

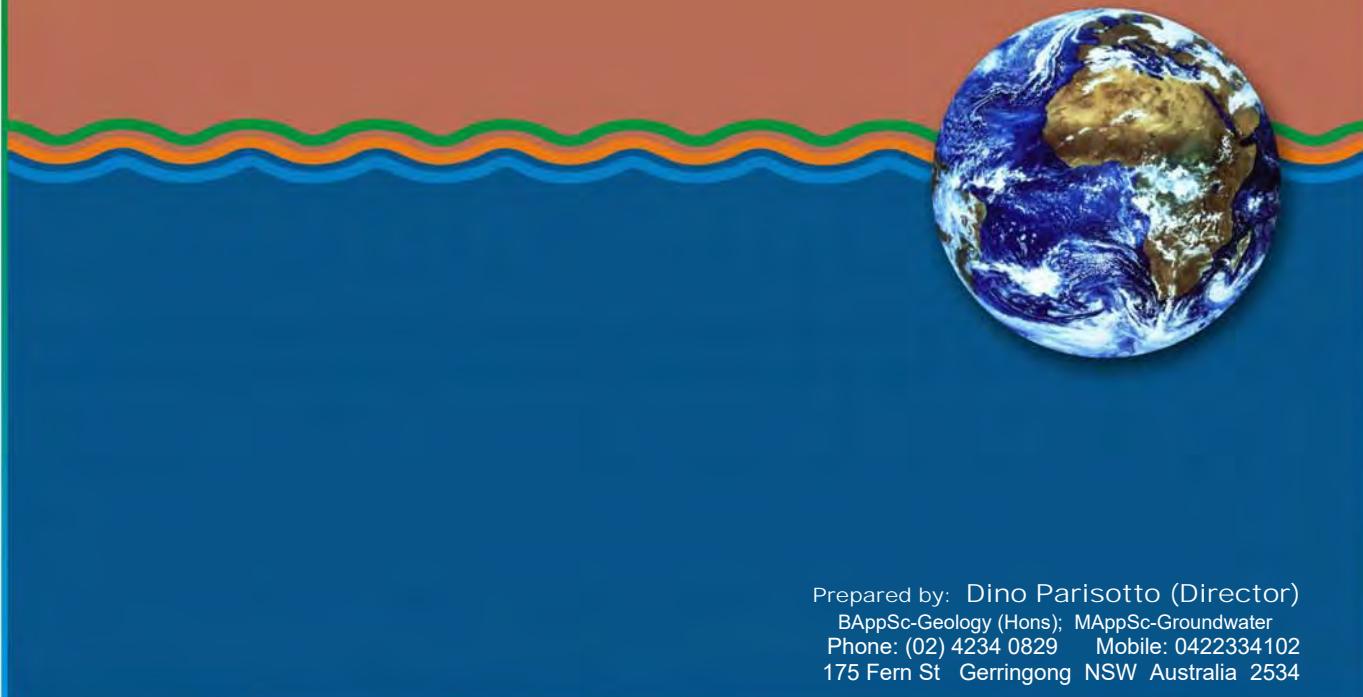


Kiama Municipal Council

Minnamurra Waste Disposal Depot
Annual Groundwater & Surface Water
Monitoring Report (EPL 2019 - 2020)

Report E2W-059 (R001 v1)

7 October 2020



Prepared by: Dino Parisotto (Director)
BAppSc-Geology (Hons); MAppSc-Groundwater
Phone: (02) 4234 0829 Mobile: 0422334102
175 Fern St Gerringong NSW Australia 2534

This document may only be used for the purpose for which it was commissioned and in accordance with the Terms of Engagement for the commission. This document should not be used or copied without written permission from Earth2Water Pty Ltd.

Client: Kiama Municipal Council

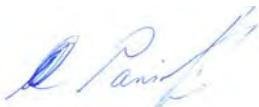
**Project: Annual Surface and Groundwater Monitoring Report
Minnamurra Waste Disposal Depot
(EPL; 2019 to 2020)**

Prepared for:
Kiama Municipal Council
P.O. Box 75 Kiama
NSW 2533

Report: 7 October 2020
Ref: E2W-059 R001 (V1)

Quarterly Field Sampling: Completed by ALS Environmental Pty Ltd
Landfill Gas Monitoring: Kiama Municipal Council
Groundwater & Surface Water Laboratory Analyses: ALS Environmental Pty Ltd

Prepared By: Earth2Water Pty Ltd



Dino Parisotto (Managing Director)
{BAppSc, Geology (Hons); MAppSc, Groundwater, Class 3 Driller (DL1977)}
CEnvP Certified Environmental Practitioner- Site Contamination Specialist (SC40118)



Email: dino@earth2water.com.au
PH: (02) 4234 0829
Office: 175 Fern Street, Gerringong, NSW, 2534

Reports Distributed and Authorised for:

Kiama Council: report - electronic copy (pdf)

© Authorisation from Earth2Water Pty Ltd is required for third party use and distribution

TABLE OF CONTENTS

1. INTRODUCTION.....	4
1.1 Background.....	4
1.2 Objectives	4
2. SCOPE OF WORK.....	5
3. ENVIRONMENTAL SETTING	6
3.1 Climate.....	6
3.2 Topography	6
3.3 Geology.....	7
3.4 Hydrogeology and Groundwater Flow Regime.....	7
3.5 Hydrology	8
4. LICENCE CRITERIA AND RELEVANT GUIDELINES	9
4.1 EPL Requirements	9
4.2 Previous Monitoring Results.....	10
5. ENVIRONMENTAL MONITORING.....	11
5.1 Landfill Gas Monitoring	11
5.2 Surface and Groundwater Monitoring Locations	12
6. MONITORING RESULTS.....	14
6.1 Groundwater Data.....	14
6.1.1 Groundwater Depth.....	14
6.1.2 Field Parameters.....	15
6.1.3 Nutrients (groundwater).....	16
6.1.4 Ammonia Trends	17
6.1.5 Hydrochemical Indicators	18
6.1.6 Inorganic Contaminants (Iron, Manganese and Fluoride)	19
6.1.7 Organic Contaminants (DOC, TOC and Phenols- Groundwater)	19
6.2 Surface Water.....	19
6.2.1 Physical Parameters	20
6.2.2 Nutrients (surface water).....	20
6.2.3 Organic Contaminants (TOC/DOC, Phenols & Fluoride).....	21
7. CHEMICALS OF CONCERN AND CONTAMINANT PLUME	22
7.1 Ecological Issues.....	22
8. CONCLUSIONS	23
8.1 Recommendations.....	25
9. LIMITATIONS	26

TABLES

- Table GW-1: Summary Analytical Report - Groundwater Wells (2019-2020)
Table SW-1: Summary Analytical Report - Surface Water (2019-2020)
Table SW-2: Rocklow Creek - Historical Ammonia Concentrations (mg/L, 1999-2020)

GRAPHS

- Graph-1: Groundwater Ammonia Concentrations (mg/L) All Wells (1999-2020)
Graph-2: Deep Groundwater Ammonia Trends (1999-2020)
Graph-3: Shallow Groundwater Ammonia Trends (1999-2020)
Graph-4: Net Increments of Ammonia; Up & Mid-Stream Samples (1999-2020)

FIGURES

- Figure 1: Site Location
Figure 2: Monitoring Well Locations & Ammonia Concentrations (2019-2020)

APPENDICES

- Appendix A: ALS Environmental Pty Ltd Laboratory Certificates
Appendix B: Figure 7 from E2W Landfill Closure Plan
Appendix C: Landfill Gas Monitoring (KMC 2020) & Figure 1

1. INTRODUCTION

Earth2Water Pty Ltd (E2W) was engaged by Kiama Municipal Council (KMC) to provide the 2019-2020 annual assessment report of landfill gas, surface water and groundwater monitoring for the Minnamurra Waste Disposal Depot (MWDD).

This report is based on information provided in field and laboratory reports provided by ALS Environmental Pty Ltd, KMC (landfill gas) and previous monitoring reports by E2W (2004 to 2019), Eco-Engineers Pty Ltd and Forbes Rigby Pty Ltd (pre 2004).

This monitoring report for the MWDD is based on quarterly monitoring results (21 November 2019, 14 February 2020, 28 May 2020, and 28 August 2020) and NSW EPA Environmental Protection Licence (EPL) conditions (R1.10). E2W completed the landfill closure plan (LCP in October 2005) and construction quality assurance (April 2008) for the landfill rehabilitation works completed by KMC in January 2008.

1.1 Background

KMC has owned and operated the MWDD from the 1960's until its closure in October 2006. The MWDD operated as a Solid Waste Class 1 Landfill under the EPL No. 5958. The MWDD formerly comprised a night soil depot for liquid pump out sullage, which ceased in 1998. The existing licence and amendments required the submission of a Landfill Closure Plan (LCP), which was completed by E2W in October 2005.

Since November 2012, Minnamurra Landfill has accepted mixed food and garden organics, together with small loads of recyclable materials. All general waste materials are diverted to the waste facility at Shellharbour (Dunmore Waste Disposal Depot).

Since 2018, KMC has undertaken groundwater remedial works at the MD9B/9C well location to reduce the ammonia concentrations at the foreshore area. Groundwater extraction is occurring at low pump rates through three spear points with pond/tank storage and irrigation/recirculation over the landfill mound (i.e. details are provided in separate documentation).

1.2 Objectives

The objective of surface and groundwater monitoring in the 2019-2020 reporting period was to assess actual or potential impacts associated with the MWDD on the surrounding aquatic environment. Gas monitoring is undertaken by KMC to measure the performance of landfill rehabilitation works.

The objective of this annual report is to provide KMC and the NSW EPA with a summary of the monitoring results obtained in the 2019-2020 reporting period (i.e. EPL 5958 conditions).

2. SCOPE OF WORK

E2W was commissioned by KMC to collate and assess surface and groundwater monitoring data provided by ALS during 2019 and 2020. The annual reporting period covers four quarterly monitoring events in November 2019, February 2020, May 2020 and August 2020 (Figures 1 & 2).

Each water monitoring event comprised the following:

- Sampling of onsite and offsite groundwater wells including; MD1B, MD1A, MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9A, MD9B, MD9C, MD10A, and MD10B¹.
- Sampling of surface water at three locations along Rocklow Creek (Rocklow-Up, Rocklow-Middle and Rocklow-Down).

Landfill gas monitoring was conducted by KMC (Greg Hardy) at gas monitoring wells, biofilter pads and inside buildings. Monitoring was conducted using a calibrated landfill gas meter (GT402) on three occasions (4 February 2020, 16 May 2020, 15 September 2020). The October 2019 gas monitoring results were incorporated into the previous EPL (2018-2019).

E2W undertook the following scope of work to satisfy KMC's surface and groundwater monitoring program at MWDD:

- Provide advice to KMC (in relation to monitoring results- as required).
- Prepare this annual report for monitoring period (November 2019 to August 2020) and comply with Section R1.10 of the EPL (No. 5958). The annual report is to include the following:
 1. Tabulation of the monitoring data obtained for the period.
 2. Graphical representation of the current and previous monitoring data (minimum - last three years). Statistically significant variations or anomalies will be highlighted.
 3. Analyses and interpretation of monitoring data.
 4. Analyses and response to any complaints received.
 5. Identification of any deficiencies in the environmental performance of the MWDD, as highlighted by the monitoring data, trends and/or accidents.
 6. Recommendations to address the above identified deficiencies.
 7. Recommendations on improving the overall environmental performance of the facility.

Rehabilitation of the landfill commenced in August 2006 and was completed by KMC in January 2008. The work included reshaping, cut/fill of waste materials and capping with clays and soil/compost mix (i.e. evapotranspiration layer). The rehabilitation works may have temporarily degraded the runoff and shallow groundwater (2007) due to exposure and leaching of buried putrescible waste which was redistributed during the reshaping.

In early to mid 2016, E2W and Council commenced testing of new extraction bores near MD-9B/9C to assess yields, water quality and the potential for reducing the leachate impact (i.e. ammonia >100 mg/L) by irrigation on the landfill mound. Groundwater remedial works are progressing and include the installation of three extraction bores, and five monitoring wells in proximity to wells (MD-9B/MD-9C). Groundwater pumps and infrastructure has been installed and commissioned (i.e. extraction works commenced 2019).

¹ The two shallow wells (MD4A and MD1A) are consistently dry.

3. ENVIRONMENTAL SETTING

The Minnamurra Waste Disposal and Recycling Depot (MWDD) is located 1 km north of the Minnamurra town ship (Figures 1 and 2). The site is located within a swamp environment, bounded to the west by the rail line and Riverside Drive (formerly a part of the Princes Highway), and to the north and east by the confluence of Rocklow Creek and Minnamurra River. The site is approximately 1 km west of Mystics (Minnamurra) Beach.

The MWDD covers an area of approximately 50 acres (~20 ha), while the landfill mound occupies approximately 6 ha. At present, the MWDD comprises the following features:

- An elevated landfill mound (capped) ranging from 1 to 14 m AHD. The landfill mound was rehabilitated in 2006/2007 according to the LCP submitted by E2W in October 2005,
- A weighbridge and administration office/toilet block,
- KMC truck parking area,
- KMC storage sheds,
- Dog impounding facility,
- Green waste/composting,
- Waste/recycling receival & transfer station.

3.1 Climate

The long-term mean and median rainfall values available for the Kiama Bowling Club (Latitude 344033 N and Longitude 1055103E) between 1897 and 2001 indicate that average yearly rainfall at the MWDD is 1261 mm/year. On average, the MWDD would receive approximately 1220 mm, based on rainfall records obtained from Shellharbour and Albion Park (Forbes Rigby, 1996).

The annual rainfall from August 2019 to July 2020 was 860 mm (drought), August 2018 to July 2019 = 871 mm (drought), 2017 to 2018 = 663mm (drought), August 2016 to July 2017 was 923 mm which is also substantially less than previous years (August 2015 to July 2016 was 1260 mm, August 2014 to July 2015 was 1269² mm).

The annual rainfall in previous years are as follows; August 2013 to July 2014 = 873.0 mm³, 1201.8 mm =August 2012 to July 2013, 1282.8 mm =August 2011 to July 2012, 1308 mm =August 2010 to July 2011, 1054.4 mm =August 2009 to July 2010.

Periods of high monthly rainfall occurred in November 2017 (116.8 mm), February 2018 (111.6 mm), and February 2020 (213.4mm). High rainfall events are reflected in higher water levels in the following month.

3.2 Topography

A plan of the existing site topography and surrounds is presented in Figure 1. The site is located within mangrove tidal flats, an estuarine environment associated with Rocklow Creek and Minnamurra River (Figure 7 of Appendix B).

² Bombo Headland, Kiama

³ Climate data is from Kiama (Bombo Headland) (Station ID 068242), ~4.5 km SSE of MWDD.

Local relief is less than 3 m AHD around the footprint of the landfill (except southern wall), with slopes generally less than 5%. The landfill forms a mound, which reaches a maximum of 14 m AHD above the surrounding low-lying ground surface (approximately 1 m AHD).

The RL of the landfill footprint area ranges from approximately 0.6 m AHD (north-east corner) to 5.2 m AHD (southern wall). On the western side of Riverside Drive the land rises rapidly to a small east and north-east facing ridge where Dunmore House is situated (Figures 1 and 2).

3.3 Geology

The site is located within Quaternary alluvial sediments comprising sands and silts. Based on drilling investigations undertaken by Forbes Rigby in 1996 and recent investigations at the site by KMC and E2W in 2005, the geology is dominated by fine to medium sandy sediments with minimal sandy silt and sandy clays. In most places, the sand is overlain by a 0.5 m thick organic silty loam.

Drill cores by the Geological Survey of NSW in the Rocklow Creek valley predominantly consist of poorly to well-sorted and fine to medium-grained quartz lithic sands. Sand deposits typically extend to a maximum depth of 14 m, with increasing clay content below about 7 m (Forbes Rigby, 1996).

3.4 Hydrogeology and Groundwater Flow Regime

The hydrogeology at the site is dominated by a semi-confined sandy aquifer. Groundwater is encountered at depths of approx 1 m below natural ground level (~0.5 m AHD) along the west, north and east sides of the landfill mound. The depth to water along the southern wall is not well known.

The groundwater quality at the site varies from fresh to saline, with electrical conductivity ranging from 0.85 to 44.6 mS/cm (E2W, October 2005). Groundwater generally becomes more saline in the vicinity of mangroves and tidal saline water bodies (i.e. Rocklow Creek and Minnamurra River).

Recharge to the aquifer system beneath and surrounding the waste disposal facility occurs from rainfall infiltration mainly outside of the capped landfill mound. Infiltration of rainfall is moderate (~30%) around the footprint area, due to the low elevation and leakage through the organic silt layer.

Groundwater gradients in the area of the waste mound are controlled by topography, permeable sands and the nearby tidal water bodies (Rocklow Creek and Minnamurra River). The predominant groundwater flow direction at the site is considered to be north-east and towards the confluence of Rocklow Creek and Minnamurra River. The hydraulic gradient is likely to be variable, depending on the tidal regime and proximity to the river. It is interpreted that the groundwater gradient is at a maximum during low tide and potentially reverses at high tide or high rainfall.

Groundwater discharge at Rocklow Creek and Minnamurra River is influenced by the presence of a fresh groundwater/saltwater interface. The interface results from the density difference between groundwater and seawater. It is a dynamic and complex region with

upward hydraulic gradients, tidal fluctuations, diverse microbiological processes, surface and groundwater interaction and salinity variations. The groundwater/saltwater interface is generally associated with natural attenuation processes (biodegradation, dilution, sorption etc.), which tend to reduce levels of contaminants prior to discharge to marine ecosystems. The groundwater/saltwater interface is interpreted to exist at the boundary of the casuarinas and mangroves at the site.

The contamination of deep and shallow groundwater arises from nutrient enrichment at the MWDD and has been reported on in previous annual monitoring reports by Ecoengineers Pty Ltd (2004) and E2W (2005, 2006 and 2007).

The leachate plume originating from the MWDD is likely to persist for many years after landfill remediation due to the age (1960s) and scale of the waste mound. Improvements in groundwater quality is expected over the short to medium term (up to ~10 years) reflecting the rate of natural attenuation and groundwater flushing effects from rainfall recharge.

3.5 Hydrology

The hydrology of the area is dominated by Rocklow Creek and Minnamurra River. Groundwater discharge, with possible leachate from both the Minnamurra and Shellharbour landfills, may be contributing to the nutrients detected in Rocklow Creek (Figure 1).

