

Gove Operations

WDL Annual Monitoring Report

17 July 2021

For the reporting period of 1 April 2020 to 31 March 2021.

Prepared in accordance with the requirements of the Northern Territory Government Waste Discharge Licence (WDL171-10, 17 September 2020) and Northern Territory Environment Protection Authority "Guideline for Reporting on Environmental Monitoring (Version 1.0, May 2016)."

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Abbreviations

ABBREVIATIONS	DESCRIPTION
ANZG	Australia and New Zealand Guidelines for fresh and marine water quality
AS	Australian Standards
BTEX	benzene, toluene, ethylbenzene and xylene
CFU	Colony Forming Units
EC	Electrical Conductivity
DEPWS	Department of Environment, Parks and Water Security (NT)
DITT	Department of Industry, Tourism and Trade (NT)
EPA	Environment Protection Authority (NT)
FSANZ	Food Standards Australia New Zealand
LFTF	Light Fuel Tank Farm
LOR	Limit of reporting
MHMP	Marine Health Monitoring Program
ML	Mega litre
ml	Millilitre
MPN	Most-Probable Number
µg/L	microgram/litre
NEPC	National Environmental Protection Council
NEPM	National Environmental Protection Measure
NTU	Nephelometric Turbidity
NT	Northern Territory
NZS	New Zealand Standards
PAH	Polycyclic Aromatic Hydrocarbons
QA/QC	Quality Assurance and Quality Control
RDA	Residue Disposal Area
Gove Operations	Rio Tinto Gove Operations Pty Ltd, RTA Gove Pty Limited (ABN 76 000 453 663)
STP	Sewerage Treatment Plant
TPH	Total Petroleum Hydrocarbons
TSS	Total Suspended Solids
TV	Trigger Value
WDL	Waste Discharge Licence
WWNP	Wastewater Neutralisation Plant
WMP	Water Monitoring Plan

Executive Summary

This Waste Discharge licence (WDL) Annual Monitoring Report presents the results of the WDL monitoring program carried out across the Refinery and marine domains of the Rio Tinto Gove Pty Ltd (Gove Operations) for the reporting period 1 April 2020 to 31 March 2021. This report has been prepared in accordance with Conditions 43 and 44 of WDL171-10 ("the Licence").

The Licence was issued to Gove Operations by the Northern Territory Government on 17 September 2020, and covers the "*controlled discharge of treated wastewater from Authorised Discharge Points at the Refinery*" to Gove Harbour. The Licence specifies the monitoring frequency, sampling and analytical requirements, and nominates site specific Trigger Values (TVs) and Limits, for a series of "Authorised Discharge Points," "Authorised Monitoring Points" and "Compliance Points."

Prior to the commencement of WDL171-10 on 17 September 2020, surface water and marine monitoring was undertaken in accordance with WDL171-08 (17 July 2018 to 17 July 2020), and interim WDL171-09 (17 July 2020 to 17 September 2020). This includes the current reporting period.

The primary objectives of this report are to assess compliance against the monitoring and reporting requirements outlined in the Licence, summarise data trends for the reporting period, and assess the potential impact (if any) of authorised discharge on marine ecosystem health.

Review of the monitoring data for the reporting period indicated that monitoring and reporting was completed in general compliance with the Licence.

The following conclusions are noted:

- Sampling of both surface water and marine environments was completed with reference to the Water Monitoring Plan (WMP, 2019). No deviations from the WMP methodology were noted during the reporting period;
- The seawater outfall channel at the Refinery generally discharges to the marine receiving environment continuously, unless offline operational maintenance or shutdowns of the seawater discharge channel occur. In instances where the seawater outfall discharge is offline and surface water flow in the channel is absent, sampling at So01 and So74 cannot be undertaken. Monitoring at these locations is not applicable when channel flow is absent. During the reporting period, the seawater outfall channel was not discharging in July 2020, for periods between September 2020 and December 2020, and also for a short period during March 2021.
- Monitoring was completed in compliance with the Licence, with the exception of the non-compliance notifications that have previously been reported to the Department of Environment, Parks and Water Security (DEPWS) (formally Department of Environment and Natural Resources (DENR)) and discussed in this report.
- One exceedance of the WDL171-10 Limit for pH was recorded and reported by Gove Operations as a non-compliant incident notification:
 - o pH at So88 on 16 January 2021 (9.57) which exceeded the WDL limit (9.5).
- Single exceedance occurrences of the WDL Trigger Value for pH (9.0) were recorded for bund release samples So44 (26 January 2021) and So88 (30 December 2020). However, there were no further exceedances of the WDL Limits for pH.
- No further non-compliance results have been identified during the reporting period, other than the incident notifications reported throughout the reporting period to the Northern Territory Government, as discussed in Section 5.3.2 and presented in Appendix F. All other analytical results reported were less than the WDL171-10 Limits throughout the reporting period.

This report also presents the 16th annual monitoring report under Gove Operations Marine Health Monitoring Program (MHMP) for Southern Melville Bay – (*Routine Surveillance Monitoring Program – Receiving Environment Quality Survey*). It presents new data for seawater, sediment and oysters for the reporting period and is presented in Appendix E.

No current evidence of deterioration of marine ecosystem health (as a result of the authorised discharge) was identified based on the monitoring data collected and incident reports reviewed for this monitoring period.

1. Operator Details

Table 1.1 Operator Details

Details	
Operator	RTA Gove Pty Limited (ABN 76 000 453 663)
Owner	Swiss Aluminium Australia Limited (ACN 008 589 099)
Operator Registered Address	123 Albert Street, Brisbane QLD 4000
Operator Postal Address	PO Box 21, Nhulunbuy NT 0881
Operator Street Address	1 Melville Bay Road, Nhulunbuy NT 0880
Waste Discharge Licence	171-10 (previous versions 171-09 and 171-08 also applicable during reporting period)
Reporting timeframe	1 April 2020 – 31 March 2021 to cover the 2020-21 wet season
Date	17 July 2021
Key site contact	Melissa Winks

2. Introduction

Rio Tinto Gove Pty Ltd ("Gove Operations") is committed to undertake annual surface water and marine monitoring and produce an Annual Monitoring Report (this report), in accordance with the Waste Discharge Licence (WDL 171-10; "the Licence").

The Licence was issued to Gove Operations by the Northern Territory Government on 17 September 2020, and covers the "*controlled discharge of treated wastewater from Authorised Discharge Points at the Refinery*" to Gove Harbour. The WDL is issued by the Department of Environment, Parks and Water Security (DEPWS) and is pursuant to Section 74 of the *Water Act* (2016). In accordance with Condition 43 of the Licence, this report presents the monitoring data collected for the reporting period: 1 April 2020 to 31 March 2021.

The domains discussed in this report include:

- the Refinery (refer Figure 1, Appendix B); and
- the Marine receiving environment.

The WDL also requires the maintenance and implementation of the following Gove Operations documents:

- Water Monitoring Plan (WMP) (2019); and
- WDL Continuous Improvement Plan (2020).

3. Objectives

The objectives of the WDL Annual Monitoring Report are to:

- Demonstrate compliance with the monitoring and reporting requirements outlined within WDL171-10;
- Detail sampling methodology over the reporting period, including deviations from the WMP (Gove Operations, 2019);
- Summarise data trends and provide data interpretation for the reporting period: 1 April 2020 to 31 March 2021;
- Demonstrate no deterioration of marine ecosystem health, as a result of authorised discharge;
- Make an assessment of environmental impact associated with authorised discharges; and
- Suggest changes to improve efficiencies in sampling and/or in the WMP.

3.1 Reporting Requirements

This report has been prepared in accordance with the requirements of the Northern Territory Environment Protection Authority (NT EPA) document "Guideline for Reporting on Environmental Monitoring" (NT EPA, 2016). It has also been prepared in consideration of WDL171-10 Condition 44, which outlines the licence requirements for the WDL Annual Monitoring Report (this report).

Table 3.1 and Table 3.2 below summarise the sections of the report that address the reporting requirements of the WDL and NT EPA, respectively.

Table 3.1 Summary of Compliance with WDL171-10 (Condition 44)

Licence Condition	Relevant Licence Requirement	Report Section
44.1	Is prepared in accordance with the requirements of the Administering Agency 'Guideline for Reporting on Environmental Monitoring' (NT EPA, 2016)	Table 3.2.
44.2	Includes a tabulation of all monitoring data required as a condition of this licence.	Appendix C (Tables)
44.3	Collectively summarises each authorised discharge from an authorised discharge point, as per requirements of condition 23.	Section 5.3.1.1 and Section 5.3.1.2
44.4	Uses information collected in accordance with condition 27 and 28 to demonstrate that there is no deterioration of marine ecosystem health as a result of authorised discharge.	Section 6 and Appendix E (Marine Health Monitoring Report)
44.5	Includes long term trend analysis of monitoring data to demonstrate any environmental impact associated with the activity over a minimum period of three years (where the data is available).	Section 5.5
44.6	Includes an assessment of environmental impact from the activity.	Section 7

Table 3.2 NT EPA (2016) Reporting Requirements

Monitoring Report Requirements	Report Section
Title page	Title page
Executive summary	Executive Summary
Monitoring objective	Section 3
Monitoring method	Section 5.2.2
Monitoring results – presentation	Appendix B (Table 1 to Table 3)
Monitoring results – quality assurance/ quality control (QA/QC) evaluation	Appendix A
Discussion and interpretation of results	Section 5.3
Conclusion and proposed actions	Section 7
Certification	Title page
Abbreviations	Abbreviations
References	Section 8
Appendices	Appendix A to Appendix F

4. Background

4.1 Surface Water Management Overview

Gove Operations manages four primary operational domains within the overall Gove mining lease area, including: the Mine, the Refinery, the Residue Disposal Area (RDA) and the marine receiving environment (refer Figure 1, Appendix B). The monitoring activities conducted within the four domains differ considerably, as each domain resides in a different surface water catchment and has different surface water management strategies and priorities.

As mentioned in Section 2, the discharge of treated wastewater from the Refinery to the marine receiving environment (Gove Harbour) is licenced under WDL171-10. There are five (5) nominated Authorised Discharge Points from which discharge can occur, including: So01, So44, So86, So87 and So88 (see Section 4.2.1 and Figure 2, Appendix B). The Licence requires that surface water quality at each of the five (5) Discharge Points be monitored (see Section 5.2 for discussion on the surface water monitoring program). There are also a series of marine monitoring points specified in the Licence where marine water quality, sediment and biological monitoring is required to be undertaken (see Section 5.3).

Surface water management plans and priorities are continually reviewed for relevance and accuracy, in conjunction with the Department of Industry, Tourism and Trade (DITT) and DEPWS, via the NT EPA.

4.2 Waste Discharge Licence (WDL)

The WDL specifies the monitoring frequency, sampling and analytical requirements, and nominates site specific Trigger Values (TVs) and Limits for the Authorised Discharge Points and Authorised Monitoring Points and Compliance Points of the Refinery, RDA and marine domains.

During the reporting period (1 April 2020 - 31 March 2021), the following WDL versions were valid:

- WDL171-08: Valid from 1 April 2020 – 17 July 2020;
- WDL171-09: Valid from 17 July 2020 – 17 September 2020; and
- WDL171-10: Valid from 17 September 2020 – Current (expires 17 September 2022).

The site's WMP was developed in accordance with the WDL171-08 monitoring program.

Consistent with Condition 43 of WDL171-10, the monitoring and analytical results for this reporting period will be assessed against the most recent licence (WDL171-10) only. However, some of the monitoring requirements (frequency, locations and parameters) outlined in WDL171-10 are different to those in WDL171-08, and this is discussed where necessary.

The location of the Authorised Discharge Points and Authorised Monitoring Points / Compliance Points is shown on Figure 2, Appendix B.

4.2.1 Authorised Discharge Points

Table 4.1 below provides a summary of the Authorised Discharge Points, as outlined in the Licence. All five (5) discharge points have trigger values and limits specified in the Licence. Further information on this is provided in Section 5.2.3 below.

Monitoring results from the Discharge Points (as well as the associated Authorised Monitoring Points So74 and So94) are discussed in Section 5.3.4.

Table 4.1 WDL Authorised Discharge Points

Discharge Point	Description	Active Discharge
So01	Seawater Outfall Channel	Treated wastewater from the Wastewater Neutralisation Plant (WWNP) and the Sewerage Treatment Plant (STP)
So44	Refinery Light Fuel Tank Farm (LFTF) Bund (housing an oily water separator)	Stormwater contained in the bunded area
So86	Refinery Tank Farm Bund	
So87		
So88		

4.2.2 Authorised Monitoring Points

Table 4.2 below provides a summary of the Authorised Monitoring Points, as outlined in the Licence. Monitoring results for the marine monitoring points are summarised in Section 6, with the exception of So74 and So94 (which are discussed in Section 5.3.4) and hydrocarbon monitoring at Compliance Points SW9, SW10 and RR2 (which is discussed in Section 5.4)..

Table 4.2 WDL Authorised Monitoring Points

Monitoring Point	Area	Source and Description
So74	Seawater Outfall Channel (Refinery)	Composite sampler at the seawater outfall channel (as per So01)
So94	Public boat ramp (Refinery)	Detects potential bacteriological impacts from So01 discharge
SW2	Arafura Sea – Off West Woody Island	Information
SW3	Gove Harbour – Off Granite Island	
SW4	Melville Bay – Off Dolphin Rocks	
SW7	Offshore Drimmie Arm	
SW8	Inverell Bay / Gove Harbour	
SW9*	Mixing Zone Boundary	Impact for authorised discharge from Refinery
SW10*	Mixing Zone Boundary	Impact for authorised discharge from Refinery
SW11	Gove Harbour – Off Outfall	Information – in seawater discharge plume
RR2*	Mixing Zone Boundary	Impact for authorised discharge from Refinery
MB1	Mixing zone boundary test site (Refinery)	
MB2	Mixing zone boundary test site (Refinery)	
MB3	Mixing zone boundary test site (Refinery)	
MB4	Mixing zone boundary test site (Refinery)	

* SW9, SW10 and RR2 are also considered to be Compliance Points under WDL171-10. As such, the Licence specifies trigger values and limits for these locations. The remaining Monitoring Points do not have specific trigger values/limits in the WDL.

4.2.3 Sediment and Biological Monitoring

Biological and sediment monitoring is also required at the Refinery, in accordance with the WMP (2019) and Condition 28 of the Licence. This is discussed in Section 6.

4.3 Site Rainfall

Gove Operations operates ten rainfall gauges around the RDA (known as Gauge 001 – Gauge 010); the location of these are presented on Figure 2, Appendix B. These gauges collect rainfall at six-hourly intervals and are accessible via an online system for real time interrogation. Rainfall data from all gauges collected over the reporting period was downloaded and assessed for this report.

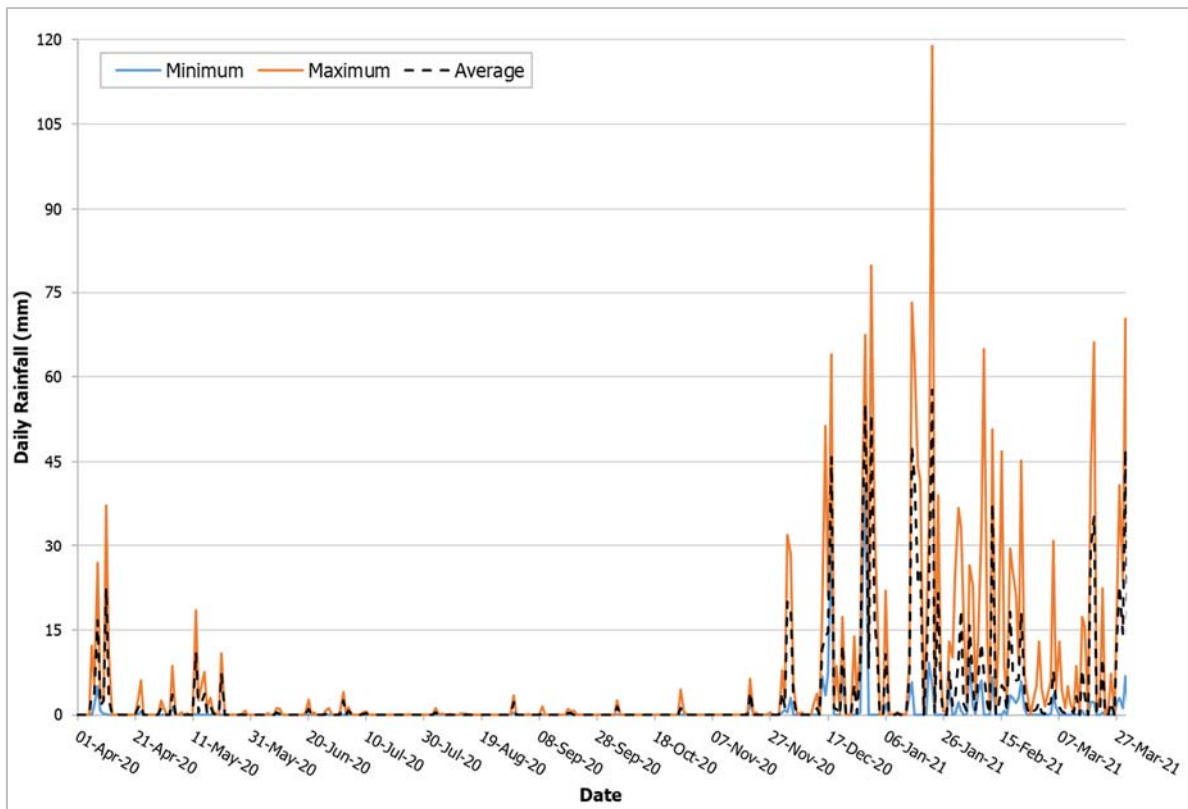
Despite their close proximity, the rainfall gauges display variable volumes of total rainfall in any given day. The minimum, maximum and average rainfall values on any given day for the 10 gauges have been calculated and are presented on Graph 4.1 below. Gauges 003 and 004 have been excluded from the evaluation due to gaps in the collection of data.

The first rainfall for the 2020-2021 reporting period occurred on 6 April 2020 with gauges across the RDA recording a daily rainfall total between 0 mm and 12.2 mm (average value of 3.86 mm). Rainfall was recorded for the following six days with a cumulative average rainfall of 53.9 mm. Additional rainfall events were recorded between 30 April and 1 December 2020. Rainfall occurring during April 2020 and May 2020 is considered to be reflective of the end of the 2019/20 wet season, and there was little rainfall between June 2020 and December 2020 (Graph 4.1).

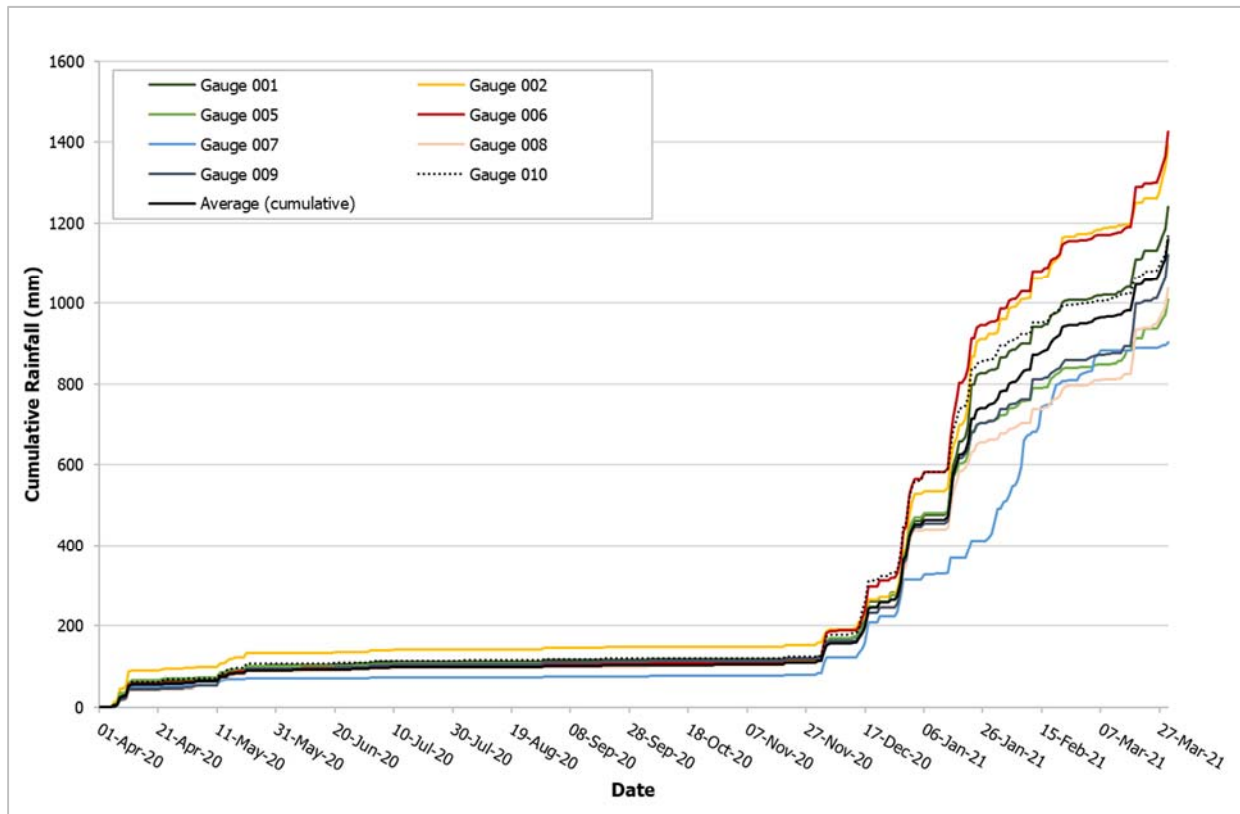
With the onset of wet-season, rainfall was recorded on 1 December 2020 with average daily totals between 0.02 mm and 57.9 mm across the RDA rain gauges, and increasing the average cumulative total rainfall for the reporting period to 1,160 mm. Depending on which gauge is used, cumulative rainfall over the reporting period ranged between 903 mm and 1,425 mm. Most of this rainfall occurred over the following events:

- Event 1 – 53.9 mm (average) between 6 April 2020 and 12 April 2020 (representing 2019/20 wet season);
- Event 2 – 46.9 mm (average) between 2 December – 5 December 2020;
- Event 3 – 100.8 mm (average) between 15 December – 22 December 2020;
- Event 4 – 205.3 mm (average) between 26 December 2020 – 6 January 2021;
- Event 5 – 317.3 mm (average) between 14 January 2021 – 1 February ;
- Event 6 – 134.2 mm (average) between 7 February – 22 February 2020; and
- Event 7 – 176.6 (average) mm between 18 March 2021 and 31 March 2021.

Graph 4.4-1 Minimum, Average and Maximum Daily Rainfall Volumes from all RDA Rain Gauges



Graph 4.4-2 Cumulative site rainfall for RDA gauges (excluding Gauges 003 and 004)



5. The Refinery: Surface Water Condition Review

5.1 Refinery Surface Water Catchments

The Refinery has a total of 14 surface water sub-catchments which drain to the Eastern, Western and Southern Containment Ponds located within the Refinery (refer Figure 3, Appendix B). These ponds are designed to collect and retain surface water runoff, including any operational release of liquids, for subsequent re-processing and/or treatment. During storm events, the Containment Ponds also provide a runoff surge capacity and, if required, allow contaminated surface water to be recycled to the RDA, and then treated via the WWNP, prior to discharge (under the Licence) via the Seawater Outfall Channel (Soo1).

The Seawater Outfall Channel is located down-gradient of the convergence of the "seawater circuit" channels (Eastern Channel and Western Channel). The seawater circuit of the Refinery comprises the main process water intake and wastewater discharge system within the Refinery Catchment, with a seawater channel discharge rate of approximately 10,000 m³/hr.

The Western Containment Pond, Oily Water Pond and the WWNP (Figure 3, Appendix B) all have the potential to discharge into the seawater circuit, and thereby potentially discharge to the marine environment via the Seawater Outfall Channel.

At the LFTF and Harbour Tank Farm, stormwater is collected in bunds and is released into Gove Harbour under licence (WDL171-10) via Authorised Discharge Points So44, So86, So87, and So88.

5.2 Surface Water Monitoring Program

5.2.1 Sampling Locations

The following Authorised Discharge Points and associated surface water sampling locations are defined by WDL171-10 for the Refinery:

- Seawater Outfall Channel (Soo1 and So74);
- Light Fuel Tank Farm Bund (So44); and
- Harbour Tank Farm Bunds (So86, So87, So88).

Aside from Soo1 (the Seawater Outfall Channel) which generally continuously discharges to Gove Harbour, the remaining four (So44, So86, So87, and So88) Discharge Points are seasonal and will typically only discharge during the wet season, or monsoonal/cyclone events. Monitoring Point So74 is not a Discharge Point, rather it is an automated, composite surface water sampler located adjacent to Soo1.

Sampling locations So74 and So94 are incorporated as part of the Marine Health Monitoring Program (MHMP) in WDL171-10, however they are included within the Surface Water Monitoring Program in the WMP (Gove Operations, 2019). As such, they are included within the Surface Water discussion in this report (Section 5.3).

Locations of the Authorised Discharge and Monitoring Points are shown on Figure 2, Appendix B.

5.2.2 Sampling Methodology and Frequency

Surface water sampling was conducted during the reporting period by Gove Operations personnel in accordance with the following documents and the WMP (2019):

- Australian Standards / New Zealand Standards (AS/NZS) 5667.1:1998 *Water Quality – Sampling, Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples*; and
- National Environment Protection Council (NEPC) (2013) *National Environment Protection (Assessment of Site Contamination) Measure (ASC NEPM)*, 1999 (amended 2013).

The approved WMP (2019) for Gove Operations covers surface water, groundwater and marine monitoring across all four domains of the site. The current version of the WMP is dated October 2019.

The WMP (2019) was written with reference to WDL171-08, which has since been superseded by the WDL171-09 (July 2020) and ultimately WDL171-10 (September 2020). While the required monitoring frequency, locations and analytical suite has been revised, trigger values and limits for the Authorised Discharge Points remain unchanged from WDL171-08 to WDL171-10.

Table 5.1 below compares the monitoring frequency detailed in the WDL171-10 and WDL171-08, for those parameters that are in WDL171-10.

Table 5.1 Surface Water Monitoring Frequency (as per WDL 171-10)

Authorised Discharge Point:	So01		So44, So86, So87 & So88	
WDL Number:	WDL171-08	WDL171-10	WDL171-08	WDL171-10
Environmental Parameters				
pH	Continuous / Monthly [^]	Continuous / Daily	Flow Event*	Daily ²
Electrical Conductivity (EC)	Continuous [^]	Continuous	-	-
Turbidity	Daily / Monthly [^]	Daily	-	-
Alkalinity	Continuous [^]	Daily	-	-
Total Suspended Solids (TSS)	Monthly [^]	Weekly	-	-
Metals and Metalloids				
Aluminium (filtered)	Monthly [^]	Weekly	-	-
Arsenic (filtered)	Monthly [^]	Weekly	-	-
Vanadium (filtered)	Monthly [^]	Weekly	-	-
Hydrocarbons				
Total Petroleum Hydrocarbons (TPH)	Hydrocarbon Related Incident	Daily ¹	Flow Event*	Weekly ³

1. Daily when there is a hydrocarbon related incident at the Refinery

2. Daily when discharging from So86, So87, So88 & So44 only (authorised or otherwise) and at least once per discharge event

3. Weekly when discharging from So86, So87, So88 & So44 only (authorised or otherwise) and at least once per discharge event

* A flow event, where the time between the previous flow event and the current event is greater than 14 days

[^] Or during an incident / investigation

As noted in Section 5.2.1, So74 and So94 are incorporated as part of the MHMP in WDL171-10. However, they are included within the Surface Water Monitoring Program in the WMP (Gove Operations, 2019). For this reason, they are discussed alongside the Surface Water results in this report (Section 5). Table 5.2 below summarises the monitoring program for So74 and So94, as per WDL171-10. The frequency of monitoring at So74 and So94 were generally the same under WDL171-08 and WDL171-10.

Table 5.2 Monitoring Frequency for So74 and So94

Authorised Monitoring Point	So74	So94
WDL Number:	WDL171-10	WDL171-10
Environmental Parameters		
pH	Daily	-
EC	Daily	-
Turbidity	Daily	-
Alkalinity	Daily	-
TSS	Daily	-
Metals and Metalloids		
Aluminium (filtered)	Monthly	-
Arsenic (filtered)	Monthly	-
Chromium (filtered)	Monthly*	-
Copper (filtered)	Monthly	-
Gallium (filtered)	Monthly	-
Manganese (filtered)	Monthly*	-
Molybdenum (filtered)	Monthly	-
Vanadium (filtered)	Monthly	-
Zinc (filtered)	Monthly	-
Biological Parameters		
Enterococci	-	Monthly
*Chromium and manganese analysis were not required at So74 under WDL171-08, but magnesium analysis was required monthly.		

With the exception of So01 pH and EC continuous recordings, and So74, which has an automated, 24-hour composite sampler (discussed in Section 5.3.4.2), all surface water locations are typically sampled via grab samples by Gove Operations personnel. The grab samples are then either analysed by an external laboratory (as per data reported in Appendix C) or by the Gove Operations internal laboratory (as per data presented in Section 5.3.4.2).

When discharging from So86, So87, So88 and So44, monthly monitoring for Total Petroleum Hydrocarbons (TPH), Polycyclic Aromatic Hydrocarbons (PAH), benzene, toluene, ethylbenzene and xylene (BTEX) is also required at SW9, SW10 and RR2. The analytical results for this are presented in Table 3 (Authorised marine mixing zone monitoring points) and discussed in Section 5.4.

5.2.3 Trigger Values and Limits

Trigger values and Limits defined by the WDL171-10 are outlined in Table 5.3 below.

Table 5.3 WDL171-10 Trigger Values and Limits for Refinery Monitoring Sites

Parameter	Unit	So01		So44, So86, So87, So88		SW9, SW10, RR2
		TV	Limit	TV	Limit	TV
Environmental Parameters						
pH	pH	9.0	9.5	9.0	9.5	7.7-8.4
EC	μS/cm	-	-	-	-	-
Turbidity	NTU	20 ¹ / 75 ²	100	-	-	20
Dissolved oxygen	mg/L	-	-	-	-	5.81
Alkalinity	mg/L	-	-	-	-	-
TSS	mg/L	-	-	-	-	-
Metals and Metalloids ³						
Aluminium	μg/L	-	200	-	-	56
Arsenic	μg/L	-	20	-	-	20
Copper	μg/L	-	-	-	-	1.3
Gallium	μg/L	-	-	-	-	800
Molybdenum	μg/L	-	-	-	-	3880
Vanadium	μg/L	-	2000	-	-	100
Zinc	μg/L	-	-	-	-	15
Hydrocarbons						
TPH	μg/L	-	600	-	600	-^
Nutrient Indicators & Biological Parameters						
Total Phosphorous	μg/L	-	-	-	-	14
Total Nitrogen	μg/L	-	-	-	-	170
Chlorophyll A	μg/L	-	-	-	-	1.4
Enterococci	cfu/100ml	-	-	-	-	35*

1. Dry conditions – when unaffected by rainfall runoff associated with a storm event

2. Storm event – includes the actual rainfall event and all associated channel storm-flow

3. Metal(loid) trigger values and limits are considered applicable to <0.45µm field filtered results

[^] Monthly when discharging from So86, So87, So88 and So44 only when safe to do so, acknowledging some discharge events will occur during monsoonal conditions

^{*} Incidental monitoring, where locations SW9, SW10 and RR2 are required to be sampled for Enterococci within one week of a Enterococci result >35 colony-forming units (cfu) /100ml at S094.

Under Condition 39 of the License (WDL171-10), a non-compliance with the includes;

- An exceedance of the limit specified in WDL171-10 (as per Table 5.3);
- An exceedance of a trigger value of three times or more than the trigger value; and
- An exceedance of the trigger value on three consecutive sampling occasions.

All analytical results for the reporting period have been screened against these trigger values and limits, and are presented in Table 1 (Seawater Outfall Channel) or Table 2 (Tank Farm Bunds), Appendix C. Results exceeding these criteria are discussed in Section 5.3.

5.3 Data Review and Interpretation

5.3.1 Discharge Events

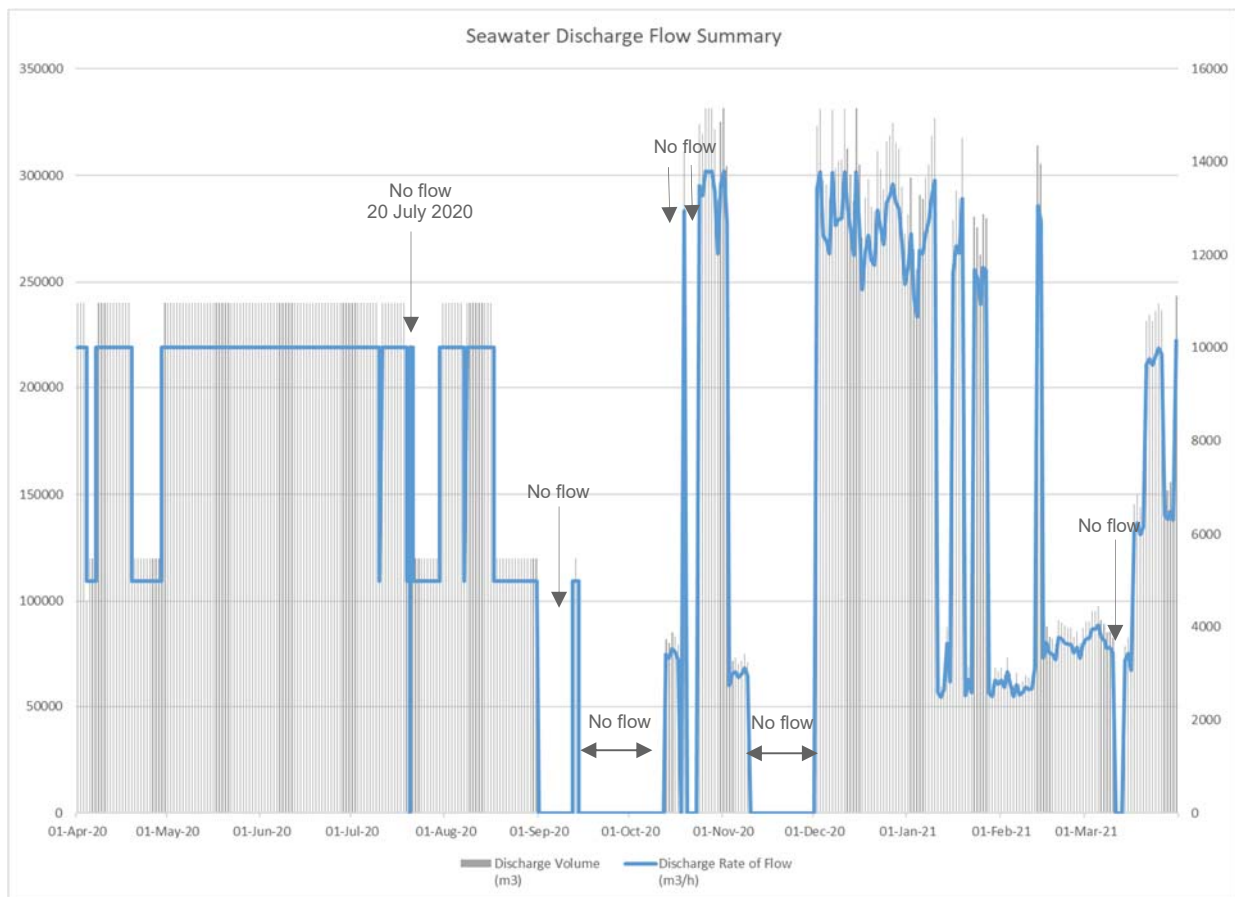
5.3.1.1 Seawater Outfall Channel Operational Flow

Graph 5.1 below shows the discharge flow from the Seawater Outfall Channel and instances when the channel flow was absent and not operational during the reporting period.

The seawater outfall channel discharges continuously, unless offline operational maintenance or shutdowns of the seawater discharge channel occur. In instances when the seawater outfall discharge is offline and surface water flow in the channel is absent, sampling at S001 and S074 cannot be undertaken (i.e. monitoring at these locations is not applicable when channel flow is absent.)

Discharge volumes from the Seawater Outfall Channel (S001) were recorded for 24-hour periods, as well as periods of less than 12-hours during the reporting period, with the exception of a number of days in July, September, October, November and December 2020 and March 2021 (refer Graph 5.1 below) when there was no discharge. When the outfall channel was discharging, the average daily discharge rate for this period was 8,260 m³/hr, and the average daily discharge volume was 191,615 ML.

Graph 5-1 Seawater Outfall Channel Discharge Flow



The seawater outfall channel was offline with absent flow events recorded (not discharging) for 72 days over the reporting period, specifically during the following dates;

- 20 July 2020;
- 1 September 2020 to 11 September 2020;
- 15 September 2020 to 12 October 2020;
- 18 October 2020;
- 20 October 2020 to 23 October 2020;
- 11 November 2020 to 1 December 2020; and
- 11 March 2021 to 13 March 2021.

5.3.1.2 Tank Farm Bunds

Discharge volumes and durations (start and stop times) were recorded for the Tank Farm Discharge Points. Discharge durations were all between 0.5 – 5.5 hours, and discharge volumes ranged from 15 m³ - 600 m³ at each point. A discharge flow meter is planned for installation at So44, So86, So87, and So88. However, flow rates may currently be assessed based on the duration and volumes of discharge.

Based on field sheets provided by Gove Operations, the following releases (discharges) occurred during the reporting period (Table 5.5). The timing of the surface water releases (April 2020 and December 2020 to March 2021), is consistent with the periods during which rainfall was recorded (Section 4.3).

Table 5.4 Summary of Releases from the Tank Farm Bunds

Date of Release	So44	So86	So87	So88
9 April 2020	X	X	X	X
12 April 2020	X	X	X	X
4 December 2020	X	X	X	X
14 December 2020	X	X	X	X
19 December 2020	X	X	X	X
23 December 2020	X	X	X	X
30 December 2020	X	X	X	X
2 January 2021	X	X	X	X
16 January 2021	X	X	X	X
22 January 2021	X	X	X	X
26 January 2021	-	X	-	X
5 February 2021	X	X	X	X
9 February 2021	-	X	X	X
12 February 2021	X	X	X	X
19 February 2021	X	X	X	X
27 February 2021	-	-	-	X
28 February 2021	X	X	-	-
23 March 2021	-	X	-	-
29 March 2021	X	X	X	X
31 March 2021	X	X	X	X

X – Release recorded at surface water Discharge Point

 TPH not collected - notification reported regarding sample frequency compliance.

5.3.2 Sample Numbers and Analysis

The number of samples collected from each WDL Discharge Point within the Refinery Catchment is provided in Table 5.50.

Table 5.5 Summary of WDL Samples Collected During the Reporting Period

Parameter	Number of Samples Analysed						
	So01	So44	So86	So87	So88	So74	So94
pH (field)	10*	18	21	17	19	10*	-
EC	10*	-	-	-	-	10*	-
Turbidity	11*	-	-	-	-	11*	-
Alkalinity	11*	-	-	-	-	11*	-
TSS	11*	-	-	-	-	11*	-
Aluminium (filtered)	37	-	-	-	-	11	-
Arsenic (filtered)	37	-	-	-	-	11	-
Chromium (filtered)	-	-	-	-	-	6	-
Copper (filtered)	-	-	-	-	-	11	-
Gallium (filtered)	-	-	-	-	-	11	-
Magnesium (filtered)	-	-	-	-	-	11	-
Manganese (filtered)	-	-	-	-	-	6 [#]	-
Molybdenum (filtered)	-	-	-	-	-	11	-
Vanadium (filtered)	37	-	-	-	-	11	-
Zinc (filtered)	-	-	-	-	-	11	-
TPH	1	9	12	8	10	-	-
Enterococci	8 [^]	-	-	-	-	-	12

■ Analysis not required under WDL171-10

Reporting period: 1 April 2020 – 31 March 2021

*Continuous and/or daily data for pH, EC, turbidity, alkalinity and weekly TSS at So01 and daily pH, EC, turbidity, alkalinity and TSS at So74 are discussed in Section 5.3.4.2.

Manganese analysis replaced Magnesium analysis in September 2020 (WDL171-10)

[^] Enterococci analysis carried out from April to September 2020 as per WDL171-08/09, prior to WDL171-10.

According to the monitoring data available for the reporting period (Table 1, Appendix C for So01 and So74, and Table 2, Appendix C for So44, So86 – So88), the following non-compliances with WDL171-10 and WDL171-08 monitoring frequency are noted with respect to the sampling frequency and have been reported to the Northern Territory Government by Gove Operations. Incident reports for each are presented in Appendix F:

- 2 – 26 June 2020 – Incident 1000556158 – Daily pH measurements were required at S1001 (Duck Pond) under WDL171-08 during the June 2020 period. Daily pH at the S1001 was not recorded for five days in this period;
- 12 August 2020 – Incident 1000555719 – Daily composite sample not collected at So74 due to equipment availability issues;
- 17 September 2020 – 16 October 2020 – Incident 1000580958 – Daily TSS at So74 was not recorded. This frequency was changed under WDL 171-10 from monthly to daily; previous WDL required monthly monitoring;
- 14 & 17 October 2020 – This incident is related to 1000561236 – Continuous pH and EC at So01 was not recorded due to power outage;
- 19 October 2020 – Incident 1000561236 – Continuous pH and EC at So01 was not recorded due to transmitter equipment issues;
- 26 October 2020 – Incident 1000561923 – Continuous pH and EC not recorded at So01 for one hour;
- November 2020 – Incident Reference 1000578911 - metal/metalloids sample was not collected in the calendar month of November 2020 at So74;
- 30 November 2020 – Incident 1000564793 – frequency of monitoring at So94 for Enterococci sample (monthly sample for November) was collected, but could not be analysed due to flight and freight

delays associated with COVID-19 (refer Section 5.3.34.4). A sample was collected on 1 December 2020 instead; and

- 4 December to 16 January 2021 – Incident 1000567997 – during an internal audit of surface water monitoring data, the frequency of monitoring at So44, So86, So87 and So88 for TPH for four (4) releases that occurred in December 2020 - January 2021, were identified. Subsequently, a further two occasions during the December 2020 - January 2021 period when TPH sampling was not completed were identified and reported. In total, six (6) TPH sampling events for So44, So86, So87 and So88 were not collected during the release events identified below;
 - 14 December 2020
 - 19 December 2020
 - 23 December 2020
 - 30 December 2020
 - 2 January 2021
 - 16 January 2021
- 24 March 2021 – Incident 1000573473 – Daily composite TSS not tested at So74;
- 31 March 2021 – Incident 1000580839 – Routine sampling for bund releases at So44, So87, So86, and So88 was completed by Gove Operations as per the requirements of the WDL171-10. The laboratory analysed So86 and erroneously discarded So44, So87 and So88 samples. TPH analysis was not completed for So44, So87 and So88 as reported in this notification. (Bund release analytical sampling results are discussed in Section 5.3.4.3.3).

As indicated in Section 5.2.2, some differences in the WDL frequency of monitoring requirements were noted when comparing WDL171-08 and WDL171-10. The frequency of monitoring at So74 for chromium (monthly) is reported from September onwards, consistent with inclusion of chromium in WDL171-10. Due to this change, analysis of magnesium (monthly to September 2020) was replaced with manganese (monthly) monitoring at So74 (after September 2020).

No TPH results were recorded for the 12 April 2020 release at So44, So86, So87 and So88 as the WDL171-08 was applicable at this time. WDL-171-08 only required TPH monitoring for a flow event where the time between the previous flow event and the current event is greater than 14 days. During this period no TPH monitoring was required as the bund release occurred for a duration of less than two (2) hours on 12 April 2020, with a preceding release occurring on 9 April 2020 for a duration of 5.5 hours.

5.3.3 Variability and Quality Control of Dataset

With the exception of the flows from the Refinery Seawater Outfall Channel (Soo1) which are generally continuous, the remaining surface water sampling locations are representative of ephemeral or seasonally responsive flow conditions. As a result, there is considerable variability in the analytical results over time, with this variability being strongly influenced by the flow conditions or residual pooled water quality encountered at the time of sampling.

A quality assurance and quality control (QAQC) program was implemented during the reporting period. The QAQC results are presented in Appendix A. It should be noted that QAQC did not assess the following (consistent with the previous WDL reporting):

- sample receipt (security seals and appropriateness of bottles);
- rinsates / field blanks;
- field duplicates and field triplicate RPDs;
- frequency of QAQC completed by laboratory;
- surrogate recoveries;
- laboratory control spikes; or
- method blanks.

The main outcome of the QAQC was that the majority of samples collected during the reporting period exceeded the temperature on receipt. This was likely due to air freight delays between Gove and Sydney

laboratories. It is noted that all samples were transported with ice, and were received below the NT ambient temperatures (which exceeded 30°C).

5.3.4 Surface Water Analytical Results

The sections provide a summary of the monitoring results for the Seawater Outfall Channel (S001 and S074) and the Tank Farm bund monitoring (S044, S086, S087, and S088), as reported by the external laboratory.

Field measured water quality and laboratory analytical results for the reporting period are summarised in the following tables in Appendix C.

- Table 1: Surface Water Analytical Results – Seawater Outfall Channel (S001, S074, S094)
- Table 2: Surface Water Analytical Results – Tank Farm Bunds (S044, S086, S087, S088)
- Table 3: Marine Impact for authorised discharge from Refinery – Mixing Zone (RR2, SW9, SW10)

The results of continuous and daily monitoring undertaken by Gove operations are either measured in the field or analysed by the internal laboratory, and are discussed in Section 5.3.4.2.

5.3.4.1 Seawater Outfall Channel – WDL Samples

The Seawater Outfall Channel is located between the Light Fuel Tank Farm (east) and the Harbour Tank Farm (west), down-gradient of the convergence of the seawater circuit channels (Eastern Channel and Western Channel) (Figure 3, Appendix B). The Western Containment Pond, Oily Water Pond, the sewage treatment plant and the WWNP all have the potential to discharge into the seawater circuit, and subsequently, discharge via the Seawater Outfall Channel.

The seawater circuit comprises the main process water intake and wastewater discharge system within the Refinery Catchment. It incorporates a number of monitoring points, however only S001 has trigger values associated with it under WDL171-10.

The Seawater Outfall Channel discharges under licence (WDL 171-10) to the south into Gove Harbour. Surface water quality is monitored via the collection of grab samples (S001), continuous sampling (pH and EC every 30 seconds), and a 24-hour composite sample via an automated sampler that collects 50 mL of water per 20 minutes (S074).

Bacterial parameters are monitored at Monitoring Point S094, further discussed in Section 5.3.4.4 below.

Table 1, Appendix C, presents the analytical results for S001 against the relevant WDL TVs and limits. Results for S074 are also included in this table, however no screening criteria are applicable under WDL171-10.

All analytical results for the surface water samples collected at S001 were reported less than the relevant WDL Trigger Values and Limits over the reporting period (refer Table 5.3).

However, Gove Operations reported a non-compliance to the Northern Territory Government for 29 June 2020 (Incident 1000552308, Appendix F) for a sample collected at S001 which showed elevated dissolved arsenic concentrations (above the WDL limit) during a non-routine sampling investigation following power outage and shutdown of the WWNP. The results for this notification are not included in Table 1, Appendix C or discussed further in this report as they formed part of a follow up investigation rather than a WDL sampling event.

5.3.4.2 Seawater Outfall Channel - Daily and Continuous Monitoring

Soo1 - pH and EC

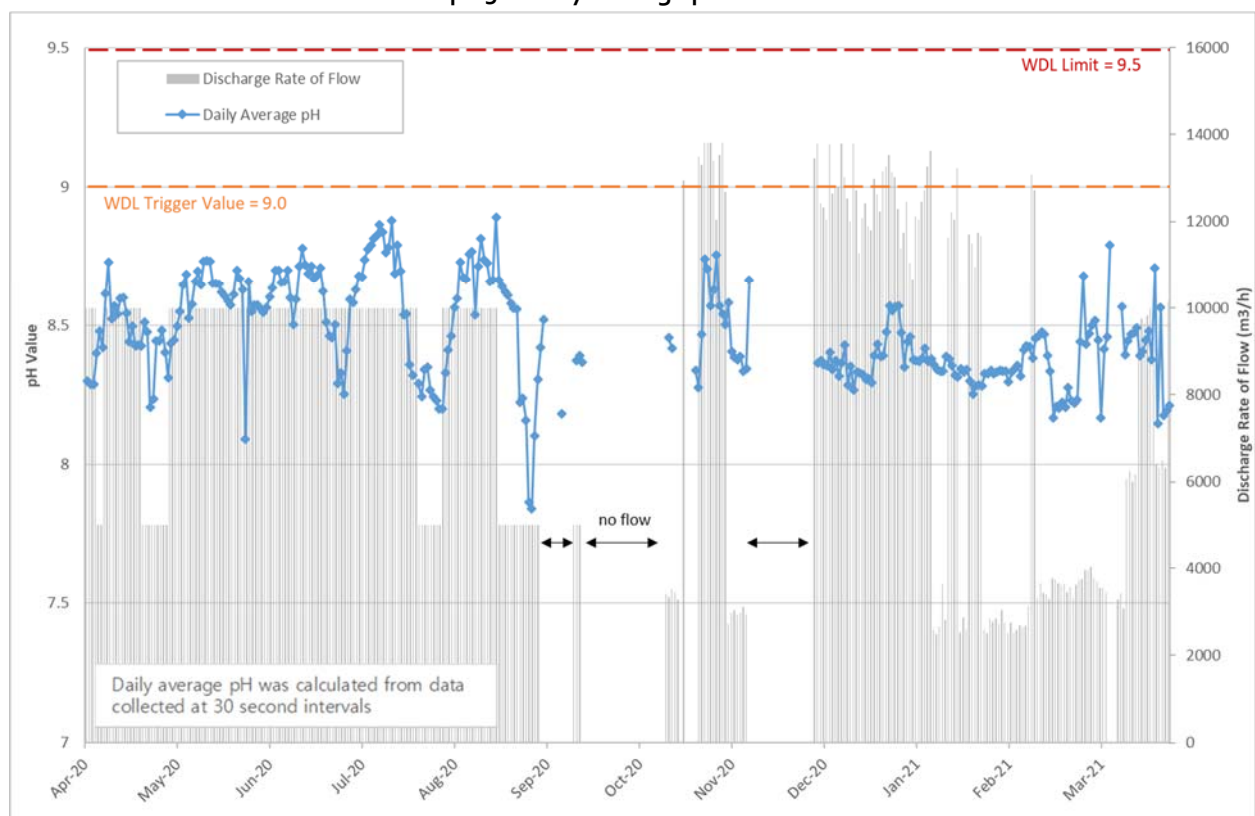
pH and EC at Soo1 are required to be monitored on a continuous basis, with pH also to be monitored on a daily basis under the WDL171-10. These parameters are measured continuously using a data logger with pH and EC data being collected every 30 seconds. Due to the large volume of data available, the daily average pH and EC from the continuous measurements are presented in Graph 5.2 and Graph 5.3 below. The seawater outfall discharge flow is also plotted to identify when flow is absent and continuous monitoring is not recorded.

Over the reporting period, the daily average pH was generally recorded within the range 7.8 - 8.9, with an overall average of 8.5. No exceedances of the WDL pH trigger value (9.0), or the pH limit (9.5) were recorded, therefore no non-compliance breaches under Condition 39 of WDL171-10 were recorded.

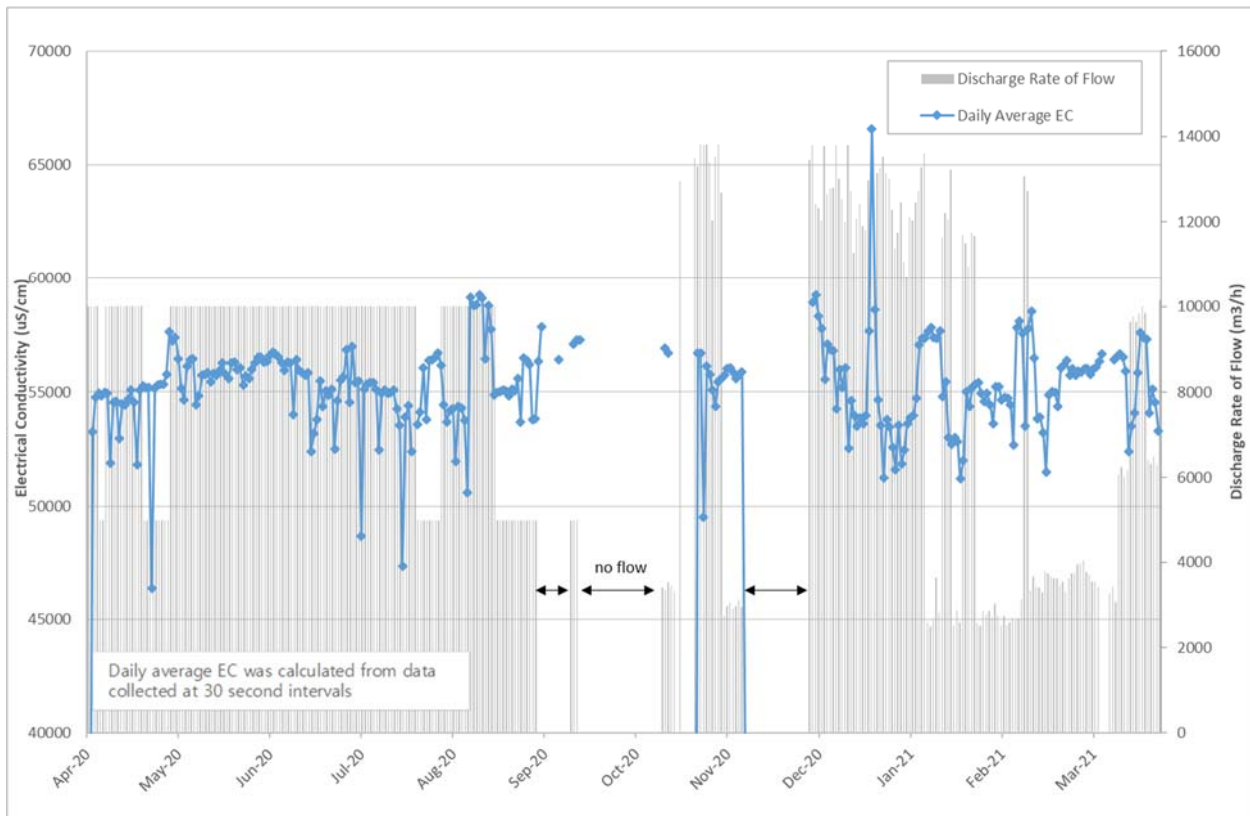
When the seawater outfall channel is discharging, the daily average EC typically oscillated between 45,000 $\mu\text{S}/\text{cm}$ and 60,000 $\mu\text{S}/\text{cm}$. There are no trigger values or limits for EC at Soo1.

The seawater outfall discharge was offline for 72 days over certain periods, as discussed in Section 5.3.1.1. Continuous pH and EC at Soo1 were not recorded on a number of days. These periods corresponded to the periods when seawater outfall discharge was offline. Additionally, on three occasions in October 2020, transmission failure and/or equipment error was reported by Gove Operations and continuous readings could not be recorded. The 14 and 17 October 2020 (recorded under 1000561236), 19 October 2020 (Incident Notification 1000561236), and 26 October 2020 (Incident Notification 1000561923) have been reported to the Northern Territory Government (refer Appendix F).

Graph 5-2 Daily Average pH at Soo1



Graph 5-3 Daily Average EC at Soo1



Soo1 - Turbidity, Alkalinity, and TSS at Soo1

Turbidity and alkalinity are required to be monitored on a daily basis, while TSS is required to be monitored weekly under the WDL171-10. Of these parameters, only turbidity has a WDL trigger value (25 NTU / 75 NTU) and limit (100 NTU) associated with it. The daily and/or weekly analytical data for these parameters is presented below in Graphs 5.4 – 5.6.

The following is noted with regards to these parameters during the reporting period:

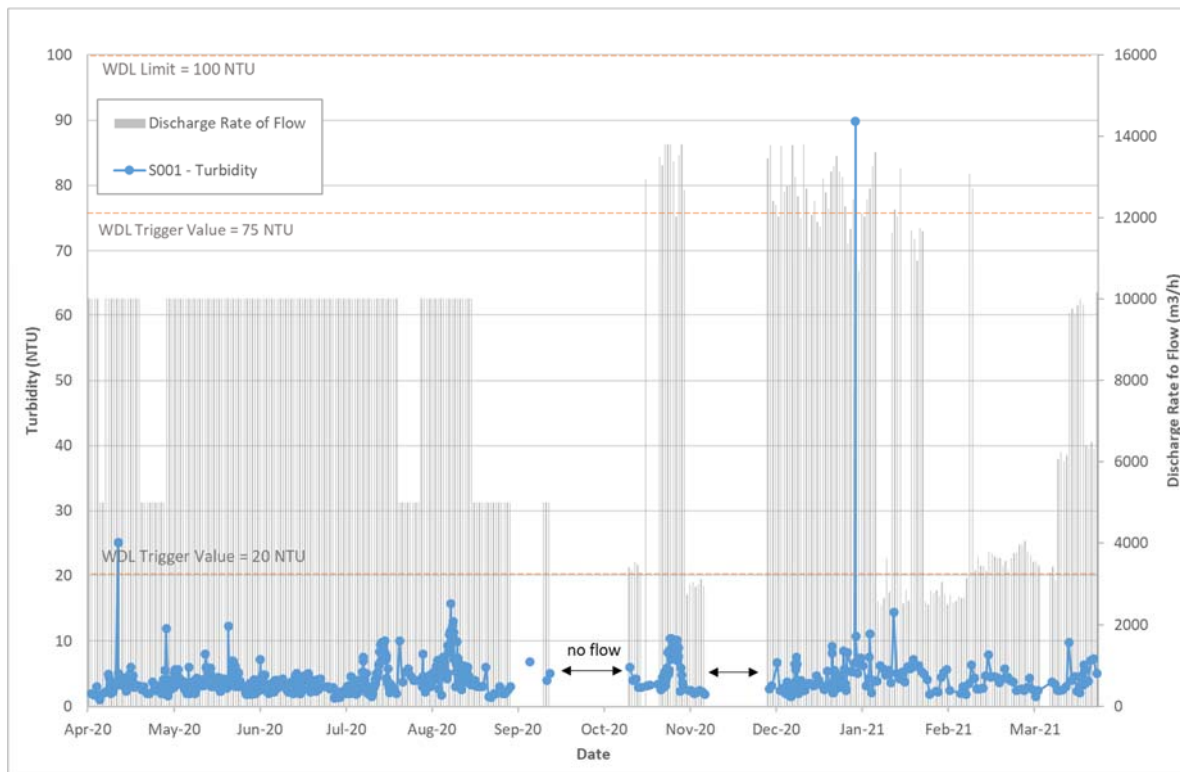
- Daily turbidity data was recorded for the entirety of the reporting period, with the exception of periods when the seawater outfall discharge channel was offline. Results for turbidity ranged from 1.4 – 15 NTU and were reported less than the WDL trigger values and limit for the duration of the reporting period, with the following exceptions:
 - On 11 April 2020 a turbidity concentration of 25 NTU was recorded which is greater than the 20 NTU trigger value for dry conditions. A rainfall event of 24.7 mm was also recorded on 11 April, therefore the trigger value of 75 NTU for storm events is applicable. This is not considered to be a non-compliance of the licence under Condition 39 of WDL171-10 and the licence limit was not exceeded; and
 - On 2 January 2021, a turbidity concentration of 89.8 NTU was recorded. Rainfall events were also recorded on 1 January (61.4 mm) and 2 January (29.6 mm) and therefore the trigger values for storm events would be applicable. The turbidity recorded on 2 January is greater than the WDL trigger value for storm events (75 NTU), however as this was below the WDL limit (100 NTU) and on a single exceedance of the trigger value, this is not considered to be non-compliance with the licence under Condition 39 of WDL171-10.
- Daily alkalinity data was recorded for the entirety of the reporting period, with the exception of periods when the seawater outfall discharge channel was offline. Results were reported within the range 109 – 445 mg/L over the reporting period.

- Weekly TSS data analysed by Gove Operations internal laboratory is available from October 2020 onwards when the Gove Operations internal Laboratory became equipped to monitor TSS. There are two weekly sampling events (14 September and 14 October 2020) that were analysed by the external laboratory to cover a short period between the introduction of the WDL171-10 weekly TSS monitoring requirements and the internal lab capabilities to monitor TSS.

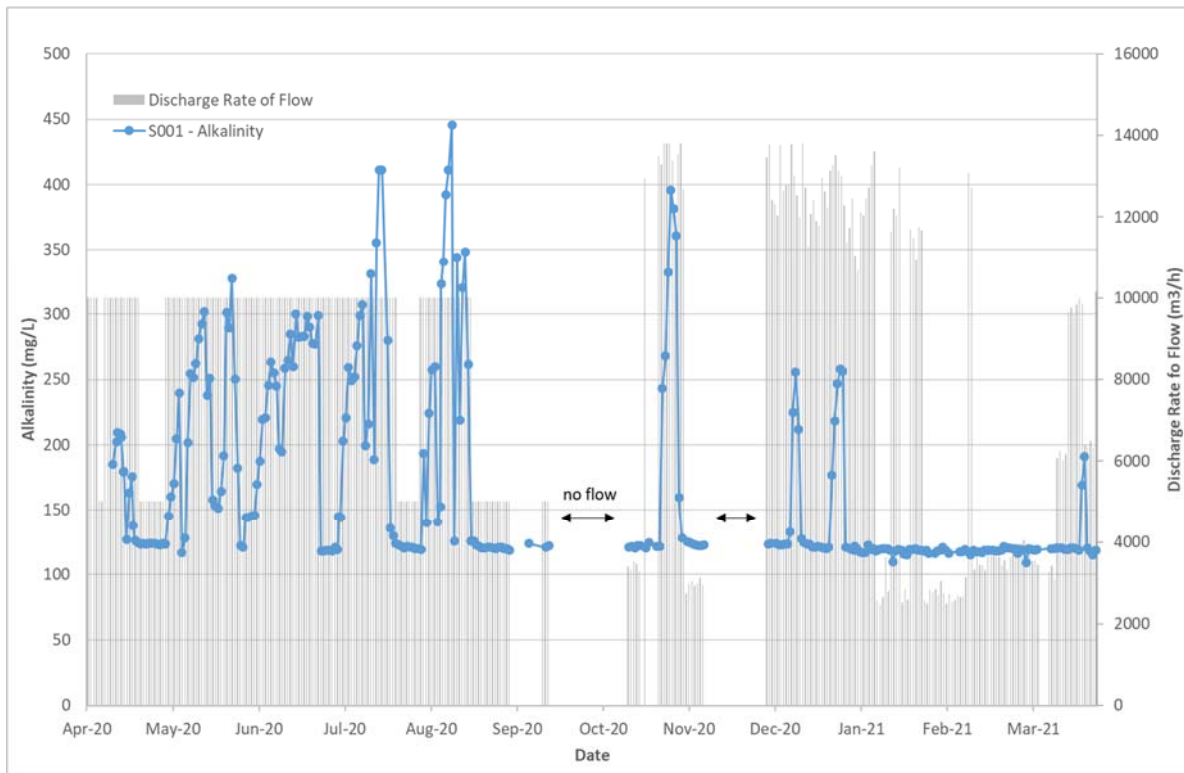
Prior to September 2020, TSS was only required to be monitored monthly as per WDL171-08. During that period TSS was analysed by an external laboratory with results included in Table 1, Appendix C. Weekly TSS generally ranged between 3 – 12 mg/L. However, one sample reported TSS of 21 mg/L (12 January 2021) which is within range of monthly data recorded from April to September 2020.

There are also periods of no recordings for TSS when the seawater outfall discharge channel was offline.

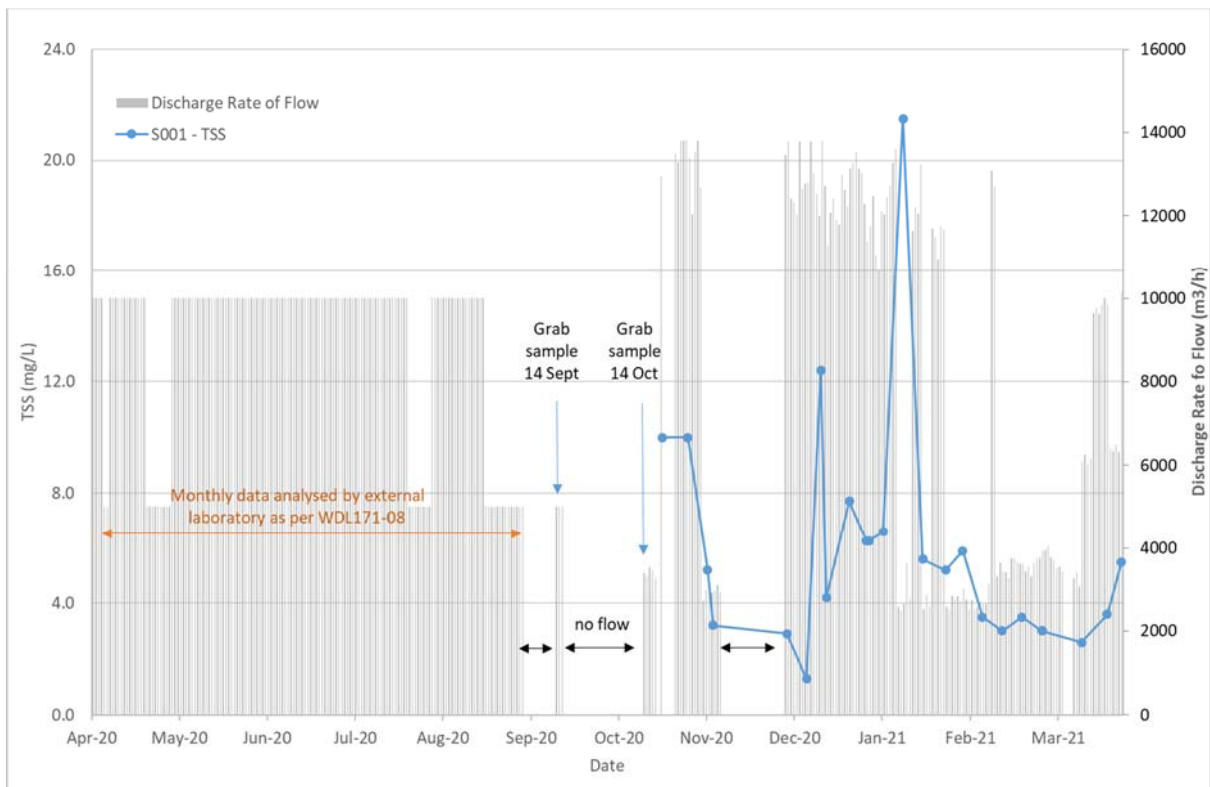
Graph 5-4 Daily Turbidity Results at S001



Graph 5-5 Daily Alkalinity Results at S001



Graph 5-6 Weekly TSS Results at S001



pH, EC, turbidity, alkalinity and TSS are required to be monitored on a daily basis at So74 under the WDL171-10. No WDL trigger values or limits are associated with monitoring location So74. All available data for these parameters is presented in Graphs 5.7 – 5.11 below.

