was performed between the 2012 dataset and the 2023 dataset, as large differences in benthic assemblages and diversity indices were obvious. Key differences are highlighted below:

- The mean number of taxa identified per site in 2012 was around 30 over the whole survey, with numbers of infauna animals frequently above 300 individuals reaching more than 1000 for some sites. The mean number of taxa identified in 2023 was six times lower with polychaete numbers reaching rarely 100 individuals.
- A significant proportion of the infauna assemblage in 2012 consisted of molluscs such as *Odostomia* sp. and *Arthritica bifurca*. Bivalves were a rare find in the 2023 survey with a total of 24 individuals from five different species for all sites.
- *Diopatra* is recognized as an ecosystem engineer when found in high densities (Berke 2022). The role of the tubes built by the polychaete are likely to be a major driver of seabed structure near the outfall and south of the outfall. Empty *Diopatra* tubes were filled with black mud (personal observation during fieldwork), and seemed to act as a fine particle trap, such as mangroves root system in the intertidal environment. The 2013 report did not mention the presence of *Diopatra* tubes. It only appeared in low numbers in the 2012 biota matrix (Appendix 9).

The major differences observed between the surveys in 2012 and 2023 could be explained by a methodology bias, a change in the sediment texture, a natural seasonal variation, or a combination of all the above.

- The 2012 survey was carried out with a Standard Ponar grab, while the 2023 survey was carried out with a Petite Ponar grab. Two Petite Ponar grabs were sampled for one replicate to equal the volume and surface grabbed by the Standard Ponar. However, the bite depth of the Petite Ponar (70mm) is shallower than that of the Standard Ponar (89mm), therefore some infauna living deeper within the sediment could have be missed. Nevertheless, the quasi-absence of molluscs in 2023 is unlikely to originate from a Ponar bite bias, as bivalves and gastropods tend to live in the first cm of the sediment surface.
- The 2012 grain size profiles showed a higher content of sand than what was found in 1995, 2006 and 2023. Grain size is known to significantly influence the distribution of benthic species and it is likely to play a role in the differences seen in the benthic communities of 2012 and 2023.

- The 2006 survey was in fact over two sampling periods: December 2006 and May 2007. To be able to compare the samples obtained over the two periods, four sites already sampled in December 2006 were re-sampled in May 2007. This allowed the authors of the survey to assess the inter-seasonal variability of recruitment and community dynamics on the seafloor. There was a clear shift in community assemblages between the two periods: in December 2006, polychaetes dominated the biota, while in May 2007, molluscs contributed significantly to the benthic assemblage with bivalves *Arthitica bifurca*, *Dosinia* sp, *Nucula hartvigiana* and *Theora lubrica*. These four species were found in significant numbers at each site sampled in March 2012 (Appendix 9) but were not present or quasi-inexistent in January 2023. This discrepancy between surveys is consistent with a seasonal change of benthic assemblage, from polychaete dominated in summer to polychaete-mollusc assemblage in autumn in the Hawke Bay region. Sampling in summer and autumn at similar sites would allow to test that hypothesis.

3.4 Summary of benthic biota composition

The sampling methodology applied in January 2023 was similar to that described in the Golder Associates report (2013) to allow comparisons between surveys.

The polychaetes were the dominant taxa group with 98% of the total number of counted individuals with *Heteromastus filiformis*, *Prionospio aucklandica*, *Paraprionospio* sp. and *Cossura consimilis* being the most abundant ones. *Diopatra akarana*, an oniphid polychaete building large tubes, formed dense patches around the outfall and in the southern transect.

A combination of univariate tests on diversity measures and multivariate tests on benthic communities revealed significant differences between sites. The western region gave the highest taxa diversity and the highest abundance of polychaetes, in contrast to the eastern region with the least number of taxa and abundance. *Heteromastus filiformis* was encountered in significant numbers at all sites, but its highest contribution was found in the west samples. Sites within 100m of the outfall were characterised by a high contribution of the spionid polychaete *Prionospio aucklandica* and *Diopatra akarana.* The benthic composition in the north and east of the outfall showed similarities with high contribution of *Heteromastus* and *Cossura consimilis*.

Despite a low relationship between contaminant levels and the distribution of the biota communities, *Diopatra* was present at sites with the highest levels of contaminants, i.e. near the outfall and on the southern transect up to 250m, suggesting a link between that species and pollution levels. However, no literature reference was found to corroborate that hypothesis.

When compared with the 2012 dataset, large differences in benthic assemblages and diversity indices were obvious. The mean number of taxa identified in 2023 and mean abundance were six times lower and 10 times lower respectively than that found in 2012. Also, a significant proportion of the infauna assemblage in 2012 consisted of molluscs, a rare find in the 2023 survey. The major differences observed between the surveys in 2012 and 2023 could be explained by a methodology bias (different sampler), a change in the sediment texture (mud content higher in 2023), a natural seasonal variation (autumn in 2012 versus summer in 2023), or a combination of all the above. In our opinion the differences are most likely explained by the differences in sediment grain size composition and minor difference in sampling season.

4. CONCLUSIONS

Hastings District Council engaged Bioresearches to conduct the benthic survey around the Clive outfall in January 2023 to assess potential effects of the treated wastewater on the receiving environment. The methodology matched the 2012 survey from Golder Associates.

The percentage of mud in the 2023 survey was high, representing more than 70% of the total weight at each site. There is no trend among the sites to suggest an influence from the outfall effluent.

Organic content was assessed by two different measures: total organic carbon, and total volatile solids. There was a trend with distance from the outfall going south suggesting an influence from the outfall.

All metals/metalloids tested in the sediments in January 2023 were at levels lower than ANZG DVG, with the exception of mercury at two sites. Therefore, the surrounding biota is unlikely to be adversely affected. The aluminium-adjusted concentrations revealed a clear metal enrichment at the sites closest to the outfall (50m north and south), and further south to a 100m or 250m distance. The decreasing gradient of metal concentrations with distance going south could indicate an effect from the outfall effluent.

The polychaetes were the dominant taxa group with 98% of the total number of counted individuals with *Heteromastus filiformis*, *Prionospio aucklandica*, *Paraprionospio* sp. and *Cossura consimilis* being the most abundant ones. *Diopatra akarana*, an oniphid polychaete building large tubes, formed dense patches around the outfall and in the southern transect. Despite a low relationship between contaminant levels and the distribution of the biota communities, *Diopatra* was present at sites with the highest levels of contaminants, i.e. near the outfall and on the southern transect up to 250m, suggesting a link between that species and pollution levels. However, no literature reference was found to corroborate that hypothesis.

Hydrodynamic modelling of the Bay in a previous study showed modelled particles going predominately south, highlighting a dominant north to south current parallel to the shore in that part of Hawke Bay. The results from the present study suggest that organic content and metals originating from the outfall effluent get deposited to the sediment south of the outfall up to 250m. The polychaete *Diopatra* was present there, but the potential influence of contaminants on its distribution was not clear.

5. REFERENCES

ANZECC (2000)

Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1, The Guidelines (Chapters 1 - 7). Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ). Paper No. 4 - Volume 1 (Chapters 1 - 7) October 2000.

ANZG (2018)

Toxicant default guideline values for sediment quality. Australian and New Zealand Governments and Australian state and territory governments. Canberra, Australia.

Berke S.K. (2022)

A review of *Diopatra* ecology: current knowledge, open questions, and future threats for an ecosystem engineering polychaete. Biology 11, 1485.

Clarke K. R., Gorley R. N., Somerfield P.J., and Warwick R.M. (2014)

Change in marine communities: an approach to statistical analysis and interpretation, 3nd edition. PRIMER-E: Plymouth

CCME (2007)

Canadian water quality guidelines for the protection of aquatic life. In: Canadian environmental quality guidelines. Canadian Council of Ministers of the Environment, Winnipeg.

Clark M.W., Davies-McConchie F., McConchie D., and Birch GF (2008)

Selective chemical extraction and grain size normalisation for environmental assessment of anoxic sediments: validation of an integrated procedure. The Science of the Total Environment 258: 149-170.

EAM (2007)

Coastal sediment characteristics of the Hawke Bay. Report prepared by EAM Environmental Consultants for Hawke's Bay Regional Council. Report EMI 07/24 August 2007.

Golder Associates (2013)

Clive outfall Benthic survey 2012. Report prepared for Hastings District Council by Golder Associates Ltd.

Ho H.H., Swennen R., Cappuyns V., Vassilieva E. and Tran T.V. (2012)

Necessity of normalization to aluminium to assess the contamination by heavy metals and arsenic in sediments near Haiphong Harbor, Vietnam. Journal of Asian Earth Sciences 56: 229-239.

Long E.R., MacDonald D.D., Smith S.L. and Calder F.D. (1995)

Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19: 81-97.

MacDonald DD, Carr RS, Calder FD, Long ER, and Igersoll, CG (1996)

Development and evaluation of sediment quality guidelines for Florida coastal waters. Ecotoxicology 5: 253–278.

Metocean and Cawthron (2010)

East Clive Watewater Outfall – hydrodynamic modelling. Prepared by Matocean Solutions Ltd and Cawthron Institute for Hastings District Council, January 2010.

HBRC (2016)

The State of the Hawke's Bay Coanstal Environment: 2004-2013. HBRC report no. RM16-16 – 4800 Prepared by Hawke's Bay Regional Council.

HBRC (2022)

Hawke's Bay State of the Environment 2018 – 2021. Prepared by Hawke's Bay Regional Council.

Simpson S.L., Batley G.E. and Chariton A.A. (2013)

Revision of the ANZECC/ARMCANZ sediment quality guidelines. CSIRO Land and Water Report 8(07). 128pp.

6. APPENDICES

Appendix 1 Coordinates of benthic samples (WG84) for 2023

Site	Latitude	Longitude
N50	S39.57613198	E176.96781409
N100	S39.57565119	E176.96763346
N250	S39.57427799	E176.96714203
N500	S39.5723639	E176.96622756
N750	S39.57028233	E176.96507958
N1000	S39.56799751	E176.96411222
N1500	S39.56395945	E176.96274404
N2500	S39.55476282	E176.95968079
S50	S39.57771457	E176.96817258
S100	S39.57808664	E176.96867315
S250	S39.57956814	E176.96861984
S500	S39.58169295	E176.96975886
S750	S39.58377603	E176.97065715
S1000	S39.58591199	E176.9718462
S1500	S39.58996229	E176.97383028
S2100	S39.59486461	E176.97658684
W250	S39.57883246	E176.96253047
W500	S39.57972622	E176.9598688
W750	S39.58063583	E176.95725834
E250	S39.57590844	E176.97129023
E500	S39.57480471	E176.97396297
E750	S39.57363007	E176.97649414

Note: these coordinates (decimal degrees) were copied from Golder Associates report 2013

Appendix 2 Raw results from Hill laboratories – 2023

Table A2.1 Certificate of Analysis for 2023 grain size & contaminants

Hill Laboratories
TRIED, TESTED AND TRUSTED

R J Hill Laboratories Limited
28 Duke Street Frankton 3204
Private Bag 3205
Hamilton 3240 New Zealand

T 0508 HILL LAB (44 555 22
T +64 7 858 2000
E mail@hill-labs.co.nz
W www.hill-laboratories.com

Certificate of Analysis Page 1 of 8

SUPv1

Client:	Bioresearches	**Lab No:**	3185840
Contact:	S West	**Date Received:**	01-Mar-2023
	C/- Bioresearches	**Date Reported:**	03-May-2023
	PO Box 2828	**Quote No:**	120564
	Auckland 1140	**Order No:**	
		Client Reference:	66270
		Add. Client Ref:	Clive Outfall Monitoring
		Submitted By:	Laureline Meynier

Sample Type: Sediment

	Sample Name:	SED-N50 a 17-Jan-2023	SED-N50 b 17-Jan-2023	SED-N50 c 17-Jan-2023	SED-N100 a 17-Jan-2023
	Lab Number:	3185840.1	3185840.2	3185840.3	3185840.4
Individual Tests					
Dry Matter of Sieved Sample*	g/100g as rcvd	54	61	66	61
Volatile Solids*	g/100g dry wt	5.9	5.1	4.2	5.2
Ash*	g/100g dry wt	94.1 ± 1.4	94.9 ± 1.4	95.8 ± 1.4	94.8 ± 1.4
Total Organic Carbon*	g/100g dry wt	1.28 ± 0.11	0.838 ± 0.079	0.528 ± 0.059	0.771 ± 0.074
3 Grain Sizes Profile as received*					
Fraction >/= 2 mm*	g/100g dry wt	< 0.1	< 0.1	0.4	< 0.1
Fraction < 2 mm, >/= 63 µm*	g/100g dry wt	16.6	17.7	23.8	10.1
Fraction < 63 µm*	g/100g dry wt	83.4	82.3	75.9	89.9

	Sample Name:	SED-N100 b 17-Jan-2023	SED-N100 c 17-Jan-2023	SED-N250 a 17-Jan-2023	SED-N250 b 17-Jan-2023
	Lab Number:	3185840.5	3185840.6	3185840.7	3185840.8
Individual Tests					
Dry Matter of Sieved Sample*	g/100g as rcvd	63	61	61	62
Volatile Solids*	g/100g dry wt	4.6	5.0	4.5	4.6
Ash*	g/100g dry wt	95.4 ± 1.4	95.0 ± 1.4	95.5 ± 1.4	95.4 ± 1.4
Total Organic Carbon*	g/100g dry wt	0.731 ± 0.071	0.745 ± 0.072	0.781 ± 0.075	0.749 ± 0.073
3 Grain Sizes Profile as received*					
Fraction >/= 2 mm*	g/100g dry wt	< 0.1	< 0.1	< 0.1	1.6
Fraction < 2 mm, >/= 63 µm*	g/100g dry wt	15.0	9.4	3.7	5.1
Fraction < 63 µm*	g/100g dry wt	85.0	90.6	96.2	93.3

	Sample Name:	SED-N250 c 17-Jan-2023	SED-N500 a 17-Jan-2023	SED-N500 b 17-Jan-2023	SED-N500 c 17-Jan-2023
	Lab Number:	3185840.9	3185840.10	3185840.11	3185840.12
Individual Tests					
Dry Matter of Sieved Sample*	g/100g as rcvd	61	67	65	62
Volatile Solids*	g/100g dry wt	5.0	4.1	4.5	5.0
Ash*	g/100g dry wt	95.0 ± 1.4	95.9 ± 1.4	95.5 ± 1.4	95.0 ± 1.4
Total Organic Carbon*	g/100g dry wt	0.780 ± 0.075	0.410 ± 0.052	0.626 ± 0.065	0.722 ± 0.071
3 Grain Sizes Profile as received*					
Fraction >/= 2 mm*	g/100g dry wt	< 0.1	0.2	0.6	0.3
Fraction < 2 mm, >/= 63 µm*	g/100g dry wt	3.8	19.4	13.4	6.5
Fraction < 63 µm*	g/100g dry wt	96.2	80.5	86.0	93.2

Sample Type: Sediment

	Sample Name:	SED-N2500 a 17-Jan-2023	SED-N2500 b 17-Jan-2023	SED-N2500 c 17-Jan-2023	SED-S50 a 17-Jan-2023
	Lab Number:	3185840.13	3185840.14	3185840.15	3185840.16
Individual Tests					
Dry Matter of Sieved Sample*	g/100g as rcvd	58	56	59	54
Volatile Solids*	g/100g dry wt	5.7	6.0	5.8	6.0
Ash*	g/100g dry wt	94.3 ± 1.4	94.0 ± 1.4	94.2 ± 1.4	94.0 ± 1.4
Total Organic Carbon*	g/100g dry wt	1.045 ± 0.093	1.21 ± 0.11	1.20 ± 0.11	1.78 ± 0.15
3 Grain Sizes Profile as received*					
Fraction >/= 2 mm*	g/100g dry wt	< 0.1	< 0.1	< 0.1	19.2
Fraction < 2 mm, >/= 63 µm*	g/100g dry wt	9.4	5.9	3.6	16.4
Fraction < 63 µm*	g/100g dry wt	90.6	94.0	96.4	64.4

	Sample Name:	SED-S50 b 17-Jan-2023	SED-S50 c 17-Jan-2023	SED-S100 a 17-Jan-2023	SED-S100 b 17-Jan-2023
	Lab Number:	3185840.17	3185840.18	3185840.19	3185840.20
Individual Tests					
Dry Matter of Sieved Sample*	g/100g as rcvd	56	56	57	57
Volatile Solids*	g/100g dry wt	5.8	6.1	4.8	6.0
Ash*	g/100g dry wt	94.2 ± 1.4	93.9 ± 1.4	95.2 ± 1.4	94.0 ± 1.4
Total Organic Carbon*	g/100g dry wt	1.33 ± 0.12	1.39 ± 0.12	0.756 ± 0.073	1.24 ± 0.11
3 Grain Sizes Profile as received*					
Fraction >/= 2 mm*	g/100g dry wt	8.4	9.8	6.0	8.3
Fraction < 2 mm, >/= 63 µm*	g/100g dry wt	13.7	17.3	17.8	24.7
Fraction < 63 µm*	g/100g dry wt	77.9	72.9	76.2	67.0

	Sample Name:	SED-S100 c 17-Jan-2023	SED-S250 a 17-Jan-2023	SED-S250 b 17-Jan-2023	SED-S250 c 17-Jan-2023
	Lab Number:	3185840.21	3185840.22	3185840.23	3185840.24
Individual Tests					
Dry Matter of Sieved Sample*	g/100g as rcvd	57	57	55	62
Volatile Solids*	g/100g dry wt	5.9	5.1	4.9	4.8
Ash*	g/100g dry wt	94.1 ± 1.4	94.9 ± 1.4	95.1 ± 1.4	95.2 ± 1.4
Total Organic Carbon*	g/100g dry wt	1.17 ± 0.11	0.909 ± 0.083	1.113 ± 0.098	0.923 ± 0.084
3 Grain Sizes Profile as received*					
Fraction >/= 2 mm*	g/100g dry wt	7.9	2.1	1.6	1.8
Fraction < 2 mm, >/= 63 µm*	g/100g dry wt	16.0	11.2	12.9	11.7
Fraction < 63 µm*	g/100g dry wt	76.0	86.6	85.5	86.5

	Sample Name:	SED-S500 a 17-Jan-2023	SED-S500 b 17-Jan-2023	SED-S500 c 17-Jan-2023	SED-S750 a 17-Jan-2023
	Lab Number:	3185840.25	3185840.26	3185840.27	3185840.28
Individual Tests					
Dry Matter of Sieved Sample*	g/100g as rcvd	65	61	64	59
Volatile Solids*	g/100g dry wt	4.4	4.6	4.3	4.8
Ash*	g/100g dry wt	95.6 ± 1.4	95.4 ± 1.4	95.7 ± 1.4	95.2 ± 1.4
Total Organic Carbon*	g/100g dry wt	0.582 ± 0.062	0.670 ± 0.067	0.643 ± 0.066	0.580 ± 0.062
3 Grain Sizes Profile as received*					
Fraction >/= 2 mm*	g/100g dry wt	0.4	0.4	< 0.1	0.4
Fraction < 2 mm, >/= 63 µm*	g/100g dry wt	15.1	11.9	16.1	9.3
Fraction < 63 µm*	g/100g dry wt	84.5	87.6	83.9	90.3

	Sample Name:	SED-S750 b 17-Jan-2023	SED-S750 c 17-Jan-2023	SED-S1000 a 17-Jan-2023	SED-S1000 b 17-Jan-2023
	Lab Number:	3185840.29	3185840.30	3185840.31	3185840.32
Individual Tests					
Dry Matter of Sieved Sample*	g/100g as rcvd	60	51	55	56
Volatile Solids*	g/100g dry wt	5.2	5.2	5.2	5.3
Ash*	g/100g dry wt	94.8 ± 1.4	94.8 ± 1.4	94.8 ± 1.4	94.7 ± 1.4
Total Organic Carbon*	g/100g dry wt	0.805 ± 0.063	0.811 ± 0.077	0.627 ± 0.065	0.818 ± 0.077

Lab No: 3185840-SUPv1 Hill Laboratories Page 2 of 8

Sample Type: Sediment

Sample Name:		SED-S750 b 17-Jan-2023	SED-S750 c 17-Jan-2023	SED-S1000 a 17-Jan-2023	SED-S1000 b 17-Jan-2023
Lab Number:		3185840.29	3185840.30	3185840.31	3185840.32
3 Grain Sizes Profile as received*					
Fraction >/= 2 mm*	g/100g dry wt	0.9	0.9	0.8	0.9
Fraction < 2 mm, >/= 63 µm*	g/100g dry wt	9.6	8.6	8.3	8.3
Fraction < 63 µm*	g/100g dry wt	89.5	90.5	90.9	90.8

Sample Name:		SED-S1000 c 17-Jan-2023	SED-S1500 a 17-Jan-2023	SED-S1500 b 17-Jan-2023	SED-S1500 c 17-Jan-2023
Lab Number:		3185840.33	3185840.34	3185840.35	3185840.36
Individual Tests					
Dry Matter of Sieved Sample*	g/100g as rcvd	54	57	65	65 [#1]
Volatile Solids*	g/100g dry wt	5.2	4.9	4.4	4.0
Ash*	g/100g dry wt	94.8 ± 1.4	95.1 ± 1.4	95.6 ± 1.4	96.0 ± 1.4 [#1]
Total Organic Carbon*	g/100g dry wt	0.742 ± 0.072	0.765 ± 0.074	0.613 ± 0.064	0.545 ± 0.060
3 Grain Sizes Profile as received*					
Fraction >/= 2 mm*	g/100g dry wt	0.2	< 0.1	0.1	< 0.1 [#1]
Fraction < 2 mm, >/= 63 µm*	g/100g dry wt	9.1	12.8	16.7	15.3 [#1]
Fraction < 63 µm*	g/100g dry wt	90.7	87.2	83.1	84.6 [#1]

Sample Name:		SED-S2100 a 17-Jan-2023	SED-S2100 b 17-Jan-2023	SED-S2100 c 17-Jan-2023	SED-E250 a 17-Jan-2023
Lab Number:		3185840.37	3185840.38	3185840.39	3185840.40
Individual Tests					
Dry Matter of Sieved Sample*	g/100g as rcvd	64 [#1]	68	64	60
Volatile Solids*	g/100g dry wt	4.4	3.7	4.3	4.4
Ash*	g/100g dry wt	95.6 ± 1.4 [#1]	96.3 ± 1.4	95.7 ± 1.4	95.6 ± 1.4
Total Organic Carbon*	g/100g dry wt	0.528 ± 0.059	0.324 ± 0.048	0.533 ± 0.059	0.679 ± 0.068
3 Grain Sizes Profile as received*					
Fraction >/= 2 mm*	g/100g dry wt	0.2 [#1]	0.1	0.3	< 0.1
Fraction < 2 mm, >/= 63 µm*	g/100g dry wt	10.0 [#1]	15.8	13.0	4.7
Fraction < 63 µm*	g/100g dry wt	89.8 [#1]	84.1	86.7	95.3

Sample Name:		SED-E250 b 17-Jan-2023	SED-E250 c 17-Jan-2023	SED-E500 a 17-Jan-2023	SED-E500 b 17-Jan-2023
Lab Number:		3185840.41	3185840.42	3185840.43	3185840.44
Individual Tests					
Dry Matter of Sieved Sample*	g/100g as rcvd	63	58	57	57
Volatile Solids*	g/100g dry wt	4.7	5.3	5.1	5.4
Ash*	g/100g dry wt	95.3 ± 1.4	94.7 ± 1.4	94.9 ± 1.4	94.6 ± 1.4
Total Organic Carbon*	g/100g dry wt	0.697 ± 0.069	0.923 ± 0.084	0.863 ± 0.080	0.962 ± 0.087
3 Grain Sizes Profile as received*					
Fraction >/= 2 mm*	g/100g dry wt	< 0.1	< 0.1	< 0.1	< 0.1
Fraction < 2 mm, >/= 63 µm*	g/100g dry wt	2.9	3.8	3.3	2.5
Fraction < 63 µm*	g/100g dry wt	97.0	96.2	96.7	97.5