The Minnamurra River drains a catchment of approximately 142 km². Seventy percent of the catchment is natural, mainly located on the steeper slopes of the Illawarra escarpment. The middle section of the catchment is characterised by a broad floodplain area called Terragong Swamp. This area, which comprises approximately 30% of the catchment, is used extensively for cattle grazing/dairying. The township of Jamberoo is located within this catchment. It can be expected that the Terragong Swamp farming area and Jamberoo itself are significant sources of nutrients and pollutants entering the river.

The entrance of Minnamurra River is permanently open, and the estuary is tidally influenced. The estuarine portion of the river extends approximately 7 km upstream from the mouth and has the suburb of Minnamurra on its western bank. The lower section of the river is an ecologically significant aquatic environment, comprising areas of seagrass, mangrove and salt marsh communities (Forbes Rigby, 1996).

Rocklow Creek catchment has an area of 23 km² and occupies the northern most portion of the Minnamurra River catchment. Rocklow Creek flows into the main arm of the Minnamurra River downstream of the MWDD, approximately 2 km upstream of the river entrance. Potential up-gradient sources of contamination may include the Shellharbour landfill, Princes Highway, Riverside Drive and nearby sand mining operations.

Water samples from Rocklow Creek and Minnamurra River have been collected by the DECCW/NSWEPA in 1991 and 2005 (Denis Pascall, August 2005), as part of a water quality and landfill impact assessment for the area (Forbes Rigby, 1996).

The following opinions were offered as a result of DECCW's sampling work:

- Concentrations of most indicators (except dissolved oxygen) are considerably higher in Rocklow Creek than in Minnamurra River; and

- Concentration of nutrients (ammonia) measured at several locations along Rocklow Creek indicate that Shellharbour and Minnamurra landfills may be contributing leachate into the aquatic ecosystem.

One upstream and one downstream Rocklow Creek location are sampled as part of the quarterly MWDD water quality monitoring program. Since 2009, a third location midstream of the creek has also been sampled. Access to the downstream location has been restricted due to mangrove growth along the track (no sample for past three years). Sampling is undertaken by ALS (formerly Ecowise- the sample location was re-established in 2014 once access was available through the mangroves).

4. LICENCE CRITERIA AND RELEVANT GUIDELINES

Under the NSW EPA requirements for Licence No. 5958, the criteria for surface and groundwater quality are based on the ANZECC (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. E2W note that the ANZECC (2000) guidelines have been superseded by ANZECC (2018), however ANZEC (2000) are referenced for this EPL report.

The ANZECC guidelines include risk-based trigger levels and indicative interim working levels (IIWLs). The IIWLs are used when insufficient data is available to calculate a trigger level and are of low reliability. It should be noted that the ANZECC water quality guidelines are applicable to receiving water and not groundwater. However, they form an appropriate basis for undertaking a screening level assessment of groundwater quality. Selection of the applicable guideline values are based on an assessment of potential pathways by which human or environmental exposure might take place, as well as the beneficial end use of the groundwater.

The beneficial use classification for groundwater at the site depends on the quality of the water and its potential use in the long term. Although groundwater in the shallow aquifer surrounding (upgradient) the waste disposal facility is likely to be of relatively good quality (depending on the presence of saline intrusions), there are no known groundwater extraction bores (agricultural or domestic) within the immediate vicinity of the site. Therefore, the appropriate beneficial use category of the groundwater is for the protection of aquatic marine and freshwater ecosystems in discharge zones at Rocklow Creek and Minnamurra River, the closest aquatic environmental receptors for the site.

The adopted groundwater assessment guidelines are presented with the summary analytical results (i.e. Tables GW-1, SW-1, SW-2). Exceedances of the ANZECC (2000) trigger values for marine water ecosystems have been highlighted on the summary tables.

4.1 EPL Requirements

The Environmental Protection Licence (EPL No. 5958) details 20 monitoring points for the MWDD (two for landfill gas and fifteen for groundwater monitoring and three for surface water). The landfill gas monitoring points are required to be analysed for methane every 6 months (i.e. twice in the reporting period). Landfill gas monitoring was conducted on a quarterly basis by KMC (Appendix C) at gas wells, trenches and inside the five buildings.

The frequency of testing of the groundwater monitoring points (MD1B, MD2A, MD2B, MD2C, MD4A, MD4B, MD4C, MD6B, MD6C, MD9A, MD9B, MD9C, MD10A, MD10B) is also half yearly (EPL requirement, note: MD2A/MD6A are dry wells). However, KMC conducts the groundwater monitoring on a quarterly basis (November 2019, February 2020, May 2020, and August 2020) to establish water quality trends post landfill rehabilitation works.

Some of the groundwater monitoring locations (i.e. MD4A, MD2A) are not sampled as they do not have enough water for sampling). Other available wells onsite including MD3B, MD3C, MD7, MD5A/B/C and MD8 however are not part of the EPL (previously tested prior to landfill closure for characterising the local groundwater).

Table 4.1 (below) lists the analytes that are included in the groundwater testing suite.

Table 4.1: Groundwater analytical suite (as per the EPL)

Alkalinity (as CaCO ₃)	Dissolved Oxygen	Nitrate	Temperature
Ammonia	Fluoride	Potassium	Total Phenolics
Calcium	Iron	Sodium	Total Organic Carbon
Chloride	Magnesium	Standing Water Level	pH
Conductivity	Manganese	Sulphate	

Surface water monitoring is required to be undertaken twice a year to comply with the EPL, however they are also undertaken quarterly by KMC in conjunction with groundwater monitoring. Surface water samples are collected and analysed from an up-stream (Rocklow-Up) and mid-gradient (Rocklow-Middle) locations. An alternative sample location was established in May and August 2015 for the down-gradient location (Rocklow-Down, Figure 2).

The mid sample location was included to assess the performance of the landfill rehabilitation works and requirement for a bund wall around the landfill (i.e. access to the downstream location was impeded due to the thick vegetation and relocated in May 2015).

4.2 Previous Monitoring Results

The previous annual monitoring reports have been provided by E2W, Ecoengineers and Forbes Rigby. Groundwater ammonia results presented in these earlier reports are included in graphical form and attached in this report (Graphs 1, 2 & 3).

Ammonia is a key landfill leachate indicator based on the results obtained from monitoring wells placed around the MWDD. Landfill leachate has impacted the local groundwater system, with potential or actual impact to Rocklow Creek and Minnamurra River (Appendix B, Figure 7).

5. ENVIRONMENTAL MONITORING

Prior to May 2005, surface and groundwater monitoring was undertaken by KMC. Ecowise were (since August 2005) engaged to sample and analyse the surface and groundwater monitoring points as per the EPL and performed the November 2009 sampling round. Ecowise were acquired by ALS in November 2009, who carried out the subsequent surface and groundwater sampling in the reporting period (2009-2010, 2010-2011, 2011-2012, 2012-2013, 2013-2014, 2014-2015, 2016-2017, 2017-2018, 2018-2019, and 2019-2020). Quarterly sampling for the 2019-2020 reporting period was undertaken on the following dates:

- 21 November 2019,
- 14 February 2020,
- 28 May 2020; and
- 28 August 2020.

The procedure for sample collection, storage and handling employed by KMC and Ecowise/ALS are generally in accordance with NEPM (2013) and ANZECC (2000). The following subsections outline the nature of the site's monitoring and analytical program, as well as conditions at the time of sample collection (from information provided by KMC).

5.1 Landfill Gas Monitoring

The landfill gas testing locations include areas where final cover was placed and inside all buildings within 250 m of the deposited waste. Testing has been undertaken by KMC staff on a quarterly basis; 4 February 2020, 16 May 2020, and 15 September 2020. The October 2019 gas monitoring results were incorporated into the previous EPL (2018-2019).

The three gas monitoring rounds (February 2020, May 2020, and September 2020) of landfill gas testing undertaken by KMC are presented in Appendix C. All buildings sampled (within 250 m of the deposited waste) recorded no detectable landfill gas readings in 4 February 2020, 16 May 2020, and 15 September 2020 (including October 2019).

KMC (& E2W) are unaware of any reportable pollution incidences or complaints from the community related to the MWDD during the 2019-2020 reporting period.

Six onsite landfill gas wells (Gas 1 to Gas 6) were installed by E2W on 2 August 2006 and gas monitoring has been performed since then as part of the landfill rehabilitation work. Landfill gas monitoring is a requirement of the EPL, but only relates to onsite buildings/sheds and the waste mound (over the capped area). Two gas monitoring wells (i.e. Gas 5 and Gas 6) have not been monitored since November 2009 as they are located at the same location as Trench 1 (i.e. alternative gas test location, Refer to Figure 1 in Appendix C). The gas well (Gas-2) was removed end of 2014 due to construction of the CRC shed.

Quarterly monitoring data (2019-2020) from the trenches (biofilter pads, Trench 1 to Trench 7) and gas monitoring wells (Gas 1, Gas 3 & Gas 4) showed similar concentrations to previous years (i.e. 2010/2011/2012/2013/2014/2015/2016/2017/2018/2019). Methane gas readings were consistent at each sampling event through the 2019-2020 monitoring period. The maximum methane (stable) gas reading was 450 ppm at Trench (5) on 15 September 2020. The lowest readings were 155 ppm at Trench 5 on 4 February 2020. Gas well locations (Gas; 1, 2, 3) in 2020 reported low landfill gas concentrations ranging from 100 to 140 ppm.

Buildings were sampled for landfill gas in 2019-2020, with all locations recording no methane gas readings (non-detectable and compliant with EPL conditions).

E2W interpret that landfill gas is unlikely to be present in the buildings due to the previous results, landfill capping, dilution by ambient air, and type of onsite buildings (i.e. well vented and/or air conditioned).

5.2 Surface and Groundwater Monitoring Locations

Groundwater monitoring was undertaken from up to 16 existing groundwater wells (shallow, intermediate and deep) located on the landfill mound perimeter and surface water monitoring at two locations along Rocklow Creek (up, middle and down-gradient of the landfill mound, whilst access was re-established at Rocklow-down in May 2015). Refer to Figure 2.

The wells and surface water locations sampled in the 2018 and 2019 reporting period are outlined below:

- 21 November 2019. Groundwater wells: MD1B, MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9B, MD9C, MD10A, MD10B, and Surface water; Rocklow-Up, Rocklow-Middle, Rocklow-Dn;
- 14 February 2020. Groundwater wells: MD1B, MD2A, MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9A, MD9B, MD9C, MD10A, MD10B, Surface water: Rocklow-Up, Rocklow-Middle, Rocklow-Down.
- 28 May 2020. Groundwater wells: MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9B, MD9C, MD10A, MD10B, Surface water: Rocklow-Up, Rocklow-Middle, Rocklow-Down;
- 28 August 2020. Groundwater wells: MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9B, MD9C, MD10A, MD10B, Surface water: Rocklow-Up, Rocklow-Middle, & Rocklow-Down.

The nature of saline water stratification within the local groundwater system and well network is presented in Table 5.2.1 (below) and Appendix B (Figure 7).

Table 5.2.1: Summary of Groundwater Salinity Changes with Depth

Well ID	Salinity (EC, $\mu\text{S}/\text{cm}$)	Comment
MD1B	850	Fresh- water 10 m away is saline
MD2A	25,200	surface water from high tide
MD2B	29,100	saline groundwater
MD2C	44,600	saline groundwater
MD4A	NA	Damaged well (shallow/dry)
MD4B	15,300	saline groundwater
MD4C	33,100	saline groundwater
MD6A	11,100	surface water from high tide
MD6B	2,221	fresh - brackish groundwater
MD6C	27,400	saline groundwater
MD9A	3,375	fresh - brackish groundwater
MD9B	3,207	fresh - brackish groundwater
MD9C	3,600	fresh - brackish groundwater
MD10A	40,900	saline groundwater
MD10B	2,797	fresh - brackish groundwater

Note: Electrical Conductivity data is from sampling by E2W on 29 June 2005. Well suffix 'A' and 'B' = shallow well screen (less than 3 m into water table).

Well suffix 'C' = well screen greater than 3 m below water table (refer to Figure 7 in Appendix B).

Several of the groundwater wells (MD-4A/B/C, MD-6A/B/C etc.) comprise nested wells, which target various depths within the coastal sand aquifer. The sampling frequency and depth of the groundwater samples are presented in Table 5.2.2 (below).

Table 5.2.2: Monitoring Summary for the 2019 to 2020 Reporting Period

Sample ID	Screen Interval (m AHD) - or Sample Location	Nov 2019	Feb 2020	May 2020	Aug 2020
(MD1A)	0.5 to -0.5	No Access/dry	No Access/dry	No Access/dry	No Access/dry
MD1B	-4.7 to -5.7	X	X	X	X
MD2A	0.525 to -0.475	X	X	X	X
MD2B	-2.93 to -3.93	X	X	X	X
MD2C	-5.2 to -6.2	X	X	X	X
(MD3B)	-3.22 to -4.22*				
(MD3C)	-5.55 to -6.55*				
MD4A	1.2 to 0.2	Dry	Dry	Dry	Dry
MD4B	-3.22 to -4.22	X	X	X	X
MD4C	-5.55 to -6.55	X	X	X	X
MD6A	0.71 to -0.30	X	X	X	X
MD6B	-1.05 to -2.05	X	X	X	X
MD6C	-8.8 to -9.8	X	X	X	X
(MD7)	0.5 to -0.5 *				
(MD8)	0.5 to -0.5*				
MD9A	0.58 to -0.42	X	X	X	X
MD9B	-2.3 to -3.3	X	X	X	X
MD9C	-4.75 to -5.75	X	X	X	X
MD10A	0.68 to -0.32	X	X	X	X
MD10B	-2.85 to -3.85	X	X	X	X
Rocklow-Up	Upstream of landfill	X	X	X	X
Rocklow-Middle	Midstream of landfill	X	X	X	X
Rocklow-Down	Downstream and opposite landfill	X (new location)	X (new location)	X (new location)	X (new location)

Note: *= to be confirmed (logs not available). X = Sample collected.

(MD7), well in brackets = well is not an EPL requirement. Blank space = not sampled.

= Not enough water for sampling

The groundwater monitoring wells and sampling depths for each event are summarised in Table 5.2.2 (above). The sampling labels for the nested wells ('A' to 'C') are attached to each of the depths associated with these wells (e.g. MD1A, MD1B, MD1C).

6. MONITORING RESULTS

All surface and groundwater analytical results for the 2019/20 reporting period are presented in Tables GW-1, and SW-1, SW-2, and SW-3. The ALS field record and laboratory reports are presented in Appendix A.

A summary of all groundwater monitoring data (1999 to 2020) for ammonia (mg/L) is presented in Graph-1, Graph-2 and Graph-3. The graphs highlight ammonia groundwater quality trends over the past ~ 20 years (January 1999 to August 2020). Ammonia concentrations are the key landfill leachate indicator for the site.

A summary of previous ammonia surface water results for Rocklow Creek is presented in Table SW-2. Ammonia is considered as the key landfill leachate indicator in surface water, however other sources of ammonia exist in the same catchment (i.e. fertiliser use in paddocks and Dunmore landfill on the opposite side of Rocklow Creek).

6.1 Groundwater Data

Groundwater for the 2019-2020 reporting period was collected from a network of seventeen monitoring wells (mostly downgradient locations) at the MWDD (Figure 2). The results of the groundwater testing are summarised in Table GW-1, Graphs-1 to 3, Figure 2 and in the following subsections.

6.1.1 Groundwater Depth

The depth to groundwater was measured prior to each sampling event using a water level probe. Depth to the groundwater below top of casing and relative to a common reference (i.e. Australian Height Datum, mAHD) is presented in Table GW-1. The inferred radial groundwater flow direction for the site is presented in Figure 2. Given the proximity to Rocklow Creek, the groundwater flow direction and gradients would be influenced by tides.

The groundwater levels recorded during 2019/20 is similar to the previous year and reflects the seasonal changes in rainfall and tide levels.

The reduced groundwater levels (m AHD) from the 16 wells sampled in 2019/20⁴ indicate a relatively low water table elevation (<1.6 m AHD), which is characteristic of the swamp/estuarine environment. The annual rainfall from August 2019 to July 2020 = 860 mm, August 2018 to July 2019 = 871 mm reflecting a 4 year drought (e.g. 2016-2017 & 2017-2018 was 923 mm, 663 mm, respectively at Bombo Headland).

Recharge to the aquifer system beneath and surrounding the waste disposal facility mainly occurs from rainfall infiltration and storm water runoff around the footprint. Minor recharge may occur through the landfill mound (e.g. <5% of annual rainfall). The infiltration of rainfall is interpreted to be moderate/high around the footprint area (uncapped areas) due to the sandy soils, low elevations and run-off.

⁴ Note; Four wells: MD2A, MD4A, MD10A, MD10B have no survey/RL measurement.

6.1.2 Field Parameters

The field parameters measured during groundwater sampling are indicative only, due to the low purge volumes (ALS sampling) and dominant reduced/anaerobic condition of the groundwater (Table GW-1).

Insitu measurements (within borehole) are likely to provide a more accurate rendition of the field chemistry, especially with respect to dissolved oxygen (parameters are not considered critical for the quarterly monitoring).

6.1.2.1 Field pH

The pH from the 15 wells (MD1A, MD1B, MD2A, MD2B, MD2C, MD4B, MD4C, MD6A, MD6B, MD6C, MD9A, MD9B, MD9C, MD10A, MD10B) ranged from pH 6.6 to 7.6 (average PH =7.06) in the 2019-2020 reporting period, indicating relatively neutral groundwater.

Fluctuation (minor) in pH is likely to relate to a combination of factors including leachate quality, acid sulphate soils, tidal influences (together with a rise in electrical conductivity) and surface water quality.

E2W considers that field pH measurements may be more reliable than laboratory, as the pH of waters can change once out of equilibrium with the natural environment and stored within containers (holding time for pH is less than 4 hrs).

6.1.2.2 Electrical Conductivity (EC)

The EC in groundwater collected from the site vary and range from approximately 594 to 49,200 uS/cm (average=20,062 uS/cm) in the 2019/20 reporting period. The salinity reflects the transgression/regression of fresh and marine groundwater and presence of saline groundwater at depth (Figure 2 & Appendix B).

The distribution of EC indicates fresh water is located under the landfill mound and close to the landfill footprint, with sharp salinity increases near Rocklow Creek and Minnamurra River (Figure 7, Appendix B). The saline water correlated with the fresh/saltwater interface and presence of mangroves/sedges (tidal area).

6.1.2.3 Dissolved Oxygen (DO)

The 15 wells recorded field dissolved oxygen (DO) concentrations ranging between 0.35 to 5.25 mg/L (average=1.85 mg/L) in the 2019/20 reporting period. The concentrations of dissolved oxygen are similar to those reported in previous annual monitoring reports.