The following is noted with regards to these parameters during the reporting period:

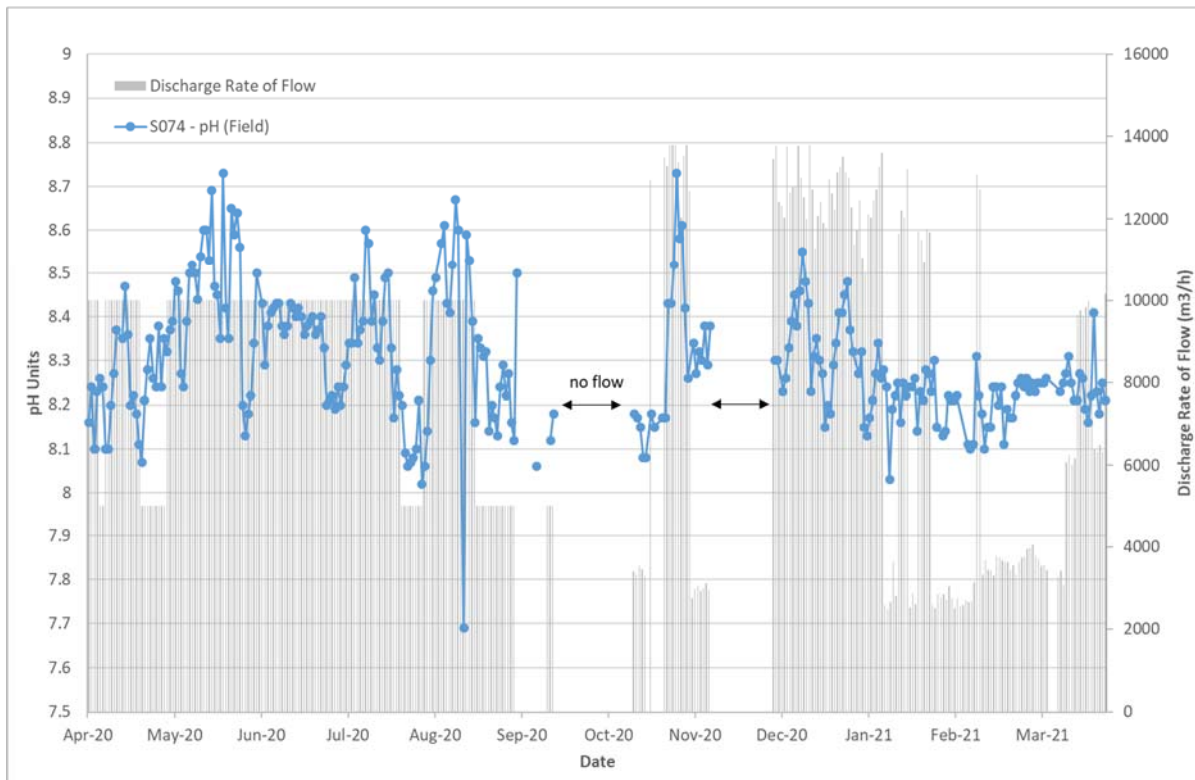
- pH was measured between 8.0 – 8.7;
- EC was reported consistently within the range of 47,900 – 53,000 $\mu\text{S}/\text{cm}$, with the exception of one result on 5 May 2020 (82,200 $\mu\text{S}/\text{cm}$) and one result on 11 August 2020 (39,100 $\mu\text{S}/\text{cm}$);
- Alkalinity oscillated within the range 110 – 365 mg/L, but generally stabilised at around 120 mg/L between January 2021 – March 2021;
- TSS was reported within the range 1-28 mg/L, with the exception of one result from January 2021 (63.7 mg/L); and
- Turbidity oscillated between 0.6 – 17 NTU, with two samples reporting results an order of magnitude greater than this range in October 2020 (31.2 NTU) and January 2021 (47.5 NTU).

For pH, EC, alkalinity, turbidity and TSS, a number of daily results were not monitored when the seawater outfall channel was offline. In addition, the following non-compliances are noted, but have previously been reported to the Northern Territory Government:

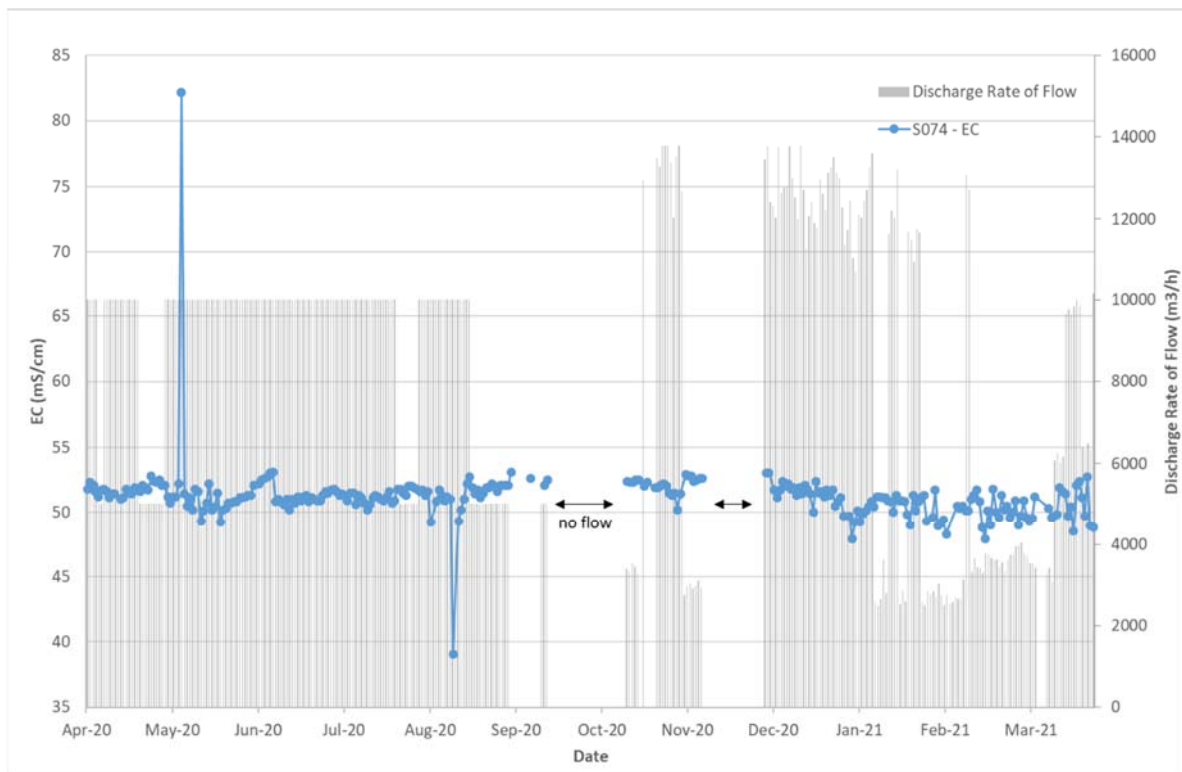
- 12 August 2020 – Incident 1000555719 (Appendix F) – a daily sample was not collected at So74 due to availability of sampling equipment; and
- 24 March 2021 – Incident 1000573473 (Appendix F) - daily sampling was conducted at So74 and analysed for daily parameters, however TSS was not analysed.

Internal laboratory analysis of daily TSS at So74 commenced in October 2020. Prior to the commencement of WDL171-10, TSS was only required to be reported on a monthly basis and this was analysed by an external Laboratory (as presented in Table 1 Appendix C).

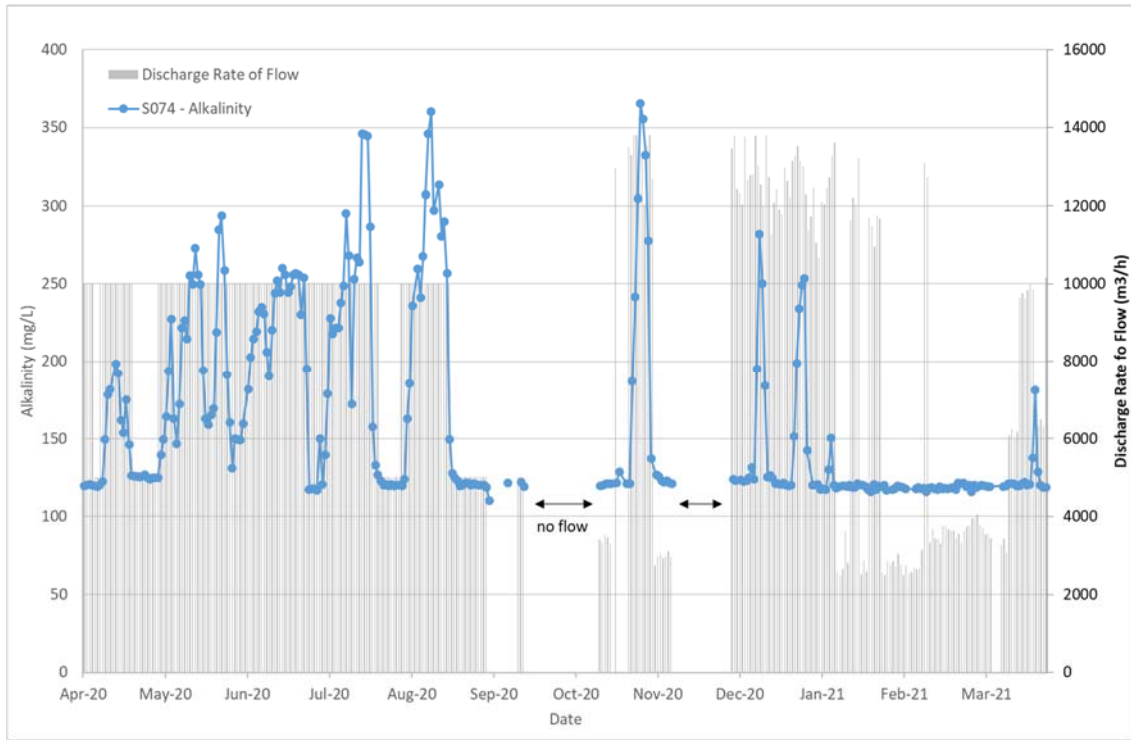
Graph 5-7 Daily pH at So74



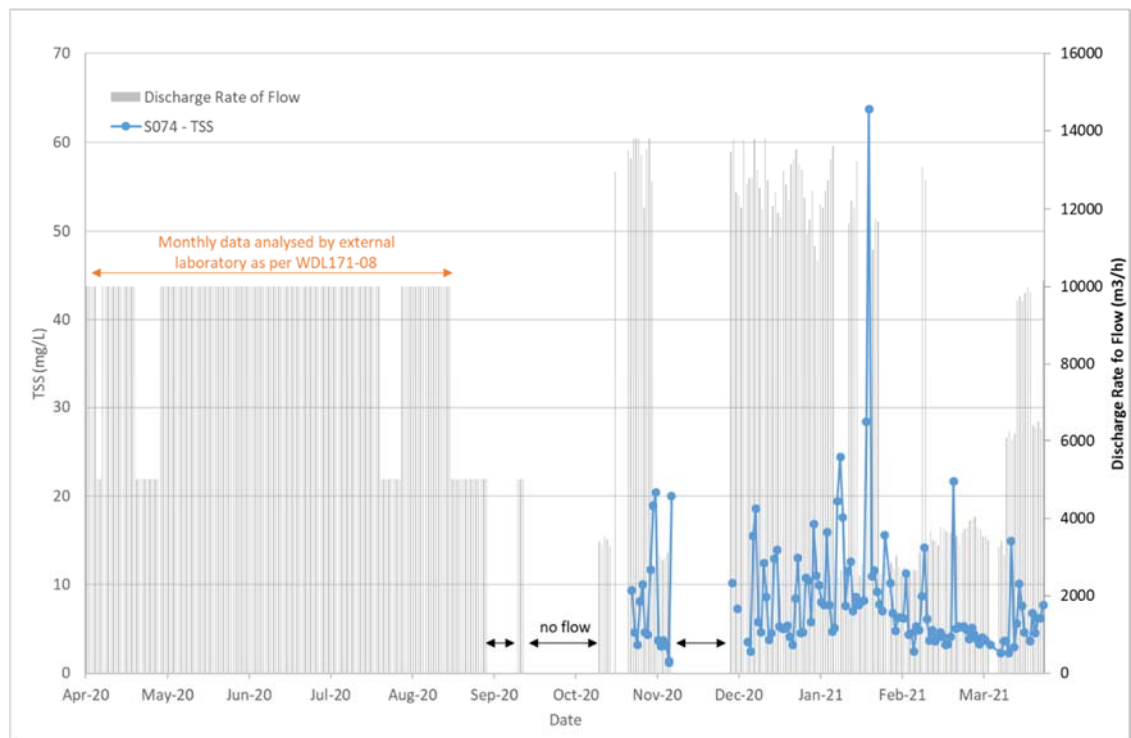
Graph 5-8 Daily EC at So74



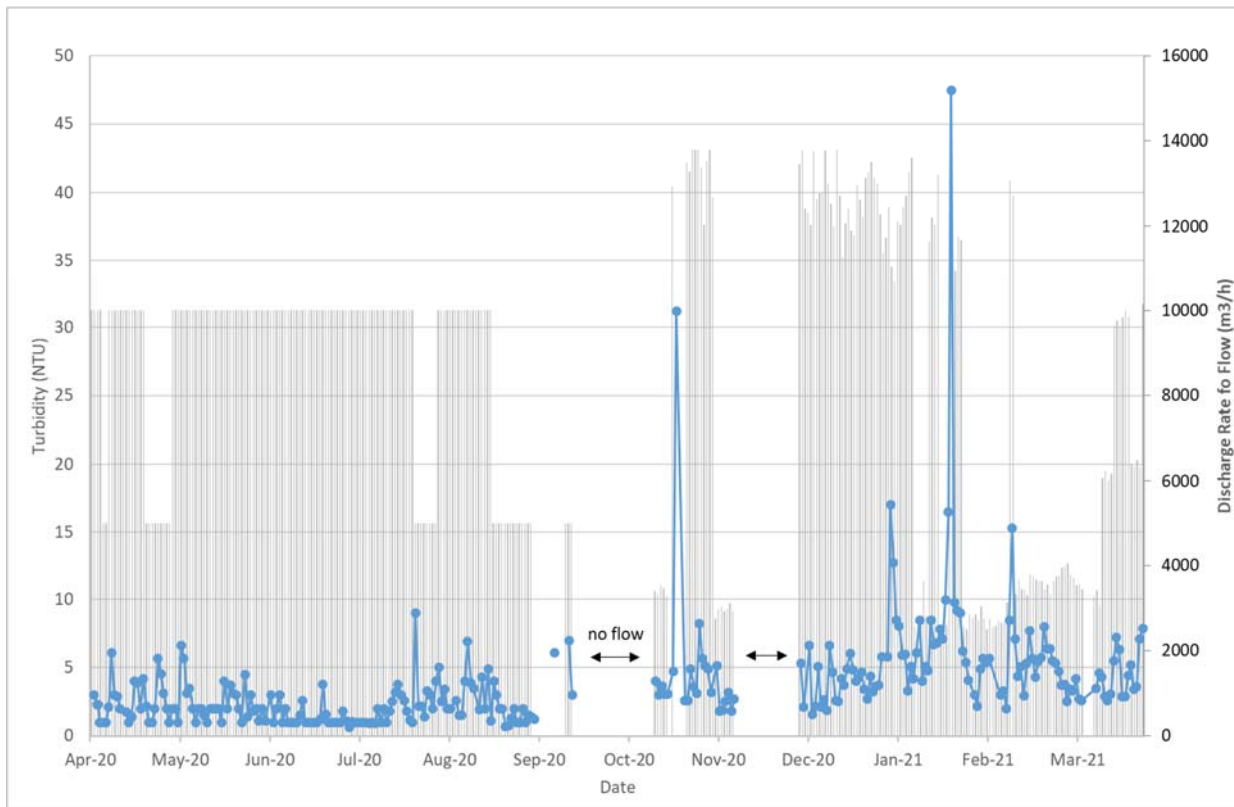
Graph 5-9 Daily Alkalinity at S074



Graph 5-10 Daily TSS at S074



Graph 5-11 Daily Turbidity at So74



5.3.4.3 Tank Farm Bund monitoring (So44, So86, So87, So88)

WDL171-10 discharge points located within the Light Fuel Tank Farm (So44) and Harbour Tank Farm bunds (So86, So87 and So88) were monitored for TPH C₁₀-C₃₆ (Total) between 8 – 12 times, predominantly between December 2020 and March 2021 (as per Section 5.3.1.2 and Section 5.3.2).

TPH sampling and analysis is required at So44, So86, So87 and So88 when discharging is occurring as per WDL171-10. As identified in Section 5.3.1.2 and Table 5.4, there were six release events (December 2020 to January 2021) when TPH sampling and analysis was not conducted (Incident Notification 1000567997), and one release event (March 2021) when TPH sampling was conducted however the analysis at So44, So87 and So88 was not completed by the analytical laboratory (Incident Notification 1000580839).

All results reported for TPH C₁₀-C₃₆ (Total) during the reporting period were reported less than the laboratory limit of reporting (LOR). As such, no results exceeded the WDL Limit for TPH (600 µg/L). Further, according to Gove Operations field notes, no visual evidence of hydrocarbon contamination was noted during sampling throughout the reporting period.

Field pH samples were collected for surface water from So44, So86, So87, and So88 at least once during discharge events, as per WDL requirements. As all discharge events were recorded for a duration of less than 5.5hrs, the requirement for further daily monitoring of pH was not applicable. All surface water samples were recorded less than the WDL trigger value (9.0) and limit (9.5), with the exception of the following:

- pH was reported at 9.14 on 26 January 2021 at So44, which is greater than the trigger value but did not exceed the WDL limit and was therefore not considered to be a non-compliance;
- pH was reported at 9.05 on 30 December 2020 at So88, which is greater than the trigger value but did not exceed the WDL limit and was therefore not considered to be a non-compliance; and

- Discharge from So88 was recorded marginally greater than the pH Limit of 9.5 on 16 January 2021, at approximately 08:00am, when the recorded pH was 9.57. This was reported to the Northern Territory Government on 18 January 2021 (refer to Notification of an Environmental Incident 1000567996, in Appendix F).

5.3.4.4 Bacteriological (Enterococci) Monitoring (S094)

The boat ramp (site S094) and areas near where the seawater channel discharges into Gove Harbour are visited by members of the public for fishing and boating activities. The area is therefore monitored for potential bacteriological impacts from wastewater discharged by Gove Operations from the refinery STP. The current refinery STP was re-commissioned in June 2016.

In accordance with WDL171-10, seawater samples are collected from S094 (Public Boat Ramp) for laboratory analysis (Enterococci). The analysis of seawater samples for Enterococci at the Public Boat Ramp provides direct monitoring of the receiving environment for sewerage contamination.

Analytical results of the monthly sampling (in most-probable number (MPN) per 100 mL) are presented in Table 1, Appendix C. As per the footnotes of Table 2 in the WDL171-10, the guideline value relevant to S094 is 35 CFU/100 ml and exceedance of this guideline requires follow up incident sampling at Marine boundary mixing locations SW9, SW10 and RR2. This guideline (35 CFU/100 ml) is the recommended recreational guideline value from Australian and New Zealand Guidelines (ANZG, 2018). The analytical results are presented in MPN/100 ml, and the discussion below assumes this is equivalent to Colony Forming Units (CFU)/100 ml.

All samples collected during the reporting period were less than the LOR (10 MPN/100 mL), with the exception of the following:

- A sample collected on 8 April 2020 which reported a concentration of 107 MPN/100 mL. Although this concentration exceeds the current WDL171-10 guideline trigger value (35 CFU/100 ml) for further incidental monitoring at SW9, SW10 and RR2, the conditions in WDL171-10 are not applicable to this sample date. In April 2020 the conditions of the WDL171-08 were applicable, which only required monthly Enterococci analysis at S094 and S001, without triggering additional sampling; and
- A sample collected on 9 February 2021 which reported a concentration of 31 MPN/100 mL. This concentration is less than WDL guideline (35 CFU/100 ml).

5.4 Mixing Zone Compliance Point Monitoring (SW9, SW10, RR2)

The laboratory analytical results for the reporting period for TPH are summarised in Table 3 in Appendix C.

As part of the WDL171-10, compliance locations SW9, SW10 and RR2, located in the mixing zone boundary of the authorised Discharge Points, are monitored for hydrocarbons. As per Section 5.2.2, SW9, SW10 and RR2 are required to be monitored monthly when discharging from So44, So86, So87 and So88.

All results for TPH at SW9, SW10 and RR2 were recorded less than the laboratory LORs, and are presented in Table 3, Appendix C

5.5 Long Term Trend Analysis

Graphs showing long-term surface water concentrations at So01 (pH, EC, turbidity, alkalinity, TSS, aluminium, arsenic, vanadium), and So44, So86, So87, and So88 (pH and TPH) are presented in Appendix D. The data presented is based on the external laboratory data only, with data presented from 2013 to 2021. A summary of the long term trends is discussed below.

Seawater Outfall Channel (So01)

The following key observations are noted for So01:

- pH has historically oscillated between 8 – 9, with typically lower pH values recorded since approximately 2019;
- Turbidity has historically oscillated between 1 – 10 NTU;
- EC has generally remained stable since March 2016, generally oscillating between 40,000 – 60,000 $\mu\text{S}/\text{cm}$;
- Alkalinity has generally remained stable between 100 – 200mg/L since January 2019, with the exception of two occasions during the current reporting period when concentrations were recorded greater than 300 mg/L (14 July 2020, 353mg/L and 27 October 2020, 400mg/L). These concentrations are comparable to historic ranges of 100 – 500mg/L.
- TSS has generally been stable between 5 – 50mg/L since March 2016, despite data gaps for 2017 and 2018;
- Dissolved aluminium and vanadium concentrations have generally been reported at concentrations below the WDL limit. Concentrations reported have decreased since approximately January 2019; and
- Dissolved arsenic concentrations have been reported at less than the WDL limit since January 2019, and have generally remained stable since this date.

Seawater Outfall Channel (So74)

- Historically, pH has been reported within the range 7.4 – 8.8. Since December 2018 the pH range is reported between 8.0 and 8.6;
- EC has generally fluctuated between 40,000 $\mu\text{S}/\text{cm}$ and 55,000 $\mu\text{S}/\text{cm}$;
- Alkalinity and turbidity have remained relatively stable at the lower range of the historical data set since September 2018;
- TSS has remained stable since the beginning of 2014, fluctuating between <5 mg/L and 25 mg/L;
- Concentrations of aluminium, arsenic, molybdenum, and vanadium have improved since January 2018; and
- Historically, concentrations of copper, chromium, gallium, and, zinc have generally been reported below the laboratory LORs.

Tank Farm Bund Release (So44, So86, So87 and So88)

The following key observations are noted for surface water samples from the Tank Farm Bunds:

- pH at So44, So86, So87 and So88 has historically fluctuated between 7-9; and
- TPH has been reported less than the laboratory LOR since December 2016 at So44, So86, So87 and So88.

The Boat Ramp (So94)

- Enterococci concentrations have generally been reported at concentrations less than the laboratory LOR or less than the guideline (35 CFU/100 mL). Periodic exceedances of the guideline have been reported historically.

5.6 Complaints Log

No complaints have been logged with Gove Operations in relation to activities conducted under the licence.

6. Marine

6.1 Summary of Marine Monitoring

The Marine Health Monitoring Program (MHMP) for the Southern Melville Bay has been reported by Charles Darwin University – *Routine Surveillance Monitoring Program – Receiving Environment Quality Survey*, dated June 2021. The report presents new data for seawater, sediment and oysters for the period 1 April 2020 – 31 March 2021, and is attached as Appendix E. A summary of the key findings from this report is presented below.

6.1.1 Seawater Monitoring

Monthly data for compliance sites along the mixing zone boundary in Inner Gove Harbour showed that all parameters monitored were recorded less than the trigger values specified by WDL171-10.

Total element concentrations at the compliance sites (unfiltered samples) were added to the MHMP in October 2020. As would be expected, total metal concentrations exceeded dissolved concentrations for aluminium, iron, chromium, manganese, and gallium. In contrast, dissolved forms of arsenic, copper, molybdenum, vanadium, uranium, and zinc accounted for almost all the total concentrations of these elements.

6.1.2 Sediment Monitoring

The most recent sediment survey was conducted in April 2020, with long term trends (2004 – 2020) showing several elements that have been recorded as elevated in surface sediment in Inner Gove Harbour compared to background sites. However, all parameters monitored since 2004 have been recorded less than the ANZG (2018) sediment quality guideline values.

6.1.3 Oyster Monitoring

Biannual oyster sampling under the MHMP was carried out in May and November 2020. A qualitative comparison of the temporal variation in average compositions for four monitoring groups (Granite Island, Harbour Islets, West Woody Island and Bonner Rocks) is carried out biannually. Where available, comparisons are made to Australia New Zealand Food Authority maximum permitted concentrations of metals in food. The results from oyster monitoring include the following;

- Long term trends (2004 – 2020) indicate that oysters from Harbour Islets, Granite Islands and West Woody Islands relatively close to the RTG Refinery had greater concentrations of aluminum and gallium compared to oysters from the more distant background site at Bonner Rocks;
- Oysters from Harbour Islets had elevated zinc and reduced cadmium concentrations relative to oysters from other sampling sites;
- Cadmium concentrations in oysters from Bonner Rocks, West Woody Island and occasionally Granite Islands have been above the Food Standards Australian and New Zealand (FSANZ) food standard (2 mg/kg) during most of the 2004-2020 monitoring period. However, this phenomenon appears to have natural causes and have been reported previously from locations in Northern Australia;
- Arsenic concentrations in oysters from all sampling sites exceeded the FSANZ maximum permitted concentrations for inorganic Arsenic. However, Arsenic speciation analyses carried out on samples from 2009 and 2017 showed that inorganic arsenic concentrations were below the FSANZ food standard; and
- Where applicable, all other concentrations were recorded less than the FSANZ food standard.

7. Conclusions

Gove Operations has undertaken annual surface water and marine monitoring and presents this report with respect to the Waste Discharge Licence (WDL171-10), and where relevant aspects of the previous WDL171-08 and WDL 171-09. The following key conclusions are made for the monitoring period (1 April 2020 to 31 March 2021):

- Sampling was completed with reference to the WMP (2019). No deviations from the WMP methodology were noted during the reporting period;
- Monitoring Frequency Notifications

Monitoring was generally completed at frequencies in compliance with the WDL, with the exception of relevant incidents previously reported by Gove Operations to the Northern Territory Government and discussed in this report.

 - o The frequency of monitoring at So01 for pH and EC (continuous/daily) was not met on three occasions, due to periodic equipment faults and transmission errors as reported in three Notifications of Environmental Incident for October 2020;
 - o Frequency of monitoring at So74 on two occasions, including daily sampling on 12 August 2020 and monthly (November) metal/metalloid sample;
 - o Frequency of daily TSS monitoring at So74 over a short period from 14 to 17 October 2020;
 - o Daily sampling was conducted at So74 and analysed for daily parameters, however TSS was not sampled in 24 March 2021;
 - o Frequency of monitoring at So94 for Enterococci (monthly sample for November 2020) was collected but could not be analysed due to freight delays associated with COVID-19;
 - o So44, So86, So87 and So88 samples were not collected for TPH during six releases over a period from 14 December 2020 to 16 January 2021; and
 - o So44, So87 and So88 samples were collected for TPH during a release on 31 March 2021. However the external laboratory failed to conduct testing.
- WDL Exceedance Notifications

Analytical results completed throughout the reporting period were generally recorded in compliance with the WDL, with the exception of relevant incidents previously reported by Gove Operations to the Northern Territory Government and discussed in this report.

 - o Exceedance of the WDL pH limit was recorded at So88 on 16 January 2021.
- Long term data trends and interpretation indicate:
 - o Recent trends for pH, EC and TSS at So01 were stable and similar to the historical ranges;
 - o Alkalinity and turbidity at So01 have remained relatively stable; and
 - o A general improvement in aluminium, arsenic, and vanadium concentrations at So01 since January 2019.
- No complaints have been logged in relation to activities conducted under the licence;

Marine monitoring continues to recommend that monthly sampling and analysis of seawater and annual sampling and analysis of sediment continues as part of the MHMP. The oyster monitoring component of the MHMP should also continue unchanged with half yearly (biannual) sampling to maintain the biological component of the MHMP. Overall, there is no current evidence of deterioration of marine ecosystem health as a result of the authorised discharge, and no significant environmental impact associated with authorised discharges, based on the monitoring data and incident reports reviewed for this monitoring period.

8. References

Australian Standards / New Zealand Standards (AS/NZS) (1998) *5667.1:1998 Water Quality – Sampling, Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples.*

Australian and New Zealand Guidelines (2018) *Australia and New Zealand Guidelines for fresh and marine water quality*, Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia.

Charles Darwin University (CDU) (2021) *Routine Surveillance Monitoring Program: Receiving Environment Quality Survey Report, No. 16, 1 April – 31 March 2021*, Environmental Chemistry & Microbiology Unit.

FSANZ (2016) *Food Standards Australia New Zealand.*

National Environment Protection Council (NEPC) (2013) *National Environment Protection (Assessment of Site Contamination) Measure (ASC NEPM)*, 1999 (amended 2013).

Northern Territory Environment Protection Agency (NT EPA) (2016) *Guideline for Reporting on Environmental Monitoring*, Version 1.0. May 2016.

Northern Territory Government, *Water Act*, July 2016.

Northern Territory Government (2020), *Waste Discharge Licence WDL171-10*, 17 September 2020.

Rio Tinto Gove Operations (RTA Gove) (2019) *Water Monitoring Plan*, October 2019.

Appendix A – Quality Assurance Quality Control

QAQC – WDL Surface Water

Monitoring Round Date	Laboratory Report Number	Holding Times Met	Comment on Holding Times	Temperature Received (°C)*	Comment on Temperature	Laboratory Duplicate RPD Acceptable**	Comment on Laboratory RPDs	Matrix Spike Acceptable	Comment on Matrix Spikes
Apr-20	ES2011545	Yes	No comment	19.5	Ice bricks present	Yes	No comment	Yes	No comment
Apr-20	ES2011724	Yes	No comment	4.1	Ice bricks present	Yes	No comment	Yes	No comment
Apr-20	ES2011725	Yes	No comment	4.1	Ice bricks present	Yes	No comment	Yes	No comment
Apr-20	ES2012425	No	• S074 & S001 analysis for turbidity 4 days overdue.	5.1	Ice bricks present	Yes	No comment	Yes	No comment
Apr-20	ES2012426	Yes	No comment	5.1	Ice bricks present	Yes	No comment	Yes	No comment
Apr-20	ES2012427	Yes	No comment	5.1	Ice bricks present	Yes	No comment	Yes	No comment
Apr-20	ES2012435	Yes	No comment	5.1	Ice bricks present	Yes	No comment	Yes	No comment
Apr-20	ES2013507	Yes	No comment	16.1	Ice bricks present	Yes	No comment	Yes	No comment
May-20	ES2015317	Yes	No comment	10.2	Ice bricks present	Yes	No comment	Yes	No comment
May-20	ES2015743	Yes	No comment	11.4	Ice bricks present	Yes	No comment	Yes	No comment
May-20	ES2015781	Yes	No comment	11.4	Ice bricks present	Yes	No comment	Yes	No comment
May-20	ES2016709	Yes	No comment	14.6	Ice bricks present	Yes	No comment	Yes	No comment
Jun-20	ES2019167	Yes	No comment	11.5	Ice bricks present	Yes	No comment	Yes	No comment
Jun-20	ES2019282	Yes	No comment	8.1	Ice bricks present	Yes	No comment	Yes	No comment
Jun-20	ES2020114	Yes	No comment	11.3	Ice bricks present	Yes	No comment	Yes	No comment
Jun-20	ES2020660	Yes	No comment	9.4	Ice bricks present	Yes	No comment	Yes	No comment
Jun-20	ES2020661	Yes	No comment	9.4	Ice bricks present	Yes	No comment	Yes	No comment
Jul-20	ES2022488	Yes	No comment	10	Ice bricks present	Yes	No comment	Yes	No comment
Jul-20	ES2022779	Yes	No comment	7.9	Ice bricks present	Yes	No comment	Yes	No comment
Jul-20	ES2023432	Yes	No comment	11.6	Ice bricks present	Yes	No comment	Yes	No comment
Jul-20	ES2023433	Yes	No comment	11.6	Ice bricks present	Yes	No comment	Yes	No comment
Jul-20	ES2024047	Yes	No comment	9.6	Ice bricks present	Yes	No comment	Yes	No comment
Jul-20	ES2024229	No	• S001 analysis for turbidity 1 day overdue.	11.6	Ice bricks present	Yes	No comment	Yes	No comment
Jul-20	ES2025872	Yes	No comment	12	Ice bricks present	Yes	No comment	Yes	No comment
Jul-20	ES2025876	Yes	No comment	12	Ice bricks present	Yes	No comment	Yes	No comment
Aug-20	ES2027410	Yes	No comment	16.5	Ice bricks present	Yes	No comment	Yes	No comment
Aug-20	ES2027411	No	• S001 & S074 analysis for suspended solids 5 days overdue. • S001 & S074 analysis for turbidity 9 days overdue.	16.5	Ice bricks present	Yes	No comment	Yes	No comment
Aug-20	ES2028422	Yes	No comment	8.7	Ice bricks present	Yes	No comment	Yes	No comment
Aug-20	ES2029423	Yes	No comment	12.8	Ice bricks present	Yes	No comment	Yes	No comment
Aug-20	ES2030018	No	• S001 analysis for turbidity, 2 days overdue.	13.8	Ice present	Yes	No comment	Yes	No comment
Aug-20	ES2030255	Yes	No comment	0.6	Ice present	Yes	No comment	Yes	No comment
Aug-20	ES2030256	Yes	No comment	9.6	Ice bricks present	Yes	No comment	Yes	No comment
Sep-20	ES2031685	Yes	No comment	6.5	Ice bricks present	Yes	No comment	Yes	No comment
Sep-20	ES2032535	No	• S074 & S001 analysis for turbidity 1 day overdue.	10.7	Ice bricks present	Yes	No comment	Yes	No comment
Oct-20	ES2034996	Yes	No comment	13.9	Ice bricks present	Yes	No comment	Yes	No comment
Oct-20	ES2036338	Yes	No comment	8.7	Ice bricks present	Yes	No comment	Yes	No comment
Oct-20	ES2036339	Yes	No comment	9	Ice bricks present	Yes	No comment	Yes	No comment
Oct-20	ES2037994	Yes	No comment	10.9	Ice bricks present	Yes	No comment	Yes	No comment
Nov-20	ES2039548	Yes	No comment	6.4	Ice bricks present	Yes	No comment	Yes	No comment
Nov-20	ES2039550	Yes	No comment	6.4	Ice bricks present	Yes	No comment	Yes	No comment
Nov-20	ES2040412	Yes	No comment	8.2	Ice present	Yes	No comment	Yes	No comment
Dec-20	ES2043660	No	• S001 analysis for pH 6 days overdue. • S001 analysis for turbidity 4 days overdue.	11.2	Ice bricks present	Yes	No comment	Yes	No comment
Dec-20	ES2043661	Yes	No comment	11.2	Ice bricks present	Yes	No comment	Yes	No comment
Dec-20	ES2043662	Yes	No comment	11.2	Ice bricks present	Yes	No comment	Yes	No comment
Dec-20	ES2043663	Yes	No comment	11.2	Ice bricks present	Yes	No comment	Yes	No comment
Dec-20	ES2044095	Yes	No comment	10.8	Ice bricks present	Yes	No comment	Yes	No comment
Dec-20	ES2044954	Yes	No comment	21.8	Ice bricks present	Yes	No comment	Yes	No comment
Dec-20	ES2045892	Yes	No comment	13.3	Ice bricks present	Yes	No comment	Yes	No comment
Dec-20	ES2046170	Yes	No comment	21.2	Ice bricks present	Yes	No comment	Yes	No comment
Dec-20	ES2045897	Yes	No comment	13.3	Ice bricks present	Yes	No comment	Yes	No comment
Dec-20	ES2045895	Yes	No comment	13.3	Ice bricks present	Yes	No comment	Yes	No comment
Dec-20	ES2045894	Yes	No comment	13.3	Ice bricks present	Yes	No comment	Yes	No comment
Dec-20	ES2045893	Yes	No comment	13.3	Ice bricks present	Yes	No comment	Yes	No comment
Jan-21	ES2100525	Yes	No comment	18.8	Ice present. Ice melted.	Yes	No comment	Yes	No comment
Jan-21	ES2100343	Yes	No comment	17.2	Ice bricks present	Yes	No comment	Yes	No comment
Jan-21	ES2100342	Yes	No comment	17.2	Ice bricks present	Yes	No comment	Yes	No comment
Jan-21	ES2100193	No	• S074 & S001 analysis for turbidity 3 days overdue.	18.8	Ice present. Ice melted.	Yes	No comment	Yes	No comment
Jan-21	ES2100191	Yes	No comment	17.2	Ice bricks present	Yes	No comment	Yes	No comment
Jan-21	ES2102220	No	• S074 analysis for turbidity 1 day overdue.	13.4	Ice bricks present	Yes	No comment	Yes	No comment
Jan-21	ES2102218	Yes	No comment	13.4	Ice bricks present	Yes	No comment	Yes	No comment
Jan-21	ES2101203	Yes	No comment	16.5	Ice bricks present	Yes	No comment	Yes	No comment
Jan-21	ES2101202	Yes	No comment	16.5	Ice bricks present	Yes	No comment	Yes	No comment
Jan-21	ES2100526	Yes	No comment	18.2	Ice bricks present	Yes	No comment	Yes	No comment
Jan-21	ES2102508	Yes	No comment	24	Ice bricks present	Yes	No comment	Yes	No comment
Jan-21	ES2102507	No	• S001 analysis for total suspended solids 1 day overdue.	24.1	Ice bricks present	Yes	No comment	Yes	No comment
Jan-21	ES2102506	Yes	No comment	24	Ice bricks present	Yes	No comment	Yes	No comment
Jan-21	ES2102505	Yes	No comment	24.1	Ice bricks present	Yes	No comment	Yes	No comment
Jan-21	ES2102221	Yes	No comment	13.4	Ice bricks present	Yes	No comment	Yes	No comment
Feb-21	ES2104096	Yes	No comment	12.1	Ice bricks present	Yes	No comment	Yes	No comment
Feb-21	ES2104095	Yes	No comment	12.1	Ice bricks present	Yes	No comment	Yes	No comment
Feb-21	ES2103096	Yes	No comment	16.5	Ice bricks present	Yes	No comment	Yes	No comment
Feb-21	ES2103095	Yes	No comment	16.5	Ice bricks present	Yes	No comment	Yes	No comment
Feb-21	ES2103094	Yes	No comment	16.5	Ice bricks present	Yes	No comment	Yes	No comment
Feb-21	ES2105717	Yes	No comment	8.6	Ice bricks present	Yes	No comment	Yes	No comment
Feb-21	ES2104588	Yes	No comment	11.7	Ice bricks present	Yes	No comment	Yes	No comment

Monitoring Round Date	Laboratory Report Number	Holding Times Met	Comment on Holding Times	Temperature Received (°C)*	Comment on Temperature	Laboratory Duplicate RPD Acceptable**	Comment on Laboratory RPDs	Matrix Spike Acceptable	Comment on Matrix Spikes
Feb-21	ES2104587	Yes	No comment	11.7	Ice bricks present	Yes	No comment	Yes	No comment
Feb-21	ES2104586	Yes	No comment	11.7	Ice bricks present	Yes	No comment	Yes	No comment
Feb-21	ES2104585	Yes	No comment	11.7	Ice bricks present	Yes	No comment	Yes	No comment
Feb-21	ES2105718	Yes	No comment	8.6	Ice bricks present	Yes	No comment	Yes	No comment
Feb-21	ES2106335	Yes	No comment	14.6	Ice bricks present	Yes	No comment	Yes	No comment
Feb-21	ES2106334	Yes	No comment	14.6	Ice bricks present	Yes	No comment	Yes	No comment
Feb-21	ES2105720	Yes	No comment	8.6	Ice bricks present	Yes	No comment	Yes	No comment
Mar-21	ES2107627	Yes	No comment	6.1	Ice bricks present	Yes	No comment	Yes	No comment
Mar-21	ES2107626	Yes	No comment	6.1	Ice bricks present	Yes	No comment	Yes	No comment
Mar-21	ES2107625	Yes	No comment	6.1	Ice bricks present	Yes	No comment	Yes	No comment
Mar-21	ES2106665	Yes	No comment	7.5	Ice bricks present	Yes	No comment	Yes	No comment
Mar-21	ES2110763	Yes	No comment	12.7	Ice bricks present	Yes	No comment	Yes	No comment
Mar-21	ES2109624	Yes	No comment	10.6	Ice bricks present	Yes	No comment	Yes	No comment
Mar-21	ES2109621	Yes	No comment	13.5	Ice bricks present	Yes	No comment	Yes	No comment
Mar-21	ES2108997	Yes	No comment	6.2	Ice bricks present	Yes	No comment	Yes	No comment
Mar-21	ES2108353	Yes	No comment	14.6	Ice bricks present	Yes	No comment	Yes	No comment
Mar-21	ES2106664	Yes	No comment	7.5	Ice bricks present	Yes	No comment	Yes	No comment
Mar-21	ES2110764	Yes	No comment	12.7	Ice bricks present	Yes	No comment	Yes	No comment
Mar-21	ES2111324	Yes	No comment	14.8	Ice bricks present	Yes	No comment	Yes	No comment
Mar-21	ES2110767	Yes	No comment	12.7	Ice bricks present	Yes	No comment	Yes	No comment
Mar-21	ES2110765	Yes	No comment	12.7	Ice bricks present	Yes	No comment	Yes	No comment

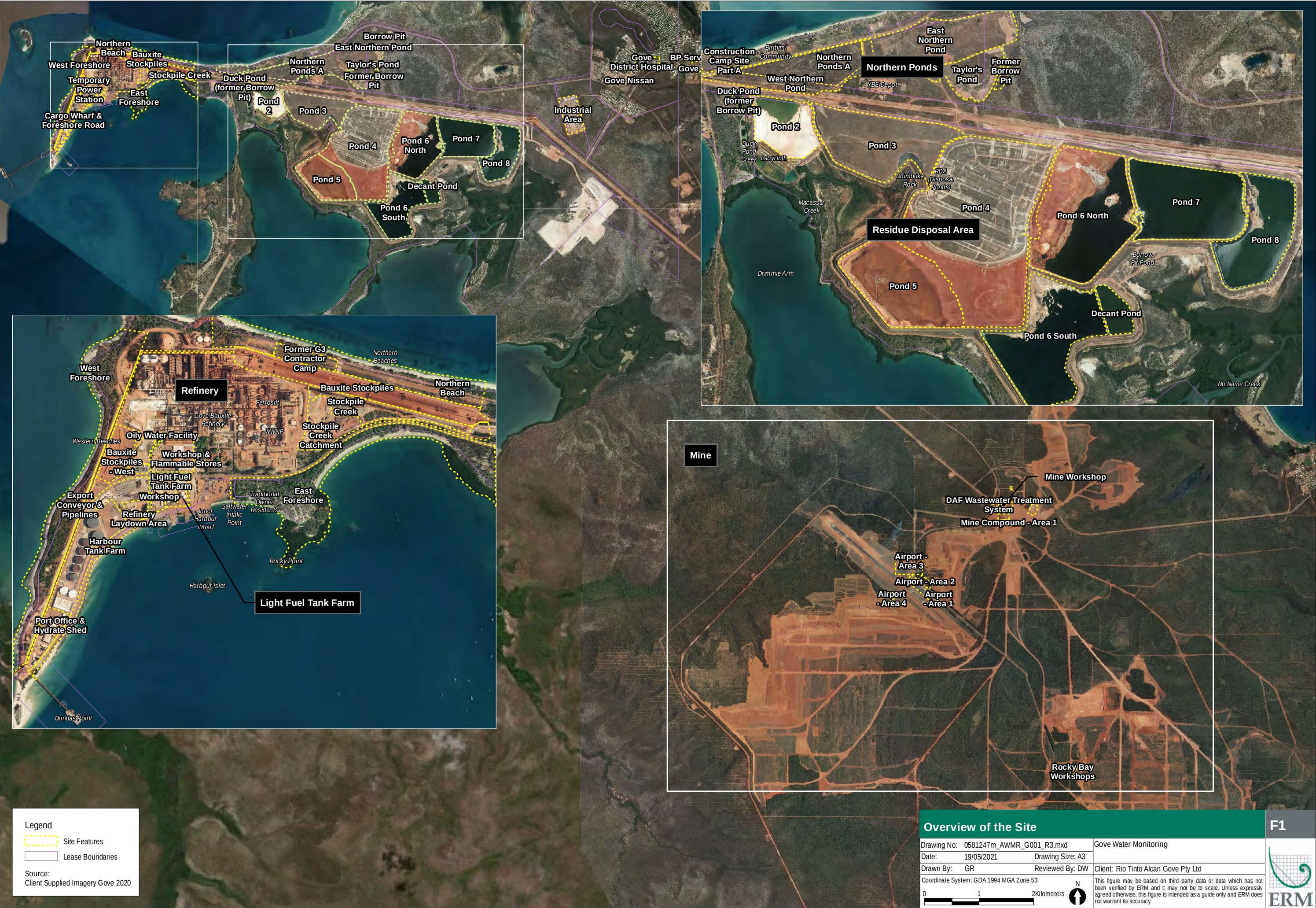
Notes: The laboratory reports included in the review above was limited to reports that were categorised as part of the WDL monitoring
*Likely due to air freight between Gove and Sydney laboratory, acceptable considering below Northern Territory ambient temperatures (>30°C).
**Relative Percentage Differences (RPD)'s due to non-detects have not been included.

Appendix B – Figures

Figure 1 – Overview of the Site

Figure 2 – Rainfall Gauges, Authorised Discharge and Monitoring Points

Figure 3 – Refinery Surface Water Catchments and Key Features



Authorised Discharge Points	Description
S001	Seawater Outfall Channel
S044	Refinery Light Fuel Tank Farm Bund
S086	Refinery Tank Farm Bund
S087	Refinery Tank Farm Bund
S088	Refinery Tank Farm Bund
Authorised Monitoring Points	Description
S074	Seawater Outfall Channel (Refinery)
S094	Public boat ramp (Refinery)
SW2	Arafura Sea – Off West Woody Island
SW3	Gove Harbour – Off Granite Island
SW4	Melville Bay – Off Dolphin Rocks
SW7	Offshore Drimmie Arm
SW8	Inverell Bay / Gove Harbour
SW9	Mixing Zone Boundary
SW10	Mixing Zone Boundary
SW11	Gove Harbour – Off Outfall
RR2	Mixing Zone Boundary
MB1, MB2, MB3, MB4	Mixing Zone boundary test sites (Refinery)





Appendix C – Data Tables

Table 1 – Surface Water Analytical Results – Seawater Outfall Channel

Table 2 – Surface Water Analytical Results – Tank Farm Bund Release Sampling

Table 3 – Surface Water Analytical Results – Marine Mixing Zone Compliance Points

**Appendix C
Table 1**

Surface Water Analytical Results – Seawater Outfall Channel

Surface Water Analytical Results
Rio_Tinto-Gove
WDL Annual Monitoring Report
2020 - 2021

Analyte Unit RIO TINTO GOVE - WDL171-10 TV RIO TINTO GOVE - WDL171-10 Limit RIO TINTO GOVE - WDL171-10 - S094				pH, Lab	pH, Field	Conductivity, Field	Total suspended solids	Turbidity	Alkalinity, Total as CaCO3	Aluminum, Dissolved	Arsenic, Dissolved	Chromium, Dissolved	Copper, Dissolved	Gallium, Dissolved	Magnesium, Dissolved	Molybdenum, Dissolved	Manganese, Dissolved	Vanadium, Dissolved	Zinc, Dissolved	C10-C36-Total	Enterococcus
				pH units	pH units	uS/cm	mg/L	NTU	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mpn/100ml
				9	9			20													
				9.5	9.5			100		200	20							2000		600	
Location ID	Sample Date	Sample Name	Lab SDG																		35
S001	8/04/2020	S001_20200408	ES2012425	-	8.15	51100	20	2.3	114	12	1.8	NA	NA	NA	NA	NA	NA	3.7	NA	-	74
S001	5/05/2020	S001_20200505	ES2015317	-	8.31	52100	8	1.1	131	< 5	1.6	NA	NA	NA	NA	NA	NA	2.6	NA	-	< 10
S001	2/06/2020	S001_20200602	ES2019282	-	8.39	51700	24	0.6	205	6	3.0	NA	NA	NA	NA	NA	NA	54.9	NA	-	< 10
S001	14/07/2020	S001_20200714	ES2024229	-	8.58	50700	< 5	2.0	353	18	4.5	NA	NA	NA	NA	NA	NA	153	NA	-	< 10
S001	24/08/2020	S001_20200824		8.08	8.42	55814	< 5	1	126	11	2	NA	NA	NA	NA	NA	NA	1.2	NA	-	< 10
S001	14/09/2020	S001_20200914	ES2032535	-	8.17	52500	20	3.4	124	< 5	1.8	NA	NA	NA	NA	NA	NA	1.6	NA	-	20
S001	14/10/2020	S001_20201016	ES2036339	-	-	-	< 5	0.8	118	5	1.6	NA	NA	NA	NA	NA	NA	2.5	NA	-	-
S001	27/10/2020	S001_20201027	ES2037994	-	8.65	51900	14	6.0	400	5	14.5	NA	NA	NA	NA	NA	NA	2.7	NA	-	< 10
S001	4/11/2020	S001_20201104	ES2039548	-	-	-	-	-	-	< 5	2.2	NA	NA	NA	NA	NA	NA	4.2	NA	-	-
S001	2/12/2020	S001_20201202	ES2043663	-	-	-	-	-	-	< 5	1.8	NA	NA	NA	NA	NA	NA	2.0	NA	-	-
S001	9/12/2020	S001_20201209	ES2044095	-	-	-	-	-	-	< 5	1.8	NA	NA	NA	NA	NA	NA	2.9	NA	-	-
S001	16/12/2020	S001_20201216		-	-	-	-	-	-	7	2.1	NA	NA	NA	NA	NA	NA	3.7	NA	-	-
S001	22/12/2020	S001_20201222	ES2045894	-	8.19	51600	< 5	2.0	127	7	2.1	NA	NA	NA	NA	NA	NA	4.4	NA	-	-
S001	31/12/2020	S001_20201231		-	-	-	-	-	-	9	1.9	NA	NA	NA	NA	NA	NA	5.1	NA	-	-
S001	5/01/2021	S001_20210105	ES2100191	-	-	-	-	-	-	7	1.8	NA	NA	NA	NA	NA	NA	4.1	NA	-	-
S001	12/01/2021	S001_20210112	ES2101202	-	-	-	-	-	-	< 5	2.2	NA	NA	NA	NA	NA	NA	< 0.5	NA	-	-
S001	19/01/2021	S001_20210119	ES2102507	-	8.08	50900	6	4.0	128	< 5	1.9	NA	NA	NA	NA	NA	NA	2.0	NA	-	-
S001	27/01/2021	S001_20210127	ES2103096	-	-	-	-	-	-	6	1.7	NA	NA	NA	NA	NA	NA	1.5	NA	-	-
S001	2/02/2021	S001_20210202	ES2104096	-	-	-	-	-	-	< 5	2.0	NA	NA	NA	NA	NA	NA	1.6	NA	-	-
S001	9/02/2021	S001_20210209	ES2104586	-	-	-	-	-	-	6	2.2	NA	NA	NA	NA	NA	NA	2.4	NA	-	-
S001	16/02/2021	S001_20210216	ES2105718	-	-	-	-	-	-	5	2.2	NA	NA	NA	NA	NA	NA	2.8	NA	-	-
S001	23/02/2021	S001_20210223	ES2106664	-	8.08	51000	< 5	2.5	126	8	1.8	NA	NA	NA	NA	NA	NA	2.4	NA	-	-
S001	4/03/2021	S001_20210304	ES2107625	-	-	-	-	-	-	< 5	1.9	NA	NA	NA	NA	NA	NA	2.7	NA	-	-
S001	9/03/2021	S001_20210309	ES2108997	-	-	-	-	-	-	7	2.0	NA	NA	NA	NA	NA	NA	2.3	NA	-	-
S001	16/03/2021	S001_20210316	ES2109624	-	-	-	< 5	0.9	131	< 5	2.4	NA	NA	NA	NA	NA	NA	2.2	NA	< 50	< 10
S001	25/03/2021	S001_20210325	ES2111994	-	-	-	-	-	-	6	2.6	NA	NA	NA	NA	NA	NA	2.5	NA	-	-
S001	30/03/2021	S001_20210330	ES2111994	-	-	-	-	-	-	6	2.0	NA	NA	NA	NA	NA	NA	2.2	NA	-	-

**Appendix C
Table 1**

Surface Water Analytical Results – Seawater Outfall Channel

Surface Water Analytical Results
Rio_Tinto-Gove
WDL Annual Monitoring Report
2020 - 2021

Analyte Unit RIO TINTO GOVE - WDL171-10 TV RIO TINTO GOVE - WDL171-10 Limit RIO TINTO GOVE - WDL171-10 - S094				pH, Lab	pH, Field	Conductivity, Field	Total suspended solids	Turbidity	Alkalinity, Total as CaCO3	Aluminum, Dissolved	Arsenic, Dissolved	Chromium, Dissolved	Copper, Dissolved	Gallium, Dissolved	Magnesium, Dissolved	Molybdenum, Dissolved	Manganese, Dissolved	Vanadium, Dissolved	Zinc, Dissolved	C10-C36-Total	Enterococcus
				pH units	pH units	uS/cm	mg/L	NTU	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mg/L	ug/L	ug/L	ug/L	ug/L	ug/L	mpn/100ml
				9	9			20													
				9.5	9.5			100		200	20							2000		600	
Location ID	Sample Date	Sample Name	Lab SDG																		35
S074	8/04/2020	S074_20200408	ES2012425	-	8.10	52300	8	1.6	113	6	1.7	-	< 1	< 1	1370	11.2	-	3.0	< 5	-	-
S074	5/05/2020	S074_20200505	ES2015317	-	8.37	52500	6	1.1	191	8	2.9	-	< 1	< 1	1570	17.4	-	42.2	< 5	-	-
S074	2/06/2020	S074_20200602	ES2019282	-	8.3	51200	21	0.6	189	8	3.7	-	< 1	< 1	1220	26.1	-	47.0	< 5	-	-
S074	27/07/2020	S074_20200727	ES2025872	-	8.1	52000	6	0.9	117	8	1.9	-	< 1	< 1	1290	10.7	-	3.6	< 5	-	-
S074	24/08/2020	S074_20200824		8.15	8.44	41186	< 5	1.1	126	82	1.7	-	< 1	< 10	1270	9.7	-	1.7	6	-	-
S074	14/09/2020	S074_20200914	ES2032535	-	8.18	52500	< 5	1.0	121	6	1.8	< 0.5	< 1	< 1	1420	10.8	1.5	< 0.5	< 5	-	-
S074	27/10/2020	S074_20201027	ES2037994	-	8.56	52000	6	1.7	318	5	11.6	< 0.5	< 1	< 1	1200	29.2	7.0	3.2	< 5	-	-
S074	22/12/2020	S074_20201222	ES2045894	-	8.18	51600	< 5	2.0	120	7	1.9	< 0.5	< 1	< 1	1440	10.6	0.9	2.3	< 5	-	-
S074	19/01/2021	S074_20210119	ES2102220	-	8.24	50900	19	3.1	126	6	1.9	< 0.5	< 1	< 1	1240	10.4	1.1	2.1	< 5	-	-
S074	23/02/2021	S074_20210223	ES2106664	-	8.19	50000	< 5	3.2	128	< 5	1.9	< 0.5	6	< 1	1290	9.3	2.3	1.9	< 5	-	-
S074	16/03/2021	S074_20210316	ES2109624	-	-	-	< 5	0.8	128	6	2.1	< 0.5	4	< 1	1330	11.8	1.6	2.2	< 5	-	-
S094	8/04/2020	S094_20200408		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	107
S094	5/05/2020	S094_30300505		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 10
S094	2/06/2020	S094_20200602		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 10
S094	14/07/2020	S094_20200714		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 10
S094	24/08/2020	S094_20200824		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 10
S094	14/09/2020	S094_20200914		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 10
S094	27/10/2020	S094_20201027		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 10
S094	1/12/2020	S094_20201201		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 10
S094	15/12/2020	S094_20201215		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 10
S094	12/01/2021	S094_20210112		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 10
S094	9/02/2021	S094_20210209		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	31
S094	16/03/2021	S094_20210316		NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	< 10

Appendix C
Table 2
Surface Water Analytical Results – Tank Farm Bund Release Sampling

Surface Water Analytical Results
Rio_Tinto-Gove
WDL Annual Monitoring Report
2020 - 2021

			Analyte FRACTION Unit	Alkalinity, Total as CaCO3 N mg/L	pH, Field N pH units	Total suspended solids N mg/L	Turbidity N NTU	Electrical Conductivity N mS/cm	Conductivity, Field N mS/cm	Aluminum (filtered) D ug/L	Arsenic (filtered) D ug/L	Vanadium (filtered) D ug/L	C10-C36-Total N ug/L
RIO TINTO GOVE - WDL171-10 Trigger Values					9								
RIO TINTO GOVE - WDL171-10 Limit					9.5								600
Location ID	Sample Date	Sample Name											
S044	9/04/2020	S044_20200409	-	7.8	-	-	-	-	-	-	-	-	< 50
S044	12/04/2020	-	-	8.01	-	-	0.041	-	-	-	-	-	-
S044	12/04/2020	-	-	8.5	-	-	-	-	-	-	-	-	-
S044	4/12/2020	S044_20201204	-	8.5	-	-	-	-	-	-	-	-	< 50
S044	14/12/2020	-	-	8.63	-	-	-	-	-	-	-	-	-
S044	19/12/2020	-	-	8.1	-	-	0.1	-	-	-	-	-	-
S044	23/12/2020	-	-	7.98	-	-	-	-	-	-	-	-	-
S044	30/12/2020	-	-	8.72	-	-	-	-	-	-	-	-	-
S044	2/01/2021	-	-	7.86	-	-	-	-	-	-	-	-	-
S044	16/01/2021	-	-	7.72	-	-	-	-	-	-	-	-	-
S044	22/01/2021	S044_20210122	-	7.41	-	-	-	-	-	-	-	-	< 50
S044	26/01/2021	S044_20210201	-	9.14	-	-	-	-	-	-	-	-	< 50
S044	5/02/2021	S044_20210205	-	8.11	-	-	-	-	-	-	-	-	< 50
S044	12/02/2021	S044_20210212	-	8.9	-	-	-	-	-	-	-	-	< 50
S044	19/02/2021	-	-	7.64	-	-	-	-	-	-	-	-	< 50
S044	28/02/2021	S044_20210228	-	8.68	-	-	-	-	-	-	-	-	< 50
S044	29/03/2021	S044_20210329	-	7.65	-	-	-	-	-	-	-	-	< 50
S044	31/03/2021	-	-	8.13	-	-	-	-	-	-	-	-	-
S086	9/04/2020	S086_20200409	-	7.93	-	-	-	-	-	-	-	-	< 50
S086	12/04/2020	-	-	8.06	-	-	0.067	-	-	-	-	-	-
S086	12/04/2020	-	-	7.82	-	-	-	-	-	-	-	-	-
S086	4/12/2020	S086_20201204	-	7.82	-	-	-	-	-	-	-	-	< 50
S086	14/12/2020	-	-	8.6	-	-	-	-	-	-	-	-	-
S086	19/12/2020	-	-	8.15	-	-	0.1	-	-	-	-	-	-
S086	23/12/2020	-	-	8.33	-	-	-	-	-	-	-	-	-
S086	30/12/2020	-	-	8.16	-	-	-	-	-	-	-	-	-
S086	2/01/2021	-	-	8.07	-	-	-	-	-	-	-	-	-
S086	16/01/2021	-	-	8.02	-	-	-	-	-	-	-	-	-
S086	22/01/2021	S086_20210122	-	7.87	-	-	-	-	-	-	-	-	< 50
S086	26/01/2021	S086_20210201	-	8.43	-	-	-	-	-	-	-	-	< 50
S086	5/02/2021	S086_20210205	-	8.16	-	-	-	-	-	-	-	-	< 50
S086	9/02/2021	-	-	8.4	-	-	-	-	-	-	-	-	< 50
S086	12/02/2021	S086_20210212	-	8.6	-	-	-	-	-	-	-	-	< 50
S086	19/02/2021	-	-	8.32	-	-	-	-	-	-	-	-	< 50
S086	28/02/2021	S086_20210228	-	8.39	-	-	-	-	-	-	-	-	< 50
S086	28/02/2021	-	-	8.08	-	-	-	-	-	-	-	-	-
S086	23/03/2021	S086_20210326	-	8.94	-	-	-	-	-	-	-	-	< 50
S086	29/03/2021	S086_20210329	-	7.96	-	-	-	-	-	-	-	-	< 50
S086	31/03/2021	-	-	8.05	-	-	-	-	-	-	-	-	< 50
S087	9/04/2020	S087_20200409	-	7.82	-	-	-	-	-	-	-	-	< 50
S087	12/04/2020	-	-	8.08	-	-	0.077	-	-	-	-	-	-
S087	12/04/2020	-	-	8.59	-	-	-	-	-	-	-	-	-
S087	4/12/2020	S087_20201204	-	8.59	-	-	-	-	-	-	-	-	< 50
S087	14/12/2020	-	-	8.24	-	-	-	-	-	-	-	-	-
S087	19/12/2020	-	-	8.04	-	-	0.1	-	-	-	-	-	-
S087	23/12/2020	-	-	8.27	-	-	-	-	-	-	-	-	-
S087	30/12/2020	-	-	8.18	-	-	-	-	-	-	-	-	-
S087	2/01/2021	-	-	7.91	-	-	-	-	-	-	-	-	-
S087	16/01/2021	-	-	8.13	-	-	-	-	-	-	-	-	-
S087	22/01/2021	S087_20210122	-	7.46	-	-	-	-	-	-	-	-	< 50
S087	5/02/2021	S087_20210205	-	8.38	-	-	-	-	-	-	-	-	< 50
S087	9/02/2021	-	-	8.58	-	-	-	-	-	-	-	-	< 50
S087	12/02/2021	S087_20210212	-	8.6	-	-	-	-	-	-	-	-	< 50
S087	19/02/2021	-	-	8.16	-	-	-	-	-	-	-	-	< 50
S087	29/03/2021	S087_20210329	-	7.83	-	-	-	-	-	-	-	-	< 50
S087	31/03/2021	-	-	8.1	-	-	-	-	-	-	-	-	-