Sample Name:		SED-E500 c 17-Jan-2023	SED-E750 a 17-Jan-2023	SED-E750 b 17-Jan-2023	SED-E750 c 17-Jan-2023
Lab Number:		3185840.45	3185840.46	3185840.47	3185840.48
Individual Tests					
Dry Matter of Sieved Sample*	g/100g as rcvd	55	61	63	55
Volatile Solids*	g/100g dry wt	5.4	5.0	4.3	4.8
Ash*	g/100g dry wt	94.6 ± 1.4	95.0 ± 1.4	95.7 ± 1.4	95.2 ± 1.4
Total Organic Carbon*	g/100g dry wt	0.981 ± 0.089	0.937 ± 0.085	0.865 ± 0.080	0.811 ± 0.077
3 Grain Sizes Profile as received*					
Fraction >/= 2 mm*	g/100g dry wt	0.1	< 0.1	< 0.1	0.6
Fraction < 2 mm, >/= 63 µm*	g/100g dry wt	4.1	2.6	2.9	4.3
Fraction < 63 µm*	g/100g dry wt	95.8	97.4	97.1	95.2

Sample Type: Sediment

Sample Name:		SED-W250 a 17-Jan-2023	SED-W250 b 17-Jan-2023	SED-W250 c 17-Jan-2023	SED-W500 a 17-Jan-2023
Lab Number:		3185840.49	3185840.50	3185840.51	3185840.52
Individual Tests					
Dry Matter of Sieved Sample*	g/100g as rcvd	61 [#2]	67	62	61
Volatile Solids*	g/100g dry wt	4.6	4.1	4.4	4.1
Ash*	g/100g dry wt	95.4 ± 1.4	95.9 ± 1.4	95.6 ± 1.4	95.9 ± 1.4
Total Organic Carbon*	g/100g dry wt	0.739 ± 0.072	0.620 ± 0.064	0.852 ± 0.080	0.642 ± 0.066
3 Grain Sizes Profile as received*					
Fraction >/= 2 mm*	g/100g dry wt	< 0.1 [#2]	< 0.1	0.2	< 0.1
Fraction < 2 mm, >/= 63 µm*	g/100g dry wt	21.5 [#2]	31.5	22.7	27.8
Fraction < 63 µm*	g/100g dry wt	78.4 [#2]	68.4	77.0	72.2

Sample Name:		SED-W500 b 17-Jan-2023	SED-W500 c 17-Jan-2023	SED-N50 a [<63um Fraction]	SED-N50 b [<63um Fraction]
Lab Number:		3185840.53	3185840.54	3185840.55	3185840.56
Individual Tests					
Dry Matter of Sieved Sample*	g/100g as rcvd	65 [#1]	56 [#1]	-	-
Volatile Solids*	g/100g dry wt	4.3	4.1	-	-
Ash*	g/100g dry wt	95.7 ± 1.4	95.9 ± 1.4	-	-
Total Recoverable Aluminium	mg/kg dry wt	-	-	13,200 ± 1,600	12,000 ± 1,500
Total Organic Carbon*	g/100g dry wt	0.667 ± 0.067	0.705 ± 0.070	-	-
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	-	-	5.88 ± 0.61	5.95 ± 0.61
Total Recoverable Cadmium	mg/kg dry wt	-	-	0.111 ± 0.015	0.085 ± 0.012
Total Recoverable Chromium	mg/kg dry wt	-	-	35.4 ± 4.3	29.6 ± 3.6
Total Recoverable Copper	mg/kg dry wt	-	-	14.3 ± 2.1	15.1 ± 2.2
Total Recoverable Lead	mg/kg dry wt	-	-	12.8 ± 1.6	13.9 ± 1.7
Total Recoverable Mercury	mg/kg dry wt	-	-	0.103 ± 0.014	0.111 ± 0.015
Total Recoverable Nickel	mg/kg dry wt	-	-	11.8 ± 1.2	12.1 ± 1.3
Total Recoverable Zinc	mg/kg dry wt	-	-	76 ± 13	71 ± 12
3 Grain Sizes Profile as received*					
Fraction >/= 2 mm*	g/100g dry wt	0.2 [#1]	0.7 [#1]	-	-
Fraction < 2 mm, >/= 63 µm*	g/100g dry wt	33.7 [#1]	30.1 [#1]	-	-
Fraction < 63 µm*	g/100g dry wt	66.1 [#1]	69.2 [#1]	-	-

Sample Name:		SED-N50 c [<63um Fraction]	SED-N100 a [<63um Fraction]	SED-N100 b [<63um Fraction]	SED-N100 c [<63um Fraction]
Lab Number:		3185840.57	3185840.58	3185840.59	3185840.60
Individual Tests					
Total Recoverable Aluminium	mg/kg dry wt	8,500 ± 1,100	16,200 ± 2,000	11,700 ± 1,500	15,200 ± 1,900
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	4.27 ± 0.45	6.08 ± 0.63	4.58 ± 0.48	5.44 ± 0.56
Total Recoverable Cadmium	mg/kg dry wt	0.117 ± 0.016	0.0570 ± 0.0091	0.0559 ± 0.0090	0.0472 ± 0.0083
Total Recoverable Chromium	mg/kg dry wt	22.8 ± 2.8	21.4 ± 2.6	23.4 ± 2.9	17.9 ± 2.2
Total Recoverable Copper	mg/kg dry wt	11.4 ± 1.6	13.0 ± 1.9	11.2 ± 1.6	11.2 ± 1.6
Total Recoverable Lead	mg/kg dry wt	11.9 ± 1.5	13.8 ± 1.7	10.9 ± 1.4	12.7 ± 1.6
Total Recoverable Mercury	mg/kg dry wt	0.089 ± 0.013	0.094 ± 0.014	0.067 ± 0.011	0.085 ± 0.013
Total Recoverable Nickel	mg/kg dry wt	9.81 ± 0.99	14.3 ± 1.5	10.7 ± 1.1	13.2 ± 1.4
Total Recoverable Zinc	mg/kg dry wt	59.8 ± 9.6	70 ± 12	56.2 ± 9.0	63 ± 11

Sample Name:		SED-N250 a [<63um Fraction]	SED-N250 b [<63um Fraction]	SED-N250 c [<63um Fraction]	SED-N500 a [<63um Fraction]
Lab Number:		3185840.61	3185840.62	3185840.63	3185840.64
Individual Tests					
Total Recoverable Aluminium	mg/kg dry wt	16,200 ± 2,000	15,700 ± 1,900	16,000 ± 2,000	15,300 ± 1,900
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	6.26 ± 0.65	5.96 ± 0.62	5.76 ± 0.60	5.84 ± 0.60
Total Recoverable Cadmium	mg/kg dry wt	0.0468 ± 0.0083	0.0387 ± 0.0076	0.0394 ± 0.0077	0.0445 ± 0.0081
Total Recoverable Chromium	mg/kg dry wt	21.2 ± 2.6	19.9 ± 2.4	19.9 ± 2.4	19.0 ± 2.3
Total Recoverable Copper	mg/kg dry wt	11.4 ± 1.7	11.2 ± 1.6	10.7 ± 1.5	10.5 ± 1.5

Sample Type: Sediment

Sample Name:		SED-N250 a [<63um Fraction]	SED-N250 b [<63um Fraction]	SED-N250 c [<63um Fraction]	SED-N500 a [<63um Fraction]
Lab Number:		3185840.61	3185840.62	3185840.63	3185840.64
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Lead	mg/kg dry wt	13.5 ± 1.7	13.0 ± 1.8	12.5 ± 1.6	12.1 ± 1.5
Total Recoverable Mercury	mg/kg dry wt	0.085 ± 0.013	0.083 ± 0.012	0.235 ± 0.029	0.079 ± 0.012
Total Recoverable Nickel	mg/kg dry wt	13.9 ± 1.4	13.4 ± 1.4	13.0 ± 1.4	12.7 ± 1.3
Total Recoverable Zinc	mg/kg dry wt	67 ± 11	65 ± 11	63 ± 11	60.9 ± 9.8

Sample Name:		SED-N500 b [<63um Fraction]	SED-N500 c [<63um Fraction]	SED-N2500 a [<63um Fraction]	SED-N2500 b [<63um Fraction]
Lab Number:		3185840.65	3185840.66	3185840.67	3185840.68
Individual Tests					
Total Recoverable Aluminium	mg/kg dry wt	15,800 ± 1,900	16,400 ± 2,000	18,300 ± 2,200	18,700 ± 2,300
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	5.84 ± 0.60	6.25 ± 0.64	7.00 ± 0.72	7.06 ± 0.72
Total Recoverable Cadmium	mg/kg dry wt	0.0489 ± 0.0084	0.0481 ± 0.0084	0.0551 ± 0.0090	0.0550 ± 0.0090
Total Recoverable Chromium	mg/kg dry wt	18.7 ± 2.3	20.5 ± 2.5	19.8 ± 2.4	19.8 ± 2.4
Total Recoverable Copper	mg/kg dry wt	11.9 ± 1.7	12.0 ± 1.7	11.0 ± 1.6	11.7 ± 1.7
Total Recoverable Lead	mg/kg dry wt	13.1 ± 1.6	13.7 ± 1.7	14.6 ± 1.8	15.2 ± 1.9
Total Recoverable Mercury	mg/kg dry wt	0.100 ± 0.014	0.091 ± 0.013	0.084 ± 0.013	0.083 ± 0.012
Total Recoverable Nickel	mg/kg dry wt	13.7 ± 1.4	14.1 ± 1.5	14.8 ± 1.5	15.5 ± 1.6
Total Recoverable Zinc	mg/kg dry wt	64 ± 11	66 ± 11	69 ± 12	72 ± 12

Sample Name:		SED-N2500 c [<63um Fraction]	SED-S50 a [<63um Fraction]	SED-S50 b [<63um Fraction]	SED-S50 c [<63um Fraction]
Lab Number:		3185840.69	3185840.70	3185840.71	3185840.72
Individual Tests					
Total Recoverable Aluminium	mg/kg dry wt	18,900 ± 2,300	12,700 ± 1,600	13,300 ± 1,700	11,500 ± 1,400
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	7.17 ± 0.73	3.88 ± 0.40	3.93 ± 0.42	3.75 ± 0.40
Total Recoverable Cadmium	mg/kg dry wt	0.0573 ± 0.0092	0.091 ± 0.013	0.087 ± 0.013	0.084 ± 0.012
Total Recoverable Chromium	mg/kg dry wt	20.2 ± 2.5	52.1 ± 6.3	38.0 ± 4.6	34.7 ± 4.2
Total Recoverable Copper	mg/kg dry wt	11.7 ± 1.7	15.4 ± 2.2	16.8 ± 2.4	12.4 ± 1.8
Total Recoverable Lead	mg/kg dry wt	15.9 ± 2.0	11.8 ± 1.5	12.4 ± 1.5	11.3 ± 1.4
Total Recoverable Mercury	mg/kg dry wt	0.087 ± 0.013	0.153 ± 0.020	0.484 ± 0.059	0.131 ± 0.018
Total Recoverable Nickel	mg/kg dry wt	15.7 ± 1.6	12.3 ± 1.3	12.5 ± 1.3	12.3 ± 1.3
Total Recoverable Zinc	mg/kg dry wt	72 ± 12	75 ± 12	78 ± 13	67 ± 11

Sample Name:		SED-S100 a [<63um Fraction]	SED-S100 b [<63um Fraction]	SED-S100 c [<63um Fraction]	SED-S250 a [<63um Fraction]
Lab Number:		3185840.73	3185840.74	3185840.75	3185840.76
Individual Tests					
Total Recoverable Aluminium	mg/kg dry wt	13,100 ± 1,600	13,400 ± 1,700	13,700 ± 1,700	17,300 ± 2,100
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	3.68 ± 0.40	5.85 ± 0.60	4.24 ± 0.45	4.23 ± 0.45
Total Recoverable Cadmium	mg/kg dry wt	0.0639 ± 0.0098	0.077 ± 0.012	0.077 ± 0.012	0.0641 ± 0.0098
Total Recoverable Chromium	mg/kg dry wt	37.6 ± 4.6	37.0 ± 4.5	37.2 ± 4.5	28.0 ± 3.4
Total Recoverable Copper	mg/kg dry wt	13.3 ± 1.9	14.6 ± 2.1	12.9 ± 1.9	14.4 ± 2.1
Total Recoverable Lead	mg/kg dry wt	11.5 ± 1.4	12.5 ± 1.6	12.3 ± 1.5	14.4 ± 1.8
Total Recoverable Mercury	mg/kg dry wt	0.098 ± 0.014	0.109 ± 0.015	0.097 ± 0.014	0.077 ± 0.012
Total Recoverable Nickel	mg/kg dry wt	11.6 ± 1.2	13.0 ± 1.4	11.8 ± 1.2	15.0 ± 1.6
Total Recoverable Zinc	mg/kg dry wt	66 ± 11	76 ± 13	69 ± 12	73 ± 12

Sample Name:		SED-S250 b [<63um Fraction]	SED-S250 c [<63um Fraction]	SED-S500 a [<63um Fraction]	SED-S500 b [<63um Fraction]
Lab Number:		3185840.77	3185840.78	3185840.79	3185840.80
Individual Tests					
Total Recoverable Aluminium	mg/kg dry wt	17,900 ± 2,200	17,000 ± 2,100	16,300 ± 2,000	16,500 ± 2,000
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	4.90 ± 0.51	5.13 ± 0.53	5.90 ± 0.61	6.12 ± 0.63
Total Recoverable Cadmium	mg/kg dry wt	0.069 ± 0.011	0.0569 ± 0.0091	0.0546 ± 0.0089	0.0528 ± 0.0088

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Sample Type: Sediment

Sample Name:		SED-S250 b [<63um Fraction]	SED-S250 c [<63um Fraction]	SED-S500 a [<63um Fraction]	SED-S500 b [<63um Fraction]
Lab Number:		3185840.77	3185840.78	3185840.79	3185840.80
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Chromium	mg/kg dry wt	24.7 ± 3.0	21.9 ± 2.7	19.7 ± 2.4	20.3 ± 2.5
Total Recoverable Copper	mg/kg dry wt	14.6 ± 2.1	14.2 ± 2.0	12.5 ± 1.8	13.5 ± 2.0
Total Recoverable Lead	mg/kg dry wt	15.0 ± 1.9	14.5 ± 1.8	13.4 ± 1.7	14.8 ± 1.8
Total Recoverable Mercury	mg/kg dry wt	0.094 ± 0.014	0.092 ± 0.013	0.095 ± 0.014	0.087 ± 0.013
Total Recoverable Nickel	mg/kg dry wt	15.4 ± 1.6	14.6 ± 1.5	13.8 ± 1.4	14.5 ± 1.5
Total Recoverable Zinc	mg/kg dry wt	75 ± 12	70 ± 12	65 ± 11	69 ± 11

Sample Name:		SED-S500 c [<63um Fraction]	SED-S750 a [<63um Fraction]	SED-S750 b [<63um Fraction]	SED-S750 c [<63um Fraction]
Lab Number:		3185840.81	3185840.82	3185840.83	3185840.84
Individual Tests					
Total Recoverable Aluminium	mg/kg dry wt	15,900 ± 2,000	17,300 ± 2,100	19,200 ± 2,400	17,300 ± 2,100
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	5.33 ± 0.55	6.41 ± 0.66	6.77 ± 0.69	6.55 ± 0.67
Total Recoverable Cadmium	mg/kg dry wt	0.0527 ± 0.0088	0.0567 ± 0.0091	0.0594 ± 0.0094	0.0523 ± 0.0087
Total Recoverable Chromium	mg/kg dry wt	20.6 ± 2.5	20.3 ± 2.5	20.5 ± 2.5	21.9 ± 2.7
Total Recoverable Copper	mg/kg dry wt	13.0 ± 1.9	13.9 ± 2.0	15.0 ± 2.1	13.4 ± 1.9
Total Recoverable Lead	mg/kg dry wt	13.7 ± 1.7	14.9 ± 1.8	16.3 ± 2.0	14.8 ± 1.8
Total Recoverable Mercury	mg/kg dry wt	0.154 ± 0.020	0.096 ± 0.014	0.141 ± 0.019	0.092 ± 0.013
Total Recoverable Nickel	mg/kg dry wt	14.3 ± 1.5	15.0 ± 1.6	15.7 ± 1.6	14.7 ± 1.5
Total Recoverable Zinc	mg/kg dry wt	68 ± 11	71 ± 12	72 ± 12	70 ± 12

Sample Name:		SED-S1000 a [<63um Fraction]	SED-S1000 b [<63um Fraction]	SED-S1000 c [<63um Fraction]	SED-S1500 a [<63um Fraction]
Lab Number:		3185840.85	3185840.86	3185840.87	3185840.88
Individual Tests					
Total Recoverable Aluminium	mg/kg dry wt	17,600 ± 2,200	17,000 ± 2,100	18,900 ± 2,300	17,700 ± 2,200
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	6.45 ± 0.66	6.53 ± 0.67	6.57 ± 0.68	6.43 ± 0.66
Total Recoverable Cadmium	mg/kg dry wt	0.0553 ± 0.0090	0.0514 ± 0.0087	0.0547 ± 0.0089	0.0526 ± 0.0088
Total Recoverable Chromium	mg/kg dry wt	18.7 ± 2.3	20.0 ± 2.5	21.1 ± 2.6	19.2 ± 2.4
Total Recoverable Copper	mg/kg dry wt	14.5 ± 2.1	14.3 ± 2.1	14.9 ± 2.1	13.2 ± 1.9
Total Recoverable Lead	mg/kg dry wt	16.0 ± 2.0	15.9 ± 2.0	16.6 ± 2.0	15.3 ± 1.9
Total Recoverable Mercury	mg/kg dry wt	0.095 ± 0.014	0.100 ± 0.014	0.106 ± 0.015	0.092 ± 0.013
Total Recoverable Nickel	mg/kg dry wt	15.3 ± 1.6	14.8 ± 1.5	15.9 ± 1.6	14.7 ± 1.5
Total Recoverable Zinc	mg/kg dry wt	71 ± 12	70 ± 12	74 ± 12	70 ± 12

Sample Name:		SED-S1500 b [<63um Fraction]	SED-S1500 c [<63um Fraction]	SED-S2100 a [<63um Fraction]	SED-S2100 b [<63um Fraction]
Lab Number:		3185840.89	3185840.90	3185840.91	3185840.92
Individual Tests					
Total Recoverable Aluminium	mg/kg dry wt	17,300 ± 2,100	17,000 ± 2,100	14,900 ± 1,800	12,600 ± 1,600
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	6.37 ± 0.66	6.55 ± 0.67	5.00 ± 0.52	4.70 ± 0.49
Total Recoverable Cadmium	mg/kg dry wt	0.0499 ± 0.0085	0.0449 ± 0.0081	0.0434 ± 0.0080	0.0326 ± 0.0072
Total Recoverable Chromium	mg/kg dry wt	21.6 ± 2.6	20.0 ± 2.5	20.1 ± 2.5	17.6 ± 2.2
Total Recoverable Copper	mg/kg dry wt	13.2 ± 1.9	12.6 ± 1.8	10.3 ± 1.5	8.3 ± 1.2
Total Recoverable Lead	mg/kg dry wt	14.6 ± 1.8	14.7 ± 1.8	12.7 ± 1.6	10.8 ± 1.3
Total Recoverable Mercury	mg/kg dry wt	0.088 ± 0.013	0.092 ± 0.013	0.082 ± 0.012	0.0609 ± 0.0099
Total Recoverable Nickel	mg/kg dry wt	14.8 ± 1.5	14.4 ± 1.5	13.2 ± 1.4	11.2 ± 1.2
Total Recoverable Zinc	mg/kg dry wt	69 ± 11	68 ± 11	61.8 ± 9.9	52.4 ± 8.4

Sample Name:		SED-S2100 c [<63um Fraction]	SED-E250 a [<63um Fraction]	SED-E250 b [<63um Fraction]	SED-E250 c [<63um Fraction]
Lab Number:		3185840.93	3185840.94	3185840.95	3185840.96
Individual Tests					
Total Recoverable Aluminium	mg/kg dry wt	12,100 ± 1,500	13,800 ± 1,700	15,500 ± 1,900	15,700 ± 1,900

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Sample Type: Sediment

Sample Name:		SED-S2100 c [<63um Fraction]	SED-E250 a [<63um Fraction]	SED-E250 b [<63um Fraction]	SED-E250 c [<63um Fraction]
Lab Number:		3185840.93	3185840.94	3185840.95	3185840.96
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	4.44 ± 0.47	5.17 ± 0.54	5.81 ± 0.58	5.78 ± 0.60
Total Recoverable Cadmium	mg/kg dry wt	0.0293 ± 0.0070	0.0449 ± 0.0081	0.0524 ± 0.0087	0.0509 ± 0.0088
Total Recoverable Chromium	mg/kg dry wt	15.7 ± 1.9	17.6 ± 2.2	19.1 ± 2.3	19.5 ± 2.4
Total Recoverable Copper	mg/kg dry wt	7.9 ± 1.2	9.5 ± 1.4	11.0 ± 1.6	12.1 ± 1.7
Total Recoverable Lead	mg/kg dry wt	10.2 ± 1.3	11.5 ± 1.4	13.0 ± 1.6	13.2 ± 1.6
Total Recoverable Mercury	mg/kg dry wt	0.064 ± 0.011	0.075 ± 0.012	0.078 ± 0.012	0.081 ± 0.012
Total Recoverable Nickel	mg/kg dry wt	11.0 ± 1.2	12.2 ± 1.3	13.5 ± 1.4	13.8 ± 1.4
Total Recoverable Zinc	mg/kg dry wt	50.5 ± 8.1	57.8 ± 9.3	64 ± 11	67 ± 11

Sample Name:		SED-E500 a [<63um Fraction]	SED-E500 b [<63um Fraction]	SED-E500 c [<63um Fraction]	SED-E750 a [<63um Fraction]
Lab Number:		3185840.97	3185840.98	3185840.99	3185840.100
Individual Tests					
Total Recoverable Aluminium	mg/kg dry wt	18,000 ± 2,000	15,100 ± 1,900	16,200 ± 2,000	16,700 ± 2,100
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	6.14 ± 0.63	5.87 ± 0.61	6.16 ± 0.64	5.68 ± 0.59
Total Recoverable Cadmium	mg/kg dry wt	0.0411 ± 0.0078	0.0465 ± 0.0082	0.0540 ± 0.0089	0.0527 ± 0.0088
Total Recoverable Chromium	mg/kg dry wt	18.5 ± 2.3	18.4 ± 2.3	19.5 ± 2.4	18.3 ± 2.2
Total Recoverable Copper	mg/kg dry wt	10.7 ± 1.5	11.8 ± 1.7	12.4 ± 1.8	13.3 ± 1.9
Total Recoverable Lead	mg/kg dry wt	12.4 ± 1.5	12.6 ± 1.6	13.3 ± 1.7	14.5 ± 1.8
Total Recoverable Mercury	mg/kg dry wt	0.082 ± 0.012	0.075 ± 0.012	0.081 ± 0.012	0.087 ± 0.013
Total Recoverable Nickel	mg/kg dry wt	13.1 ± 1.4	13.9 ± 1.4	14.4 ± 1.5	14.7 ± 1.5
Total Recoverable Zinc	mg/kg dry wt	61.6 ± 9.9	65 ± 11	67 ± 11	67 ± 11

Sample Name:		SED-E750 b [<63um Fraction]	SED-E750 c [<63um Fraction]	SED-W250 a [<63um Fraction]	SED-W250 b [<63um Fraction]
Lab Number:		3185840.101	3185840.102	3185840.103	3185840.104
Individual Tests					
Total Recoverable Aluminium	mg/kg dry wt	14,700 ± 1,800	16,500 ± 2,000	15,900 ± 2,000	13,900 ± 1,700
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	5.53 ± 0.57	6.18 ± 0.64	5.61 ± 0.58	5.31 ± 0.55
Total Recoverable Cadmium	mg/kg dry wt	0.0474 ± 0.0083	0.0503 ± 0.0086	0.0603 ± 0.0094	0.0606 ± 0.0095
Total Recoverable Chromium	mg/kg dry wt	16.5 ± 2.0	18.7 ± 2.3	19.0 ± 2.3	18.5 ± 2.3
Total Recoverable Copper	mg/kg dry wt	11.2 ± 1.6	12.3 ± 1.8	12.6 ± 1.8	12.2 ± 1.8
Total Recoverable Lead	mg/kg dry wt	12.9 ± 1.6	14.2 ± 1.8	13.7 ± 1.7	13.1 ± 1.6
Total Recoverable Mercury	mg/kg dry wt	0.075 ± 0.012	0.085 ± 0.013	0.080 ± 0.012	0.077 ± 0.012
Total Recoverable Nickel	mg/kg dry wt	13.4 ± 1.4	14.2 ± 1.5	13.3 ± 1.4	12.7 ± 1.3
Total Recoverable Zinc	mg/kg dry wt	62 ± 10	67 ± 11	67 ± 11	64 ± 11

Sample Name:		SED-W250 c [<63um Fraction]	SED-W500 a [<63um Fraction]	SED-W500 b [<63um Fraction]	SED-W500 c [<63um Fraction]
Lab Number:		3185840.105	3185840.106	3185840.107	3185840.108
Individual Tests					
Total Recoverable Aluminium	mg/kg dry wt	16,200 ± 2,000	17,700 ± 2,200	18,100 ± 2,200	17,200 ± 2,100
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg					
Total Recoverable Arsenic	mg/kg dry wt	5.98 ± 0.62	6.71 ± 0.69	7.52 ± 0.77	6.31 ± 0.65
Total Recoverable Cadmium	mg/kg dry wt	0.0654 ± 0.0099	0.0571 ± 0.0092	0.069 ± 0.011	0.0599 ± 0.0094
Total Recoverable Chromium	mg/kg dry wt	19.9 ± 2.4	20.7 ± 2.5	21.6 ± 2.6	20.9 ± 2.6
Total Recoverable Copper	mg/kg dry wt	13.1 ± 1.9	13.0 ± 1.9	15.0 ± 2.2	13.6 ± 2.0
Total Recoverable Lead	mg/kg dry wt	14.3 ± 1.8	14.9 ± 1.8	16.1 ± 2.0	14.9 ± 1.8
Total Recoverable Mercury	mg/kg dry wt	0.084 ± 0.013	0.094 ± 0.014	0.105 ± 0.015	0.097 ± 0.014
Total Recoverable Nickel	mg/kg dry wt	14.0 ± 1.5	14.5 ± 1.5	14.9 ± 1.5	14.9 ± 1.5
Total Recoverable Zinc	mg/kg dry wt	69 ± 12	71 ± 12	74 ± 12	72 ± 12

The reported uncertainty is an expanded uncertainty with a level of confidence of approximately 95 percent (i.e. two standard deviations, calculated using a coverage factor of 2). Reported uncertainties are calculated from the performance of typical matrices, and do not include variation due to sampling.