It is likely the concentrations of DO would be lower if measured insitu, as opposed to during the purging and sampling process. Wells with low purge volumes (& sampling via a bailer) are unlikely to provide representative groundwater DO concentrations.

Landfill leachate and the organic rich sediments (estuary) are likely to deplete DO in the groundwater (e.g. MD9C). This phenomenon is seen on many landfill sites, where organic carbon and nutrients provide surplus electron acceptors, which react with and consume the available DO in groundwater.

6.1.3 Nutrients (groundwater)

6.1.3.1 Nitrogen-based compounds

Groundwater collected from the MWDD monitoring wells were analysed for ammonia and nitrate in the 2019/20 reporting period (note: Total nitrogen is not an EPL requirement).

Two (MD2A, MD9A) out of the 15 wells reported one or more samples with nitrate concentrations above the ANZECC (2000) trigger value for freshwater ecosystems (0.7 mg/L, at 95% protection level). In 2019/2020, nitrate concentrations ranged from <0.01 (non-detected) to 4.66 mg/L (average= 0.84 mg/L) which are similar to the previous years.

Elevated Nitrate has been detected in two shallow wells (MD2A, MD9A) in the 2019/2020 monitoring round (i.e. 2016/2017 reported nine wells above the ANZECC 2000 guidelines) in comparison to the 2012/2013 monitoring round (eight wells above the ANZECC 2000). The nitrate concentrations in groundwater in 2019/2020 are generally low and below ANZECC (2000), except for the shallow wells (MD2A, MD9A). Nitrate is associated with the shallow wells due to oxidation of the ammonia concentrations.

Nitrogen species in the groundwater is predominantly ammonia, and indicative of a reducing groundwater environment. Thus, potential impact to the aquatic environment is interpreted to arise from ammonia, and to a lesser extent, the oxidised nitrogen form (nitrate).

The guidelines (ammonia) for the protection of freshwater and marine ecosystems vary according to pH and temperature. Given the range of pH and temperature measured across the site and in Rocklow Creek, the guideline values have been calculated as 1.88 and 2.84 mg/L for fresh and marine waters, respectively (at pH of 7.3).

Fourteen (14) out of 15 wells (excluding MD4C, MD10A) reported ammonia concentrations in excess of the ANZECC (2000) trigger value for marine ecosystems (2.84 mg/L, based on a pH of 7.3) in the 2019-2020 monitoring. Concentration of ammonia ranges from 0.14 to 116 mg/L, with an average of 29.09 mg/L (2019/2020).

Groundwater from the wells MD1B, MD2A, MD4B, MD4C, MD6A, MD6B, MD6C, MD9B, MD9C and MD10B, located on the north and eastern landfill perimeters (plume centreline path) reported the highest concentrations of ammonia (Figure 2). Remedial works is in progress at the wells (i.e. MD9B/9C and MD10B).

The well (**MD9B**, intermediate well) reported the maximum ammonia of 116 mg/L in February 2020 (note; previous maximum concentrations were reported at MD-9C, however groundwater extraction commenced during 2019). The results are lower than previous years at MD-9C (e.g. May 2016 =160 mg/L, November 2014 =170 mg/L). Ammonia trends are presented in the time series Graphs 1 to 3. Groundwater remedial works are underway at MD9C which is likely to reduce ammonia concentrations.

Highest ammonia concentrations correlate with the main downgradient area (plume centreline) of the waste mound and above average rainfall events. The ammonia concentrations from 2015 to 2020 are variable and elevated reflecting leachate spikes which are interpreted to reflect the variable dry climate with occasional and heavy rainfall events (e.g. March 2017 @ 309 mm, February 2020 @ 213 mm, July 2020= 216 mm).

It is noted that rehabilitation works were completed in early 2008, and the 2008/09 and 2009/10 ammonia concentrations have generally decreased since then at most well locations.

The ammonia trends at the MB9C, MD10B area are currently variable to reducing. Additional monitoring is required due to the variable trends at various depths and the groundwater remedial works.

Groundwater extraction works are in progress since 2019 to address the previous rising ammonia trend (above 100 mg/L) at MD9C. A series of extraction and monitoring wells have been installed by E2W and KMC together to enable irrigation of the leachate on the batter slopes.

6.1.4 Ammonia Trends

The groundwater ammonia trends from 1999-2020 are presented in Graphs-1, Graph-2 and Graph-3. The data indicates ammonia in most monitoring wells exceed the ANZECC (2000) marine water trigger value. A summary the ammonia trends are presented in Table 6.1.4.

Table 6.1.4 Summary of Ammonia Trends in Groundwater (1999 to 2020)

South-east of Landfill (Across-gradient)		North of Landfill (Down-gradient, plume centreline)	
Well ID	Trend	Well ID	Trend
MD1B	Overall decreasing but variable	MD4B	Variable to decreasing trend
MD2B	Decreasing	MD4C	Decreasing
MD2C	Decreasing	MD9B	Variable and decreasing trend (currently <100 mg/L)
MD6B	Variable to decreasing trend	MD9C	Variable and decreasing trend (currently <100 mg/l)
MD6C	Variable to decreasing trend	MD10B	Variable and decreasing trend

Note: "B" and "C" denote shallow and deep wells, respectively.

The ammonia trends are generally variable over time; however most locations show a downward or stable trend. The ammonia from the quarterly monitoring events may reflect a combination of seasonal rainfall, plume movement, tidal fluctuations and landfill rehabilitation works.

Monitoring reports (e.g. E2W, 2008-09, 2009-10, 2010-11, 2011-12, 2012-13, 2013-2014, 2014-2015, 2016-2017, 2017-2018, 2018-2019, 2019-2020) have identified spikes in ammonia concentrations that are interpreted to result from high rainfall and leachate plume migration. For example, in February 2008, high rainfall (169.2 mm, 5 February) was followed by a rise in ammonia in early to mid 2008. In October 2009, 187.8 mm of rainfall, which was the highest monthly rainfall recorded for the 2009 calendar year (next highest December 2009, 106.2 mm). During the 2010-11 monitoring period, 22 March 2011 (163.8 mm rainfall) was followed by a rise in ammonia (May 2011, Graphs 1-3)⁵. Over the 2011/12 period, a combined 176.2mm rainfall from 20 to 23 July was followed by an increase in ammonia (November 2011, Graph 1-3). Rainfall of 289 mm in February and 213.2mm in March 2012 (502.2mm combined in 2 months) was followed by rises in ammonia (May 2012, Graph 1-3)⁷.

⁵ Rainfall data taken from the Kiama (Bombo Headland) Weather Station, (Station ID 068242)

During the 2012/13 period, high rainfall was experienced in January 2013 (170.8 mm) and February 2013 (153.2 mm) resulting in elevated ammonia during the February monitoring. In addition, high rainfall in April 2013 (183.6 mm) was followed by a rise in ammonia in May 2013. This occurred again in the 2013/14 period with high rainfall in November 2013 followed by a rise in Ammonia in the November 2013 samples and high rainfall again in March and April 2014 followed by an increase in Ammonia in the May 2014 samples. The ammonia peak in November 2014 (170 mg/L) and November 2015 are interpreted to be associated with high recharge rainfall events.

Heavy rain occurred in February (158.8 mm) and March (309 mm) 2017, however rainfall during the 2016 -2017 (923 mm), 2017-2018 (663mm), 2018-2019 (871 mmm) and 2019-2020 (860 mm) monitoring period are below the annual average.

Rainfall events before or on the dates of sampling may contribute to rising ammonia concentrations in the groundwater due to flushing (e.g. leachate migration/generation and/or rising water table).

During 2014 to 2020 ammonia concentrations are generally variable and recently decreasing at MD9C and MD9B (hotspot area). The elevated ammonia concentrations are reported at the north east corner of the landfill (e.g. MD10B & MD9C/MD9B). This area has been further investigated and subjected to groundwater remedial works to minimise potential impacts to the aquatic ecosystems.

Review of aerial photographs taken of the landfill in late 2007 shows that the NE corner (where most of the wells are situated) was the last to be reshaped, capped and vegetated (& increase the potential for leachate generation and migration, as would have disturbance of soil and waste in that area). Continued monitoring of ammonia concentrations and climate is required to establish seasonal trends.

The amount of landfill leachate declined following the closure of the landfill and completion of rehabilitation works. The groundwater quality is likely to take years (5 years+) to show improvements due to the age and scale of the landfill mound, and generally flat hydraulic gradients.

Results from 2012 to 2020 monitoring periods show cyclical seasonal trends related to climate and landfill closure works. Future monitoring is required to assess ammonia trends during various climate and active remedial works (MD9C/MD9B, & MD10B). The MD9C area is interpreted to represent the centreline and core of leachate plume and main discharge area to Rocklow creek.

6.1.4.1 Total Phosphorus (TP, groundwater)

The total phosphorus (TP) is not an EPL requirement and was not sampled during the 2016-2020 monitoring period. In the 2007/08 monitoring period, the majority of TP concentrations from twelve wells exceeded the ANZECC (2000) trigger values for the protection of marine ecosystems.

6.1.5 Hydrochemical Indicators

Concentrations of major ions (chloride, sulphate, calcium, magnesium, sodium and potassium) in the groundwater at the site are presented in Table GW-1. The concentrations of major ions in all monitoring wells are within previously reported ranges and generally dominated by one cation (sodium) and anion (chloride).

In wells with freshwater, (MD6B and MD10B) calcium concentrations are similar to and sometimes greater than sodium. The calcium may relate to the geology (shells) or leachate.

The landfill leachate may be contributing concentrations of ions including calcium, potassium and magnesium. Contribution of sodium and chloride is difficult to ascertain as these ions are common with marine environments (e.g. salt spray, tidal influence).

6.1.6 Inorganic Contaminants (Iron, Manganese and Fluoride)

Dissolved iron (filtered at the laboratory) ranges from the <0.1 mg/L to 20.2 mg/L (average= 2.77 mg/L). With exception of two wells (MD6A/6B), all the groundwater wells reported ANZECC (2000) exceedances (freshwater ecosystems, 0.3 mg/L) in at least one out of the four sampling rounds.

It is noted that the ANZECC (2000) guideline for iron is an indicative interim working level (IIWL) and is of low reliability. No guideline is available for iron in marine water, which has a higher relevance to Rocklow Creek and receiving water bodies.

Concentrations of manganese ranged from 0.017 mg/L to 0.61 mg/L (average= 0.14 mg/L). The ANZECC (2000) guideline for manganese in fresh water is 1.9 mg/L. All results were reported below the ANZECC (2000) freshwater guidelines.

The levels of dissolved iron and manganese are similar to previous reporting periods.

Concentrations of fluoride ranged from 0.1 mg/L to 1 mg/L (average= 0.6 mg/L). No recommended reliable ANZECC (2000) guidelines exist for fluoride in fresh or marine waters. The data ranges between the minimum and maximum values are similar to the previous levels. The results indicate that fluoride levels are generally associated with landfill leachate.

6.1.7 Organic Contaminants (DOC, TOC & Phenols- Groundwater)

Concentrations of total and dissolved organic carbon (TOC/DOC) ranged from 4 / 2 mg/L to 147 / 143 mg/L in the 2019-2020 reporting period. ANZECC (2000) guidelines do not exist for TOC. The TOC may relate to landfill leachate and/or naturally occurring organic matter associated with the estuary.

Concentrations of phenols were all reported below the LOR (0.05 mg/L).

6.2 Surface Water

Surface water sampling was undertaken quarterly during the 2019-2020 reporting period. The EPL requirement is only six-monthly sampling.

The three surface water locations provide a general indication of water quality impacts from the MWDD (Figure 2). Impacts to the water quality in Rocklow Creek may also occur from the neighbouring Shellharbour Waste Disposal Depot situated on the northern side of Rocklow Creek.

The ammonia data indicate a general increase in ammonia concentrations from the upstream to downstream locations. Highest ammonia increments are interpreted to be associated with dry weather, groundwater baseflow discharges and a run-out tide cycle.

The three surface water locations are not sampled according to consistent tide (a low tide with outflow) or climate. Rocklow Creek represents a mix of tidal water, groundwater baseflow discharges and stormwater (i.e. following rainfall). Therefore, variations in water quality can occur due to tidal dilution associated with incoming and outgoing flows.

The surface water monitoring data is variable and possibly reflecting a combination of tide sampling regimes and the prevailing climate (i.e. November 2019 had low rainfall, whilst heavy rain occurred in February 2020).

Timing of the samples should be coordinated with the tide so that creek samples are collected during a run-out tide when the maximum amount of groundwater discharges into the creek. Variation in the ammonia concentration between the four sample events is also reflected in the salinity levels (e.g. EC= 1,610 uS/cm and 55,200 uS/cm at Rocklow-Up).

6.2.1 Physical Parameters

6.2.1.1 pH

The pH in Rocklow Creek at the middle and upstream location is generally neutral (6.6 to 7.4) in 2019-2020, and has not changed significantly from previous reporting periods.

6.2.1.2 TDS - EC

The conductivity (EC, mS/cm) of waters at the upstream location are generally lower than those recorded downstream (Rocklow-Middle), reflecting the tidal range and groundwater discharge from the catchment area.

Water collected from Rocklow Creek is slightly brackish to saline (1,610 to 55,200 uS/cm). Sampling at low tide would result in decreased salinity due to an increased baseflow (fresh groundwater) contribution.

6.2.1.3 Dissolved Oxygen (DO)

The DO of waters ranged from 2.09 to 10.5 mg/L (average 6.11 mg/L). Higher DO values are associated with the up-stream section of Rocklow Creek.

6.2.2 Nutrients (surface water)

6.2.2.1 Nitrogen

Rocklow Creek surface water samples collected in the 2019-2020 reporting period reported ammonia below the ANZECC (2000) guidelines for marine and freshwater ecosystems (2.84 and 1.88 mg/L, respectively, Tables SW-1 and SW-2).

Nitrate concentrations for the 2019-2020 ranged from 0.02 to 0.37 mg/L (average 0.236 mg/L) and were below the ANZECC (2000) guidelines. Ammonia concentrations for the 2019-2020 ranged from 0.04 to 1.2 mg/L (average 0.44 mg/L) and were below the ANZECC (2000) guidelines. The elevated concentrations in the upstream sample indicates elevated and variable background concentrations from the agricultural catchment area.

Water samples collected from Rocklow Creek during 2019/20 reporting period generally show variable concentrations of ammonia an upstream to downstream locations. The greatest increase in ammonia from upstream to midstream location occurs on 21 November 2019 (<0.1 mg/L to 0.9 mg/L, Refer to Tables: SW-1 & SW-2). The midstream location

corresponds to the area of MD9C, where active remedial works are occurring to reduce ammonia concentrations in the groundwater.

Other increases in ammonia from upstream to downstream location occurs on 17 August 2017 (0.05 mg/L to 1.59 mg/L). The ammonia increments between the upper, mid and down stream samples are presented in Table SW-2 and Graph-4 (note: mid-stream location is downgradient to MD9C, MD10B which have elevated and irregular ammonia trends).

Ammonia concentrations in Rocklow Creek (2019-2020) are generally comparable to previous results (2018-2019, 2017-2018, 2016-2017, 2014/2015, 2013/2014, 2012/13 and 2011/12, Table SW-2). However, the ammonia increments, and seasonal variability in the Rocklow-Mid and Rocklow-Low is evident from 2011 to 2020 (spiking of ammonia), which is interpreted to reflect tidal influences, variable background concentrations, climate and potentially the groundwater (MD9C) discharges.

Increases in ammonia from upstream to downstream of the landfill have been observed during previous monitoring periods (Graph-4). While these increases could be attributable to the discharge of groundwater impacted by ammonia from the MWDD, other sources of nitrogen input such as polluted runoff from the Shellharbour Landfill and agricultural areas is not discounted.

Graph-4 shows the ammonia increments in all monitoring periods since 1999 to 2020 and illustrates a decreasing difference between upstream and downstream ammonia concentrations. Ammonia concentrations at Rocklow-Up have remained relatively stable over time while ammonia concentrations at Rocklow-Middle and Rocklow-Down show a variable trend.

The ammonia contribution from the MWDD into Rocklow Creek is complicated by the sampling regime (i.e. sampling at various tides level with dilution from tidal water) and other potential sources of nitrogen in the area (Dunmore Landfill and nutrients from upstream agricultural areas). Surface water results should be interpreted as indicative only due to the dynamic nature of the catchment and multiple nutrient sources.

6.2.2.2 Total Phosphorous (surface water)

Total phosphorus (TP) is not an EPL requirement and were not analysed during the 2019-2020 monitoring period.

Monitoring from previous years indicate that TP concentrations decrease from up to downstream of the landfill (except in August 2008), implying there is nutrient contribution from other (agricultural) sources in the catchment area.

6.2.3 Organic Contaminants (TOC, Phenols & Fluoride)

Concentrations of total organic carbon (TOC) ranged from 1 to 25 mg/L in the 2019/20 reporting period. No recommended ANZECC (2000) guidelines exist for TOC. Concentrations of TOC could be related to natural waters or leachate.

Concentrations of phenols were reported all below LOR (0.05 mg/L) in all surface water samples.

Concentrations of fluoride ranged from 0.2 mg/L to 0.9 mg/L, with concentrations showing a general increase in the Rocklow-Mid & Rocklow-Low sampling locations relative to the upstream sample.

7. CHEMICALS OF CONCERN AND CONTAMINANT PLUME

The results of 2019-2020 monitoring have been assessed to determine the surface and groundwater conditions with respect to the relevant guidelines which serve to protect aquatic ecosystems (both fresh and marine). Aquatic ecosystem protection is considered as the key environmental beneficiary of the local groundwater.

The primary landfill leachate indicator at the site is ammonia. Ammonia represents the analyte which exceeds ANZECC (2000) guidelines in majority of monitoring wells. The landfill is also a source of dissolved salts, metals (i.e. iron, which was generally above interim guidelines) and potentially organics. The dissolved salts, metals and organics are associated with the buried waste material.

Results of the sampling (1999-2020) confirm that ammonia concentrations are elevated above background levels. Improvement in the groundwater quality (i.e. a decreasing ammonia trend) is evident in several wells (MD2B, MD2C, MD4C, MD6C) since landfill rehabilitation works (2007).

Groundwater remedial works are occurring to reduced elevated ammonia (>100 mg/L) at the plume centreline area, which including the well location (MD9B/9C and MD10B) on the north east corner of the site. Recently, all wells are showing a decreasing ammonia trend, however some variability is occurring at the area of groundwater remediation (commenced in 2019).

High rainfall periods since landfill rehabilitation completion are interpreted to have resulted in periodic ammonia increases (e.g. February 2008, March 2011, July 2011, February/March 2012, January/February 2013, April 2013, November 2013, March-April & late 2014, August 2015, June 2016, March 2017). Some heavy rain events over the past few years is also likely to create ammonia spikes in the groundwater. The past four years indicate a dry weather pattern and potentially less dilution of the ammonia plume around the landfill perimeter.