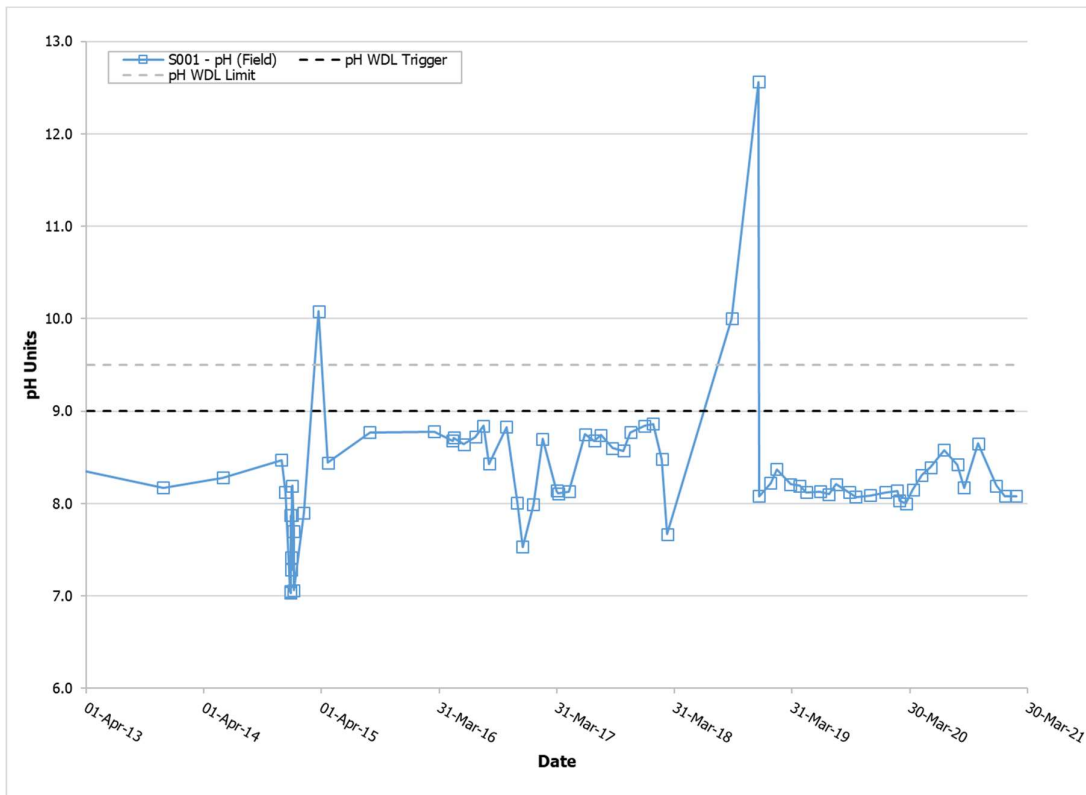
Appendix C
Table 2
Surface Water Analytical Results – Tank Farm Bund Release Sampling

Surface Water Analytical Results
Rio_Tinto-Gove
WDL Annual Monitoring Report
2020 - 2021

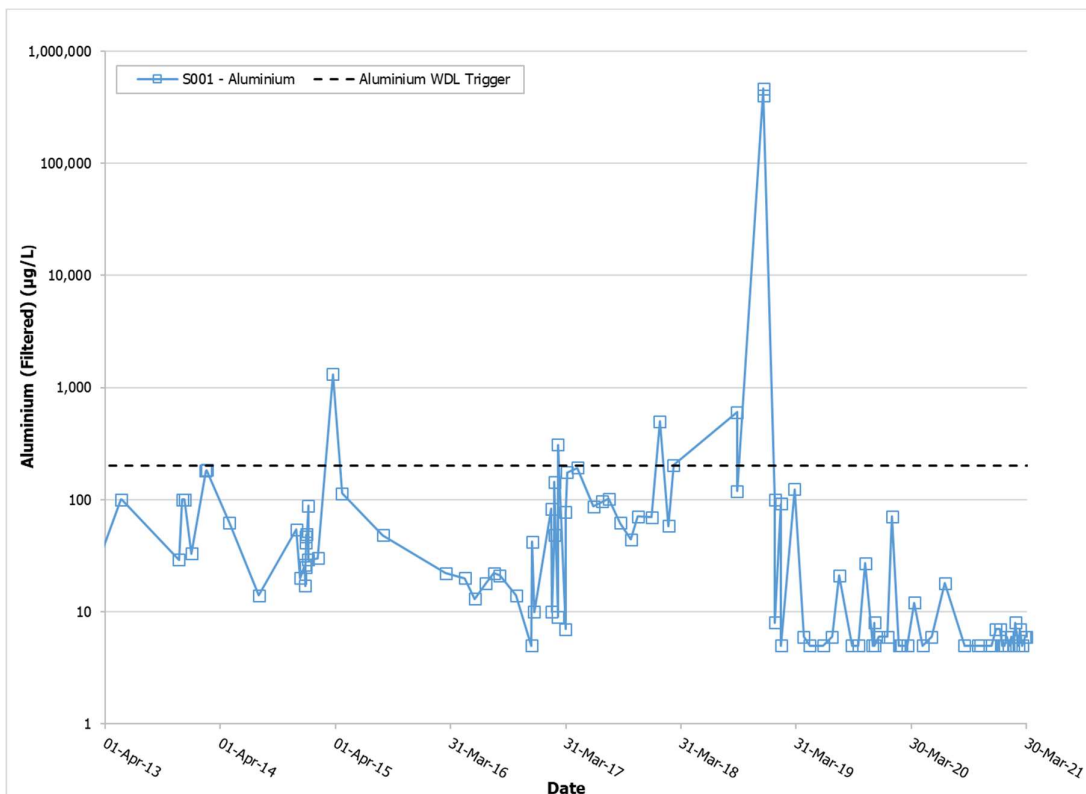
Analyte FRACTION Unit			N Alkalinity, Total as CaCO3 mg/L	N pH, Field pH units	N Total suspended solids mg/L	N Turbidity NTU	N Electrical Conductivity mS/cm	N Conductivity, Field mS/cm	D Aluminum (filtered) ug/L	D Arsenic (filtered) ug/L	D Vanadium (filtered) ug/L	N C10-C36-Total ug/L
RIO TINTO GOVE - WDL171-10 Trigger Values				9								
RIO TINTO GOVE - WDL171-10 Limit				9.5								600
Location ID	Sample Date	Sample Name										
S088	9/04/2020	S088_20200409	-	7.88	-	-	-	-	-	-	-	< 50
S088	12/04/2020	-	-	8.17	-	-	0.091	-	-	-	-	-
S088	12/04/2020	-	-	8.41	-	-	-	-	-	-	-	-
S088	4/12/2020	S088_20201204	-	8.41	-	-	-	-	-	-	-	< 50
S088	14/12/2020	-	-	8.66	-	-	-	-	-	-	-	-
S088	19/12/2020	-	-	8.37	-	-	0.2	-	-	-	-	-
S088	23/12/2020	-	-	8.72	-	-	-	-	-	-	-	-
S088	30/12/2020	-	-	9.05	-	-	-	-	-	-	-	-
S088	2/01/2021	-	-	7.94	-	-	-	-	-	-	-	-
S088	16/01/2021	-	-	9.57	-	-	-	-	-	-	-	-
S088	22/01/2021	S088_20210122	-	7.53	-	-	-	-	-	-	-	< 50
S088	26/01/2021	S088_20210201	-	8.46	-	-	-	-	-	-	-	< 50
S088	5/02/2021	S088_20210205	-	8.7	-	-	-	-	-	-	-	< 50
S088	9/02/2021	-	-	8.1	-	-	-	-	-	-	-	< 50
S088	12/02/2021	S088_20210212	-	8.6	-	-	-	-	-	-	-	< 50
S088	19/02/2021	-	-	8.12	-	-	-	-	-	-	-	< 50
S088	27/02/2021	S088_20210227	-	8.08	-	-	-	-	-	-	-	< 50
S088	29/03/2021	S088_20210329	-	7.61	-	-	-	-	-	-	-	< 50
S088	31/03/2021	-	-	8.02	-	-	-	-	-	-	-	-

Appendix D – WDL Surface Water Data Trends

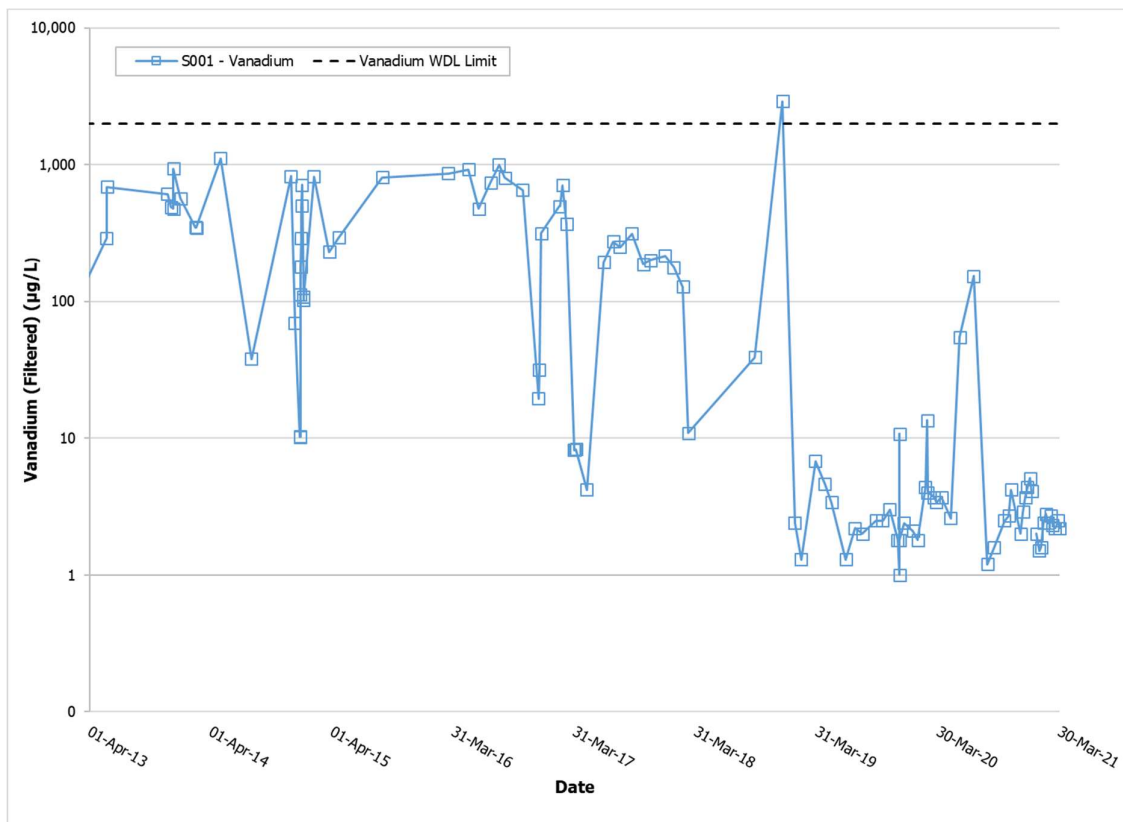
S001 (grab sample) – pH (Field)



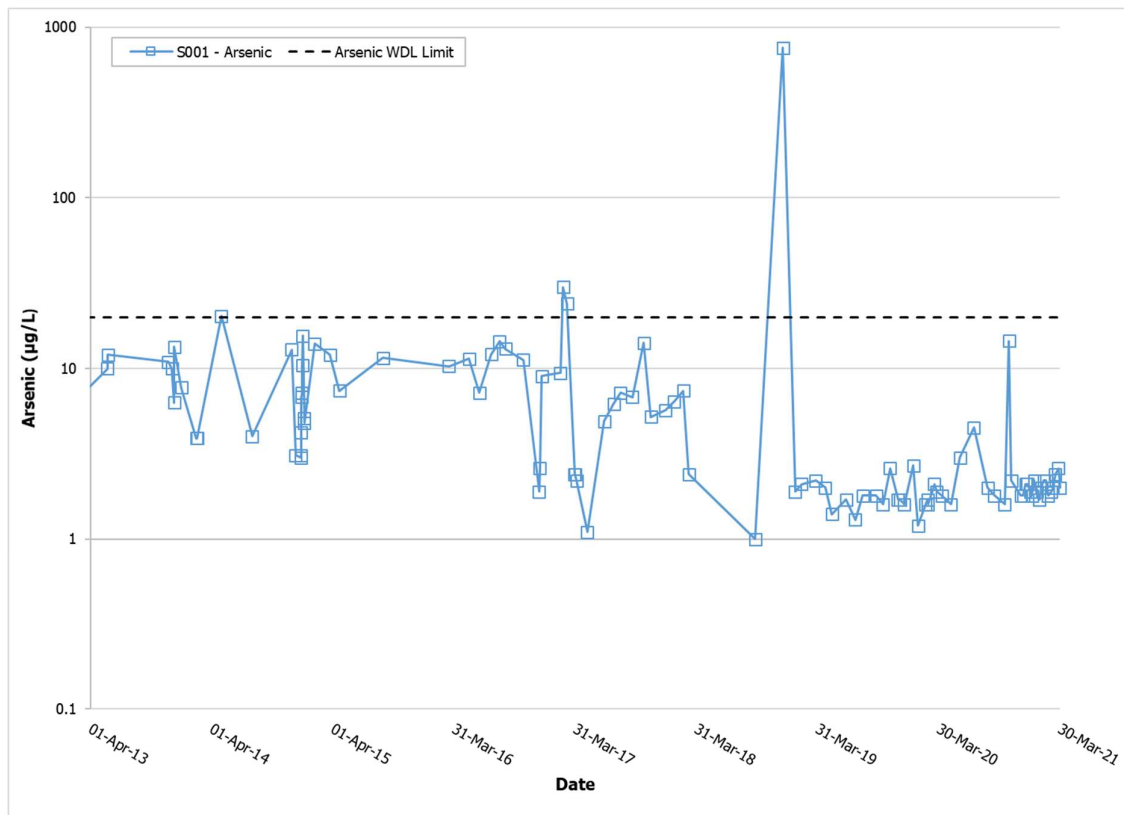
S001 (grab sample) – Aluminium Concentrations (filtered)



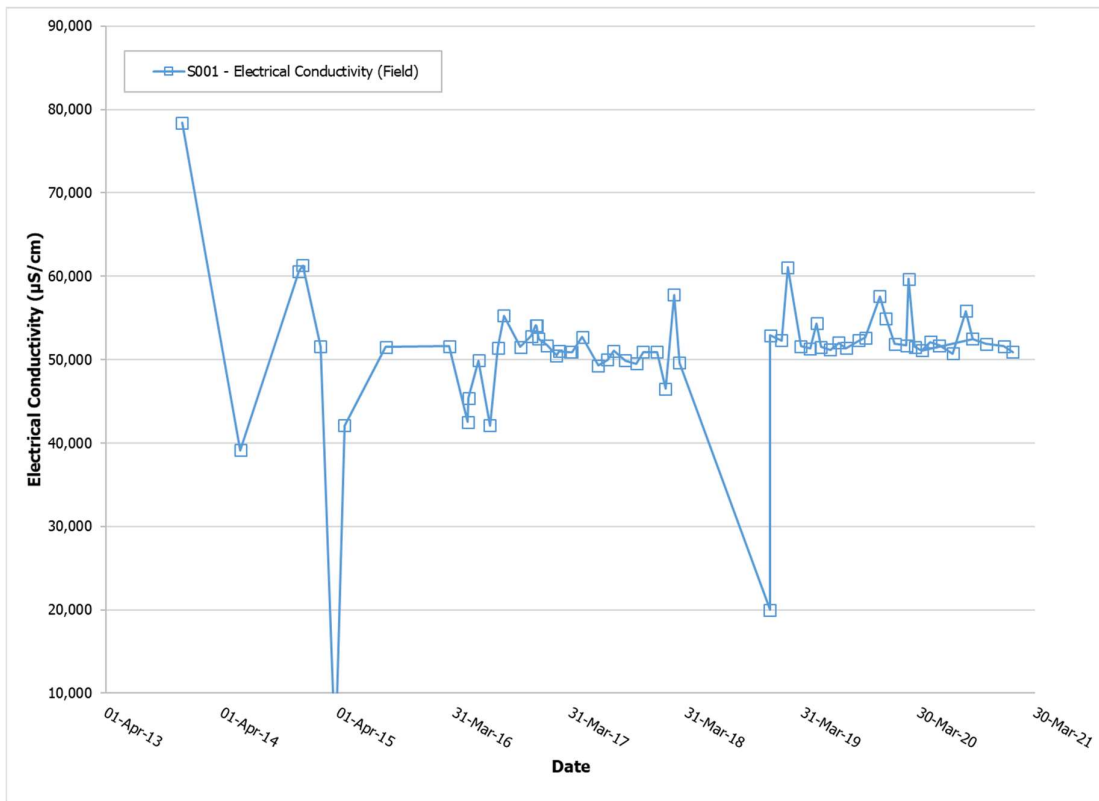
Soo1 (grab sample) – Vanadium Concentrations (filtered)



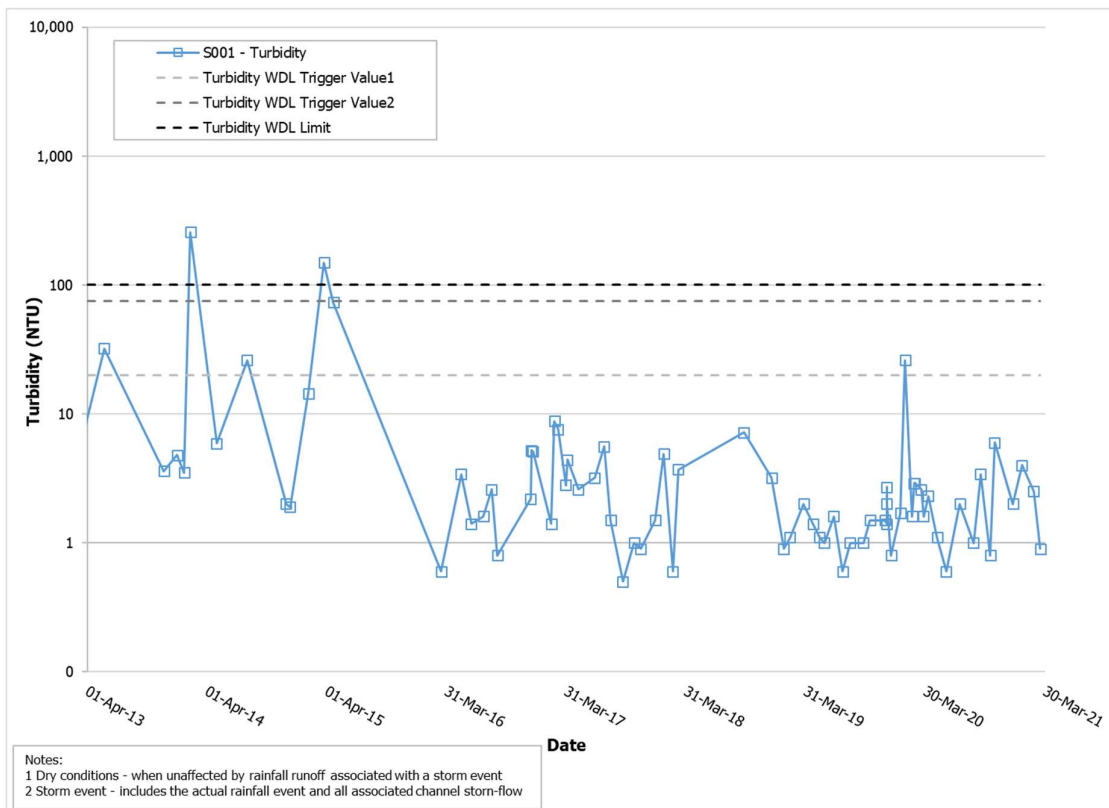
Soo1 (grab sample) and So74 (composite sample) – Arsenic (filtered)



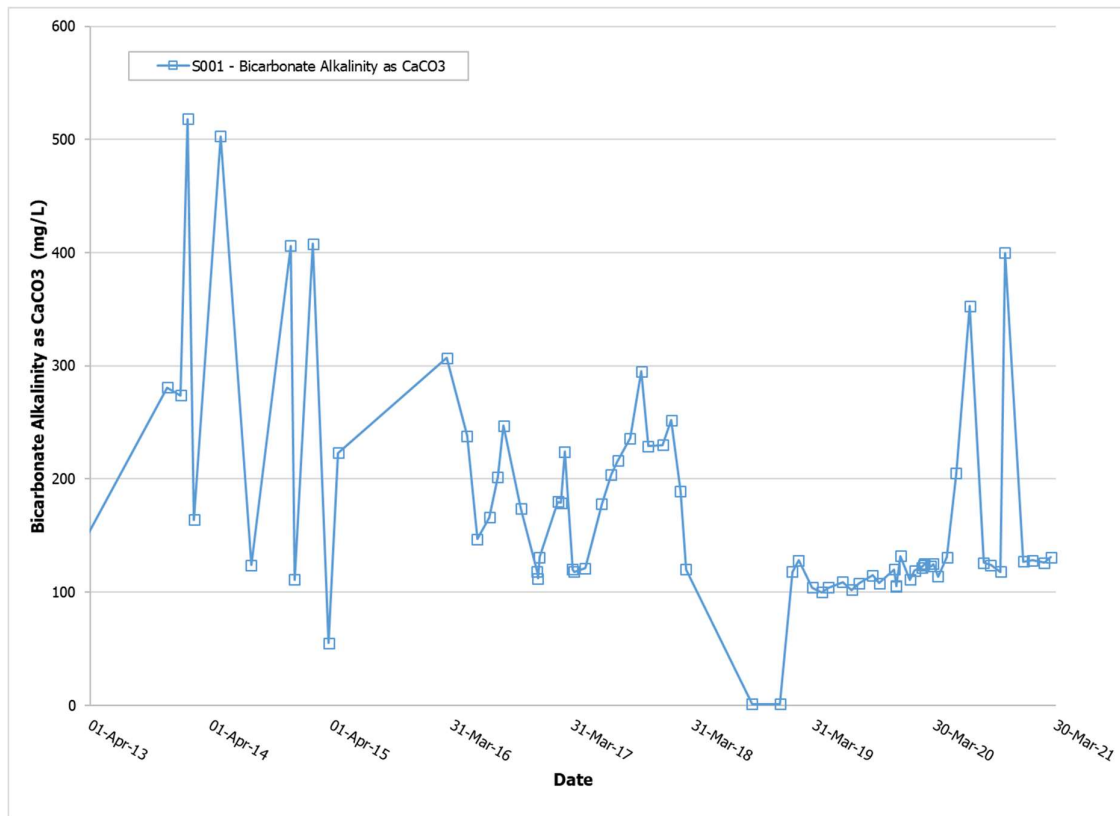
S001 (grab sample) – Electrical Conductivity



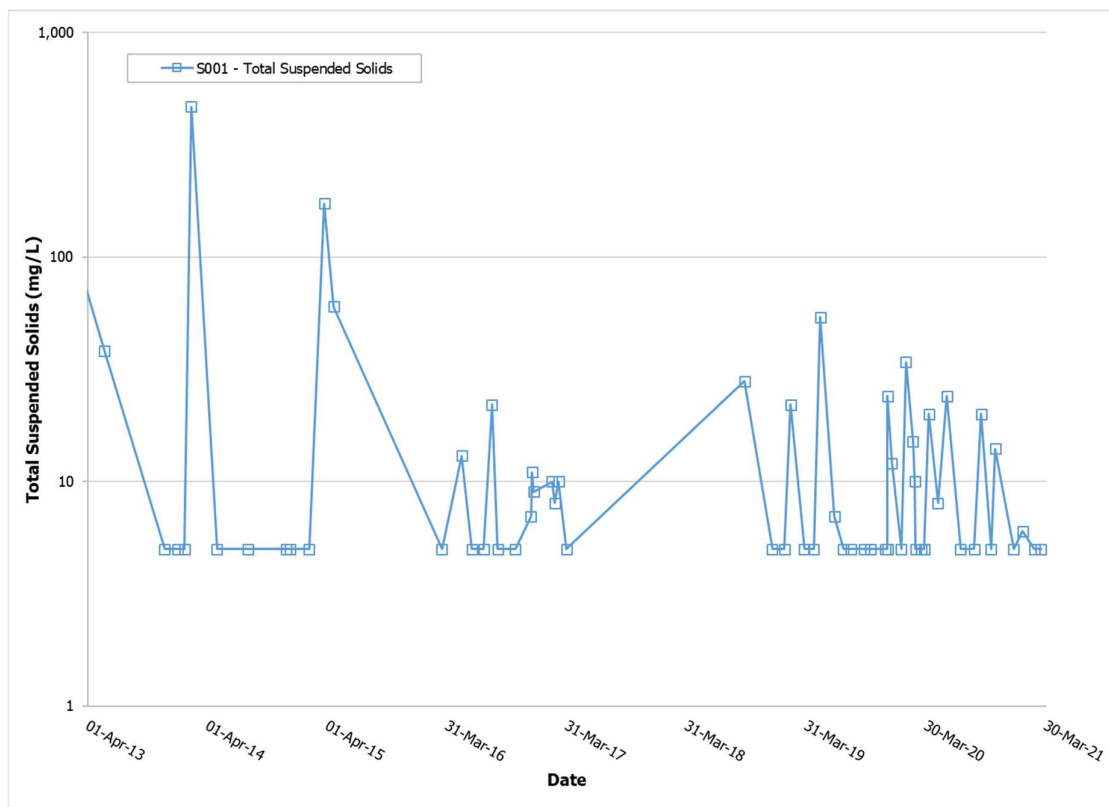
S001 (grab sample) – Turbidity



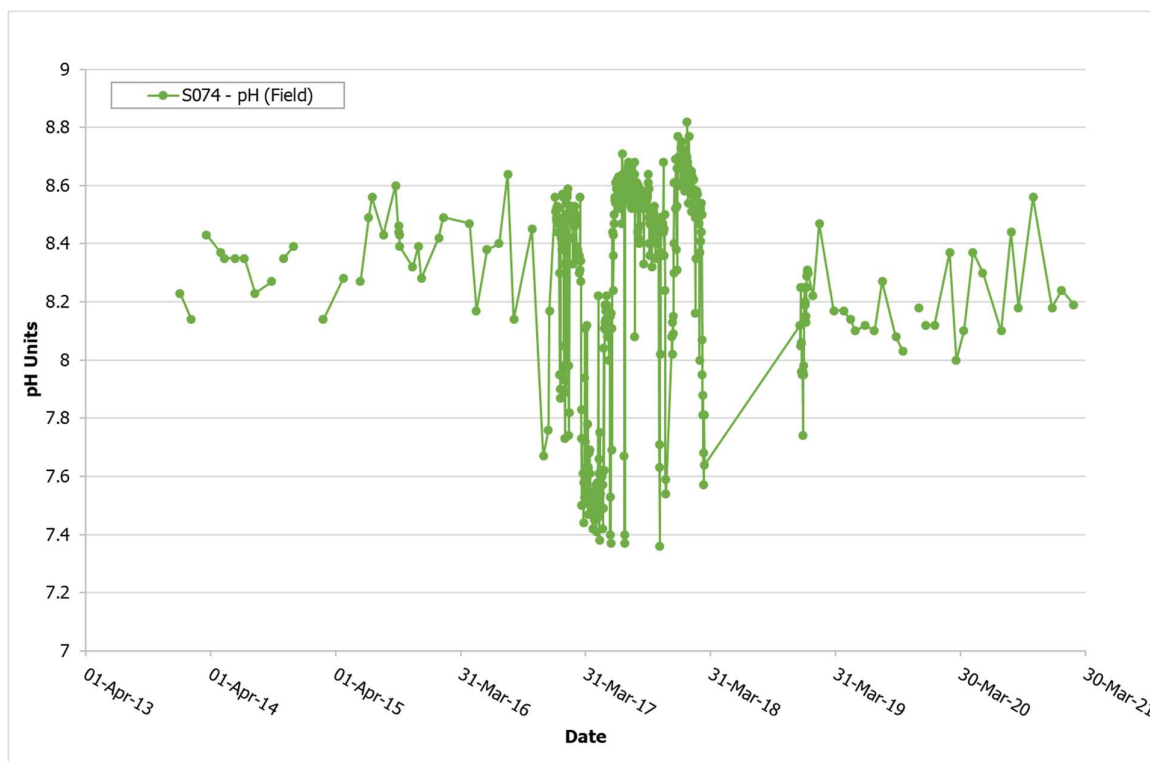
S001 (grab sample) – Alkalinity



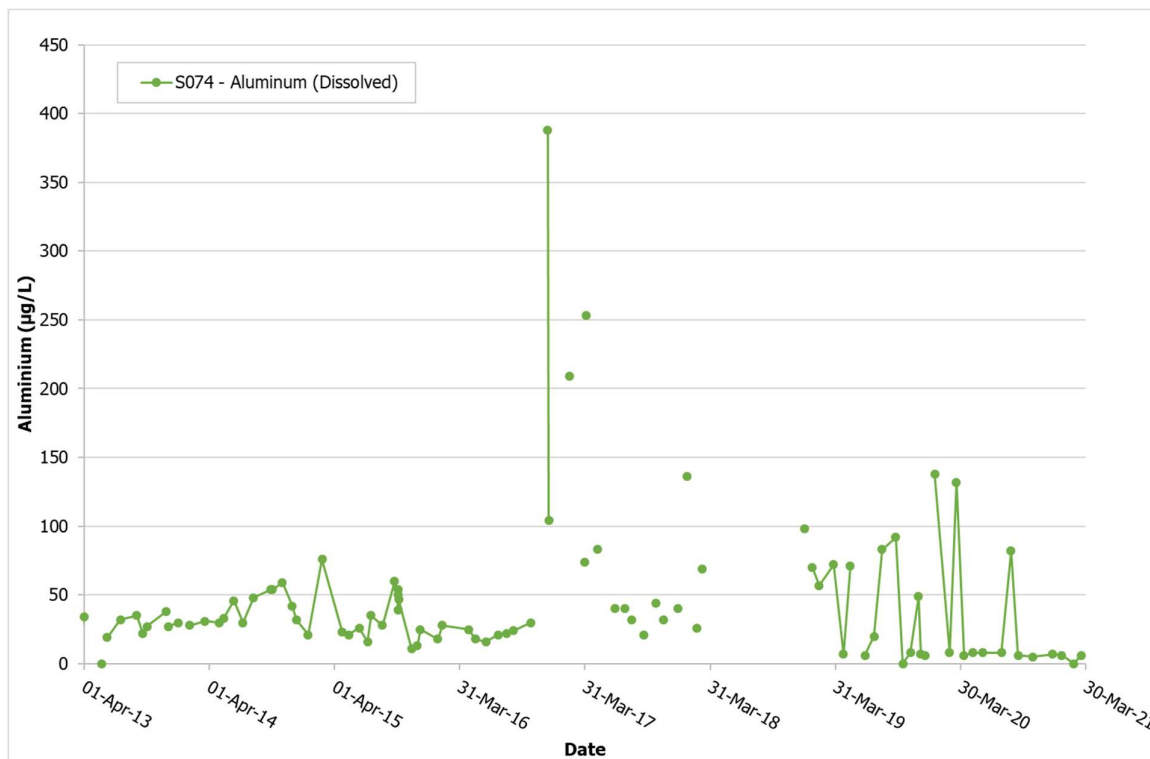
S001 (grab sample) – Total Suspended Solids (TSS)



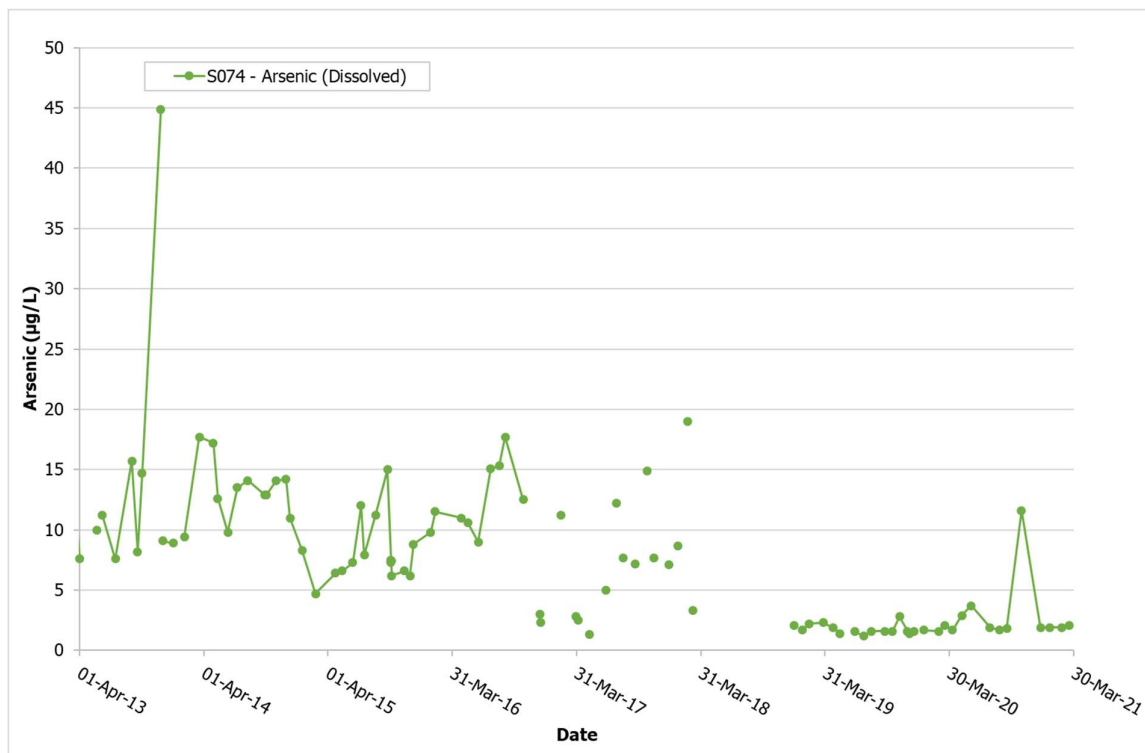
S074 (composite sample) – pH (Field)



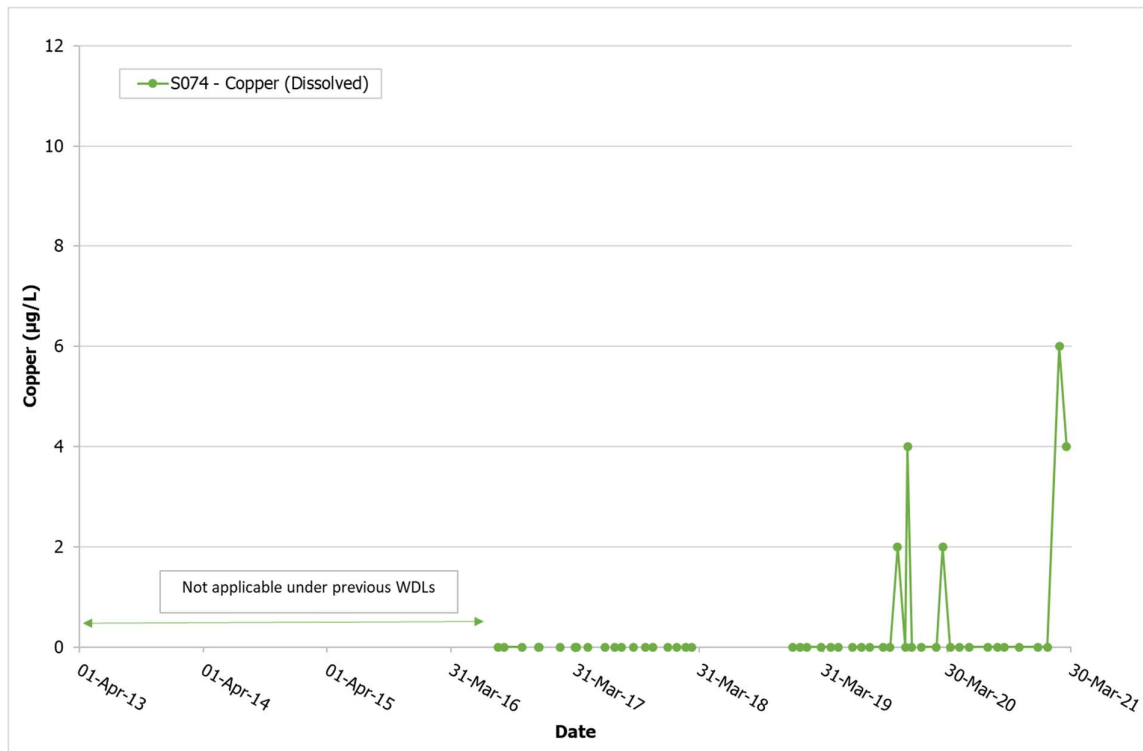
S074 (composite sample) – Aluminium (filtered)



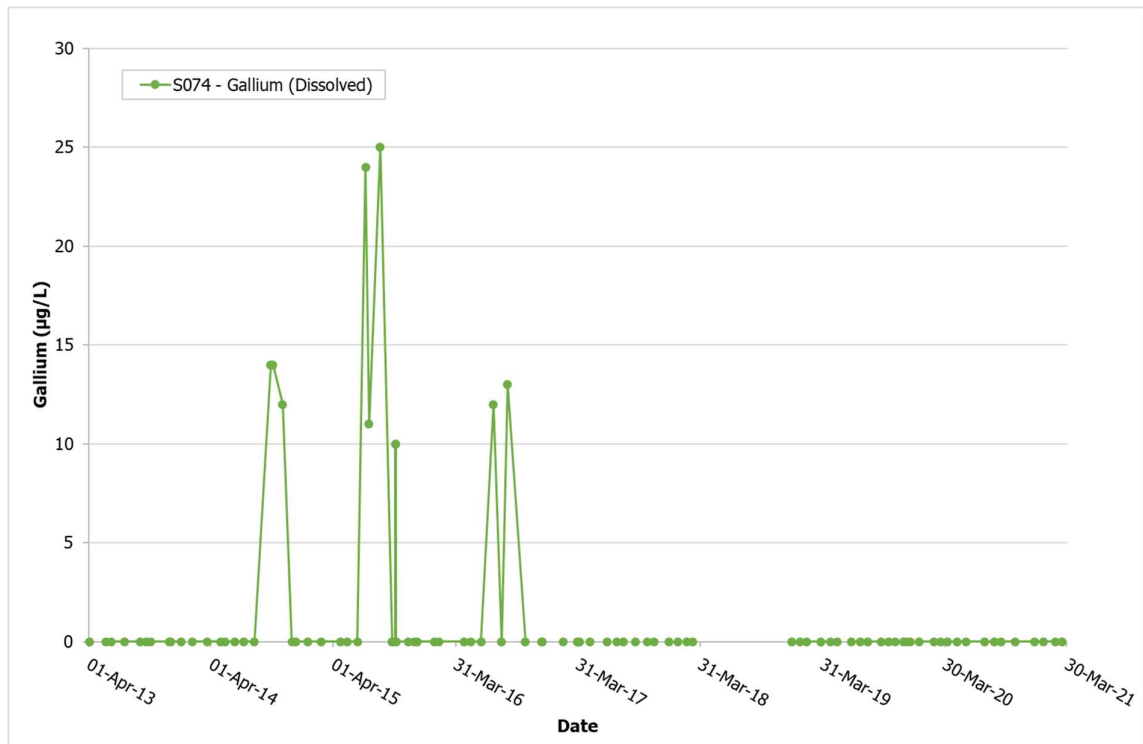
So74 (composite sample) – Arsenic (filtered)



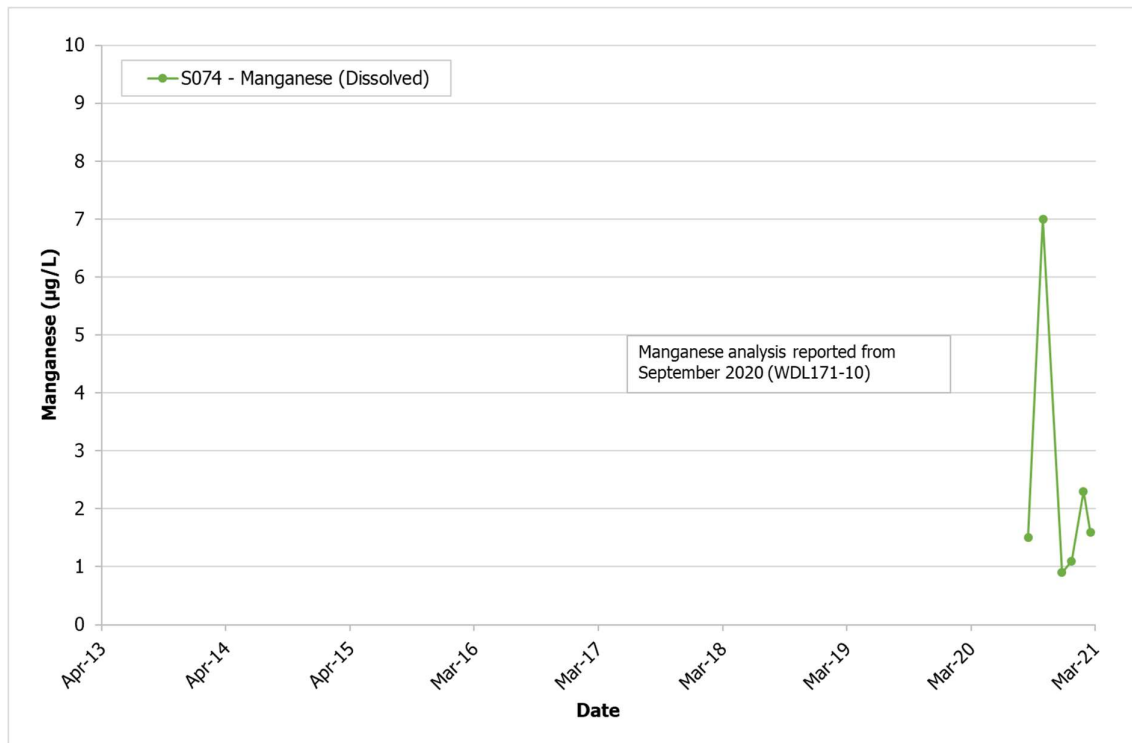
So74 (composite sample) – Copper (filtered)



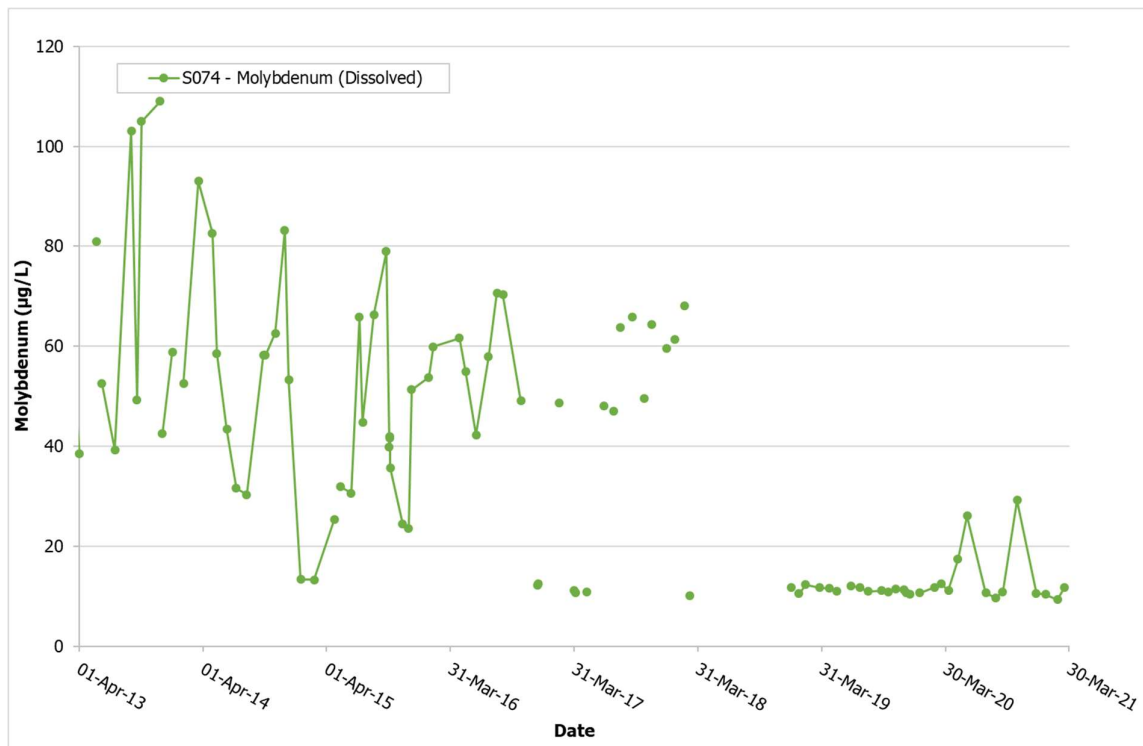
So74 (composite sample) – Gallium (filtered)



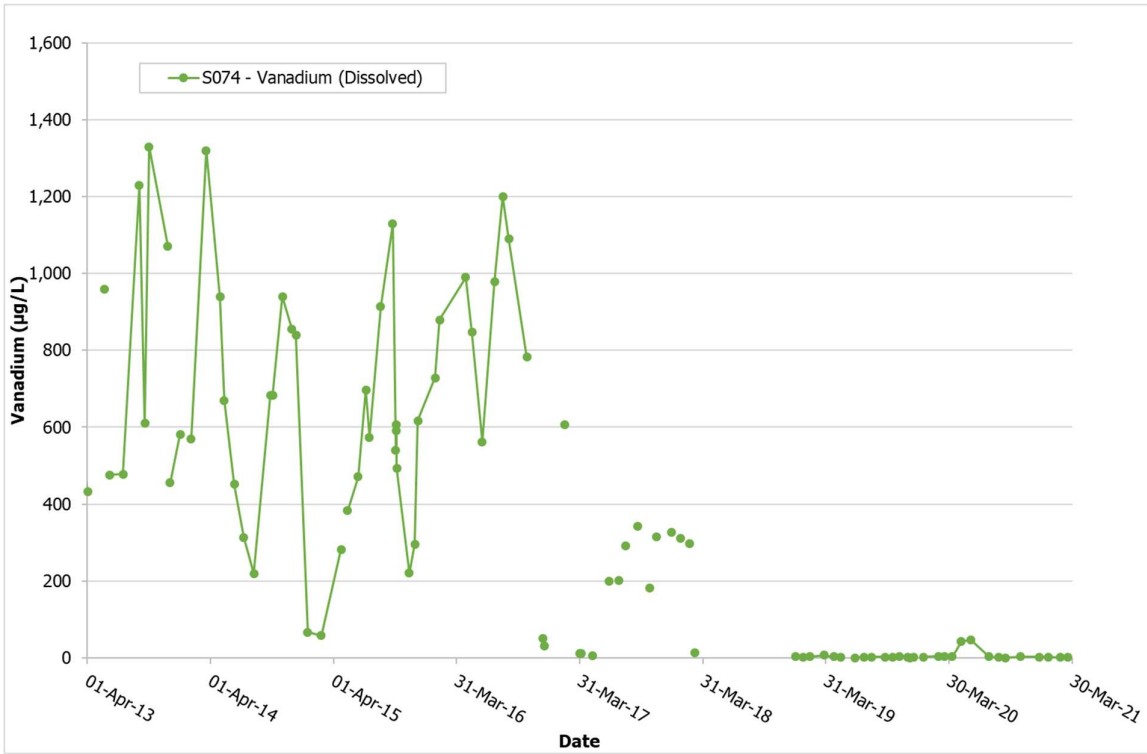
So74 (composite sample) – Manganese (filtered)



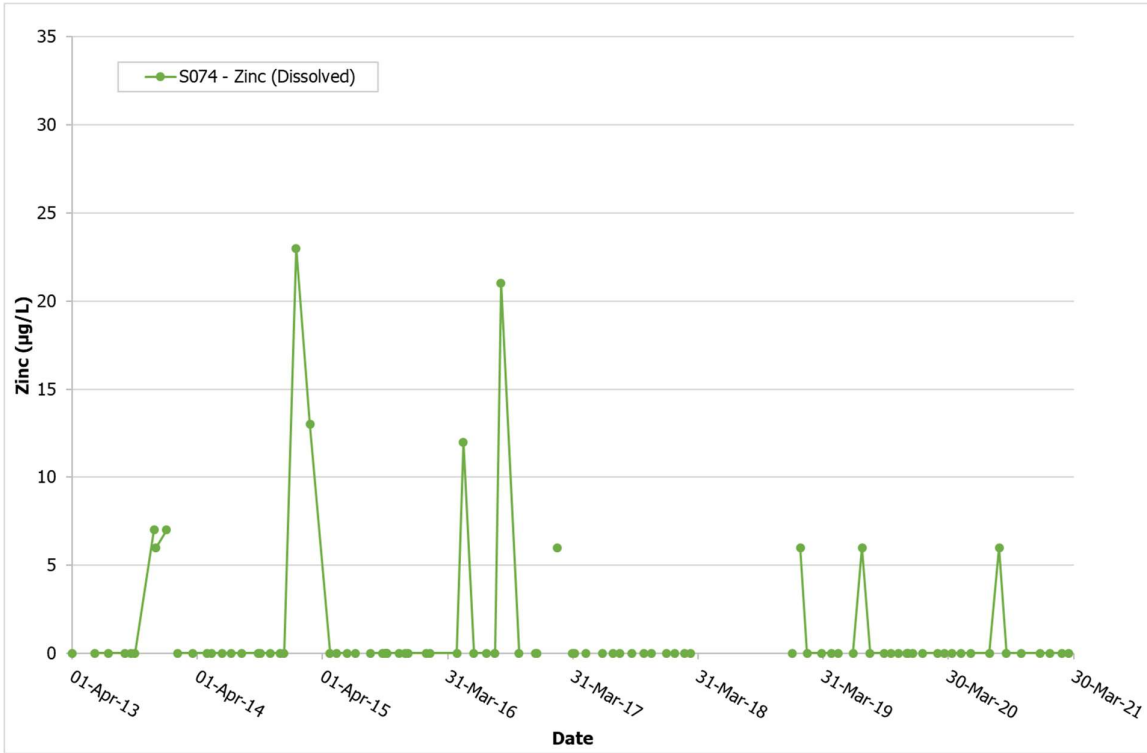
So74 (composite sample) – Molybdenum (filtered)



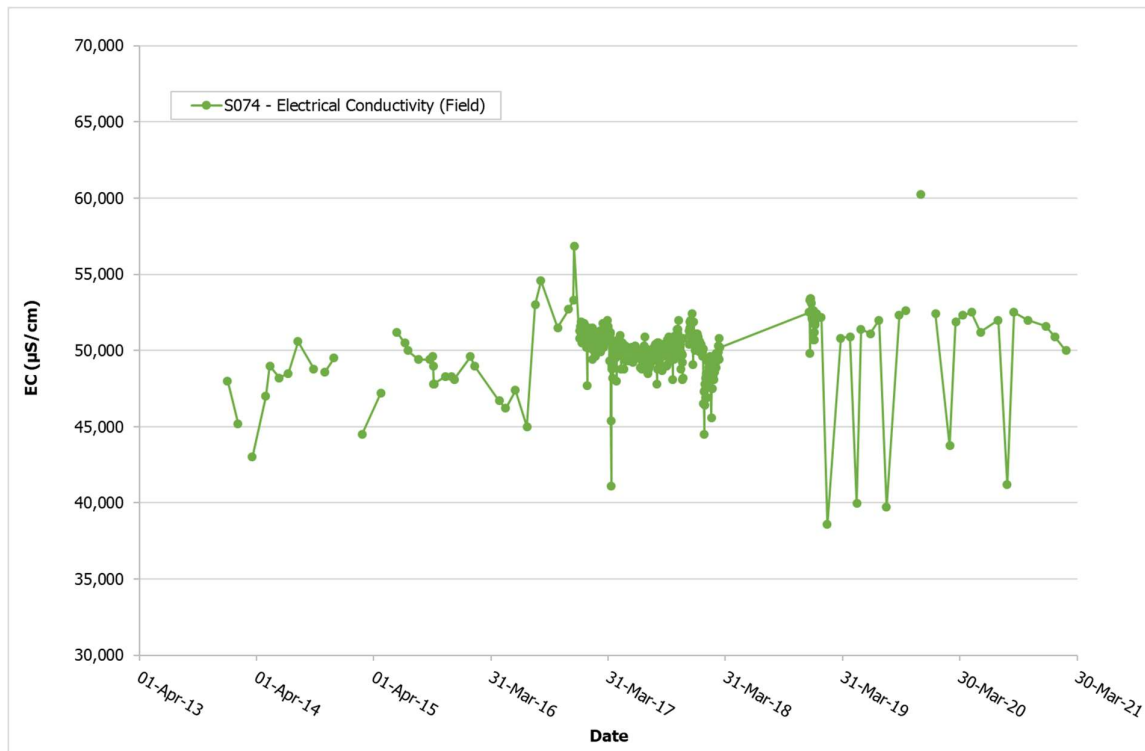
So74 (composite sample) – Vanadium (filtered)



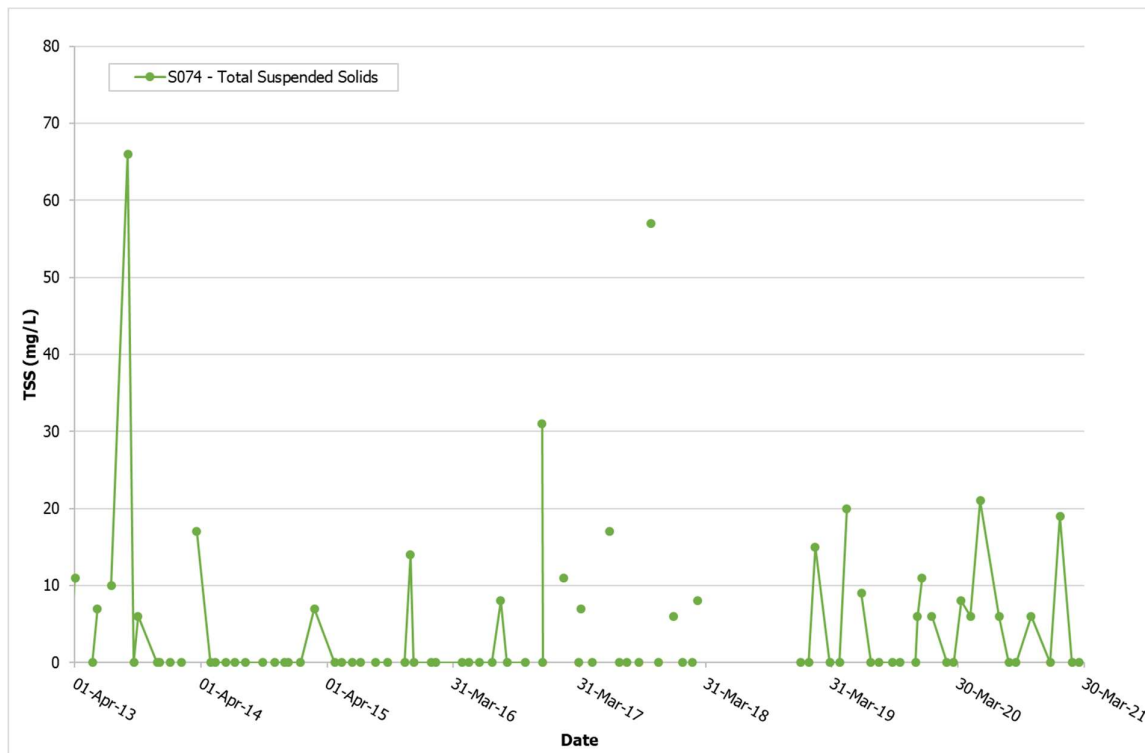
So74 (composite sample) – Zinc (filtered)



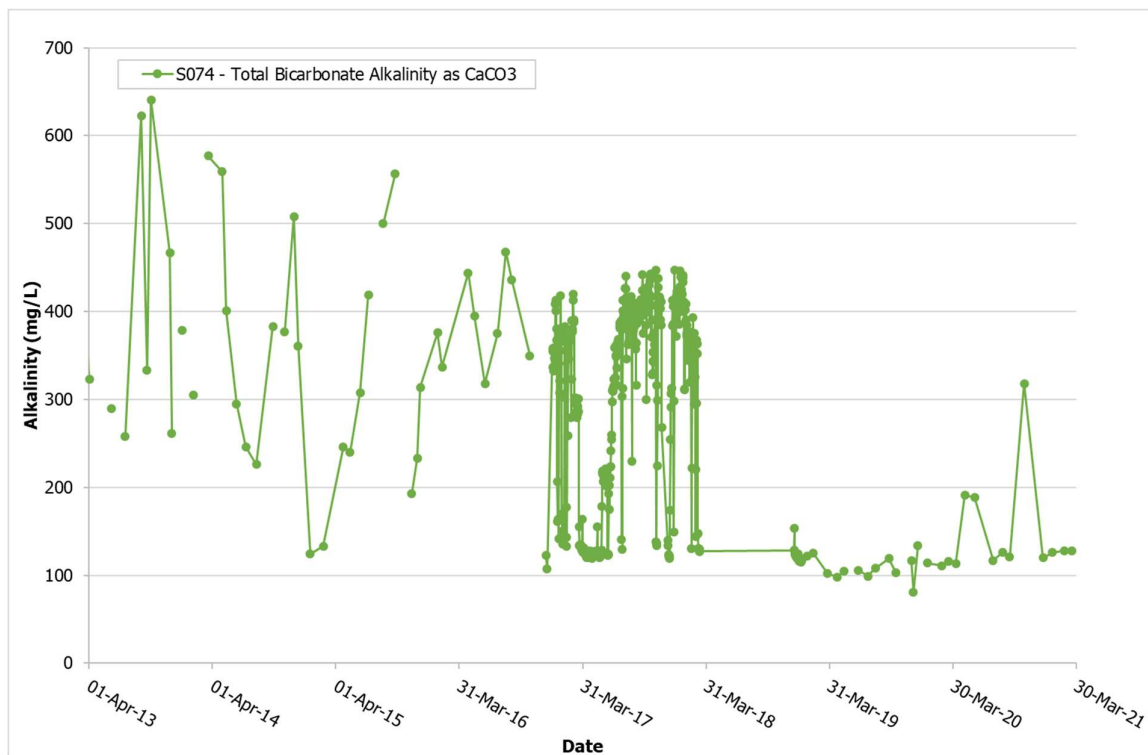
So74 (composite sample) – Electrical Conductivity



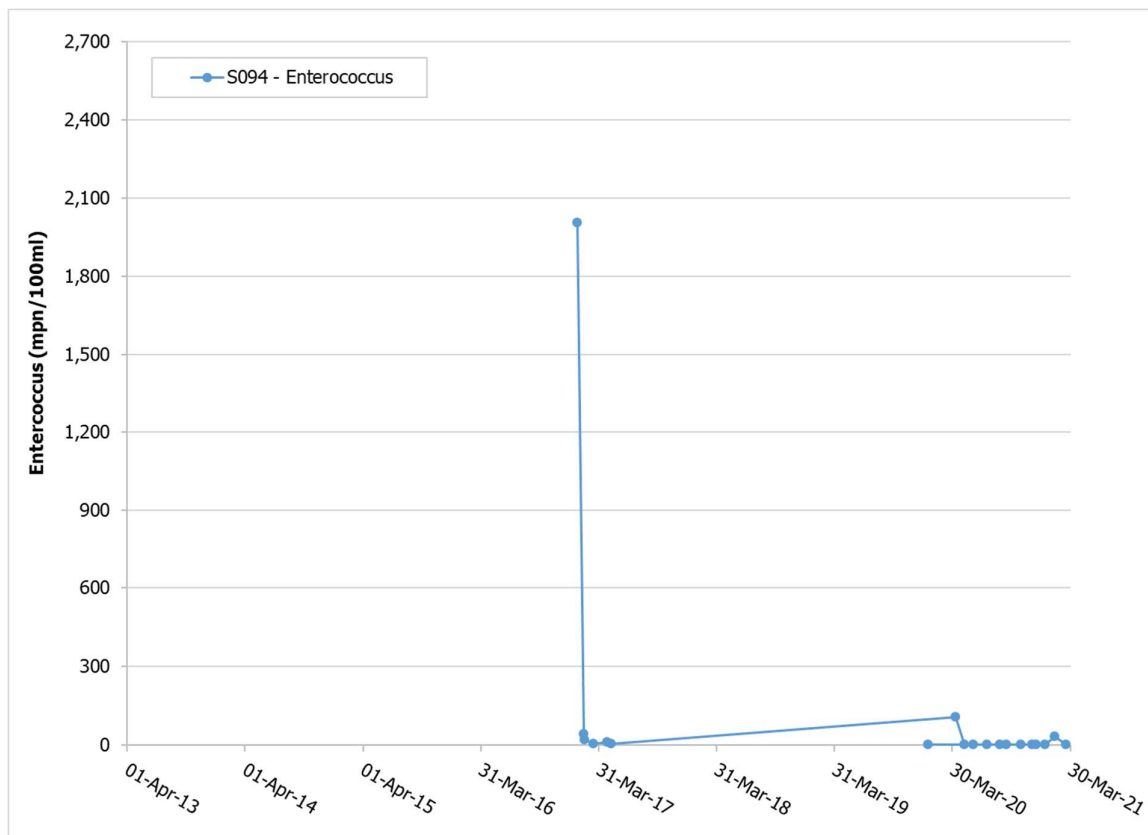
So74 (composite sample) – Total Suspended Solids



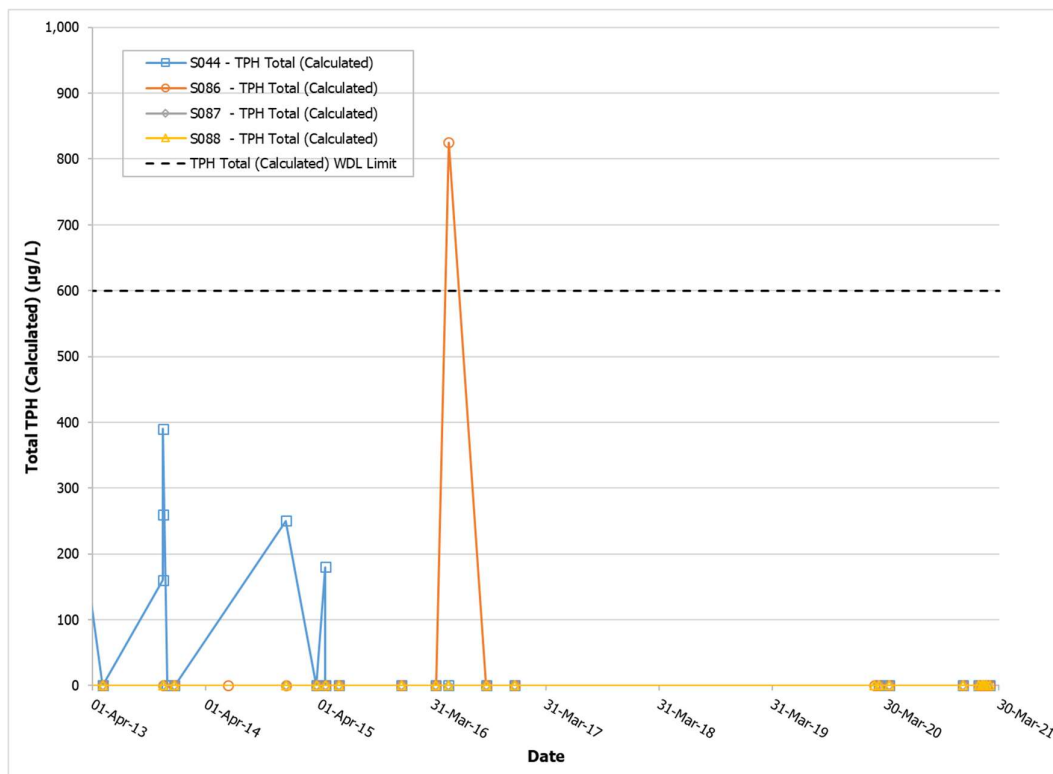
S074 (composite sample) – Alkalinity



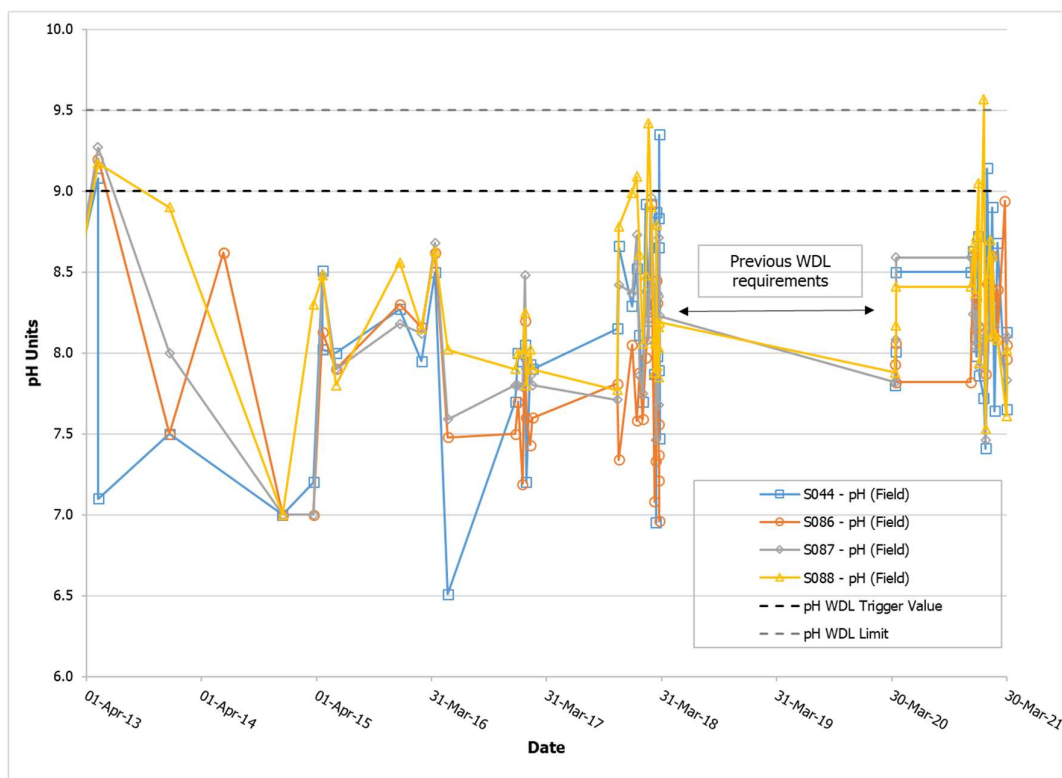
S094 Boat Ramp – Enterococcus



So44, So86, So87, So88 – Total petroleum hydrocarbons (calculated)



So44, So86, So87, So88 – pH (Field)



**Appendix C
Table 3**

Surface Water Analytical Results – Marine Mixing Zone Compliance Points

Surface Water Analytical Results
Rio_Tinto-Gove
WDL Annual Monitoring Report
2020 - 2021

				AUS-5 TRH-W											
Analyte Unit				C6-C9	C10-C14	C15-C28	C29-C36	C10-C36 (sum)	C6-C10	C6-C10 minus BTEX (F1)	>C10-C16	>C10-C16 minus Naphthalene (F2)	>C16-C34	>C34-C40	>C10-C40 (sum)
Location ID	Sample Date	Sample Name	Lab SDG	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
RR2	18/12/2020	RR2_20201218	ES2045895	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100
RR2	22/01/2021	RR2_20210122	ES2102505	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100
RR2	27/02/2021	RR2_20210227	ES2108194	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100
RR2	21/03/2021	RR2_20210321	ES2110765	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100
SW09	18/12/2020	SW9_20201218	ES2045895	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100
SW09	22/01/2021	SW9_20210122	ES2102505	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100
SW09	27/02/2021	SW9_20210227	ES2108194	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100
SW09	21/03/2021	SW9_20210321	ES2110765	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100
SW10	18/12/2020	SW10_20201218	ES2045895	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100
SW10	22/01/2021	SW10_20210122	ES2102505	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100
SW10	27/02/2021	SW10_20210227	ES2108194	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100
SW10	21/03/2021	SW10_20210321	ES2110765	< 20	< 50	< 100	< 50	< 50	< 20	< 20	< 100	< 100	< 100	< 100	< 100

Appendix E – Marine Monitoring Report

**RIEL**

Research Institute for
the Environment and
Livelihoods

Rio Tinto Gove Operations Marine Health Monitoring Program

Routine Surveillance Monitoring Program: Receiving Environment Quality Survey Report no. 16: 1st April 2020 - 31st March 2021_FINAL

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Executive Summary

This report is the sixteenth annual monitoring report under Rio Tinto Gove's (RTG's) Marine Health Monitoring Program (MHMP) for Southern Melville Bay (Project no. 6 – *Routine Surveillance Monitoring Program – Receiving Environment Quality Survey*). It presents new data for seawater, sediment and oysters for the period 1st April 2020 – 31st March 2021.