For further information on uncertainty of measurement at Hill Laboratories, refer to the technical note on our website: www.hill-laboratories.com/files/Intro_To_UOM.pdf, or contact the laboratory.

Analyst's Comments

#1 It should be noted that the sample contained a few worms, thereby possibly altering the portion of >2mm and <2mm fractions. This should be kept in mind when interpreting these results.

#2 It should be noted that there was insufficient sample to complete the Grainsize_3_as analysis at the default quantity required of 100g. The analysis proceeded using approximately 53g of sample. This should be kept in mind when interpreting these results.

Summary of Methods

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

Sample Type: Sediment

Test	Method Description	Default Detection Limit	Sample No
Individual Tests			
Environmental Solids Sample Drying*	Air dried at 35°C Used for sample preparation. May contain a residual moisture content of 2-5%.	-	1-54
Environmental Solids Sample Preparation	Air dried at 35°C and sieved, <2mm fraction. Used for sample preparation May contain a residual moisture content of 2-5%.	-	1-54
Dry Matter for Grainsize samples (sieved as received)*	Drying for 16 hours at 103°C, gravimetry (Free water removed before analysis).	0.10 g/100g as rcvd	1-54
Total Recoverable digestion	Nitric / hydrochloric acid digestion. US EPA 200.2.	-	55-108
Volatile Solids*	Calculation: 100% - Ash. APHA 2540 G 23rd ed. 2017.	0.04 g/100g dry wt	1-54
Ash*	Ignition in muffle furnace 550°C, 6hr, gravimetric. APHA 2540 G 23rd ed. 2017.	0.04 g/100g dry wt	1-54
Sieving through 63 um sieve, no gravimetric result*	<63µm Wet Sieved with no gravimetric determination.	-	1-54
Total Recoverable Aluminium	Dried sample, sieved as specified (if required). Nitric/Hydrochloric acid digestion. ICP-MS, screen level. US EPA 200.2.	10 mg/kg dry wt	55-108
Total Organic Carbon*	Acid pretreatment to remove carbonates present followed by Catalytic Combustion (O2), separation, Thermal Conductivity Detector [Elementar Analyser].	0.05 g/100g dry wt	1-54
Heavy metals, trace As,Cd,Cr,Cu,Ni,Pb,Zn,Hg	Dried sample, <2mm fraction. Nitric/Hydrochloric acid digestion, ICP-MS, trace level	0.010 - 0.8 mg/kg dry wt	55-108
3 Grain Sizes Profile as received			
Fraction >/= 2 mm*	Wet sieving with dispersant, as received, 2.00 mm sieve, gravimetry.	0.1 g/100g dry wt	1-54
Fraction < 2 mm, >/= 63 µm*	Wet sieving using dispersant, as received, 2.00 mm and 63 µm sieves, gravimetry (calculation by difference).	0.1 g/100g dry wt	1-54
Fraction < 63 µm*	Wet sieving with dispersant, as received, 63 µm sieve, gravimetry (calculation by difference).	0.1 g/100g dry wt	1-54

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

Testing was completed between 01-Mar-2023 and 03-May-2023. For completion dates of individual analyses please contact the laboratory.

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

Kim Harrison MSc
Client Services Manager - Environmental

Table A2.2 2023 Contaminant data (mg/kg dry weight) on the <63µm sediment fraction

Stations	% dry weight	TOC %d.w.	TVS %d.w.	Total Aluminium	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Lead	Total Mercury	Total Nickel	Total Zinc
N50 A	54	1.26	5.9	13200	5.9	0.111	35	14.3	12.8	0.1	11.8	76
N50 B	61	0.84	5.1	12000	5.9	0.085	30	15.1	13.9	0.11	12.1	71
N50 C	66	0.53	4.2	8500	4.3	0.117	23	11.4	11.9	0.09	9.8	60
N50	60	0.87	5	11233	5.4	0.104	29	13.6	12.9	0.10	11.2	69
se	3	0.21	0.4	1410	0.5	0.010	3	1.1	0.6	0.01	0.7	5
N100 A	61	0.77	5.2	16200	6.1	0.057	21	13	13.8	0.09	14.3	70
N100 B	63	0.73	4.6	11700	4.6	0.056	23	11.2	10.9	0.07	10.7	56
N100 C	61	0.74	5	15200	5.4	0.047	17.9	11.2	12.7	0.09	13.2	63
N100	62	0.74	4.9	14367	5.4	0.053	21	11.8	12.5	0.08	12.7	63
se	1	0.01	0.1	1364	0.4	0.003	1	0.6	0.8	0.01	1.1	4
N250 A	61	0.78	4.5	16200	6.3	0.047	21	11.4	13.5	0.09	13.9	67
N250 B	62	0.75	4.6	15700	6	0.039	19.9	11.2	13	0.08	13.4	65
N250 C	61	0.78	5	16000	5.8	0.039	19.9	10.7	12.5	0.23	13	63
N250	61	0.77	4.7	15967	6.0	0.042	20	11.1	13.0	0.13	13.4	65
se	0	0.01	0.1	145	0.1	0.003	0	0.2	0.3	0.05	0.3	1
N500 A	67	0.41	4.1	15300	5.8	0.045	19	10.5	12.1	0.08	12.7	61
N500 B	65	0.63	4.5	15800	5.8	0.049	18.7	11.9	13.1	0.1	13.7	64
N500 C	62	0.72	5	16400	6.3	0.048	21	12	13.7	0.09	14.1	66
N500	65	0.58	4.5	15833	6.0	0.047	20	11.5	13.0	0.09	13.5	64
se	1	0.09	0.2	318	0.2	0.001	1	0.5	0.5	0.01	0.4	1
N2500 A	58	1.04	5.7	18300	7	0.055	19.8	11	14.6	0.08	14.8	69
N2500 B	56	1.21	6	18700	7.1	0.055	19.8	11.7	15.2	0.08	15.5	72
N2500 C	59	1.2	5.8	18900	7.2	0.057	20	11.7	15.9	0.09	15.7	72
N2500	58	1.15	5.8	18633	7.1	0.056	20	11.5	15.2	0.08	15.3	71
se	1	0.05	0	176	0.1	0.001	0	0.2	0.4	0.00	0.3	1
S50 A	54	1.78	6	12700	3.7	0.091	52	15.4	11.8	0.15	12.3	75
S50 B	56	1.33	5.8	13300	3.9	0.087	38	16.8	12.4	0.48	12.5	76
S50 C	58	1.39	6.1	11500	3.7	0.084	35	12.4	11.3	0.13	12.3	67
S50	56	1.5	5.9	12500	3.8	0.087	42	14.9	11.8	0.25	12.4	73
se	1	0.14	0	529	0.1	0.002	5	1.3	0.3	0.11	0.1	3
S100 A	57	0.76	4.8	13100	3.7	0.064	38	13.3	11.5	0.10	11.6	66
S100 B	57	1.24	6	13400	5.8	0.077	37	14.6	12.5	0.11	13	76
S100 C	57	1.17	5.9	13700	4.2	0.077	37	12.9	12.3	0.10	11.8	69
S100	57	1.05	5.5	13400	4.6	0.073	37	13.6	12.1	0.10	12.1	70
se	0	0.14	0.3	173	0.6	0.004	0	0.5	0.3	0.00	0.4	3
S250 A	57	0.91	5.1	17300	4.2	0.064	28	14.4	14.4	0.08	15	73
S250 B	55	1.11	4.9	17900	4.9	0.069	25	14.6	15	0.09	15.4	75
S250 C	62	0.92	4.8	17000	5.1	0.057	22	14.2	14.5	0.09	14.8	70
S250	58	0.98	4.9	17400	4.7	0.063	25	14.4	14.6	0.09	15.1	73
se	2	0.06	0	265	0.3	0.003	2	0.1	0.2	0.00	0.2	1
S500 A	65	0.58	4.4	17300	4.2	0.064	28	14.4	14.4	0.08	15	73
S500 B	61	0.67	4.6	17900	4.9	0.069	25	14.6	15	0.09	15.4	75
S500 C	64	0.64	4.3	17000	5.1	0.057	22	14.2	14.5	0.09	14.8	70
S500	63	0.63	4.4	16233	5.8	0.054	20	13.0	14.0	0.11	14.2	67
se	1	0.02	0	176	0.2	0.001	0	0.3	0.4	0.02	0.2	1
S750 A	59	0.58	4.8	17300	6.4	0.057	20	13.9	14.9	0.1	15	71
S750 B	60	0.6	5.2	19200	6.8	0.059	21	15	16.3	0.14	15.7	72
S750 C	51	0.81	5.2	17300	6.6	0.052	22	13.4	14.8	0.09	14.7	70
S750	57	0.66	5.1	17933	6.6	0.056	21	14.1	15.3	0.11	15.1	71
se	3	0.07	0.1	633	0.1	0.002	1	0.5	0.5	0.02	0.3	1
S1000 A	55	0.63	5.2	17600	6.5	0.055	18.7	14.5	16	0.09	15.3	71
S1000 B	56	0.82	5.3	17000	6.5	0.051	20	14.3	15.9	0.1	14.8	70
S1000 C	54	0.74	5.2	18900	6.6	0.055	21	14.9	16.6	0.11	15.9	74
S1000	55	0.73	5.2	17833	6.5	0.054	20	14.6	16.2	0.10	15.3	72
se	1	0.05	0	561	0.0	0.001	1	0.2	0.2	0.01	0.3	1

Stations	% dry weight	TOC %d.w.	TVS %d.w.	Total Aluminium	Total Arsenic	Total Cadmium	Total Chromium	Total Copper	Total Lead	Total Mercury	Total Nickel	Total Zinc
S1500 A	57	0.76	4.9	17700	6.4	0.053	19.2	13.2	15.3	0.09	14.7	70
S1500 B	65	0.61	4.4	17300	6.4	0.05	22	13.2	14.6	0.09	14.8	69
S1500 C	65	0.54	4	17000	6.6	0.045	20	12.6	14.7	0.09	14.4	68
S1500	62	0.63	4.4	17333	6.5	0.049	20	13.0	14.9	0.09	14.6	69
se	3	0.06	0.2	203	0.1	0.002	1	0.2	0.2	0.00	0.1	1
S2100 A	64	0.53	4.4	14900	5	0.043	20	10.3	12.7	0.08	13.2	62
S2100 B	68	0.32	3.7	12600	4.7	0.033	17.6	8.3	10.8	0.06	11.2	52
S2100 C	64	0.53	4.3	12100	4.4	0.029	15.7	7.9	10.2	0.06	11	51
S2100	65	0.46	4.1	13200	4.7	0.035	18	8.8	11.2	0.07	11.8	55
se	1	0.07	0.2	862	0.2	0.004	1	0.7	0.8	0.01	0.7	4
E250 A	60	0.68	4.4	13800	5.2	0.045	17.6	9.5	11.5	0.08	12.2	58
E250 B	63	0.7	4.7	15500	5.6	0.052	19.1	11	13	0.08	13.5	64
E250 C	56	0.92	5.3	15700	5.8	0.051	19.5	12.1	13.2	0.08	13.8	67
E250	60	0.76	4.8	15000	5.5	0.049	19	10.9	12.6	0.08	13.2	63
se	2	0.07	0.2	603	0.2	0.002	1	0.8	0.5	0.00	0.5	3
E500 A	57	0.86	5.1	16000	6.1	0.041	18.5	10.7	12.4	0.08	13.1	62
E500 B	57	0.96	5.4	15100	5.9	0.047	18.4	11.8	12.6	0.08	13.9	65
E500 C	55	0.98	5.4	16200	6.2	0.054	19.5	12.4	13.3	0.08	14.4	67
E500	56	0.93	5.3	15767	6.1	0.047	19	11.6	12.8	0.08	13.8	65
se	1	0.03	0.1	338	0.1	0.004	0	0.5	0.3	0.00	0.4	1
E750 A	61	0.94	5	16700	5.7	0.053	18.3	13.3	14.5	0.09	14.7	67
E750 B	63	0.86	4.3	14700	5.5	0.047	16.5	11.2	12.9	0.07	13.4	62
E750 C	55	0.81	4.8	16500	6.2	0.05	18.7	12.3	14.2	0.09	14.2	67
E750	60	0.87	4.7	15967	5.8	0.050	18	12.3	13.9	0.08	14.1	65
se	2	0.03	0.2	636	0.2	0.002	1	0.6	0.5	0.01	0.4	2
W250 A	61	0.74	4.6	15900	5.6	0.06	19	12.8	13.7	0.08	13.3	67
W250 B	67	0.62	4.1	13900	5.3	0.061	18.5	12.2	13.1	0.08	12.7	64
W250 C	62	0.85	4.4	16200	6	0.065	19.9	13.1	14.3	0.08	14	69
W250	63	0.73	4.3	15333	5.6	0.062	19	12.7	13.7	0.08	13.3	67
se	2	0.06	0.1	722	0.2	0.002	0	0.3	0.3	0.00	0.4	1
W500 A	61	0.64	4.1	17700	6.7	0.057	21	13	14.9	0.09	14.5	71
W500 B	65	0.67	4.3	18100	7.5	0.069	22	15	16.1	0.11	14.9	74
W500 C	56	0.71	4.1	17200	6.3	0.06	21	13.6	14.9	0.1	14.9	72
W500	61	0.67	4.1	17667	6.8	0.062	21	13.9	15.3	0.10	14.8	72
se	3	0.02	0	260	0.4	0.004	0	0.6	0.4	0.01	0.1	1
ANZG (2018)			**DGV**		20	1.5	80	65	50	0.15	21	200
			GV-HIGH		70	10	370	270	220	1	52	410

Appendix 3 Total organic carbon (TOC) and Total volatile solids (TVS) analysis

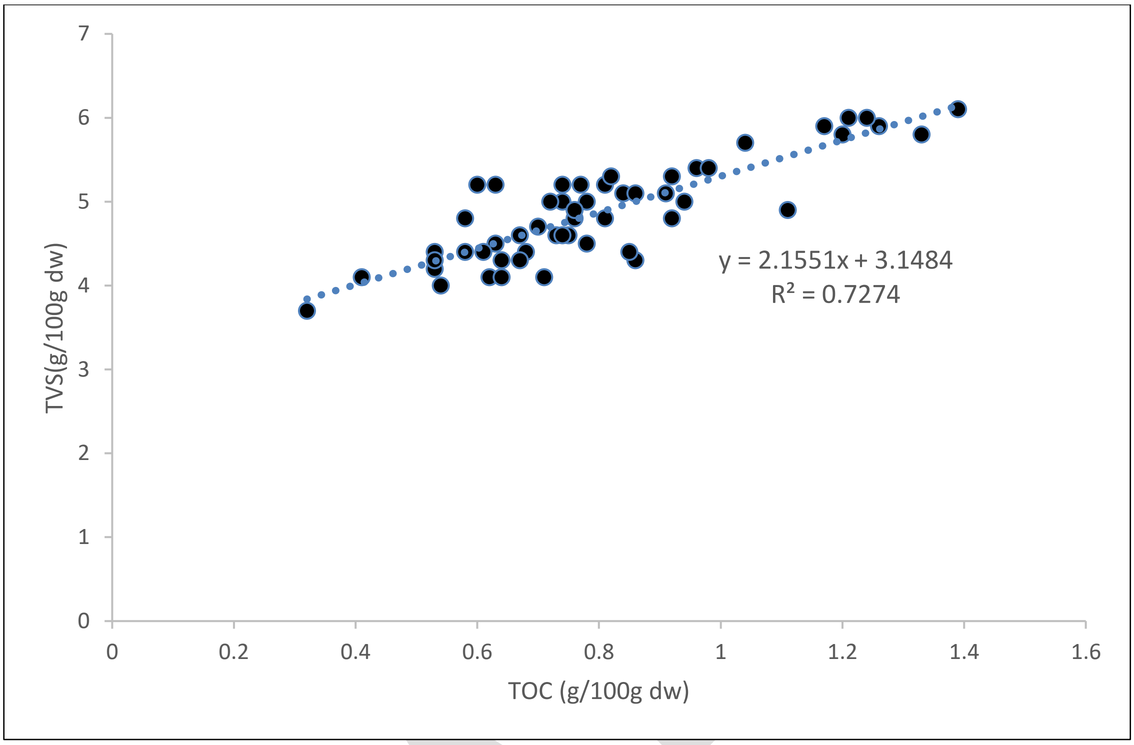


Figure A3.1 Correlation between TOC (% dry weight) and TVS (% dry weight)

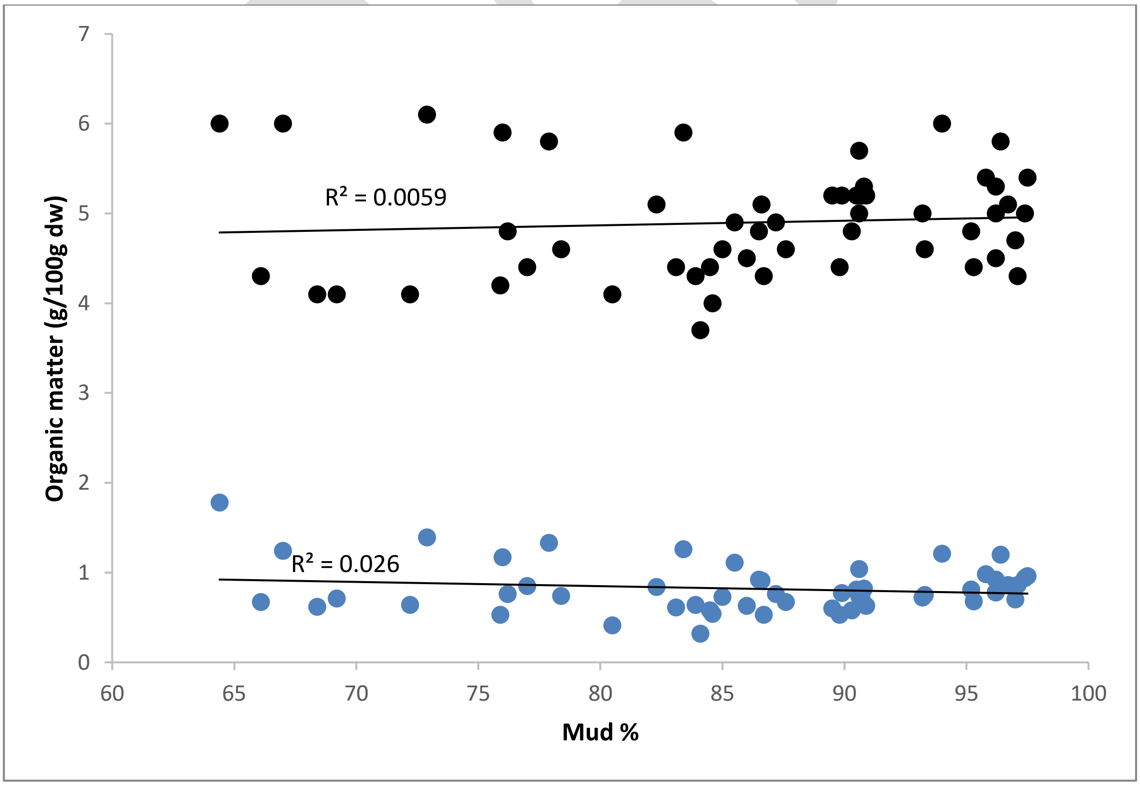
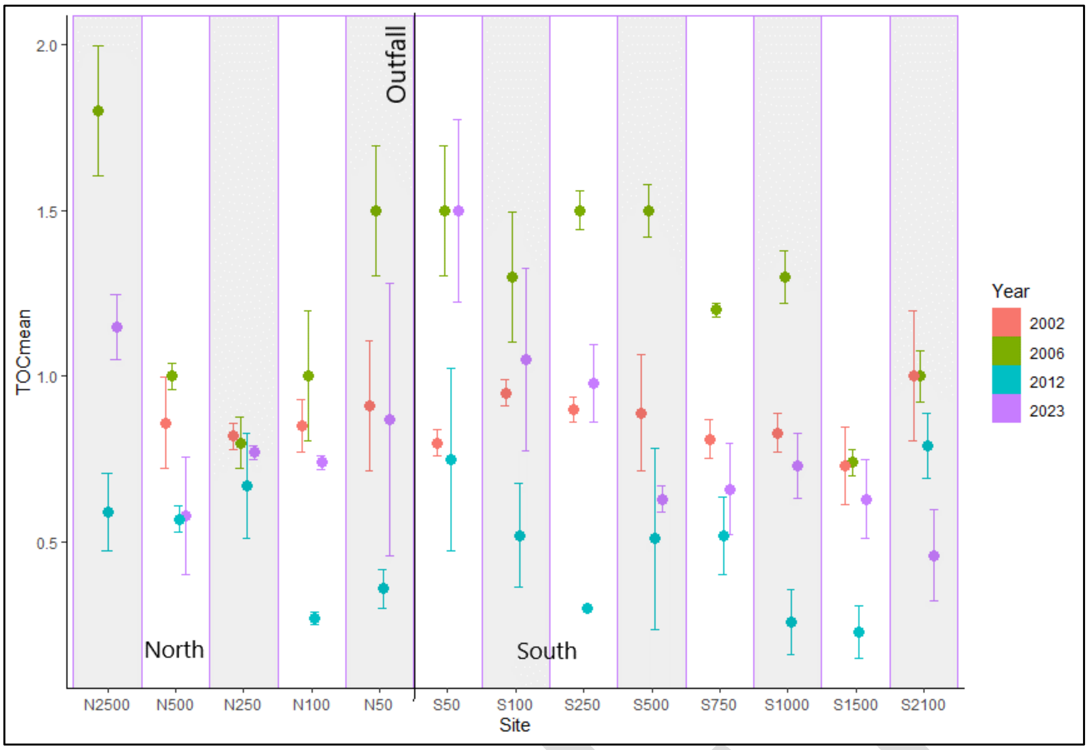