It is likely the leachate plume arising from the landfill mound would migrate radially (local system) and with the regional flow regime towards the north-east and east (MD9C). Landfill leachate infiltrates into the sandy aquifer and migrates towards Rocklow Creek and Minnamurra River.

The extent of natural attenuation and degradation of the nutrient plume prior to discharge is not well known, however the groundwater/saltwater interface and mangrove environment are likely to enhance attenuation of the ammonia plume (Appendix B, Figure 7).

7.1 Ecological Issues

Groundwater migrating from under the landfill mound to Rocklow Creek and Minnamurra River would be diluted by the dynamic and tidal nature of the environment. Contaminants contained within this discharge will be diluted and dispersed via biological, chemical and physical processes which occur at the groundwater/saltwater interface. Uptake of the nutrients by plants (mangroves, sedges) dependent on groundwater will also occur at the creek and river.

The adverse effects arising from landfill leachate on the Rocklow Creek and Minnamurra River aquatic environments is unclear and difficult to ascertain, given the multiple sources of

nutrients present and disturbance in the catchment area. No obvious evidence of degradation is evident in the water bodies or surrounding vegetation (Note; some trees were damaged/removed during landfill rehabilitation works in 2007-2008).

Discharges of landfill leachate to Rocklow Creek would be at a maximum when the tide is low (& with fresh water) and the outward groundwater gradients are steepest.

The net increment of ammonia in the midstream sample (Rocklow-Middle) averaged ~0.05 mg/L in the 2014-2015, ~0.96 mg/L the 2015-2016, ~0.146 mg/L in the 2016-2017, 0.605 mg/L in the 2017-2018, 0.285 mg/L in 2018-2019, and 0.425 mg/L in the 2019-2020 reporting period (Table SW-2). This net increment in 2019-2020 is also dependant on tidal regime during sampling which is variable during the quarterly sampling events.

The reduced net increment of ammonia may also reflect the below average climate (860 mm) during the 2019-2020 monitoring period.

The ammonia in groundwater plume (MD4B, MD9C, MD10B) during 2019-2020 is interpreted to potentially contribute to the nutrient concentrations in the surface water (i.e. Rocklow-Middle & Rocklow-Down locations). However, other potential sources (Dunmore landfill) and sampling variables are noted (e.g. climate, tidal regime). Downstream ammonia concentrations show some significant variability since monitoring commenced in 1999 (Graph-4).

While it is likely that some nitrogen-impacted groundwater may discharge into Rocklow Creek and Minnamurra River, it is unclear as to the extent of attenuation of the nitrogen plume prior to discharge. Attenuation is likely to occur through a combination of dilution, through mixing of groundwater from north of the creek, by flows and tidal movements within the creek and estuary itself, oxidation of the ammonia to nitrate, and finally as conversion to nitrogen gas. Rocklow creek has extensive mangroves and casuarinas.

Since early 2016, Council and E2W have investigated groundwater near MD9C and installed test bores (3) and pumping infrastructure to progress remedial works to reduce the elevated ammonia concentrations. Leachate management include extraction of groundwater at MD9C via three pumping bores (2018) and irrigation/recirculation over the landfill mound (2019).

Ammonia and nitrate concentrations in all surface water samples collected in the 2019-2020 reporting period were below ANZECC (2000) trigger values for fresh and marine water ecosystems.

8. CONCLUSIONS

Surface and groundwater monitoring were undertaken at the Minnamurra Waste Disposal Facility by ALS on a quarterly basis from November 2019 to August 2020 (EPL reporting period). Monitoring data collected during the 2019-2020 period was assessed by E2W (Dino Parisotto; *CEnvP- Site Contamination Specialist*) to determine the impact of the landfill facility on local groundwater and aquatic ecosystems.

Based on the environmental data reviewed and assessed, E2W offer the following conclusions:

- Elevated concentrations of nutrients, particularly ammonia continues to be detected in groundwater at the landfill site. Ammonia concentrations exceed the ANZECC (2000) guidelines for the protection of fresh and marine water ecosystems in 14 out of 15 monitoring wells sampled (i.e. MD1A, MD4A are dry wells, whilst ammonia at MD10A is below guidelines).
- The impacted wells are located on the footprint of the landfill mound, indicating contaminant migration towards the two water ways (i.e. Rocklow Creek and Minnamurra River).
- Elevated ammonia concentrations (above ANZECC 2000) were reported at majority of wells (Figure 2), with highest concentrations exceeding 100 mg/L reported at MD9B/9C (i.e. MD9B= 116 mg/L, and MD9C =106 mg/L). This hotspot area is currently being remediated via three spear points at MD9/MD10 area to reduce the ammonia concentrations.
- The nitrate concentrations in groundwater in 2019-2020 are generally low and below ANZECC (2000), except for the 2 wells (MD2A, MD9A), which were above the ANZECC (2000) trigger value for freshwater ecosystems (0.7 mg/L, at 95% protection level). Nitrate concentrations in 2019-2020 are lower than previous years.
- Ammonia concentrations in the 2019-2020 monitoring period continue to be elevated and variable, however show an overall decreasing trend in all wells. Some variability in ammonia occurs at the remedial area (MD9B) given the groundwater extraction. Variations in ammonia are inferred to reflect seasonal trends (climate, storm events, groundwater extraction) and plume migration.
- Low concentrations of ammonia (below ANZECC 2000) were reported from the upstream, mid and down stream locations of Rocklow Creek during 2019-2020. Ammonia increases consistently in the downstream or Rocklow-Mid surface water locations relative to the upstream location. The net increment of ammonia between the upstream, midstream and downstream concentrations is variable since 1999. E2W interprets that potential nutrient impact occurs from the MWDD site during the 2019-2020 monitoring period. Other sources of potential leachate impact is likely to occur from the neighbouring active landfill (Dunmore). The leachate plume on the MWDD (MD9C area) is currently being remediated by Council using a groundwater extraction and re-circulation system.
- Net increments of ammonia in the midstream sample (Rocklow-Middle) averaged ~0.05 mg/L in 2014-2015, ~0.96 mg/L the 2015-2016, ~0.146 mg/L in the 2016-2017, 0.605 mg/L in 2017-2018, 0.285 mg/L in 2018-2019, and 0.425 mg/L in the 2019-2020 reporting period (Table SW-2). Net increments in 2019-2020 is also dependant on tidal regime during the sampling. Elevated ammonia in the groundwater plume (MD9C/MD9B) may be contributing ammonia concentrations in the surface water at the two sample locations (i.e. Rocklow-Mid & downstream). Further monitoring is required to verify this interpretation, as tidal dilution and multiple nutrient sources are situated around the creek (e.g. Dunmore landfill, degraded agricultural runoff).
- Recent water quality indicators were consistent with the results of previous monitoring periods. No phenols were detected in the groundwater or surface water samples during 2019-2020.
- The quarterly testing of the gas monitoring wells (Gas 1, Gas 3, Gas 4) and trenches (Trench 1 to Trench 7- gas biofilter pads) by Council indicated that landfill gas levels are comparable to previous years. All buildings sampled (within 250 m of the deposited waste) recorded no detectable landfill gas readings on 4 February 2020, 16 May 2020, 15 September 2020 (including 2 October 2019). The five buildings assessed for landfill gas during 2019-2020 include the weighbridge, cleaning shed, MRF, lunch room, and ute shed.

- KMC (& E2W) are unaware of any reportable pollution incidences or complaints from the community related to the MWDD during the 2019-2020 reporting period.

The nutrients in the local surface and groundwater are likely to decrease over time due to the landfill closure and rehabilitation works. Leachate generation has decreased due to the landfill capping from August 2006 to January 2008. Monitoring data in 2019-2020 supports this interpretation and improvement in the local water quality.

The elevated ammonia concentrations reported at MD9C/MD9B and MD10B relates to the plume centreline migrating from under the landfill mound to the site boundary and foreshore area. Other areas are showing a decrease in leachate strength associated with landfill closure works and reduction of leachate generation due to site capping works.

Monitoring over the next few years will continue to provide the relevant environmental data to assess the effectiveness and performance of the landfill rehabilitation.

Groundwater remediation works and monitoring of elevated ammonia at monitoring wells and Rocklow Creek is required to assess ammonia trends and potential adverse water quality impacts. Current remedial works include groundwater extraction at three spear points (area of MD9C/MB10B) and irrigation of the landfill mound since 2019. The groundwater remediation and monitoring are planned to continue at low extraction rates for at least the next 5 years.

8.1 Recommendations

E2W offer the following recommendations regarding the monitoring at the Minnamurra Waste Disposal Depot (MWDD):

- Continue to monitor the groundwater and surface water and assess potential landfill leachate impacts.
- Continue with the groundwater remedial works (MD9C) and integrate the EPL monitoring results (including any surface water quality improvements). Implement the recommendations (E2W Independent Review Report, 13 August 2020) to increase aeration of the unlined pond and leachate holding tanks to minimise potential impact to aquatic ecosystems.

Water Sampling Procedures

- Recording of groundwater purge volumes and any observations (odour, sheen, turbidity) during sampling of monitoring wells,
- Use of calibrated field instruments for measuring field chemistry (pH, EC, DO, Eh, T) prior to sampling (documentation required to verify equipment calibration),
- Sampling of surface water to be timed with a low ‘run out’ tide. Documenting the tidal and climatic conditions during sampling.
- Include the details regarding the well conditions (eg. damaged or dry wells). Any damaged wells should be replaced or substituted with nearby wells.

The recommended groundwater monitoring program for the prescribed well locations (i.e. EPL conditions) is summarised in Table 8.1. E2W acknowledge that the EPL recommends a half yearly sampling frequency, whilst KMC have continued with quarterly groundwater

monitoring and include the surface water sampling of Rocklow Creek at three locations. Increased monitoring frequency facilitates earlier detection of rising trends and decisions regarding potential remedial works.

E2W recommend the current surface water monitoring program is continued on a quarterly basis for the 2019-2020 reporting period. Quarterly review of results from the Rocklow-Mid/Down stream sampling locations is required to address ecosystem risks associated with the elevated ammonia concentrations at well (MD9C/MD9B & MD10B) and the groundwater remediation.

Continued monitoring of landfill gas at the gas monitoring wells, trenches (biofilter pads) and buildings (6 monthly) is recommended to comply with the EPL.

9. LIMITATIONS

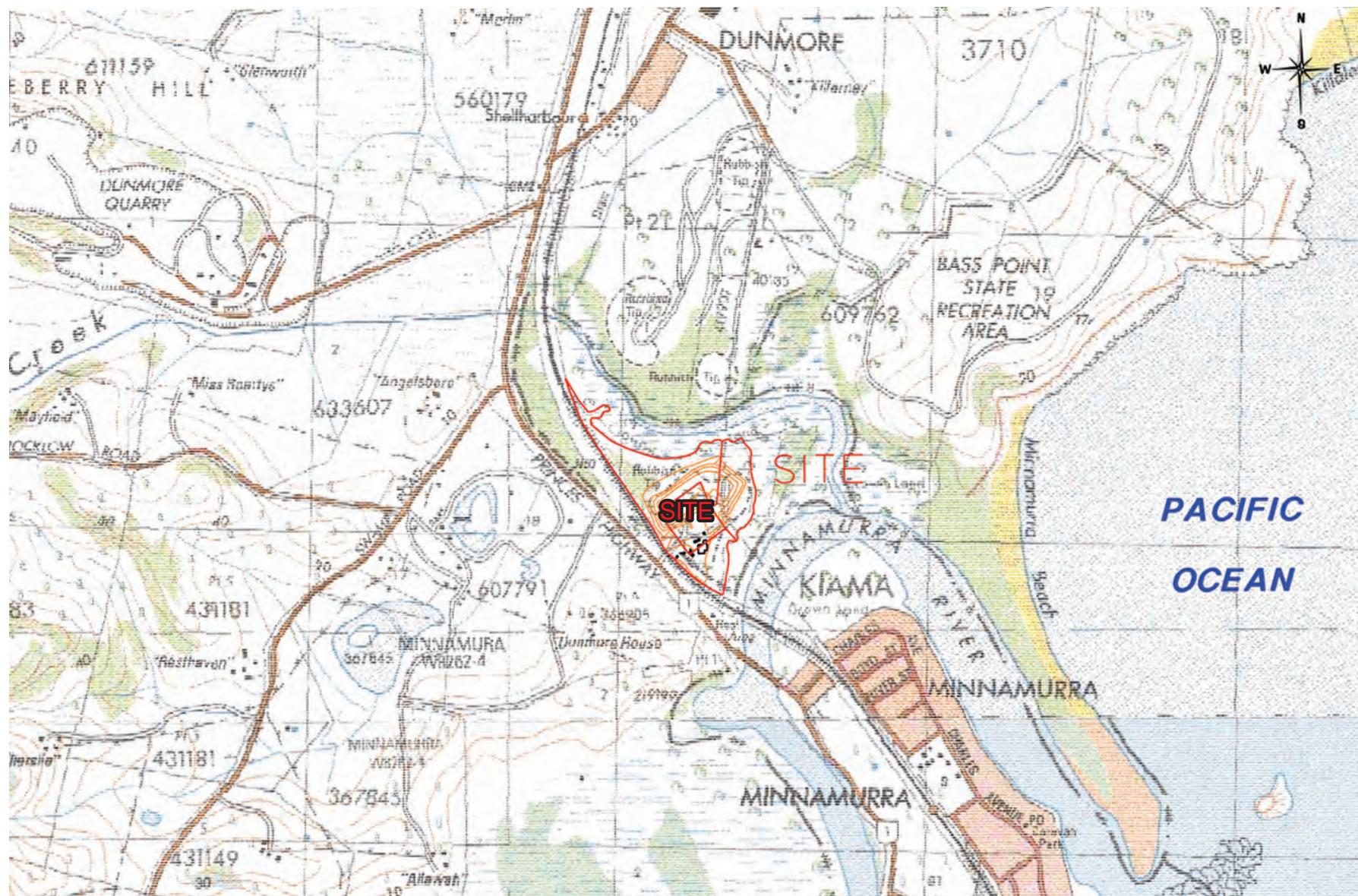
Earth2Water Pty Ltd has prepared this report for the use of Kiama Municipal Council in accordance with the standard terms and conditions of the consulting profession. This report is prepared in accordance with the agreed scope of work. The methodology adopted and sources of information used by E2W are outlined in this report.

This report was prepared during September & October 2020 and is based on the information reviewed at the time of preparation. This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties.

The precision with which conditions are indicated depends largely on the frequency and method of sampling, and the uniformity of conditions as constrained by the project budget limitations. The behaviour of groundwater and some aspects of contaminants in soil and groundwater are complex. Our conclusions are based upon the analytical data presented by Ecowise and our experience.

Where conditions encountered at the site are subsequently found to differ significantly from those anticipated in this report, E2W should be notified of any such findings and be provided with an opportunity to review our content and recommendations.

Figures



SITE LOCATION

Date: Sept 2020

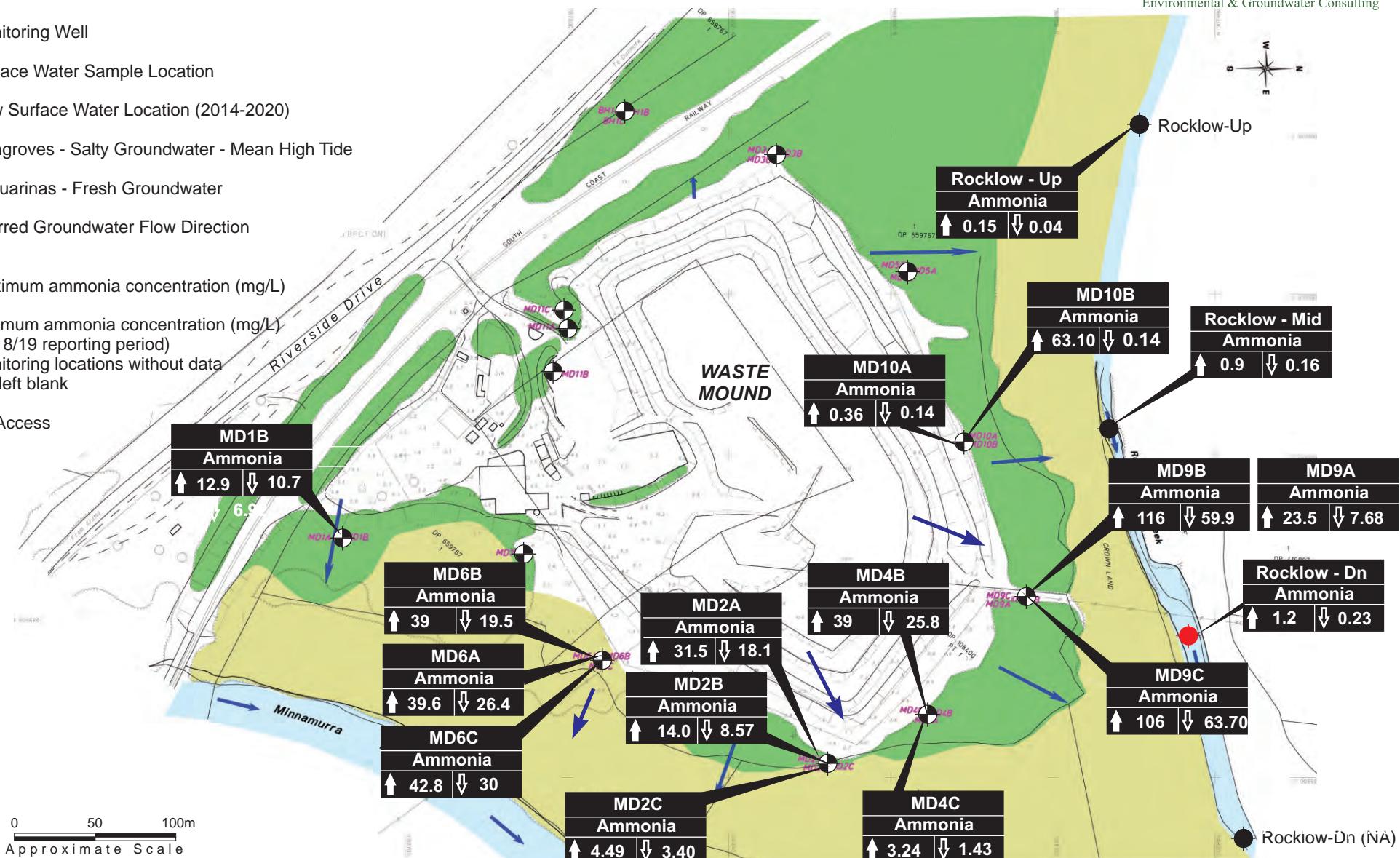
Reference: E2W_059_01.cdr

KIAMA COUNCIL - MINNAMURRA ANNUAL MONITORING REPORT (2019-2020)