RTG's Waste Discharge Licence specifies trigger values and limits for a range of water quality parameters in seawater at several monitoring sites near RTG's operations. The monitoring and analytical results for this reporting period are assessed against the most recent licence (WDL 171-10, condition no. 4). WDL 171-10 specifies trigger values for pH, dissolved oxygen, turbidity, chlorophyll-a, total dissolved nitrogen and phosphorus, and metals/metalloid concentrations in seawater at monitoring sites SW9, SW10 and RR2. The MHMP also includes monitoring of metals/metalloids in marine sediment and oyster tissue and this data is assessed by evaluating temporal trends since the commencement of the MHMP in 2004. The data is also compared to the ANZG (2018) sediment quality guidelines and the FSANZ food quality standards.

Before its curtailment in late 2014, the Gove Refinery's principal impact on marine water and sediment quality in Gove Harbour resulted from occasional entrainment of process liquor into the refinery's cooling seawater circuit which was discharged to the harbour. The refinery discharge contained elevated aluminium (Al), vanadium (V), gallium (Ga), arsenic (As) and molybdenum (Mo) which were incorporated in hydrotalcite-rich precipitates resulting in the formation of an anoxic, microbially active, sulfide-rich sediment with elevated nutrient, metal and metalloid concentrations.

In late 2012, a Waste Water Neutralisation Plant (WWNP) was commissioned to treat liquor from the Residue Disposal Area (RDA). The WWNP effluent resulted in an increase in the discharge of mainly V (and lesser amounts of Al, Ga, As and Mo) to Inner Gove Harbour. As a result, dissolved V concentrations in seawater at monitoring sites located along the mixing zone boundary increased compared to previous years. Elevated concentrations of dissolved V, compared to background, have also been detected at several sampling sites outside the mixing zone. Discharges from the WWNP ceased in March 2018. Intermittent WWNP operation resumed in March 2020. It was commissioned with seawater only as a trial; then seawater neutralisation commenced on 9 April 2020 followed by periods of operations and shutdowns during the reporting period.

Summary of main findings:

Seawater monitoring April 2020 – March 2021:

- Monthly data for compliance sites along the mixing zone boundary in Inner Gove Harbour showed that all parameters monitored were below the trigger values specified by Waste Discharge Licence (WDL171-10).

- Dissolved concentrations of V and associated elements (mainly Al, Ga and As) have remained near background levels at the mixing zone boundary compliance sites in Inner Gove Harbour as well as most other information sites in Southern Melville Bay.
- Total element concentrations at the compliance sites (unfiltered sample) were added to the MHMP in October 2020. As would be expected, total concentrations of Al and Fe substantially exceeded dissolved concentrations. Total concentrations of Cr, Mn and Ga also exceeded dissolved concentrations of the same metals. In contrast, dissolved phases of V, Cu, Zn, As, Mo and U accounted for almost all the total concentrations of these elements.

Sediment monitoring 2004-2020:

- The most recent sediment survey was conducted in April 2020.
- Several elements are elevated in surface sediment in Inner Gove Harbour compared to background sites. However, since 2006-07 Mg, Zn and Ga concentrations have decreased in surface sediment in Inner Gove Harbour. Vanadium concentrations in sediment increased in 2014 and have been slightly higher in Inner Gove Harbour compared to other monitored areas throughout 2014-20.
- Drimmie Arm sediment had slightly elevated concentrations of As compared to background sediments during 2004-2020. No temporal trends were observed.
- Sediment from Crawford's Creek had slightly elevated TKN and As concentrations compared to background sites. These concentrations can be ascribed to the organic-rich and mud-dominated mangrove environment and have been observed every year of the MHMP.
- The concentrations of all parameters monitored in sediment during 2004-2020 were below the ANZG (2018) SQGVs where available.

Oyster monitoring 2004-2020:

- During 2004-20 oysters from Harbour Islets, Granite Islands and West Woody Islands relatively close to the RTG Refinery had higher concentrations of Al and Ga compared to oysters from the more distant background site at Bonner Rocks.
- Oysters from Harbour Islets had elevated Zn and reduced Cd concentrations relative to oysters from other sampling sites. The reduced Cd concentrations are likely to be related to the increased Zn concentration in Gove Harbour due to a mechanism of competitive exclusion of Cd by Zn.

- Cadmium concentrations in oysters from Bonner Rocks, West Woody Island and occasionally Granite Islands have been above the FSANZ food standard (2 mg/kg) during most of the 2004-20 monitoring period. However, this phenomenon appears to have natural causes and have been reported previously from locations in Northern Australia (Noller, 1991; McConchie & Saenger, 1993). Cadmium is not a chemical of primary concern in Gove Refinery discharges.
- Total As concentrations in oysters from all four sampling sites increased substantially in April and October 2017 compared to the previous concentrations. However, since 2017 As concentrations at all four sampling sites have been lower, but variable. It is likely that As concentrations in oysters is subject to a naturally occurring environmental cycle.
- Total As in oysters from all sampling sites exceeded the FSANZ maximum permitted concentrations for inorganic As. However, As speciation analyses carried out on samples from 2009 and 2017 showed that inorganic As concentrations were below the FSANZ food standard.
- Lead concentrations in oysters from all sampling sites were below the FSANZ maximum permitted concentrations.

Recommendations:

- It is recommended that monthly sampling and analysis of seawater and annual sampling and analysis of sediment continues as part of the MHMP.
- The oyster monitoring component of the MHMP should also continue unchanged with half yearly sampling. It is the only ongoing biological component of the MHMP and remains an important tool for monitoring of both environmental health and marine food safety.
- Careful monitoring of data quality for water samples should continue to ensure that 'clean' sampling techniques appropriate for trace level metal/metalloid analysis is followed and that recent improvements in MHMP data quality is maintained. Adherence to RTG's field sampling procedures is essential.

1. Introduction

Monitoring of receiving environment quality of southern Melville Bay under the Rio Tinto Gove Operations (RTGO) Marine Health Monitoring Program (MHMP Project no. 6) now consists of (a) annual surveys of the chemical composition of sediment (b) half-yearly surveys of the chemical composition of oysters and (c) monthly analysis of physico-chemical parameters and sampling for chemical analysis of seawater samples. The survey program assists in meeting the following MHMP objectives:

1. Assess and monitor the level of impact RTG operations are having on the marine environment.
2. Establish internal RTG water quality discharge guidelines for Gove operations.

The MHMP component as detailed in the Water Monitoring Plan (October 2019) was implemented as required in Condition 27 of the Gove Waste Discharge Licence (WDL 171-10).

This report presents new data for the period 1st April 2020 – 31st March 2021 and is the sixteenth annual monitoring report. The monitoring surveys build on the 2004-2005 baseline studies of southern Melville Bay (Parry and Munksgaard, 2005; Munksgaard and Parry, 2005). These studies formed the basis for establishing the sample types, sites and analytes to be included in the half-yearly monitoring surveys. RTG commenced monthly monitoring surveys of the receiving waters of southern Melville Bay in May 2005 using the same sites as used in the half-yearly and yearly surveys.

A mixing zone for the refinery main discharge was established in accordance with licence requirements and monitoring at test sites along the edge of the mixing zone boundary commenced in August 2007. The mixing zone was subsequently reduced in the current WDL with new mixing zone boundary monitoring sites, albeit sites that already were included in the MHMP.

2. Sampling sites and Methodology

Within the sampling area **Inner Gove Harbour**, **Crawford's Creek** and **Drimmie Arm** are the main areas of potential impact from the RTG operation, mainly via the **Refinery Seawater Channel Outfall** and **Residue Disposal Area (RDA)** discharge and seepage (Figures 1 and 2). Table 1 shows the monthly, half-yearly and yearly sampling and analytical programs as of March 2021. Sampling sites are shown in Figures 1 and 2, with the location coordinates in Appendix 1.

Table 1. Rio Tinto Gove's Marine Health Monitoring Program (MHMP)

Parameter	Method Reference Numbers*	Seawater monthly	Sediment yearly, oysters half-yearly
Seawater <i>in situ</i>			
pH, Dissolved Oxygen, Turbidity, Conductivity, Temperature	GO - Water Monitoring Plan, October 2019	18 sites, 0.5m depth	
Seawater – unfiltered sample			
Acid Neutralising Capacity*	GO - ENV-M-05	18 sites, 0.5m depth	
Total Suspended Solids	CDU - ALC02	18 sites, 0.5m depth	
Chlorophyll a	CDU - ALC09	18 sites, 0.5m depth	
Seawater – filtered (<0.45µm) sample			
Al, V, Cr, Mn, Fe, Cu, Zn, As, Ga, Mo, U	CDU - ALC03A	18 sites, 0.5m depth	
Total Dissolved P and N	FSSQH - 13802, 13800	18 sites, 0.5m depth	
Seawater – total samples			
Al, V, Cr, Mn, Fe, Cu, Zn, As, Ga, Mo, U	CDU - ALC03A	3 sites, 0.5m depth	
Sediments – sieved to <0.063mm - yearly sampling			
Mg, Al, V, Fe, Cu, Zn, Ga, As, Mo, Cd, Pb, U	CDU - ALC05		32 sites
Sediments – sieved to <2mm – yearly sampling			
Total Kjeldahl N	FSSQH - 13804		32 sites
Oysters – soft tissue – half-yearly sampling			
Al, V, Fe, Cu, Zn, Ga, As, Mo, Cd, Pb	CDU - ALC07		4 sites

***Note:** Analysing laboratory and method reference: GO = Gove Operations Environment Section; CDU = Charles Darwin University; FSSQH = Forensic and Scientific Services Queensland Health.

Following pages:

Figure 1. Southern Melville Bay MHMP seawater sampling sites.

Figure 2 a, b, c. Southern Melville Bay MHMP sediment and oyster sampling sites.



LEGEND		SCALE	1:42,000	PROJECTION	WGS84 UTM53S		2016 MARINE MONITORING SITES
	RT Gove Leases	DATE	9/5/16	DEPARTMENT	ENVIRONMENT		
	Mixing Zone Boundary	PAGE	1 of 1	DOCUMENT	WDL 2016		
		AUTHOR	FAYE.LAWTON				
							A3



Figure 2a

LEGEND		SCALE 1:10,000		PROJECTION GDA 1994 MGA Zone 53			GOVE INNER HARBOUR SEDIMENT SITES			A3
— Lease Boundary		DATE 19/05/2016		DEPARTMENT ENVIRONMENT						
		PAGE 1 of 1		DOCUMENT WDL 2016						
		AUTHOR FAYE.LAWTON								

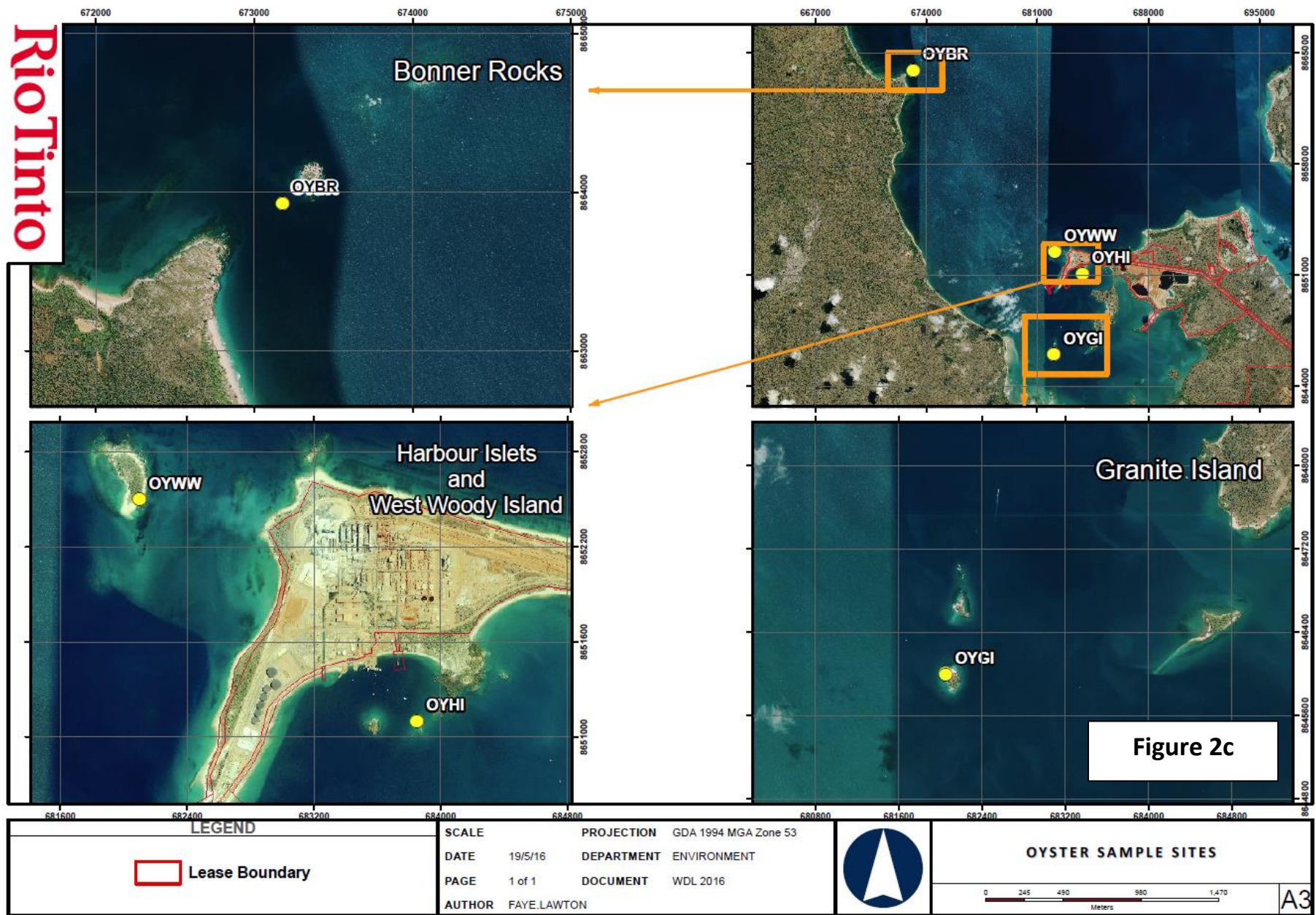


Figure 2b

LEGEND		SCALE	1:42,000	PROJECTION	GDA 1994 MGA Zone 53		GOVE OUTER HARBOUR SEDIMENT SITES	
— Lease Boundary		DATE	19/5/16	DEPARTMENT	ENVIRONMENT			
		PAGE	1 of 1	DOCUMENT	WDL 2016			
		AUTHOR	FAYE LAWTON					

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Seawater sampling sites:

- Background sites: SW1, SW3, SW4, SW7. These sites were identified in the baseline studies (Parry and Munksgaard, 2005; Munksgaard and Parry, 2005) as being near-pristine.
- Compliance sites: SW9, SW10, RR2 at the mixing zone boundary. Data for these sites are assessed according to WDL 171-10 requirements.
- Monitoring sites: MB1, MB2, MB3, MB4, SW2, SW3, SW4, SW7, SW8, SW11. These are identified monitoring sites in WDL 171-10.
- Other information sites: SW1, SW5, SW6 and SW12, the latter being the Refinery seawater outfall channel.

Sediment sampling sites:

- Background sites: A2.0, B2.0, C2.0, D1.0, D4.0, E1.0, E5.0, E7.25, F0.0, F3.0, G1.5, H2.0, I1.0. These sites were identified in the baseline studies (Parry and Munksgaard, 2005; Munksgaard and Parry, 2005) as having no anthropogenic impact.
- Information sites Potential impact zones in Inner Harbour, Drimmie Arm and Crawford's Creek: C0.0, C0.25, C0.50, C1.0, D0.0, F6.5, G0.5, H3.0, IH4, IH5, IH6, IH7, IH10, IH12, IH14, IH15, IH16, IH17, IH19.

Oyster sampling sites:

- Background site: Bonner Rocks.
- Information sites: Harbour Islets, West Woody Island, Granite Islands.

The routine marine field sampling methodology is described in Gove Operations Water Monitoring Plan, October 2019. Description of sampling and analytical methodology can be found in the Baseline Study reports (Parry and Munksgaard, 2005; Munksgaard and Parry, 2005) and updates can be requested from CDU. A brief outline of the current MHMP sampling and analytical methodology is given below:

In situ measurements: pH, dissolved oxygen (DO), turbidity, conductivity and temperature profiles are collected with a YSI water quality sonde.

Seawater sampling and analysis: A peristaltic pump is used to collect unfiltered) and filtered samples (0.45µm in-line filter capsule). Samples are analysed for metal and arsenic concentrations by Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Total dissolved nitrogen and phosphorus concentrations are determined by Flow Injection Analysis and

Chlorophyll concentrations by fluorometric analysis. Total suspended solids are filtered (0.45µm) and determined gravimetrically.

Sediment sampling and analysis: Seafloor sediments are sampled from the top 5-10cm of sediment using a Van-Veen stainless steel grab sampler. Samples for elemental analysis are wet sieved to <63µm and digested in nitric + perchloric acid in an open tube block digester at 180°C for 6-8 hours. Elemental concentrations are determined by ICP-MS. Samples for Total Kjeldahl Nitrogen (TKN) analysis are wet-sieved to <2mm and TKN is determined by Flow Injection Analysis after digestion in sulfuric acid in the presence of copper sulfate.

Oyster sampling: Oysters are collected whole using a hammer and chisel. The soft tissue is extracted in the laboratory under clean room conditions and digested in nitric acid and hydrogen peroxide at approximately 130°C for 60 min. Elemental concentrations are determined by ICP-MS.

Note 1: Three main species of oysters commonly found in Southern Melville Bay are *Saccostrea cucullata*, *Saccostrea mordax* and *Saccostrea mytiloides*. The subtle differences between these species were not initially identified and the comparison of data from different surveys may be affected by different species distributions.

3. Quality Control

Field sampling is conducted according to Gove Operations Water Monitoring Plan, October 2019. Quality control includes replicate sampling. Chain of custody documentation accompanies all samples dispatched to the analysing laboratory.

The YSI EXO water quality probe is calibrated immediately prior to taking it into the field and the calibration is checked on return from the field. Calibration records are maintained in the RTG environmental laboratory.

Laboratory quality control procedures included procedural blanks, replicate analyses, spike recovery analysis and analysis of certified reference materials.

4. Results and Discussion

4.1 Seawater

4.1.1 Data presentation

In-situ instrumental and laboratory seawater data for April 2020 – March 2021 are presented in Appendix 2. There are separate tables for each water quality parameter. Each table includes statistics for the total dataset (2004 to 2021) and include minimum, maximum, median values plus 20th, 80th and 90th percentile values. The median value of each parameter for the last 12-month period (April 2020 to March 2021) is also provided. The tables also include the 80th percentile value of background sites (SW1, SW3, SW4 and SW7) and the Trigger Investigation Limits (TILs) previously used in the assessment of MHMP data (prior to April 2016) and continues to be included for continuity of data.

Water quality data is presented and discussed in two sections below: Section 4.2 contains data for the mixing zone boundary sites (SW9, SW10 and RR2) in Inner Gove Harbour and Section 4.3 contains monitoring data for sites at Crawford's Creek (SW5) and Drimmie Arm (SW6).

Note: Some Chlorophyll-a, TDN, TDP, Al, Cu, Zn and Ga data were below the limit of reporting (LOR). To enable continuity of statistical data, concentration values below the LOR have been replaced by half the LOR. A small number of erroneous data for EC, TSS, TDN, TDP and dissolved Al in seawater samples in past years have been removed in order that they do not influence the statistical summaries. The erroneous data were identified in previous annual reports based on probable sampling or laboratory errors. The removed data are identified in Appendix 2.

4.1.2 Waste Discharge Licence Trigger Values and Limits

The monitored parameters under the MHMP are temperature (T), conductivity (EC), pH, dissolved oxygen (DO), turbidity, total suspended solids (TSS), acid neutralising capacity (ANC), chlorophyll-a, total dissolved nitrogen (TDN), total dissolved phosphorus (TDP), dissolved aluminium (Al), dissolved vanadium (V), dissolved iron (Fe), dissolved copper (Cu), dissolved zinc (Zn), dissolved gallium (Ga), dissolved arsenic (As), dissolved molybdenum (Mo) and dissolved uranium (U). The dissolved fraction is the filtrate from 0.45 µm membrane filtration. Some of the parameters monitored provide contextual information although no trigger values or limits are specified in WDL 171-10.

Waste Discharge Licence 171-10 specifies 'Trigger Values' for pH, dissolved oxygen, turbidity, chlorophyll-a, TDN, TDP and dissolved Al, V, Cu, Zn, Ga, As, and Mo at compliance sites SW9, SW10 and RR2 along the mixing zone boundary in Gove Inner Harbour (Table 2). The new trigger values are based on a reassessment of the local ecotoxicity studies or species protection trigger value concentrations published by ANZG (2018).

Table 2. WDL 171-10 receiving waters Trigger Values

	Trigger Level (Limit) for sites: SW9, SW10, RR2
pH	< 7.7 or > 8.4
Dissolved Oxygen (mg/L)	<5.81
Turbidity (NTU)	20.0
Chlorophyll-a (µg/L)	1.4
Total Dissolved Nitrogen (µg/L)	170
Total Dissolved Phosphorus (µg/L)	14
Dissolved Al (µg/L)	56
Dissolved As (µg/L)	20
Dissolved Cu (µg/L)	1.3
Dissolved Ga (µg/L)	800
Dissolved Mo (µg/L)	3880
Dissolved V (µg/L)	100
Dissolved Zn (µg/L)	15

4.2. Inner Gove Harbour Mixing Zone

The Waste Water Neutralisation Plant (WWNP) was taken offline in March 2018. The WWNP was restarted in March 2020 with seawater only during commissioning; seawater neutralisation commenced 9 April 2020 followed by intermittent periods of operation for the remainder of the reporting period. WWNP operation/shutdowns have resulted in measurable changes to several parameters at sampling sites in Inner Gove Harbour and other sites in Southern Melville Bay. The most significant of these changes will be noted in the individual sections below.

4.2.1. Temperature

Variations in temperature at the mixing zone boundary sites SW9, SW10 and RR2 for 2004-21 are shown in Figure. 3. There are pronounced seasonal effects on temperature in all monitoring areas with temperature maxima usually occurring during October - March and minima occurring in July - August.

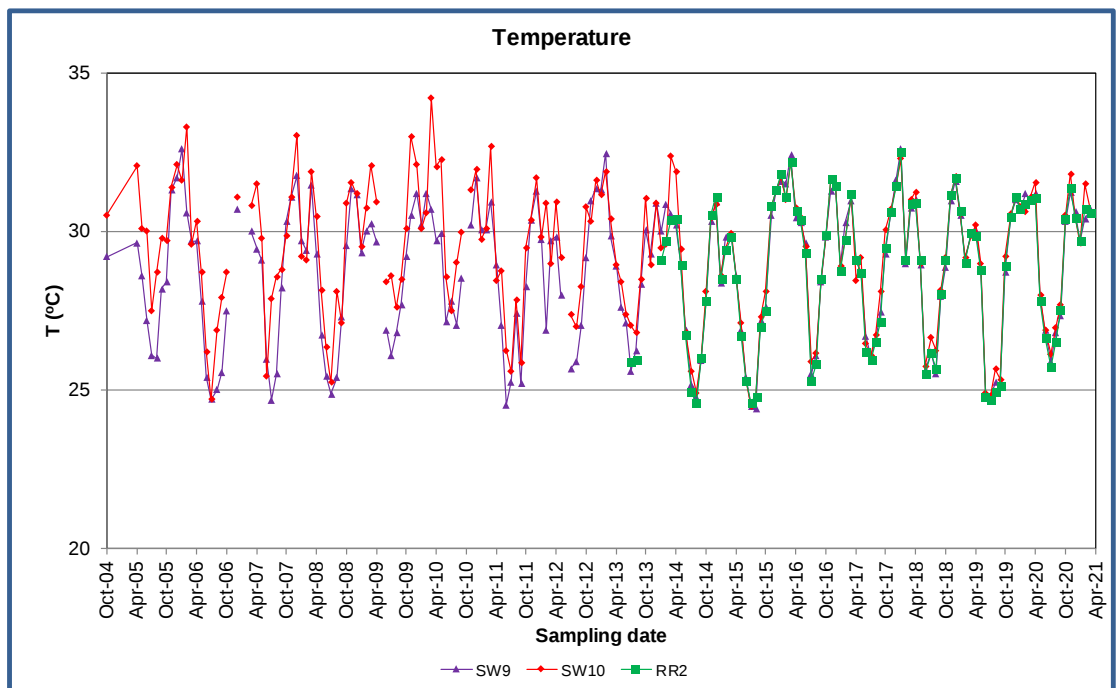


Figure 3. Temperature variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.2. Electrical Conductivity

Variations in EC at the mixing zone boundary sites SW9, SW10 and RR2 for 2004-21 are shown in Figure. 4. There are pronounced seasonal effects on electrical conductivity in all monitoring areas with minima usually occurring during December – April (wet season) and maxima in October-November (late dry season).

During 2012-15 several erroneous EC data were collected due to incorrect instrument calibration. These data are no longer included in the assessment.

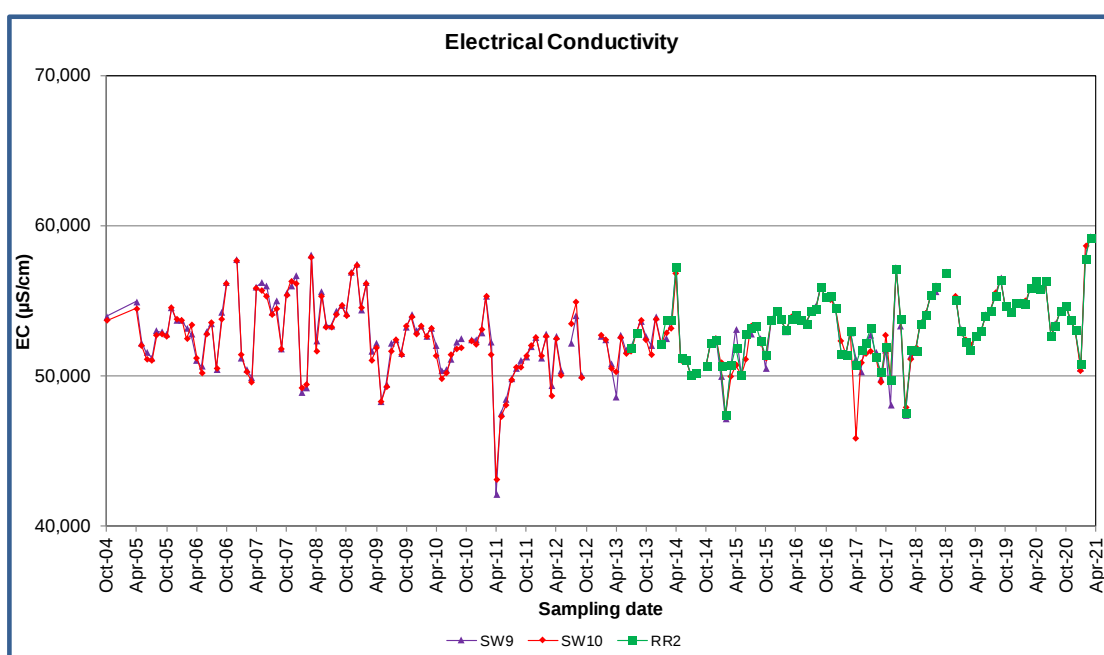


Figure 4. Electrical conductivity variations at the mixing zone boundary compliance sites SW9, SW10 and RR2. Data gaps indicate the removal of erroneous data.

4.2.3. pH (WDL parameter)

Variations in pH at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2004-20 are shown in Figure. 5. No exceedances of the pH trigger value <7.7 or >8.4 were recorded during April 2020 – March 2021.

pH variations at the monitoring sites can partly be ascribed to seasonal variations in freshwater runoff mixing into saline waters during the wet season. Limited accuracy of the YSI field pH probes (approximately ± 0.2 units, YSI specifications) is also likely to explain some of the observed variation.

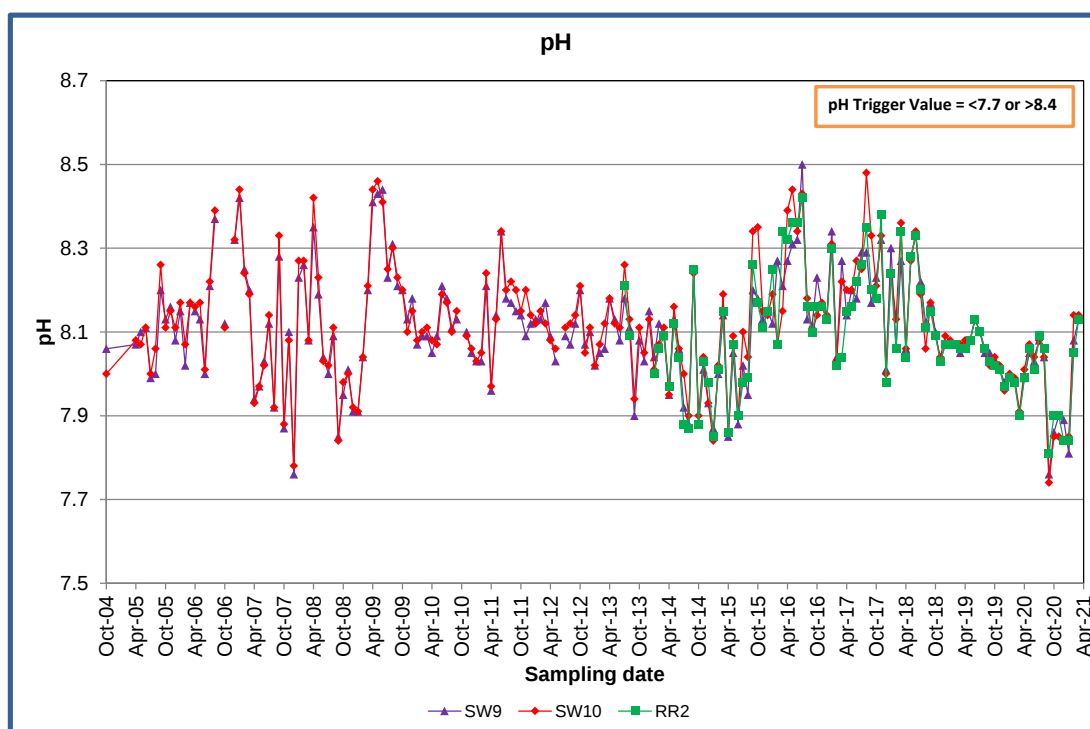


Figure 5. pH variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.4 Dissolved Oxygen (WDL parameter based on WDL171-10)

Variations in Dissolved Oxygen (DO) at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2004-21 are shown in Figure. 6.

The median DO values for 2020-21 varied little across most monitoring sites including background sites (DO $\approx$ 6.0 – 6.9 mg/L, Appendix 2).

Nominal exceedances of the trigger value for DO (<5.81 mg/L) occurred in February and March 2021 at site RR2 (5.72 and 5.51 mg/L, respectively) and in March 2021 for sites SW9 and SW10 (5.60 and 5.70 mg/L, respectively). However, the DO trigger value is based on the 20th percentile of background data and therefore values lower than the trigger value should be expected 20% of the time. The median DO during April 2020 to March 2021 at the compliance sites (6.62 to 6.86 mg/L) were within the trigger level.

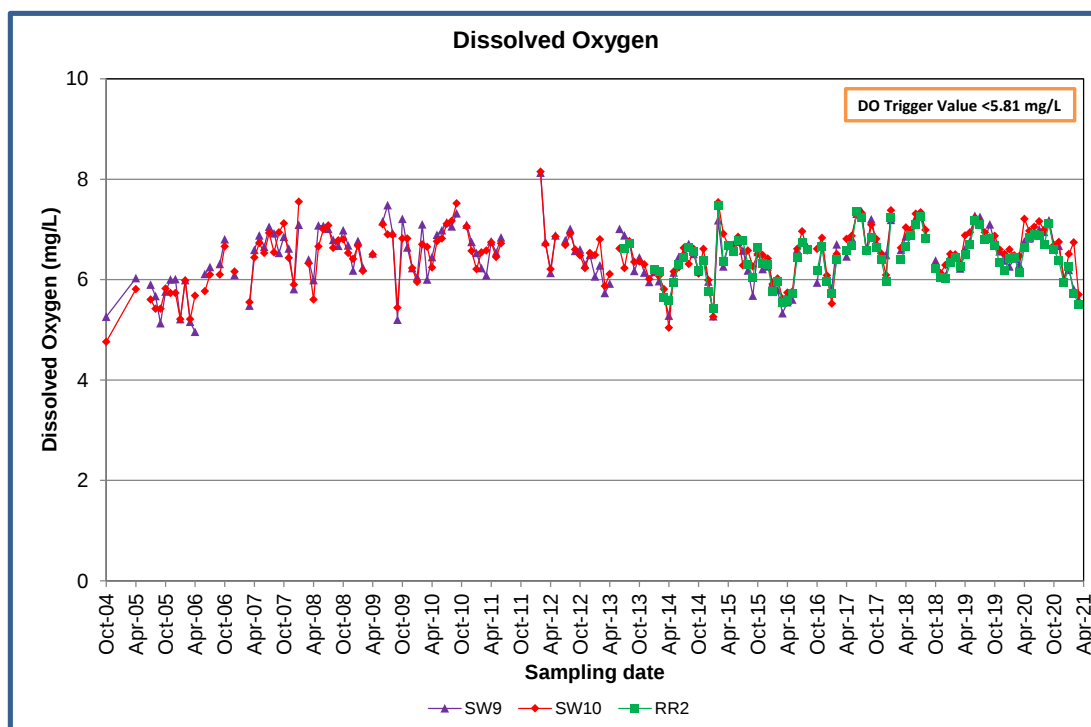


Figure 6. Dissolved oxygen variations at the mixing zone boundary compliance sites SW9, SW10 and RR2. Data gaps indicate the removal of erroneous data.

4.2.5 Turbidity (WDL parameter based on new WDL171-10)

Variations in turbidity at mixing zone boundary compliance sites SW9, SW10 and RR2 for 2004-21 are shown in Figure 7.

Site SW12 at the refinery outfall channel had a median turbidity of 4.3 NTU during 2020-21. This compares to a median turbidity range of 0.6 – 2.4 NTU at the background sites (Appendix 2).

The median turbidity at the compliance sites SW9, SW10 and RR2 (1.3 – 1.9 NTU) were within the background range.

There have been no exceedances of the trigger value (20.0 NTU) since October 2020

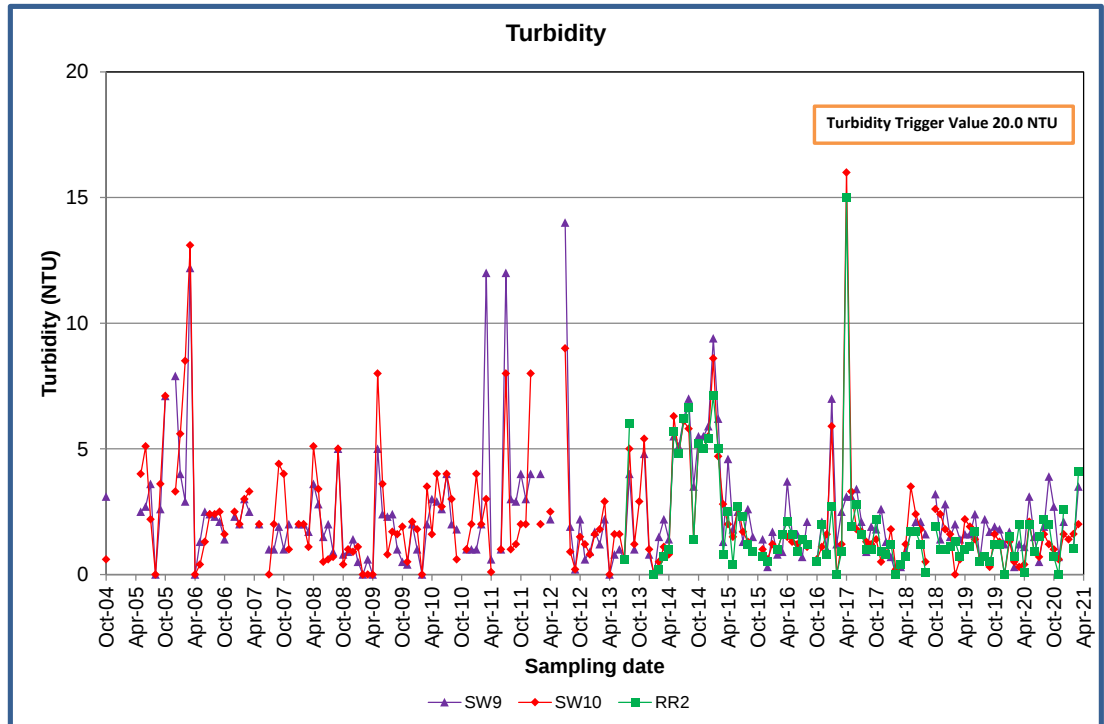


Figure 7. Turbidity variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.6 Total Suspended Solids

Variations in Total Suspended Solids (TSS) at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2004-21 are shown in Figure 8.

Site SW12 at the refinery outfall channel had a median TSS of 5.8 mg/L during 2020-21. This is slightly higher than the median TSS concentrations (2.4 – 3.1 mg/L) at the compliance sites SW9, SW10 and RR2 and the range of median concentrations (2.4 – 5.0 mg/L) at the background sites (Appendix 2).

Erroneous TSS concentrations were recorded at several sampling sites in March-August 2012 due to laboratory error. These data are no longer included in the MHMP assessment.

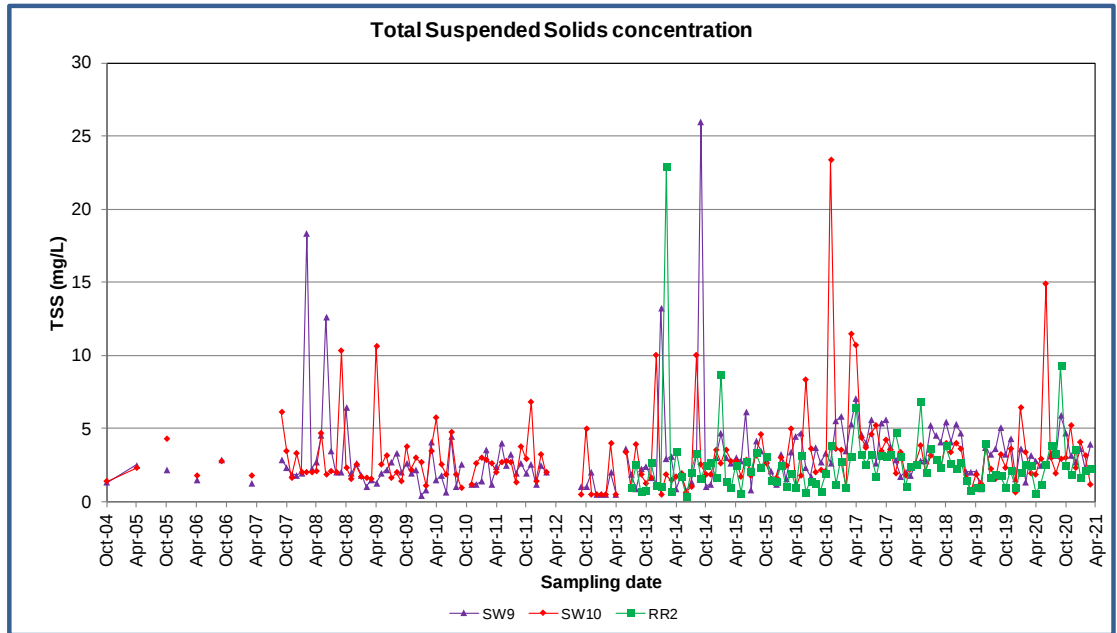


Figure 8. Total Suspended Solids variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.7 Acid neutralising capacity

Variations in Acid Neutralising Capacity (ANC) at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2004-21 are shown in Figure 9.

Site SW12 at the refinery outfall channel had a median ANC of 121 mg/L CaCO_3 during 2020-21. This was similar to the median ANC values (120-121 mg/L CaCO_3) at compliance sites SW9, SW10 and RR2 which were similar to the median values (120 mg/L CaCO_3) at the background sites (Appendix 2). ANC values decreased following cessation of WWNP discharges in 2018.

Acid Neutralising Capacity values at site SW12 as well as one or more of sites RR2, SW9, SW10, SW11 in Inner Gove Harbour were elevated in June and October 2020 but were still considerably lower than during WWNP operations in previous monitoring periods.

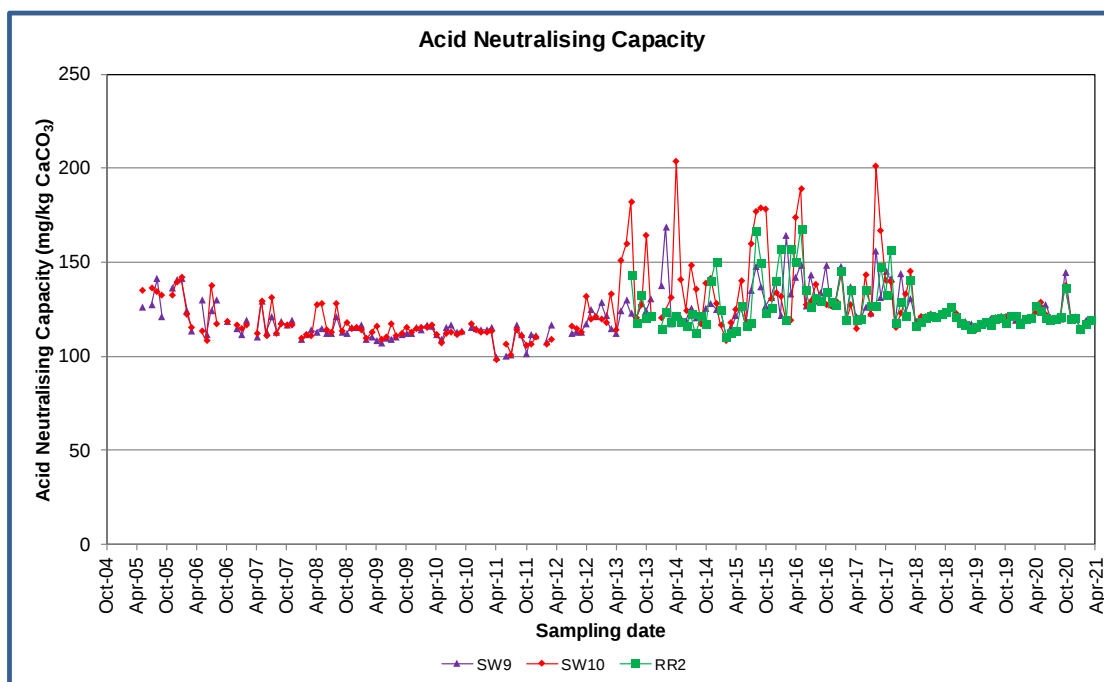


Figure 9. Acid Neutralising Capacity variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.8 Chlorophyll-a (WDL parameter based on WDL171-10)

Variations in Chlorophyll-a at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2004-21 are shown in Figure 10.

During 2020-21 the median chlorophyll-a value was 0.9 µg/L at compliance sites SW9, SW10 and RR2, similar to the range of median concentrations at background sites (0.6 – 1.0 µg/L). Site SW12 at the refinery outfall channel had a median Chlorophyll-a concentration of 1.3 µg/L.

There were nominal exceedances of the Chlorophyll-a trigger value (1.4 µg/L) at site SW9 in October 2020 and March 2021 (1.6 µg/L and 1.7 µg/L, respectively) and at site SW10 in December 2020 and January 2021 (1.5 µg/L and 1.6 µg/L respectively). However, the trigger value for Chlorophyll-a is based on the 80th percentile of background data values higher than the trigger value should be expected 20% of the time. The median Chlorophyll-a during April 2020 to March 2021 at the compliance sites (0.9 µg/L) were within the trigger level.

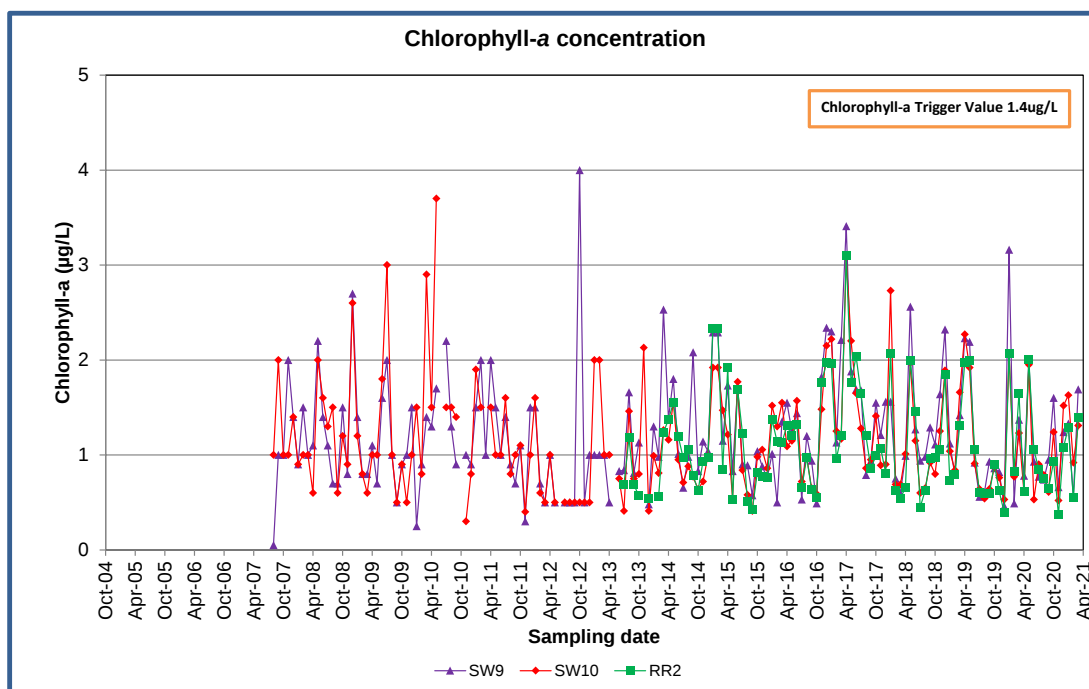


Figure 10. Chlorophyll-a variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.9 Total Dissolved Nitrogen (WDL parameter based on WDL171-10)

Variations in Total Dissolved Nitrogen (TDN) at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2004-21 are shown in Figure 11.

During 2020-21 the median TDN concentrations (100 - 110 µg/L) at compliance sites SW9, SW10 and RR2 were within the range of median values (110 - 150 µg/L) at background sites. There were no exceedances of the TDN trigger value (170 µg/L). Site SW12 at the refinery outfall channel had a median TDN concentration of 120 µg/L.

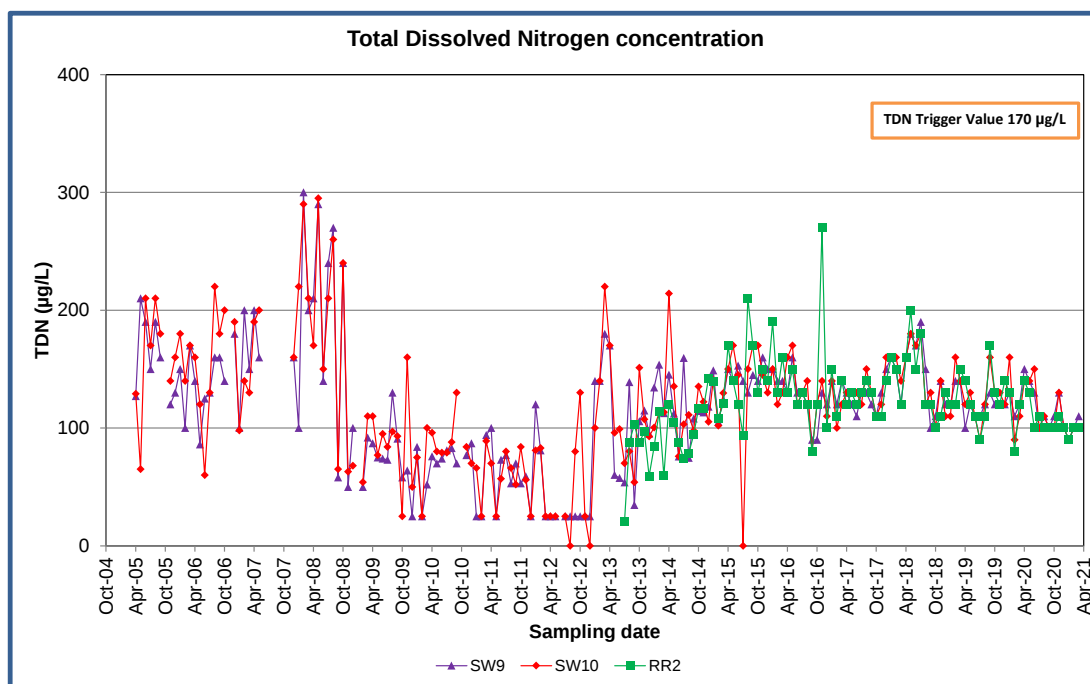


Figure 11. Total Dissolved Nitrogen variations at the mixing zone boundary compliance sites SW9, SW10 and RR2. Data gaps indicate the removal of erroneous data.

4.2.10 Total Dissolved Phosphorus (WDL parameter based on WDL171-10)

Variations in Total Dissolved Phosphorus (TDP) at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2004-21 are shown in Figure 12.

During 2020-21 the median TDP concentrations (3 - 4 µg/L) at compliance sites SW9, SW10 and RR2 were similar to the median concentration at background sites (4 µg/L). There were no exceedances of the TDP trigger value (14 µg/L). Site SW12 at the refinery outfall channel had a median TDP concentration of 5 µg/L.

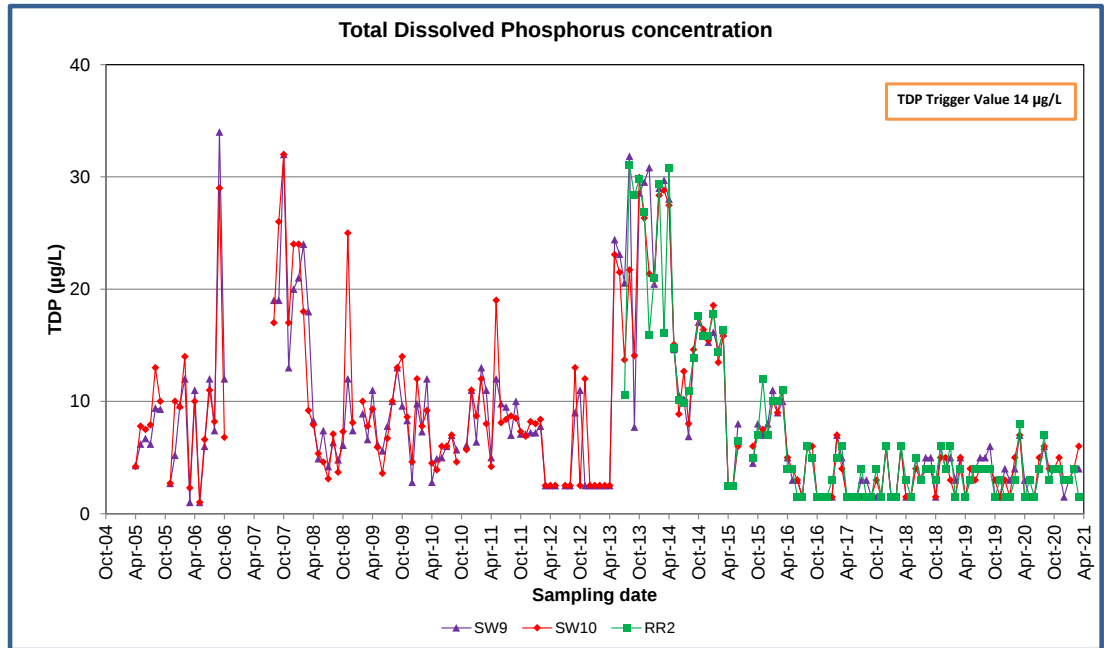


Figure 12. Total Dissolved Phosphorus variations at the mixing zone boundary compliance sites SW9, SW10 and RR2. Data gaps indicate the removal of erroneous data.

4.2.11 Dissolved and Total Aluminium (WDL parameter)

Variations in dissolved aluminium (Al) at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2004-21 are shown in Figure 13. There were no recorded exceedances of the WDL 171-10 dissolved Al Trigger Value (56 µg/L).

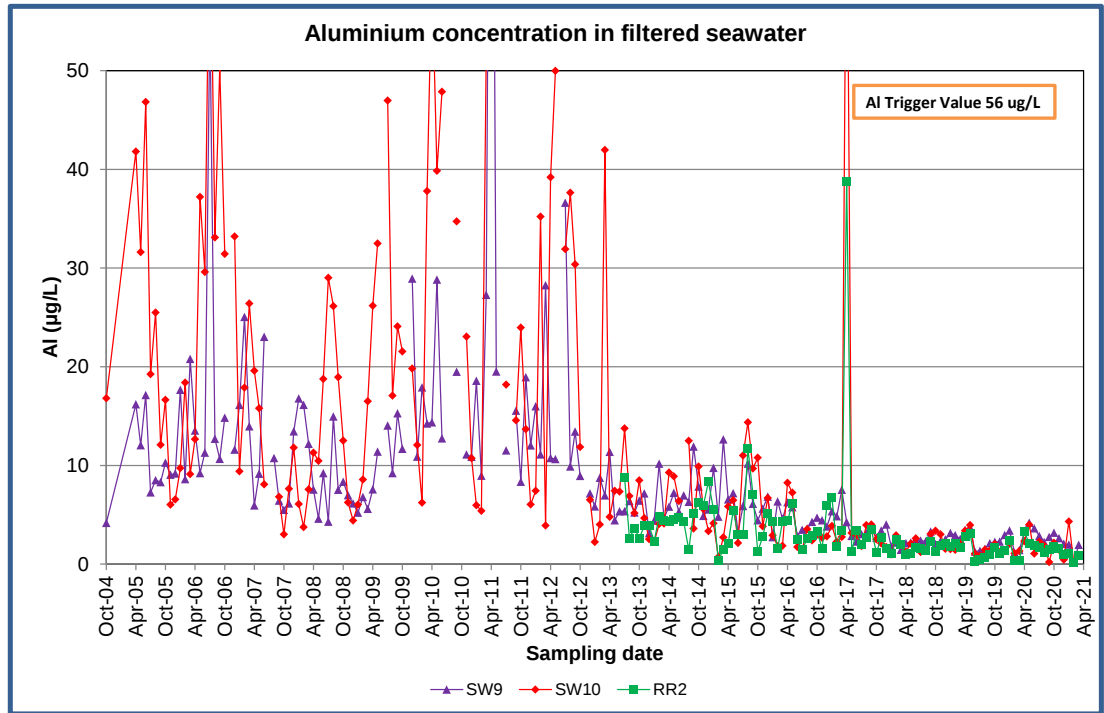


Figure 13. Dissolved aluminium variations at the mixing zone boundary compliance sites SW9, SW10 and RR2. Data gaps indicate the removal of erroneous data.

During April 2020 to March 2021 site SW12 at the refinery outfall channel had a median dissolved Al concentration of 3.0 µg/L. This was substantially below the discharge limit of 200 µg/L at the seawater channel licensed discharge site S001.

The median concentration at compliance sites SW9, SW10 and RR2 ranged from 1.5 to 2.7 µg/L and at the background sites the range was 0.9 to 1.3 µg/L. There has been a reduction in the median dissolved Al concentrations at sites SW9, SW10 and RR2 in recent years, partly as a result of the cessation of WWNP discharges in March 2018. WWNP operations resumed intermittently during the reporting period (mainly during April - August 2020) without noticeable increases in dissolved Al concentrations.

Dissolved Al data were affected by contamination during the collection process on several occasions during 2007-2011 resulting in falsely elevated data. These data are no longer included in the MHMP assessment.

The concentrations of total aluminium at the mixing zone boundary compliance sites SW9, SW10 and RR2 for October 2020 - March 2021 are shown in Figure 14.

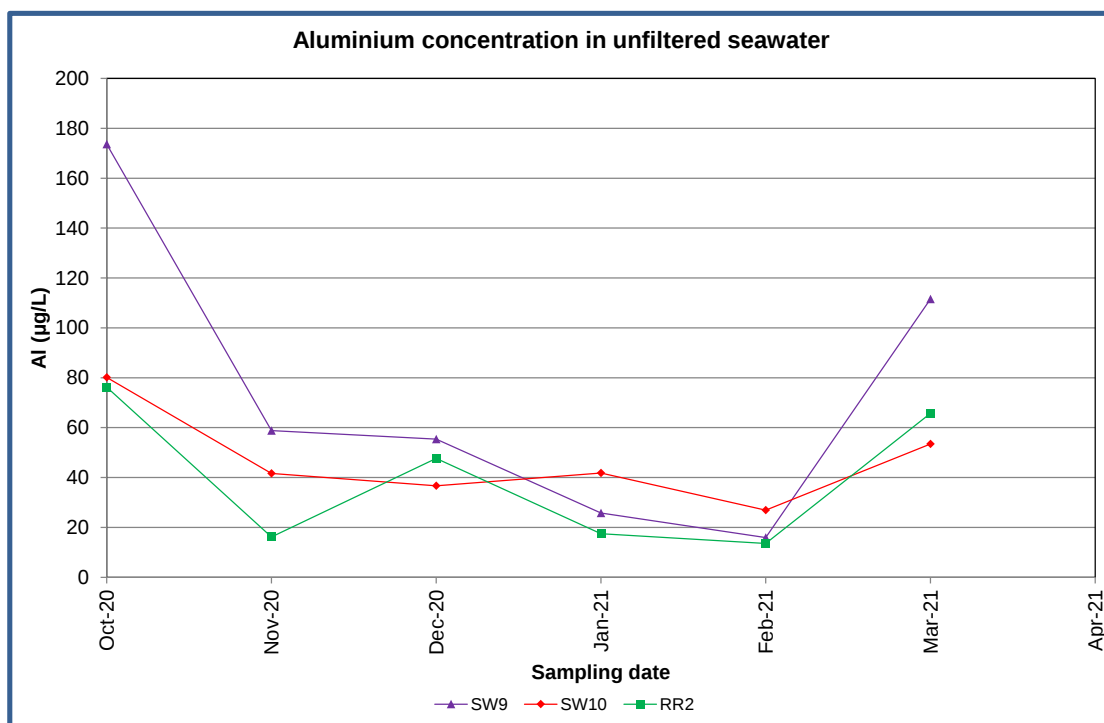


Figure 14. Total (unfiltered) aluminium variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.12 Dissolved and Total Vanadium (WDL parameter)

Variations in dissolved vanadium (V) at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2004-21 are shown in Figure 15. No exceedance of the dissolved V Trigger Value (100 µg/L) was recorded during 2020-21.

During April 2020 to March 2021 site SW12 at the refinery outfall channel had a median dissolved V concentration of 2.6 µg/L. This was substantially below the discharge limit of 2,000 µg/L at the seawater channel licensed discharge site S001. The median concentration at compliance sites SW9, SW10 and RR2 ranged from 2.3 to 2.5 µg/L and at the background sites the range was 2.0 to 2.3 µg/L.

From late 2012 dissolved V concentrations increased in large parts of Southern Melville Bay. Figure 16 shows dissolved V concentrations at site SW12 (refinery outfall channel), the mixing zone compliance sites SW9, SW10 and RR2 and the background monitoring sites (80th percentile of sites SW1, SW3, SW4 and SW7) during 2004-21. The increase in dissolved V at all sites followed commissioning of the WWNP in September 2012. After the WWNP was taken offline in March 2018, a rapid decrease in V concentrations in the Inner Harbour and Southern Melville Bay to near-background levels were recorded within a month. WWNP operations resumed intermittently during the reporting period (mainly during April - August 2020). Small increases in the dissolved V concentrations at

compliance sites SW9 and SW10 (up to 8.80 µg/L but well below the trigger Value of 100 µg/L) were recorded in April and May 2020.

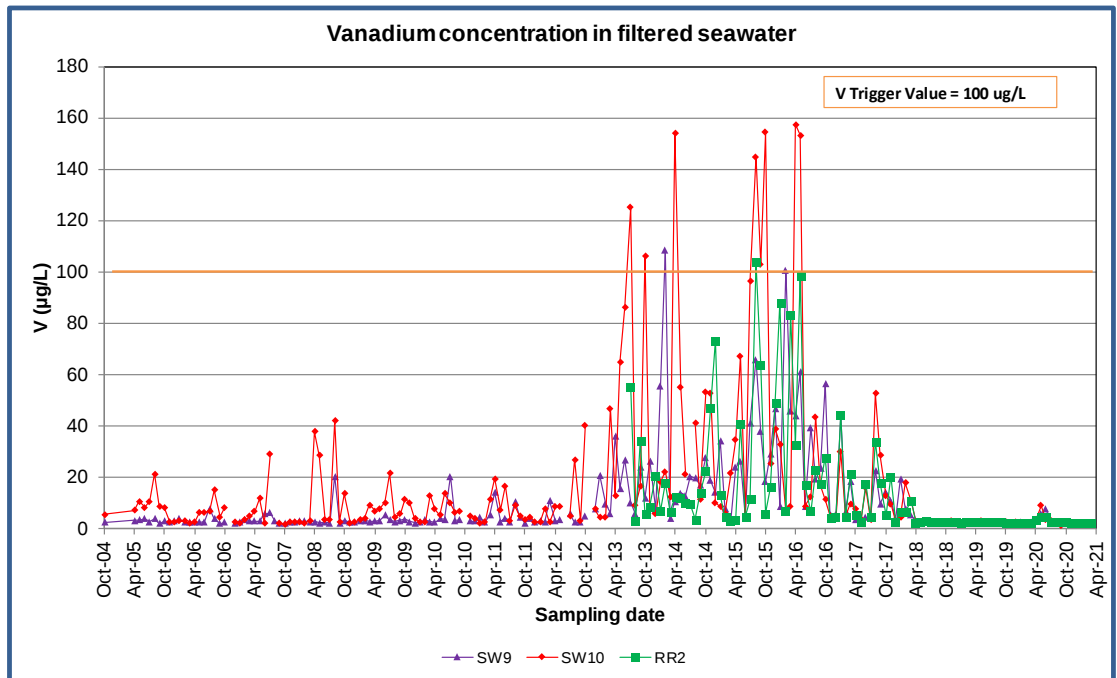


Figure 15. Dissolved vanadium variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

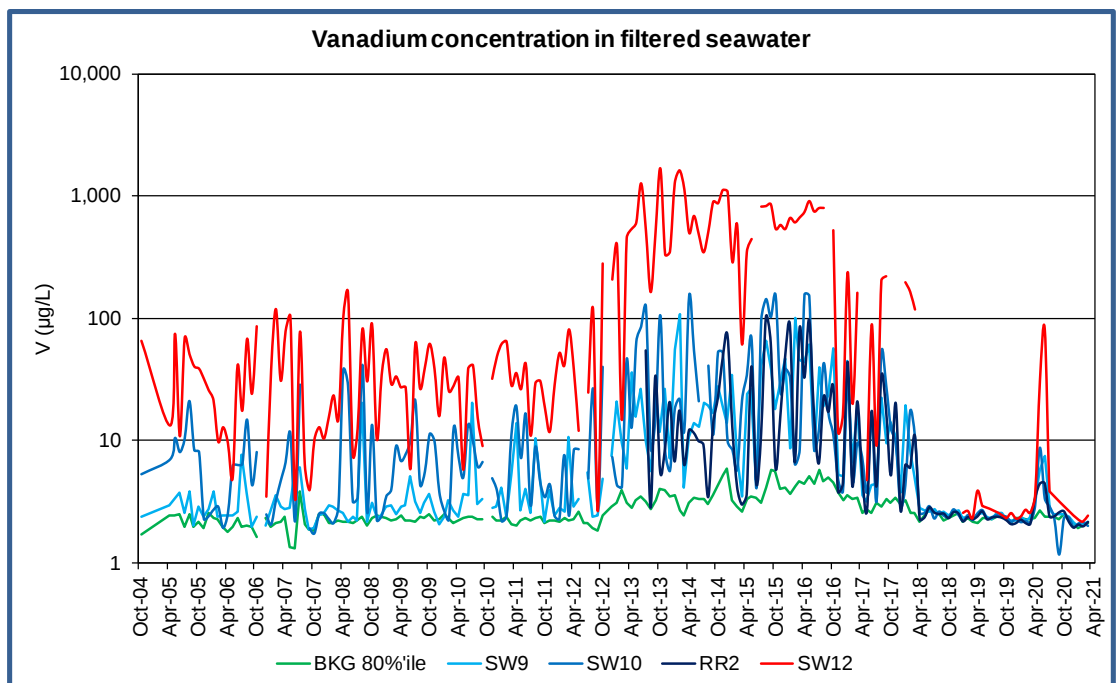


Figure 16. Dissolved vanadium concentrations at background sites (80th percentile of sites SW1, SW3, SW4 and SW7), compliance sites SW9, SW10 and RR2 and SW12 (refinery outfall channel) during 2004-2021. Note the logarithmic concentration scale.