Figure A3.2 Correlation between mud % and TOC (% dry weight) in blue, and between mud% and TVS (% dry weight) in black



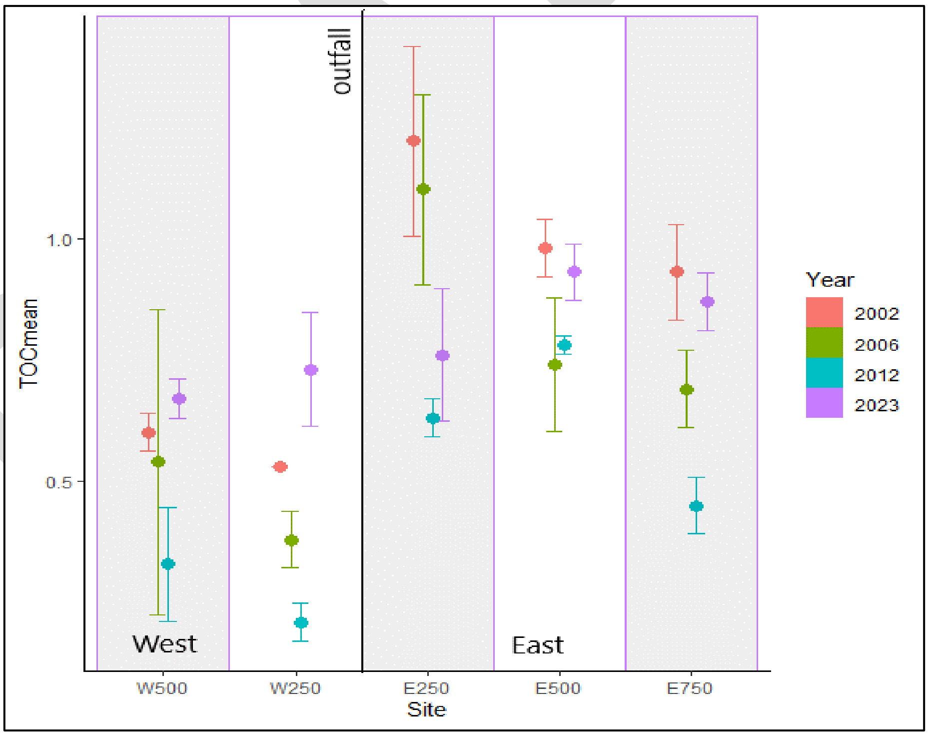
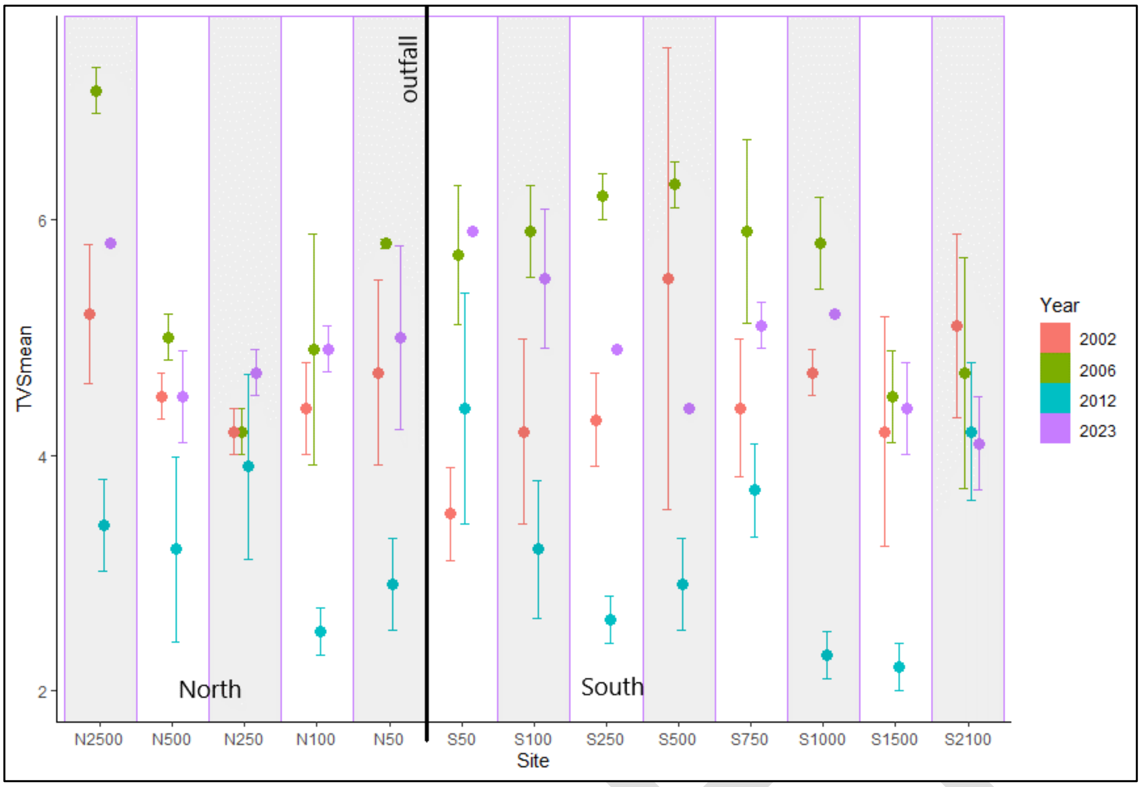


Figure A3.3 TOC (% dry weight) per site during the last 4 surveys



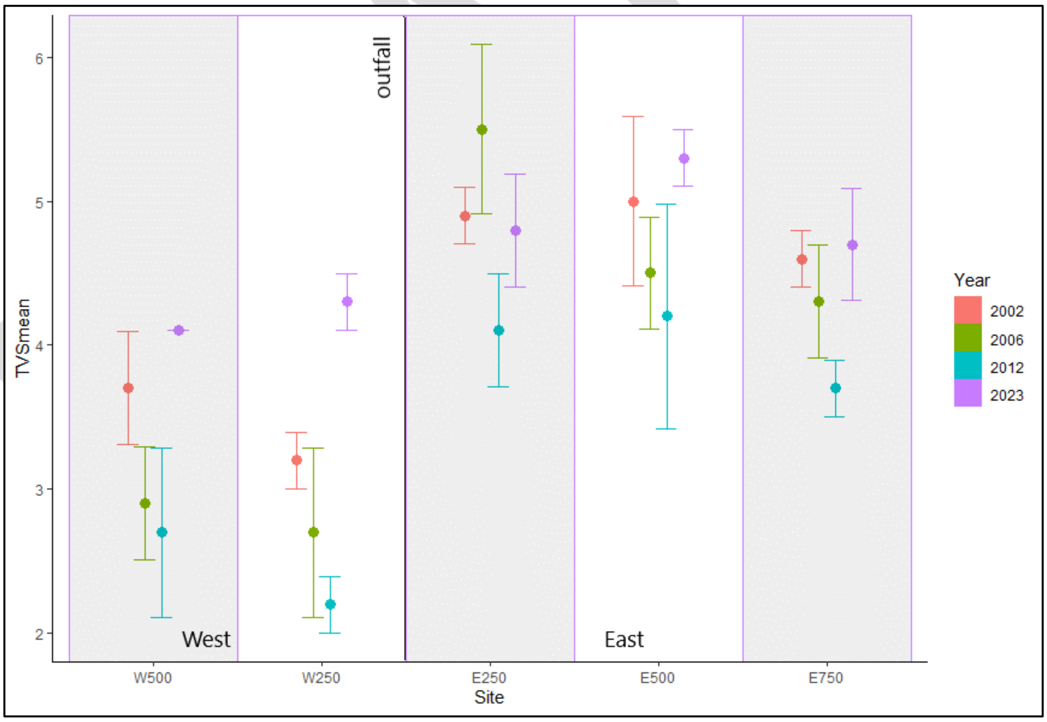


Figure A3.4 TVS (% dry weight) per site during the last 4 surveys

Appendix 4 Univariate statistical tests on 2023 contaminant concentrations

Table A4.1 Total Arsenic & metals - Statistical tests results for distance

Krukal-Wallis tests were conducted on the Aluminium-normalised data.

Element	DISTANCE north-south		DISTANCE west-east	
	K-W Statistic value	P value	K-W Statistic value	P value
Aluminium	H=23.161	p=0.001	H=4.629	p=0.098
Arsenic	H=2.034	p=0.958	H=4.920	p=0.085
Cadmium	H=26.082	p<0.001	H=5.029	p=0.081
Chromium	H=24.097	p=0.001	H=10.554	p=0.005
Copper	H=28.576	p<0.001	H=0.289	p=0.866
Lead	H=26.459	p<0.001	H=2.078	p=0.354
Mercury	H=24.552	p<0.001	H=1.273	p=0.529
Nickel	H=19.243	p=0.007	H=0.956	p=0.620
Zinc	H=25.378	p<0.001	H=4.464	p=0.107

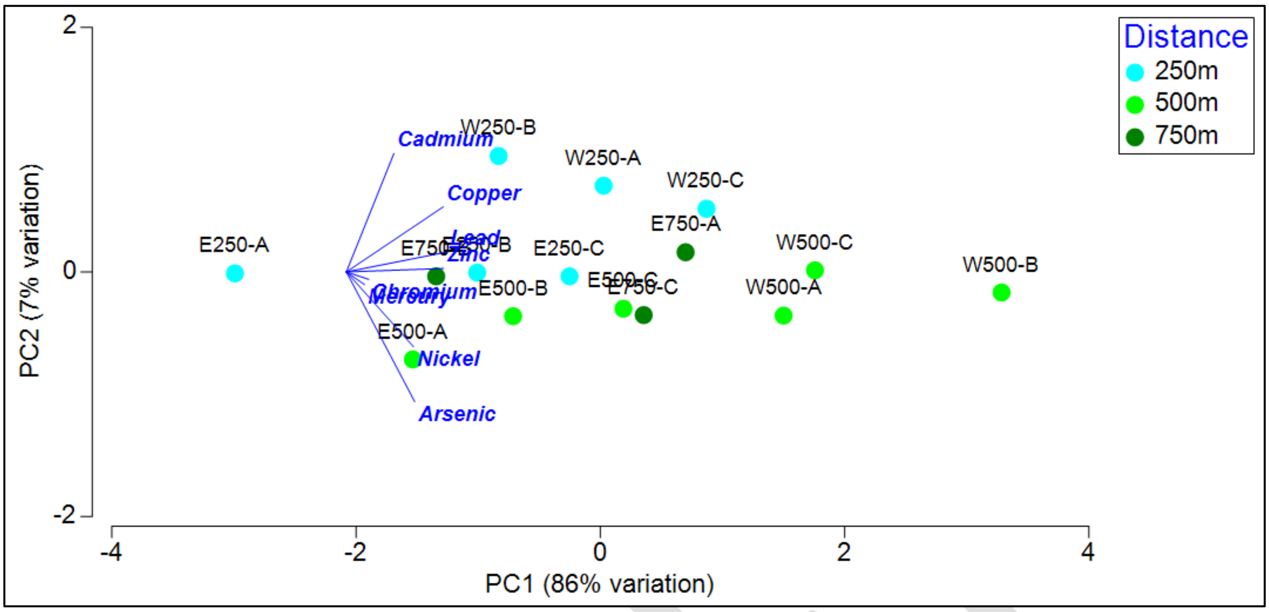
Highlighted p values are statistically significant at alpha = 0.05.

Table A4.2 Total Arsenic & metals - Post hoc tests detailed differences

Dunn tests were conducted on the Aluminium-normalised data.

Factor	**DISTANCE** north-south	DISTANCE west-east
Aluminium	50m < 250m, 750m, 1000m, 1500m	
Cadmium	50m > distances over 250m	
Chromium	50m > distances over 100m	750m < others
Copper	50m > distances over 250m & 100m > over 2000m	
Lead	50m > 250m, 500m, over 2000m	
Mercury	50m > 250m, 500m, 1500m, over 2000m	
Nickel	50m > distances over 250m	
Zinc	50m > distances over 250m	

Appendix 5 Contaminant Analysis



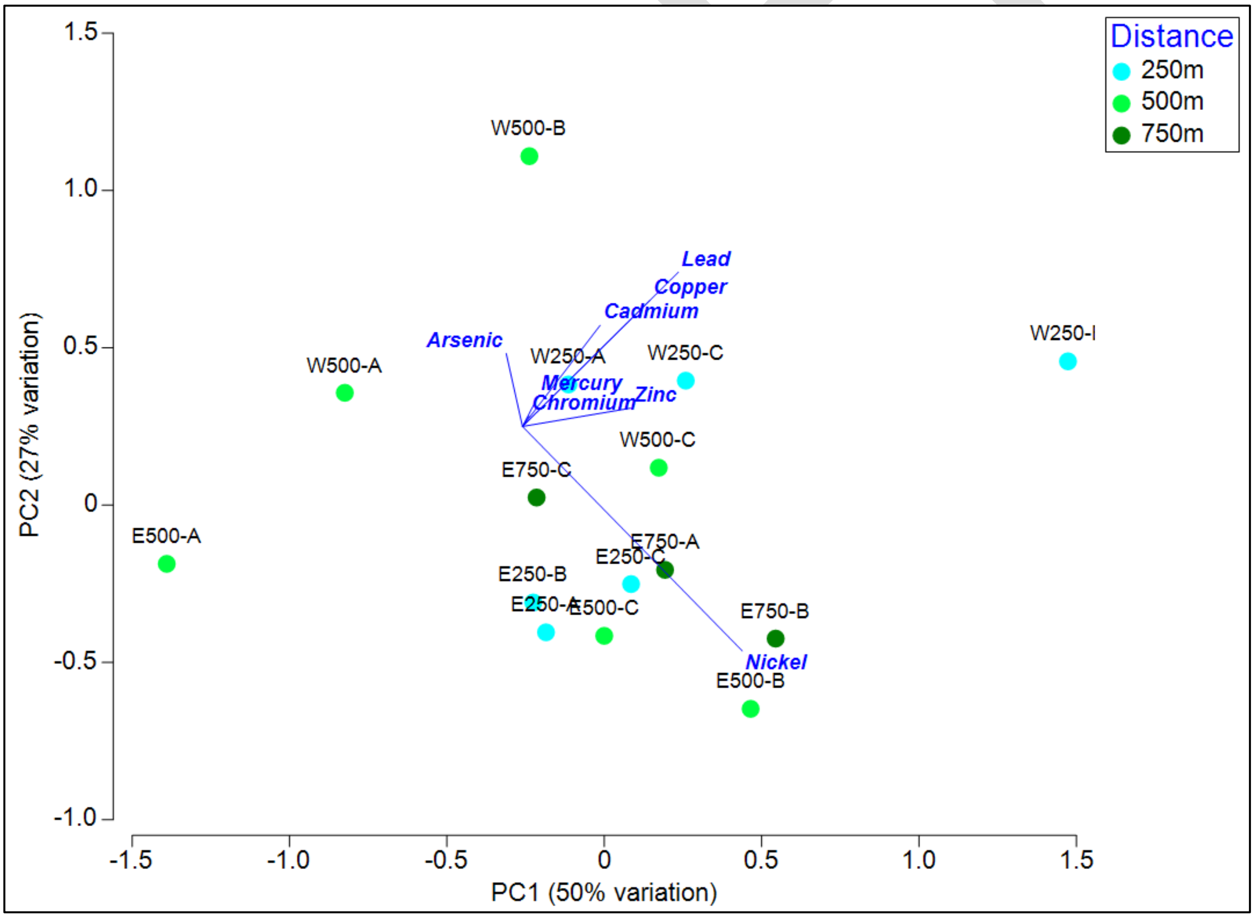
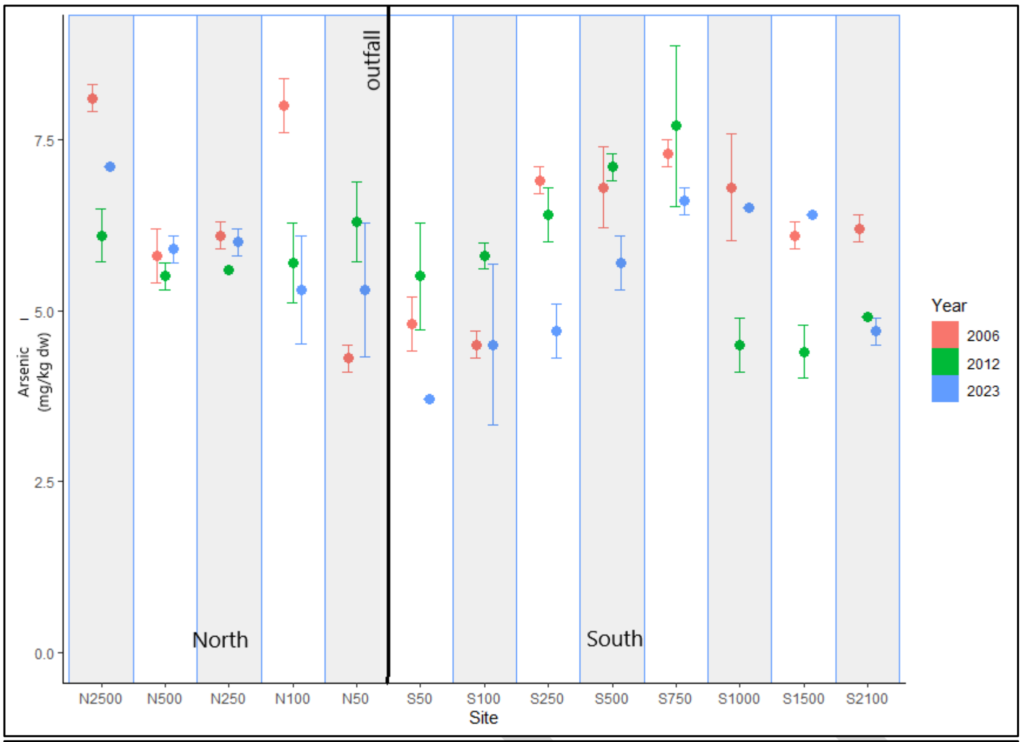


Figure A5.5 Principal Component Analyses based on metal/metalloid concentrations along the west-east sampling axis. Top PCA with raw data, bottom PCA with Al-normalised data.



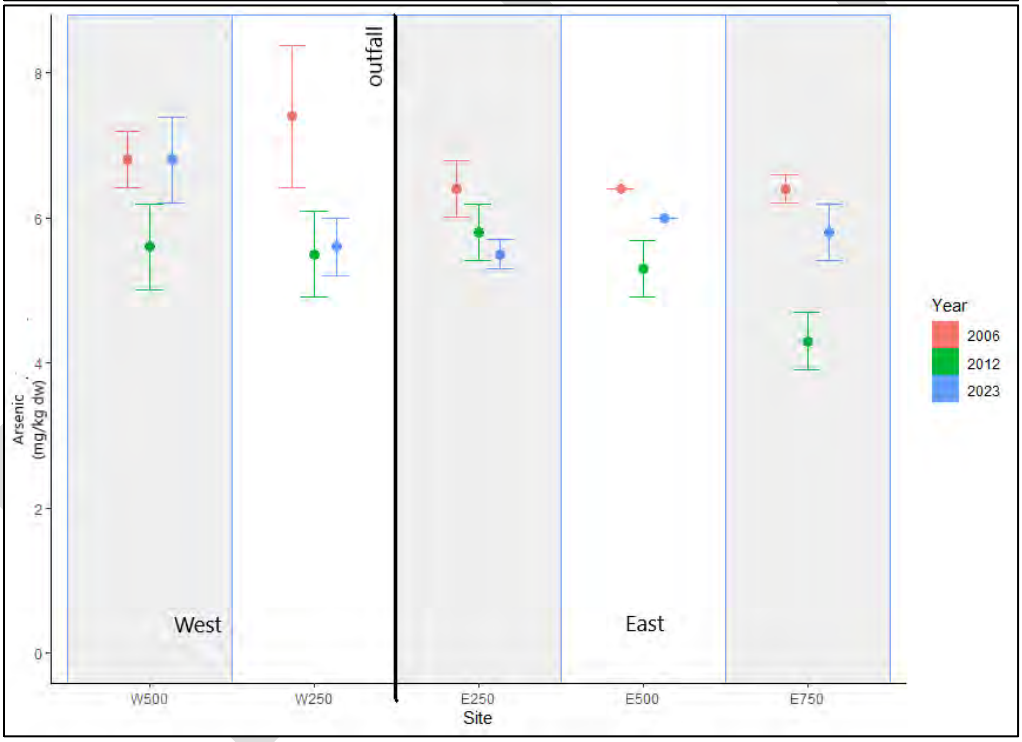
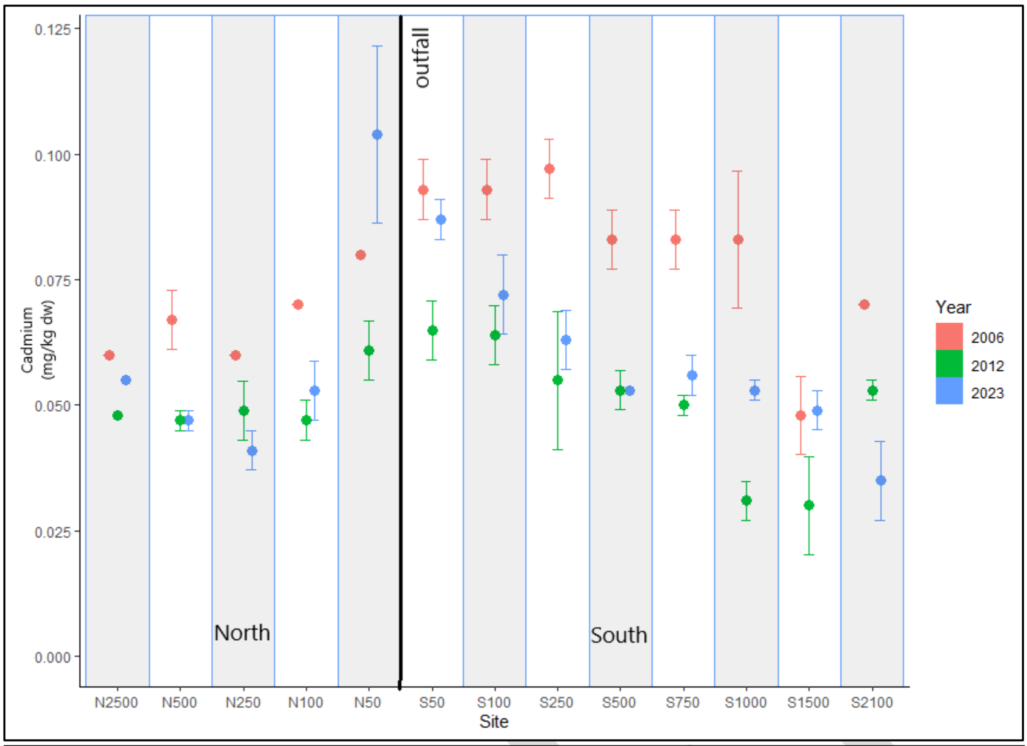


Figure A5.6 Arsenic concentrations (Mean ± 95%CI) per site and per year. 2006 and 2012 data from Golder