Figure 1

LEGEND

- Monitoring Well
 - Surface Water Sample Location
 - New Surface Water Location (2014-2020)
 - Mangroves - Salty Groundwater - Mean High Tide
 - Casuarinas - Fresh Groundwater
 - ← Inferred Groundwater Flow Direction
- ▲ 3.2** Maximum ammonia concentration (mg/L)
- ▼ 0.4** Minimum ammonia concentration (mg/L)
(2018/19 reporting period)
Monitoring locations without data
are left blank
- NA** No Access



Source: Neil Charters Pty Ltd

MONITORING WELL LOCATIONS & MAXIMUM & MINIMUM AMMONIA CONCENTRATIONS (2019- 2020)

Date: 25 Sept 2020

Reference: E2W_059_04.cdr

KIAMA COUNCIL - MINNAMURRA ANNUAL MONITORING REPORT (2019-2020)

Tables

Table 8.1 - Recommended Groundwater Analytical Program for MWDD (2019-2020)

Analytes	Detection Limit	Sampling Frequency	Method Reference
Alkalinity	0.5 mg/L	6 monthly	APHA 2320B
pH/Eh	0.01 pH unit	3 monthly	pH meter and probe/APHA4500-HB
Electrical Conductivity	0.01 mS/cm	3 monthly	Conductivity meter and probe
Dissolved Oxygen	0.01 %	6 monthly	DO meter and probe
Temperature	1 deg	6 monthly	Temperature meter and probe
Ammonia	0.01 mg/L	3 monthly	FIA
Nitrate	10 µg/L	3 monthly	FIA
Calcium	1 mg/L	6 monthly	USEPA 6010 A
Chloride	0.5 mg/L	6 monthly	Titrated with mercuric nitrate using diphenol-carbazone/xylene cyanol FF indicator
Fluoride	0.1 mg/L	6 monthly	APHA4500-FC
Magnesium	0.02 mg/L	6 monthly	USEPA 6010 A
Sulphate	1 mg/L	6 monthly	ICID/MS
Sodium	0.05 mg/L	6 monthly	USEPA 6010 A
Total Alkalinity	0.5 mg/L	6 monthly	APHA 2340C
Potassium	0.05 mg/L	6 monthly	USEPA 6010 A
Dissolved Organic Carbon	0.50 mg/L	6 monthly	APHA 531 OC
Iron	1 µg/L	6 monthly	USEPA 6010 A
Manganese	1 µg/L	6 monthly	USEPA 6010
Phenols	1 µg/L	6 monthly	APHA 5530D
Standing Water Level	m AHD	6 monthly	Water level Probe

Note:

The key landfill indicator (ammonia/nitrate) is proposed on a quarterly basis in groundwater/surface water locations

ICP - Inductively Coupled Plasma

FIA - Flow Injection Analyser

MS - Mass Spectrometry

FC - Client Filtered

µS/cm - micro Siemens per centimetre

µg/L - micrograms per litre

mg/L - milligrams per litre

APHA - American Public Health Association

USEPA - United States Environment Protection Agency

Table GW-1: Summary 2019 to 2020 Analytical Results - Minnamurra Waste Disposal Depot

Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD 1B	MD 1B	MD 1B	MD 1B	No. Sample	Min	Mean	Max
Field Measurements	Freshwater	Marine	21/11/19	14/2/20	28/5/20	28/8/20				
RL (mAHD at TOC)			NA							
Standing water level (mTOC)			1.62	1.08	1.34	1.32	4	1.08	1.34	1.62
Reduced SWL (mAHD)							4			
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.60	7.60	7.60	7.60	4	7.6	7.6	7.6
Temperature			22.20	24.90	20.70	21.20	4	20.7	22.3	24.9
Electrical Conduct (uS/cm)	0.125-2.2 (a)		594	601	611	594	4	594	600	611
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9-10 (a)	1.02	2.52	1.23	0.78	4	0.78	1.39	2.52
Laboratory Analyses (mg/L)										
Sodium (ICP)			33	34	34	34	4	33	34	34
Potassium (ICP)			13	14	14	12	4	12	13	14
Calcium (ICP)			50	49	52	46	4	46	49	52
Magnesium (ICP)			8	9	9	8	4	8	9	9
Chloride			38	43	42	42	4	38	41	43
Sulphate (SO4)			16	16	17	20	4	16	17	20
Water Parameters (mg/L)										
Alkalinity (as CaCO3)			222	222	226	220	4	220	223	226
Fluoride			0	0	0	0	4	0.2	0.2	0.2
Phenols	0.40	<0.05	<0.05	<0.05	<0.05	<0.05	4	ND	ND	ND
Metals (mg/L)										
Iron (ICP)	0.3 (1)		0.50	0.68	0.76	0.60	4	0.50	0.64	0.76
Manganese (ICP)	1.90		0.049	0.057	0.054	0.049	4	0.049	0.052	0.057
Nutrients (mg/L)										
Nitrate (NO3 as N)	0.7 (7)		0.26	0.06	<0.01	0.26	4	0.06	0.19	0.26
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	12.2	17.0	11.7	10.7	4	10.70	12.90	17.00
Total Nitrogen	0.5 (3)	0.12 (4)								
Dissolved Organic Carbon (DOC)			<1	7	4	10	4	4.00	7.00	10.00
Total Organic Carbon (TOC)			<1	7	5	7	4	5.00	6.33	7.00

Notes:

1. Trigger value is an indicative interim working level only (IIWL).
2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
5. Trigger value for total phosphorus in lowland rivers in NSW.
6. Trigger value for total phosphorus in marine ecosystems in NSW.
7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Prepared by: Earth2Water Pty Ltd

Table GW-1: Summary 2019 to 2020 Analytical Results - Minnamurra Waste Disposal Depot

Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD2A	MD2A	MD2A	No. Sample	Min	Mean	Max	MD 2B	MD 2B	MD 2B	MD 2B	No. Sample	Min	Mean	Max	
Field Measurements	Freshwater	Marine	21/11/19	14/2/20	28/5/20	28/8/20				21/11/19	14/2/20	28/5/20	28/8/20					
RL (mAHD at TOC)			1.17	1.17	1.17	1.17				1.17	1.17	1.17	1.17					
Standing water level (mTOC)			0.55	0.21	0.22	0.39	4	0.21	0.34	0.55	0.85	0.50	0.57	0.65	4	0.50	0.64	0.85
Reduced SWL (mAHD)			0.62	0.96	0.95	0.78	4	0.62	0.82	0.96	0.32	0.67	0.60	0.52	4	0.32	0.52	0.67
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.00	6.90	7.10	7.30	4	6.90	7.08	7.30	6.90	6.90	6.90	6.90	4	6.90	6.90	6.90
Temperature			19.40	26.30	17.20	14.50	4	14.50	19.35	26.30	18.20	24.70	17.80	16.60	4	16.60	19.33	24.70
Electrical Conduct (uS/cm)	0.125-2.2 (a)		21200	18200	1840	21200	4	1840	15610	21200	30200	33800	35500	30200	4	30200	32425	35500
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9-10 (a)	2.62	3.69	0.79	1.05	4	0.79	2.04	3.69	2.66	2.53	0.40	0.72	4	0.40	1.58	2.66
Laboratory Analyses (mg/L)																		
Sodium (ICP)			3580	3040	3010	3410	4	3010.00	3260.00	3580.00	6750	6140	6420	4690	4	4690.00	6000.00	6750.00
Potassium (ICP)			186	176	182	188	4	176.00	183.00	188.00	278	262	268	219	4	219.00	256.75	278.00
Calcium (ICP)			317	250	297	288	4	250.00	288.00	317.00	454	496	433	392	4	392.00	443.75	496.00
Magnesium (ICP)			459	405	410	450	4	405.00	431.00	459.00	907	782	811	627	4	627.00	781.75	907.00
Chloride			6180	5980	5220	5900	4	5220.00	5820.00	6180.00	11000	11600	12100	8620	4	8620.00	10830.00	12100.00
Sulphate (SO4)			732	605	705	721	4	605.00	690.75	732.00	1720	1710	1740	1330	4	1330.00	1625.00	1740.00
Water Parameters (mg/L)																		
Alkalinity (as CaCO3)			867	990	973	867	4	867.00	924.25	990.00	749	736	739	838	4	736.00	765.50	838.00
Fluoride			0.8	0.9	0.8	0.9	4	0.80	0.85	0.90	0.6	0.6	0.6	0.6	4	0.60	0.60	0.60
Phenols			0.40	<0.05	<0.05	<0.05	4	0.00	#DIV/0!	0.00	<0.05	<0.05	<0.05	<0.05	4	0.00	#DIV/0!	0.00
Metals (mg/L)																		
Iron (ICP)	0.3 (1)		0.31	2.75	0.47	0.37	4	0.31	0.98	2.75	1.51	1.65	1.28	1.09	4	1.09	1.38	1.65
Manganese (ICP)	1.90		0.077	0.067	0.066	0.071	4	0.07	0.07	0.08	0.148	0.137	0.115	0.101	4	0.10	0.13	0.15
Nutrients (mg/L)																		
Nitrate (NO3 as N)	0.7 (7)		2.16	0.19	3.65	3.11	4	0.19	2.28	3.65	0.08	<0.01	<0.10	0.08	4	0.08	0.08	0.08
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	22.90	31.50	21.20	18.10	4	18.10	23.43	31.50	9.09	14.00	9.74	8.57	4	8.57	10.35	14.00
Total Nitrogen	0.5 (3)	0.12 (4)																
Dissolved Organic Carbon (DOC)			20	66	37	66	4	20.00	47.25	66.00	15	44	28	61	3	15.00	37.00	61.00
Total Organic Carbon (TOC)			27	65	46	76	4	27.00	53.50	76.00	16	43	30	52	4	16.00	35.25	52.00

Notes:

1. Trigger value is an indicative interim working level only (IIWL).
2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
5. Trigger value for total phosphorus in lowland rivers in NSW.
6. Trigger value for total phosphorus in marine ecosystems in NSW.
7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2019 to 2020 Analytical Results - Minnamurra Waste Disposal Depot

Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD 2C	MD 2C	MD 2C	No. Samples	Min	Mean	Max	MD4A	MD4A	MD4A	MD4A	No. of Samples	
	Freshwater	Marine													
Field Measurements															
RL (mAHD at TOC)			1.165	1.165	1.165					Dry	Dry	Dry	Dry		0
Standing water level (mTOC)			0.89	0.52	0.59	0.68	4	0.52	0.67	0.89	-	-	-	-	0
Reduced SWL (mAHD)			0.28	0.65	0.58	0.49	4	0.28	0.50	0.65	-	-	-	-	0
pH (field)	6.5-8.0 (a)	8-8.4 (a)	6.90	7.00	6.90	7.10	4	6.9	7.0	7.1	-	-	-	-	0
Temperature			19.70	24.80	17.40	17.10	4	17.1	19.8	24.8	-	-	-	-	0
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		46100	48000	48500	46100	4	46100	47175	48500	-	-	-	-	0
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	0.95	2.47	0.41	0.52	4	0.41	1.09	2.47	-	-	-	-	0
Laboratory Analyses (mg/L)															
Sodium (ICP)			9030	8720	9600	8000	4	8000	8838	9600	-	-	-	-	0
Potassium (ICP)			351	344	363	323	4	323	345	363	-	-	-	-	0
Calcium (ICP)			503	547	512	479	4	479	510	547	-	-	-	-	0
Magnesium (ICP)			1120	1080	1180	995	4	995	1094	1180	-	-	-	-	0
Chloride			13800	16200	16200	14500	4	13800	15175	16200	-	-	-	-	0
Sulphate (SO4)			2260	2450	2440	2220	4	2220	2343	2450	-	-	-	-	0
Water Parameters (mg/L)															
Alkalinity (as CaCO3)			588	543	586	616	4	543	583	616	-	-	-	-	0
Fluoride			1	1	1	1	4	0.6	0.7	0.8	-	-	-	-	0
Phenols			0.40	<0.05	<0.05	<0.05	4	ND	ND	ND	-	-	-	-	0
Metals (mg/L)															
Iron (ICP)	0.3 (1)		1.60	1.56	1.53	1.60	4	1.53	1.57	1.60	-	-	-	-	0
Manganese (ICP)	1.90		0.16	0.143	0.138	0.15	4	<0.01	0.148	0.2	-	-	-	-	0
Nutrients (mg/L)															
Nitrate (NO3 as N)	0.7 (7)		<0.01	<0.01	<0.01	<0.01	4	NA	NA	NA	-	-	-	-	0
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	4.5	3.4	3.4	4.0	4	3.40	3.82	4.49	-	-	-	-	0
Total Nitrogen	0.5 (3)	0.12 (4)													
Dissolved Organic Carbon (DOC)			4	26	18	24	4	4.00	18.00	26.00	-	-	-	-	0
Total Organic Carbon (TOC)			5	25	16	24	4	5.00	17.50	25.00	-	-	-	-	0

Notes:

1. Trigger value is an indicative interim working level only (IIWL).
 2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
 3. Trigger value for total nitrogen for lowland rivers in SE Australia.
 4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
 5. Trigger value for total phosphorus in lowland rivers in NSW.
 6. Trigger value for total phosphorus in marine ecosystems in NSW.
 7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Unsampled well on EPL
Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2019 to 2020 Analytical Results - Minnamurra Waste Disposal Depot

Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD 4B	MD 4B	MD 4B	MD 4B	No. Samples	Min	Mean	Max	MD 4C	MD 4C	MD 4C	MD 4C	No. Samples	Min	Mean	Max
	Freshwater	Marine	21/11/19	14/2/20	28/5/20	28/8/20					21/11/19	14/2/20	28/5/20	28/8/20				
Field Measurements																		
RL (mAHD at TOC)			1.63	1.63	1.63	1.63					1.59	1.59	1.59	1.59				
Standing water level (mTOC)			1.29	0.90	0.98	1.07	4	0.90	1.06	1.29	1.29	0.94	1.00	1.08	4	0.94	1.08	1.29
Reduced SWL (mAHD)			0.34	0.73	0.65	0.56	4	0.34	0.57	0.73	0.30	0.65	0.59	0.51	4	0.30	0.51	0.65
pH (field)	6.5-8.0 (a)	8-8.4 (a)	6.90	7.00	6.70	7.00	4	6.7	6.9	7.0	6.90	7.00	6.80	6.80	4	6.8	6.9	7.0
Temperature			19.10	24.60	17.90	17.50	4	17.5	19.8	24.6	18.90	24.40	17.60	16.80	4	16.8	19.4	24.4
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		12900	18100	24800	12900	4	12900	17175	24800	47000	45900	47100	47000	4	45900	46750	47100
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	2.58	2.84	2.02	0.64	4	0.64	2.02	2.84	3.03	3.31	2.34	0.78	4	0.78	2.37	3.31
Laboratory Analyses (mg/L)																		
Sodium (ICP)			4270	2850	4020	1930	4	1930	3268	4270	9200	8350	8900	7410	4	7410	8465	9200
Potassium (ICP)			194	165	190	131	4	131	170	194	352	311	337	301	4	301	325	352
Calcium (ICP)			446	386	450	321	4	321	401	450	503	523	510	497	4	497	508	523
Magnesium (ICP)			551	385	524	249	4	249	427	551	1140	1030	1130	962	4	962	1066	1140
Chloride			7090	6220	9280	3590	4	3590	6545	9280	13800	15400	16900	13900	4	13800	15000	16900
Sulphate (SO4)			1010	625	1120	405	4	405	790	1120	2230	2360	2370	2110	4	2110	2268	2370
Water Parameters (mg/L)																		
Alkalinity (as CaCO3)			878	875	877	871	4	871	875	878	605	618	750	848	4	605	705	848
Fluoride			0.50	0.60	0.50	0.60	4	0.5	0.6	0.6	0.90	1.00	0.80	1.00	4	0.8	0.9	1.0
Phenols			0.40	<0.05	<0.05	<0.05	4	ND	ND	ND	<0.05	<0.05	<0.05	<0.05	4	ND	ND	ND
Metals (mg/L)																		
Iron (ICP)	0.3 (1)		2.3	1.8	2.31	0.94	4	0.94	1.84	2.31	1.46	1.66	1.42	1.85	4	1.42	1.60	1.85
Manganese (ICP)	1.90		0.137	0.106	0.13	0.078	4	0.078	0.11	0.14	0.153	0.164	0.133	0.177	4	0.133	0.157	0.177
Nutrients (mg/L)																		
Nitrate (NO3 as N)	0.7 (7)		0.14	0.03	<0.10	0.31	4	0.03	0.16	0.31	<0.01	<0.01	<0.10	<0.01	4	0.00	NA	0.00
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	25.8	38.5	30.5	39.0	4	25.80	33.45	39.00	1.43	2.18	2.16	3.2	4	1.43	2.25	3.24
Total Nitrogen	0.5 (3)	0.12 (4)																
Dissolved Organic Carbon (DOC)			6	47	22	69	4	6.00	36.00	69.00	<1	28	23	52	4	23.00	34.33	52.00
Total Organic Carbon (TOC)			4	47	33	57	4	4.00	35.25	57.00	2	29	22	48	4	2.00	25.25	48.00

Notes:

1. Trigger value is an indicative interim working level only (IIWL).
2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
5. Trigger value for total phosphorus in lowland rivers in NSW.
6. Trigger value for total phosphorus in marine ecosystems in NSW.
7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2019 to 2020 Analytical Results - Minnamurra Waste Disposal Depot

Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD6A	MD6A	MD6A	MD6A	No. Samples	Min	Mean	Max	MD 6B	MD 6B	MD 6B	MD 6B	No. Samples	Min	Mean	Max
	Freshwater	Marine	21/11/19	14/2/20	28/5/20	28/8/20					21/11/19	14/2/20	28/5/20	28/8/20				
Field Measurements																		
RL (mAHD at TOC)			1.85	1.85	1.85	1.85					1.85	1.85	1.85	1.85				
Standing water level (mTOC)			1.36	1.22	1.17	1.28	4	1.17	1.26	1.36	1.42	1.05	1.13	1.12	4	1.05	1.18	1.42
Reduced SWL (mAHD)			0.49	0.63	0.68	0.57	4	0.49	0.59	0.68	0.43	0.80	0.72	0.73	4	0.43	0.67	0.80
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.10	7.00	7.00	7.10	4	7.0	7.1	7.1	7.00	7.10	7.00	7.00	4	7.0	7.0	7.1
Temperature			18.9	20.6	19.8	19.0	4	18.9	19.6	20.6	20.3	25.3	20.3	19.8	4	19.8	21.4	25.3
Electrical Conduct (uS/cm)	0.125-2.2(a)		1620	1620	1600	1620	4	1600	1615	1620	1700	1520	1600	1700	4	1520	1630	1700
Dissolved Oxygen (mg/L)	8.5-11 (a)	9-10 (a)	0.88	0.81	2.06	0.88	4	0.81	1.16	2.06	0.82	2.5	1.62	0.53	4	0.53	1.37	2.50
Laboratory Analyses (mg/L)																		
Sodium (ICP)			82	92	104	101	4	82	95	104	103	94	94	114	4	94	101	114
Potassium (ICP)			44	46	48	45	4	44	46	48	50	46	45	40	4	40	45	50
Calcium (ICP)			110	116	105	106	4	105	109	116	129	108	117	127	4	108	120	129
Magnesium (ICP)			41	42	45	46	4	41	44	46	55	50	46	47	4	46	50	55
Chloride			71	95	76	82	4	71	81	95	102	87	85	108	4	85	96	108
Sulphate (SO4)			29	38	46	43	4	29	39	46	38	6	40	61	4	6	36	61
Water Parameters (mg/L)																		
Alkalinity (as CaCO3)			614	699	636	575	4	575	631	699	688	625	808	658	4	625	695	808
Fluoride			0.3	0.5	0.4	0.5	4	0.3	0.4	0.5	0.5	0.6	0.5	0.5	4	0.5	0.5	0.6
Phenols		0.40	<0.05	<0.05	<0.05	<0.05	4	0.05	0.05	0.05	<0.05	<0.05	<0.05	<0.05	4	0.05	0.05	0.05
Metals (mg/L)																		
Iron (ICP)	0.3 (1)		0.20	0.20	0.18	0.18	4	0.18	0.19	0.20	0.22	0.22	0.20	0.22	4	0.20	0.22	0.22
Manganese (ICP)	1.90		0.095	0.099	0.091	0.106	4	0.091	0.098	0.106	0.109	0.104	0.101	0.117	4	0.101	0.108	0.117
Nutrients (mg/L)																		
Nitrate (NO3 as N)	0.7 (7)		<0.01	<0.01	0.08	0.06	4	0.06	0.07	0.08	0.02	0.05	0.02	0.05	4	0.02	0.04	0.05
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	39.6	26.4	33.1	33.6	4	26.40	33.18	39.60	30.5	39.0	31.1	19.5	4	19.50	30.03	39.00
Total Nitrogen	0.5 (3)	0.12 (4)																
Dissolved Organic Carbon (DOC)			30	31	41	34	4	30.00	34.00	41.00	13	36	15	52	4	13.00	29.00	52.00
Total Organic Carbon (TOC)			30	32	40	35	4	30.00	34.25	40.00	12	36	22	52	4	12.00	30.50	52.00

Notes:

1. Trigger value is an indicative interim working level only (IIWL).
2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
5. Trigger value for total phosphorus in lowland rivers in NSW.
6. Trigger value for total phosphorus in marine ecosystems in NSW.
7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2019 to 2020 Analytical Results - Minnamurra Waste Disposal Depot

Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD 6C	MD 6C	MD 6C	No. Samples	Min	Mean	Max	MD9A	MD9A	MD9A	MD9A	No. Samples	Min	Mean	Max	
	Freshwater	Marine	21/11/19	14/2/20	28/5/20	28/8/20				21/11/19	14/2/20	28/5/20	28/8/20					
Field Measurements																		
RL (mAHD at TOC)			1.855	1.855	1.855					1.35	1.35	1.35	1.35					
Standing water level (mTOC)			1.6	1.18	1.28	1.32	4	1.18	1.35	1.60	0.6	0.26	0.28	0.32	4	0.26	0.37	0.60
Reduced SWL (mAHD)			0.26	0.68	0.58	0.54	4	0.26	0.51	0.68	0.75	1.09	1.07	1.03	4	0.75	0.99	1.09
pH (field)	6.5-8 (a)	8-8.4 (a)	7.20	7.10	7.20	7.20	4	7.1	7.2	7.2	7.00	7.00	7.20	7.20	4	7.0	7.1	7.2
Temperature			21.50	24.50	19.10	19.20	4	19.1	21.1	24.5	20.70	25.20	18.10	15.10	4	15.1	19.8	25.2
Electrical Conduct (uS/cm)	0.125-2.2(a)		29800	38800	38500	29800	4	29800	34225	38800	7390	4400	6490	7390	4	4400	6418	7390
Dissolved Oxygen (mg/L)	8.5-11 (a)	9-10 (a)	0.9	1.8	0.6	1.1	4	0.55	1.09	1.82	2.5	1.3	3.9	0.8	4	0.79	2.13	3.92
Laboratory Analyses (mg/L)																		
Sodium (ICP)			7260	7270	7200	5590	4	5590	6830	7270	993	590	970	1160	4	590	928	1160
Potassium (ICP)			259	256	248	204	4	204	242	259	74	67	74	66	4	66	70	74
Calcium (ICP)			401	426	384	391	4	384	401	426	96	118	112	72	4	72	100	118
Magnesium (ICP)			956	936	926	720	4	720	885	956	140	120	124	121	4	120	126	140
Chloride			11000	13200	12700	10300	4	10300	11800	13200	1460	1080	1930	2150	4	1080	1655	2150
Sulphate (SO4)			1820	2070	1920	1650	4	1650	1865	2070	236	106	253	331	4	106	232	331
Water Parameters (mg/L)																		
Alkalinity (as CaCO3)			468	386	410	406	4	386	418	468	1090	670	474	310	4	310	636	1090
Fluoride			0.1	0.6	0.4	0.5	4	0.1	0.4	0.6	0.7	0.2	0.1	0.1	4	0.1	0.3	0.7
Phenols			0.40	<0.05	<0.05	<0.05	<0.05	4	0.00	0.00	0.00	<0.05	<0.05	<0.05	4	0.00	0.00	0.00
Metals (mg/L)																		
Iron (ICP)	0.3 (1)		18.60	20.20	18.60	19.40	4	18.60	19.20	20.20	0.12	0.08	<0.05	0.07	4	0.07	0.09	0.12
Manganese (ICP)	1.90		0.062	0.066	0.05	0.073	4	0.050	0.063	0.073	0.026	0.029	0.017	0.021	4	0.017	0.023	0.029
Nutrients (mg/L)																		
Nitrate (NO3 as N)	0.7 (7)		<0.01	<0.01	<0.01	0.26	4	0.26	0.260	0.26	0.66	<0.01	1.4	0.1	4	0.10	0.71	1.38
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	36.6	42.8	35.4	30.0	4	30.00	36.20	42.80	8.7	23.5	8.0	7.7	4	7.68	11.96	23.50
Total Nitrogen	0.5 (3)	0.12 (4)																
Dissolved Organic Carbon (DOC)			<1	13	10	26	4	10.00	16.33	26.00	20	50	54	143	4	20.0	66.8	143.0
Total Organic Carbon (TOC)			<1	14	10	36	4	10.00	20.00	36.00	18	50	55	147	4	18.0	67.5	147.0

Notes:

1. Trigger value is an indicative interim working level only (IIWL).
2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
5. Trigger value for total phosphorus in lowland rivers in NSW.
6. Trigger value for total phosphorus in marine ecosystems in NSW.
7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2019 to 2020 Analytical Results - Minnamurra Waste Disposal Depot

Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD 9B	MD 9B	MD 9B	MD 9B	No. Samples	Min	Mean	Max
Field Measurements	Freshwater	Marine	21/11/19	14/2/20	28/5/20	28/8/20				
RL (mAHD at TOC)			1.35	1.35	1.35	1.35				
Standing water level (mTOC)			0.84	0.66	0.67	0.66	4	0.66	0.71	0.84
Reduced SWL (mAHD)			0.51	0.69	0.68	0.69	4	0.51	0.64	0.69
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.20	7.10	7.00	7.00	4	7.0	7.1	7.2
Temperature			19.70	24.40	19.00	17.00	4	17.0	20.0	24.4
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		3420	3250	3210	3420	4	3210	3325	3420
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	2.45	2.37	1.44	0.35	4	0.35	1.65	2.45
Laboratory Analyses (mg/L)										
Sodium (ICP)			279.00	300.00	270.00	271.00	4	270	280	300
Potassium (ICP)			125	126	108	106	4	106	116	126
Calcium (ICP)			119	114	143	141	4	114	129	143
Magnesium (ICP)			58	59	73	70	4	58	65	73
Chloride			277	378	350	458	4	277	366	458
Sulphate (SO4)			<1	<1	<10	<1	4			
Water Parameters (mg/L)										
Alkalinity (as CaCO3)			975	1210	1250	1170	4	975	1151	1250
Fluoride			0.5	0.7	0.6	0.7	4	0.5	0.6	0.7
Phenols		0.40	<0.05	<0.05	<0.05	<0.05	4	0.00	0.00	0.00
Metals (mg/L)										
Iron (ICP)	0.3 (1)		2.85	2.82	2.88	3.02	4	2.82	2.89	3.02
Manganese (ICP)	1.90		0.17	0.16	0.18	0.197	4	0.160	0.177	0.197
Nutrients (mg/L)										
Nitrate (NO3 as N)	0.7 (7)		0.11	0.04	0.26	<0.01	4	0.04	0.14	0.26
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	105.00	116.00	77.90	59.90	4	59.90	89.70	116.00
Total Nitrogen	0.5 (3)	0.12 (4)								
Dissolved Organic Carbon (DOC)			11	66	53	81	4	11	53	81
Total Organic Carbon (TOC)			10	71	52	83	4	10	54	83

Notes:

1. Trigger value is an indicative interim working level only (IIWL).
2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
5. Trigger value for total phosphorus in lowland rivers in NSW.
6. Trigger value for total phosphorus in marine ecosystems in NSW.
7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2019 to 2020 Analytical Results - Minnamurra Waste Disposal Depot

Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD 9C	MD 9C	MD 9C	MD 9C	No. Samples	Min	Mean	Max
Field Measurements	Freshwater	Marine	21/11/19	14/2/20	28/5/20	28/8/20				
RL (mAHD at TOC)			1.40	1.40	1.40	1.40				
Standing water level (mTOC)			0.92	0.63	0.74	0.68	4	0.63	0.74	0.92
Reduced SWL (mAHD)			0.48	0.77	0.66	0.72	4	0.48	0.66	0.77
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.00	7.00	7.00	7.10	4	7.00	7.03	7.10
Temperature			19.70	24.70	18.90	18.80	4	18.80	20.53	24.70
Electrical Conductivity (uS/cm)	0.125-2.2 (a)		30200	33800	35500	30200	4	30200	32425	35500
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	2.17	1.64	1.08	1.46	4	1.08	1.59	2.17
Laboratory Analyses (mg/L)										
Sodium (ICP)			1610	2200	2100	1470	4	1470.00	1845.00	2200.00
Potassium (ICP)			135	149	155	139	4	135.00	144.50	155.00
Calcium (ICP)			218	258	256	183	4	183.00	228.75	258.00
Magnesium (ICP)			179	253	229	157	4	157.00	204.50	253.00
Chloride			2830	4470	4540	2730	4	2730.00	3642.50	4540.00
Sulphate (SO4)			178	345	349	202	4	178.00	268.50	349.00
Water Parameters (mg/L)										
Alkalinity (as CaCO3)			295	864	1030	1040	4	295.00	807.25	1040.00
Fluoride			0.50	0.60	0.50	0.60	4	0.50	0.55	0.60
Phenols		0.40	<0.05	<0.05	<0.05	<0.05	4	0.00		0.00
Metals (mg/L)										
Iron (ICP)	0.3 (1)		4.48	5.94	4.93	3.22	4	3.22	4.64	5.94
Manganese (ICP)	1.90		0.202	0.222	0.186	0.145	4	0.15	0.19	0.22
Nutrients (mg/L)										
Nitrate (NO3 as N)	0.7 (7)		0.67	0.09	0.15	0.19	4	0.09	0.28	0.67
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	63.70	92.00	106.00	79.30	4	63.70	85.25	106.00
Total Nitrogen	0.5 (3)	0.12 (4)								
Dissolved Organic Carbon (DOC)			<1	64	66	90	4	64.00	73.33	90.00
Total Organic Carbon (TOC)			20	64	67	84	4	20.00	58.75	84.00

Notes:

1. Trigger value is an indicative interim working level only (IIWL).
 2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
 3. Trigger value for total nitrogen for lowland rivers in SE Australia.
 4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
 5. Trigger value for total phosphorus in lowland rivers in NSW.
 6. Trigger value for total phosphorus in marine ecosystems in NSW.
 7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table GW-1: Summary 2019 to 2020 Analytical Results - Minnamurra Waste Disposal Depot

Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD10A	MD10A	MD10A	MD10A	No. Samples	Min	Mean	Max	MD 10B	MD 10B	MD 10B	MD 10B	No. Sample	Min	Mean	Max
	Freshwater	Marine	21/11/19	14/2/20	28/5/20	28/8/20					21/11/19	14/2/20	28/5/20	28/8/20				
Field Measurements																		
RL (mAHD at TOC)			NM	NM	NM	NM					NM	NM	NM	NM				
Standing water level (mTOC)			0.83	0.78	0.38	0.51	4	0.38	0.63	0.83	0.92	0.67	0.7	0.71	4	0.67	0.75	0.92
Reduced SWL (mAHD)							4									4		
pH (field)	6.5-8.0 (a)	8-8.4 (a)	6.8	6.6	7	7.1	4	6.6	6.9	7.1	7.1	7.1	7.1	7	4	7.0	7.1	7.1
Temperature			21.5	28.8	17.7	14.8	4	14.8	20.7	28.8	20.3	26.6	20.6	18.9	4	18.9	21.6	26.6
Electrical Conductivity (uS/cm)	0.125-2.2(a)		37400	49200	34500	37400	4	34500	39625	49200	1860	1880	1880	1860	4	1860	1870	1880
Dissolved Oxygen (mg/L)	8.5-11 (a)	9-10 (a)	2.78	4.52	5.25	2.61	4	2.61	3.79	5.25	1.84	2.42	1.9	0.62	4	0.62	1.70	2.42
Laboratory Analyses (mg/L)																		
Sodium (ICP)			7900	8500	5950	5640	4	5640	6998	8500	111	124	120	98	4	98	113	124
Potassium (ICP)			179	196	162	141	4	141	170	196	69	75	70	67	4	67	70	75
Calcium (ICP)			861	1060	658	820	4	658	850	1060	97	104	86	80	4	80	92	104
Magnesium (ICP)			1000	1090	688	821	4	688	900	1090	38	43	35	34	4	34	38	43
Chloride			12800	16600	12800	11500	4	11500	13425	16600	153	185	199	195	4	153	183	199
Sulphate (SO4)			2270	2840	1790	1890	4	1790	2198	2840	<10	<1	<10	<10	4	0	0	0
Water Parameters (mg/L)																		
Alkalinity (as CaCO3)			754	250	455	440	4	250	475	754	686	710	697	662	4	662	689	710
Fluoride			0.8	0.6	0.6	0.7	4	0.6	0.7	0.8	0.7	0.9	0.9	0.9	4	0.7	0.9	0.9
Phenols			0.40	<0.05	<0.05	<0.05	4	ND	ND	ND	<0.05	<0.05	<0.05	<0.05	4	ND	ND	ND
Metals (mg/L)																		
Iron (ICP)	0.3 (1)		<0.10	0.64	1	<0.10	4	0.64	0.82	1.00	0.93	0.89	0.68	0.71	4	0.68	0.80	0.93
Manganese (ICP)	1.90		0.216	0.61	0.451	0.249	4	0.216	0.382	0.610	0.378	0.365	0.283	0.295	4	0.283	0.330	0.378
Nutrients (mg/L)																		
Nitrate (NO3 as N)	0.7 (7)		0.15	0.04	3.17	0.24	4	0.04	0.90	3.17	<0.01	0.6	<0.10	<0.01	4	0.60	0.60	0.60
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	0.36	0.19	0.28	0.14	4	0.14	0.24	0.36	58.90	0.14	63.10	52.50	4	0.14	43.66	63.10
Total Nitrogen	0.5 (3)	0.12 (4)																
Dissolved Organic Carbon (DOC)			46	62	56	64	4	46.00	57.00	64.00	31	51	33	52	3	31.00	41.75	52.00
Total Organic Carbon (TOC)			48	62	54	65	4	48	57	65	37	53	32	54	4	32	44	54

Notes:

1. Trigger value is an indicative interim working level only (IIWL).
2. Ammonia trigger value at pH = 8.0, 95% PL, corrected to pH = 7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.
5. Trigger value for total phosphorus in lowland rivers in NSW.
6. Trigger value for total phosphorus in marine ecosystems in NSW.
7. Trigger value for 95% protection level
- a. Reference only, not directly applicable to groundwater.

Exceeds ANZECC (2000) marine trigger value

Exceedance of IIWL values or fresh water not highlighted.