The concentrations of total vanadium at the mixing zone boundary compliance sites SW9, SW10 and RR2 for October 2020 -March 2021 are shown in Figure 17.

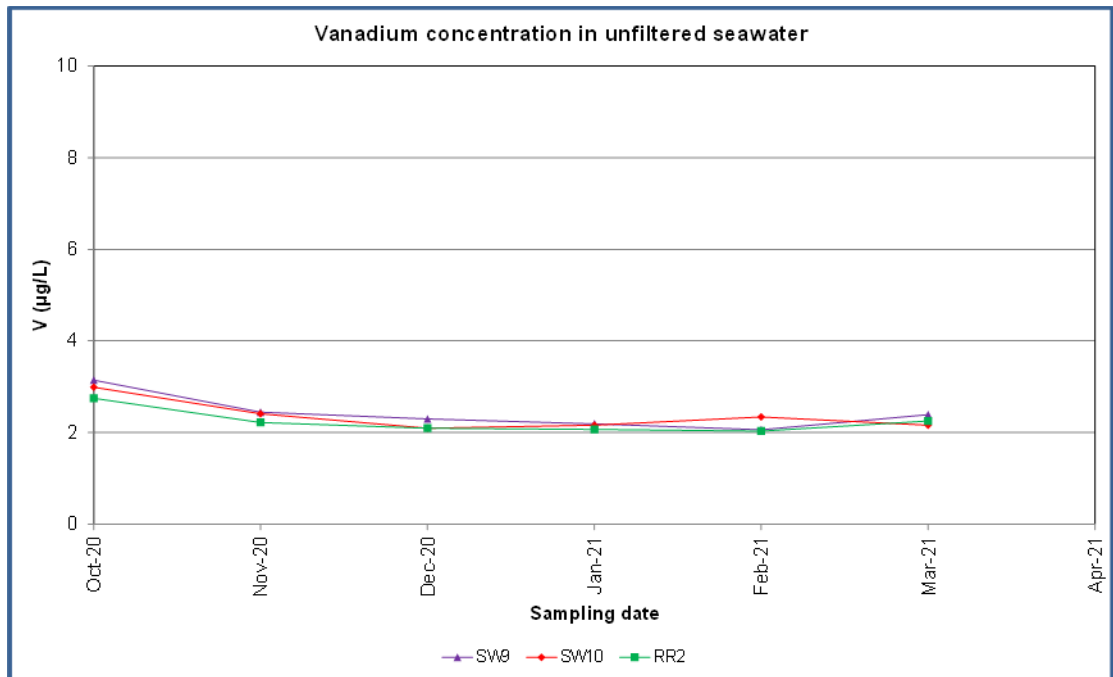


Figure 17. Total (unfiltered) vanadium variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.13 Dissolved and Total Chromium

Chromium was included in WDL171-10 as part of the Compliance Point Monitoring Program. Variations in dissolved chromium (Cr) at the mixing zone boundary compliance sites SW9, SW10 and RR2 for September 2020 to March 2021 are shown in Figure 18.

During September 2020 to March 2021 site SW12 at the refinery outfall channel had a median dissolved Cr concentration of 0.09 µg/L. Monitoring sites SW9, SW10 and RR2 had median dissolved Cr concentrations of 0.05 – 0.07 µg/L. The median concentrations at the background sites ranged from 0.05 – 0.09 µg/L.

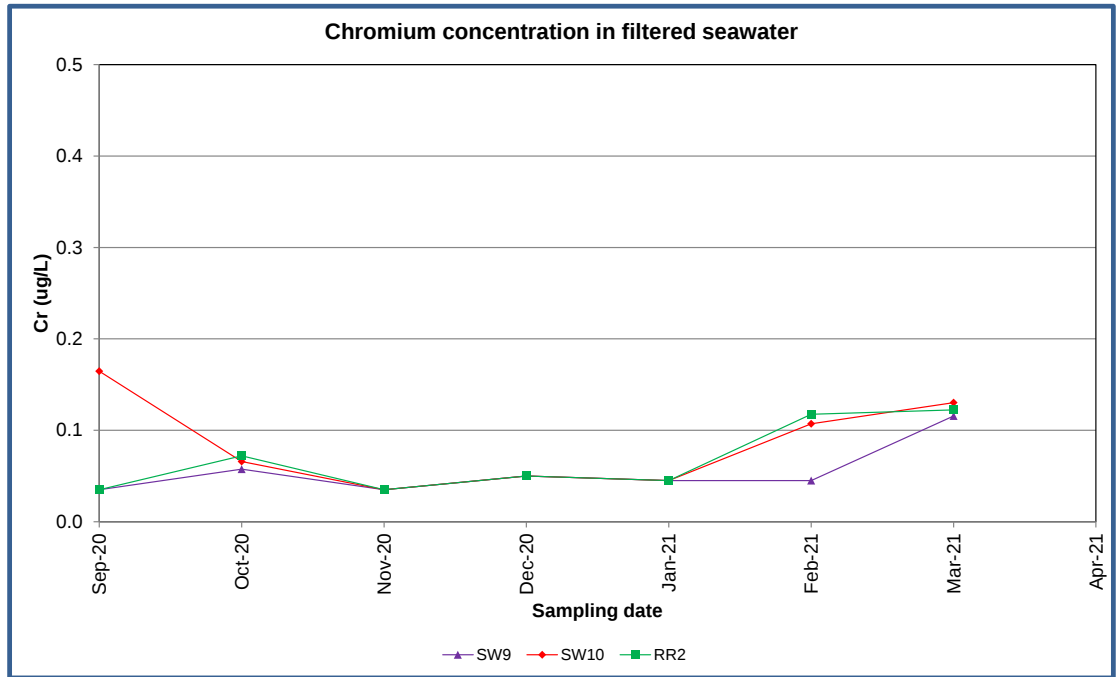


Figure 18. Dissolved chromium variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

The concentrations of total (unfiltered) chromium at the mixing zone boundary compliance sites SW9, SW10 and RR2 for October 2020 - March 2021 are shown in Figure 19.

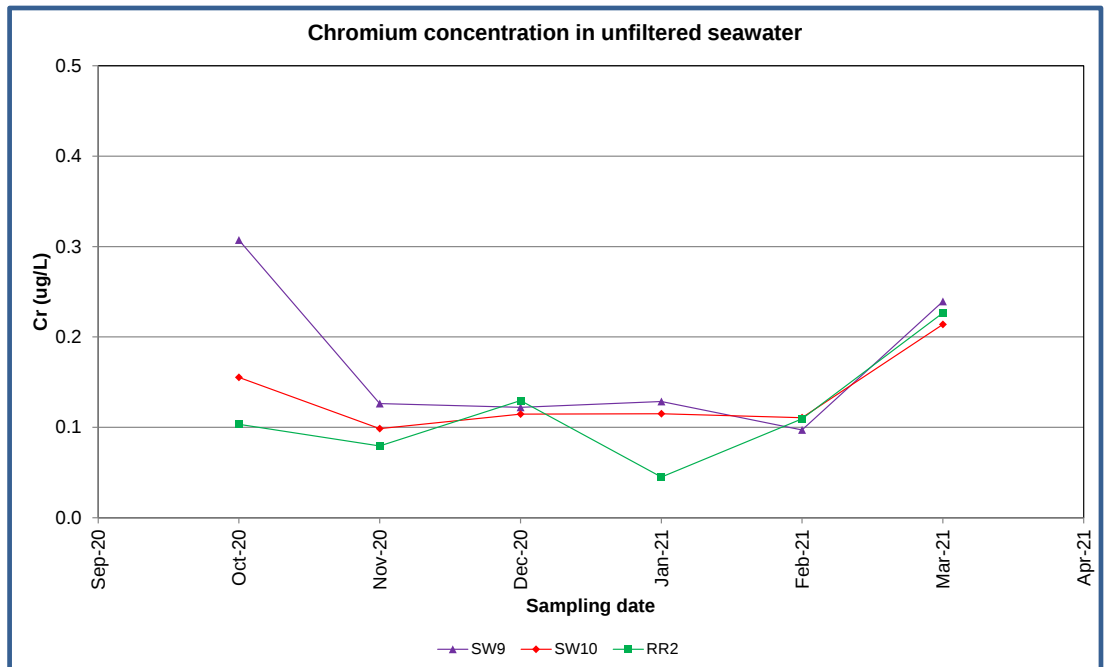


Figure 19. Total chromium variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.14 Dissolved and Total Manganese

Variations in dissolved manganese (Mn) at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2010-21 are shown in Figure 20 (Mn was not measured 2007-2008).

During April 2020 to March 2021 site SW12 at the refinery outfall channel had a median dissolved Mn of 1.1 µg/L. Compliance sites SW9, SW10 and RR2 had median dissolved Mn concentrations of 0.7 – 0.9 µg/L. The median concentrations at the background sites ranged from 0.6 – 1.0 µg/L.

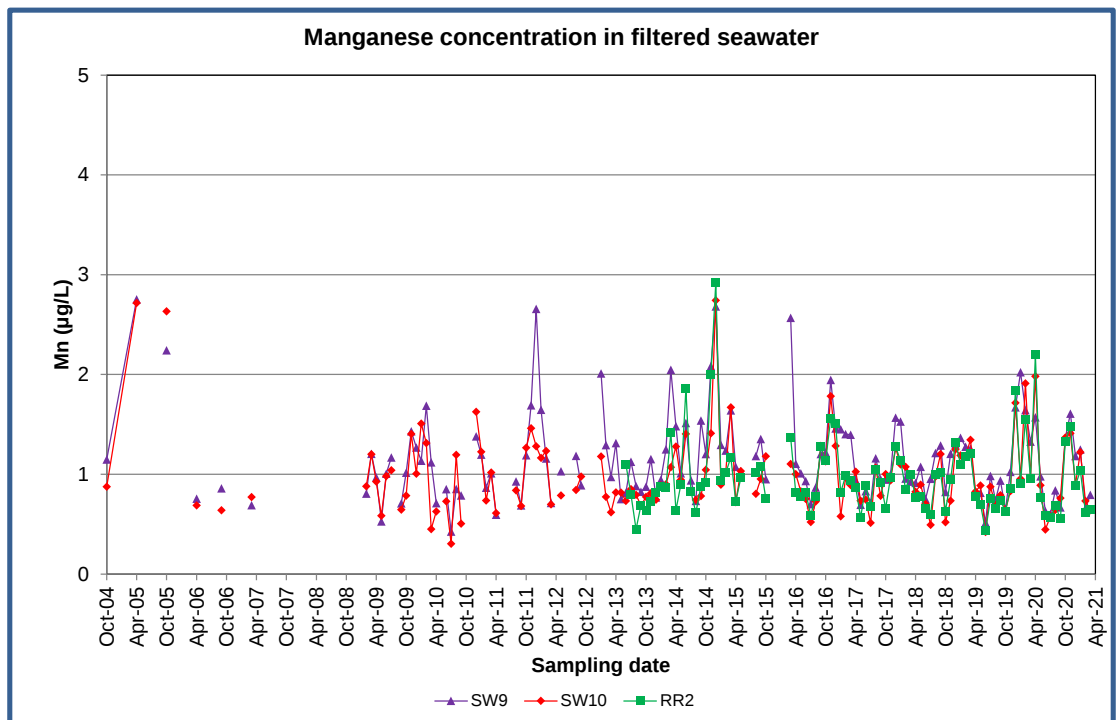


Figure 20. Dissolved manganese variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

The concentrations of total (unfiltered) manganese at the mixing zone boundary sites SW9, SW10 and RR2 for October 2020 -March 2021 are shown in Figure 21.

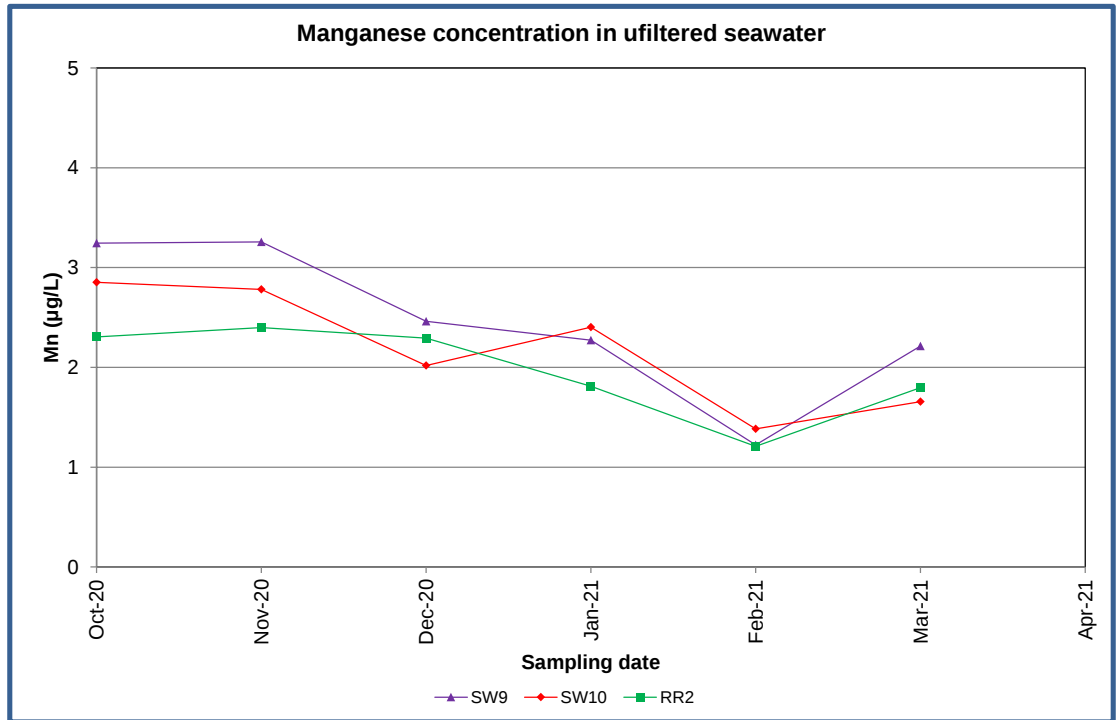


Figure 21. Total (unfiltered) manganese variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.15 Dissolved and Total Iron

Variations in dissolved iron (Fe) at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2010-21 are shown in Figure 22 (Fe was not measured prior to 2010).

During April 2020 to March 2021 site SW12 at the refinery outfall channel had a median dissolved Fe concentration of 0.6 µg/L and compliance sites SW9, SW10 and RR2 had median dissolved Fe of 0.3 µg/L. The median concentrations at the background sites were 0.4 – 0.5 µg/L.

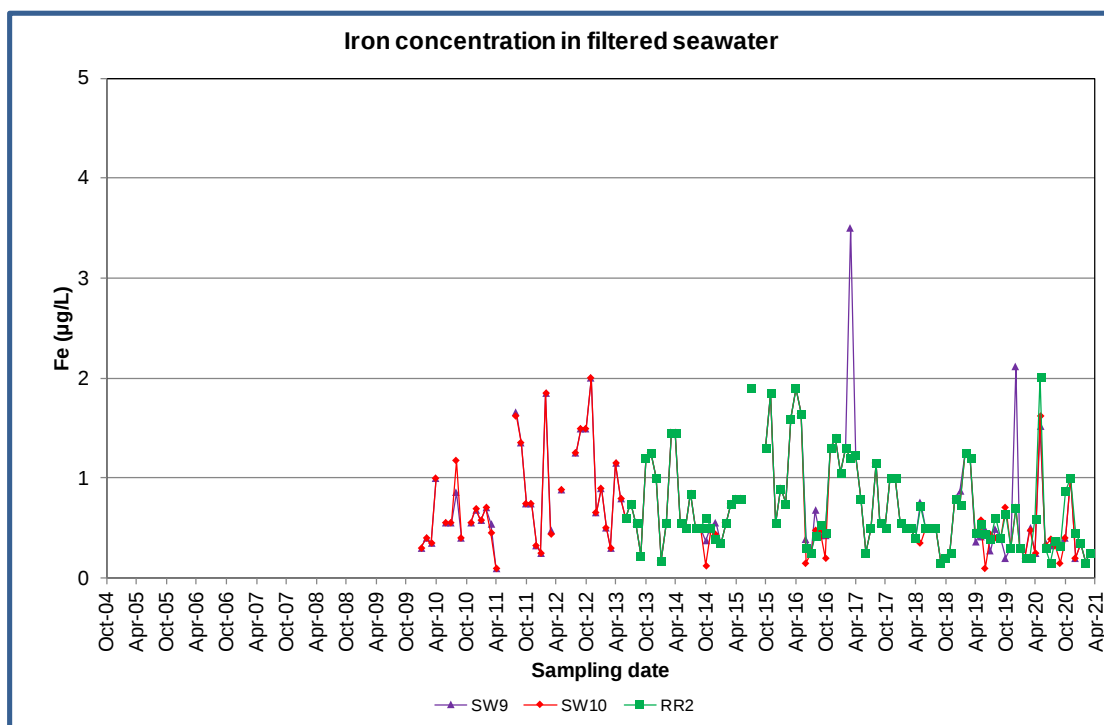


Figure 22. Dissolved iron variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

The concentrations of total (unfiltered) iron at the mixing zone boundary compliance sites SW9, SW10 and RR2 for October 2020 - March 2021 are shown in Figure 23.

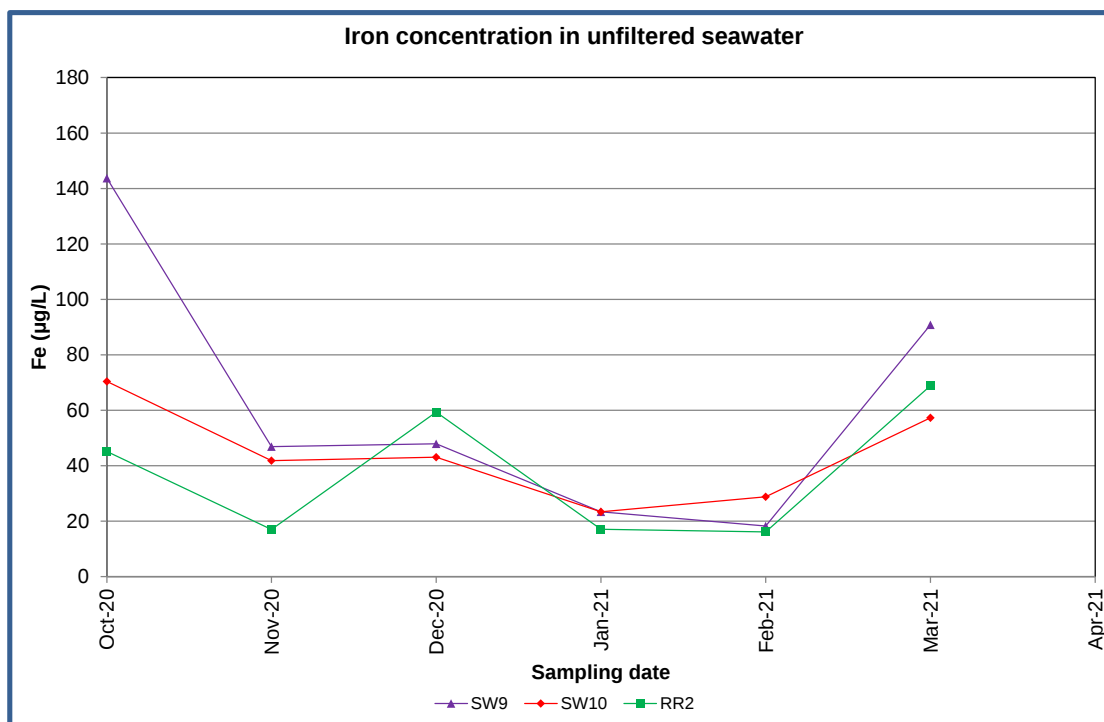


Figure 23. Total (unfiltered) iron variations at the mixing zone boundary sites SW9, SW10 and RR2.

4.2.16 Dissolved and Total Copper (WDL parameter)

Variations in dissolved copper (Cu) at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2004-21 are shown in Figure 24. No exceedances of the dissolved Cu trigger value (1.3 µg/L) were recorded.

During April 2020 to March 2021 site SW12 at the refinery outfall channel had a median dissolved Cu concentration of 0.2 µg/L. This was substantially below the discharge trigger value of 8 µg/L at the seawater channel licensed discharge site S001. The median concentrations were 0.2 µg/L at monitoring sites SW9, SW10 and RR2 and 0.2 – 0.3 µg/L at the background sites.

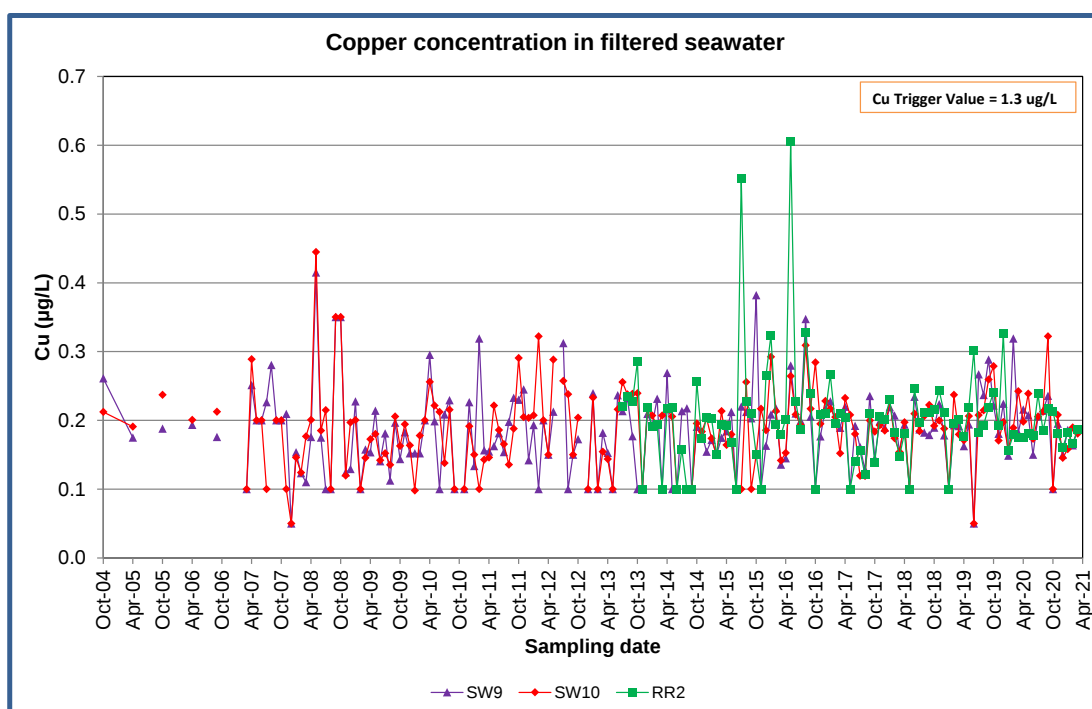


Figure 24. Dissolved copper variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

The concentrations of total (unfiltered) copper at the mixing zone boundary compliance sites SW9, SW10 and RR2 for October 2020 -March 2021 are shown in Figure 25.

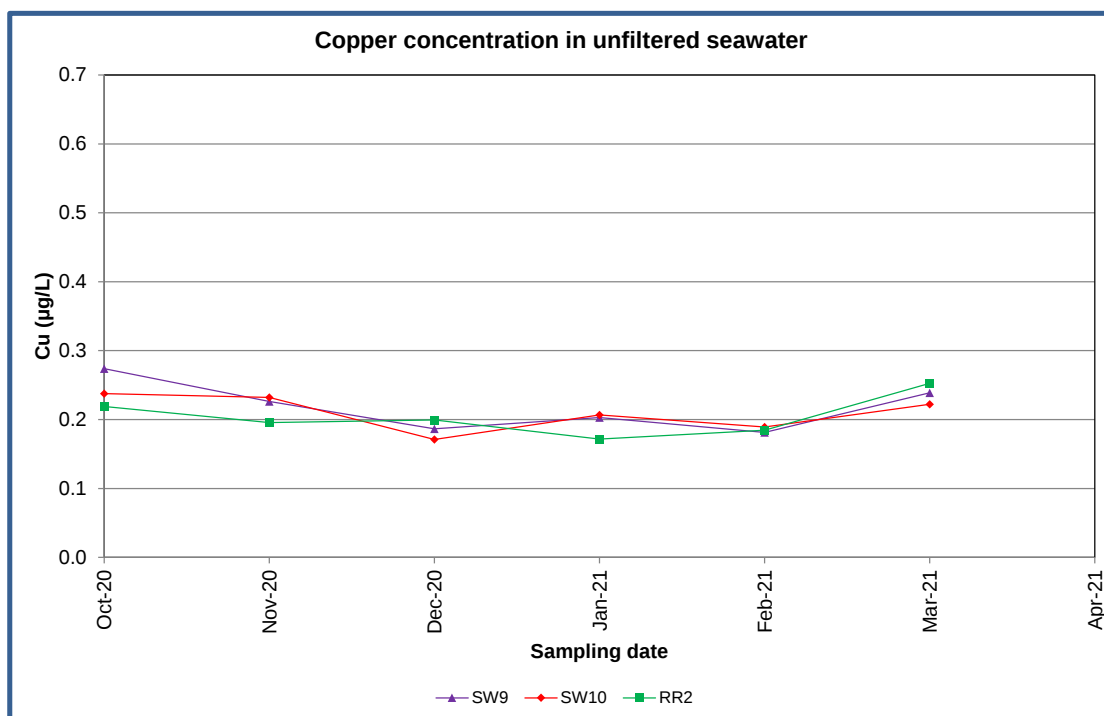


Figure 25. Total (unfiltered) copper variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.17 Dissolved and Total Zinc (WDL parameter)

Variations in dissolved zinc (Zn) at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2004-21 are shown in Figure 26. No exceedances of the dissolved Zn trigger value (15 µg/L) were recorded.

During April 2020 to March 2021 site SW12 at the refinery outfall channel had a median dissolved Zn concentration of 0.4 µg/L. The median concentration at compliance sites SW9, SW10 and RR2 was 0.3 µg/L similar to the background sites at 0.3 – 0.4 µg/L.

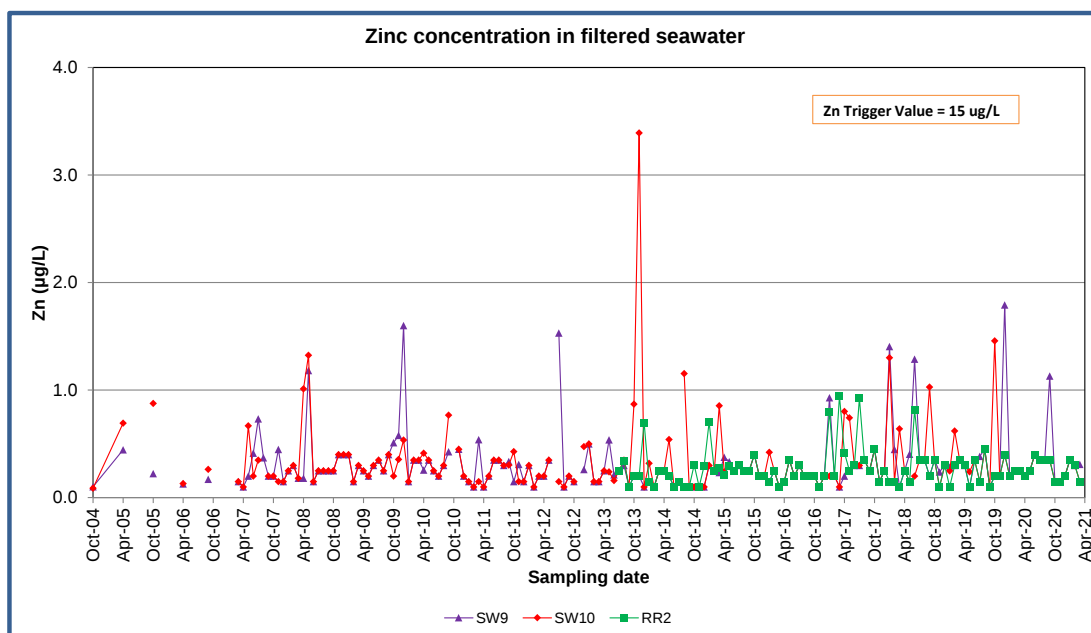


Figure 26. Dissolved zinc variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

The concentrations of total (unfiltered) zinc at the mixing zone boundary compliance sites SW9, SW10 and RR2 for October 2020 -March 2021 are shown in Figure 27.

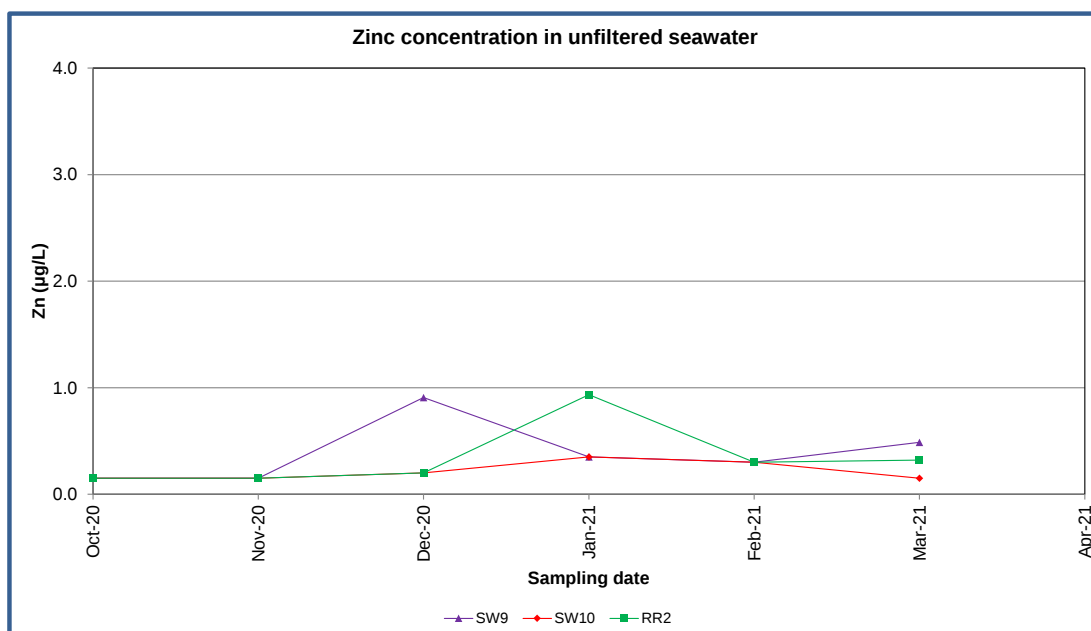


Figure 27. Total (unfiltered) zinc variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.18 Dissolved and Total Gallium (WDL parameter)

Variations in dissolved gallium (Ga) at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2004-21 are shown in Figure 28. No exceedances of the dissolved Ga trigger values (800 µg/L) were recorded.

During April 2020 to March 2021 site SW12 at the refinery outfall channel had a median dissolved Ga concentration of 0.06 µg/L. The median concentrations at compliance sites SW9, SW10 and RR2 ranged from 0.02 to 0.04 µg/L while the median concentration at background sites ranged from 0.01 to 0.02 µg/L.

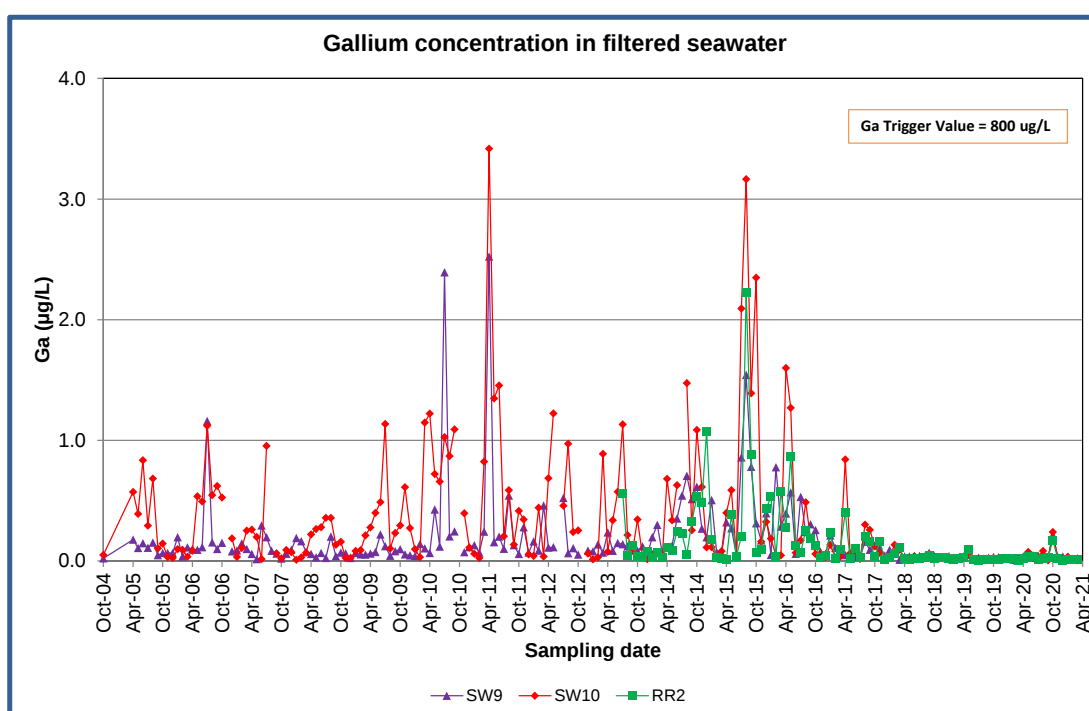


Figure 28. Dissolved gallium variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

The concentrations of total (unfiltered) gallium at the mixing zone boundary compliance sites SW9, SW10 and RR2 for October 2020 - March 2021 are shown in Figure 29.

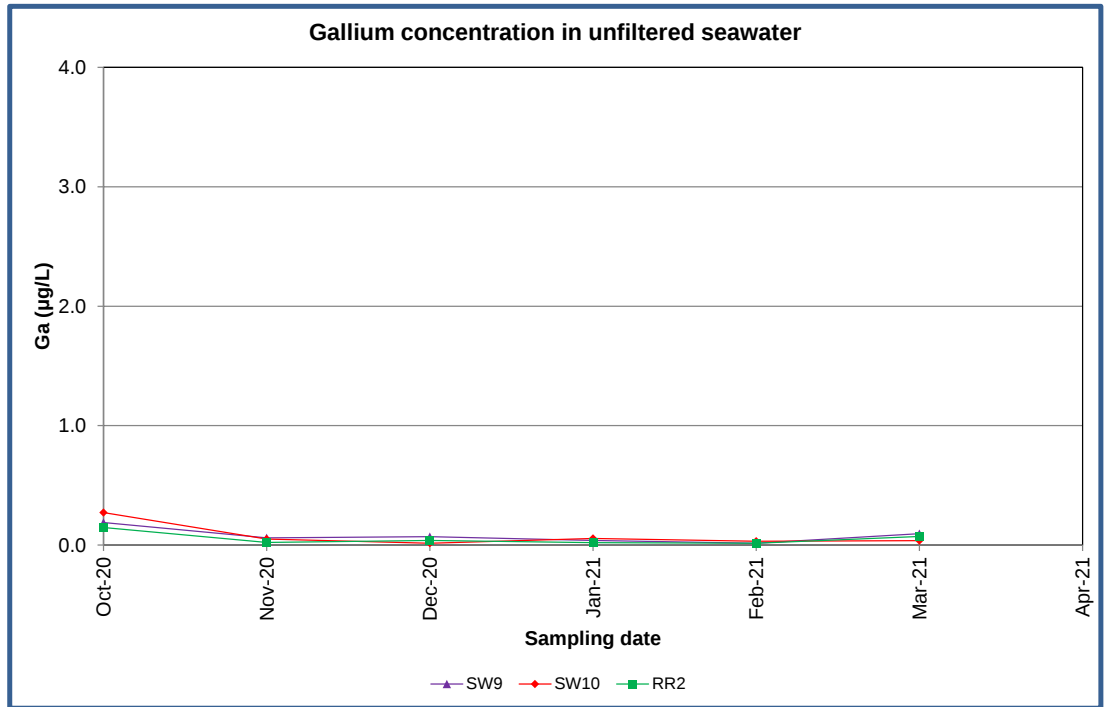


Figure 29. Total (unfiltered) gallium variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.19 Dissolved and Total Arsenic (WDL parameter)

Variations in dissolved arsenic (As) at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2004-21 are shown in Figure 30. No exceedances of the dissolved As trigger values (20.0 µg/L) were recorded.

During April 2020 to March 2021 site SW12 at the refinery outfall channel had a median dissolved As concentration of 1.8 µg/L. This was substantially below the discharge limit of 20 µg/L at the seawater channel licensed discharge site S001. The median concentrations at compliance sites SW9, SW10 and RR2 were 1.6 - 1.7 µg/L while the median concentration at background sites ranged from 1.3 to 1.5 µg/L.

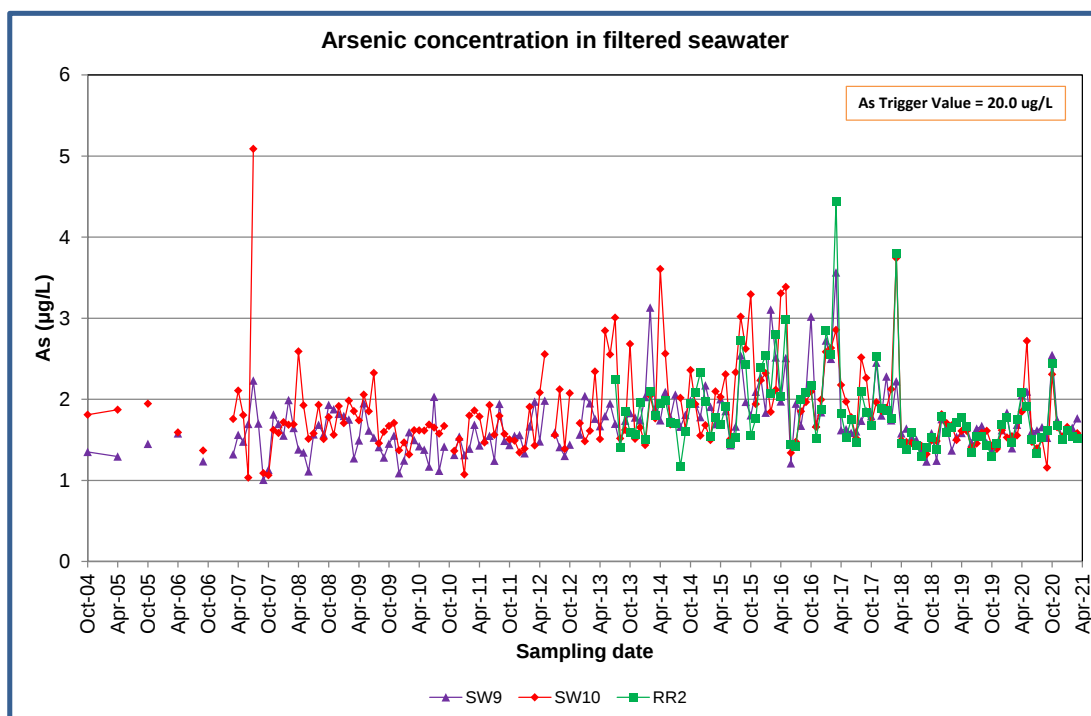


Figure 30. Dissolved arsenic variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

The concentrations of total (unfiltered) arsenic at the mixing zone boundary compliance sites SW9, SW10 and RR2 for October 2020 -March 2021 are shown in Figure 31.

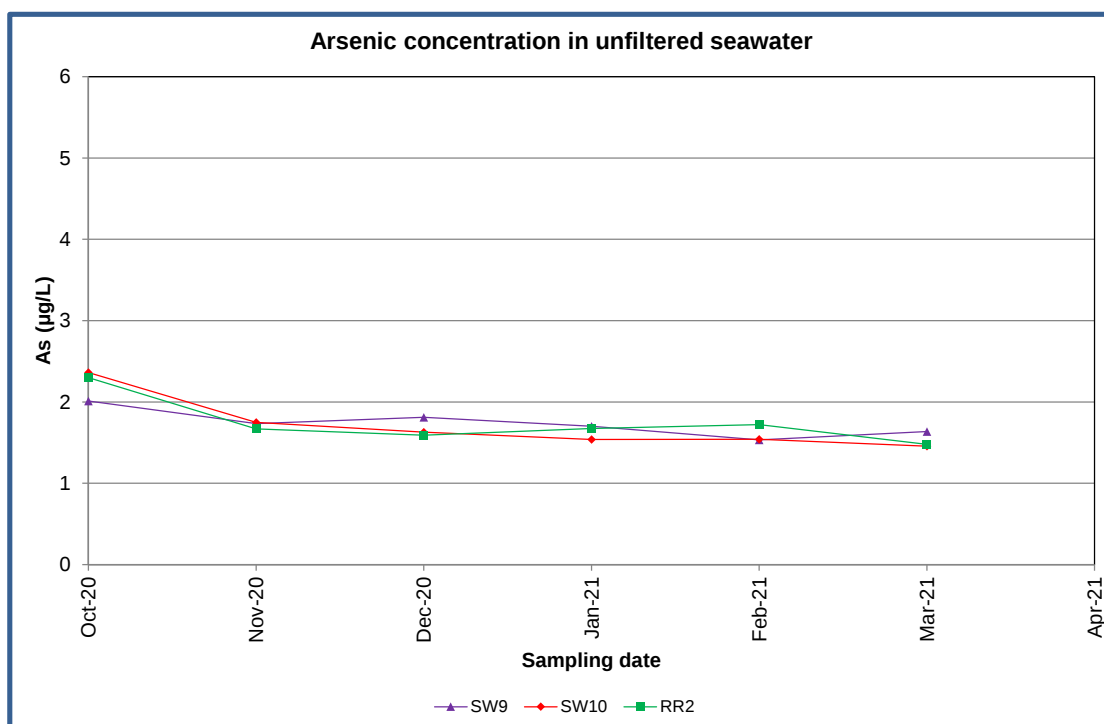


Figure 31. Total (unfiltered) arsenic variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.20 Dissolved and Total Molybdenum (WDL parameter)

Variations in dissolved molybdenum (Mo) at the mixing zone boundary sites SW9, SW10 and RR2 for 2004-21 are shown in Figure 32. No exceedances of the dissolved Mo trigger values (3880 µg/L) were recorded.

During April 2020 to March 2021 site SW12 at the refinery outfall channel had a median dissolved Mo concentration of 10.9 µg/L. The median concentrations at compliance sites SW9, SW10 and RR2 were 10.6 to 10.8 µg/ and at background sites ranged from 10.3 to 10.7 µg/L.

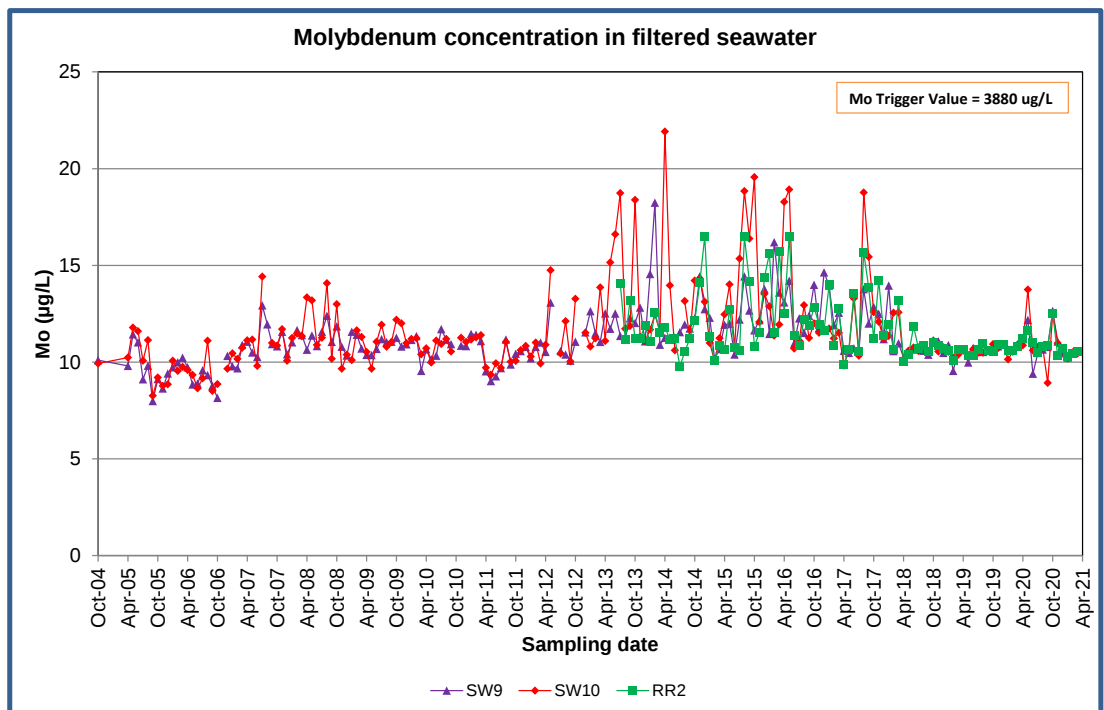


Figure 32. Dissolved molybdenum variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

The concentrations of total (unfiltered) molybdenum at the mixing zone boundary compliance sites SW9, SW10 and RR2 for October 2020 -March 2021 are shown in Figure 33.

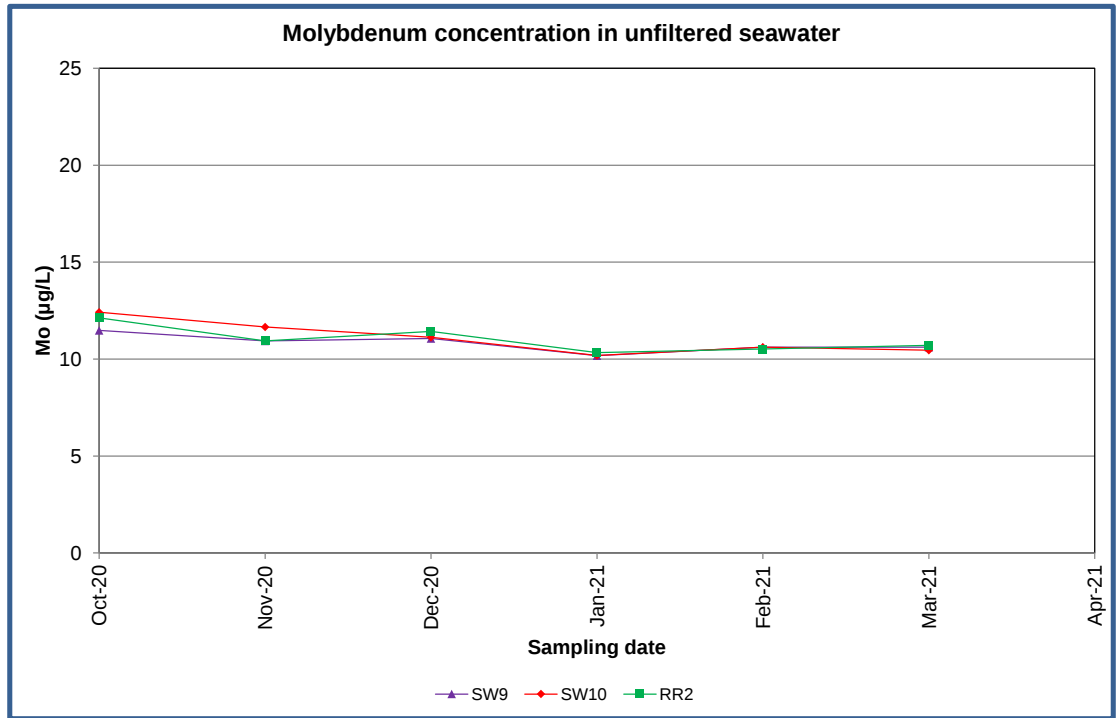


Figure 33. Total (unfiltered) molybdenum variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.21 Dissolved and Total Uranium

Monitoring of U commenced in April 2012. Variations in dissolved uranium (U) at the mixing zone boundary compliance sites SW9, SW10 and RR2 for 2004-21 are shown in Figure 34.

There has been no substantial difference in U concentrations between the monitoring sites with median concentrations of 3.2µg/L during 2020-21.

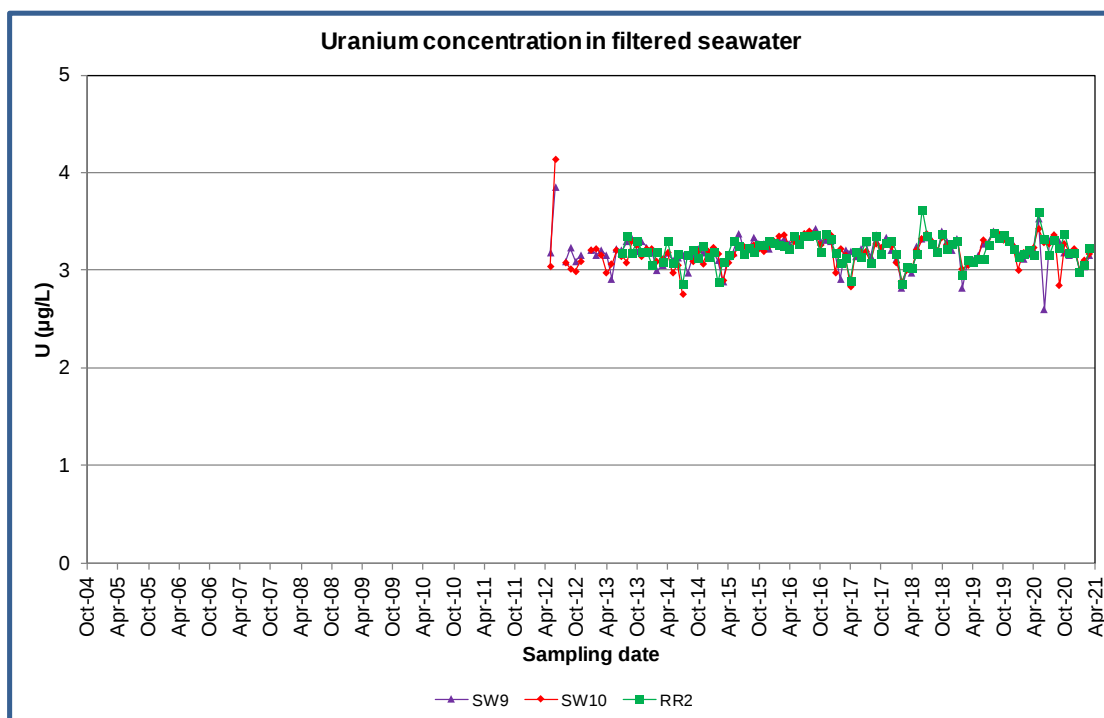


Figure 34. Dissolved uranium variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

The concentrations of total (unfiltered) uranium at the mixing zone boundary compliance sites SW9, SW10 and RR2 for October 2020 -March 2021 are shown in Figure 35.

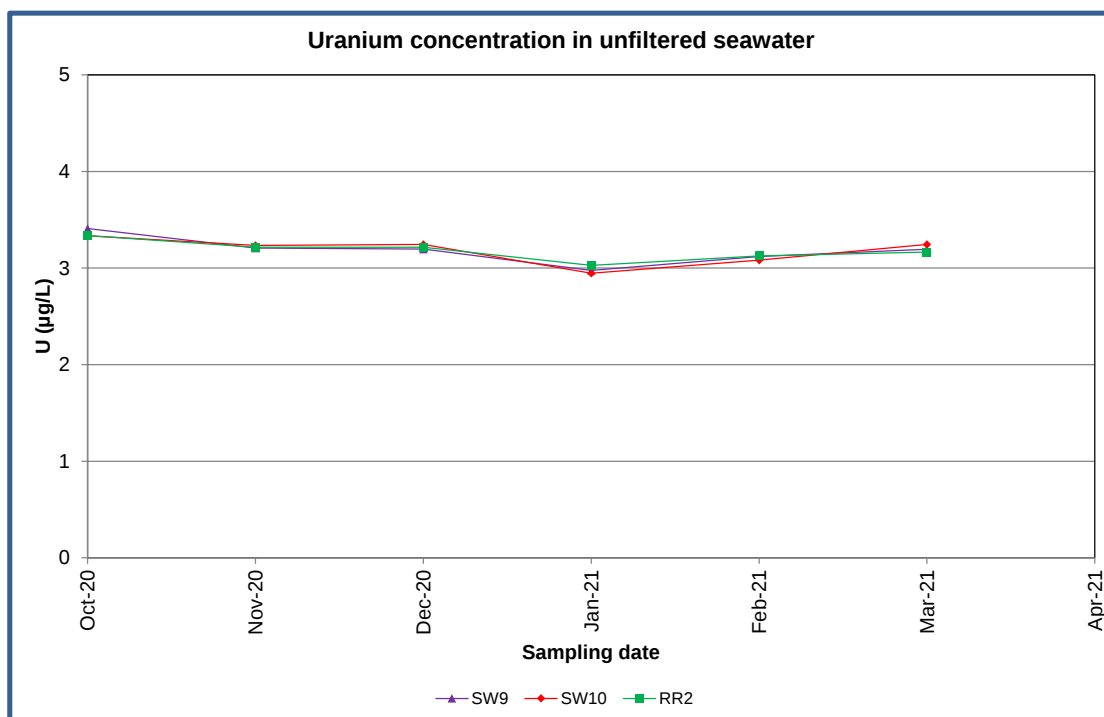


Figure 35. Total uranium variations at the mixing zone boundary compliance sites SW9, SW10 and RR2.

4.2.22 Summary of Trigger Value exceedances

There were no recorded exceedances of WDL171-10 trigger values at the mixing zone boundary compliance sites in Gove Inner Harbour during April 2020 – March 2021.

On 29/6/20 a spike in As concentrations (32 µg/L) occurred in wastewater discharged to the Inner Harbour (environmental incident no. 1000552308). Subsequent MHMP sampling on 24/7/20 showed that As concentrations in Inner Gove Harbour was at normal levels.

4.3 Crawford's Creek (SW5) and Drimmie Arm (SW6)

4.3.1. Temperature

Variations in temperature at information sites SW5 and SW6 for 2004-21 are shown in Figure 36. There are similar seasonal effects on temperature in both areas and at background sites.

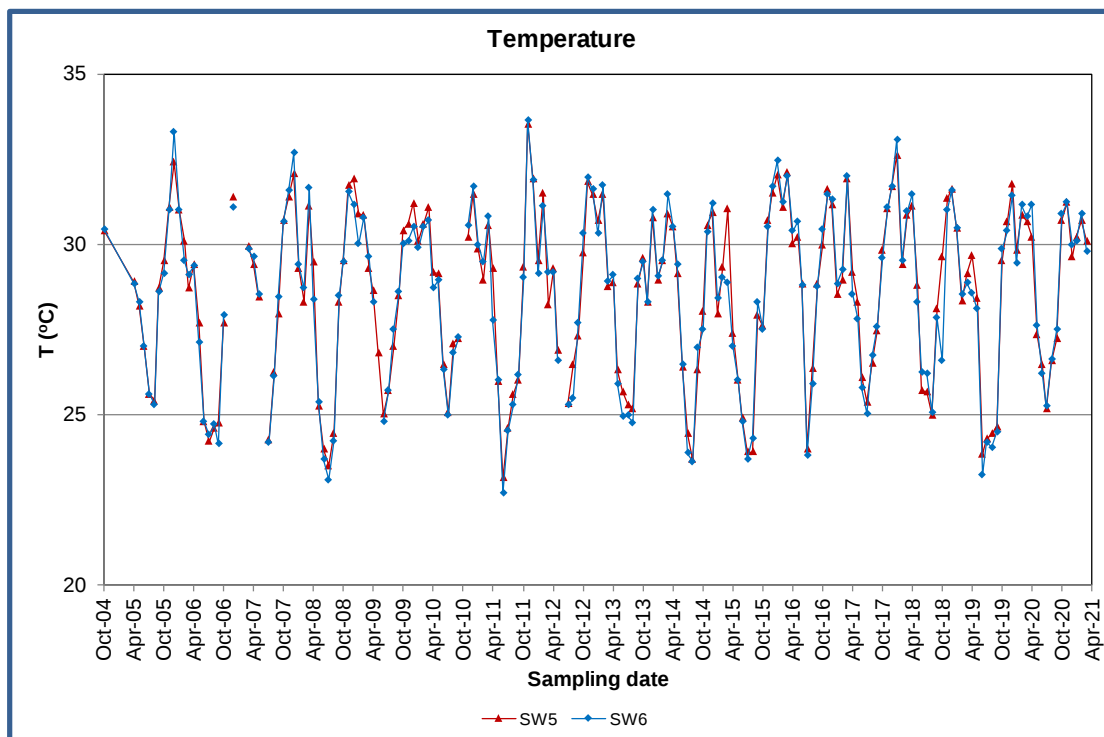


Figure 36. Temperature variations at Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.3.2. Electrical Conductivity

Variations in EC at information sites SW5 and SW6 for 2004-21 are shown in Figure 37. There are similar seasonal effects on electrical conductivity in both areas and at background sites.

During 2012-15 erroneous EC data were collected on some occasions due to incorrect instrument calibration. These data are no longer included in the assessment.

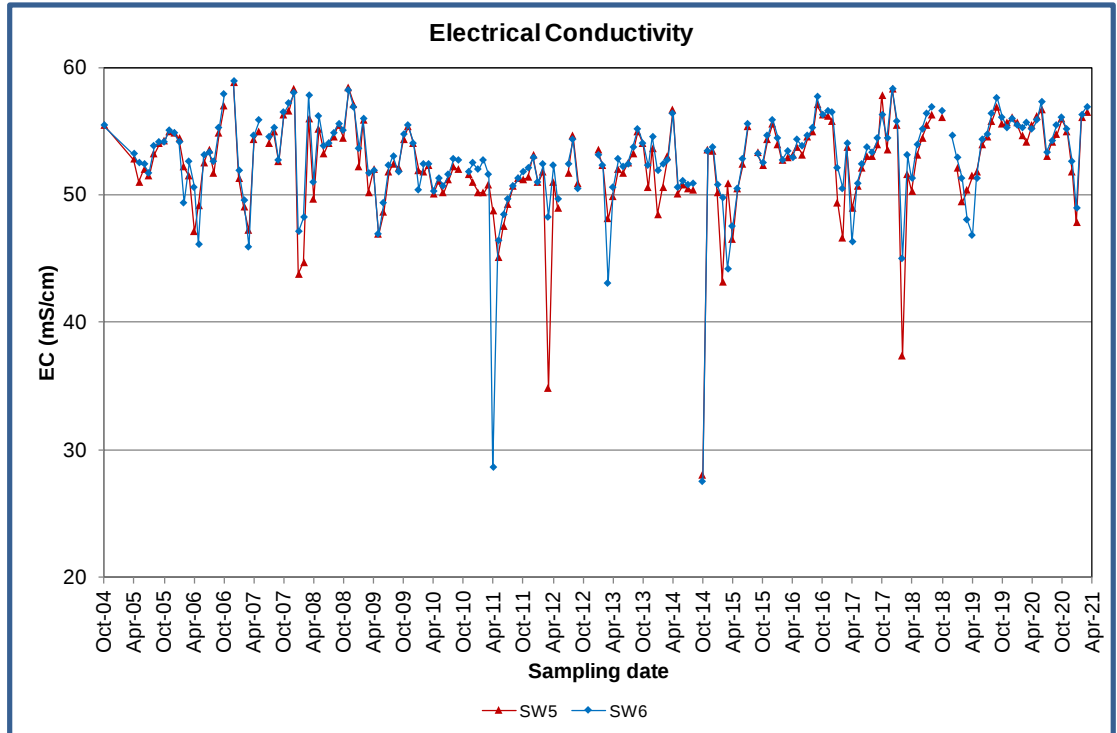


Figure 37. Electrical conductivity variations at Crawford's Creek (SW5) and Drimmie Arm (SW6). Data gaps indicate the removal of erroneous data.

4.3.3. pH

Variations in pH at information sites SW5 and SW6 for 2004-21 shown in Figure 38. The median annual pH values at the two sites were similar to the median range for background sites (pH = 7.9 to 8.0).

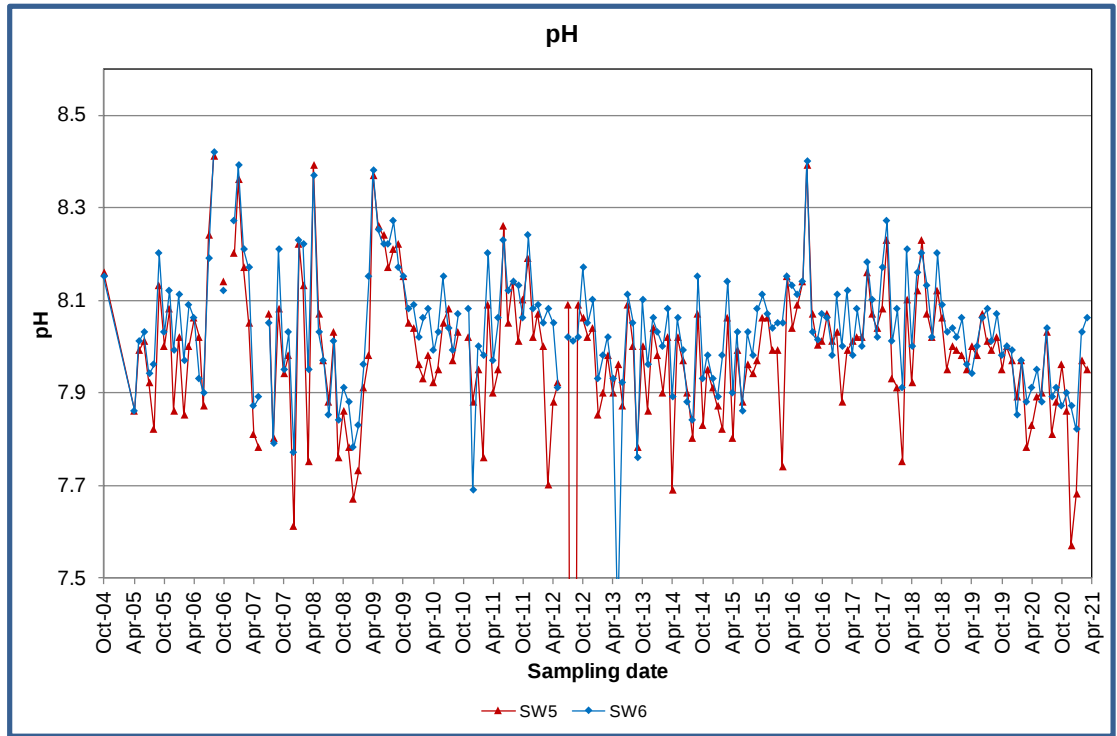


Figure 38. pH variations at Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.3.4 Dissolved Oxygen

Variations in Dissolved Oxygen (DO) at information sites SW5 and SW6 for 2004-21 are shown in Figure 39. The range of values in both areas were similar to the range obtained for background sites during the majority of the reporting period but were lower than usual at site SW5 in March and April 2021.