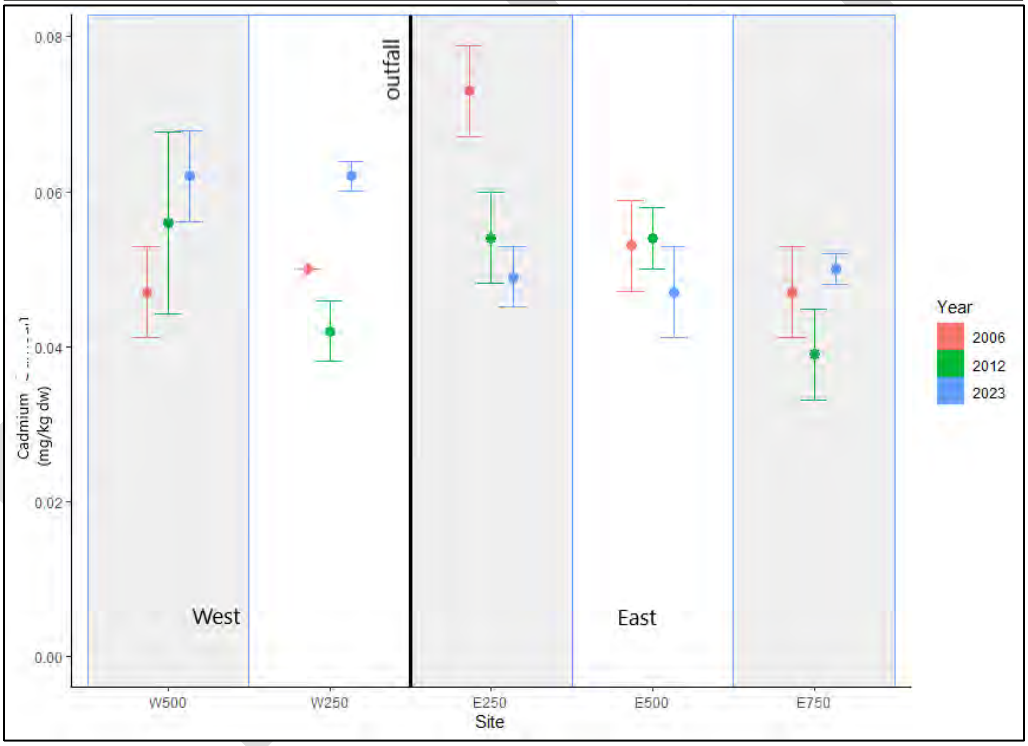


Figure A5.7 Cadmium concentrations (Mean ± 95%CI) per site and per year. 2006 and 2012 data from Golder

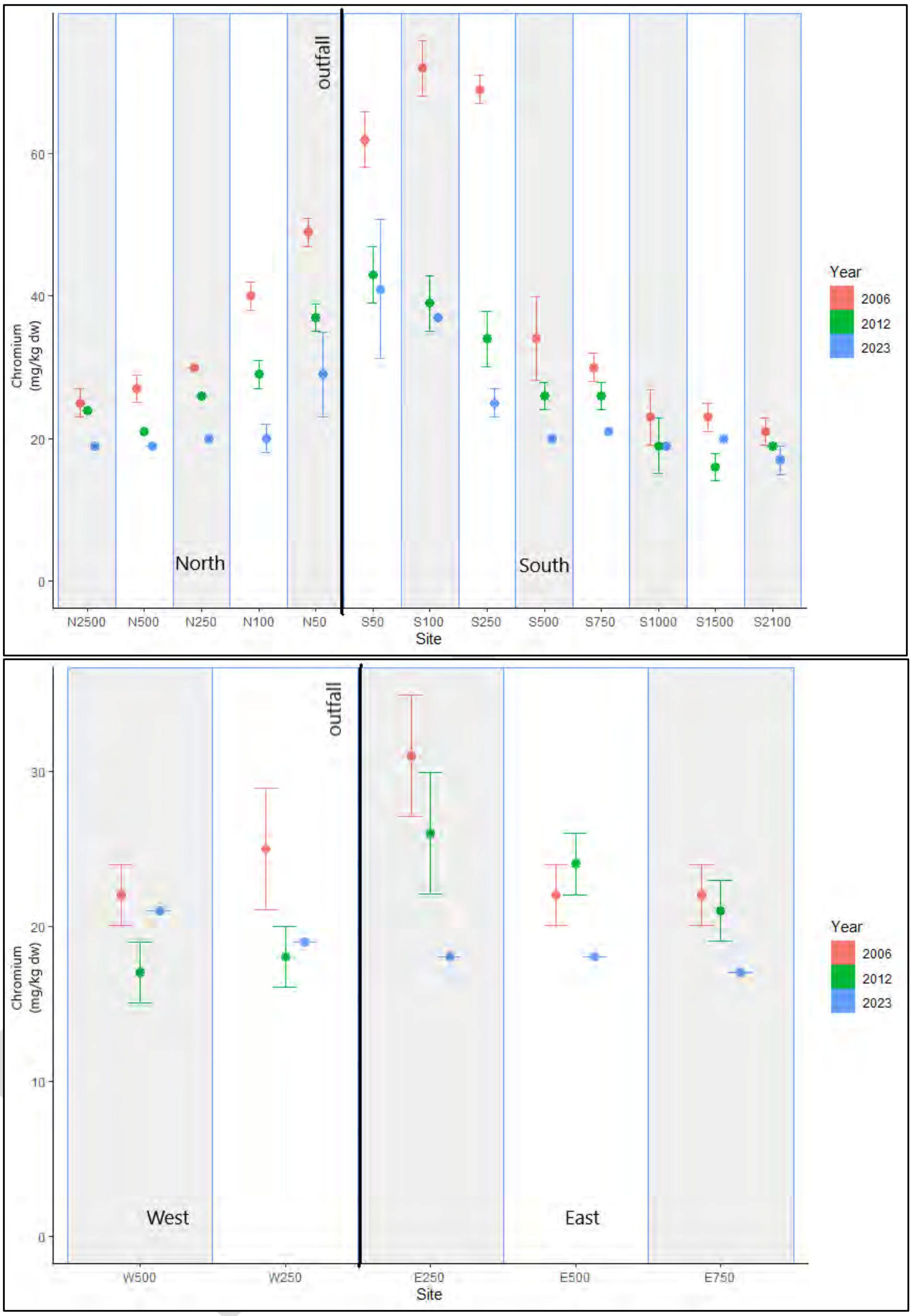
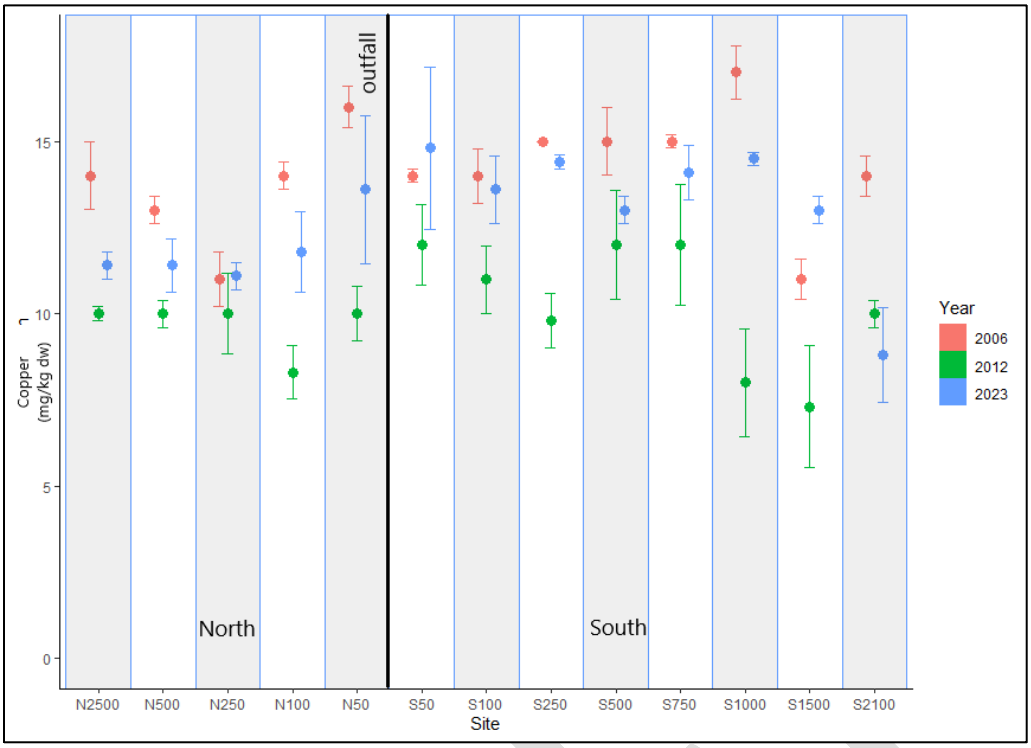


Figure A5.8 Chromium concentrations (Mean ± 95%CI) per site and per year. 2006 and 2012 data from Golder



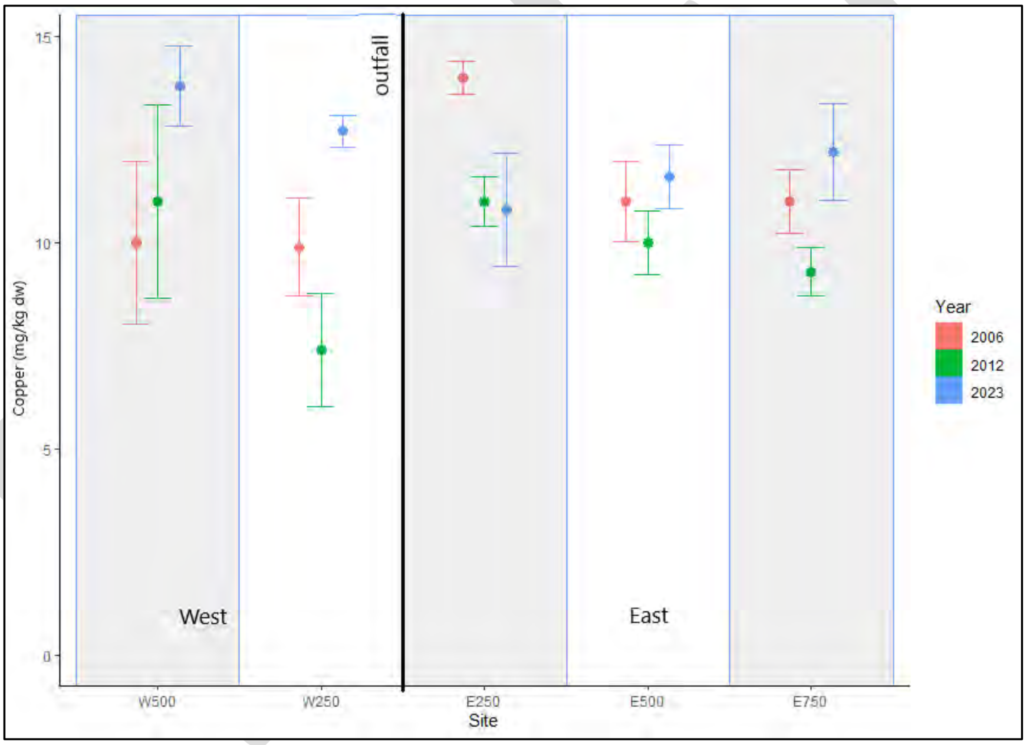


Figure A5.9 Copper concentrations (Mean ± 95%CI) per site and per year. 2006 and 2012 data from Golder

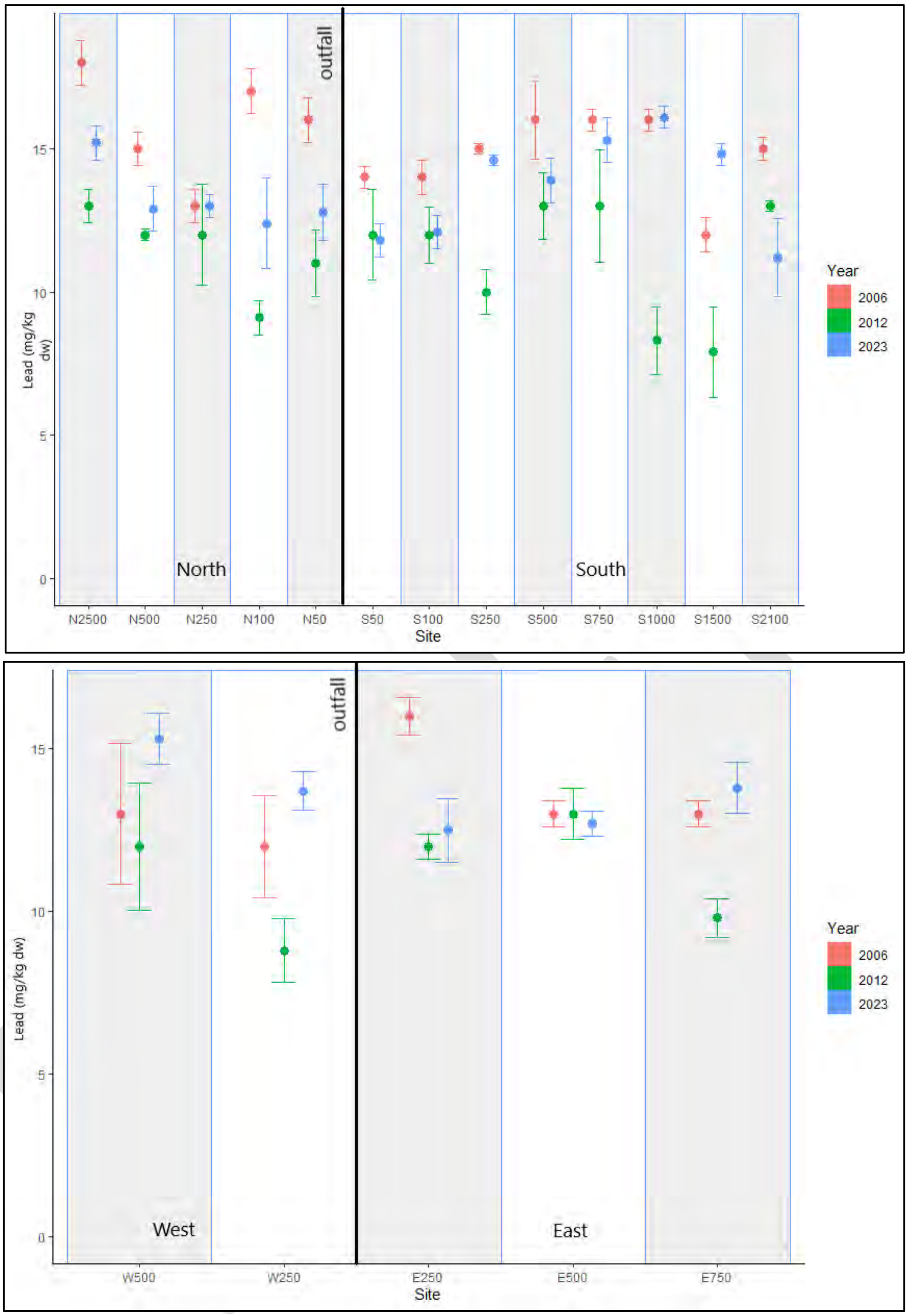


Figure A5.10 Lead concentrations (Mean ± 95%CI) per site and per year. 2006 and 2012 data from Golder

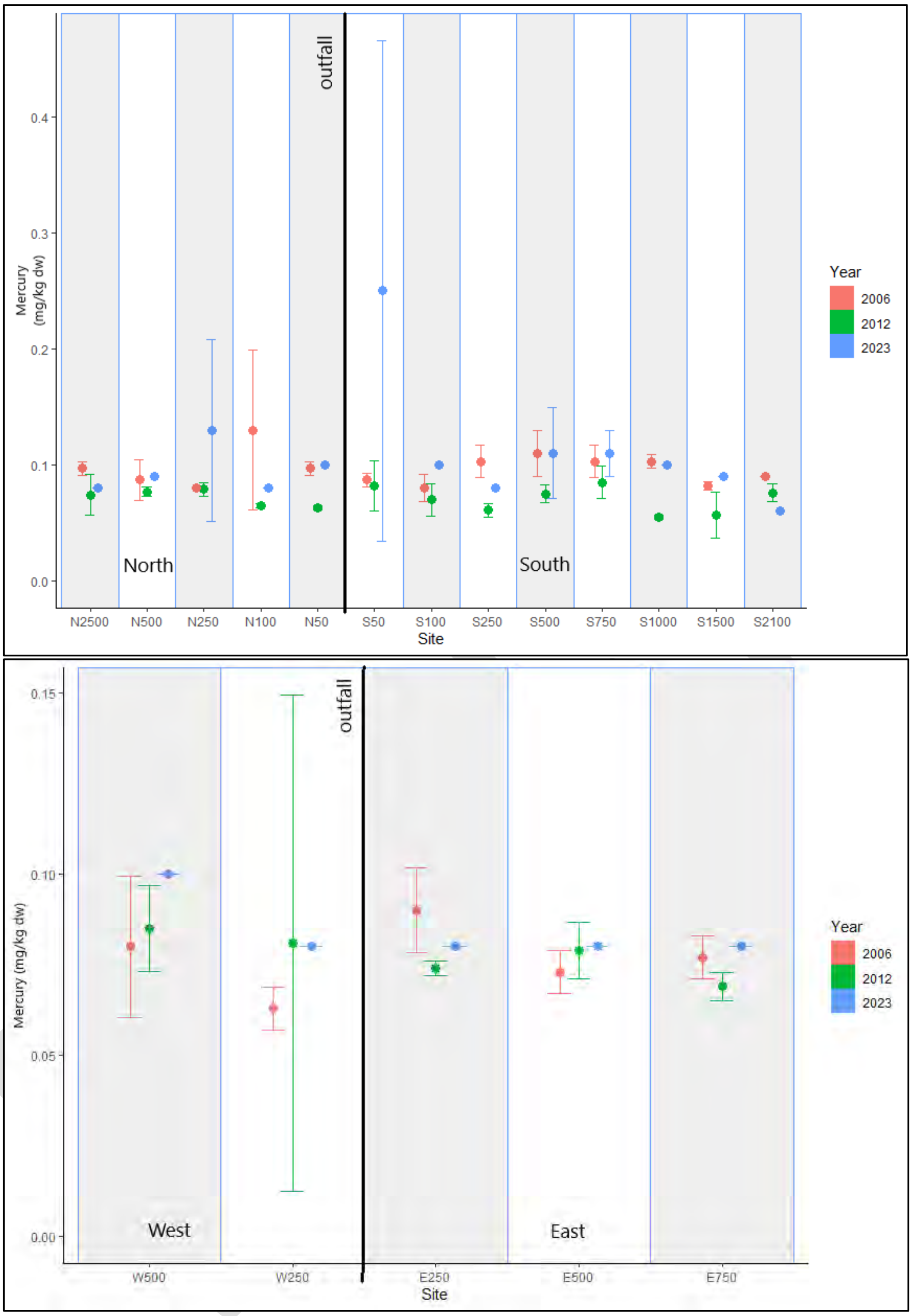


Figure A5.11 Mercury concentrations (Mean ± 95%CI) per site and per year. 2006 and 2012 data from Golder

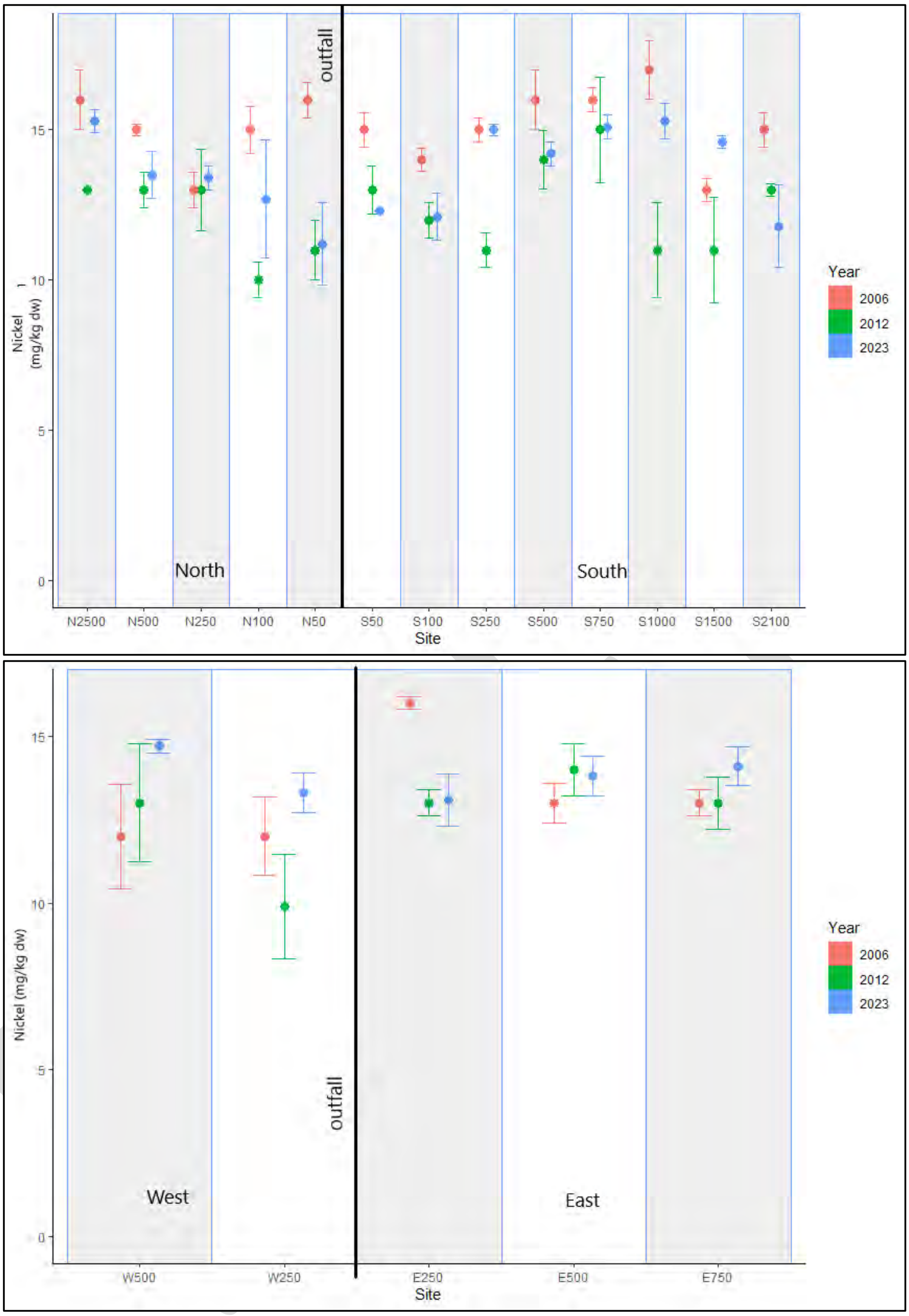


Figure A5.12 Nickel concentrations (Mean ± 95%CI) per site and per year. 2006 and 2012 data from Golder