Table SW-1: Minnamurra Waste Disposal Depot (Rocklow Creek)
(2019 to 2020)

Sample ID	ANZECC, 2000		Rocklow Up	Rocklow Middle	Rocklow Down	Rocklow Up	Rocklow Middle	Rocklow Down	Rocklow Up	Rocklow Middle	Rocklow Down	Rocklow Up	Rocklow Middle	Rocklow Down
Field Measurements	Freshwater	Marine	21/11/19	21/11/19	21/11/19	14/02/20	14/02/20	14/02/20	28/05/20	28/05/20	28/05/20	28/08/20	28/08/20	28/08/20
pH (field)	6.5-8.0	8-8.4	7.4	7.0	7.10	6.6	7.1	7.20	7.3	7.1	7.00	7.4	7.3	7.20
Temperature			22.1	21.0	22.80	28.4	29.2	28.60	14.9	14.8	14.50	12.0	12.4	12.60
Electrical Conductivity (m)	0.125-2.2		55200.00	50500.00	51000.00	1610.00	2670.00	3010.00	22000.00	32500.00	32700.00	2250.00	6310.00	6240.00
Dissolved Oxygen (mg/L)	8.5-11.0	9.0-10.0	3.12	2.09	4.73	4.84	6.28	6.65	7.67	4.53	5.39	10.50	8.96	8.63
Laboratory Analyses (mg/L)														
Sodium (ICP)			10800	9850	10000	238	386	444	2670	6220	5880	327	956	950
Potassium (ICP)			388	356	363	17	18	20	100	228	215	12	35	35
Calcium (ICP)			501	476	479	22	52	54	138	286	272	34	78	77
Magnesium (ICP)			1300	1190	1220	34	51	57	324	748	720	42	120	120
Chloride			15800	14400	14600	493	781	900	5660	12000	10800	565	1520	1540
Sulphate (SO4)			2590	2370	2380	86	169	186	606	1730	1580	111	314	306
Water Parameters (mg/L)														
Hardness (as CaCO3)														
Fluoride			0.9	0.8	1	0.2	0.3	0	0.4	0.6	1	0.2	0.4	0
Phenols			0.40	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Metals (mg/L)														
Iron (ICP)	0.3 (1)		0.35	0.51	0.44	0.98	0.99	0.88	0.55	0.23	0.28	1.26	0.68	1
Manganese (ICP)	1.90		0.146	0.208	0.174	0.086	0.068	0.066	0.048	0.057	0.055	0.049	0.058	0
Nutrients (mg/L)														
Total Organic Carbon			<1	1	6.00	25	17	16.00	3	13	8.00			
Total Nitrogen	0.5 (3)	0.12 (4)												
Nitrate (NO3 as N)	0.7 (7)		<0.01	<0.01	<0.01	0.43	0.57	0.57	0.02	0.04	0.02	0.02	0.24	0.22
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	<0.10	0.90	1.20	0.15	0.16	0.23	0.06	0.58	1.03	0.04	0.21	0.31
Ammonia Increment (Upper to Mid Rocklow)				0.90			0.11			0.52			0.17	
Ammonia Increment (Mid to lower Rocklow)					0.30			0.07			0.45			0.10
Total Organic Carbon (TOC)			<1	1	6.00	25	17	16.00	3	13	8.00	7	6	7

Notes:

1. Trigger value-indicative interim working level (IIWL).
2. Ammonia trigger value; pH =8, 95% PL,adj to pH=7.3.
3. Trigger value for total nitrogen for lowland rivers in SE Australia.
4. Trigger value for oxides of nitrogen (NOx) for marine ecosystems, NSW.

Table SW-2: Rocklow Creek - Historical & Current Ammonia Concentrations (1999 - 2020)

Minnamurra Waste Disposal Depot

Sample ID	6/05/1999	17/08/1999	21/12/2000	28/02/2000	11/05/2000	10/08/2000	21/11/2000	15/02/2001	17/05/2001	16/08/2001	13/11/2001	22/02/2002	8/04/2002	19/08/2002	14/11/2002	12/06/2003	22/08/2003	20/11/2003	17/02/2004	12/05/2004	11/08/2004	7/12/2004	2/02/2005	4/05/2005	16/08/2005	
Upper Rocklow (mg/L)	0.16	<0.02	0.10	0.16	0.03	0.06	0.04	0.10	0.22	0.35	0.18	0.10	0.07	0.13	0.06	0.01	0.11	0.14	0.03	0.17	0.28	0.03	0.22	<0.02	<0.02	0.06
Middle Rocklow (mg/L)																										
Lower Rocklow (mg/L)	1.00	0.65	2.07	1.74	0.57	1.34	0.26	0.56	0.69	0.42	0.24	0.64	1.11	2.00	1.60	0.51	0.13	1.40	1.70	0.38	0.55	0.65	0.92	<0.02	0.31	1.40
Net Increment (mg/L)	0.84	0.64	1.97	1.58	0.54	1.28	0.22	0.46	0.47	0.07	0.06	0.54	1.04	1.87	1.54	0.50	0.02	1.26	1.67	0.21	0.27	0.62	0.70	NA	0.30	1.34

Sample ID	9/11/2005	28/02/2006	30/05/2006	30/08/2006	27/11/2006	26/02/2007	22/04/2007	21/08/2007	20/11/2007	21/02/2008	28/05/2008	26/08/2008	25/11/2008	16/02/2009	18/05/2009	28/08/2009	27/11/2009	26/02/2010	20/05/2010	17/08/2010	29/11/2010	25/02/2011	23/05/2011	23/08/2011	21/11/2011	2/02/2012
Upper Rocklow (mg/L)	<0.02	<0.02	0.22	0.09	0.39	0.66	0.41	0.32	0.39	<0.1	0.27	0.12	<0.1	0.56	0.12	0.15	0.10	0.20	<0.1	0.05	0.30	<0.1	0.01	0.05	0.03	0.14
Middle Rocklow (mg/L)																										
Lower Rocklow (mg/L)	<0.02	<0.02	0.64	0.90	1.20	0.32	0.62	0.48	1.60	NM	1.60	1.20	0.16	0.66	0.30	0.21	0.60	<0.1	<0.1	0.27	0.33	5.65	0.56	0.20	0.31	0.58
Net Increment (mg/L)	NA	NA	0.42	0.81	0.81	(0.34)	0.21	0.16	1.21	NA	1.33	1.08	NA	0.10	0.18	0.06	0.50	NA	NA	0.37	0.03	5.55	0.55	0.15	0.28	0.44

Sample ID	30/05/2012	9/08/2012	20/11/2012	18/02/2013	30/05/2013	29/04/2013	26/11/2013	6/02/2014	6/05/2014	18/08/2014	17/11/2014	26/02/2015	10/04/2015	3/11/2015	15/02/2016	30/05/2016	11/08/2016	9/11/2016	20/02/2017	19/05/2017	17/08/2017	9/11/2017	20/02/2018	19/05/2018	17/08/2018		
Upper Rocklow (mg/L)	<0.01	0.04	0.10	0.10	0.12	0.16	0.09	0.16	0.39	0.14	0.14	0.14	0.14	0.06	0.09	0.12	0.19	0.17	0.06	0.07	0.99	0.52	0.05	0.20	<0.05	0.16	0.56
Middle Rocklow (mg/L)	1.06	1.91	0.44	0.71	0.19	0.40	0.18	1.60	0.29	0.14	0.24	0.13	0.29	0.23	1.08	2.49	0.67	0.17	0.18	0.38	0.70	0.20	0.56	1.39	0.35	1.09	
Lower Rocklow (mg/L)	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	0.09	0.28	0.19	2.09	0.58	0.68	0.23	0.58	0.06	1.59	0.44	1.07	0.20	0.08
Net Increment (mg/L) Middle- Lower	1.06	1.87	0.34	0.61	0.07	0.24	0.09	1.44	(0.10)	0.00	0.10	(0.05)	0.01	0.04	1.01	(1.91)	0.01	0.06	0.11	0.20	(0.64)	1.39	(0.12)	(0.32)	(0.15)	(1.01)	

Sample ID	15/11/2018	13/02/2019	29/05/2019	28/08/2019	21/11/2019	14/02/2020	28/05/2020	28/08/2020
Upper Rocklow (mg/L)	0.09	0.04	0.24	1.49	<0.10	0.15	0.06	0.04
Middle Rocklow (mg/L)	1.56	0.18	0.08	1.19	0.90	0.16	0.58	0.21
Lower Rocklow (mg/L)	1.81	0.22	0.13	0.02	1.20	0.23	1.03	0.31
Net Increment (mg/L) Middle- Lower	0.25	0.04	0.05	(1.17)	0.30	0.07	0.45	0.10

Legend

NA = Not Analysed

NM= Not measured

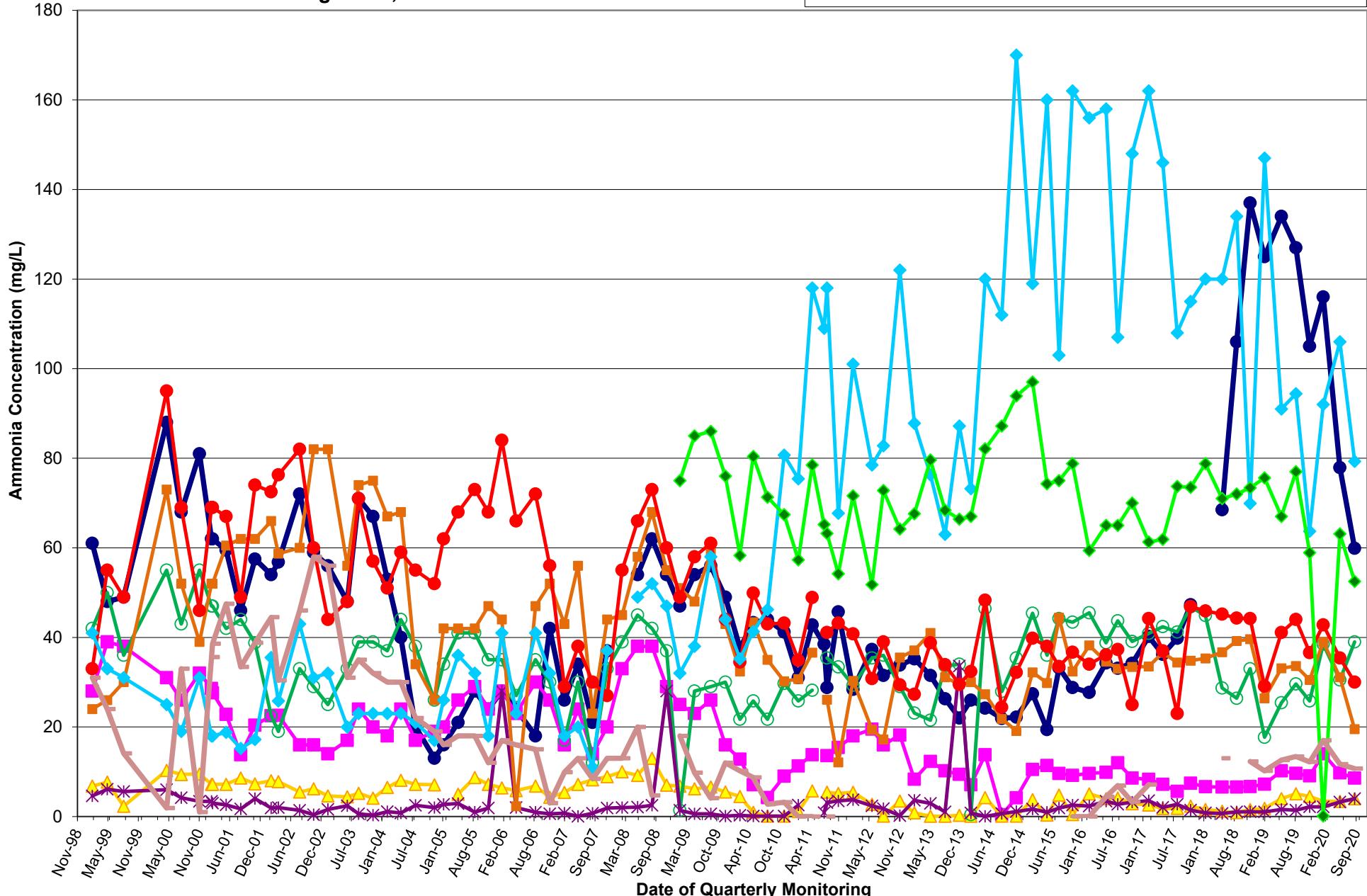
Note: red (reduction in ammonia)

Note: Rocklow Down was inaccessible during the 2010-2014 monitoring periods

Graphs

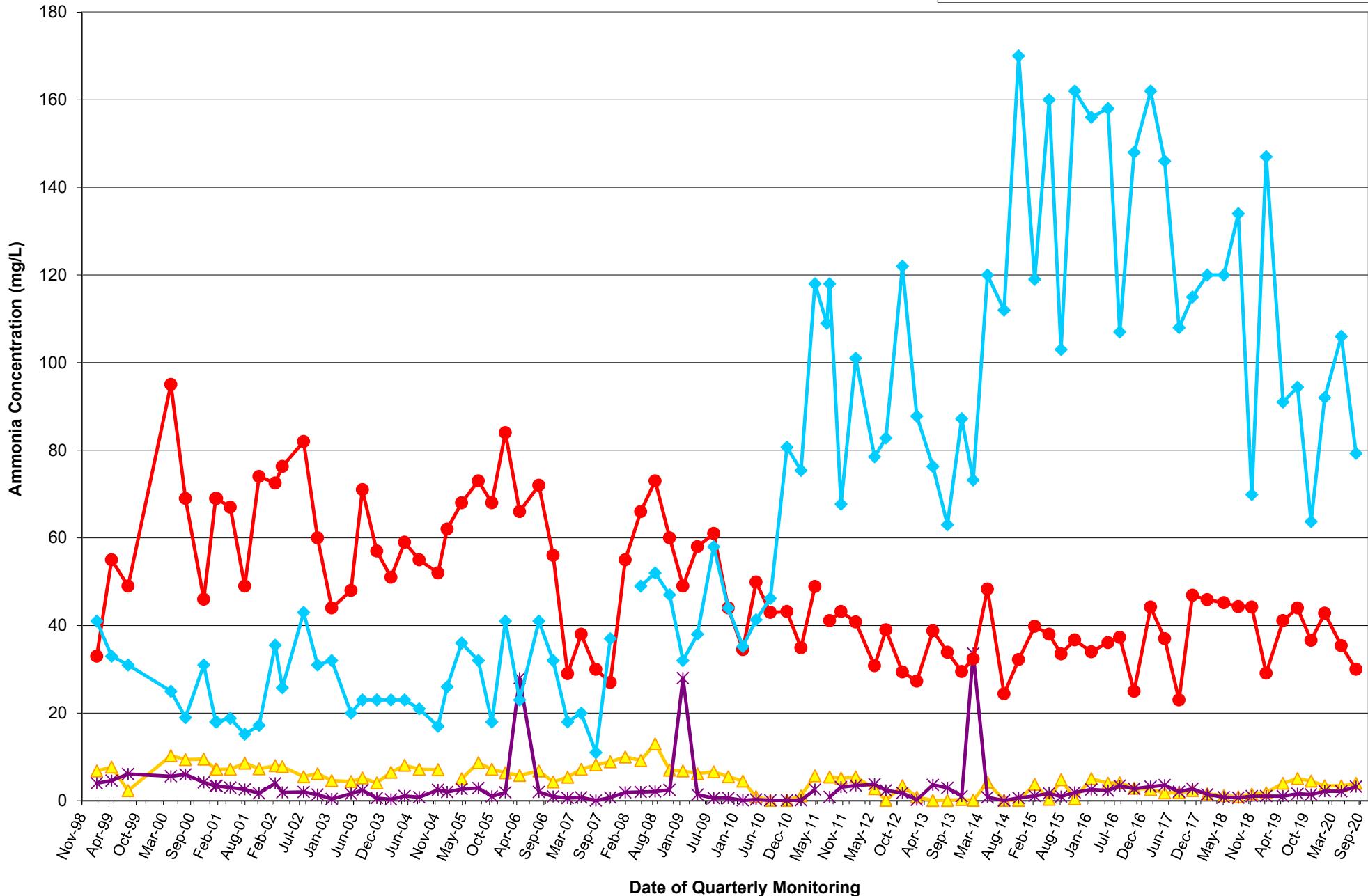
Graph-1: Groundwater Ammonia Concentrations (mg/L)
All Monitoring Wells; 1999 to 2020