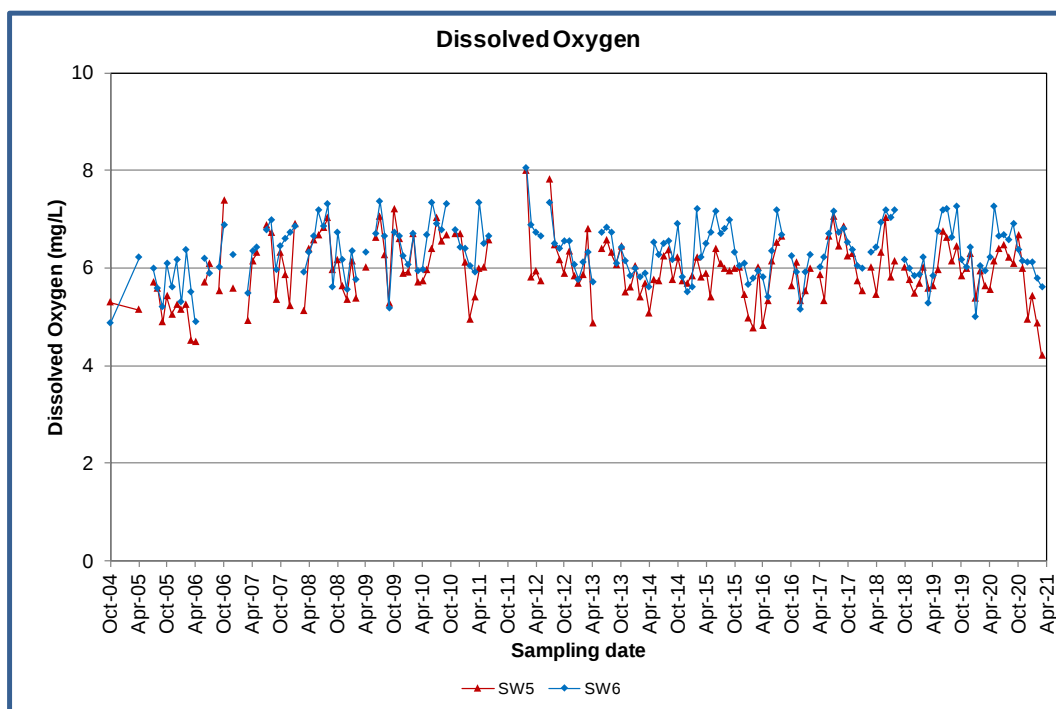


Figure 39. Dissolved oxygen variations at Crawford's Creek (SW5) and Drimmie Arm (SW6). Data gaps indicate the removal of erroneous data.

4.3.5 Turbidity

Variations in Turbidity at information sites SW5 and SW6 for 2004-21 are shown in Figure 40.

Turbidity at sites SW5 and SW6 are occasionally elevated due to resuspension of sediment by tidal flow and/or wave action at these shallow sites (water depth of 1-2 m). The 2020-21 median turbidity at SW5 was 4.7 NTU and at SW6 it was 6.4 NTU. In comparison, the 2020-21 median turbidity at the background sites ranged from 0.6 to 2.4 NTU.

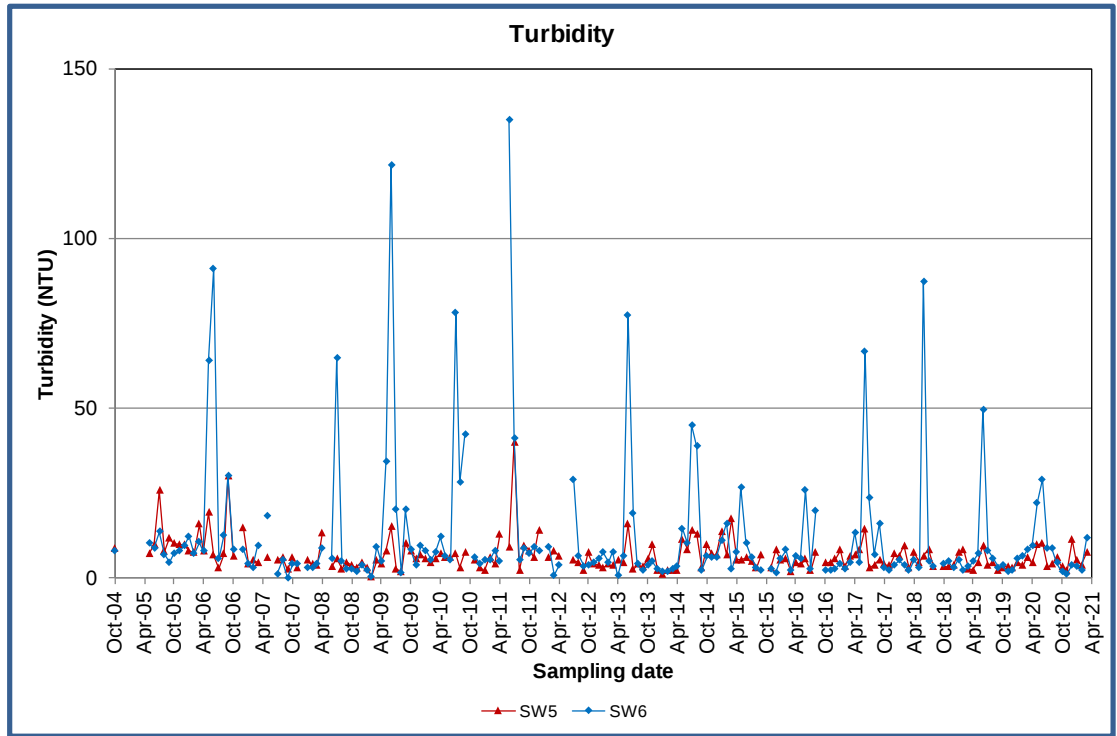


Figure 40. Turbidity variations at Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.3.6 Total Suspended Solids

Variations in Total Suspended Solids (TSS) at information sites SW5 and SW6 for 2004-21 are shown in Figure 41.

Similar to turbidity, TSS at sites SW5 and SW6 are occasionally elevated due to resuspension of sediment by tidal flow and/or wave action at this shallow site (water depth of 1-2 m).

Erroneous TSS concentrations were recorded at several sampling sites in March-August 2012 due to laboratory error. These data are no longer included in the MHMP assessment.

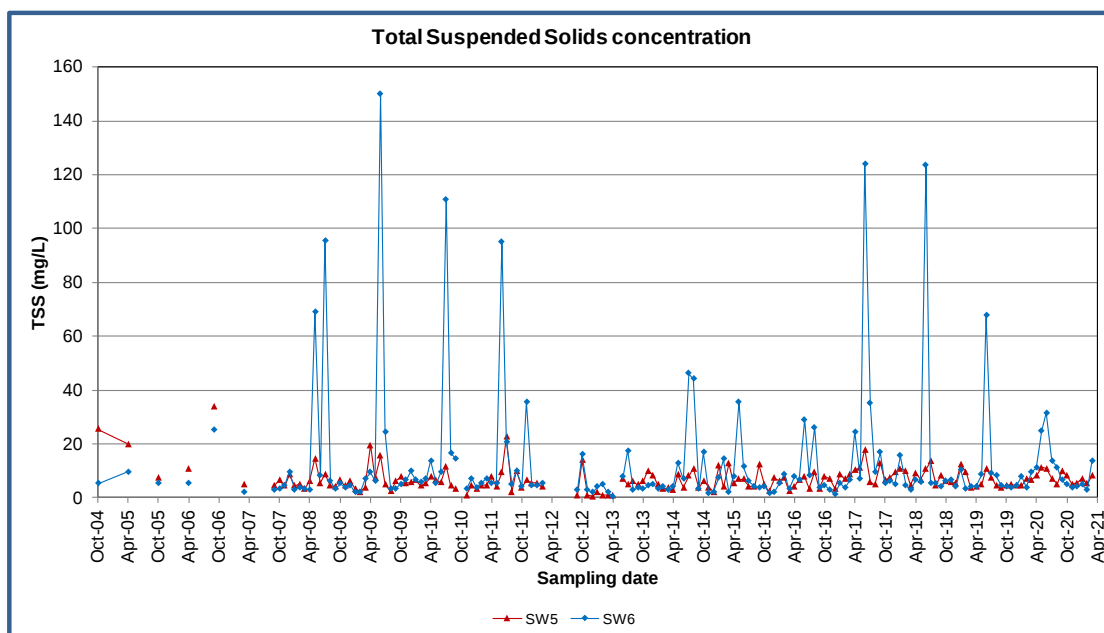


Figure 41. Total Suspended Solids variations at Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.3.7 Acid neutralising capacity

Variations in Acid Neutralising Capacity (ANC) at information sites SW5 and SW6 for 2004-21 are shown in Figure 42. The 2020-21 median ANC at SW5 was 120 mg/kg CaCO_3 and at SW6 it was 123 mg/kg CaCO_3 . In comparison, the 2020-21 median ANC at the background sites was 120 mg/kg CaCO_3 .

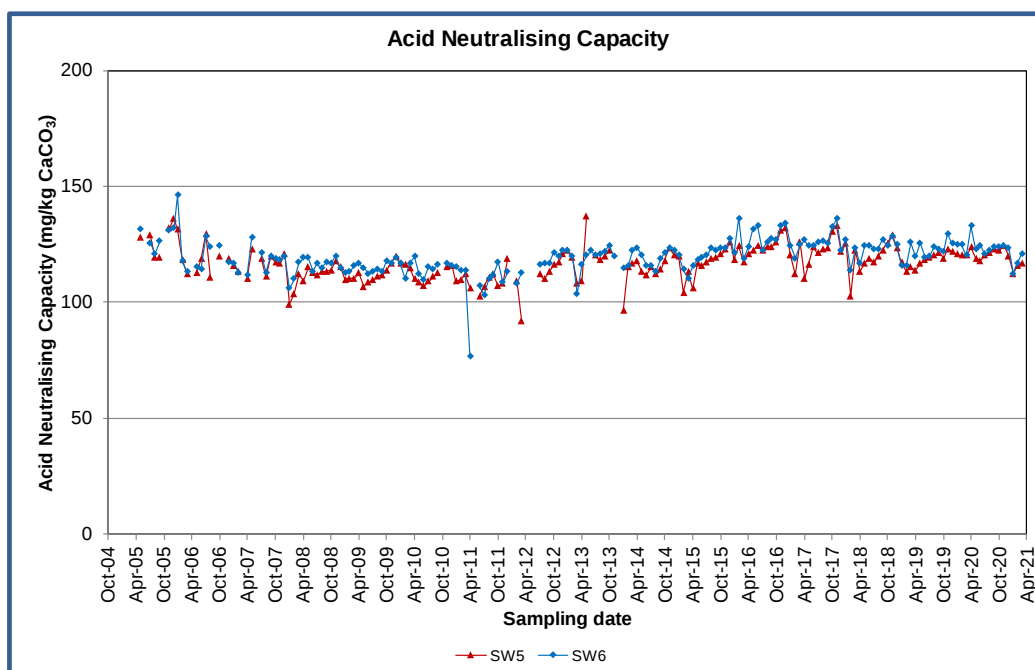


Figure 42. Acid Neutralising Capacity variations at Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.3.8 Chlorophyll-a

Variations in Chlorophyll-a at information sites SW5 and SW6 for 2004-21 are shown in Figure 43.

During 2020-21 the annual median Chlorophyll-a concentrations at sites SW5 and SW6 (1.3 µg/L and 1.2 µg/L, respectively) were slightly elevated compared to the background sites (0.6 – 1.0 µg/L).

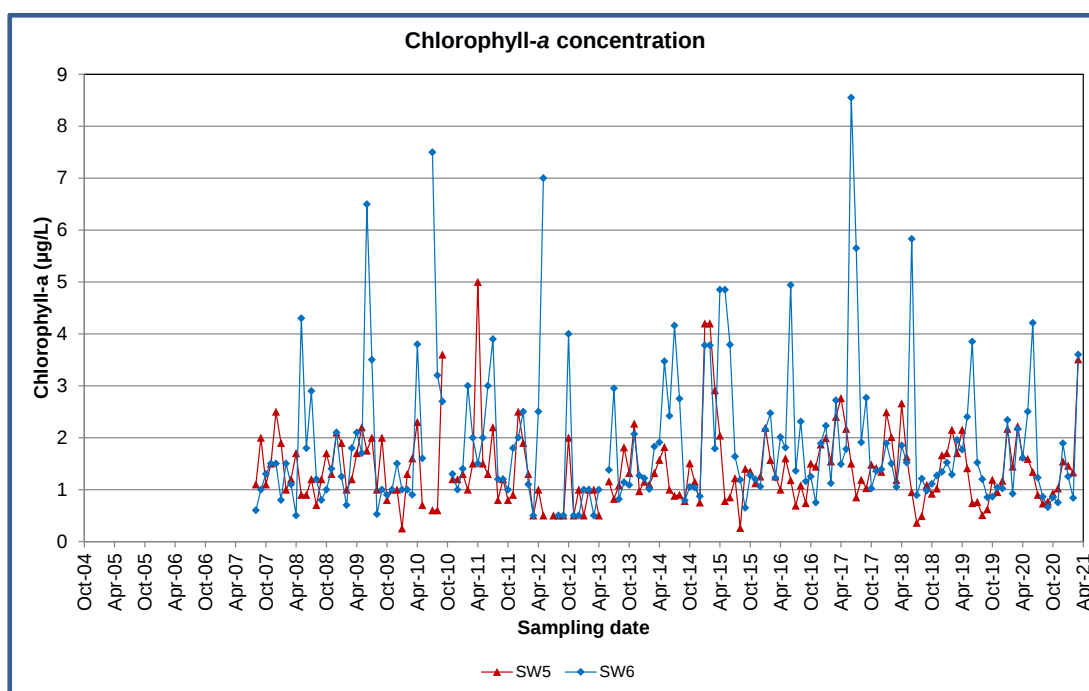


Figure 43. Chlorophyll-a variations at Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.3.9 Total Dissolved Nitrogen

Variations in Total Dissolved Nitrogen (TDN) at information sites SW5 and SW6 for 2004-21 are shown in Figure 44.

The median TDN concentrations at sites SW5 (130 µg/L) and SW6 (120 µg/L) were within the range of median values (110 - 150 µg/L) at background sites.

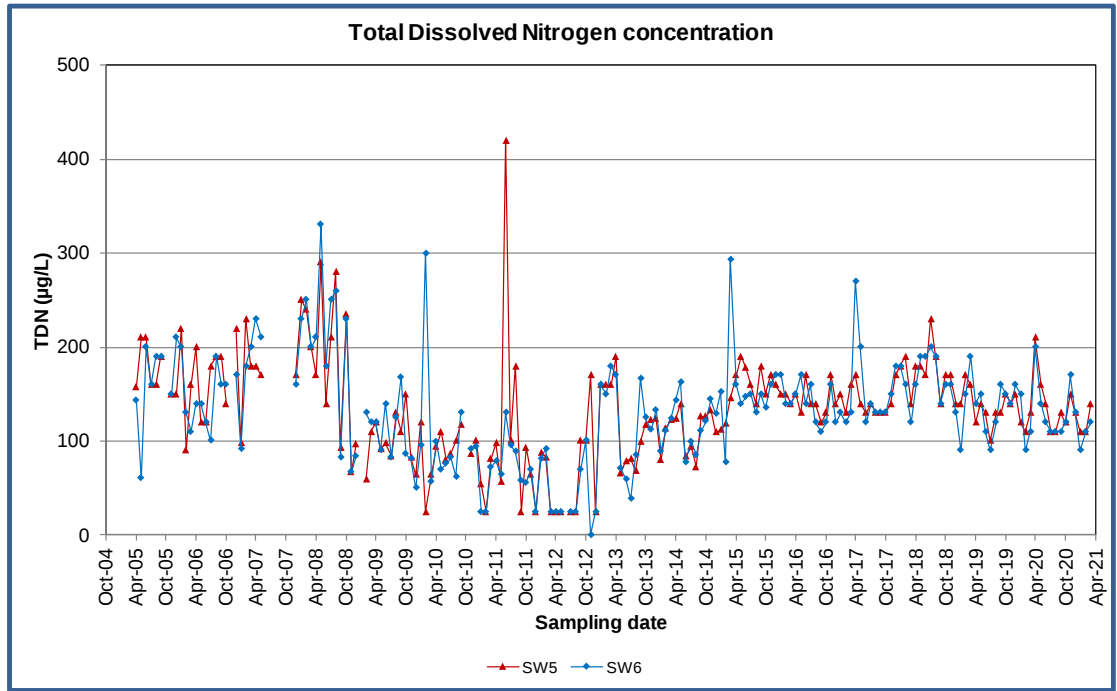


Figure 44. Total Dissolved Nitrogen variations Crawford's Creek (SW5) and Drimmie Arm (SW6). Data gaps indicate the removal of erroneous data.

4.3.10 Total Dissolved Phosphorus

Variations in Total Dissolved Phosphorus (TDP) at information sites SW5 and SW6 for 2004-21 are shown in Figure 45.

The median TDP concentrations at sites SW5 and SW6 (3 µg/L) were slightly lower than the median value (4 µg/L) at background sites.

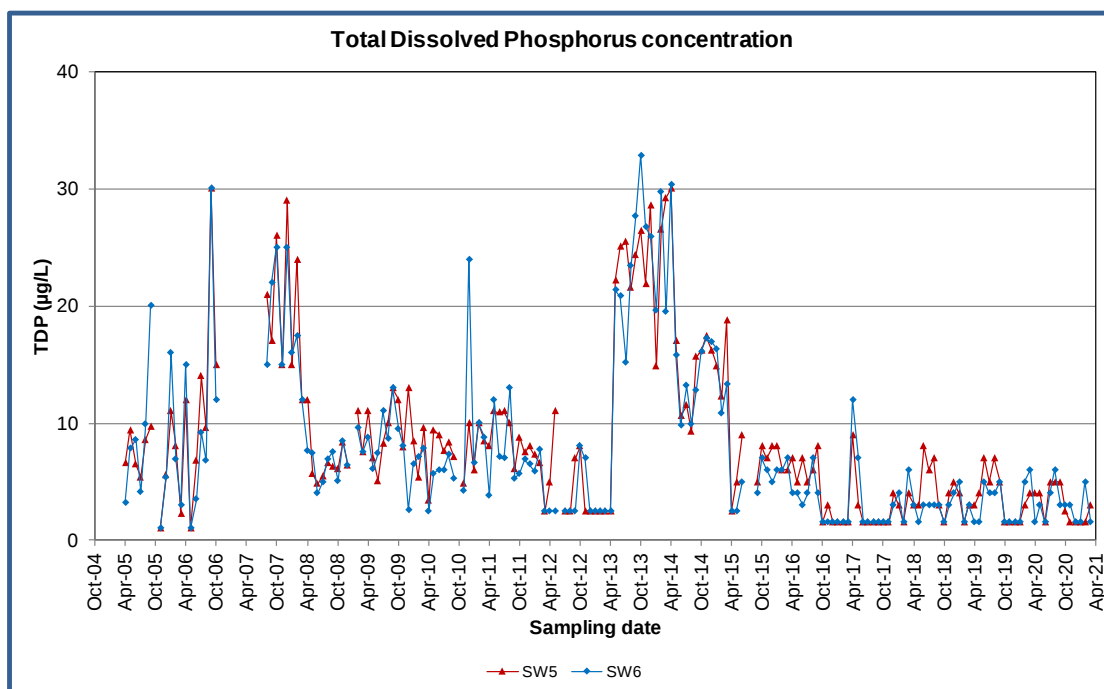


Figure 45. Total Dissolved Phosphorus variations at Crawford's Creek (SW5) and Drimmie Arm (SW6). Data gaps indicate the removal of erroneous data.

4.3.11 Dissolved Aluminium (WDL parameter until September 2020)

Variations in dissolved aluminium (Al) at information sites SW5 and SW6 for 2004-21 are shown in Figure 46.

During April 2020 to March 2021 the median concentration of dissolved Al at sites SW5 (2.2 µg/L) and SW6 (2.9 µg/L) were above the range of median concentrations for the background sites (0.9 – 1.3 µg/L). The elevation of dissolved Al levels is likely associated with continual resuspension of the fine sediments at these sites as evidenced by the higher turbidity and TSS levels recorded at these two sites compared to background sites.

Dissolved Al data were affected by contamination during the collection process on several occasions during 2007-2011 resulting in falsely elevated data. These data are no longer included in the MHMP assessment.

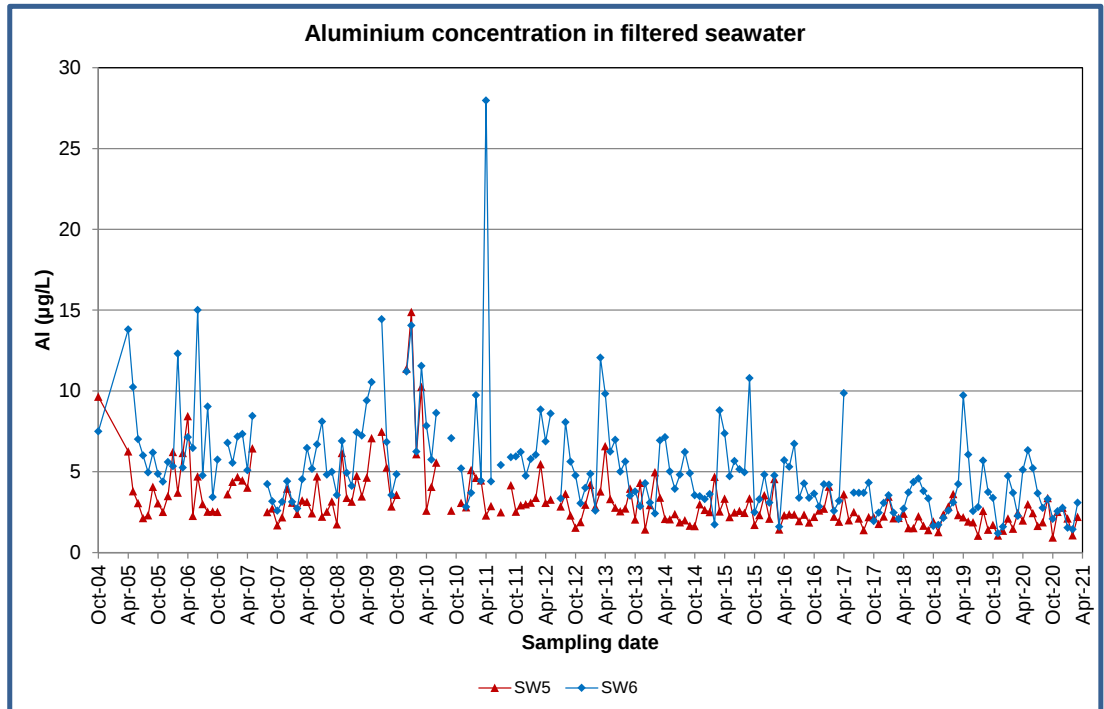


Figure 46. Dissolved aluminium variations at Crawford's Creek (SW5) and Drimmie Arm (SW6). Data gaps indicate the removal of erroneous data.

4.3.12 Dissolved Vanadium

Variations in dissolved vanadium (V) at information sites SW5 and SW6 for 2004-21 are shown in Figure 47.

During April 2020 to March 2021 the median concentration of dissolved V at site SW5 (2.3 µg/L) was within the range of median concentrations at the background sites (2.0 – 2.3 µg/L). The median concentration of dissolved V at site SW6 (2.6 µg/L) was slightly above the range of median concentrations at the background sites. Like dissolved Al, the elevation of dissolved V levels is likely associated with continual resuspension of the fine sediments at SW6. The median dissolved V concentrations at both SW5 and SW6 decreased from early 2018 similar to the reduced concentrations recorded in Inner Gove Harbour and at sites across Southern Melville Bay.

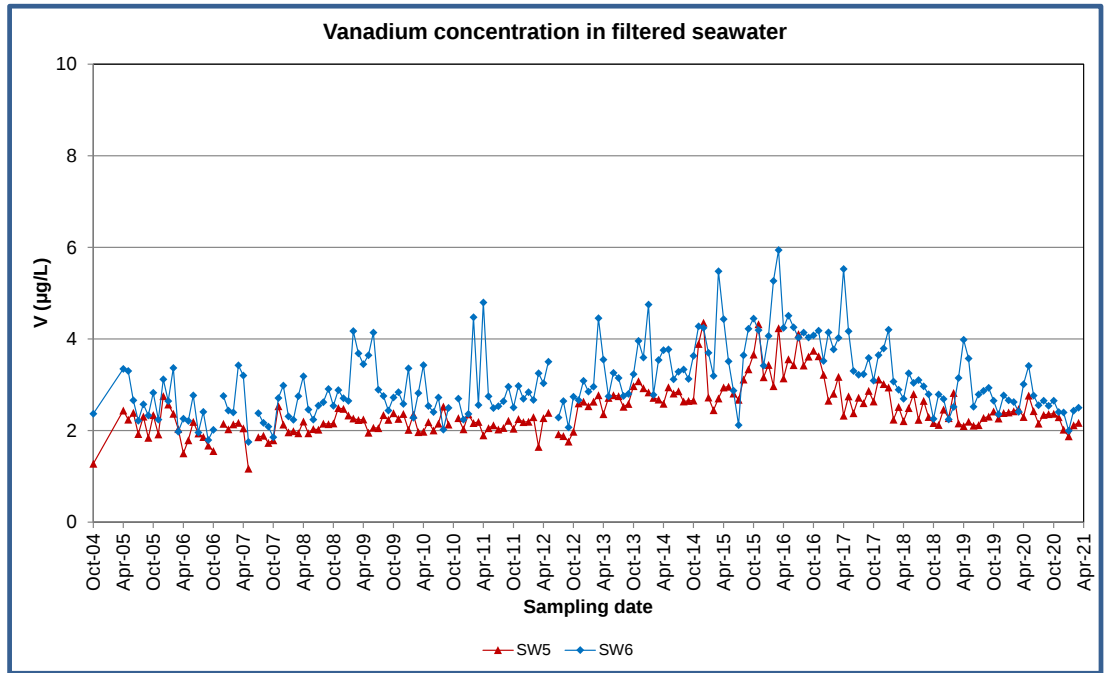


Figure 47. Dissolved vanadium variations at Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.3.13 Dissolved Chromium

Variations in dissolved chromium (Cr) at information sites SW5 and SW6 for September 2020 to March 2021 are shown in Figure 48.

During September 2020 to March 2021 the median concentrations of dissolved Cr at sites SW5 and SW6 (0.05 µg/L) were within the median concentrations at the background sites (0.05 – 0.09 µg/L).

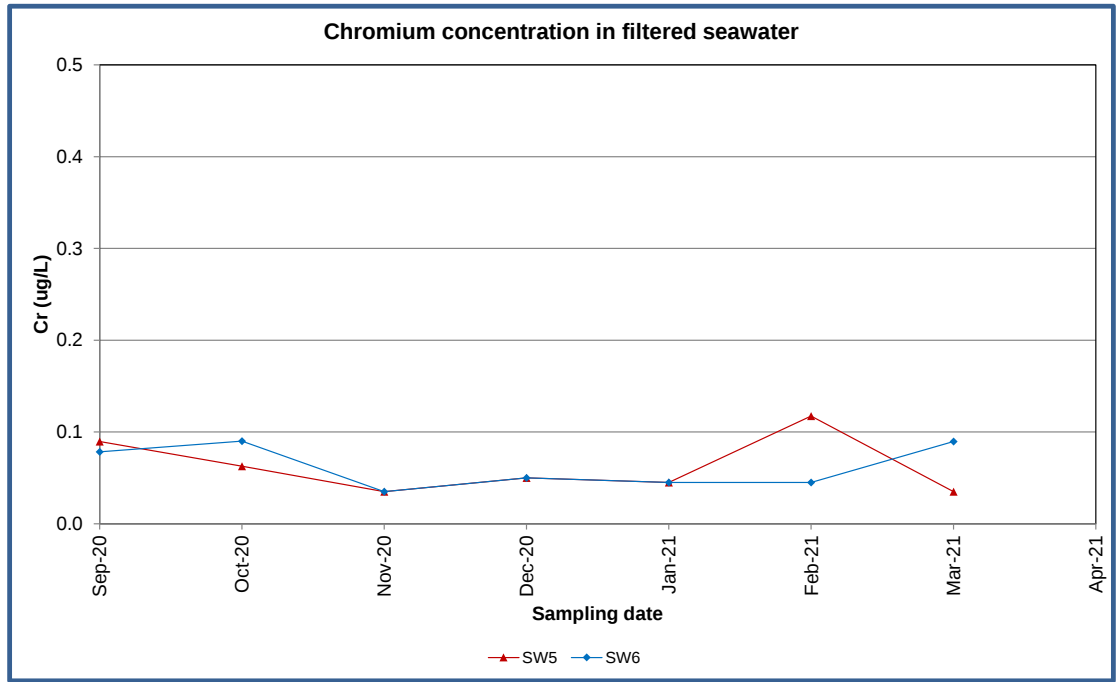


Figure 48. Dissolved chromium variations at Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.3.14 Dissolved Manganese

Variations in dissolved manganese (Mn) at information sites SW5 and SW6 for 2009-21 are shown in Figure 49.

During April 2020 to March 2021 the median concentrations of dissolved Mn at sites SW5 (1.7 µg/L) and at SW6 (1.8 µg/L) were higher than the median concentrations at the background sites (0.7 – 0.9 µg/L). Like dissolved Al, the elevation of dissolved Mn levels is likely associated with continual resuspension of the fine sediments at SW5 and SW6.

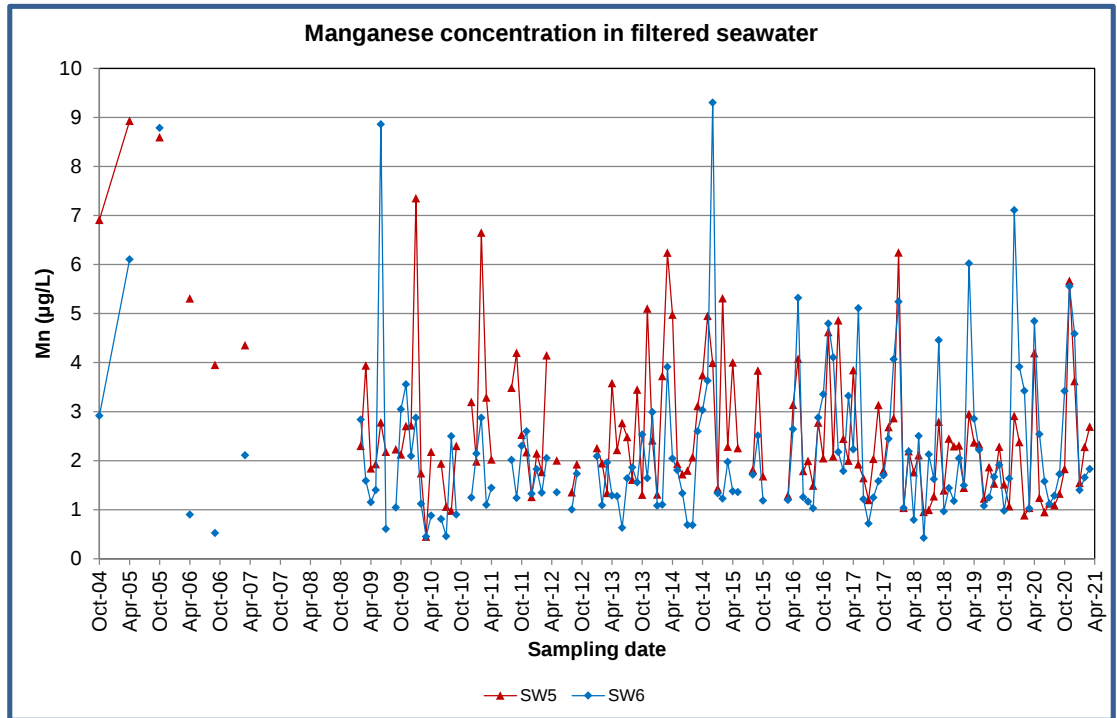


Figure 49. Dissolved manganese variations at Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.3.15 Dissolved Iron

Variations in dissolved iron (Fe) at information sites SW5 and SW6 for 2009-21 are shown in Figure 50.

During April 2020 to March 2021 the median concentration of dissolved Fe at sites SW5 and SW6 (0.5 µg/L) were similar to the median concentrations at the background sites (0.4 - 0.5 µg/L).

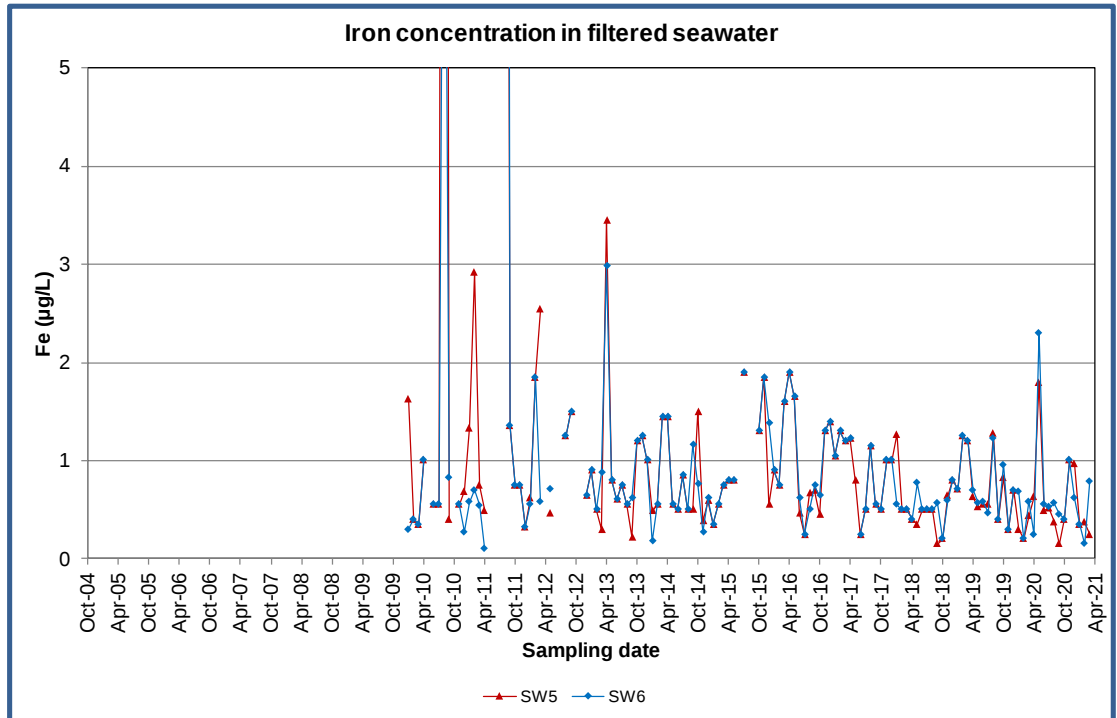


Figure 50. Dissolved iron variations at Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.3.16 Dissolved Copper

Variations in dissolved Copper (Cu) at information sites SW5 and SW6 for 2004-21 are shown in Figure 51.

During April 2020 to March 2021 the median concentrations of dissolved Cu at sites SW5 and SW6 (0.2 µg/L) were similar to the median concentrations at the background sites (0.2 – 0.3 µg/L).

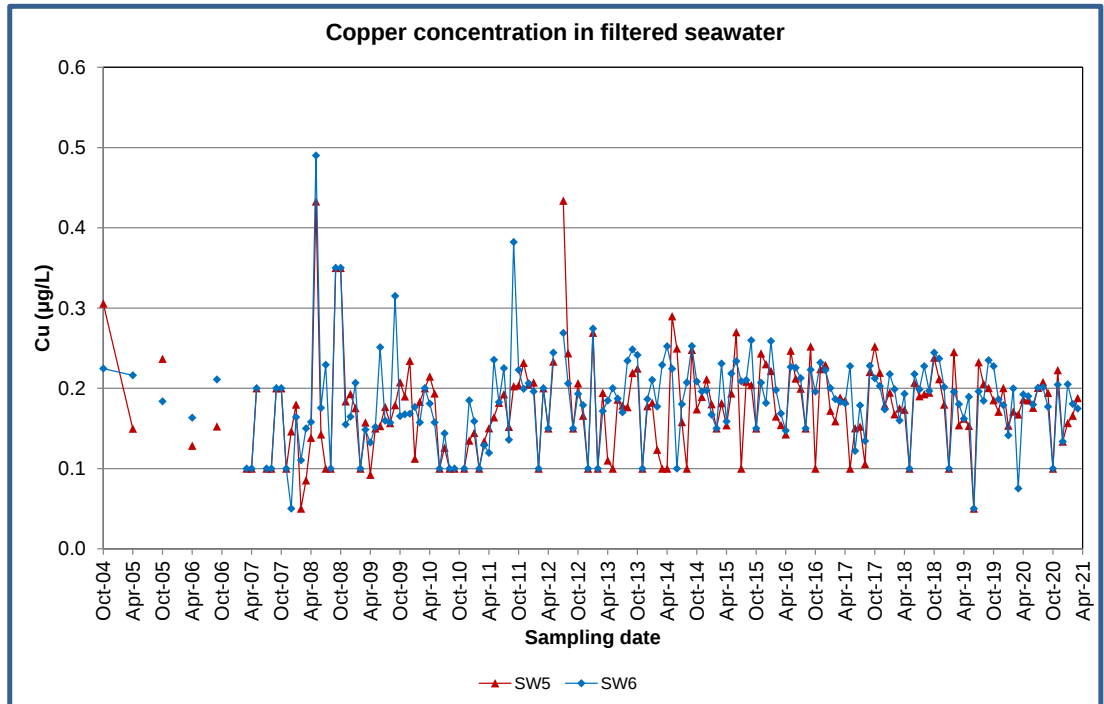


Figure 51. Dissolved copper variations at Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.3.17 Dissolved Zinc

Variations in dissolved zinc (Zn) at information sites SW5 and SW6 for 2004-21 are shown in Figure 52.

During April 2020 to March 2021 the median concentrations of dissolved Zn at sites SW5 and SW6 (0.3 µg/L) were similar the median concentrations at the background sites (0.3 – 0.4 µg/L).

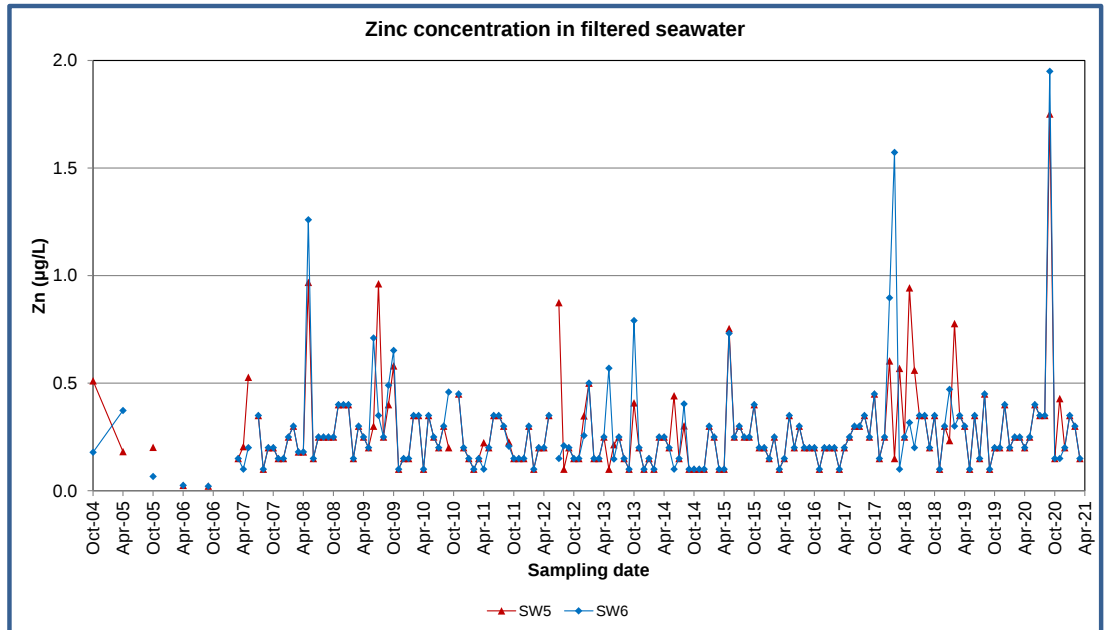


Figure 52. Dissolved zinc variations at Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.3.18 Dissolved Gallium

Variations in dissolved gallium (Ga) at information sites SW5 and SW6 for 2004-21 are shown in Figure 53.

During April 2020 to March 2021 the median concentration of dissolved Ga at site SW6 (0.05 µg/L) was higher than the median concentrations at the background sites (0.01 – 0.02 µg/L). Like dissolved Al, the elevation of dissolved Ga levels is likely associated with continual resuspension of the fine sediments at SW6. The median concentration of dissolved Ga at site SW5 (0.02 µg/L) was within the range for the background sites.

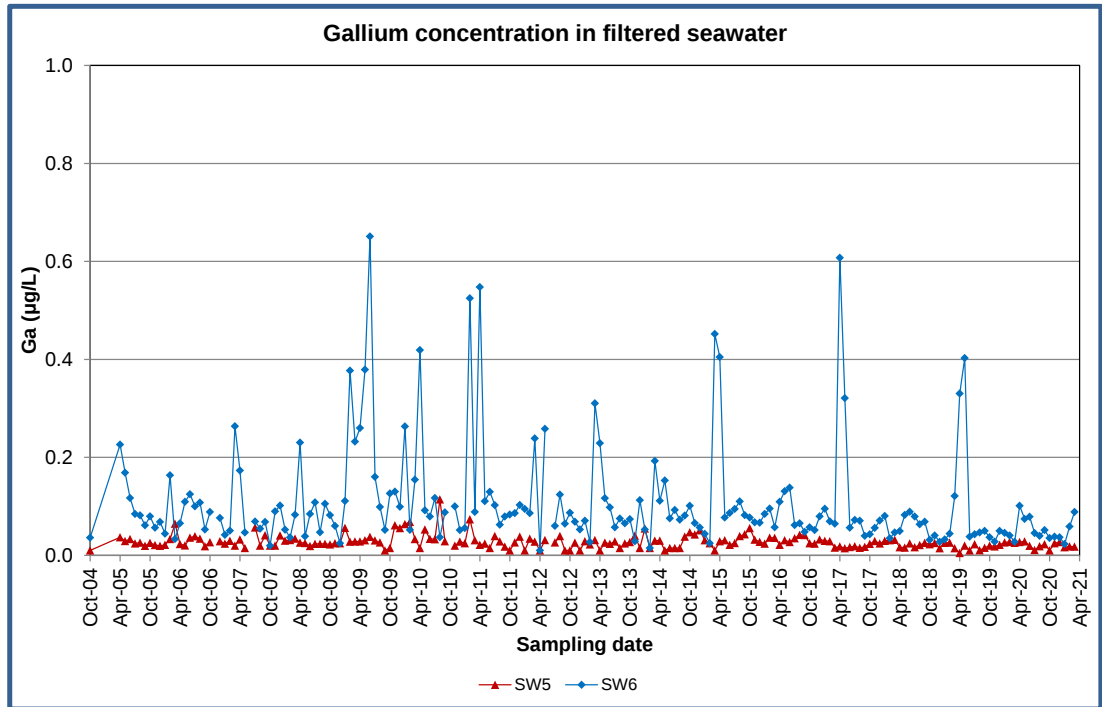


Figure 53. Dissolved gallium variations at Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.3.19 Dissolved Arsenic

Variations in dissolved arsenic (As) at information sites SW5 and SW6 for 2004-21 are shown in Figure 54.

During April 2020 to March 2021 the median concentration of dissolved As at site SW5 (1.4 µg/L) was within the range of median concentrations at the background sites (1.3 – 1.5 µg/L). At site SW6 the median concentration of As (1.6 µg/L) was slightly higher than at the background sites.

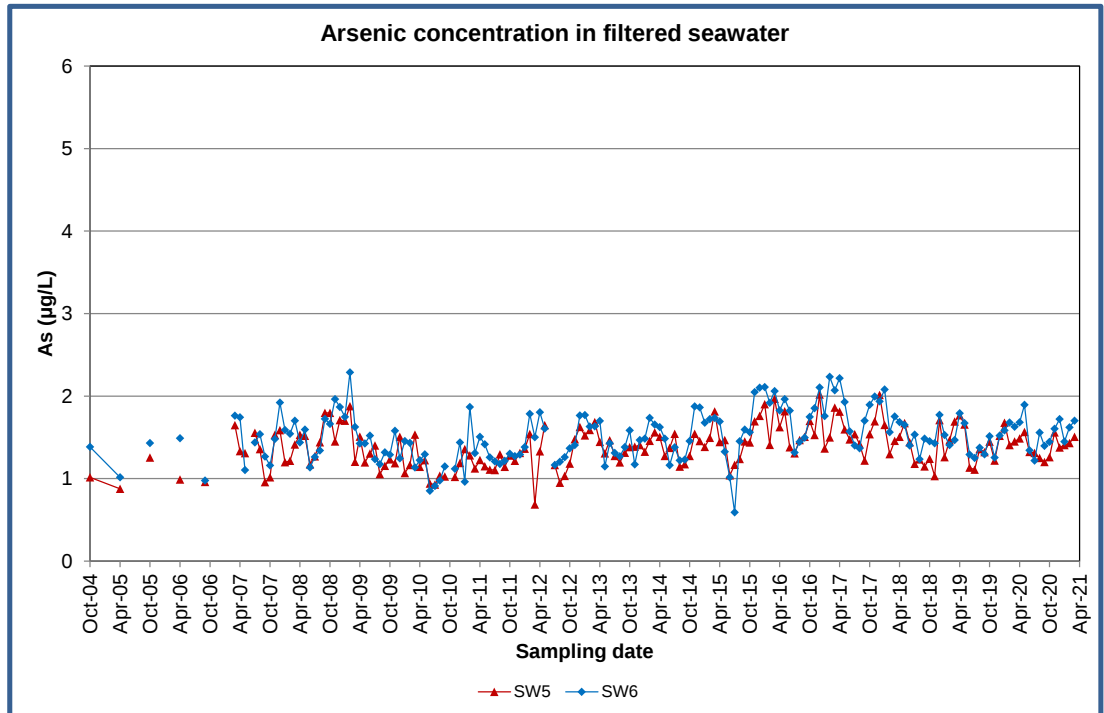


Figure 54. Dissolved arsenic variations Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.3.20 Dissolved Molybdenum

Variations in dissolved molybdenum (Mo) at information sites SW5 and SW6 for 2004-21 are shown in Figure 55.

During April 2020 to March 2021 the median concentration of dissolved Mo at sites SW5 and SW6 (10.9 and 11.0 µg/L, respectively) were slightly higher than the range of median concentrations at the background sites (10.3 – 10.7 µg/L).

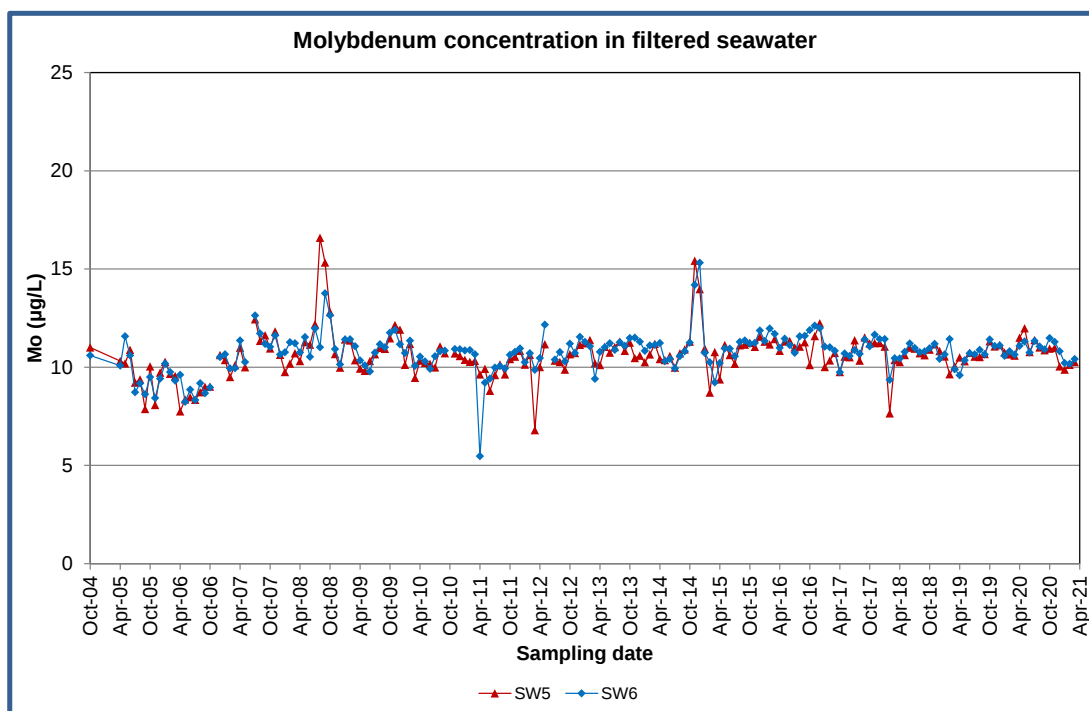


Figure 55. Dissolved molybdenum variations at Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.3.21 Dissolved Uranium

Monitoring of U commenced in April 2012. Variations in Dissolved uranium (U) at monitoring sites SW5 and SW6 for 2004-21 are shown in Figure 56.

During April 2020 to March 2021 the median concentration of dissolved U at sites SW5 and SW6 (3.3 µg/L) were slightly higher than the median concentrations at the background sites (3.2 µg/L).

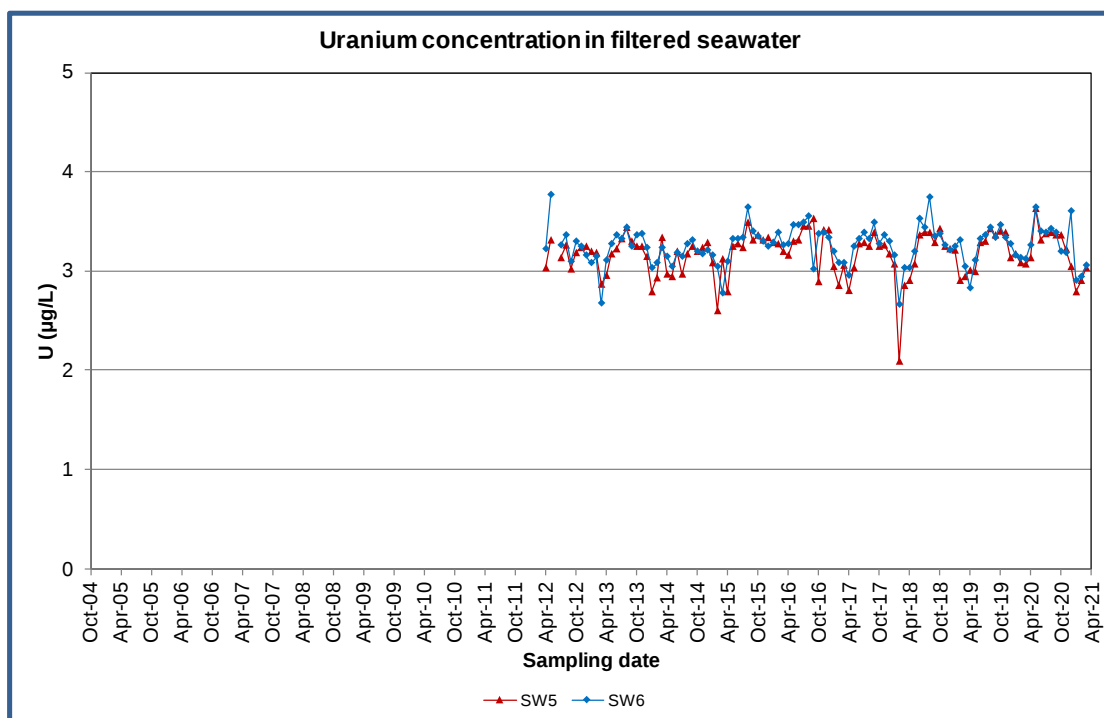


Figure 56. Dissolved uranium variations at Crawford's Creek (SW5) and Drimmie Arm (SW6).

4.4 Sediment

Annual sediment sampling under the MHMP was carried out in April 2020. The analytical data is provided in Appendix 3 which also contains summary statistics for all sampling events (2004-2020) for the following sampling areas:

Background sites, Inner Harbour sites, Drimmie Arm sites, Crawford's Creek

Monitoring of sediment composition is required under the RTG MHMP but development of Trigger Values was not stipulated. A qualitative comparison of the temporal and spatial variation in average compositions for each of the four groups listed above is carried out on an annual basis.

Where available, comparisons are made to the Australian and New Zealand Environment and Conservation Council guideline concentrations (ANZG 2018).

4.4.1 Total Kjeldahl Nitrogen

Total Kjeldahl Nitrogen (TKN) concentrations in the <2mm fraction of sediment samples from 2004-2020 are shown in Figure 57.

The Inner Harbour sediments had elevated concentrations of TKN concentrations during 2004-2020 compared to background sites. A similar finding was reported by Alongi (2006, 2007) who discussed the link to the RTG Refinery wastewater discharge and nutrient cycling in Inner Gove Harbour.

Drimmie Arm sediments had TKN concentrations similar to the background sites. Crawford's Creek sediments had elevated TKN concentrations compared to the background sites during most sampling events. This is likely to be related to a higher content of organic material typically present in mangrove lined creeks such as Crawford's Creek. There has been no clear trend in temporal variations.

There is no recommended ANZG sediment quality guideline value for TKN in sediments.

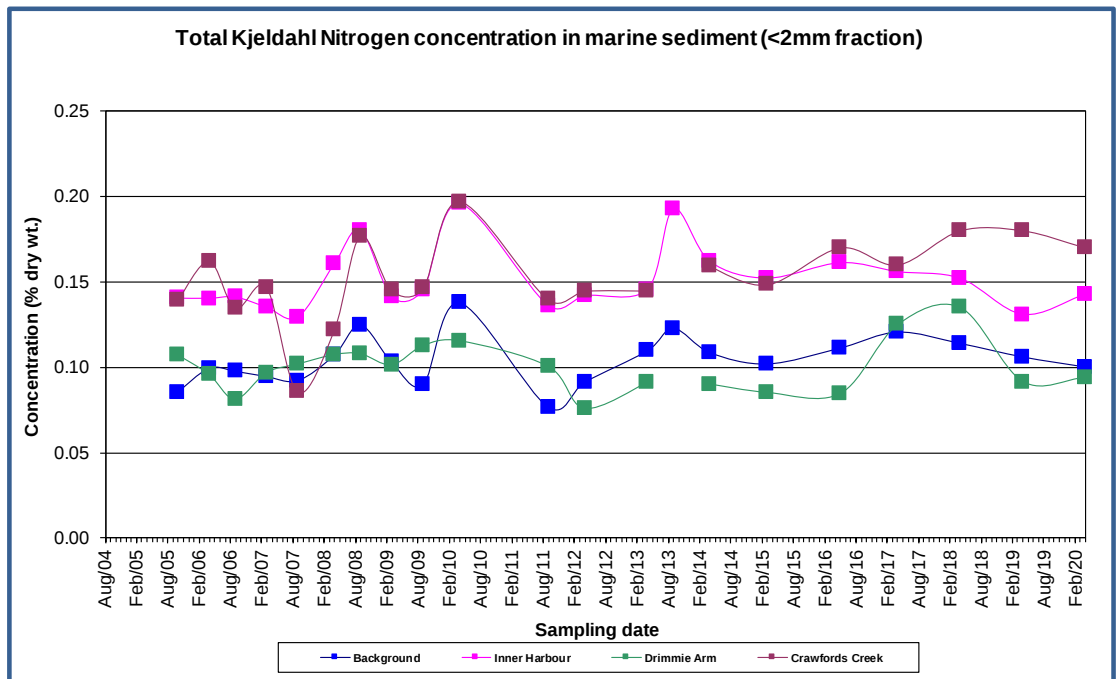


Figure 57. Temporal variations in the average Total Kjeldahl Nitrogen (TKN) concentration in sediments at Inner Harbour, Background, Drimmie Arm and Crawford's Creek sites 2004-2020.

4.4.2 Magnesium

Magnesium (Mg) concentrations in the <0.063mm fraction of sediment samples from 2004-2020 are shown in Figure 58.

The Inner Gove Harbour sediments had elevated Mg concentrations during 2004-2020 compared to background sites. This can be linked to previous RTG Refinery discharges and associated deposits of hydrotalcite in Inner Gove Harbour (Parry and Munksgaard, 2005; Munksgaard and Parry 2005, 2006b, 2006c, 2009). The average Mg concentration in the surface sediments of the Inner Harbour samples was approximately 5.1 % dry wt. in September 2006. Since 2008 this has reduced to approximately 2.9 % dry wt. in April 2020. This reduction is likely to correspond to a decline in the amount of hydrotalcite present in the surface layers of Inner Harbour sediment.

Drimmie Arm and Crawford's Creek sediments had Mg concentrations similar to the background sites (2.4 % Mg dry wt.). Sediment at the Drimmie Arm and Crawford's Creek sites had approximately 2.3% and 2.1 % Mg dry wt., respectively, in April 2020.

There is no recommended ANZG sediment quality guideline value for Mg.

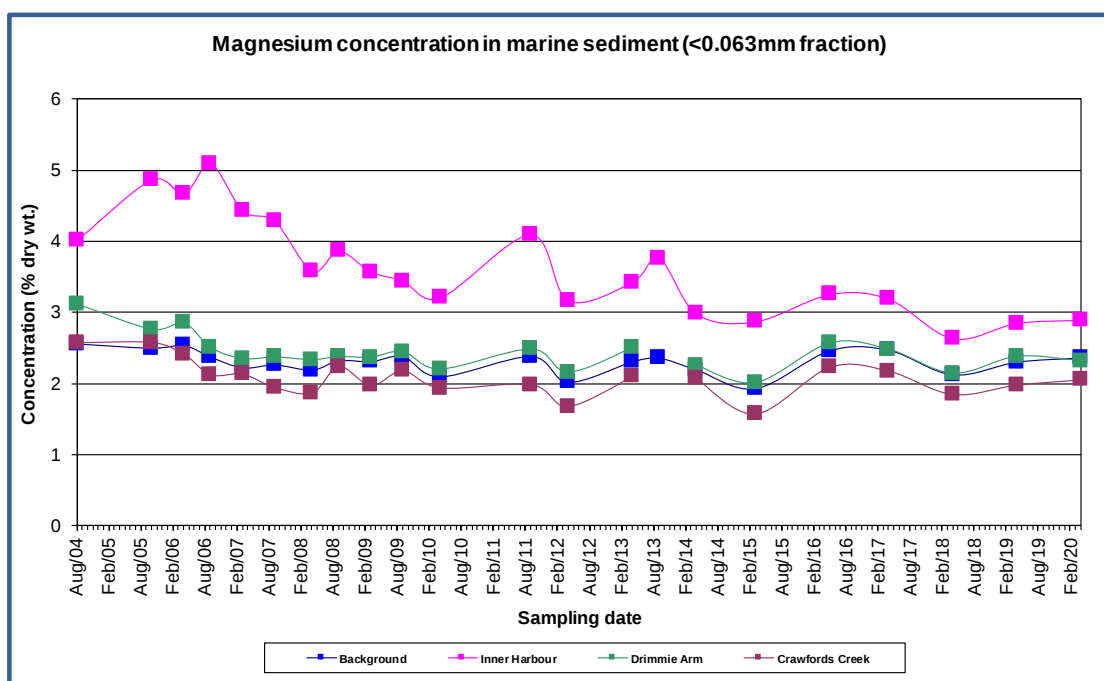


Figure 58. Temporal variations in the average magnesium (Mg) concentration in sediments at Inner Harbour, Background, Drimmie Arm and Crawford's Creek sites 2004-2020.

4.4.3 Aluminium

Aluminium (Al) concentrations in the <0.063mm fraction of sediment samples from 2004-2020 are shown in Figure 59.

Sediment in Inner Gove Harbour and at background sites had similar Al concentrations during 2004-2020. Despite the high content of Al in

hydrotalcite, Al is not elevated in Inner Harbour sediments as the general Al level is high in Southern Melville Bay sediments due to their high content of clay minerals.

Drimmie Arm and Crawford's Creek sediments had slightly higher Al concentrations than background sites throughout 2004-2020 which is likely due to their slightly higher clay content (fine average grainsize).

There is no recommended ANZG sediment quality guideline value for Al.

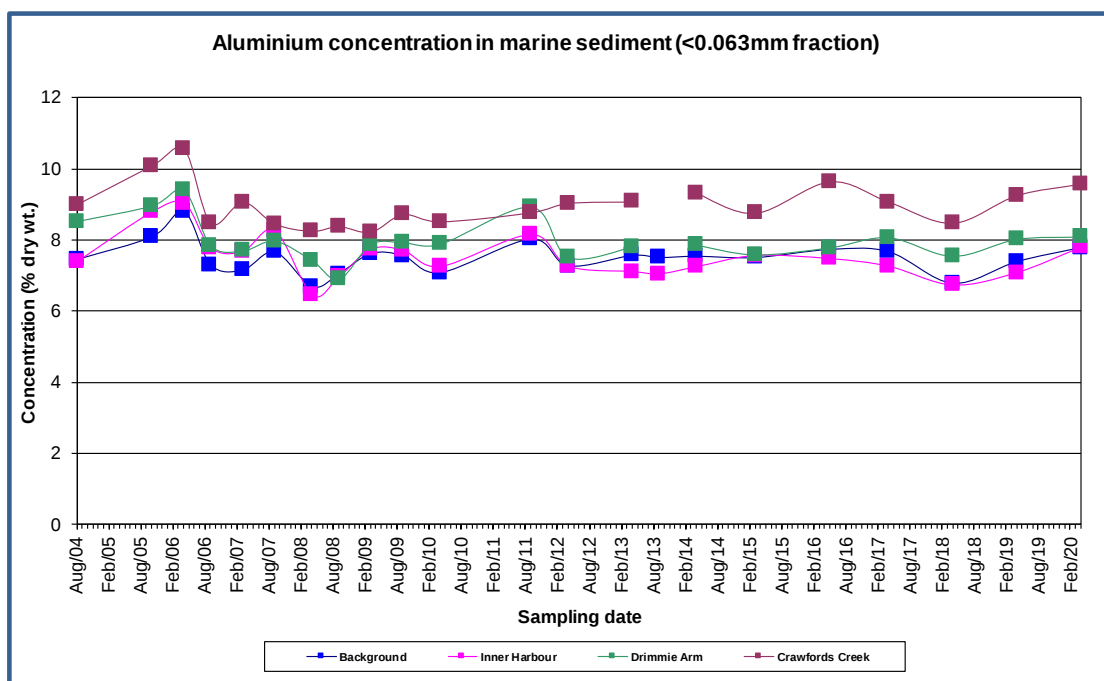


Figure 59. Temporal variations in the average aluminium (Al) concentration in sediments at Inner Harbour, Background, Drimmie Arm and Crawford's Creek sites 2004-2020.

4.4.4 Vanadium

Vanadium (V) concentrations in the <0.063mm fraction of sediment samples from 2004-2020 are shown in Figure 60.

Sediment in Inner Gove Harbour had similar or slightly higher V concentrations than sediment at background sites during 2004-2013. In 2014-2018, V concentrations in sediment increased in Inner Gove Harbour compared to previous years. This increase is likely to be related to the increased concentration of V in the discharge from the Waste Water Neutralisation Plant (WWNP) during 2012 - 2018. Since then V concentrations have decreased slightly after discharges from the WWNP ceased in March 2018. From April 2020 the WWNP has been operating intermittently (mainly during April - August 2020).

Drimmie Arm and Crawford's Creek sediments had similar or slightly higher V concentrations than background sites throughout 2004-2020.

During 2004 to early 2006 there was an increase in average V concentrations in sediment from all four areas. This was followed by a rapid decrease in concentrations during late 2006 to early 2007. The reasons for these rapid changes in V concentration are unknown.

There is no recommended ANZG sediment quality guideline values for V.

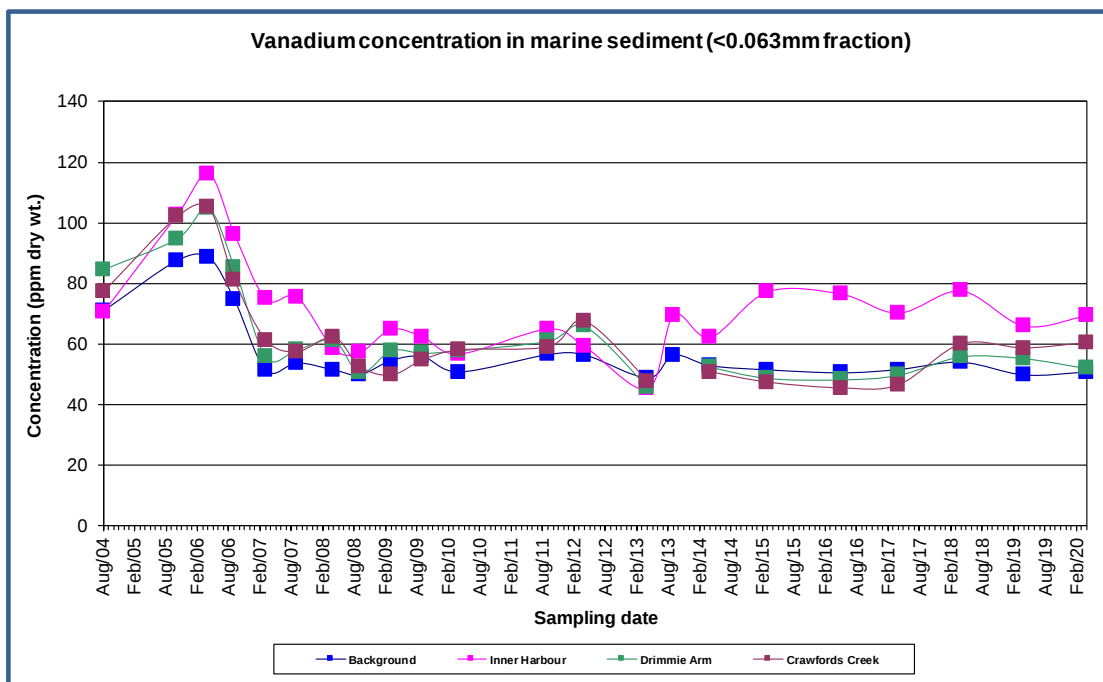


Figure 60. Temporal variations in the average vanadium (V) concentration in sediments at Inner Harbour, Background, Drimmie Arm and Crawford's Creek sites 2004-2020.