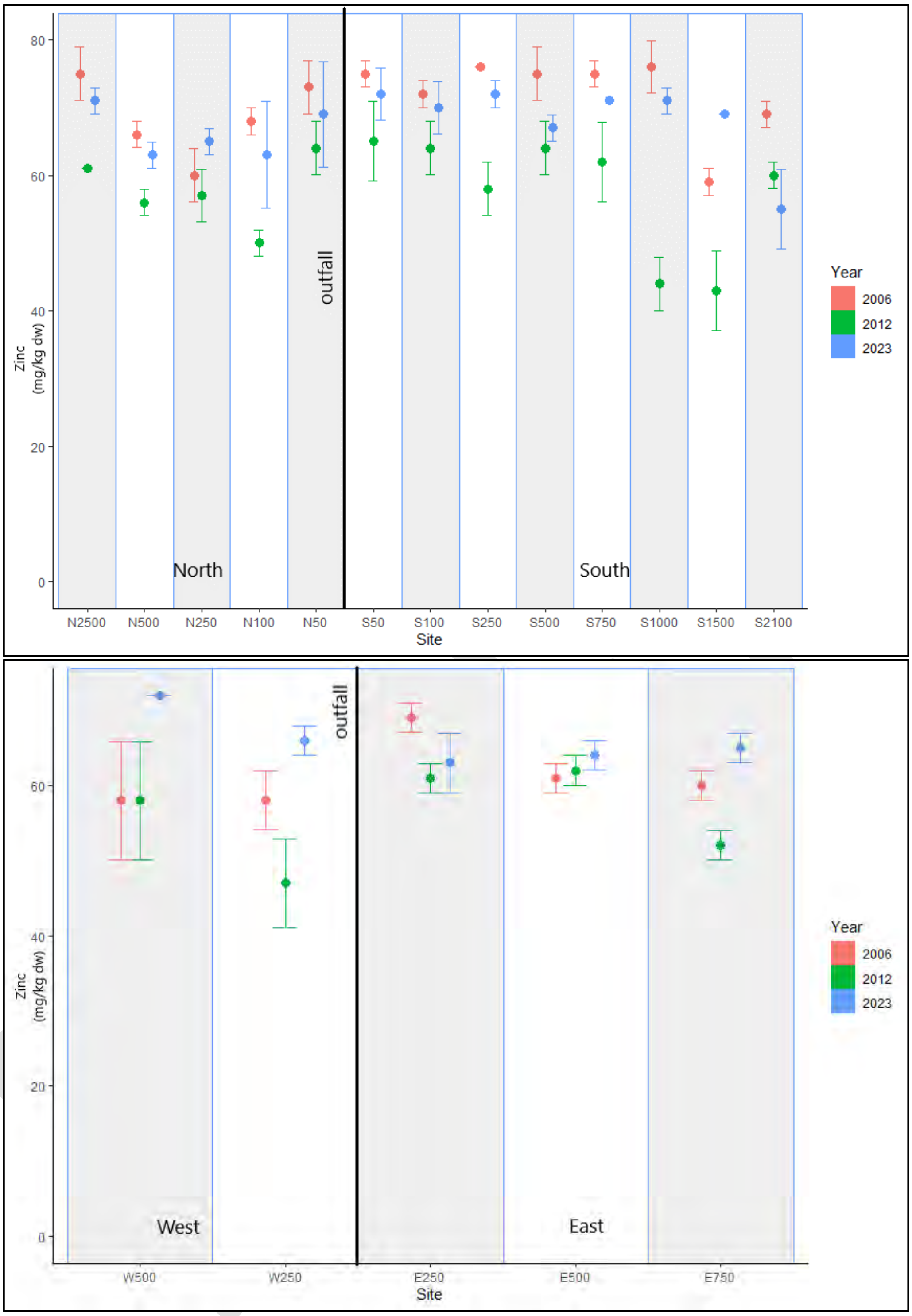


Figure A5.13 Zinc concentrations (Mean ± 95%CI) per site and per year. 2006 and 2012 data from Golder

Appendix 6 Benthic biota 2023 raw data

Table A6.1 Benthic biota North and South Transects raw data (No./0.05 m²)

		Region	NORTH															SOUTH																							
		Site	N50			N100			N250			N500			N2500			S50			S100			S250			S500			S750			S1000			S1500			S2100		
		Common Name	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Hydrozoa	Hydroida (athecate)	Hydroid athecate																																							1
Anthozoa	Edwardsia sp.	Burrowing anemone												3													1				2	1	1	1							
Nemertea	Nemertea	Proboscis worms																																						2	
Sipuncula	Sipunculus sp.	Peanut worm																																						1	
Bivalvia	Arthritica bifurca	Small bivalve					1	1																	3																
Bivalvia	Leptomya retiaria retiaria	Small bivalve																																						1	2
Bivalvia	Ruditapes largillierti	Thick lipped buscuit shell				1																																			
Bivalvia	Theora lubrica	Window shell																		1					1													1			
Bivalvia	Varinucula gallinacea	Nut shell															2			1													1		1					3	
Oligochaeta	Oligochaeta	Oligochaete worms																																							
Polychaeta: Paraonidae	Paraonidae	Polychaete worm																																							
Polychaeta: Cossuridae	Cossura consimilis	Polychaete worm		2		4	6	11	23	23	38	6	12	9	2	3	2							9	1	1	7	4			7	10	3	4	5	4	1			5	8
Polychaeta: Spionidae	Paraprionospio sp.	Polychaete worm			1			3	2	1	3	1	1	5	1	5	3							2	4		72	12	9		8		12	8	9	3	5		11	19	20
Polychaeta: Spionidae	Polydora sp.	Polychaete worm		151																																					
Polychaeta: Spionidae	Prionospio aucklandica	Polychaete worm		313			1	4										3	1	98		5	8	1	109	4														1	4
Polychaeta: Spionidae	Prionospio yuriel	Polychaete worm					1			1				1		2	1								6																
Polychaeta: Magelonidae	Magelona dakini	Polychaete worm																																						1	
Polychaeta: Capitellidae	Capitella sp.	Polychaete worm		6				5												2							1														
Polychaeta: Capitellidae	Heteromastus filiformis	Polychaete worm		102	1	2	20	54	19	17	16	10	40	26	1	60	16			4		2	4	8	13	1	14	5	1		3					2	1			3	5
Polychaeta: Sigalionidae	Sigalionidae	Polychaete worm																																					1		
Polychaeta: Hesionidae	Hesionidae	Polychaete Worm		1																																			1		
Polychaeta: Glyceridae	Glyceridae	Polychaete worm		1																																			1		1
Polychaeta: Nephtyidae	Aglaophamus sp.	Polychaete worm										1				1																								3	
Polychaeta: Onuphidae	Diopatra akarana	Polychaete worm		20	1	12												6	2	12	23	23	20	6	10	26		1	4	4			1			1					1
Polychaeta: Onuphidae	Onuphis aucklandensis	Polychaete worm																																			1		1		
Polychaeta: Lumbrineridae	Lumbrineridae	Polychaete worm		1																													1	1			1			2	
Polychaeta: Dorvilleidae	Dorvilleidae	Polychaete worm		2																					7																
Polychaeta: Oweniidae	Owenia petersenae	Polychaete worm						1	1			6	1	2		1																	3	5	7			2	2	3	6
Polychaeta: Ampharetidae	Ampharetidae	Polychaete worm														5	8										3		1									1	8	10	9
Polychaeta: Cirratulidae	Cirratulidae	Polychaete worm		2																					1						1					2					
Polychaeta: Pectinariidae	Pectinaria australis	Polychaete worm		2		1																2	1		19	3													2		1
Amphipoda	Corophiidae	Amphipod (family)		2																																					
Ostracoda	Scleroconcha sp.	Ostracod																																							1
Phoronida	Phoronus sp.	Horseshoe worms									1		2																		1										
Holothuroidea	Heterothyone alba	Sea Cucumber				1																																			
Holothuroidea	Paracaudina chilensis	Sea Cucumber						1																														1	1		
		Total Number of Individuals	0	610	4	22	30	80	45	42	58	24	56	46	4	77	32	9	3	118	23	32	33	26	174	35	98	22	16	4	23	11	22	19	22	12	9	5	28	54	59
		Total Number of Species/Taxa	0	13	3	6	5	8	4	4	4	5	5	6	3	7	6	2	2	6	1	4	4	5	11	5	6	4	4	1	6	2	7	5	4	5	5	4	9	13	12
		Species diversity 1/d	-	1.9	4.0	1.8	1.5	1.5	2.0	1.8	1.5	2.4	1.4	1.8	2.0	1.3	2.0	1.5	1.5	1.2	1.0	1.4	1.7	2.9	1.6	1.3	1.4	1.8	1.8	1.0	2.9	1.1	1.8	2.4	2.4	3.0	1.8	2.5	2.5	2.8	3.0

Table A6.2 Benthic biota West and East Transects raw data (No./0.05 m²)

		Region	EAST									WEST					
		Site	E250			E500			E750			W250			W500		
		Common Name	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Hydrozoa	Hydroida (athecate)	Hydroid athecate												1			
Anthozoa	Edwardsia sp.	Burrowing anemone												4			
Nemertea	Nemertea	Proboscis worms															
Sipuncula	Sipunculus sp.	Peanut worm															
Bivalvia	Arthritica bifurca	Small bivalve															1
Bivalvia	Leptomya retiaria retiaria	Small bivalve														1	
Bivalvia	Ruditapes largillierti	Thick lipped buscuit shell															
Bivalvia	Theora lubrica	Window shell														1	
Bivalvia	Varinucula gallinacea	Nut shell														1	
Oligochaeta	Oligochaeta	Oligochaete worms													2		
Polychaeta: Paraonidae	Paraonidae	Polychaete worm			1								1		1		
Polychaeta: Cossuridae	Cossura consimilis	Polychaete worm	18	19	20	1	3	6	7	5	6	12	33	7	2	2	1
Polychaeta: Spionidae	Paraprionospio sp.	Polychaete worm	1	1	3				1			2	32	55	19	33	8
Polychaeta: Spionidae	Polydora sp.	Polychaete worm											1				
Polychaeta: Spionidae	Prionospio aucklandica	Polychaete worm										30	5	1		1	
Polychaeta: Spionidae	Prionospio yuriel	Polychaete worm	1											6	5		
Polychaeta: Magelonidae	Magelona dakini	Polychaete worm											4	7	18	6	7
Polychaeta: Capitellidae	Capitella sp.	Polychaete worm										1	1				
Polychaeta: Capitellidae	Heteromastus filiformis	Polychaete worm	9	10	12		1	1	3			30	122	128	248	20	8
Polychaeta: Sigalionidae	Sigalionidae	Polychaete worm															
Polychaeta: Hesionidae	Hesionidae	Polychaete Worm															
Polychaeta: Glyceridae	Glyceridae	Polychaete worm															
Polychaeta: Nephtyidae	Aglaophamus sp.	Polychaete worm									1						
Polychaeta: Onuphidae	Diopatra akarana	Polychaete worm		1				1	1			15					
Polychaeta: Onuphidae	Onuphis aucklandensis	Polychaete worm															
Polychaeta: Lumbrineridae	Lumbrineridae	Polychaete worm															
Polychaeta: Dorvilleidae	Dorvilleidae	Polychaete worm															
Polychaeta: Oweniidae	Owenia petersenae	Polychaete worm			3		1	3				4	6	6	9	12	13
Polychaeta: Ampharetidae	Ampharetidae	Polychaete worm												2	3	2	3
Polychaeta: Cirratulidae	Cirratulidae	Polychaete worm															
Polychaeta: Pectinariidae	Pectinaria australis	Polychaete worm										1		3			
Amphipoda	Corophiidae	Amphipod (family)															
Ostracoda	Scleroconcha sp.	Ostracod															
Phoronida	Phoronus sp.	Horseshoe worms															1
Holothuroidea	Heterothyone alba	Sea Cucumber															
Holothuroidea	Paracaudina chilensis	Sea Cucumber											1				
		Total Number of Individuals	30	32	41	1	5	11	12	5	7	95	206	220	307	79	42
		Total Number of Species/Taxa	4	4	5	1	3	4	4	1	2	8	10	11	9	10	8
		Species diversity 1/d	1.7	1.7	2.1	1.0	1.7	1.8	1.7	1.0	1.2	3.2	1.7	1.7	1.2	2.4	3.2

Appendix 7 Statistical tests on benthic biota

Table A7.1 Univariate statistical tests results on diversity measures for combined factor "distance-region"

Factor	Combined factor (6 groups)			
	General test	Post-hoc test	Statistic value	P value
S	Kruskal-Wallis	Dunn	H = 18.293	p = 0.003
N	Kruskal-Wallis	Dunn	H = 18.742	p = 0.002
1/d	Kruskal-Wallis	Dunn	H = 8.112	p = 0.150

Highlighted p values are statistically significant at alpha = 0.05.

Table A7.2 Post hoc tests detailed differences from tests on diversity measures

Factor	Combined factor (6 groups)
S	West > near outfall, North, South, East
N	West > East, South

Note: Near outfall *= sites at 50m and 100m (12 samples);* ***North*** *= N250 and N500 (6 samples);* ***South*** *= S250 to S1500 (15 samples);* ***West*** *= all west sites (6 samples);* ***East*** *= all east sites (9 samples);* ***>2000m*** *= N2500 and S2100 (6 samples)*

Table A7.3 ANOSIM results on the benthic biota matrix – combined factor "distance-region"

Tests for differences between unordered distance-region groups

Global Test

Sample statistic (R): 0.265

Significance level of sample statistic: 0.1%

Number of permutations: 999 (Random sample from a large number)

Number of permuted statistics greater than or equal to R: 0

Pairwise Tests

Groups	R Statistic	Significance Level %	Possible Permutations	Actual Permutations	Number >= Observed
East, near outfall	0.542	0.1	167960	999	0
East, North	0.166	7.1	5005	999	70
East, >2000	0.452	0.2	5005	999	1
East, South	0.115	8.9	1307504	999	88
East, West	0.739	0.2	5005	999	1
near outfall, North	0.5	0.5	12376	999	4
near outfall, >2000	0.518	0.1	12376	999	0
near outfall, South	0.285	0.1	7726160	999	0
near outfall, West	0.476	0.1	12376	999	0
North, >2000	0.507	0.2	462	462	1
North, South	0.031	38.4	54264	999	383
North, West	0.746	0.2	462	462	1
Control, South	0	48.4	54264	999	483
Control, West	0.294	0.9	462	462	4
South, West	0.185	9	54264	999	89

Highlighted p values are statistically significant at alpha = 0.05.

Table A7.4 SIMPER results on the benthic biota matrix – combined factor "distance-direction"

Groups near outfall & >2000m

Average dissimilarity = 80.56

Species	Near outfall Av.Abund	>2000m Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Diopatra akarana	2.76	0.17	12.67	1.14	15.72	15.72
Heteromastus filiformis	2.7	2.79	11.82	1.18	14.67	30.39
Paraprionospio sp.	0.25	2.85	11.39	1.8	14.14	44.53
Prionospio aucklandica	3.49	0.5	9.95	0.93	12.35	56.88
Ampharetidae	0	2.34	9.81	1.59	12.18	69.06
Cossura consimilis	0.83	1.6	6.74	1.25	8.37	77.43

Groups near outfall & West

Average dissimilarity = 77.62

Species	Near outfall Av.Abund	West Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Heteromastus filiformis	2.7	8.48	17.58	1.55	22.65	22.65
Paraprionospio sp.	0.25	4.57	11.75	2.04	15.14	37.78
Owenia petersenae	0.09	2.83	8.13	1.91	10.48	48.26
Prionospio aucklandica	3.49	1.62	7.66	1	9.87	58.13
Diopatra akarana	2.76	0.65	7.17	1.32	9.24	67.37
Magelona dakini	0	2.33	6.52	1.62	8.4	75.77

Groups East & near outfall

Average dissimilarity = 79.82

Species	East Av.Abund	Near outfall Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Diopatra akarana	0.33	2.76	18.55	1.15	23.23	23.23
Cossura consimilis	2.84	0.83	16.94	1.42	21.22	44.46
Prionospio aucklandica	0	3.49	14.05	1.05	17.6	62.06
Heteromastus filiformis	1.48	2.7	13	1.35	16.28	78.34

Groups near outfall & North

Average dissimilarity = 77.14

Species	Near outfall Av.Abund	North Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Cossura consimilis	0.83	4.11	16.94	1.51	21.96	21.96
Heteromastus filiformis	2.7	4.51	16.52	1.62	21.42	43.38
Diopatra akarana	2.76	0	12.75	1.43	16.53	59.91
Prionospio aucklandica	3.49	0	10.28	0.97	13.32	73.23

Groups near outfall & South

Average dissimilarity = 76.37

Species	Near outfall Av.Abund	South Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Diopatra akarana	2.76	1.18	13.57	1.16	17.77	17.77
Prionospio aucklandica	3.49	0.9	12.76	1.06	16.71	34.48
Paraprionospio sp.	0.25	2.3	11.36	1.15	14.88	49.35
Heteromastus filiformis	2.7	1.24	10.39	1.23	13.6	62.96
Cossura consimilis	0.83	1.63	8.68	1.02	11.37	74.32

Groups East & >2000m

Average dissimilarity = 66.36

Species	East Av.Abund	>2000m Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Paraprionospio sp.	0.53	2.85	12.82	1.66	19.32	19.32
Heteromastus filiformis	1.48	2.79	12.6	1.16	18.99	38.31
Ampharetidae	0	2.34	11.75	1.74	17.71	56.01
Cossura consimilis	2.84	1.6	8.91	1.27	13.43	69.44
Owenia petersenae	0.5	1.1	5.31	1.13	8.01	77.45

Groups North & >2000m

Average dissimilarity = 54.73

Species	North Av.Abund	>2000m Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Heteromastus filiformis	4.51	2.79	12.51	1.48	22.86	22.86
Cossura consimilis	4.11	1.6	11.28	1.38	20.6	43.46
Ampharetidae	0	2.34	8.8	1.98	16.08	59.54
Paraprionospio sp.	1.4	2.85	6.05	1.45	11.05	70.59

Groups East & West

Average dissimilarity = 73.13

Species	East Av.Abund	West Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Heteromastus filiformis	1.48	8.48	20.44	1.73	27.95	27.95
Paraprionospio sp.	0.53	4.57	12.68	2.01	17.33	45.28
Owenia petersenae	0.5	2.83	8.07	1.66	11.03	56.31
Magelona dakini	0	2.33	7.48	1.73	10.22	66.54
Cossura consimilis	2.84	2.61	5.29	1.4	7.24	73.77

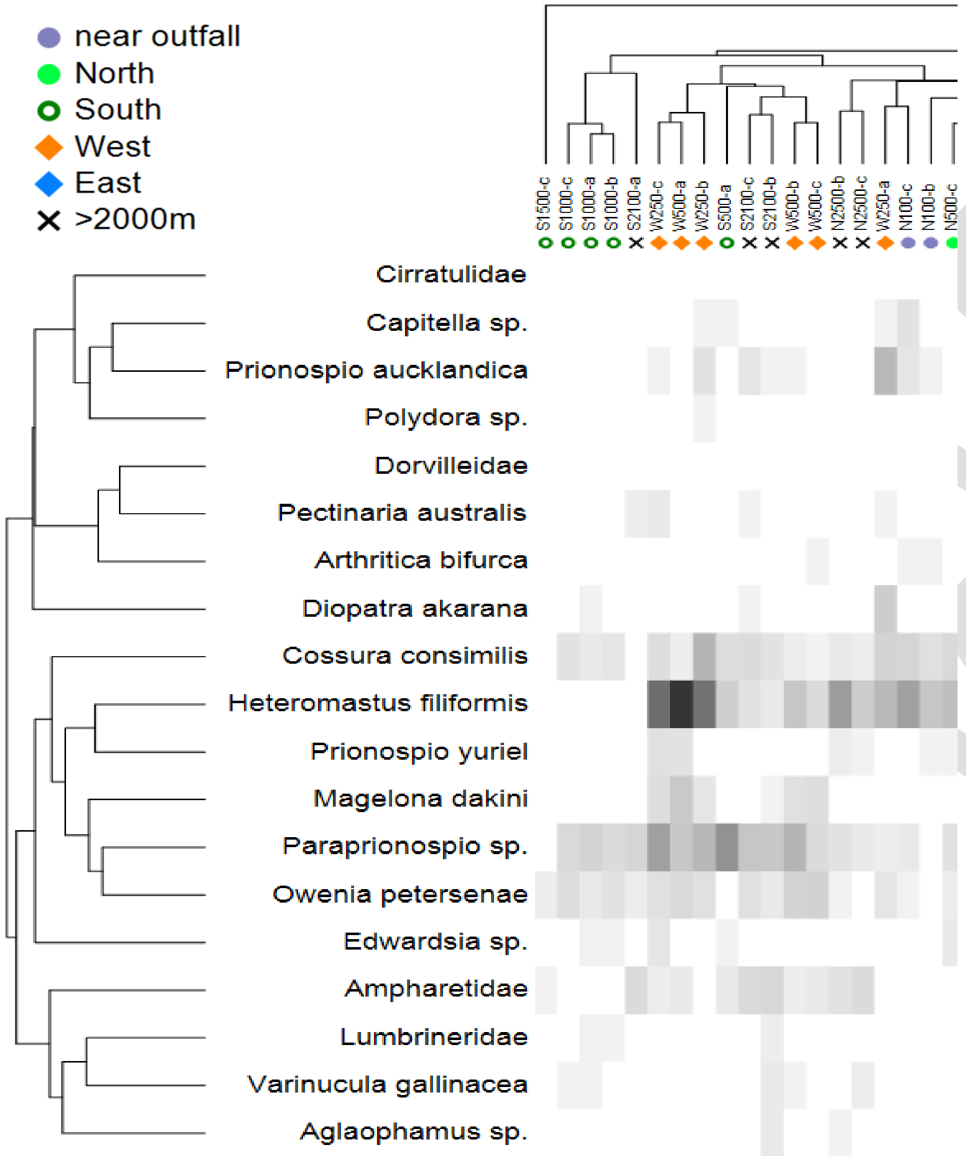
Groups North & West

Average dissimilarity = 53.25

Species	North Av.Abund	West Av.Abund	Av.Diss	Diss/SD	Contrib%	Cum.%
Heteromastus filiformis	4.51	8.48	11.2	1.31	21.03	21.03
Paraprionospio sp.	1.4	4.57	8.21	1.78	15.43	36.46
Magelona dakini	0	2.33	6.17	1.83	11.59	48.04
Cossura consimilis	4.11	2.61	6.06	1.36	11.38	59.42
Owenia petersenae	0.98	2.83	5.27	1.55	9.89	69.31
Prionospio aucklandica	0	1.62	4.31	0.8	8.09	77.4

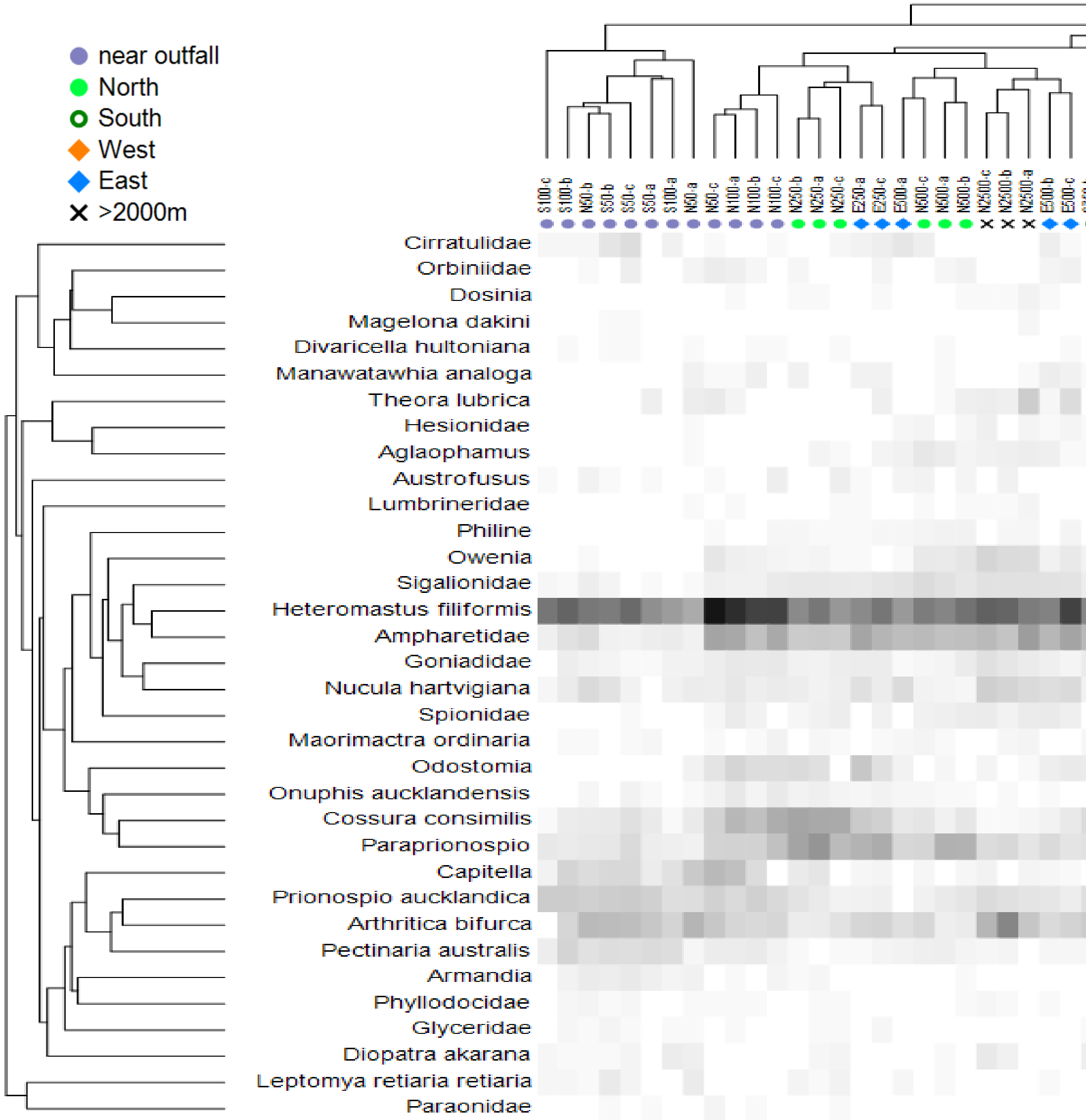
Appendix 8 Benthic biota matrix 2023

The matrix was created on square-root-transformed data.