4.4.5 Manganese

Manganese (Mn) concentrations in the <0.063mm fraction of sediment samples from 2004-2020 are shown in Figure 61 (Mn was not analysed during (2010-11)). The average Mn concentrations in sediment from all areas have remained approximately constant since 2006.

There is no recommended ANZG sediment quality guideline value for Mn.

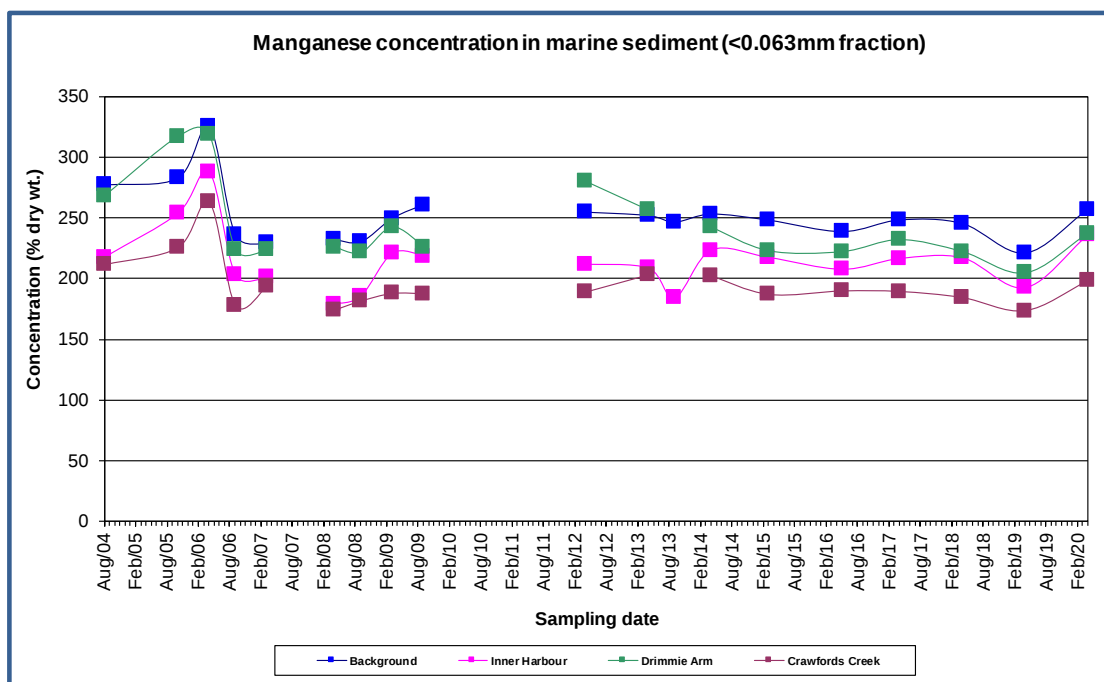


Figure 61. Temporal variations in the average manganese (Mn) concentration in sediments at Inner Harbour, Background, Drimmie Arm and Crawford's Creek sites 2004-2020.

4.4.6 Iron

Iron (Fe) concentrations in the <0.063mm fraction of sediment samples from 2004-2020 are shown in Figure 62 (Fe was not analysed during 2007-11). There have been no consistent trends in the average Fe concentrations in sediment from all areas since 2011.

There is no recommended ANZG sediment quality guideline value for Fe.

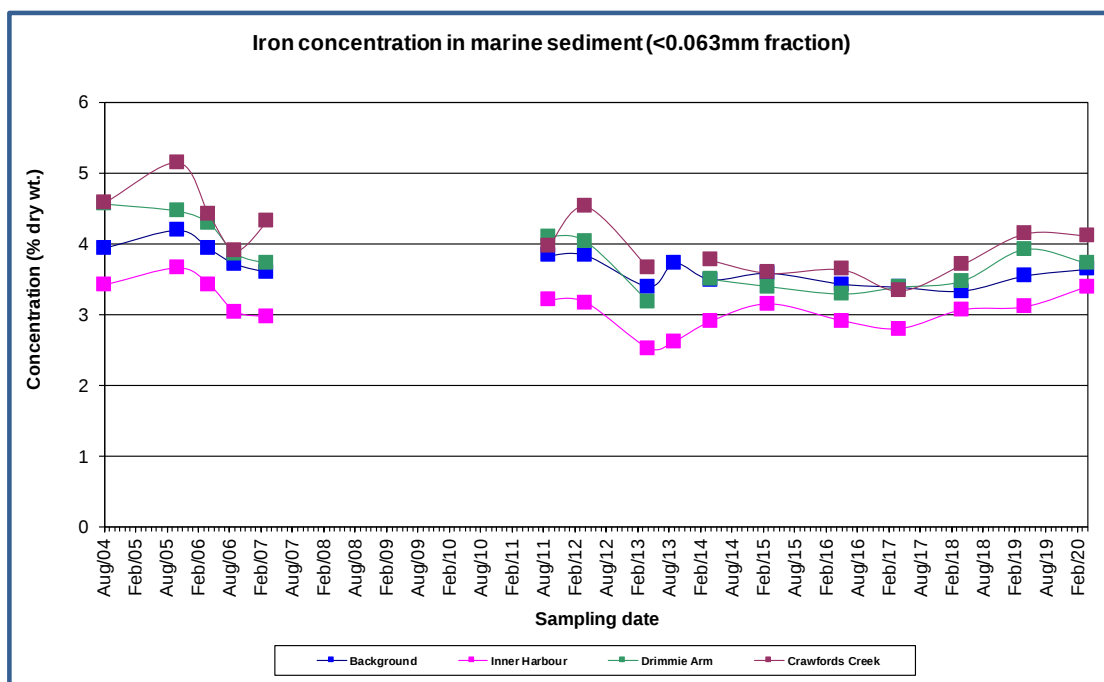


Figure 62. Temporal variations in the average iron (Fe) concentration in sediments at Inner Harbour, Background, Drimmie Arm and Crawford's Creek sites 2004-2020.

4.4.7 Zinc

Zinc (Zn) concentrations in the <0.063mm fraction of sediment samples from 2004-2020 are shown in Figure 63.

The Inner Harbour sediments had elevated concentrations of Zn during 2004-2020 compared to background sites. Previous refinery wastewater from the Western Channel contained elevated concentrations of Zn, and in the Inner Harbour sediments Zn became bound to sulfides associated with high concentrations of microbial activity (Alongi, 2006, 2007; Munksgaard and Parry 2006b, 2006c). There are likely additional sources of Zn, such as harbour infrastructure and shipping activity, in Inner Gove Harbour. The average Zn concentrations in surface sediments have decreased substantially between 2004 (97 ppm dry wt.) and 2020 (58 ppm dry wt.).

Drimmie Arm and Crawford's Creek sediments had Zn concentrations similar to the background sites.

The average Zn concentrations for all sampling areas are well below the ANZG sediment quality guideline values (SQGV = 200 mg/kg (ppm); SQG-High = 410 mg/kg (ppm)). Note that the SQGVs are usually applied to the <2mm grainsize fraction; comparing to the <0.063mm grainsize fraction, as done here, is therefore conservative as metals and metalloids are predominantly concentrated in the finer silt and clay fraction.

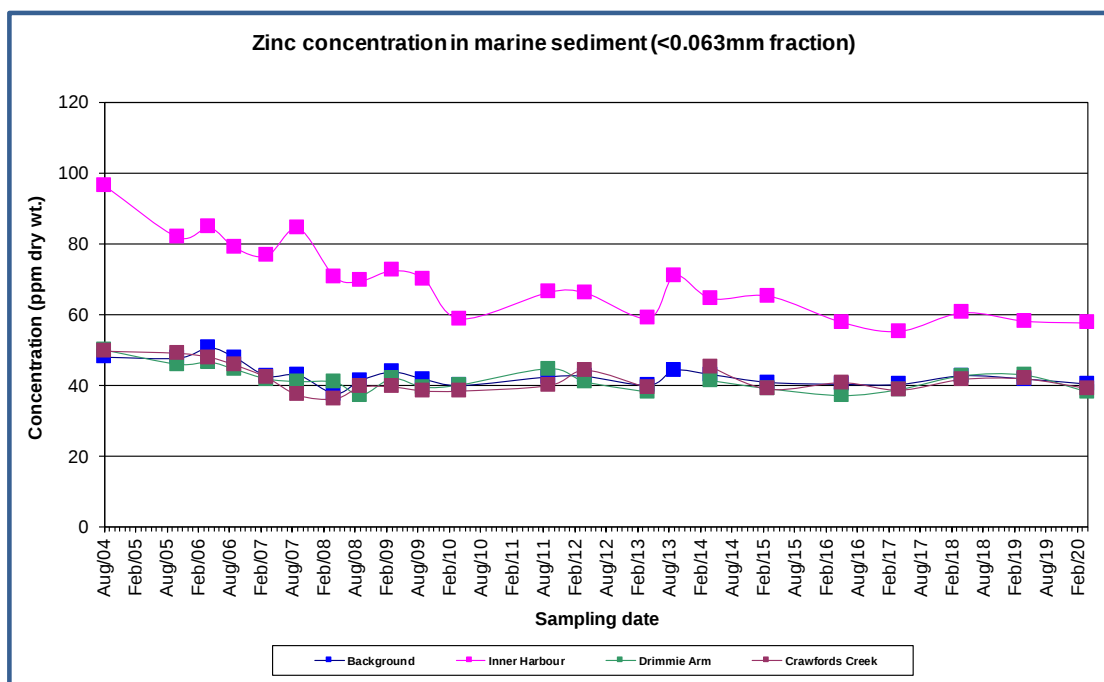


Figure 63. Temporal variations in the average zinc (Zn) concentration in sediments at Inner Harbour, Background, Drimmie Arm and Crawford's Creek sites 2004-2020.

4.4.8 Gallium

Gallium (Ga) concentrations in the <0.063mm fraction of sediment samples from 2004-2020 are shown in Figure 64.

The Inner Harbour sediments had elevated concentrations of Ga during 2004-2020 compared to background sites. This can be ascribed to the presence of high concentrations of hydrotalcite precipitates in the Inner Harbour sediments (Munksgaard and Parry, 2006b, 2006c, 2009). Gallium concentrations were lower in 2008-2020 than during 2004-2007.

Drimmie Arm and Crawford's Creek sediments had small degrees of elevation in Ga throughout 2004-2020 compared to background sites.

There is no recommended ANZG sediment quality guideline value for Ga.

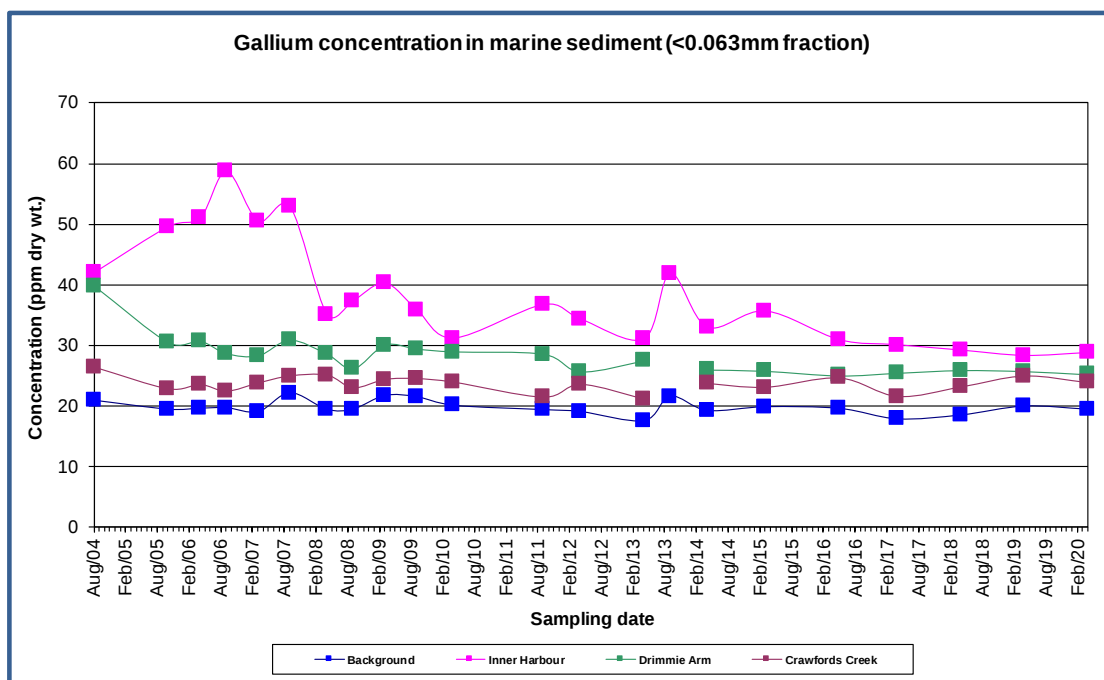


Figure 64. Temporal variations in the average gallium (Ga) concentration in sediments at Inner Harbour, Background, Drimmie Arm and Crawford's Creek sites 2004-2020.

4.4.9 Arsenic

Arsenic (As) concentrations in the <0.063mm fraction of sediment samples from 2004-2020 are shown in Figure 65.

The Inner Harbour sediments had elevated concentrations of As during 2004-2007 compared to background sites. However, As concentrations have decreased since 2007 and are now at background concentrations.

Drimmie Arm and Crawford's Creek sediments have had elevated As throughout 2004-2020 compared to background sites. The higher As concentrations in Drimmie Arm and Crawford's Creek are likely to be due to anoxic accumulation in sulfide-rich fine grained sediment predominant in this shallow, mangrove lined part of southern Melville Bay.

The average As concentrations for all sampling areas were below the ANZG sediment quality guideline values (SQGV = 20 mg/kg (ppm); SQG-High = 70 mg/kg (ppm)).

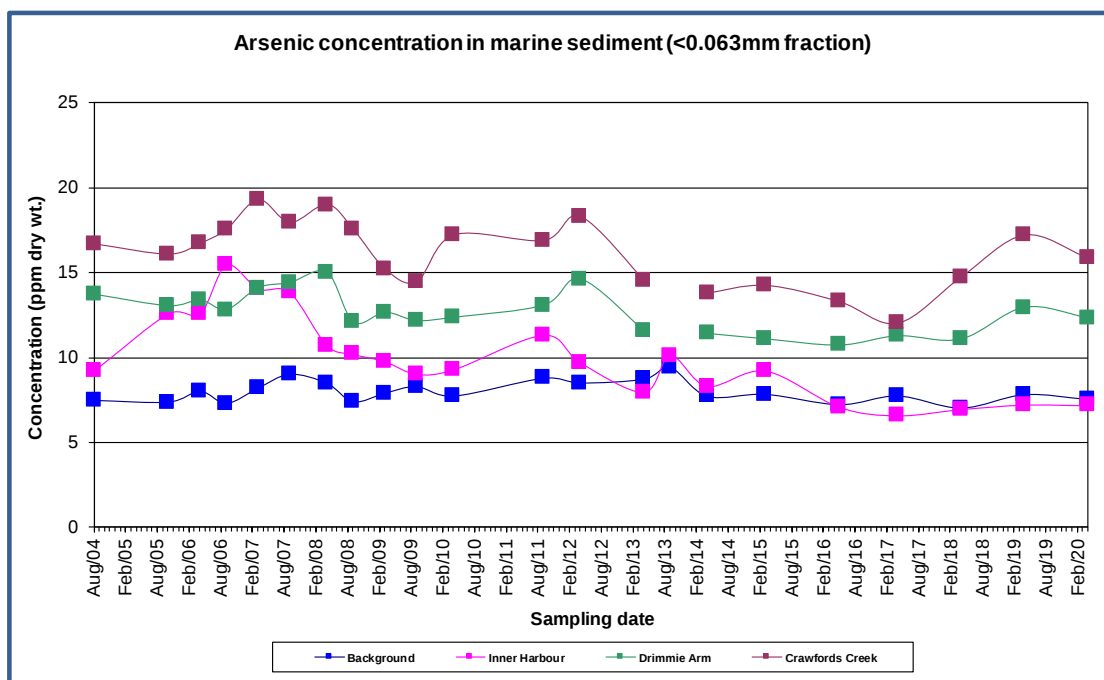


Figure 65. Temporal variations in the average arsenic (As) concentration in sediments at Inner Harbour, Background, Drimmie Arm and Crawford's Creek sites 2004-2020.

4.4.10 Molybdenum

Molybdenum (Mo) concentrations in the <0.063mm fraction of sediment samples from 2004-2020 are shown in Figure 66.

The Inner Harbour sediments had elevated, but fluctuating, concentrations of Mo throughout 2004-2020 compared to background sites. This is likely to be linked to the elevated concentrations of refinery-derived hydrotalcite precipitates and/or formation of molybdenum sulfides in Inner Harbour sediments (Munksgaard and Parry, 2006b, 2006c, 2009).

Drimmie Arm and Crawford's Creek sediments had Mo concentrations slightly above the background sites.

There is no recommended ANZG sediment quality guideline value for Mo.

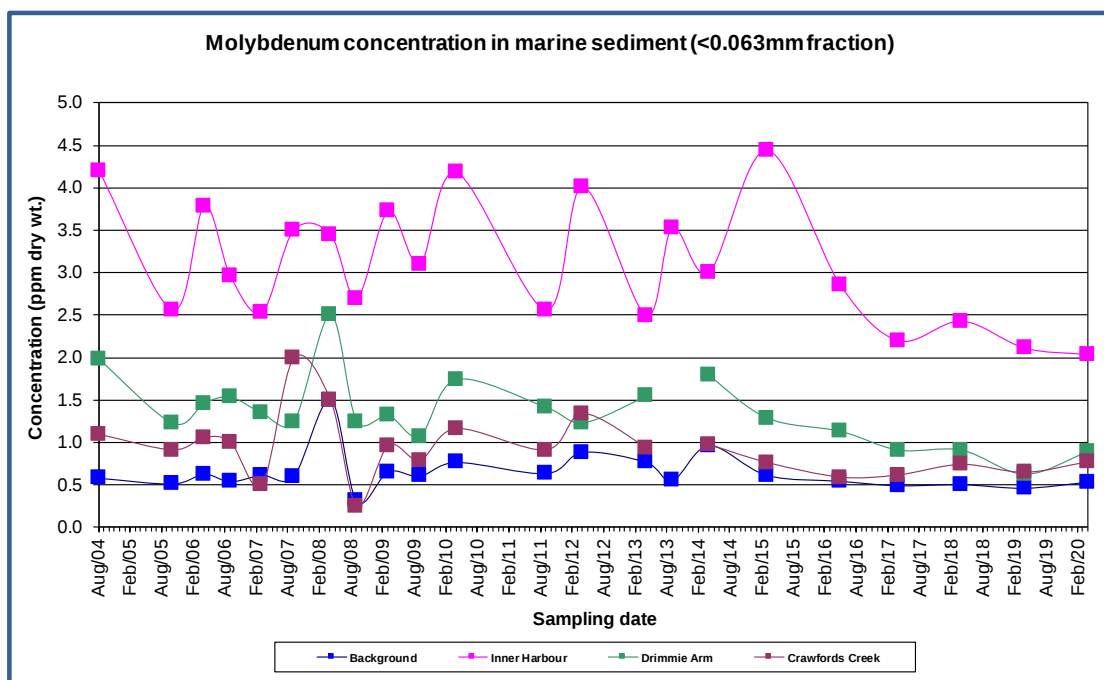


Figure 66. Temporal variations in the average molybdenum (Mo) concentration in sediments at Inner Harbour, Background, Drimmie Arm and Crawford's Creek sites 2004-2020.

4.4.11 Cadmium

Cadmium (Cd) concentrations in the <0.063mm fraction of sediment samples from 2004-2020 are shown in Figure 67.

The Inner Harbour sediments have had elevated concentrations of Cd during 2004-2020 compared to background sites. However, Cd concentrations in sediment have reduced slightly from approximately 0.3 – 0.4 mg/kg during 2004-2009 to approximately 0.25 mg/kg since 2014. Cadmium is not commonly elevated in any refinery waste water streams (Parry and Munksgaard, 2005, Munksgaard and Parry, 2006a, 2006b, 2006c, 2009) but may be derived from other anthropogenic or natural sources within the harbour. Cadmium is likely to be bound to sulfide phases generated microbially in the hydrotalcite impacted sediments.

Drimmie Arm and Crawford's Creek sediments had Cd concentrations similar to background site sediments.

The average Cd concentrations for all sampling areas are below the ANZG sediment quality guideline values (SQGV = 1.5 mg/kg (ppm); SQG-High = 10 mg/kg (ppm)).

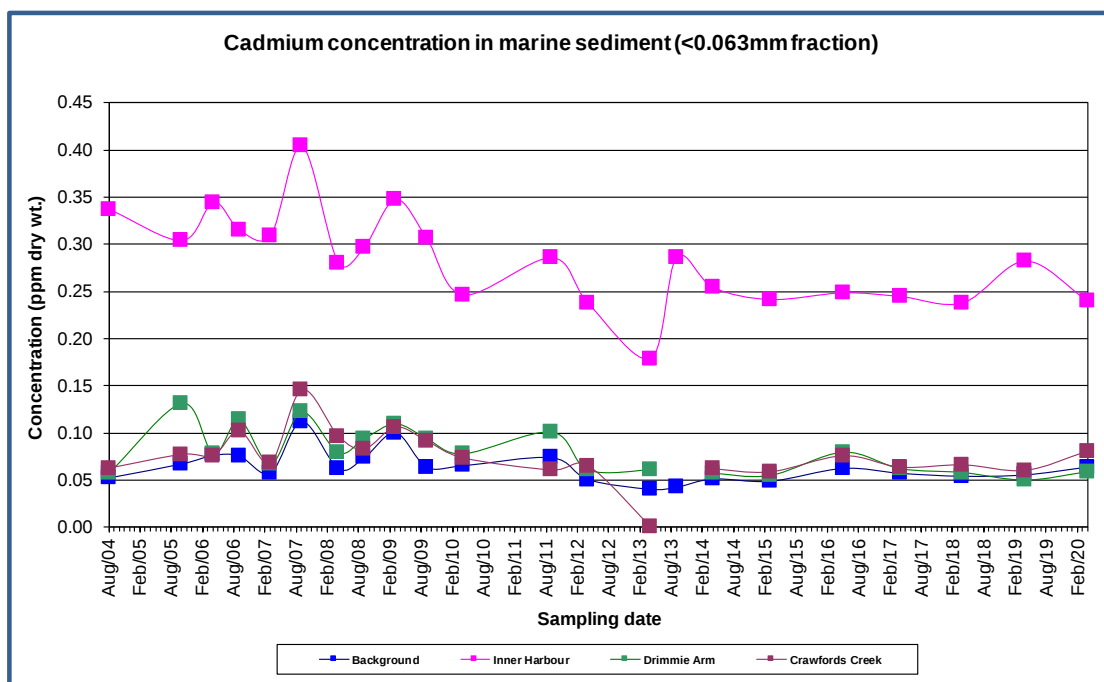


Figure 67. Temporal variations in the average cadmium (Cd) concentration in sediments at Inner Harbour, Background, Drimmie Arm and Crawford's Creek sites 2004-2020.

4.4.12 Other monitored elements

Copper (Cu) concentrations were slightly elevated in Inner Harbour sediments compared to the other sampling areas (Appendix 3). Copper may be derived from previous discharges from the refinery's Western Channel as well as a range of harbour sources and general shipping activity. Sedimentary Cu is likely bound by sulfides. Copper concentrations for all sampling sites are well below the ANZG sediment quality guideline values (SQGV = 65 mg/kg (ppm); SQG-High = 270 mg/kg (ppm)).

Lead (Pb) concentrations are not elevated in the Inner Harbour sediments (Appendix 3) and are not commonly elevated in any refinery waste water streams (Parry and Munksgaard, 2005, Munksgaard and Parry, 2006a, 2006b, 2006c). Lead concentrations for all sampling areas are below the ANZG sediment quality guideline values (SQGV = 50 mg/kg (ppm); SQG-High = 220 mg/kg (ppm)).

Uranium (U) is slightly elevated in Inner Harbour sediments (Appendix 3) but is not commonly elevated in any refinery wastewater streams (Parry and Munksgaard, 2005, Munksgaard and Parry, 2006a, 2006b, 2006c). The small increase in U may be due to extraction of U from seawater by organic-rich hydrotalcite impacted sediments under reducing conditions. Crawford's Creek sediment is also slightly elevated in U compared to background sediment which may be related to a higher organic content in sediment of the mangrove lined creek. There is no recommended ANZG sediment quality guideline value for U in sediments.

4.5. Oysters

Monitoring of metal and As concentrations in oyster soft tissue is required under the MHMP but development of Trigger Values was not stipulated. A qualitative comparison of the temporal and spatial variation in average compositions at four sites listed below is carried out on an annual basis.

Bi-annual oyster sampling under the MHMP was carried out in May and November 2020. The analytical data is provided in Appendix 4 which also contains summary statistics for all sampling events (2004-2020) for the following sampling areas:

- Granite Island
- Harbour Islets
- West Woody Island
- Bonner Rocks

A qualitative comparison of the temporal variation in average compositions for each of the four groups above is carried out on a half-yearly basis. Where available, comparisons are made to Australia New Zealand Food Authority maximum permitted concentrations of metals in food (FSANZ 2016).

4.5.1. Aluminium

Aluminium (Al) concentrations in oyster soft tissue samples from 2004-2020 are shown in Figure 68.

For the four sites sampled during 2004-20 oyster Al concentrations were variable with no clear overall temporal trend. During this period, the average Al concentrations for the four oyster collection sites were: Harbour Islets: 8.8 +/- 2.8, West Woody Island: 8.6 +/- 1.7, Granite Islands: 6.0 +/- 2.2 and Bonner Rocks: 3.2 +/- 0.4 mg/kg wet weight. It is notable that the mean Al concentration in oysters for the period 2014-2020 show a statistically significant ($P = 0.02$) decrease with increasing distance from Gove Harbour and the RTAG refinery.

There is no FSANZ (2016) food standard for Al.

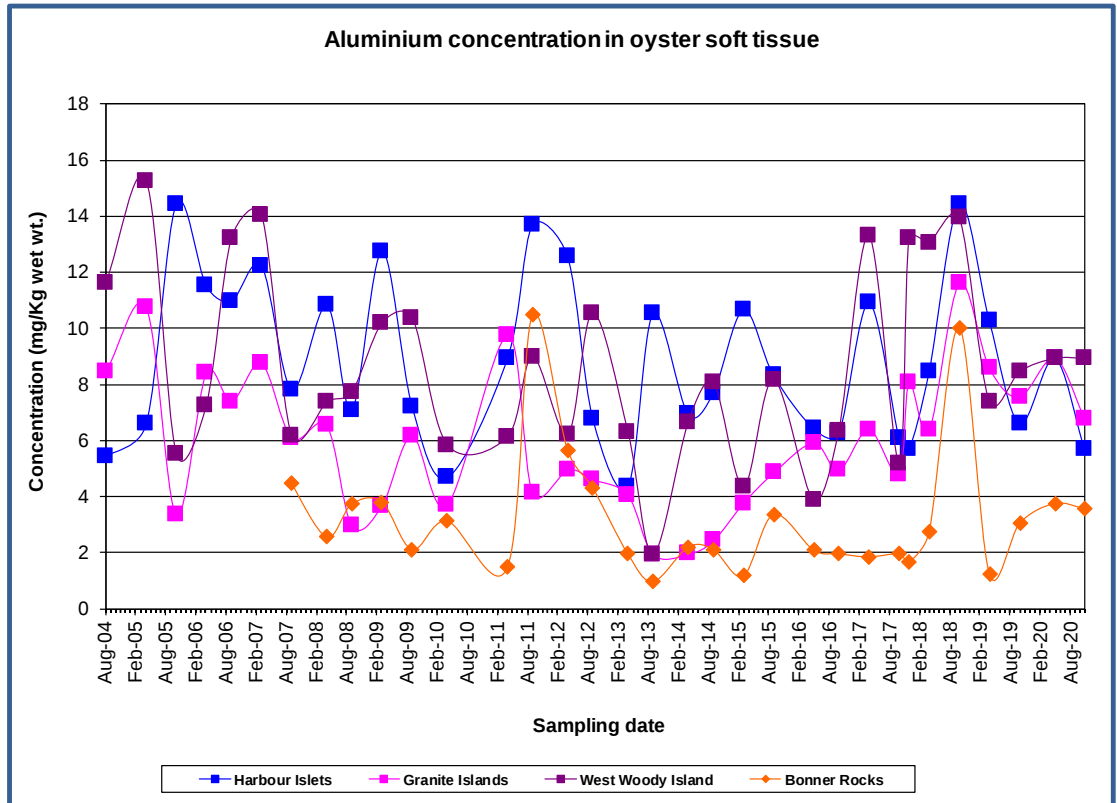


Figure 68. Temporal variations in the average aluminium (Al) concentration in oyster soft tissue at Harbour Islets, Granite Islands, West Woody Island, and Bonner Rocks 2004-2020.

4.5.2. Vanadium

Vanadium (V) concentrations in oyster soft tissue samples from 2004-2020 are shown in Figure 69.

At Bonner Rocks and West Woody Island, oyster V concentrations were variable during 2004-2020. At Harbour Islets and Granite Islands highly variable concentrations of V have been recorded since 2014. Relatively high values compared to the other sampling sites were recorded in September 2014, May 2016 and April 2018. However, at other sampling times since 2014 the V concentrations at Harbour Islets and Granite Islands were similar to those recorded at Bonner Rocks and West Woody Island. Following the cessation of WWNP discharges in March 2018, V concentrations in oysters have been amongst the lowest recorded since 2004. From April 2020 the WWNP has been operating intermittently (mainly April - August 2020).

During 2004-20, the average V concentrations for the four oyster collection sites were: Harbour Islets: 0.31 +/- 0.11, West Woody Island: 0.37 +/- 0.07, Granite Islands: 0.34 +/- 0.05 and Bonner Rocks: 0.20 +/- 0.01 mg/kg wet weight.

There is no FSANZ (2016) food standard for V.

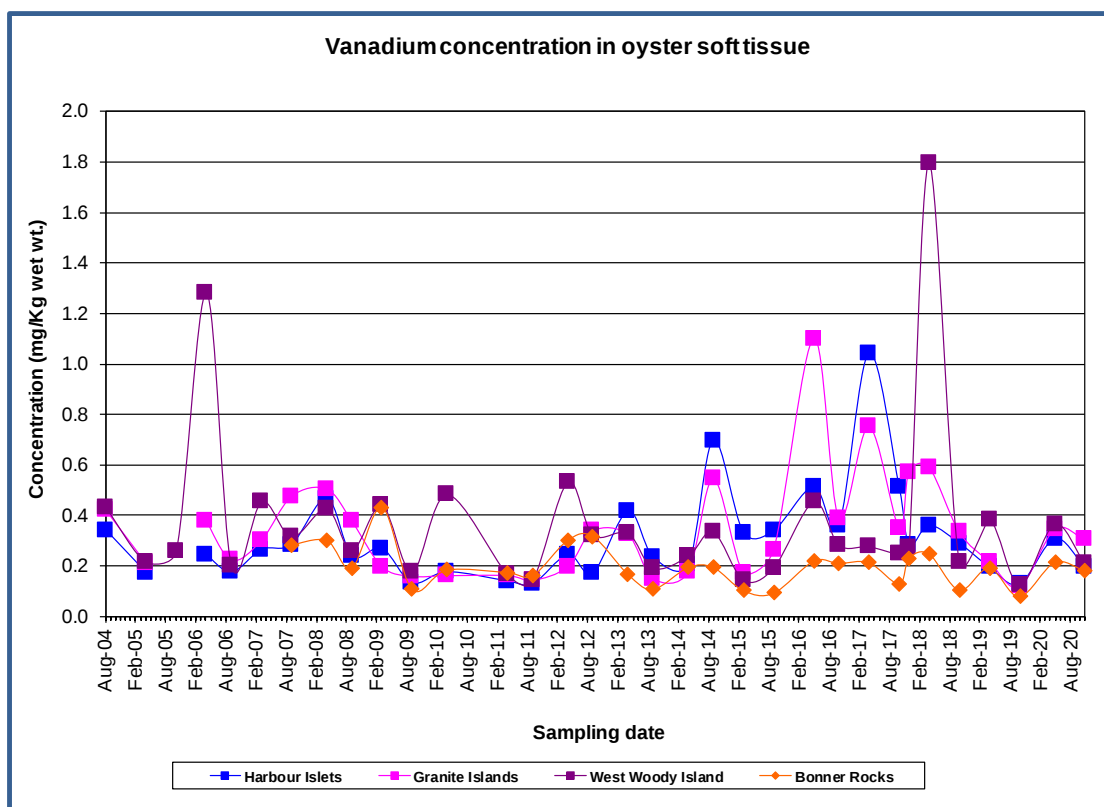


Figure 69. Temporal variations in the average vanadium (V) concentration in oyster soft tissue at Harbour Islets, Granite Islands, West Woody Island, and Bonner Rocks 2004-2020.

4.5.3. Manganese

Manganese (Mn) concentrations in oyster soft tissue samples from 2004-2020 are shown in Figure 70. Note there are gaps in the data set as Mn was not included as an analyte in the oyster monitoring program on a consistent basis.

For the four sites sampled during 2004-20 oyster Mn concentrations were variable with no clear temporal trend. During this period, the average Mn concentrations for the four oyster collection sites were: Harbour Islets: 1.01 +/- 0.23, West Woody Island: 1.39 +/- 0.51, Granite Islands: 1.04 +/- 0.40 and Bonner Rocks: 0.98 +/- 0.28 mg/kg wet weight.

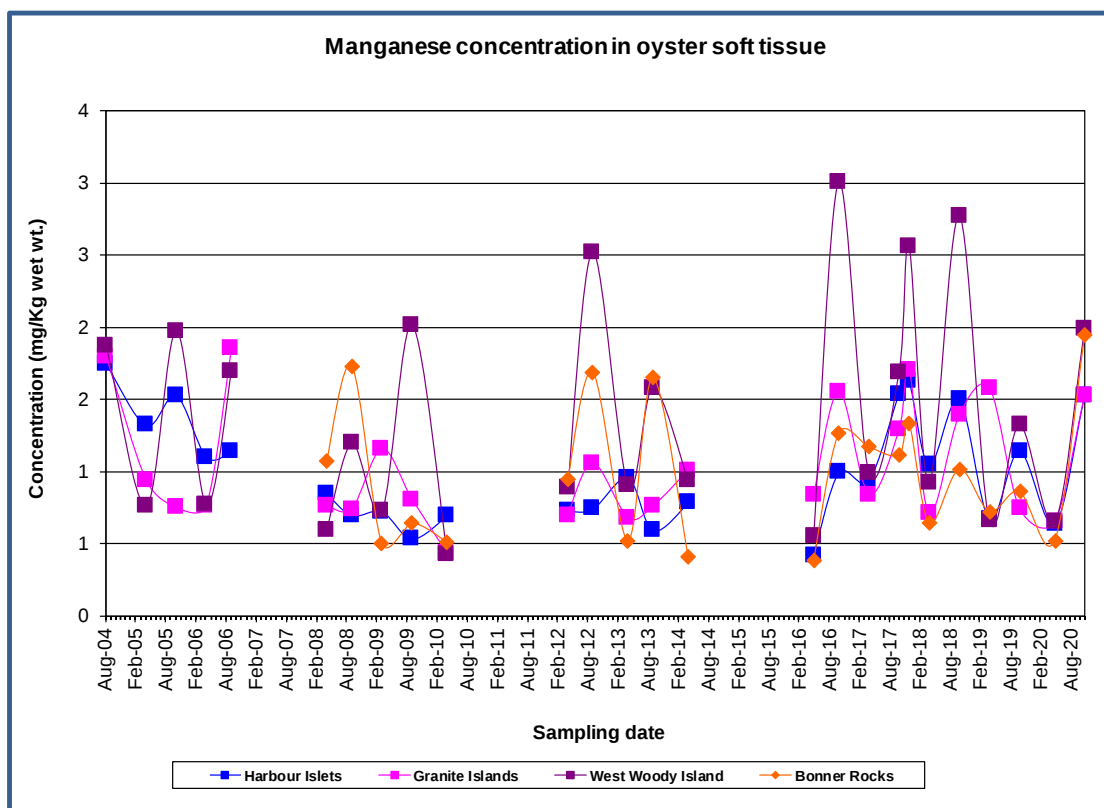


Figure 70. Temporal variations in the average manganese (Mn) concentration in oyster soft tissue at Harbour Islets, Granite Islands, West Woody Island, and Bonner Rocks 2004-2020.

4.5.4. Iron

Iron (Fe) concentrations in oyster soft tissue samples from 2004-2020 are shown in Figure 71. Note that prior to 2016 Fe was not included as an analyte in the oyster monitoring program on a consistent basis.

For the four sites sampled during 2004-20 oyster Fe concentrations were variable with no clear overall temporal trend. During this period, the average Fe concentrations for the four oyster collection sites were: Harbour Islets: 21.0 +/- 3.6, West Woody Island: 22.3 +/- 1.9, Granite Islands: 21.8 +/- 2.8 and Bonner Rocks with the lowest concentration at 13.8 +/- 1.0 mg/kg wet weight.

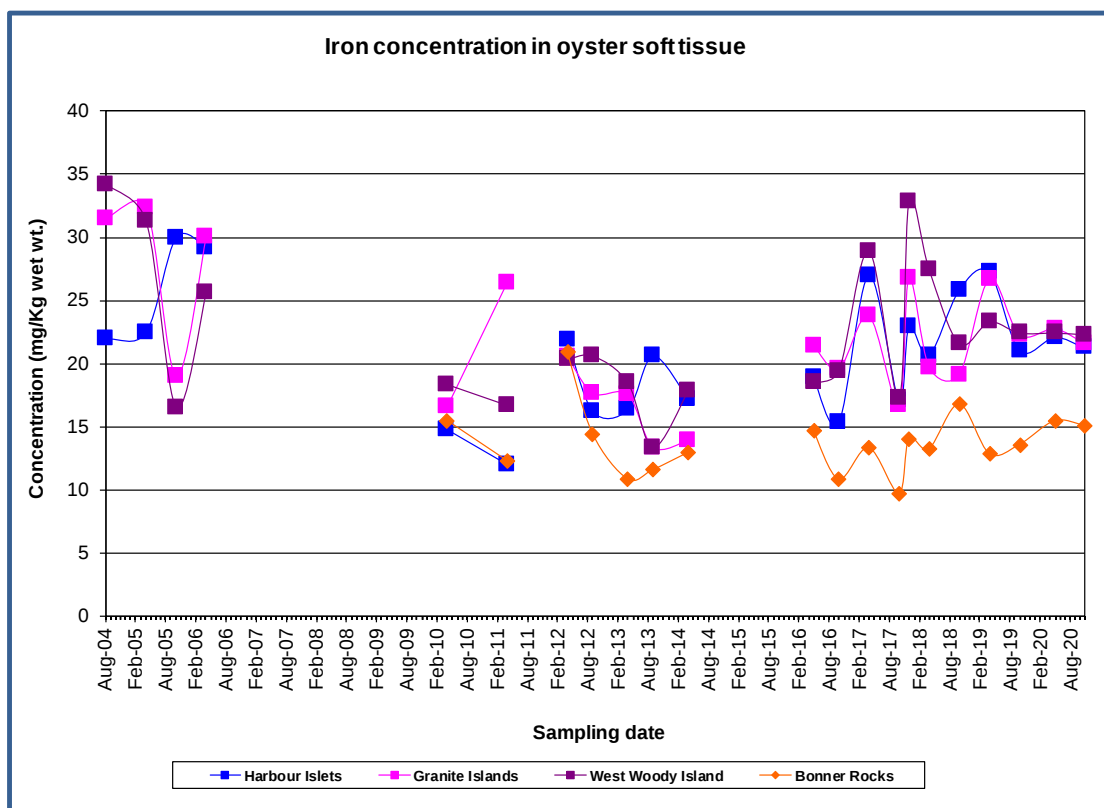


Figure 71. Temporal variations in the average iron (Fe) concentration in oyster soft tissue at Harbour Islets, Granite Islands, West Woody Island, and Bonner Rocks 2004-2020.

4.5.5. Copper

Copper (Cu) concentrations in oyster soft tissue samples from 2004-2020 are shown in Figure 72.

Oysters from Harbour Islets, West Woody Island and Granite Islands sampled throughout 2004-2020 had variable Cu concentrations with no clear overall temporal trend. During this period, the average Cu concentrations for the four oyster collection sites were: Harbour Islets: 22.2 +/- 5.0, West Woody Island: 20.7 +/- 3.5, Granite Islands: 18.1 +/- 2.8 and Bonner Rocks: 34.3 +/- 2.5 mg/kg wet weight. Copper concentrations in oysters from Bonner Rocks, the most distant sampling site from Gove Harbour, have mostly been above the ranges of all other sites.

Copper concentrations at all sites throughout 2004-2020 exceeded the ANZFA (2004) food standard (Cu = 10 mg/kg). However, the current FSANZ (2016) food standards do not contain a maximum permitted concentration for Cu in food.

Copper concentrations similar to those recorded under the MHMP have been reported previously from southern Melville Bay (Noller, 1991; McConchie & Saenger, 1993) and elsewhere along the North Australian coastline

(McConchie and Lawrance, 1991; Parry and Munksgaard, unpublished data) and appear to be natural concentrations unrelated to anthropogenic sources.

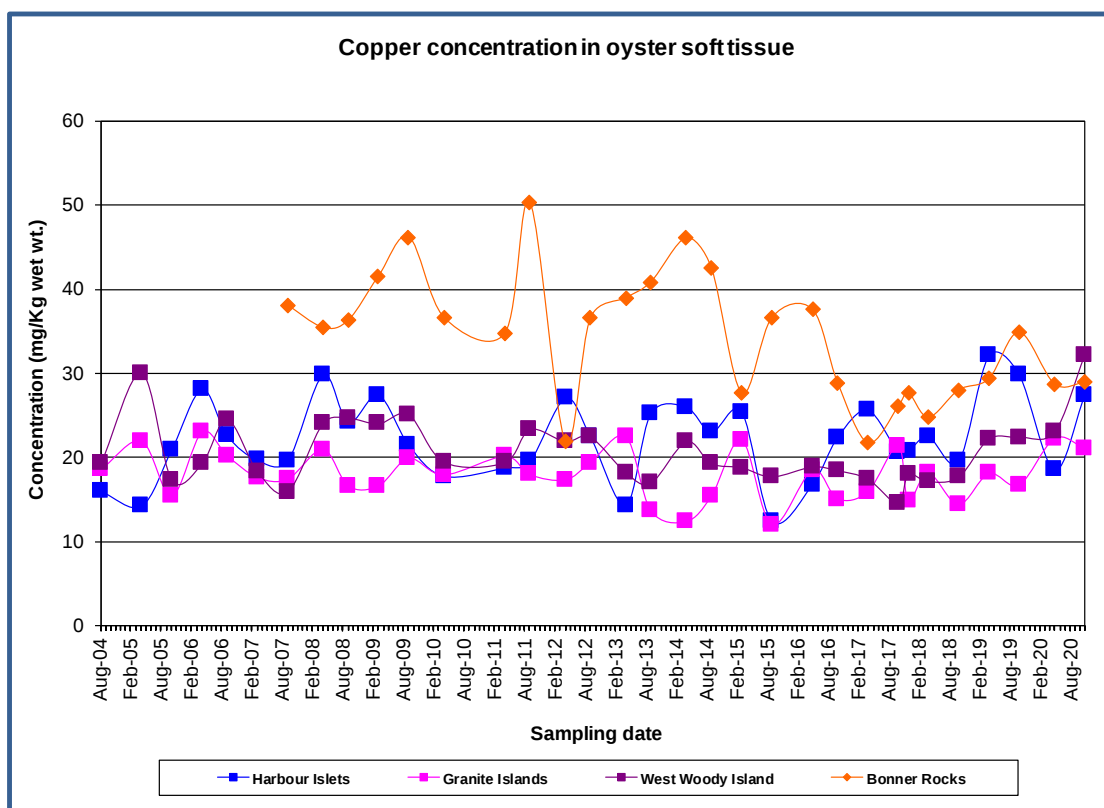


Figure 72. Temporal variations in the average copper (Cu) concentration in oyster soft tissue at Harbour Islets, Granite Islands, West Woody Island, and Bonner Rocks 2004-2020.

4.5.6. Zinc

Zinc (Zn) concentrations in oyster soft tissue samples from 2004-2020 are shown in Figure 73.

Harbour Islet oysters had consistently elevated concentrations of Zn throughout 2004-2020 compared to all other sites. The increased Zn concentrations are likely to reflect a combination of elevated Zn concentrations in refinery waste waters previously discharged from Western Channel (Munksgaard and Parry, 2006c) and other Zn sources such as general port operations in Gove Harbour. Zinc levels in Inner Harbour oysters have declined since Oct. 2017.

The Bonner Rocks and West Woody Island sites had the lowest Zn concentrations measured during 2004-2020.

Zinc concentrations at all sites throughout 2004-2020 were below the ANZFA (2004) food standard (Zn = 1000 mg/kg). However, the current FSANZ (2016) food standards do not contain a maximum permitted level for Zn in food.

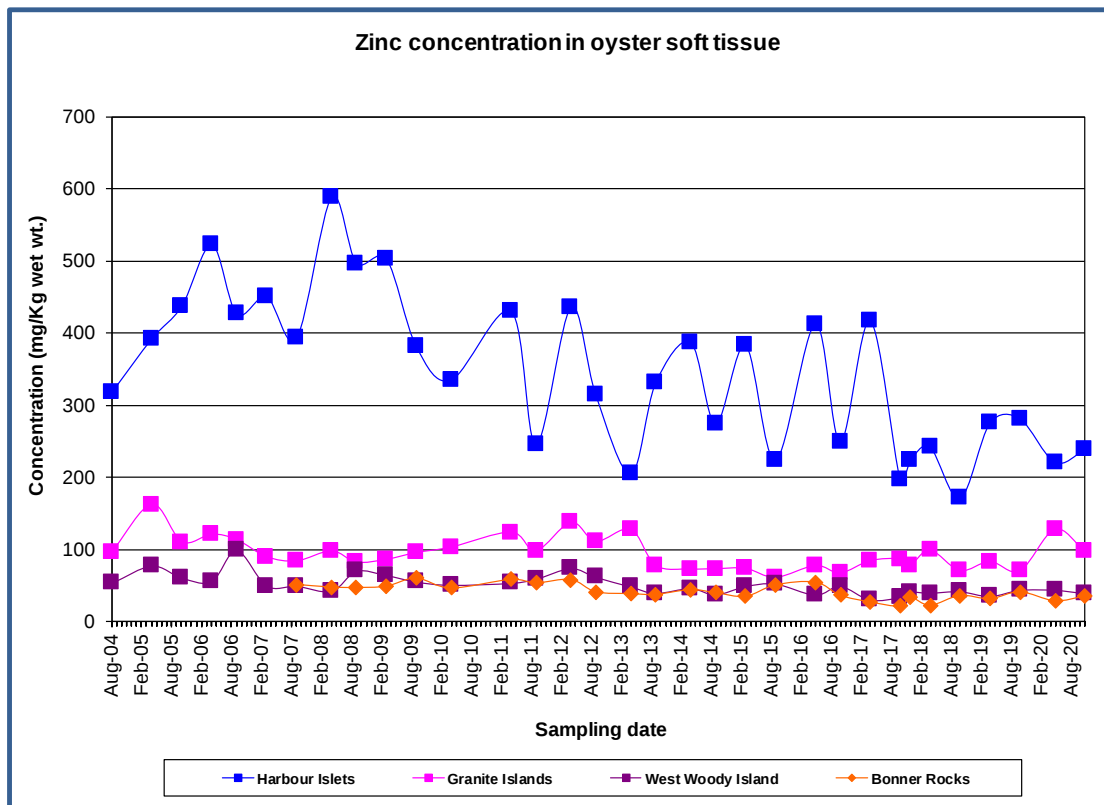


Figure 73. Temporal variations in the average zinc (Zn) concentration in oyster soft tissue at Harbour Islets, Granite Islands, West Woody Island, and Bonner Rocks 2004-2020.

4.5.7. Arsenic

Arsenic (As) concentrations in oyster soft tissue samples from 2004-2020 are shown in Figure 74. During this period, the average As concentrations for the four oyster collection sites were: Harbour Islets: 6.23 +/- 0.72, West Woody Island: 7.36 +/- 0.80, Granite Islands: 6.41 +/- 0.77 and Bonner Rocks: 8.50 +/- 0.56 mg/kg wet weight.

Oyster As concentrations were variable at the four sites sampled throughout 2004-2016 with no overall temporal trend. However, in April and October 2017, As levels in oysters from all four sampling sites increased substantially compared to the previous range of concentrations. Due to the rapid increase in As concentrations an additional sampling round was undertaken in December 2017. Arsenic concentrations at three of the four sampling sites (Bonner Rocks excepted) were substantially lower in December 2017 compared to October 2017 and have returned to the previous range since

then. It is highly likely that the increase in oyster As concentrations during 2017 was part of a natural cycle of environmental changes as the effect was observed at the control site at Bonner Rocks over 15km distant from the refinery.

Total As concentrations measured at all sites throughout 2004-2020 were above the FSANZ (2012) food standard set for inorganic As (1 mg/kg). However, the food standard is for inorganic As only whereas the total As concentration measured in the MHMP program includes both inorganic and organic As.

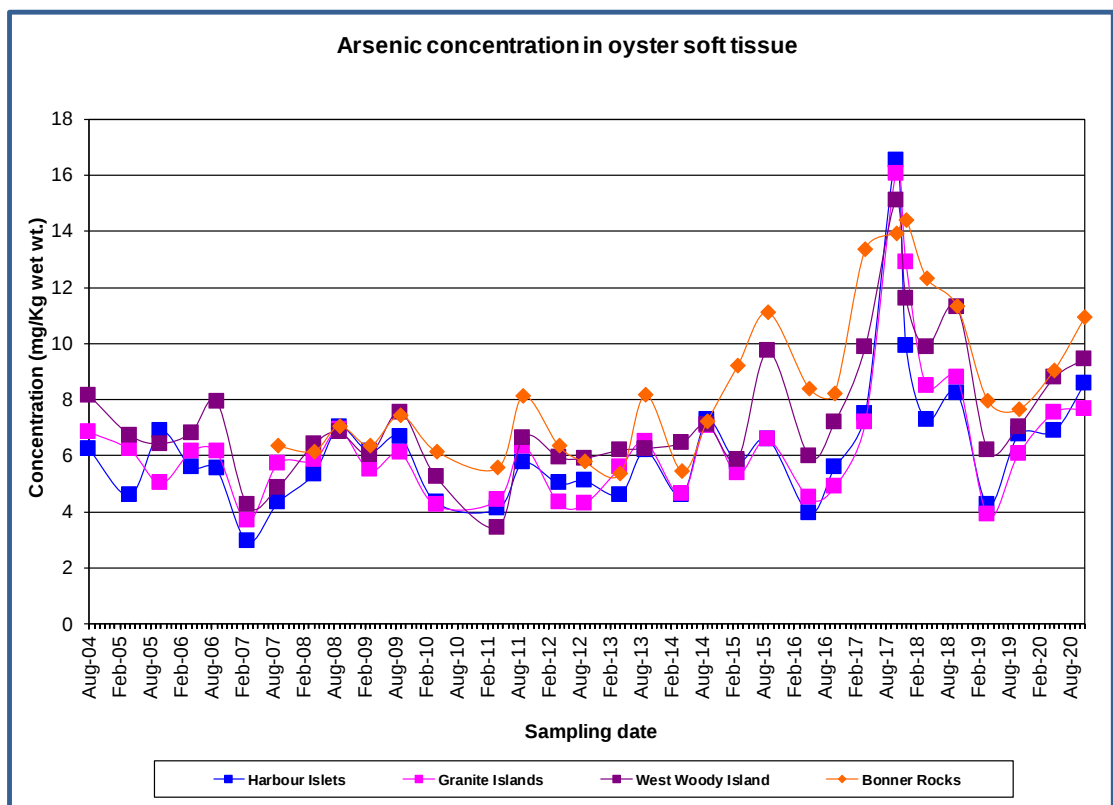


Figure 74. Temporal variations in the average arsenic (As) concentration in oyster soft tissue at Harbour Islets, Granite Islands, West Woody Island, and Bonner Rocks 2004-2020.

The proportion of inorganic and organic As was determined in ten oyster samples collected in April 2009 (Munksgaard 2010). Less than 1% of the total As content were found to be inorganic. Consequently, inorganic As in most oysters sampled from 2004-2019 are highly likely to have been well below the FSANZ maximum permitted level for inorganic As in food (1 mg/kg). This was confirmed by analysis of inorganic As in oysters from April and October 2017 (data reported separately). The maximum inorganic As concentration recorded was 0.4 mg/kg (2.7% of total As) in a sample from Harbour Islets. The average inorganic As concentration was 0.2 mg/kg (n=24).

4.5.8. Gallium

Gallium (Ga) concentrations in oyster soft tissue samples from 2004-2020 are shown in Figure 75.

Gallium concentrations were generally very low (<0.06 mg/kg) in oyster tissues at all sites during 2004-2020. Oysters from Harbour Islets and Granite Islands had variable, but generally higher Ga concentrations than oysters from West Woody Island and Bonner Rocks. However, Ga in oysters from Harbour Islets and Granite islands have been decreasing over the last 15 years. Oysters from Bonner Rocks contain the lowest Ga concentrations amongst all sampled oysters.

There is no FSANZ (2016) food standard for Ga.

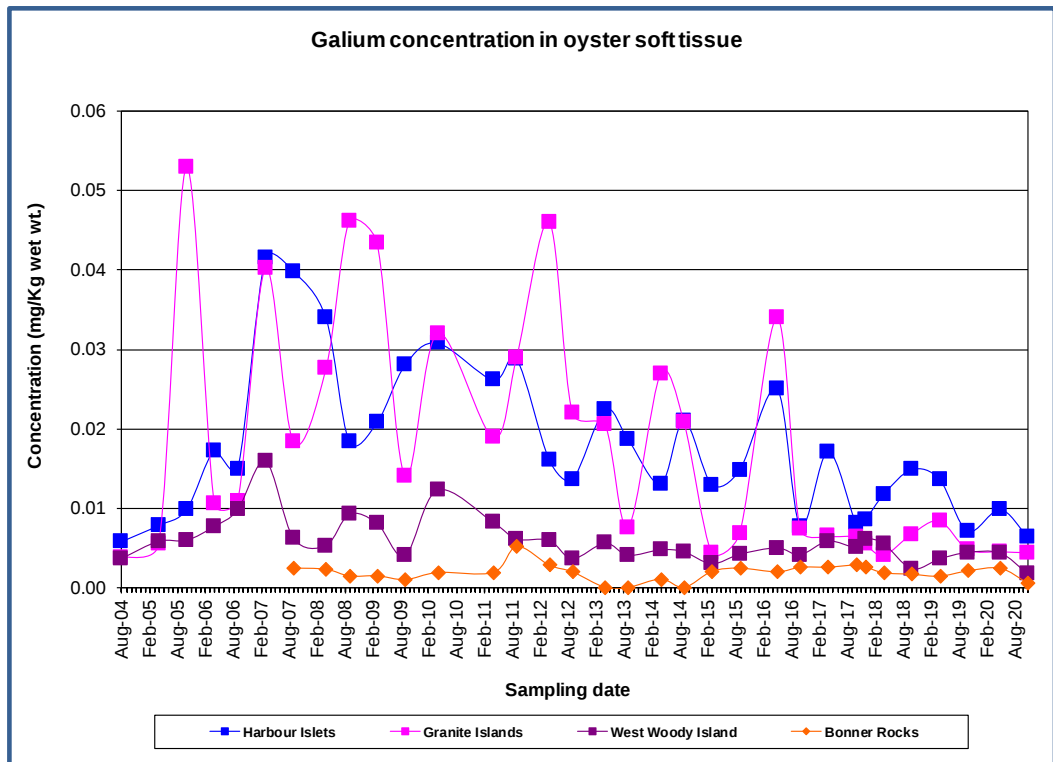


Figure 75. Temporal variations in the average gallium (Ga) concentration in oyster soft tissue at Harbour Islets, Granite Islands, West Woody Island, and Bonner Rocks 2004-2020.

4.5.9. Molybdenum

Molybdenum (Mo) concentrations in oyster soft tissue samples from 2004-2020 are shown in Figure 76.

For the four sites sampled during 2004-20 oyster Mo concentrations were variable with no clear overall temporal trend. During this period, the average Mo concentrations for the four oyster collection sites were: Harbour Islets: 0.34 +/- 0.22, West Woody Island: 0.40 +/- 0.20, Granite Islands: 0.46 +/- 0.215 and Bonner Rocks: 0.12 +/- 0.02 mg/kg wet weight.

There is no FSANZ (2016) food standard for Mo.

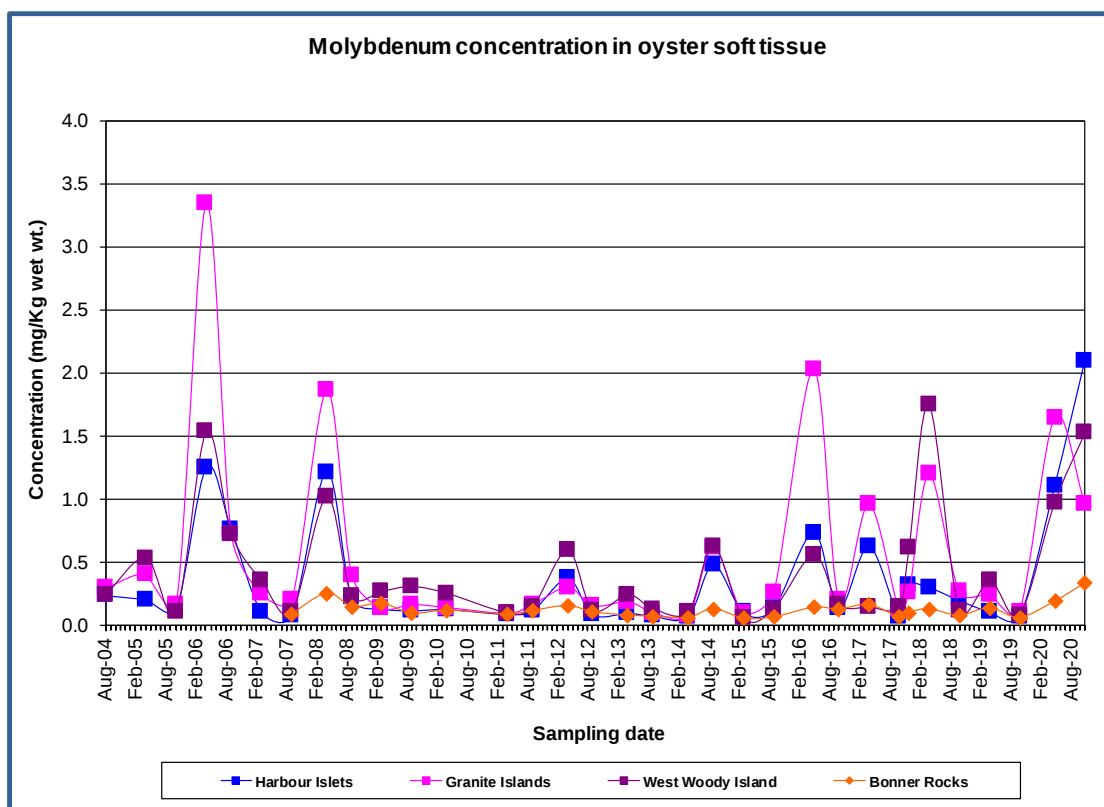


Figure 76. Temporal variations in the average molybdenum (Mo) concentration in oyster soft tissue at Harbour Islets, Granite Islands, West Woody Island, and Bonner Rocks 2004-2020.

4.5.10. Cadmium

Cadmium (Cd) concentrations in oyster soft tissue samples from 2004-2020 are shown in Figure 77.

Harbour Islet oysters had consistently lower concentrations of Cd during 2004-2020 compared to oysters from other sites. The lower Cd concentrations may be explained by competitive Cd exclusion by Zn as the latter metal is in relatively higher concentration in oysters from inner Gove Harbour (Figure 59). Such a mechanism has been shown to occur in trout kidney cells (Gagnon et al, 2007). There is a well correlated inverse

relationship between Zn and Cd concentrations in oysters sampled from all sites throughout 2004-2020 ($R^2 = 0.74$).

Oysters from West Woody Island and Bonner Rocks had the highest Cd concentrations measured during 2004-2020.

Cadmium concentrations in oysters from West Woody Island, Bonner Rocks and Granite Islands (but not Harbour Islets) have exceeded the FSANZ (2016) food standard (Cd = 2 mg/kg wet weight) during most of 2004-2020. However, high Cd concentrations have been reported previously from southern Melville Bay (Noller, 1991; McConchie & Saenger, 1993) and elsewhere along the North Australian coastline (McConchie and Lawrance, 1991; Parry and Munksgaard, unpublished data) and appear to be a natural phenomenon unrelated to anthropogenic sources.

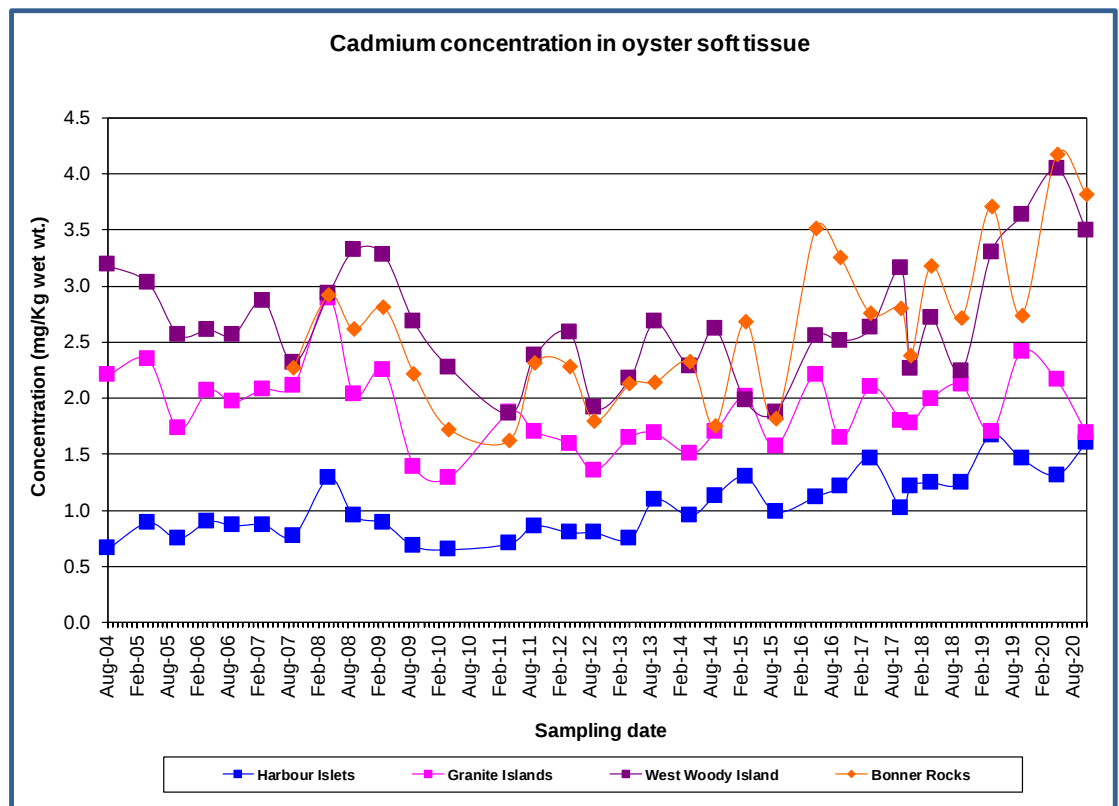


Figure 77. Temporal variations in the average cadmium (Cd) concentration in oyster soft tissue at Harbour Islets, Granite Islands, West Woody Island, and Bonner Rocks 2004-2020.

4.5.11. Other monitored elements

Lead (Pb) concentrations were below 0.1 mg/kg for all samples during 2004-2020 with the exception of one higher concentration of 0.15 mg/kg at West Woody Island in September 2006 (Appendix 4). Oysters from Harbour Islets generally have had slightly higher Pb concentrations during 2004-2020 than

oysters from other sites whereas oysters from the control site at Bonner Rocks had the lowest Pb concentrations. All site-averaged Pb concentrations in oyster soft tissue during 2004-2020 were well below the FSANZ (2016) food standard (Pb = 2.0 mg/kg).

4.6. Summary

The Marine Health Monitoring Program (MHMP) for Rio Tinto Gove's (RTG's) operations in Southern Melville Bay commenced in 2004 and includes sampling and analysis of a range of physico-chemical parameters in seawater, sediment and oysters. RTG's Waste Discharge Licence (WDL 171-10) specifies Trigger Values in seawater at compliance sites near RTG's operations. Sediment and oyster metal/metalloid data are assessed by evaluating temporal trends since 2004 and by comparison to the ANZG (2018) default sediment quality guidelines and the FSANZ food quality standards

Before curtailment in late 2014, the Gove Refinery's principal impact on marine water and sediment quality in Gove Harbour resulted from occasional entrainment of process liquor into the refinery's cooling seawater circuit which was discharged to the harbour. The refinery discharge contained elevated metal and metalloid concentrations (mainly Al, V, Ga, As and Mo) which were incorporated in hydrotalcite-rich precipitates resulting in the formation of an anoxic, microbially active, sulfide-rich sediment with elevated nutrient, metal and metalloid concentrations.

In late 2012, a Waste Water Neutralisation Plant (WWNP) was commissioned to treat liquor from the RDA. The WWNP effluent discharge resulted in an increase in the concentration of mainly V (and lesser amounts of Al, Ga, As and Mo) to Inner Gove Harbour. As a result, dissolved V concentrations in seawater at compliance sites located along the mixing zone boundary increased compared to previous years. Elevated concentrations of dissolved V, compared to background concentrations, have also been measured at several sampling sites outside the mixing zone. Following the curtailment of discharges from the WWNP in March 2018 substantial decreases in the concentrations of V and associated elements in Inner Gove Harbour and parts of Southern Melville Bay were recorded. Intermittent operation of the WWNP re-commenced in April 2020.

4.6.1 Seawater monitoring April 2020 – March 2021:

- Monthly data for monitoring sites along the mixing zone boundary in Inner Gove Harbour showed that all parameters monitored were below the Trigger Values specified by the Waste Discharge Licence (WDL-10).

- Dissolved concentrations of V and associated elements (mainly Al, Ga and As) have remained near background levels at the mixing zone boundary compliance sites in Inner Gove Harbour as well as most other information sites in Southern Melville Bay.
- Total element concentrations at the compliance sites (unfiltered sample) were added to the MHMP program in October 2020. As would be expected, total concentrations of Al and Fe substantially exceeded dissolved concentrations. Total concentrations of Cr, Mn and Ga also exceeded dissolved concentrations of the same metals. In contrast, dissolved phases of V, Cu, Zn, As, Mo and U accounted for almost all the total concentrations of these elements.

4.6.2 Sediment monitoring 2004-2020:

- The most recent sediment survey was conducted in April 2020.
- Several elements are elevated in surface sediment in Inner Gove Harbour compared to background sites. However, since 2006-07 Mg, Zn and Ga concentrations have decreased in surface sediment in Inner Gove Harbour. Vanadium concentrations in sediment increased in 2014 and have been slightly higher in Inner Gove Harbour compared to other monitored areas throughout 2014-20.
- Drimmie Arm sediment had slightly elevated concentrations of As compared to background sediments during 2004-2020. No temporal trends were observed.
- Sediment from Crawford's Creek had slightly elevated TKN and As concentrations compared to background sites. These concentrations can be ascribed to the organic-rich and mud-dominated mangrove environment.
- The concentrations of all parameters monitored in sediment during 2004-2020 were below the ANZG (2018) SQGVs where available.

4.6.3 Oyster monitoring 2004-2020:

- During 2004-20 oysters from Harbour Islets, Granite Islands and West Woody Islands relatively close to the RTG Refinery had higher concentrations of Al and Ga compared to oysters from the more distant background site at Bonner Rocks.
- Oysters from Harbour Islets had elevated Zn and reduced Cd concentrations relative to oysters from other sampling sites. The reduced Cd concentrations are likely to be related to the increased Zn concentration in Gove Harbour due to a mechanism of competitive exclusion of Cd by Zn.

- Cadmium concentrations in oysters from Bonner Rocks, West Woody Island and occasionally Granite Islands have been above the FSANZ food standard (2 mg/kg) during most of the 2004-20 monitoring period. However, this phenomenon appears to have natural causes and have been reported previously from locations in Northern Australia. Cadmium is not a chemical of primary concern in Gove Refinery discharges.
- Total As concentrations in oysters from all four sampling sites increased substantially in April and October 2017 compared to the previous concentrations. However, since 2017 As concentrations at all four sampling sites have been lower, but variable. It is likely that As concentrations in oysters is subject to a naturally occurring environmental cycle.
- Total As in oysters from all sampling sites exceeded the FSANZ maximum permitted concentrations for inorganic As. However, As speciation analyses carried out on samples from 2009 and 2017 showed that inorganic As concentrations were below the FSANZ food standard.
- Lead concentrations in oysters from all sampling sites were below the FSANZ maximum permitted concentrations.

4.6.4 Recommendations:

- It is recommended that monthly sampling and analysis of seawater and annual sampling and analysis of sediment continues as part of the MHMP.
- The oyster monitoring component of the MHMP should also continue unchanged with half yearly sampling. It is the only ongoing biological component of the MHMP and remains an important tool for monitoring of both environmental health and marine food safety.
- Careful monitoring of data quality for water samples should continue to ensure that 'clean' sampling techniques appropriate for trace level metal/metalloid analysis is followed and that recent improvements in MHMP data quality is maintained. Adherence to RTG's field sampling procedures is essential.

5. Acknowledgements

We thank Arafura Diving and Marine Logistics (John Drysdale) for carrying out the field component of the MHMP. Seydou Cisse and Evan Thomas

(RTG) are thanked for logistical support and for supplying data and other information for this report.

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Appendices are provided as electronic files

Appendix 1:

Sampling site coordinates in Southern Melville Bay (Word file 'MHMP sites 2018')

Appendix 2:

Physico-chemical parameters and elemental concentrations in seawater from Southern Melville Bay 2004-2021 (Excel file 'MHMP seawater trends to March 21')

Appendix 3:

Overview of elemental concentrations in sediment from Southern Melville Bay 2004-2020 (Excel file 'MHMP sediment trends to April 2020')

Appendix 4:

Overview of elemental concentrations in oysters from Southern Melville Bay 2004-2020 (Excel file 'MHMP oyster trends to November 2020')

Appendix F – WDL Incident Reports

Notification of an Environmental Incident

☒ Incident☐ Critical Incident☒ Preliminary☐ FinalCompleted form: waste@nt.gov.au

Incident number:	1000556158
Name of mining site:	Rio Tinto - Gove operations
Name of operator:	RTA Gove Pty Limited
Date & time of detection:	Date: 20.08.2020 Time: 13:12
Date & time of incident:	Date: Various June 2020
Name of person notifying:	Ben McTavish
Position/Title:	Environment Superintendent
Contact person:	Ben McTavish
Contact details:	Business: 08 8987 5233 Mobile: 0477 353 879 E-mail: ben.mctavish@riotinto.com
INCIDENT LOCATION (use GPS co-ordinates, attach map, etc. as appropriate)	S1001 Duck Pond- -12.193011, 136.711153S100
INCIDENT DETAIL	A daily pH measurement is required at S1001 as per Table 2 of Appendix 3 of WDL171-08. A review of the S1001 pH dataset has found five days in June 2020 where a daily pH record could not be located. The dates are as follows: • Tuesday 2nd June • Friday 5th June • Sunday 14th June • Wednesday 17th June • Friday 26th June This data gap was discovered during a process improvement project attempting to upload historical data into the site environmental database. A pH reading was likely measured on each of the days. However, no record of the result can be located.

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Rev No:	12	Date of Issue:	2/03/17
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NOTIFICATION OF AN ENVIRONMENTAL INCIDENT

REF: GPM-EHS-020

Causes & contributing factors to the incident:	System of work did not ensure data was input.	
Potential causes & contributing factors to the incident:	To be determined during an investigation.	
Action Taken:	YES ☒	NO ☐
If no, why?		
Corrective Actions that have/will be undertaken to ensure this does not reoccur:	Second check person to ensure that data is always input into work sheet (RDA Engineer). Supervisors have to confirm data is on the visual management board daily and verbally confirm at daily pre-start meeting that the operator has completed all data storage. Operators recording results in field have been instructed to take a photograph of the measurement on screen. The photographic record will not be deleted until each record has been confirmed to have been captured.	

ENVIRONMENTAL DETAILS

Nature of impact and severity: (Volume of spillage, area impacted, wildlife/vegetation/ erosion, etc.)	No environmental impact. Very minimal rainfall during June 2020, so water release from S1001 has been minimal. The pH values on days either side of the missing data were well below the trigger value and limit for S1001.
Emergency & remedial actions taken:	Mandatory monitoring requirement missed only. No environmental impact envisaged.
Current situation: (Potential / ongoing / ceased / etc.)	Data input has recommenced.
Details of any samples taken: (when / where / type / number / time for results /etc)	Due to the gap between occurrence and detection additional monitoring was not able to be employed.

OPERATOR INTERNAL REPORTING

Has the incident been reported internally?	☒ YES		☐ NO
If so, to whom:	Name:	David Bennett	
	Position:	Services Supervisor	

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FRM-EHS-024

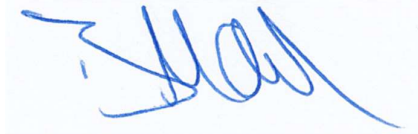
NOTIFICATION OF AN ENVIRONMENTAL INCIDENT

REF: GPM-EHS-020

Has the department been notified earlier?	☒ YES	☐ NO
Who was notified:	Edel Stoner	
How: (phone/email/fax)	Phone	
When: (date & time)	20.08.2020 15:49	
By whom:	Ben McTavish	

Name: Ben McTavish

Signed



Date: 21.08.2020

Title: Environmental Superintendent

OFFICE USE ONLY

Received by: _____

Date: _____

Time: _____

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Notification of an Environmental Incident

☒ Incident☐ Critical Incident☐ Preliminary☒ FinalCompleted form: waste@nt.gov.au & mineral.info@nt.gov.au

Incident number:	1000552308
Name of mining site:	Rio Tinto - Gove operations
Name of operator:	RTA Gove Pty Limited
Date & time of detection:	Date: 29/06/20 Time: Approximately 0000hrs
Date & time of incident:	Date: 29/06/20 Time: Approximately 0000hrs
Name of person notifying:	Ben McTavish
Position/Title:	Environment Superintendent
Contact person:	As above
Contact details:	Business: 08 8987 5233 Mobile: 0477 353 879
	E-mail: ben.mctavish@riotinto.com
INCIDENT LOCATION (use GPS co-ordinates, attach map, etc. as appropriate)	Seawater Outfall Station: Waste Discharge Licence (WDL) monitoring location S001 (grab sample).
Causes & contributing factors to the incident:	The root cause of the arsenic spike was determined to be the poor neutralisation reaction resulting in carry-over of arsenic. The poor reaction was due to low aluminium and/or caustic concentration in the SPL stream. The SPL from Tank Farm was transferred in batches from different tanks within the Harbour Tank Farm. This batching process created separation in the SPL tank feeding WWNP as the Tank Farm SPL tanks contain various caustic and aluminium concentration.

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Potential causes & contributing factors to the incident:	Potential other causes: - Arsenic spike in the inlet streams to the mixing tank. SPL and SNL sample were within usual range at 1:20am just prior to the plant shut down. Seawater sample taken the following day was also normal. - Poor reaction due to insufficient aluminium and/or caustic present in the mixing tank. Aluminium was found sufficient in SPL sample (50g/L) at 1:20am sample just prior to shut down. In addition, the laboratory neutralisation reaction using the incident time SPL and SNL samples confirmed the good reaction and 96% arsenic removal. However, it is still possible that a low quality SPL (low aluminium/caustic) or SNL (high arsenic) has gone to the plant in the 4 hours prior to sampling time.	
Action Taken:	YES ☒	NO ☐
If no, why?		
Corrective Actions that have/will be undertaken to ensure this does not reoccur:	Rio Tinto Gove Operations have established an enhanced monitoring plan in place at this location whilst the Waste Water Neutralisation Plant (WWNP) is in operation, which was 4-hourly monitoring on this occasion. This represents a significant investment in process improvement which includes additional night shift chemist, plant operators and site-based lab for rapid chemistry analysis. The following actions were/have been taken: - Plant shutdown at ~01:20 Monday 29/06/20 based on the action plans designed in WWNP Trigger Action Response Plan (TARP). - The neutralisation test was done at site laboratory using the time of incident SPL and SNL samples. - The last Neutralised SNL (plant discharge to sea water channel) and S001 samples prior to shutdown were sent to the external lab (NATA-Accredited) for comparison. - Restart the plant from minimum SNL rate following with the gradual ramp-up strategy. Any step changes will be based on the lab results. - Hourly sampling regime instead of 4-hourly for start-up of the plant and process step-changes. - Continuation of using strong SPL source from Tank Farm to ensure a uniform SPL feed to WWNP and improve the neutralisation reaction.	

ENVIRONMENTAL DETAILS

Nature of impact and severity: (Volume of spillage, area impacted, wildlife/vegetation/erosion, etc.)	There was no observed impact to the environment. The elevated arsenic concentration could only have occurred for less than 10 hours (see data in Details of samples section below). The arsenic concentration at S074 (24-hour composite sample spanning the time of the incident) at the same location as S001 reported an arsenic concentration of 9.7 µg/L, which is less than half the WDL Limit for that location. Also there is a minimum of 1:5 dilution within 100m of the end of the discharge channel. The concentration of dissolved As that protects 99% of species (the highest level of protection for high ecological value ecosystems) is 7.5µg/L. Therefore, if the maximum discharge concentration was 32µg/L dissolved As (as shown in Table below) that
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	would have resulted in a concentration <99% protection level in the receiving environment. This is a very conservative assessment as inner Gove Harbour is slightly to moderately disturbed which requires a 95% level of protection which is 20µg/L. [REFERENCE: VAN DAM J.W. 2017. ASSESSING THE BIOLOGICAL EFFECTS OF ARSENATE ON TROPICAL MARINE BIOTA. REPORT PREPARED FOR RIO TINTO. AUSTRALIAN INSTITUTE OF MARINE SCIENCE, DARWIN. (49 PP)]																														
Emergency & remedial actions taken:	There was no observed impact to the environment.																														
Current situation: (Potential / ongoing / ceased / etc.)	WWNP has been back online since 01/07/20 and running with full capacity while all parameters at the S001/S074 are well below WDL limits.																														
Details of any samples taken: (when / where / type / number / time for results /etc)	Following a power outage, the WWNP was restarted on 28/06/20 at 1600 hours. The 1st 4-hourly sample was collected at 20:00 hours (as per procedure) and site laboratory analysis showed elevated arsenic levels at S001. Additional samples were collected and analysed as per below. The sample analysed from S074 (24hr composite sample) was below the WDL limit (9.6µg/L). The below table provides details of date, time, sample location and comparison between RTA lab and ALS (NATA accredited) laboratory results. <table border="1"> <thead> <tr> <th>Date</th><th>Time</th><th>Location</th><th>As [µg/L] RT Lab</th><th>As [µg/L] - NATA Lab</th></tr> </thead> <tbody> <tr> <td>28/6/20</td><td>20:00</td><td>S001</td><td>24</td><td>26.1</td></tr> <tr> <td>29/6/20</td><td>0:00</td><td>S001</td><td>28.1</td><td>31.7</td></tr> <tr> <td>29/6/20*</td><td>1:20</td><td>S001</td><td>22.7</td><td>25.2</td></tr> <tr> <td>29/6/20</td><td>8:00</td><td>S074</td><td>9.6</td><td>9.7</td></tr> <tr> <td>29/6/20</td><td>8:00</td><td>S001</td><td>2.2</td><td>3.4</td></tr> </tbody> </table> * All samples were received and then WWNP shut down for investigation at approximately 1:20am 29/06/20. These samples were initially analysed at our site laboratory. Following identification of elevated arsenic, the samples for the matching time periods were sent off site to a NATA-accredited laboratory. Overall the result from the two laboratories reported very similar results, which provides confidence in the site laboratory to provide reliable analytical results.	Date	Time	Location	As [µg/L] RT Lab	As [µg/L] - NATA Lab	28/6/20	20:00	S001	24	26.1	29/6/20	0:00	S001	28.1	31.7	29/6/20*	1:20	S001	22.7	25.2	29/6/20	8:00	S074	9.6	9.7	29/6/20	8:00	S001	2.2	3.4
Date	Time	Location	As [µg/L] RT Lab	As [µg/L] - NATA Lab																											
28/6/20	20:00	S001	24	26.1																											
29/6/20	0:00	S001	28.1	31.7																											
29/6/20*	1:20	S001	22.7	25.2																											
29/6/20	8:00	S074	9.6	9.7																											
29/6/20	8:00	S001	2.2	3.4																											

OPERATOR INTERNAL REPORTING

Has the incident been reported internally?	☒ YES	☐ NO
If so, to whom:	Name:	Matt Mafu
	Position:	Acting Manager – Gove Closure

Document Owner:	Environmental Advisor	Authorised By:	HSE Superintendent
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FRM-EHS-024

NOTIFICATION OF AN ENVIRONMENTAL INCIDENT

REF: GPM-EHS-020

Has the department been notified earlier?	☒ YES	☐ NO
Who was notified:	DENR and DPIR	
How: (phone/email/fax)	Email	
When: (date & time)	30/06/2020 14:57	
By whom:	Ben McTavish	

Name: Ben McTavish

Signed

BMcTavish

Date:

13 August 2020

Title: Environment Superintendent

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Date: _____

Time: _____

Document Owner:	<i>Environmental Advisor</i>	Authorised By:	<i>HSE Superintendent</i>
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Notification of an Environmental Incident

☒ Incident☐ Critical Incident☒ Preliminary☐ Final

Completed waste@nt.gov.au
form:

Incident number:	1000555719
Name of mining site:	Rio Tinto - Gove operations
Name of operator:	Alcan Gove Pty Limited
Date & time of detection:	Date: 12/08/2020 Time: 11:30hrs
Date & time of incident:	Date: 12/08/2020 Time: 08:30hrs
Name of person notifying:	Ben McTavish
Position/Title:	Environment Superintendent
Contact person:	Ben McTavish
Contact details:	Business: 08 8987 52332 Mobile: 0477 353 879
	E-mail: ben.mctavish@riotinto.com
INCIDENT LOCATION (use GPS co-ordinates, attach map, etc. as appropriate)	S074 -12.19229, 136.68448 Seawater Outfall, Gove Operations

Document Owner:	<i>Environmental Advisor</i>	Authorised By:	<i>HSE Superintendent</i>
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NOTIFICATION OF AN ENVIRONMENTAL INCIDENT

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Causes & contributing factors to the incident:	The daily composite water sample collected at the Refinery sea water outfall channel (S074) is collected using a peristaltic sampler. The flexible sample tubing wasn't located inside the sample collection bucket, resulting in no water being collected. As a result, no daily sample is available to be analysed for S074 for 12 August 2020 as per Appendix 3 Table 1 of WDL171-09.	
Potential causes & contributing factors to the incident:	Human error - sampling tube was omitted from the sample collection bucket.	
Action Taken:	YES ☒	NO ☐
If no, why?		
Corrective Actions that have/will be undertaken to ensure this does not reoccur:	Staff reminded to ensure sampling tube is included in sample collection bucket Grab sample collected and analysed for identical parameters.	

ENVIRONMENTAL DETAILS

Nature of impact and severity: (Volume of spillage, area impacted, wildlife/vegetation/ erosion, etc.)	No environmental impact.
Emergency & remedial actions taken:	Sampling tube located back in sample collection bucket.
Current situation: (Potential / ongoing / ceased / etc.)	Sampling tube located in sample collection bucket. The Laboratory continues to do 4 hourly grab S001 samples for the WWNP re-commissioning.
Details of any samples taken: (when / where / type / number / time for results /etc)	A grab sample at S001 (same physical location as S074) was collected and analysed for the same parameters as required for S074.

OPERATOR INTERNAL REPORTING

Has the incident been reported internally?	☒ YES	☐ NO
If so, to whom:	Name: Jon Regan	
	Position: Specialist - Laboratory	
Has the department been notified earlier?	☒ YES	☐ NO

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FRM-EHS-024

NOTIFICATION OF AN ENVIRONMENTAL INCIDENT

REF: GPM-EHS-020

Who was notified:	Edel Stoner
How: (phone/email/fax)	Email.
When: (date & time)	09:30 13/08/2020
By whom:	Ben McTavish

Name: Ben McTavish

Signed

B McTavish

Date:

13/08/2020

Title: Environment Superintendent

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Received by: _____

Date: _____

Time: _____

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Notification of an Environmental Incident

☒ Incident ☐ Critical Incident ☒ Preliminary ☐ Final

Completed form: waste@nt.gov.au & mineral.info@nt.gov.au

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Incident number:	1000580958 (Condition 27)
Name of mining site:	RTA Gove
Name of operator:	RTA Gove Pty Limited
Date & time of detection:	Date: 02/07/2021 Time: -
Date & time of incident:	Date: 17/09/2020 – 15 /10/2020 Time: N/A
Name of person notifying:	Ben McTavish
Position/Title:	Environment Superintendent
Contact person:	Ben McTavish
Contact details:	Business:08 8987 5233 Mobile: 0477 353 879
	E-mail: ben.mctavish@riotinto.com
INCIDENT LOCATION (use GPS co-ordinates, attach map, etc. as appropriate)	S074

Document Owner:	Senior Advisor Environment – Gove	Authorised By:	Specialist Environment – Gove
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INCIDENT DESCRIPTION (attach photos if available)	Data gap for daily TSS monitoring at S074 (Condition 27) While conducting the annual audit on WDL monitoring, a data gap was identified for daily TSS as required under WDL171-10. Previously, TSS for S074 was required monthly and analysis was being conducted by external lab. WDL171-10 issued to RTA Gove on 17/09/2020 changed TSS monitoring frequency to daily. Data gap corresponds to period of WDL171-10 introduction and the internal lab capabilities to monitor TSS.	
Causes & contributing factors to the incident:	Internal lab did not have capacity to monitor TSS and equipment required procurement. RTA Gove is unable to provide written correspondence that this potential for a gap in data was highlighted during the WDL amendment.	
Potential causes & contributing factors to the incident:	RTA Gove location is remote, procurement and commissioning of such equipment take time to implement.	
Action Taken:	YES ☒	NO ☐
If no, why?		
Corrective Actions that have/will be undertaken to ensure this does not reoccur:	Equipment have since been sourced and installed. Daily TSS is now being tested onsite.	

ENVIRONMENTAL DETAILS

Nature of impact and severity: (Volume of spillage, area impacted, wildlife/vegetation/ erosion, etc.)	This was more a change to monitoring frequency rather than an environmental release that has the potential to impact the surrounding environment. Current monitoring data for TSS have been reported with the range of 1-28mg/L. Based on this, RTA Gove anticipate no environmental impact.
Emergency & remedial actions taken:	N/A
Current situation: (Potential / ongoing / ceased / etc.)	TSS monitoring device has since been sourced and installed. Daily monitoring is now being conducted onsite.
Details of any samples taken: (when / where / type / number / time for results /etc) If incident is related to Total Nitrogen, refer to WDL171-10 section 38.8 for further analysis.	No sample was taken since this is not a release event likely to cause exceedance to WDL conditions.

OPERATOR INTERNAL REPORTING

Has the incident been reported internally?	☒ YES	☐ NO
If so, to whom:	Name: Jon Regan Position: Specialist Laboratory b	

Has the department been notified earlier?	☐ YES	☒ NO
Who was notified:		
How: (phone/email/fax)		
When: (date & time)		
By whom:		

Name: Ben McTavish

Signed

B McTavish

Date:

2 July 2021

Title: Environment Superintendent

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Date: _____

Time: _____

Document Owner: Senior Advisor Environment – Gove Authorised By: Specialist Environment – Gove

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Notification of an Environmental Incident

☒ Incident
 ☐ Critical Incident
 ☒ Preliminary
 ☐ Final

Completed waste@nt.gov.au & mineral.info@nt.gov.au
form:

Incident number:	TBD
Name of mining site:	Rio Tinto - Gove operations
Name of operator:	RTA Gove Pty Limited
Date & time of detection:	Date: 01/07/21 Time: -
Date & time of incident:	Date: 14-17/10/20 Time: -
Name of person notifying:	Ben McTavish
Position/Title:	Environment Superintendent
Contact person:	Ben McTavish
Contact details:	Business: 08 8987 5233 Mobile: 0477 353 879
	E-mail: ben.mctavish@riotinto.com
INCIDENT LOCATION (use GPS co-ordinates, attach map, etc. as appropriate)	S001 Outfall -12.19229, 136.68448
INCIDENT DESCRIPTION (attach photos if available)	WDL 171-10, Condition 27 Continuous measurements of pH and Electrical Conductivity are required at S001 as per Table 1 of Appendix 2 of WDL 171-10. During annual review of monitoring data, it was noticed that continuous data for pH and EC were not recorded from 14 & 17 October 2020 at S001. Recording for pH and EC stopped on 14/10/2020 at 09.00Hrs and continued until on 17/10/2020 at 07.30hrs when discharge was ceased in the channel.
Causes & contributing factors to the incident:	Failure of Transmitter due to communication issues.
Potential causes & contributing factors to the incident:	During the period of the incidents, the site faced regular power outages which caused communication faults and affected Transmitter.

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Action Taken:	YES ☒	NO ☐
If no, why?		
Corrective Actions that have/will be undertaken to ensure this does not reoccur:	RTA Gove is continually working on improving the compliance checking for WDL monitoring. This work is on-going to prevent delayed notifications of WDL data gaps. This data loss is also related to the transmitter failure on 19 October and the corrective actions related to that incident are deemed sufficient to address this transmitter failure.	

ENVIRONMENTAL DETAILS

Nature of impact and severity: (Volume of spillage, area impacted, wildlife/vegetation/ erosion, etc.)	There was only seawater flowing in the seawater channel during the incident period. WWNP was offline. Daily pH were below WDL trigger values and EC readings were within normal range for seawater. The environmental impact is considered to be very low.																										
Emergency & remedial actions taken:	Set up an alert system for the Control Room to identify and report abnormal function of the monitoring devices.																										
Current situation: (Potential / ongoing / ceased / etc.)	Monitoring devices are currently operating normally. Data are being recorded in PI System.																										
Details of any samples taken: (when / where / type / number / time for results /etc)	Routine WDL monitoring were conducted during the time of incident. Table 1 below presents daily pH and EC recorded prior and after the incident period. <table border="1"> <tr> <th></th> <th>Unit</th> <th>13/10</th> <th>14/10</th> <th>15/10</th> <th>16/10</th> <th>17/10</th> </tr> <tr> <td>pH</td> <td>pH unit</td> <td>8.2</td> <td>8.1</td> <td>8.1</td> <td>8.0</td> <td>8.0</td> </tr> <tr> <td>EC</td> <td>mS/cm</td> <td>52.6</td> <td>52.3</td> <td>52.3</td> <td>52.5</td> <td>52.5</td> </tr> </table>							Unit	13/10	14/10	15/10	16/10	17/10	pH	pH unit	8.2	8.1	8.1	8.0	8.0	EC	mS/cm	52.6	52.3	52.3	52.5	52.5
	Unit	13/10	14/10	15/10	16/10	17/10																					
pH	pH unit	8.2	8.1	8.1	8.0	8.0																					
EC	mS/cm	52.6	52.3	52.3	52.5	52.5																					

OPERATOR INTERNAL REPORTING

Has the incident been reported internally?	☒ YES		☐ NO
If so, to whom:	Name:	Steve Moratti	
	Position:	Utilities Superintendent	

Has the department been notified earlier?	☐ YES	☒ NO
Who was notified:		
How: (phone/email/fax)		
When: (date & time)		

Document Owner: <i>Environmental Advisor</i>	Authorised By: <i>HSE Superintendent</i>		
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FRM-EHS-024

NOTIFICATION OF AN ENVIRONMENTAL INCIDENT

REF: GPM-EHS-020

By whom:

Name: Ben McTavish

Signed *B McTavish*

Date: 01/07/2021

Title:

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Date:

Time:

Document Owner: *Environmental Advisor*Authorised By: *HSE Superintendent*

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Notification of an Environmental Incident

☒ Incident
 ☐ Critical Incident
 ☐ Preliminary
 ☒ Final

Completed form: waste@nt.gov.au & mineral.info@nt.gov.au

Incident number:	1000561236		
Name of mining site:	Rio Tinto - Gove operations		
Name of operator:	RTA Gove Pty Limited		
Date & time of detection:	Date: 19.10.2020	Time: 16:00	
Date & time of incident:	Date: 19.10.2020	Time: 14:51	
Name of person notifying:	Ben McTavish		
Position/Title:	Environment Superintendent		
Contact person:	Ben McTavish		
Contact details:	Business: 08 8987 5233 Mobile: 0477 353 879		
	E-mail: ben.mctavish@riotinto.com		
INCIDENT LOCATION (use GPS co-ordinates, attach map, etc. as appropriate)	S001 Outfall -12.19229, 136.68448		
INCIDENT DESCRIPTION (attach photos if available)	Continuous measurements of pH and Electrical Conductivity are required at S001 as per Table 1 of Appendix 2 of WDL 171-10, as per Condition 27 . It was noticed at 16:00 19.10.2020 and reported to the Environment team at 17:15 19.10.2020 that a failure of the S001 transmitter had occurred. Subsequently a gap in continuous monitoring data has been observed since 14:51 19.10.2020.		
Causes & contributing factors to the incident:	S001 data transmitter (equipment) failure.		
Potential causes & contributing factors to the incident:	N/A		
Action Taken:	YES ☒	NO ☐	
If no, why?			

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NOTIFICATION OF AN ENVIRONMENTAL INCIDENT

REF: GPM-EHS-020

Corrective Actions that have/will be undertaken to ensure this does not reoccur:	Initially: - Hourly pH and EC readings during release. - Ceased release at S001 09:19 20.10.2020. Since initial notification: - Device has been reconfigured to become operational - A replacement transmitter has been ordered to be kept in stock as a spare
---	--

ENVIRONMENTAL DETAILS

Nature of impact and severity: (Volume of spillage, area impacted, wildlife/vegetation/ erosion, etc.)	No rainfall has occurred over the last seven days and the WWNP has been shut off. Therefore, only seawater has been released at S001. As a result of the incident, seawater pumps have been turned off. RTA Gove conclude no environmental impact.
Emergency & remedial actions taken:	Commencement of hourly readings at S001 until cessation of discharge.
Current situation: (Potential / ongoing / ceased / etc.)	Initially the discharge was ceased the following morning. Discharge has only occurred since when the transmitter has been functional. Current situation: Seawater pumps are online. Transmitter has been remedied. Spare unit on order.
Details of any samples taken: (when / where / type / number / time for results /etc)	Hourly readings were taken at S001 until flow was ceased.

OPERATOR INTERNAL REPORTING

Has the incident been reported internally?	☒ YES	☐ NO
If so, to whom:	Name:	Steve Moratti
	Position:	Utilities Superintendent

Has the department been notified earlier?	☒ YES	☐ NO
Who was notified:	Sally-Anne Orchard	
How: (phone/email/fax)	Phone	
When: (date & time)	20.10.2020 11:00	

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FRM-EHS-024

NOTIFICATION OF AN ENVIRONMENTAL INCIDENT

REF: GPM-EHS-020

By whom:

Ben McTavish

Name: Ben McTavish

Signed

BMcTavish

Date:

03.12.2020

Title: Environment Superintendent

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Date:

Time:

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Notification of an Environmental Incident

☒ Incident ☐ Critical Incident ☒ Preliminary ☐ Final

Completed form: waste@nt.gov.au & mineral.info@nt.gov.au

Incident number:	1000561923
Name of mining site:	Rio Tinto - Gove operations
Name of operator:	RTA Gove Pty Limited
Date & time of detection:	Date: 26/10/20 Time: 0900
Date & time of incident:	Date: 26/10/20 Time: 0800
Name of person notifying:	Ben McTavish
Position/Title:	Environment Superintendent
Contact person:	Ben McTavish
Contact details:	Business: 08 8987 5233 Mobile: 0477 353 879
	E-mail: Ben.McTavish@riotinto.com
INCIDENT LOCATION (use GPS co-ordinates, attach map, etc. as appropriate)	S001 Outfall Station Coordinates in GDA 1994 MGA Zone 53 Easting: 683264.8793 Northing: 8651609.938
INCIDENT DESCRIPTION (attach photos if available)	Continuous pH and EC were not recorded for one hour on 26/10/2020. This notification is associated with condition 27 of WDL171-10.
Causes & contributing factors to the incident:	The pH and EC readings are collected from a monitoring trough at S001 that is supplied by a pump within the sea water channel. Routine cleaning of the trough and monitoring equipment required the pump to be isolated. Upon completion of routine cleaning the final check for returned flow to the trough was not completed.
Potential causes & contributing factors to the incident:	The laboratory officer was occupied by another task at the monitoring station.

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Action Taken:	YES ☒	NO ☐
If no, why?		
Corrective Actions that have/will be undertaken to ensure this does not reoccur:	- Pump was activated and water flow was returned to the trough. - Issue was discussed at team pre-start meetings with the responsible workgroup. - Work Instruction to be updated.	

ENVIRONMENTAL DETAILS

Nature of impact and severity: (Volume of spillage, area impacted, wildlife/vegetation/ erosion, etc.)	The current inputs to S001 are seawater and treated SNL. The Waste Water Neutralisation Plant operations had no deviations in the process during the time of this incident and recorded a stable continuous pH of SNL leaving the plant. S074 composite sample returned satisfactory pH and EC results for the elapsed 24hrs since the incident. Therefore, RTA Gove believe the inputs to the system were consistent and the environment remained protected.
Emergency & remedial actions taken:	N/A
Current situation: (Potential / ongoing / ceased / etc.)	Working as per requirements
Details of any samples taken: (when / where / type / number / time for results /etc) If incident is related to Total Nitrogen, refer to WDL171-10 section 38.8 for further analysis.	N/A

OPERATOR INTERNAL REPORTING

Has the incident been reported internally?	☒ YES	☐ NO
If so, to whom:	Name: Jon Regan Position: Specialist - Laboratory	

Has the department been notified earlier?	☒ YES	☐ NO
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Who was notified:	Sally-Anne Orchard
How: (phone/email/fax)	Phone and email follow-up
When: (date & time)	26/10/20 16:20
By whom:	Ben McTavish

Name: Ben McTavish

Signed: *BMcTavish*

Date: 27/10/20

Title: Environment Superintendent

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Received by:

Date: Time:

Document Owner:	Senior Advisor Environment – Gove	Authorised By:	Specialist Environment – Gove
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Notification of an Environmental Incident

☒ Incident☐ Critical Incident☒ Preliminary☐ Final

Incident number:	1000578911	
Name of mining site:	Rio Tinto - Gove operations	
Name of operator:	RTA Gove Pty Limited	
Date & time of detection:	Date: 02/06/2021	Time: 3:45 PM
Date & time of incident:	Date: Nov 2020	Time: N/A
Name of person notifying:	Ben McTavish	
Position/Title:	Environment Superintendent	
Contact person:	Ben McTavish	
Contact details:	Business: 08 8987 5233 Mobile: 0477 353 879	
	E-mail: ben.mctavish@riotinto.com	
INCIDENT LOCATION (use GPS co-ordinates, attach map, etc. as appropriate)	Authorised monitoring point S074.	
INCIDENT DESCRIPTION (attach photos if available)	Metal and metalloid samples are required to be collected monthly at S074 as per Table 3 in Appendix 2 of WDL171-10 (Condition 27). It was identified that metal/metalloids sample was not collected in the calendar month of November 2020.	
Causes & contributing factors to the incident:	The discharge from the seawater channel ceased on 10 November 2020, which was prior to the date scheduled to sample S074 for metal/metalloids. There were no further releases from the sea water channel until early December. The result was that a monthly sample during November at S074 was not able to be collected. The previous S074 sample was collected on 27 October, which was only 2 weeks prior to the cease of discharge.	
Potential causes & contributing factors to the incident:	Cease of discharge resulting in a sample not being able to be collected.	
Action Taken:	YES ☐	NO ☒
If no, why?	No sample was able to be collected.	
Corrective Actions that have/will be undertaken to ensure this does not reoccur:	Pending investigation.	

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ENVIRONMENTAL DETAILS

Nature of impact and severity: (Volume of spillage, area impacted, wildlife/vegetation/ erosion, etc.)	There is no indication of any environmental impact.
Emergency & remedial actions taken:	N/A
Current situation: (Potential / ongoing / ceased / etc.)	Monitoring is currently occurring in accordance with the WDL.
Details of any samples taken: (when / where / type / number / time for results /etc) If incident is related to Total Nitrogen, refer to WDL171-10 section 38.8 for further analysis.	Additional samples are collected and analysed through the internal laboratory. Details of those samples and results will be provided in the subsequent notification after investigation.

OPERATOR INTERNAL REPORTING

Has the incident been reported internally?	☒ YES	☐ NO
If so, to whom:	Name:	Ben McTavish
	Position:	Environment Superintendent

Has the department been notified earlier?	☒ YES	☐ NO
Who was notified:	Sally-Anne Orchard	
How: (phone/email/fax)	Phone	
When: (date & time)	03/06/2021 1:10 PM	
By whom:	Ben McTavish	

Name: Ben McTavish

Signed *B McTavish*

Title:

Date: 03/06/2021

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Notification of an Environmental Incident

☒ Incident ☐ Critical Incident ☒ Preliminary ☐ Final

Completed form: waste@nt.gov.au & mineral.info@nt.gov.au

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Incident number:	1000564793
Name of mining site:	Rio Tinto - Gove operations
Name of operator:	RTA Gove Pty Limited
Date & time of detection:	Date: 01/12/2020 Time: 7.30hrs
Date & time of incident:	Date: 30/11/2020 Time: 17.00hrs
Name of person notifying:	Seydou Cisse
Position/Title:	Senior Advisor, Environment
Contact person:	Seydou Cisse
Contact details:	Business: 08 8987 5219 Mobile: 0427 806 346
	E-mail: Seydou.Cisse@riotinto.com
INCIDENT LOCATION (use GPS co-ordinates, attach map, etc. as appropriate)	Boat Ramp sampling at S094 (AGD 84 E/N 683243.3; 8651242.5)
INCIDENT DESCRIPTION (attach photos if available)	WDL171-10 requires, under condition 27, that Gove Operations collect monthly water sample at the Public Boat Ramp for bacterial analysis (Enterococci) as per WDL Table 3 of Appendix 2. An initial sampling was planned for Wednesday 25/11/2020; however, sampling did not take place as it was found the laboratory would only accept bacterial samples at the beginning of the week (Monday and Tuesday). Sampling was then conducted early on Monday 30/11/2020 for dispatch on the 07:00 flight. Unfortunately, that flight was cancelled. Another sample was collected at 13:30 for the dispatch on the afternoon flight. The afternoon flight was overcrowded and the airline decided to remove some freight, including Gove bacterial samples.

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Causes & contributing factors to the incident:	There have been ongoing and increasing changes in the flight movements from and to Gove in the past few weeks, included significant flight delays and cancellation.	
Potential causes & contributing factors to the incident:	The potential causes that led to this incident are the timing for sampling. If sampling was planned and executed in earlier days of the month, the business would have had enough time to collect another sample should there be issues with the flight.	
Action Taken:	YES ☒	NO ☐
If no, why?		
Corrective Actions that have/will be undertaken to ensure this does not reoccur:	Additional sample will be collected today (01/12/2020) to be dispatched in the afternoon flight. Future sampling requiring bacterial analyses will be planned for early in the month to enable the business to adjust to changes in flight movements.	

ENVIRONMENTAL DETAILS

Nature of impact and severity: (Volume of spillage, area impacted, wildlife/vegetation/ erosion, etc.)	There is no environmental impact anticipated from this incident. Effluent from the Sewerage Treatment Plant is not currently being discharged into the Seawater Channel. The WWNP was shutdown on 2 November and remained offline for the rest of the month. No discharge occurred from the Seawater Channel since 2 November.
Emergency & remedial actions taken:	Organise collection of another sample for dispatch in the afternoon flight of 1/12/2020.
Current situation: (Potential / ongoing / ceased / etc.)	WWNP is offline and there is no discharge happening from the Seawater Channel.
Details of any samples taken: (when / where / type / number / time for results /etc) If incident is related to Total Nitrogen, refer to WDL171-10 section 38.8 for further analysis.	Another sample will be collected from S094 and analysed for Enterococci.

OPERATOR INTERNAL REPORTING

Has the incident been reported internally?	☒ YES	☐ NO
If so, to whom:	Name:	Ben McTavish
	Position:	Superintendent Environment

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Has the department been notified earlier?	☐ YES	☐ NO
Who was notified:		
How: (phone/email/fax)		
When: (date & time)		
By whom:		

Name:

Signed

Date:

Title:

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Date:	Time:

Notification of an Environmental Incident

☒ Incident ☐ Critical Incident ☒ Preliminary ☐ Final

Completed form: waste@nt.gov.au & mineral.info@nt.gov.au

PLEASE TYPE / PRINT CLEARLY

Incident number:	1000567996 (Condition 24) 1000567997 (Condition 27)
Name of mining site:	RTA Gove
Name of operator:	RTA Gove Pty Limited
Date & time of detection:	Date: 18.01.2021 Time: 14:35
Date & time of incident:	Date: Various Time: Various
Name of person notifying:	Ben McTavish
Position/Title:	Environment Superintendent
Contact person:	Ben McTavish
Contact details:	Business: 08 8987 5233 Mobile: 0477 353 879 E-mail: ben.mctavish@riotinto.com
INCIDENT LOCATION (use GPS co-ordinates, attach map, etc. as appropriate)	S044, S088, S087 and S088

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INCIDENT DESCRIPTION (attach photos if available)	Discharge from S088 above pH Limit (Condition 24) A release from S088 was conducted on 16 January 2021 at approximately 08:00 where the recorded pH (9.57) was above the Limit (9.5). TPH samples not collected for releases from S044, S086, S087, S088 (Condition 27) From an informal internal audit, no Total Petroleum Hydrocarbon (TPH) results have been received or evidence of samples collected for releases dated: • 23 December 2020 • 30 December 2020 • 2 January 2021 • 16 January 2021	
Causes & contributing factors to the incident:	Condition 24 • Significant pooled rainfall combined with caustic run off to increase the pH Condition 27 • Pending investigation.	
Potential causes & contributing factors to the incident:	Condition 24 • The local electrical substation had been offline, so the area has had no sump pump to remove caustic contaminated rain water. Condition 27 • Pending investigation)	
Action Taken:	YES ☒	NO ☐
If no, why?		
Corrective Actions that have/will be undertaken to ensure this does not reoccur:	Preliminary actions: Condition 24 • Operators have been notified to ensure releases do not occur when the recorded pH is above the Limit • Site documentation will be updated to reflect this condition. Condition 27 • Operators have been notified that TPH samples are required for all releases and weekly for releases that exceed 7 days. • Site documentation will be updated to reflect this Licence requirement	

ENVIRONMENTAL DETAILS

Nature of impact and severity: (Volume of spillage, area impacted, wildlife/vegetation/ erosion, etc.)	Condition 24 All marine monitoring pH values were within the Trigger Values and also within the historical range. Condition 27 No visible hydrocarbon plumes were present, either at the authorised discharge points or within the bay. Based on current data, RTA Gove anticipate no environmental impact.
Emergency & remedial actions taken:	
Current situation: (Potential / ongoing / ceased / etc.)	Condition 24 - The release has ceased. Condition 27 - The requirement for TPH sampling has been communicated with the area personnel.
Details of any samples taken: (when / where / type / number / time for results /etc) If incident is related to Total Nitrogen, refer to WDL171-10 section 38.8 for further analysis.	Routine marine monitoring was conducted 16 January 2021 (date of release). RTA Gove is currently organising for marine hydrocarbon sampling to occur at the earliest possible time.

OPERATOR INTERNAL REPORTING

Has the incident been reported internally?	☒ YES	☐ NO
If so, to whom:	Name: Shaun Dennis	
	Position: Services Supervisor	

Has the department been notified earlier?	☒ YES	☐ NO
Who was notified:	Sally-Anne Orchard	
How: (phone/email/fax)	Phone (Voicemail) and follow-up call	
When: (date & time)	19 January 2021 11:53 and 12:40	
By whom:	Ben McTavish	

Name: Ben McTavish

Signed

B McTavish

Date:

19 January 2021

Title: Environment Superintendent

Document Owner:	Senior Advisor Environment – Gove	Authorised By:	Specialist Environment – Gove
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Notification of an Environmental Incident

☒ Incident ☐ Critical Incident ☒ Preliminary ☐ Final

Completed form: waste@nt.gov.au & mineral.info@nt.gov.au

PLEASE TYPE / PRINT CLEARLY

Incident number:	1000567996 (Condition 24) 1000567997 (Condition 27)
Name of mining site:	RTA Gove
Name of operator:	RTA Gove Pty Limited
Date & time of detection:	Date: 18.01.2021 Time: 14:35
Date & time of incident:	Date: Various Time: Various
Name of person notifying:	Ben McTavish
Position/Title:	Environment Superintendent
Contact person:	Ben McTavish
Contact details:	Business: 08 8987 5233 Mobile: 0477 353 879 E-mail: ben.mctavish@riotinto.com
INCIDENT LOCATION (use GPS co-ordinates, attach map, etc. as appropriate)	S044, S088, S087 and S088

INCIDENT DESCRIPTION (attach photos if available)	Discharge from S088 above pH Limit (Condition 24) A release from S088 was conducted on 16 January 2021 at approximately 08:00 where the recorded pH (9.57) was above the Limit (9.5). TPH samples not collected for releases from S044, S086, S087, S088 (Condition 27) From an informal internal audit, no Total Petroleum Hydrocarbon (TPH) results have been received or evidence of samples collected for releases dated: • 23 December 2020 • 30 December 2020 • 2 January 2021 • 16 January 2021	
Causes & contributing factors to the incident:	Condition 24 • Significant pooled rainfall combined with caustic run off to increase the pH Condition 27 • Pending investigation.	
Potential causes & contributing factors to the incident:	Condition 24 • The local electrical substation had been offline, so the area has had no sump pump to remove caustic contaminated rain water. Condition 27 • Pending investigation)	
Action Taken:	YES ☒	NO ☐
If no, why?		
Corrective Actions that have/will be undertaken to ensure this does not reoccur:	Preliminary actions: Condition 24 • Operators have been notified to ensure releases do not occur when the recorded pH is above the Limit • Site documentation will be updated to reflect this condition. Condition 27 • Operators have been notified that TPH samples are required for all releases and weekly for releases that exceed 7 days. • Site documentation will be updated to reflect this Licence requirement	

ENVIRONMENTAL DETAILS

Nature of impact and severity: (Volume of spillage, area impacted, wildlife/vegetation/ erosion, etc.)	Condition 24 All marine monitoring pH values were within the Trigger Values and also within the historical range. Condition 27 No visible hydrocarbon plumes were present, either at the authorised discharge points or within the bay. Based on current data, RTA Gove anticipate no environmental impact.
Emergency & remedial actions taken:	
Current situation: (Potential / ongoing / ceased / etc.)	Condition 24 - The release has ceased. Condition 27 - The requirement for TPH sampling has been communicated with the area personnel.
Details of any samples taken: (when / where / type / number / time for results /etc) If incident is related to Total Nitrogen, refer to WDL171-10 section 38.8 for further analysis.	Routine marine monitoring was conducted 16 January 2021 (date of release). RTA Gove is currently organising for marine hydrocarbon sampling to occur at the earliest possible time.

OPERATOR INTERNAL REPORTING

Has the incident been reported internally?	☒ YES	☐ NO
If so, to whom:	Name: Shaun Dennis	
	Position: Services Supervisor	

Has the department been notified earlier?	☒ YES	☐ NO
Who was notified:	Sally-Anne Orchard	
How: (phone/email/fax)	Phone (Voicemail) and follow-up call	
When: (date & time)	19 January 2021 11:53 and 12:40	
By whom:	Ben McTavish	

Name: Ben McTavish

Signed

B McTavish

Date:

19 January 2021

Title: Environment Superintendent

Document Owner:	Senior Advisor Environment – Gove	Authorised By:	Specialist Environment – Gove
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Drew Carmichael

From: McTavish, Ben (RTAGove) <Ben.McTavish@riotinto.com>
Sent: Tuesday, 8 June 2021 12:34 PM
To: Cisse, Seydou (RTAGove)
Subject: FW: [External] RE: WDL171-10: RTA Gove - pH exceeding Limit and TPH samples not collected
Attachments: Tank Farm Discharge Data.xlsx; Discharge Field Sheets.pdf; COA - Bund release - 4 Dec 2020.pdf; 201218 - COA - MHMP - Hydrocarbons.pdf; 201218 - COA - MHMP - Hydrocarbons.XLS; 210122 - COA - MHMP - Hydrocarbons.pdf; 210122 - COA - MHMP - Hydrocarbons.XLS; MHMP Field Sheets.pdf; MHMP data SEP2020 - Jan 2021.xlsx

From: McTavish, Ben (RTAGove)
Sent: Wednesday, 3 February 2021 3:19 PM
To: 'Waste NTEPA' <Waste.NTEPA@nt.gov.au>
Cc: Winks, Melissa (RTA) <Melissa.Winks@riotinto.com>
Subject: RE: [External] RE: WDL171-10: RTA Gove - pH exceeding Limit and TPH samples not collected

Hi Sally-Anne,

Please find attached the data as requested. If there are any aspects that you feel have not been covered please contact me at your convenience for us to rectify.

Bund Releases (S044, S086, S087 and S088)

Please find attached the spreadsheet and scanned field sheets detailing the releases from the Bunds (S044, S086, S087 and S088). For the period requested the releases did not extend for longer than 2.5 hours. The releases occurred on the following dates:

1. 4 December 2020 – No Trigger Value (TV) or Limit exceedances. TPH analysis completed and all results below the laboratory Limit of Reporting (LoR)
2. 14 December 2020 – No TV or Limit exceedances. TPH sample not collected.
3. 19 December 2020 – No TV or Limit exceedances. TPH sample not collected.
4. 23 December 2020 – No TV or Limit exceedances. TPH sample not collected.
5. 31 December 2020 – Please note that the pH result was obtained on 30 December. However, the release was delayed as it was close to the end of shift. The release commenced the following morning. The pH at S088 was above the TV, but below the Limit. TPH sample not collected.
6. 2 January 2021 – No TV or Limit exceedances. TPH sample not collected.
7. 16 January 2021 – The pH at S088 was above the Limit (instigation for preliminary notification and reported on Tuesday 19 January 2021). TPH sample not collected.

We have no indication that any releases were ceased under condition 24.

Preliminary investigation findings indicate that improvements could be made in respect of the guidance provided to the operators concerning specific requirements to collect TPH samples under the WDL. Actions have been established to:

1. Correct the relevant Work Instructions to detail the TPH sampling requirements of weekly and at least once per discharge event;
2. Update guidance on the field sheet to specify that no releases can commence if the pH is above the Limit and to contact the area supervisor if it is above the TV.

The investigation is still on-going and a summary of findings will be provided in the final notification upon completion.

Marine Monitoring

Data provided

- The scanned field sheets for both December 2020 and January 2021 have been provided.
- The MHMP data for September* to December 2020 has been provided. As of writing we are still waiting for the (non-TPH) laboratory results from the vendor (CDU).
- The TPH Certificate of Analysis (COA) for both the 18 December 2020 and 22** January 2021 have been provided (both PDF and Excel format).

*Please note that the total metal(loid)s (unfiltered) analysis for the MHMP is not available for September 2020. This is due to the routine monitoring occurring on 12 September, prior to the new WDL being applied 17 September 2020.

**It was found that the requirement for hydrocarbon samples to be collected monthly at the compliance points not undertaken on Saturday 16 January. An additional round of sampling for hydrocarbons was organised for Friday 22 January 2021 to ensure compliance with the WDL requirement for monthly monitoring of TPH at the compliance points when discharges have occurred from S044, S086, S087 and/or S088.

Potential for Environmental Impact

In relation to the pH above the Limit at S088, the release on 16 January 2021 from S088 occurred for 2 hours. It was during this time that the Marine Health Monitoring Program (MHMP) was being conducted. The pH values recorded were within both the Trigger Values and historical values. Due to the short duration and volumes of the event, the release would have rapidly dispersed within inner Gove Harbour with no measureable environmental impact.

In relation to the TPH samples not collected, there were no signs of hydrocarbon sheens or discolouration during any of the release events or during the marine sampling. The hydrocarbon results for all samples taken for the MHMP have been reported as below the LoR. The review of the previous three years has shown that all previous results for TPH have been below the LoR. Hence, it is considered unlikely that there would have been any environmental impact due to hydrocarbons during these releases.

Again, please reach out at your convenience should you require anything further.

Kind regards,
Ben McTavish

From: Sally-anne Orchard <Sally-anne.Orchard@nt.gov.au> **On Behalf Of** Waste NTEPA
Sent: Tuesday, 19 January 2021 4:25 PM
To: McTavish, Ben (RTAGove) <Ben.McTavish@riotinto.com>
Cc: Waste NTEPA <Waste.NTEPA@nt.gov.au>
Subject: [External] RE: WDL171-10: RTA Gove - pH exceeding Limit and TPH samples not collected

Thank you for the preliminary investigation report for non-compliances against conditions 24 and 27. The nature of the non-compliances raise serious concerns with the conduct of the waste discharge licence (WDL) monitoring program and the ability of RTA Gove to detect potential impacts to water quality.

With reference to condition 6 of WDL171-10, please provide a copy of the environmental monitoring data collected in accordance with condition 27. The monitoring data must:

- Be in excel format;
- Highlight exceedances of trigger values specified in the WDL;
- For the period 17 September 2020 to 19 January 2021;
- Display information collected in accordance with condition 23; and
- Identify whether discharge was ceased under condition 24 at any time during that above period.

In addition, please provide a copy of the field sheets (scanned originals), field based physico-chemical measurements and observations for the weekly sampling events undertaken at S044, S086, S087 and S088, nearest to the release dates specified on page 2 of the investigation report:

- 23 December 2020
- 30 December 2020

- 2 January 2021
- 16 January 2021

Please also provide the a copy of the field sheets, field based physico-chemical measurements and observations for the routine monthly water monitoring event on 16 January 2021.

Thank you.

Regards,

Sally-Anne Orchard

Environmental Officer
Environmental Authorisations
Department of Environment, Parks and Water Security
Northern Territory Government

Providing services for the
Northern Territory Environment Protection Authority



Level 1, Arnhemica House, 16 Parap Road, Parap NT 0820
GPO Box 3675, Darwin NT 0801

P: +61 8 8924 4028
E: sally-anne.orchard@nt.gov.au

W: [Northern Territory Environment Protection Authority](#)
W: [Department of Environment, Parks and Water Security](#)
W: [Parks and Wildlife Commission](#)

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From: McTavish, Ben (RTAGove) <Ben.McTavish@riotinto.com>
Sent: Tuesday, 19 January 2021 3:21 PM
To: Waste NTEPA <Waste.NTEPA@nt.gov.au>; Sally-anne Orchard <Sally-anne.Orchard@nt.gov.au>
Cc: Winks, Melissa (RTA) <Melissa.Winks@riotinto.com>
Subject: WDL171-10: RTA Gove - pH exceeding Limit and TPH samples not collected

Hi Sally-Anne,

As discussed earlier today, on Saturday 16 January 2021 the pH value recorded for a discharge from S088 was recorded as 9.57, which is above the Limit of 9.5. The reason for the release above the pH Limit and the elevated pH is under investigation. Currently the Gove peninsula has been experiencing a significant amount of rainfall as a result of an above-average wet season. This release from S088 was due to significant rainfall prior and also anticipated rainfall to occur over the weekend.

Corrective actions already implemented are:

- The operators have all been notified to ensure releases do not occur when the pH is above the Limit; and

- Relevant site documentation will be updated to reflect this condition.

The routine marine water monitoring was conducted on the same day, and all pH values were within the trigger values and consistent with background values.

After this elevated pH was communicated, a review of the required monitoring for releases from S044, S086, S087 and S088 was conducted. It has since been discovered that no TPH samples or results can be identified currently for releases on:

- 23 December 2020
- 30 December 2020
- 2 January 2021
- 16 January 2021

This aspect is also under investigation to determine whether samples were collected or not. Corrective actions already implemented are:

- Operators have been notified that TPH samples are required for all releases and weekly for releases that exceed 7 days; and
- Relevant site documentation will be updated to reflect this condition.

Unfortunately during the routine monthly water monitoring event on 16 January 2021 the additional hydrocarbon samples were not collected. RTA Gove is currently organising the collection of additional hydrocarbon samples at the compliance locations to be conducted as early as possible, and results will be shared in the final notification.

These non-compliances have been reported internally and are currently under investigation. Please find attached our preliminary notification of the incident. This will be updated once the investigations are completed and corrective actions are determined to ensure this non-compliance is not repeated. Please feel free to contact me at your convenience should you have any queries.

Kind regards,

Ben McTavish
Environment superintendent, Gove Operations

Melville Bay Road, Nhulunbuy, Northern Territory 0880
PO Box 21, Nhulunbuy, Northern Territory 0881

T +61 8 8987 5233
M +61 477 353 879



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Notification of an Environmental Incident

☒ Incident ☐ Critical Incident ☒ Preliminary ☐ Final

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PLEASE TYPE / PRINT CLEARLY

Incident number:	1000573473 (Condition 27)
Name of mining site:	RTA Gove
Name of operator:	RTA Gove Pty Limited
Date & time of detection:	Date: 25.03.2021 Time: 08:15
Date & time of incident:	Date: 24.03.2021 Time: 08:00
Name of person notifying:	Seydou Cisse
Position/Title:	Senior advisor, Environment
Contact person:	Seydou Cisse
Contact details:	Business:08 8987 5219 Mobile: 0427 806 346
	E-mail: Seydou.Cisse@riotinto.com
INCIDENT LOCATION (use GPS co-ordinates, attach map, etc. as appropriate)	S074

Document Owner:	Senior Advisor Environment – Gove	Authorised By:	Specialist Environment – Gove
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INCIDENT DESCRIPTION (attach photos if available)	Missed daily TSS for S074 (Condition 27) Daily sampling was conducted at S074 in accordance the requirements of Table 3 – Appendix 2 on the 24/03/2021 at ~08:00. The sample was taken back to RTA Gove internal lab and was analysed for daily parameters. Unfortunately, the TSS analysis was not completed and this was not noticed until the following morning 25/03/2021. WWNP was not running at time of sampling and there was no rain event. Only clean seawater would have been discharging from the channel.	
Causes & contributing factors to the incident:	Pending investigation.	
Potential causes & contributing factors to the incident:	Pending investigation	
Action Taken:	YES ☒	NO ☐
If no, why?		
Corrective Actions that have/will be undertaken to ensure this does not reoccur:	Preliminary actions: Laboratory personnel have reported the incident and Lab documentation will be reviewed to identify need for holding samples until results reported.	

ENVIRONMENTAL DETAILS

Nature of impact and severity: (Volume of spillage, area impacted, wildlife/vegetation/ erosion, etc.)	Based on current data, RTA Gove anticipate no environmental impact. WWNP was not operating during the time of the incident and no rain event was occurring. Parameters analysed indicate that only clean seawater was discharging from the channel.																																				
Emergency & remedial actions taken:	Continue on routine sampling and analysis.																																				
Current situation: (Potential / ongoing / ceased / etc.)	Seawater channel continue discharging. WWNP was started on 24/03/2021 at approximately 14.30. Routine sampling and analysis program is continuing.																																				
Details of any samples taken: (when / where / type / number / time for results /etc) If incident is related to Total Nitrogen, refer to WDL171-10 section 38.8 for further analysis.	Samples taken on the 23, 24 & 25 March 2021 were analysed for daily parameters for S074. Data are presented below. <table border="1" style="margin-top: 10px;"> <thead> <tr> <th colspan="6">S074</th> </tr> <tr> <th>Date</th> <th>pH</th> <th>EC</th> <th>Turb</th> <th>Alk</th> <th>TSS</th> </tr> <tr> <th></th> <th>unit</th> <th>mS/cm</th> <th>NTU</th> <th>mg/L</th> <th>mg/L</th> </tr> </thead> <tbody> <tr> <td>25/03</td> <td>8.22</td> <td>52.4</td> <td>4.4</td> <td>137.5</td> <td>3.6</td> </tr> <tr> <td>24/03</td> <td>8.16</td> <td>52.1</td> <td>2.9</td> <td>120.6</td> <td>not analysed</td> </tr> <tr> <td>23/03</td> <td>8.19</td> <td>48.5</td> <td>2.9</td> <td>119.8</td> <td>4.6</td> </tr> </tbody> </table>	S074						Date	pH	EC	Turb	Alk	TSS		unit	mS/cm	NTU	mg/L	mg/L	25/03	8.22	52.4	4.4	137.5	3.6	24/03	8.16	52.1	2.9	120.6	not analysed	23/03	8.19	48.5	2.9	119.8	4.6
S074																																					
Date	pH	EC	Turb	Alk	TSS																																
	unit	mS/cm	NTU	mg/L	mg/L																																
25/03	8.22	52.4	4.4	137.5	3.6																																
24/03	8.16	52.1	2.9	120.6	not analysed																																
23/03	8.19	48.5	2.9	119.8	4.6																																

OPERATOR INTERNAL REPORTING

Has the incident been reported internally?	☒ YES	☐ NO
If so, to whom:	Name: Jon Regan	
	Position: Specialist, Laboratory	

Has the department been notified earlier?	☒ YES	☐ NO
Who was notified:	Sally-Anne Orchard	
How: (phone/email/fax)	Email	
When: (date & time)	26/03/2021	
By whom:	Seydou Cisse	

Name: Seydou Cisse

Signed

Date:

26 March 2021

Title: Senior Advisor, Environment

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Document Owner: Senior Advisor Environment – Gove	Authorised By: Specialist Environment – Gove
Rev No: 13	Date of Issue: 26/10/20
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Notification of an Environmental Incident

☒ Incident ☐ Critical Incident ☒ Preliminary ☐ Final

Completed form: waste@nt.gov.au & mineral.info@nt.gov.au

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Incident number:	TBD (Condition 27)
Name of mining site:	RTA Gove
Name of operator:	RTA Gove Pty Limited
Date & time of detection:	Date: 30/06/2021 Time: -
Date & time of incident:	Date: 31/03/2021 Time: N/A
Name of person notifying:	Ben McTavish
Position/Title:	Environment Superintendent
Contact person:	Ben McTavish
Contact details:	Business: 08 8987 5233 Mobile: 0477 353 879 E-mail: ben.mctavish@riotinto.com
INCIDENT LOCATION (use GPS co-ordinates, attach map, etc. as appropriate)	S044, S087, and S088.

Document Owner:	Senior Advisor Environment – Gove	Authorised By:	Specialist Environment – Gove
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INCIDENT DESCRIPTION (attach photos if available)	TPH samples not analysed for releases from S044, S087, and S088 (Condition 27) While conducting the annual audit on WDL monitoring data, it was identified that TPH results were missing for discharge locations S044, S087, and S088 for sample collected on 31/03/2021. On 31 March 2021, TPH samples were collected from bund release sites (S044, S086, S087, and S088). These samples were dispatched and received by the Australian Laboratory Services (ALS) under work order ES2112263 on 3/04/2021 to test for TPH. However, TPH testing was only conducted on S086 sample; nothing was reported for the remaining 3 sites.	
Causes & contributing factors to the incident:	- Only one sample (S086) was logged in for analysis. - Log in was not copied across to other samples (S044, S087 and S088).	
Potential causes & contributing factors to the incident:	Sample bottle allocation was not checked prior to committal leading to samples been either missed or not picked up during testing.	
Action Taken:	YES ☒	NO ☐
If no, why?		
Corrective Actions that have/will be undertaken to ensure this does not reoccur:	- ALS was notified immediately to investigate the incident. - Internal discussion was held at ALS and operational procedures were reviewed. - Reinforcement of ALS committal checklist before commencing lab testing.	

ENVIRONMENTAL DETAILS

Nature of impact and severity: (Volume of spillage, area impacted, wildlife/vegetation/ erosion, etc.)	No visible hydrocarbon plumes were present, either at the authorised discharge points or within the bay for this discharge event. TPH results from the only sample tested (S086) reported below LOR. Based on current data, RTA Gove anticipate no environmental impact.																																
Emergency & remedial actions taken:																																	
Current situation: (Potential / ongoing / ceased / etc.)	There is no discharge occurring at the moment. Discharges from these locations are seasonal and typically occur in the wet season.																																
Details of any samples taken: (when / where / type / number / time for results /etc) If incident is related to Total Nitrogen, refer to WDL171-10 section 38.8 for further analysis.	Sample taken the same day from the adjacent bund release site S086 returned TPH below LOR. Other TPH samples prior and after the event all reported TPH below LOR. <table border="1"> <thead> <tr> <th>Date</th> <th>Analyte</th> <th>S044</th> <th>S086</th> <th>S087</th> <th>S088</th> </tr> </thead> <tbody> <tr> <td>12/02/21</td> <td rowspan="5">TPH (µg/L)</td> <td><50</td> <td><50</td> <td><50</td> <td><50</td> </tr> <tr> <td>29/03/21</td> <td><50</td> <td><50</td> <td><50</td> <td><50</td> </tr> <tr> <td>31/03/21</td> <td>Not tested</td> <td><50</td> <td>Not tested</td> <td>Not tested</td> </tr> <tr> <td>26/04/21</td> <td><50</td> <td><50</td> <td><50</td> <td><50</td> </tr> <tr> <td>28/04/21</td> <td><50</td> <td><50</td> <td><50</td> <td><50</td> </tr> </tbody> </table>	Date	Analyte	S044	S086	S087	S088	12/02/21	TPH (µg/L)	<50	<50	<50	<50	29/03/21	<50	<50	<50	<50	31/03/21	Not tested	<50	Not tested	Not tested	26/04/21	<50	<50	<50	<50	28/04/21	<50	<50	<50	<50
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26/04/21		<50	<50	<50	<50																												
28/04/21		<50	<50	<50	<50																												

OPERATOR INTERNAL REPORTING

Has the incident been reported internally?	☒ YES	☐ NO
If so, to whom:	Name: Shaun Dennis	
	Position: Services Supervisor	

Has the department been notified earlier?	☐ YES	☒ NO
Who was notified:		
How: (phone/email/fax)		
When: (date & time)		
By whom:		

Name: Ben McTavish

Signed

B McTavish

Date:

1 July 2021

Title: Environment Superintendent

Document Owner:	Senior Advisor Environment – Gove	Authorised By:	Specialist Environment – Gove
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