Appendix 9 Benthic biota matrix 2012

The matrix was extracted from Golder Associates (2013) and was limited to polychaetes and molluscs, the main representative taxonomic groups in 2012.



Appendix H Diffuser Inspection and Maintenance records

Connect with us

HDC WASTEWATER OUTFALL REACTIVE WORKS

REPORT NUMBER: HWORW01 150323

HASTINGS DISTRICT COUNCIL

15th March 2023

HASTINGS, NEW ZEALAND

Reviewed	Released
....	....
Matua Moeke Superintendent and Projects Coordinator	Lana Stevens Wellington Regional Business and Operations Manager

1. INTRODUCTION

A New Zealand Diving and Salvage Ltd (NZDS) dive team attended the Hastings District Council (HDC) outfall. The purpose of which was to carry out a CCTV inspection of the WYE junction, followed by the recovery and repositioning of the inshore marker. A submerged tree was also required removal and recovery. These works were conducted from 15th day of March, as requested by Stantec and Hastings District Council.

The conditions on site at time of works were:

- Visibility < 5m
- Wind variable 10knts
- Sea state calm

2. NZDS PERSONNEL

Vessel – MV Island Leader (IL2)
Vessel – MV AllyCat
Vessel Master – Lee McFetrish, Cameron Smith
Supervisor – Luke Ogilvy
Divers – Jacob Campion, Curtis Martelli, Lee McFetrish, Cameron Smith

3. RESULTS

WYE Junction

Upon locating the WYE junction, the diver was able to confirm that the debris visible on the surface was not in contact with the WYE. The WYE was inspected for damage, the diver was unable to see any damage caused by the cyclone and subsequent debris. The WYE appeared to be in good condition. No leaks were observed at the time of survey. All anodes were seen and accounted for.

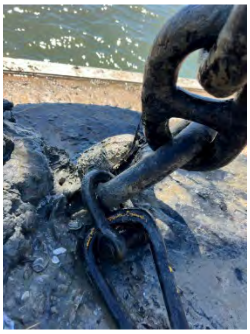
- WYE anodes <15% depletion
- Pile at the clamp <40% depletion
- Support clamp anodes <20% depletion
- Offshore WYE pile anodes <50% depletion
- Stub flange anode <5% depletion

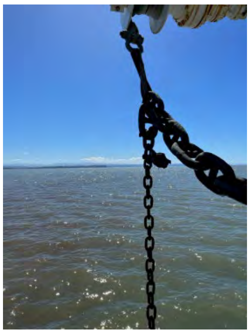
Eighteen (18) diffusers were located and identified these were all flowing and clear. Seabed levels were much the same as when inspected in November 2022.

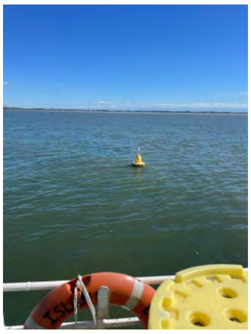
Recovery of the inshore marker buoy.

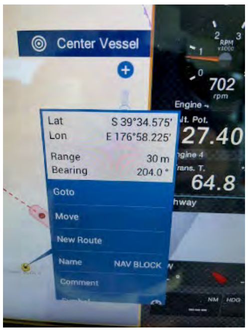
The inshore marker buoy had migrated approximately 700m to the northwest of the outfall. This was recovered and cleaned. All linkages were of <5% wear. The marker was then repositioned in its original coordinates.
The offshore marker had not moved and was still in position.


Block Connection


Ground Chain

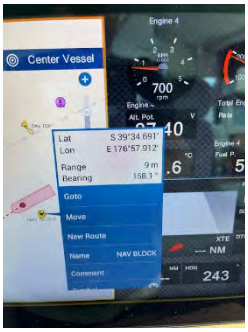

Junction to Ground Chain


Offshore Marker



Offshore Marker Position

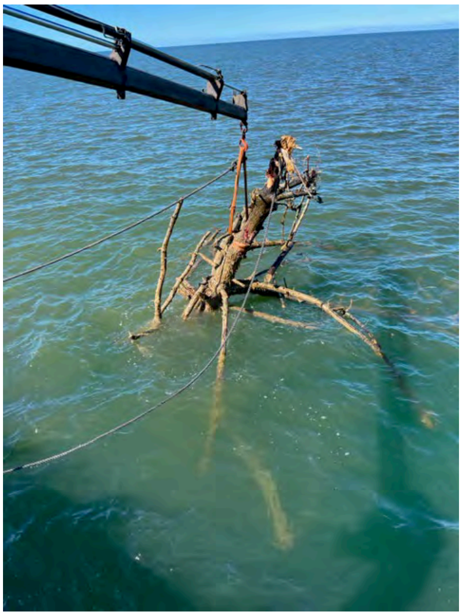

Inshore Marker

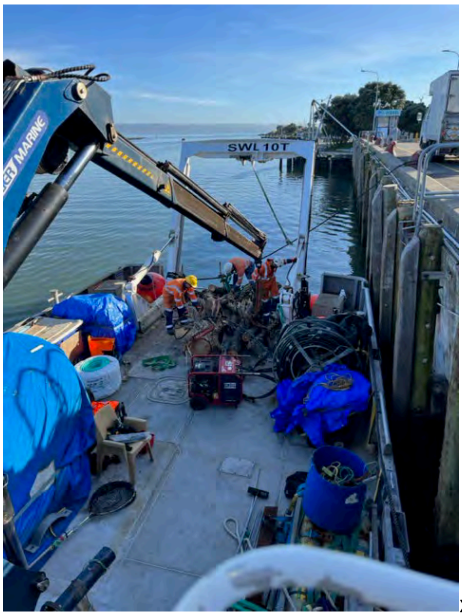


Inshore Marker Position

Removal of the tree

A tree was located the near the section of the WYE. On inspection it was not fouling the WYE but was 50m inshore and no damaged sighted.
The tree was lifted with the vessels crane and cut into smaller pieces. These were recovered to IL2 to prevent further hazards to navigation. The timber was then off loaded to shore and taken away by Fulton Hogan.





x

NEW ZEALAND DIVING AND SALVAGE LIMITED

134 GRACEFIELD ROAD, SEAVIEW, LOWER HUTT
PO BOX 30 392, LOWER HUT, 5040, NEW ZEALAND
P: +64 4 568 2505 | W: www.nzds.co.nz

VISUAL INSPECTION OF OUTFALL Date: 7/10/22

750m North

	Yes	No
Any conspicuous suspended material		✓
Any change in colour or clarity		✓

500m North

	Yes	No
Any conspicuous oil or grease films, scums or foams or floatable material		✓
Any emission of objectionable odour		✓
Any visual undesirable biological growths		✓

Over the Diffuser

	Yes	No
Any conspicuous suspended material		✓
Any change in colour or clarity		✓
Any conspicuous oil or grease films, scums or foams or floatable material		✓
Any emission of objectionable odour		✓
Any visual undesirable biological growths		✓

500m South

	Yes	No
Any conspicuous oil or grease films, scums or foams or floatable material		✓
Any emission of objectionable odour		✓
Any visual undesirable biological growths		✓

750m South

	Yes	No
Any conspicuous suspended material		✓
Any change in colour or clarity		✓

HASTINGS DISTRICT COUNCIL

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207 Lyndon Road East
Hastings 4122
Private Bag 9002
Hastings 4156

Phone 06 871 5000
Fax 06 871 5100
www.hastingsdc.govt.nz

TE KAUNIHERA O HERETAUNGA

VISUAL INSPECTION OF OUTFALL Date: 8/8/22

750m North

	Yes	No
Any conspicuous suspicious material		✓
Any change in colour or clarity		✓

500m North

	Yes	No
Any conspicuous oil or grease films, scums or foams or floatable material		✓
Any emission of objectionable odour		✓
Any visual undesirable biological growths		✓

Over the Diffuser

	Yes	No
Any conspicuous suspicious material		✓
Any change in colour or clarity		✓
Any conspicuous oil or grease films, scums or foams or floatable material		✓
Any emission of objectionable odour		✓
Any visual undesirable biological growths		✓

500m South

	Yes	No
Any conspicuous oil or grease films, scums or foams or floatable material		✓
Any emission of objectionable odour		✓
Any visual undesirable biological growths		✓

750m South

	Yes	No
Any conspicuous suspicious material		✓
Any change in colour or clarity		✓

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TE KAUNIHERA O HERETAUNGA

VISUAL INSPECTION OF OUTFALL Date: 3/3/23

750m North

	Yes	No
Any conspicuous suspicious material		✓
Any change in colour or clarity	✓	

500m North

	Yes	No
Any conspicuous oil or grease films, scums or foams or floatable material		✓
Any emission of objectionable odour		✓
Any visual undesirable biological growths		✓

Over the Diffuser

	Yes	No
Any conspicuous suspicious material		✓
Any change in colour or clarity	✓	
Any conspicuous oil or grease films, scums or foams or floatable material		✓
Any emission of objectionable odour		✓
Any visual undesirable biological growths		✓

500m South

	Yes	No
Any conspicuous oil or grease films, scums or foams or floatable material		✓
Any emission of objectionable odour		✓
Any visual undesirable biological growths		✓

750m South

	Yes	No
Any conspicuous suspicious material		✓
Any change in colour or clarity	✓	

Colour is from river silt.

HASTINGS DISTRICT COUNCIL

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TE KAUNIHERA O HERETAUNGA

11/5/23 Wakefield

VISUAL INSPECTION OF OUTFALL Date:

750m North

	Yes	No
Any conspicuous suspicious material		✓
Any change in colour or clarity		✓

500m North

	Yes	No
Any conspicuous oil or grease films, scums or foams or floatable material		✓
Any emission of objectionable odour		✓
Any visual undesirable biological growths		✓

Over the Diffuser

	Yes	No
Any conspicuous suspicious material		✓
Any change in colour or clarity		✓
Any conspicuous oil or grease films, scums or foams or floatable material		✓
Any emission of objectionable odour		✓
Any visual undesirable biological growths		✓

500m South

	Yes	No
Any conspicuous oil or grease films, scums or foams or floatable material		✓
Any emission of objectionable odour		✓
Any visual undesirable biological growths		✓

750m South

	Yes	No
Any conspicuous suspicious material		✓
Any change in colour or clarity		✓

Appendix I Peer Review Report

Connect with us

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Raglan 3265
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www.ecoast.co.nz
info@ecoast.co.nz

27 October 2023

Malanie Lee
Senior Project Manager
First Floor,
100 Warren Street South,
Hastings
4122

Dear Melanie,

Re: eCoast review of Hastings WWTP Annual Compliance Report

This letter provides a review of the report entitled *East Clive Wastewater Treatment Plant - Annual Monitoring Report* and its appendices (A - K) in conjunction with the associated Resource Consent document (CD130214W). The review is presented for each condition below.

Review by condition:

1. This condition has been met.
2. There has been no exceedance of the discharge limit of 2,800 L/s in the reporting period.
3. The report documents that the outfall dimensions and location are correct.
4. The report confirms that the diffuser has been designed to the required specification.
5. The report confirms that the wastewater screening requirements have been met.
    a. The report confirms that all wastewater passed through a milli-screen consistent with this consent condition.
    b. As per the report, there was a single breach of this condition due to a spill of 50m^3 of untreated wastewater. As noted, this was likely to be highly diluted and additionally because of the location of the spill, this has been reported as a minor breach which we consider to be appropriate.

    The report also notes that the measurements of BTF organic loading rate appear to be considerably lower than previous years for no apparent reason and for this reason may be unreliable. We would strongly recommend that the sampling methodology be checked to ensure consistency with previous years.

6. The monitoring confirms that the requirements for Final Combined Wastewater (FCW) metal concentrations were met throughout the reporting period.
7. As noted in the report, due to the highly anomalous meteorological conditions during the previous monitoring year, it is very difficult to isolate effects of the wastewater discharge from background conditions. The noted change in colour at 750 m North and South of the outfall is highly likely to be at least partly caused by aftereffects from Cyclone Gabrielle. Consequently, this condition cannot be said to have been met or not met.
8. The monitoring confirms that the Total Oil and Grease (TOG) concentrations in the final combined wastewater were under 200 g/m^3.
9. Inspections were carried out as per this condition. Minor damage was recorded in the accompanying report.

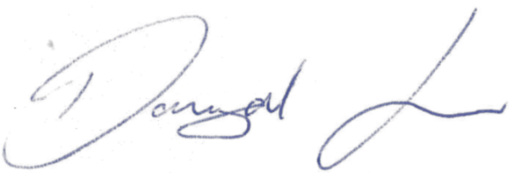
10. The report confirms that maintenance of the plant and treatment plant were undertaken as required.
11. The meters and monitoring methodology outlined in the report and MOU mostly meet the requirements of this condition. One exception to this is the YSI ProDSS Multiparameter Digital Water Quality Meter which has not been calibrated in line with manufacturers recommendations. As per the report, it is recommended that the instrument be calibrated prior to each sampling round. Instruments used for measuring conductivity are particularly subject to drift and require frequent calibration. I would strongly agree that more regular calibration of this instrument is required.
12. The monitoring methodology and instrumentation standards meet the requirements of this condition.
13. The report states that this condition no longer applies since 2015.
14. Total suspended solids, TOG and $cBOD_5$ were appropriately monitored as per this condition.
15. The 4 quarterly toxicity reports were all greater than 2 months apart, and although there were 4 tests that did not meet the test acceptability, the tests compiled with the decision tree (i.e., they were not in two consecutive quarterly tests), and so compliance was met for this condition:
    - 1st Quarter – collected 8-9 August 2022, report September 2022. The blue mussel test showed detectable toxicity at 200-fold and did not meet the conditions. However, the highest no-toxicity dilution for blue mussel was 282-fold (i.e., below 400-fold), and there was no detectable toxicity at 200-fold in the previous sampling (May 1-2 2022). Therefore no further action was required.
    - 2nd Quarter – collected 17-18 October 2022, report December 2020. The alga and blue mussel test showed detectable toxicity at a 200-fold dilution. However, the highest no-toxicity dilution was 286-fold derived from both the alga and blue mussel tests (i.e., below 400-fold). Both tests had TEC <5% effluent, however, neither species had a consecutive incidence of TEC <0.25% effluent between quarters (Condition 15(2)). Therefore, no further action was required.
    - 3rd Quarter – collected 27-28 February 2023, report May 2023. All 4 tests complied with the conditions.
    - 4th Quarter – collected 8-9 May 2023, report June 2023. The alga test showed detectable toxicity at a 200-fold dilution. The highest no-toxicity dilution was 556-fold derived from the alga test. However, this was not a consecutive incidence of TEC <0.25% effluent between quarters (Condition 15(2)). Therefore, no further action was required.
16. Currents are likely to be shore parallel and changing direction between incoming and outgoing tides. This will only give rise to degradation of water quality in one direction only. While the report states that water quality metrics are reasonably uniform across all sites (outside of the March 2023 monitoring), some trends can be seen in the data. For example:
    - Total Nitrogen – 8/8/2022
    - Total Nitrogen – 17/10/2022
    - Oxidised nitrogen – 8/8/2022
    - DRP – 8/8/2022

    For the 8/8/2022 monitoring, the reductions in water quality are consistently observed to the north of the diffuser. Nonetheless, if these trends were due to the outfall, then a high concentration would be expected over the diffuser with a decay in concentration with increasing distance from the outfall. Since the trends are observed to increase with distance, this indicates that that the concentration gradients are likely due to background processes (e.g., nearby river mouths).
17. As noted in the report, the GPS drogue surface current measurements were undertaken 3 times instead of 4 as stipulated in the conditions and consequently this condition was only partially met.
18. This condition requires a benthic assessment on the 8th year following the granting of the resource consent; this is due 2022/2023. A draft form of this report has been provided though it has not been considered in this review following advice from David Mackenzie (pers comms 24/Oct/2023).
19. Sediment samples were taken in accordance with this consent. All measurements were below ANZG 2018 default guideline values for sediment quality (previously the ISQG-Low in ANZECC 2000. Consequently, this condition has been met.
20. Hill Laboratories is an appropriate institution to use for analysis of samples.

21. The MOU is included in this report (Appendix C) and provides detail around the protocols and methodologies as per this condition.
22. This is confirmed in the MOU document.
23. A contact (David Mackenzie) has been provided and this condition has been met.
24. The report was issued almost 1 month after the 1 October date stipulated in the conditions, however, an extension was sought and granted in good time so this condition can be considered to have been met.
    a. This condition has been met.
    b. This condition has been met.
    c. This condition has been met.
    d. This condition has been met.
    e. This condition has been met.
    f. This condition has been met.
    g. This condition has been met.
25. A live link to the previous annual report is provided in the current report meeting the requirement on this condition.
26. The open day was held as required and the details have been provided in accordance with this condition.
27. This report states that work is underway on this report, and it will be available in early 2024.
28. The complaint logging system is in place. One minor complaint (relating to cutting of the plant grass) was received and logged. This condition has been met.
29. The reporting indicates that this condition has been met; the meeting's minutes could be added as an appendix for completeness.
30. There were no non-compliances to be reported.
31. As noted, the event that occurred on 27 June 2023 was reported on the same day, but the investigation report was not provided within 1 calendar month.
32. The report confirms that detailed monitoring data is available on request where it is not provided in the report.

Please don't hesitate to contact us if you require any clarifications.

Yours sincerely



Dougal Greer
Director, eCoast
Environmental Scientist

Dr Shaw Mead
Managing Director, eCoast
Environmental Scientist

Appendix J HDC – Tangata Whenua Joint Wastewater Committee Meeting Minutes

Connect with us

Te Hui o Te Kaunihera ā-Rohe o Heretaunga
Administered by HDC - I whakahaeretia e te Kaunihera ā-Rohe o Heretaunga
HDC : Tangata Whenua Wastewater Joint Committee Meeting

Ngā Miniti

Minutes

Te Rā Hui: Meeting date:	**Tuesday, 6 June 2023**
Te Wāhi: Venue:	**Council Chamber** **Ground Floor** **Civic Administration Building** **Lyndon Road East** **Hastings**
Time start – end:	**1.00pm – 1.50pm**

Go to www.hastingsdc.govt.nz to see all documents

HASTINGS DISTRICT COUNCIL
207 Lyndon Road East, Hastings 4122 | Private Bag 9002, Hastings 4156
Phone **06 871 5000** | **www.hastingsdc.govt.nz**
TE KAUNIHERA Ā-ROHE O HERETAUNGA

Tuesday, 6 June 2023

Te Hui o Te Kaunihera ā-Rohe o Heretaunga

Hastings District Council: HDC : Tangata Whenua Wastewater Joint Committee Meeting

Ngā Miniti

Minutes

Te Rārangi Upoko

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Tuesday, 6 June 2023

Te Hui o Te Kaunihera ā-Rohe o Heretaunga

Hastings District Council: HDC : Tangata Whenua Wastewater Joint Committee Meeting

Ngā Miniti

Minutes

Kua Tae ā-tinana: Present:	**Chair:** Councillor Ana Apatu (Chair) Marei Apatu (Deputy Chair) Councillors Kellie Jessup, Simon Nixon and Kevin Watkins **Tangata Whenua members:** Evelyn Ratima, Beverley Te Huia, Marei Apatu and Darlene Carroll
Kua Tatū: In attendance:	3 Waters Manager – Steve Cave Wastewater Manager – David Mackenzie Pou Ahurea Matua: Principal Advisor: Relationships, Responsiveness and Heritage – Dr James Graham Democracy & Governance Advisor – Lynne Cox

The meeting opened with the 3 Waters Manager, Steve Cave, in the Chair. He welcomed all committee members and remained in the Chair until the Committee had elected its Chairperson.

Marei Apatu gave an opening karakia.

1. APOLOGIES – *NGĀ WHAKAPĀHATANGA*

Councillor Apatu/Councillor Jessup

That apologies for absence from Councillor Nepe be accepted.

Leave of Absence had previously been granted to Councillor Heke.

CARRIED

2. CONFLICTS OF INTEREST - *HE NGĀKAU KŌNATUNATU*

There were no declarations of conflicts of interest.

3. CONFIRMATION OF MINUTES - *TE WHAKAMANA I NGĀ MINITI*

There were no minutes to confirm.

4. ELECTION OF CHAIR AND DEPUTY CHAIR TO HDC : TANGATA WHENUA WASTEWATER JOINT COMMITTEE

Document 23/162

The 3 Waters Manager, Steve Cave called for nominations for the positions of Chairperson and Deputy Chairperson of the HDC : Tangata Whenua Wastewater Joint Committee.

Election of Chair

Councillor Apatu was nominated as Chair by Councillor Jessup and seconded by Beverly Te Huia.

Councillor Nixon was nominated as Chair by Councillor Watkins, there was no seconder.

Steve Cave took a round of voting with Councillor Apatu having a majority vote of 5-1.

Councillor Apatu was duly elected as Chair of the HDC : Tangata Whenua Wastewater Joint Committee.

Election of Deputy Chair

Marei Apatu was nominated as Deputy Chair by Evelyn Ratima and seconded by Beverley Te Huia.

As there were no other nominations, Marei Apatu was duly elected unopposed as Deputy Chair of the HDC : Tangata Whenua Wastewater Joint Committee.

Councillor Jessup/Beverley Te Huia

A) That the HDC : Tangata Whenua Wastewater Joint Committee receive the report titled Election of Chair and Deputy Chair to HDC : Tangata Whenua Wastewater Joint Committee dated 6 June 2023.

B) That Councillor Ana Apatu be appointed as Chair of the HDC : Tangata Whenua Wastewater Joint Committee, effective from the 6 June 2023 meeting.

C) That Tangata Whenua member Marei Apatu be appointed as Deputy Chair of the HDC : Tangata Whenua Wastewater Joint Committee, effective from the 6 June 2023 meeting.

CARRIED

5. NINE YEAR REVIEW REPORT

Document 23/181

Wastewater Manager, David Mackenzie presented the report and showed a powerpoint presentation (CG-17-18-00008). David Mackenzie and Steve Cave responded to questions from the Committee.

Councillor Watkins/Councillor Nixon

A) That the HDC : Tangata Whenua Wastewater Joint Committee receive the report titled Nine Year Review Report dated 6 June 2023.

B) That the HDC : Tangata Whenua Wastewater Joint Committee:

i. Approve the draft scope for the Nine Year Review Report.

ii. Approve the Independent Peer Review of the Nine Year Review Report.

iii. Approve the proposed approach to undertake the Cultural Review.

iv. Develop an outline on our Community Engagement.

CARRIED

6. MINOR ITEMS - *NGĀ TAKE ITI*

There were no additional business items.

7. URGENT ITEMS - *NGĀ TAKE WHAKAHIHIRI*

There were no extraordinary business items.

The Deputy Chair Marei Apatu closed the meeting with a karakia.

____

The meeting closed at 1.50pm

Confirmed:

Chair:

Date:

Te Hui o Te Kaunihera ā-Rohe o Heretaunga

Administered by HDC - I whakahaeretia e te Kaunihera ā-Rohe o Heretaunga

HDC : Tangata Whenua Wastewater Joint Committee Meeting

Ngā Miniti

Minutes

Te Rā Hui: Meeting date:	**Monday, 5 December 2022**
Te Wāhi: Venue:	**Council Chamber** **Ground Floor** **Civic Administration Building** **Lyndon Road East** **Hastings**
Time start – end:	**10.15am – 12.20pm**

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TE KAUNIHERA Ā-ROHE O HERETAUNGA

Te Hui o Te Kaunihera ā-Rohe o Heretaunga

Hastings District Council: HDC : Tangata Whenua Wastewater Joint Committee Meeting

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Monday, 5 December 2022

Te Hui o Te Kaunihera ā-Rohe o Heretaunga

Hastings District Council: HDC : Tangata Whenua Wastewater Joint Committee Meeting

Ngā Miniti

Minutes

Kua Tae ā-tinana: Present:	**Chair:** Marei Apatu (Chair) Councillors Ana Apatu, Alwyn Corban, Michael Fowler, Simon Nixon and Kevin Watkins Evelyn Ratima and Beverley Te Huia
Kua Tatū: In attendance:	Group Manager: Asset Management - Craig Thew POU AHUREA MATUA: Principal Advisor: Relationships, Responsiveness and Heritage – Dr James Graham Wastewater Manager, David Mackenzie Wastewater Treatment Plant Engineer, Wakefield Harland Baker Environmental Planning Analyst, Wilson Pearse Democracy & Governance Advisor – Lynne Cox
Ka hiahiatia: As Required:	Mr Mark von Dadelszen, Legal Counsel Mr Grant Russell, Planning Consultant, Stantec Jim Bradley, Stantec
Kei Konei: Also present:	Ally Naylor and Kane Grundy (Grundy Productions) Ngaio Tiuka, Shade Smith, Mike Paku, Wayne Ormsby & Darlene Carroll

The meeting was opened with the Group Manager: Asset Management, Craig Thew in the Chair. Mr Thew advised the Committee that Hasting District Council had appointed interim members for this meeting with permanent appointments being made at the Council meeting on 8 December 2022. Therefore an election for the Chair and Deputy Chair would be deferred until the first meeting of this committee in 2023.

The Committee agreed for Marei Apatu to remain as the interim Chair for this meeting.

POU AHUREA MATUA: Principal Advisor: Relationships, Responsiveness and Heritage – Dr James Graham opened the meeting with a karakia.

Marei Apatu assumed as Chair of this meeting and welcomed and congratulated both new and re-elected Councillors along with visitors to the meeting.

Marei Apatu introduced the crew from Grundy Productions who would be filming this meeting.

1. APOLOGIES – *NGĀ WHAKAPĀHATANGA*

Marei Apatu/Councillor Watkins

That apologies for absence from Councillor Corban and lateness of Evelyn Ratima be accepted.

CARRIED

2. CONFLICTS OF INTEREST - *HE NGĀKAU KŌNATUNATU*

There were no declarations of conflicts of interest.

3. CONFIRMATION OF MINUTES - *TE WHAKAMANA I NGĀ MINITI*

There were no minutes to confirm.

Evelyn Ratima joined the meeting at 10.25am.

4. ANNUAL MONITORING REPORT 2021/2022

(Document 22/475)

Wastewater Manager, David Mackenzie spoke to the report, Wastewater Treatment Plant Engineer, Wakefield Harland Baker showed a PowerPoint presentation (CG-17-18-00002) and both responded to questions from the Committee.

Councillor Nixon/Councillor Watkins

That the HDC : Tangata Whenua Wastewater Joint Committee receives the report titled Annual Monitoring Report 2021/2022 dated 5 December 2022.

CARRIED

Wasterwater Manager, David Mackenzie showed a video showcasing a reflection of the path that this committee and the wastewater plant have travelled. (CG-16-18-00015)

The Chair, Marei Apatu acknowledged all the people past and present that have been involved in this journey.

Mayor Hazlehurst joined the meeting at 11.50am.

5. SCOPE OF THE NINE YEAR REVIEW REPORT

(Document 22/476)

Planning Consultant, Stantec, Grant Russell spoke to the report and showed a PowerPoint presentation (CG-17-18-00001) and responded to questions from the Committee.

Councillor Watkins/Beverley Te Huia

A) That the HDC : Tangata Whenua Wastewater Joint Committee receives the report titled Nine Year Review Report dated 5 December 2022.

B) That the Committee approve the scope of the Nine Year Review Report.

CARRIED

6. MINOR ITEMS - *NGĀ TAKE ITI*

There were no additional business items.

7. URGENT ITEMS - *NGĀ TAKE WHAKAHIHIRI*

There were no extraordinary business items.

____

The meeting closed at 12.20pm

Confirmed:

Chair:

Date:

Appendix K Non-compliance Investigation Report (June 2023)

Connect with us

EAST CLIVE WASTEWATER TREATMENT PLANT (AUTH-120712-01 CD130214W)

– Wastewater Spill to Roadside Drain

Figure 1: East Clive Wastewater Treatment Plant - Biological Trickling Filters

Introduction

This report is required due to the non-compliance with condition 5b of the discharge consent AUTH-120712-01 (CD130214W) following the discharge of approximately 50m3 of untreated (heavily diluted) domestic wastewater from an inlet manhole at the East Clive Wastewater Treatment Plant (WWTP) into a roadside drain (Grey Street). As per condition 31 of the discharge consent AUTH-120712-01 (CD130214W) this report has been produced.

Wastewater treatment and standards

5. The final combined wastewater discharged shall meet the following requirements:

   a) All separable industrial wastewater shall pass through a milliscreen having a maximum aperture slot width of 1mm.

   b) All domestic and non-separable industrial wastewater shall pass through a 3mm diameter hole size screening device or equivalent, followed by treatment in a biological trickling filter, with an annual average daily loading of carbonaceous biochemical oxygen demand (5 day test) ($cBOD_5$) that shall not exceed 0.4 kg per cubic metre of media, with the treatment plant managed in accordance with best wastewater engineering practice and industry standards, and:

      i) the media in the biological trickling filters shall consist of randomly packed plastic material that provides a specific surface area of not less than $90m^2/m^3$, and

      ii) the wastewater remaining after that treatment, prior to being discharged, shall pass through the Rakahore channel.

Figure 2: Condition 5 of discharge consent AUTH-120715-01 (CD130214W)

31. Within one calendar month of any unforeseen event that resulted in non-compliance with the conditions of this Resource Consent, the Consent Holder shall provide a further report to the Regional Council (Manager Resource Use). This report shall include, but not be limited to the provision of any further information on the reasons for the non-compliance and the measures investigated and put in place or to be put in place to avoid or at least minimise the possibility of any similar problems in the future that may cause non-compliance.

Figure 3: Condition 31 of discharge consent Auth-120712-01 (CD130214W)

Summary of the Event

Untreated (heavily diluted) domestic wastewater spill – Domestic inlet manhole to roadside drain

1. On June 27th 2023 at approximately 1220-1230pm approximately 50m3 of untreated (heavily diluted) domestic wastewater spilled from an inlet manhole at the East Clive WWTP into the Grey Street roadside drain adjacent to the WWTP. At the time of the wastewater spill the Hastings wastewater network was experiencing high flowrates due to rainfall, that morning and the previous day, which had heavily diluted the wastewater concentration coming into the East Clive WWTP with and what was spilled into the Grey Street roadside drain with stormwater. The Hawkes Bay Regional Council urban drainage system was also experiencing higher than typical flows due to the recent rainfall, particularly in Clive, which meant the Grey Street roadside drain was conveying considerably more flow/volume than normal. The increased flow/volume in the Grey Street roadside drain aided in the dispersion and dilution of the wastewater spill, mitigating the immediate impact on the receiving environment. Once the wastewater spill had been resolved, inspection of the spill site did not identify any

debris that required cleaning or any evidence of wastewater in or around the drain, this is most likely due to the highly diluted nature of the incoming wastewater to the East Clive WWTP.

2. A closed gate/penstock on the domestic wastewater inlet chamber at the East Clive WWTP was found to be the cause of the untreated (heavily diluted) wastewater spill into the Grey Street roadside drain. As part of the WWTP shutdown, the gate/penstock was closed in order to be able to undertake critical repairs to a leaking air valve on the first section of the long ocean outfall

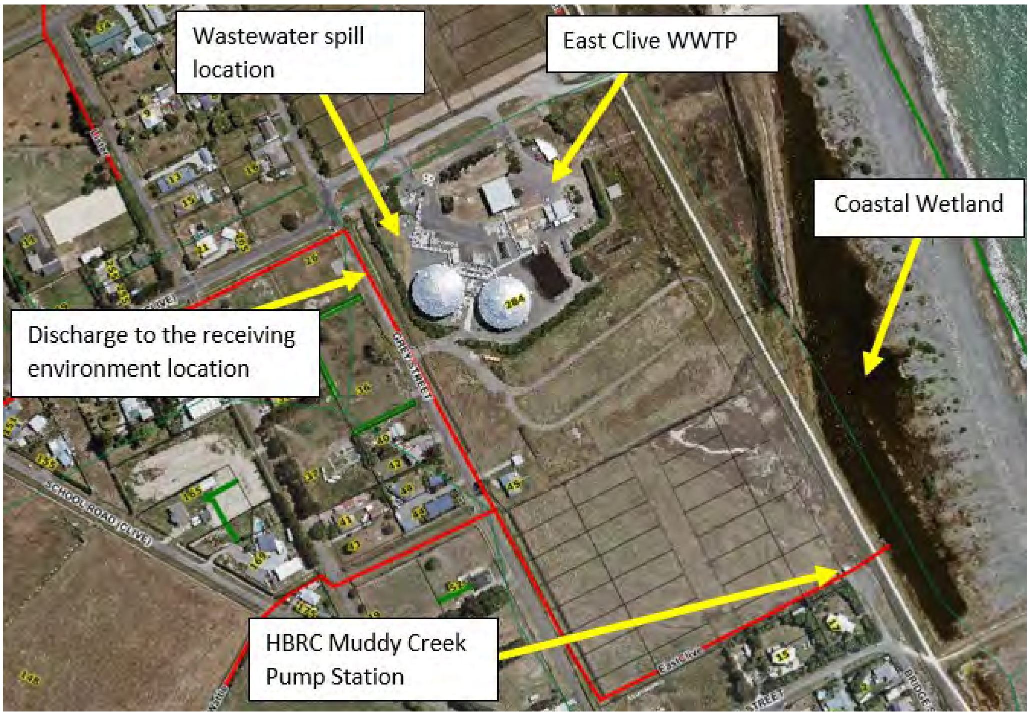

Figure 4: Map of East Clive WWTP wastewater spill into receiving environment

Figure 5: Domestic wastewater Inlet manhole (East Clive WWTP spill location)

Figure 6: Wastewater spill overland flow towards Grey Street roadside drain

Contained treated wastewater spill – Leaking air valve

3. On 27th June 2023 at approximately 7am a leak was discovered on one of the air valves on the first section of the long ocean outfall. This resulted in localised ponding of treated wastewater that was contained within the WWTP site and did not flow into any receiving water bodies. Investigation determined that a section of the air valve pipework had failed due to internal corrosion.

4. At around 11am on 27th June 2023 a repair was made to the failed section of the air valve pipework which resolved the leak and enabled the WWTP to function at full capacity to manage the high flows from the recent rain. While repairs were underway, sucker trucks were cleaning up the treated wastewater ponding, this was put back into the headworks of the WWTP to be retreated. Clean up of the ponding continued into the next day. A permanent repair was undertaken the following day to the air valve pipework.

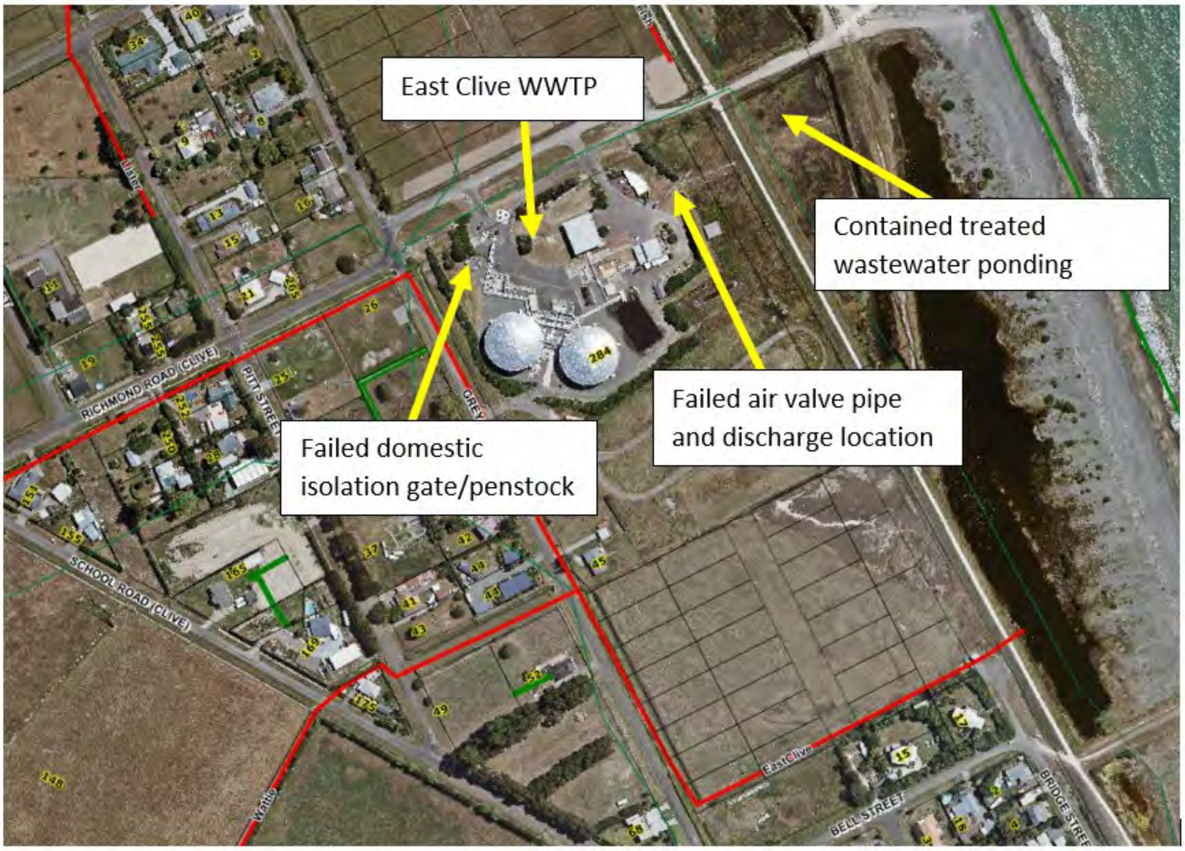

Figure 7: Map of East Clive WWTP outfall leak

Figure 8: Contained treated wastewater ponding

5. To enable investigation and repair works several shutdowns of the WWTP were undertaken. This involved closing the domestic and industrial inlet gates/penstocks and using the upstream wastewater trunk networks to store flows. After the repair works were completed on the leaking air valve pipe the WWTP was brought “back into work” by opening the domestic and industrial inlet gates/penstocks. When trying to open the domestic inlet gate/penstock the motor failed, this was likely due to the hydraulic head tilting the gate/penstock within its guide tracks and increasing the friction needing to be overcome. To resolve this the gate was opened manually with no wastewater spill issues. The process for putting the plant “back into work” involves gradually lifting the domestic inlet gate/penstock to gradually increase flows.

6. Shortly after opening the gate manually, an electrician was used to assess why the motor failed and to assess the torque settings. The torque limit was increased, and the contractor was instructed to fully open the gate/penstock using the motor, this occurred at approximately between 1145-1150am. At approximately 1220pm it was discovered that domestic inlet manhole was spilling untreated (heavily diluted) wastewater towards the Grey Street roadside drain. The gate/penstock on the domestic wastewater inlet chamber was found to be closed and when trying to operate the gate/penstock motor it failed to operate. The gate was then manually opened to relieve the wastewater spill.

7. Investigation into the motor driving the domestic inlet gate/penstock was inconclusive as to the reason why the gate/penstock was in the closed position and not the open position, there is potential that this could have been caused by equipment failure or human error.

Proposed actions and improvements

Proposed Actions/Improvements	Risk Mitigation Comments
Investigate the installation of a "Spill/Overflow Alarm" at the domestic inlet manhole Also look to install in the industrial inlet manhole	There are existing alarms hi & hihi, however, a spilling/overflowing alarm will also be beneficial
Install risers to vulnerable MHs inside the WWTP	Work has started on this
Update HBRC notification process	
Implement more thorough record keeping processes for high risk operational activities/tasks	This has been implemented
Investigate the correct torque setting and appropriate rotork for the domestic inlet gate/penstock	Work has started on this
Undertake mechanical inspection of the domestic inlet gate/penstock	Work has started on this
Implement a critical change process for the following critical infrastructure; - Penstocks (modulated gates) - Outfall pumps (WWTP shut downs) - Odour control off - Water pump shut downs	Work has started on this
Review SOP for shutting down the WWTP	Work has started on this

From:	David Mackenzie
To:	Grinter, Jessica
Subject:	FW: WWTP outfall leak 27062023
Date:	Friday, 22 September 2023 11:13:24 am
Attachments:	image001.png image002.gif image003.gif image004.gif image005.png image006.jpg image008.png image007.png image010.jpg

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From: David Mackenzie
Sent: Tuesday, 27 June 2023 10:03 PM
To: 'Michelle Mackintosh' <Michelle.Mackintosh@hbrc.govt.nz>; 'Mike Signal' <Mike.Signal@hbrc.govt.nz>; Matt Wilkinson <Matt.Wilkinson@hbrc.govt.nz>
Subject: RE: WWTP outfall leak 27062023

Hi All,

This is a follow up email relating to the wastewater spills at the East Clive WWTP today and the subsequent phone calls to the HBRC Pollution Hotline and Matt Wilkinson and the site visit with Michelle and Mike this afternoon.

Treated Wastewater Spill

At around 7am this morning at the East Clive WWTP treatment plant operators discovered a leak on the treated wastewater outfall pipe. The location of the leak was at the air valves on the pressurised section of the outfall pipe (see below picture and blue circled location). This resulted in localised ponding of treated wastewater that was contained within the WWTP site in away from the public and did not flow into any water bodies (see below picture and yellow circled location). Investigation determined that the a section of the air valve pipework had failed.

At around 11am a repair was made to the failed section of air valve pipework which resolved the leak and enabled the WWTP to function at full capacity to manage the high flows from the recent rain. While repairs were underway sucker trucks were organised to clean up the ponding of treated wastewater, this was put back into the headworks of the WWTP to be retreated. Clean up of the ponding will continue tomorrow.

A permanent repair has also been sourced today and fabricated in order to be installed tomorrow.

Untreated Wastewater Spill

In order to enable the repair to the failed air valve pipework, incoming influent flows to the WWTP (domestic and industrial) were reduced by adjusting penstock heights. To test the repair the penstocks were used to gradually increase the flow to the WWTP. Once the team were confident that the repair would hold under the normal operating pressures the penstocks were put back into “normal operation” height.

Unfortunately when doing this the penstock for the domestic influent was set to the incorrect position resulting in an untreated wastewater spill of approx. 50m3 from the incoming domestic sewer (see below picture and purple circled location) into the roadside drain on Grey Street. This occurred at approx. 1220pm-1230pm. I believe this drain flows to one of the HBRC Muddy Creek storm water pump stations that discharges to the coastal wetland.

Once the overflow was identified it was resolved relatively quickly by opening the penstock to the correct position.

Post inspection of the overflow site did not identify any debris that required cleaning which I suspect is largely due to the highly diluted wastewater that was coming into the East Clive WWTP at the time. In addition to this the drain looked to be flowing well due to the recent rain and operation of the HBRC storm water pump station which would have assisted with lessoning the impact on the receiving environment. We have taken samples from the drain and will continue to take a daily grab sample for the next few days.

Next Steps

In terms of next steps I will work through the reporting requirements as per the East Clive WWTP consent (thank you Michelle for sending through the below excerpt).

Regarding notification, while I understand we are required to notify immediately of an event this if often a challenge as all resources are typically redirected to identifying what the issue is and how to resolve it as fast as possible while also keeping everyone safe. My preference for the wording of notifications (which I have seen elsewhere) is that we will notify you as soon as practically possible. As discussed, in relation to the late notification of the Karamu Rd/Collinge Rd overflow I will update our notification procedure of a spills to the receiving environment to ensure we have a consistent process. Once this is complete I will send you a copy.

If you require any information in the meantime please let me know.

Ngā mihi,

DAVID MACKENZIE
WASTEWATER MANAGER

Wāea / Phone (06) 871 5110 ext 5446 **Wāea Pūkoro / Mobile** 027 359 4494
Īmēra / Email davidm@hdc.govt.nz **Pae Tukutuku / Web** hastingsdc.govt.nz
Te Kaunihera ā-Rohe o Heretaunga / Hastings District Council
Private Bag 9002, Hastings 4156, New Zealand

From: Michelle Mackintosh <Michelle.Mackintosh@hbrc.govt.nz>
Sent: Tuesday, 27 June 2023 4:05 PM
To: David Mackenzie <davidm@hdc.govt.nz>
Subject: WWTP outfall leak 27062023

Hi Dave,

Thanks for meeting with us earlier, appreciate your time.

Following our discussion I've looked over the consent (AUTH-120712-01) and the relevant conditions will be:

30. *In the event of the Consent Holder becoming aware of:*

    b. *circumstances having occurred that have, or could, lead to non-compliance,*

    immediate notification of such problems shall be made to the Regional Council (Manager Resource Use). This notification shall include, but not be limited to, provision of the following information as far as such information is known to the Consent Holder at that time:

    i) The extent of non-compliance if it has occurred, including the duration of non-compliance, volume discharged during that period, and the nature and quality of the discharge,

    ii) The immediate and further planned measures being undertaken to minimise and mitigate any adverse effects of the non-compliance,

    iii) The Consent Holder's assessment of public health risk arising from the event including advice received from the Hawke's Bay District Health Board Chief Executive Officer and Medical Officer of Health, and

    iv) Updating the Regional Council (Manager Resource Use) at not greater than 24 hourly intervals of the current situation until the problems are rectified and the Consent Holder is compliant with the Resource Consent conditions.

31. *Within one calendar month of any unforeseen event that resulted in non-compliance with the conditions of this Resource Consent, the Consent Holder shall provide a further report to the Regional Council (Manager Resource Use). This report shall include, but not be limited to the provision of any further information on the reasons for the non-compliance and the measures investigated and put in place or to be put in place to avoid or at least minimise the possibility of any similar problems in the future that may cause non-compliance.*

In relation to 30b, please ensure you are notifying the pollution hotline (0800 108 838) immediately following spill events. As discussed, this service is managed by a call centre afterhours but we do have on call staff who will respond accordingly. In this instance please state your name, that you are calling from HDC, and that you wish to report a spill event to the HBRC Pollution team.

Please also be aware that Condition 32 of your consent states that HBRC may request any records kept in relation to the discharge and its effects on the environment. This can include samples, testing etc so please ensure these records are kept should we require them.

Any questions please let me know.

Kind Regards,

Michelle

Michelle Mackintosh
Environmental Compliance Officer - Urban & Industrial
0800 108 838 | 06 835 9200
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Enhancing Our Environment Together | Te Whakapakari Tahi I Tō Tātau Taiao

HBRC Compliance Section is ISO 9001:2015 certified

Let us know how we're doing, give your feedback here.

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