MD9B	MD2 B	MD2 C	MD4 B	MD4 C
MD6 B	MD6 C	MD9 C	MD10 B	MD1 B

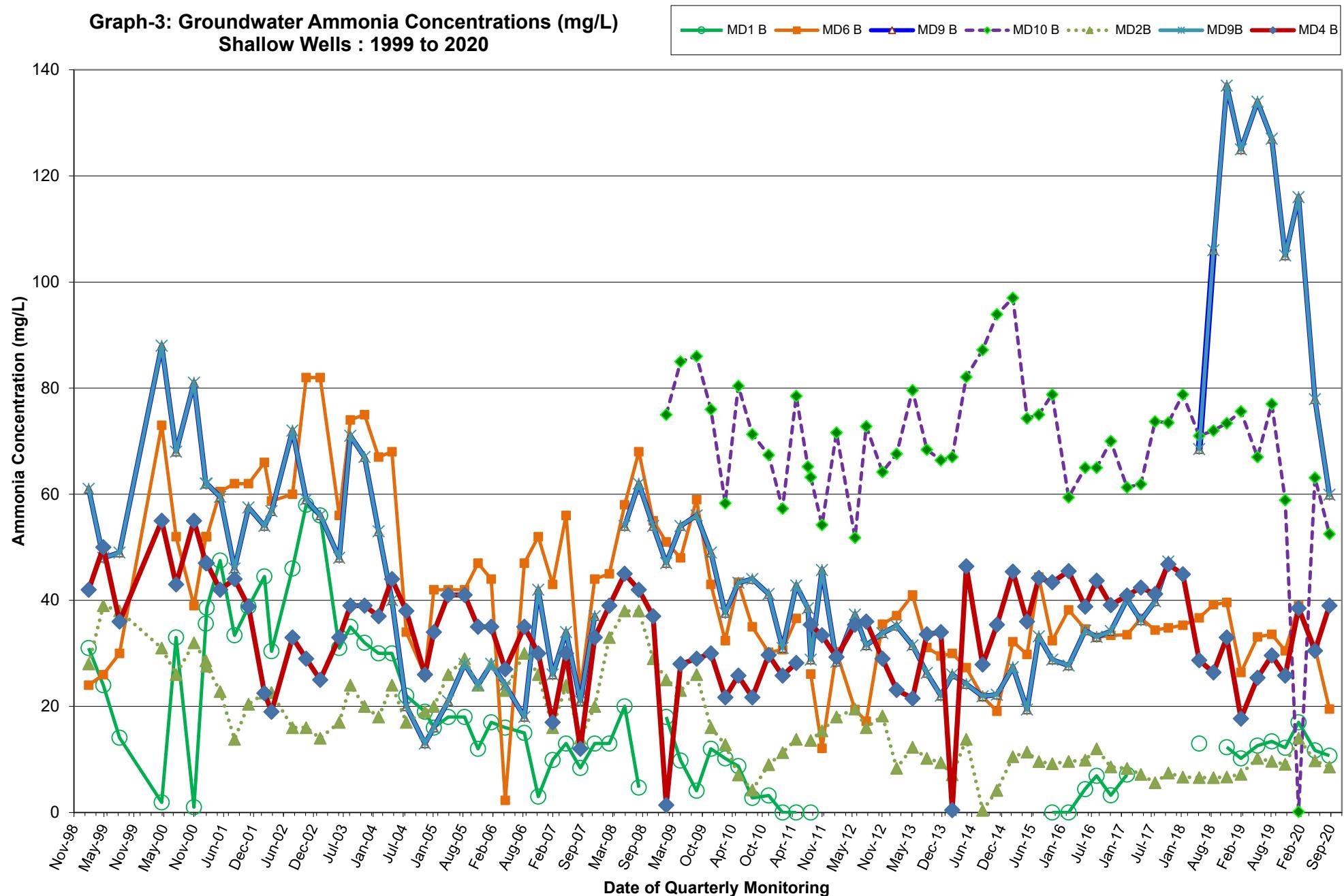


Graph-2: Groundwater Ammonia Concentrations (mg/L)
Deep Wells: 1999 to 2020

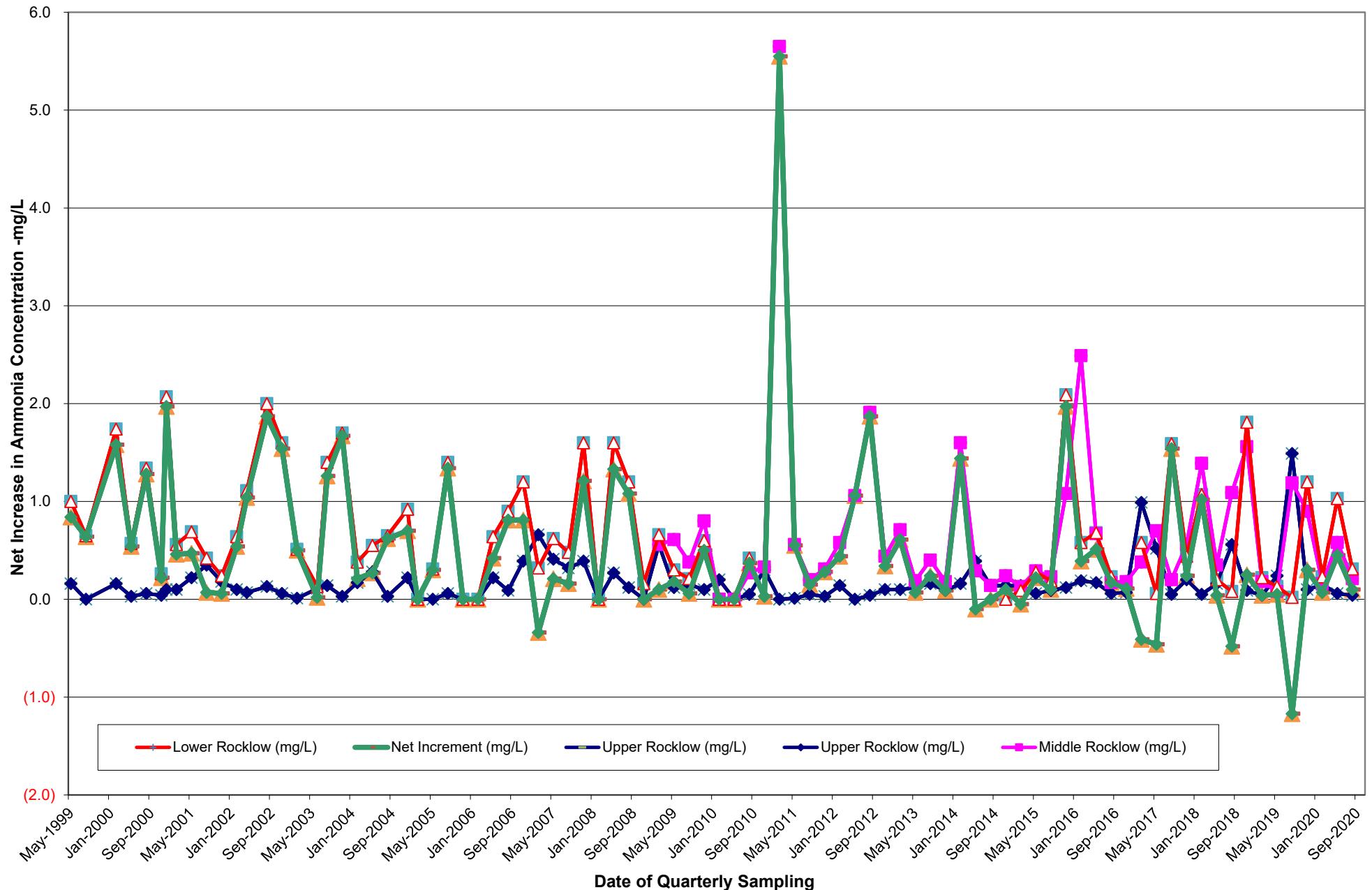
MD2 C MD4 C MD6 C MD9 C



Graph-3: Groundwater Ammonia Concentrations (mg/L)
Shallow Wells : 1999 to 2020



Graph-04: Net Increment of Ammonia Between The Up/Mid & The Down Stream Sample (1999 to 2020)



Appendix A


CHAIN OF CUSTODY

ALS Laboratory: please tick →

Sydney: 277 Woodpark Rd, Smithfield NSW 2176
Ph: 02 8784 8555 E:samples.sydney@alsenviro.com

Brisbane: 32 Shand St, Stafford QLD 4053
Ph: 07 3243 7222 E:samples.brisbane@alsenviro.com

Newcastle: 5 Rosegun Rd, Warabrook NSW 2304
Ph: 02 4968 9433 E:samples.newcastle@alsenviro.com

Townsville: 14-16 Desma Ct, Bohle QLD 4818
Ph: 07 4796 0600 E:townsville.environmental@alsenviro.com

Melbourne: 2-4 Westall Rd, Springvale VIC 3171
Ph: 03 8549 9600 E:samples.melbourne@alsenviro.com

Perth: 10 Hod Way, Mt Barker WA 6050
Ph: 08 9200 7655 E:sam@alsenviro.com

Adelaide: 2-1 Burma Rd, Pooraka SA 5095
Ph: 08 8359 0890 E:adelaide@alsenviro.com

Launceston: 27 Wallin St, Launceston TAS 7250
Ph: 03 6331 2158 E:laun@alsenviro.com

Environmental Division
Wollongong

Work Order Reference

EW1905023

CLIENT:	Kiama Municipal Council	TURNAROUND REQUIREMENTS :	<input type="checkbox"/> Standard TAT (List due date): (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)																							
OFFICE:	PO Box 75 Kiama NSW 2533	ALS QUOTE NO.:	<input type="checkbox"/> Non Standard or urgent TAT (List due date):																							
PROJECT:	Minnamurra Landfill					FOR LABORATORY Custody Seal Intact Presence / frozen recipient Random Sample Other comment: _____																				
ORDER NUMBER:	126589					COC: <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7	OF: <input type="checkbox"/> 1 <input checked="" type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7																			
PROJECT MANAGER:	Paul Czulowski	CONTACT PH: 4232 0418																								
SAMPLER:	Robert DaLio	SAMPLER MOBILE: 0437721557																								
COC emailed to ALS? (YES / NO)		EDD FORMAT (or default):																								
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:																										
ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION			ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) <i>Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).</i>							Additional Information												
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	NT-02A (Alkalinity, Cl, SO ₄ & Fluoride) NT-01 (Mg, Ca, Na, K)	Nitrate, Ammonia, Total Phenolics	DOC (Filtered)	TOC	(Dissolved Filtered) Fe, (Mn, Mn, Mn, Mn, Mn, Mn)	(Total) Fe, Mn, Mg, Ca, Na, K		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.													
						YSI (Field Results) pH, Temp, EC, Sal, DO, Depth																				
						1								MD 1A	21.11.19 13:40	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	Destroyed	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
						2								MD 1B	13:45	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
						3								MD 2A	12:10	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
						4								MD 2B	12:25	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
						5								MD 2C	12:35	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
						6								MD 4A	11:15	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	No Sample	Bone block 10.20 Field Tests pH, Temp, EC, Sal, DO, Depth
						7								MD 4B	11:20	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
						8								MD 4C	11:35	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
						9								MD 6A	13:00	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
						10								MD 6B	13:15	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
						11								MD 6C	13:25	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
12	MD 9A	10:25	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth													
				TOTAL																						

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
 V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphite Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
 Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.



CHAIN OF CUSTODY

ALS Laboratory: please tick →

Sydney: 277 Woodpark Rd, Smithfield NSW 2176
Ph: 02 8784 8555 E:samples.sydney@alsenviro.com

Newcastle: 5 Rosegum Rd, Warabrook NSW 2304
Ph: 02 4968 9433 E:samples.newcastle@alsenviro.com

Brisbane: 32 Shand St, Stafford QLD 4053
Ph: 07 3243 7222 E:samples.brisbane@alsenviro.com

Townsville: 14-15 Desma Ct, Bohle QLD 4818
Ph: 07 4796 0600 E:townsville.environmental@alsenviro.com

Melbourne: 2-4 Westall Rd, Springvale VIC 3171
Ph: 03 8549 9600 E: samples.melbourne@alsenviro.com

Adelaide: 2-1 Burma Rd, Pooraka SA 5095
Ph: 08 8359 0890 E:adelaide@alsenviro.com

Perth: 10 Hod Way, Malaga WA 6090
Ph: 08 9209 7655 E: samples.perth@alsenviro.com

Launceston: 27 Wellington St, Launceston TAS 7250
Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: Kiamia Municipal Council				TURNAROUND REQUIREMENTS : <input type="checkbox"/> Standard TAT (List due date): (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics) <input type="checkbox"/> Non Standard or urgent TAT (List due date):				FOR LABORATORY USE ONLY (Circle)							
OFFICE: PO Box 75 Kiamia NSW 2533				PROJECT: Minnamurra Landfill				COC SEQUENCE NUMBER (Circle)							
ORDER NUMBER:				ALS QUOTE NO.:				coc: 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7	Custody Seal intact: Yes No N/A						
PROJECT MANAGER: Paul Czulowski CONTACT PH: 4232 0418								OF: 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7	Freeze /Frozen ice bricks present upon receipt: Yes No N/A						
SAMPLER: Robert DaLio SAMPLER MOBILE: 0437721557				RELINQUISHED BY: <i>Robert</i>				RECEIVED BY:				Random Sample Temperature on Receipt: °C			
COC emailed to ALS? (YES / NO)				DATE/TIME:				RELINQUISHED BY:				Other comment:			
Email Reports to (will default to PM if no other addresses are listed):				DATE/TIME:				RELINQUISHED BY:				DATE/TIME:			
Email Invoice to (will default to PM if no other addresses are listed):				DATE/TIME:				RECEIVED BY:				DATE/TIME:			
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:															
ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION			ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).							Additional Information	
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	NT-02A (Alkalinity, Cl, SO4 & Fluoride) NT-01 (Mg, Ca, Na, K)	Nitrate, Ammonia, Total Phenolics	DOC (Filtered)	TOC	(Dissolved Filtered) Fe, (Total) Fe, Mn, Mg, Ca, Na, K				Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.	
13	MD 9B	21.11.01 10:40 W		500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	(Total) Fe, Mn, Mg, Ca, Na, K				YSI (Field Results) pH, Temp, EC, Sal, DO,
14	MD 9C	10:50 W		500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	(Total) Fe, Mn, Mg, Ca, Na, K				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
15	MD 10A	9:50 W		500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	(Total) Fe, Mn, Mg, Ca, Na, K				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
16	MD 10B	10:00 W		500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	(Total) Fe, Mn, Mg, Ca, Na, K				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
17	Rocklow Down	8:30 W		500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	(Total) Fe, Mn, Mg, Ca, Na, K				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
18	Rocklow Middle	9:20 W		500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	(Total) Fe, Mn, Mg, Ca, Na, K				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
19	Rocklow Up	8:50 W		500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	(Total) Fe, Mn, Mg, Ca, Na, K				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
20	Blank	8:25 W		VS, N	2						(Total) Fe, Mn, Mg, Ca, Na, K				
					TOTAL										

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphite Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Acid Preserved Plastic; Z = Zinc Acetate Preserved Plastic; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

CERTIFICATE OF ANALYSIS

Work Order	: EW1905023	Page	: 1 of 10
Client	: KIAMA COUNCIL	Laboratory	: Environmental Division NSW South Coast
Contact	: MR PAUL CZULOWSKI	Contact	: Glenn Davies
Address	: 11 MANNING STREET KIAMA NSW, AUSTRALIA 2533	Address	: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW Australia
Telephone	: +61 02 4232 0444	Telephone	: 02 42253125
Project	: Minnamurra Landfill	Date Samples Received	: 21-Nov-2019 15:21
Order number	: 126509	Date Analysis Commenced	: 21-Nov-2019
C-O-C number	: ----	Issue Date	: 30-Nov-2019 16:53
Sampler	: Robert DaLio		
Site	: Minnamurra Landfill		
Quote number	: WO/017/18		
No. of samples received	: 20		
No. of samples analysed	: 20		

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatures

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

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW
Robert DaLio	Sampler	Laboratory - Wollongong, NSW



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

General Comments

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

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

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

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

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

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

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

Ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- ED041G: LOR raised for Sulfate on sample 16 due to sample matrix.
- EG020: Some sample were diluted and rerun due to matrix interference and LOR's have been raised accordingly. (High Total Dissolved Solids)
- EK055G: LOR raised for Ammonia on sample 19 due to sample matrix.
- EP002: It has been noted that DOC is greater than TOC various samples, however this difference is within the limits of experimental variation.
- Sampling and sample data supplied by ALS Wollongong.
- Sampling completed as per FWI-EN001 Groundwater Sampling.
- Sampling completed as per FWI-EN002 Surface Water Sampling.
- Field tests completed on day of sampling/receipt.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Client sample ID				MD 1A	MD 1B	MD 2A	MD 2B	MD 2C
Compound	CAS Number	LOR	Unit	EW1905023-001	EW1905023-002	EW1905023-003	EW1905023-004	EW1905023-005
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	---	0.1	pH Unit	---	7.6	7.0	6.9	6.9
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	---	600	21000	38000	47400
EA020FD: Field Salinity								
Salinity	---	0.2	g/L	---	0.3	14.2	28.2	34.8
EA116: Temperature								
Temperature	---	0.1	°C	---	22.2	19.4	18.2	19.7
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	---	<1	<1	<1	<1
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	---	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	---	222	867	749	588
Total Alkalinity as CaCO ₃	---	1	mg/L	---	222	867	749	588
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	---	16	732	1720	2260
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	---	38	6180	11000	13800
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	---	50	317	454	503
Magnesium	7439-95-4	1	mg/L	---	8	459	907	1120
Sodium	7440-23-5	1	mg/L	---	33	3580	6750	9030
Potassium	7440-09-7	1	mg/L	---	13	186	278	351
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	---	0.049	0.077	0.148	0.160
Iron	7439-89-6	0.05	mg/L	---	0.50	0.31	1.51	1.60
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	---	0.2	0.8	0.6	0.7
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	---	12.2	22.9	9.09	4.49
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	---	<0.01	0.03	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	---	0.26	2.16	0.08	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 1A	MD 1B	MD 2A	MD 2B	MD 2C
		Client sampling date / time		21-Nov-2019 13:40	21-Nov-2019 13:45	21-Nov-2019 12:10	21-Nov-2019 12:25	21-Nov-2019 12:35
Compound	CAS Number	LOR	Unit	EW1905023-001	EW1905023-002	EW1905023-003	EW1905023-004	EW1905023-005
Result								
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	---	0.01	mg/L	---	0.26	2.19	0.08	<0.01
EN055: Ionic Balance								
ø Total Anions	---	0.01	meq/L	---	5.84	207	361	448
ø Total Cations	---	0.01	meq/L	---	5.79	---	---	---
ø Total Cations	---	0.01	meq/L	---	---	214	398	519
ø Ionic Balance	---	0.01	%	---	0.45	---	---	---
ø Ionic Balance	---	0.01	%	---	---	1.70	4.87	7.34
EN67 PK: Field Tests								
Field Observations	---	0.01	--	destroyed	---	---	---	---
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	---	1	mg/L	---	<1	20	15	4
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	---	1	mg/L	---	<1	27	16	5
EP025FD: Field Dissolved Oxygen								
Dissolved Oxygen	---	0.01	mg/L	---	1.02	2.62	2.66	0.95
Dissolved Oxygen - % Saturation	---	0.1	% saturation	---	11.7	28.1	28.5	10.3
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)	---	0.05	mg/L	---	<0.05	<0.05	<0.05	<0.05
FWI-EN/001: Groundwater Sampling - Depth								
Depth	---	0.01	m	---	1.62	0.55	0.85	0.89

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 4A	MD 4B	MD 4C	MD 6A	MD 6B
Compound	CAS Number	LOR	Unit	21-Nov-2019 11:15	21-Nov-2019 11:20	21-Nov-2019 11:35	21-Nov-2019 13:00	21-Nov-2019 13:15
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	---	0.1	pH Unit	---	6.9	6.9	7.2	7.0
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	---	24100	47600	1560	1630
EA020FD: Field Salinity								
Salinity	---	0.2	g/L	---	16.7	35.7	0.8	0.9
EA116: Temperature								
Temperature	---	0.1	°C	---	19.1	18.9	21.4	20.3
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	---	<1	<1	<1	<1
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	---	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	---	878	605	637	688
Total Alkalinity as CaCO ₃	---	1	mg/L	---	878	605	637	688
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	---	1010	2230	43	38
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	---	7090	13800	96	102
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	---	446	503	124	129
Magnesium	7439-95-4	1	mg/L	---	551	1140	44	55
Sodium	7440-23-5	1	mg/L	---	4270	9200	117	103
Potassium	7440-09-7	1	mg/L	---	194	352	42	50
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	---	0.137	0.153	0.038	0.109
Iron	7439-89-6	0.05	mg/L	---	2.30	1.46	0.15	0.22
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	---	0.5	0.9	0.7	0.5
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	---	25.8	1.43	17.9	30.5
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	---	<0.01	<0.01	0.05	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	---	0.14	<0.01	4.66	0.02

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 4A	MD 4B	MD 4C	MD 6A	MD 6B	
Compound	CAS Number	LOR	Unit	Client sampling date / time	21-Nov-2019 11:15	21-Nov-2019 11:20	21-Nov-2019 11:35	21-Nov-2019 13:00	21-Nov-2019 13:15
				Result	Result	Result	Result	Result	Result
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	---	0.01	mg/L	---	0.14	<0.01	4.71	0.02	
EN055: Ionic Balance									
ø Total Anions	---	0.01	meq/L	---	238	448	16.3	17.4	
ø Total Cations	---	0.01	meq/L	---	258	528	16.0	16.7	
ø Ionic Balance	---	0.01	%	---	3.97	8.23	1.11	2.03	
EN67 PK: Field Tests									
Field Observations	---	0.01	--	no sample, borehole blocked	---	---	---	---	---
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	---	1	mg/L	---	6	<1	4	13	
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	---	1	mg/L	---	4	2	11	12	
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	---	0.01	mg/L	---	2.58	3.03	1.65	0.82	
Dissolved Oxygen - % Saturation	---	0.1	% saturation	---	27.9	32.7	18.7	9.1	
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	---	0.05	mg/L	---	<0.05	<0.05	<0.05	<0.05	
FWI-EN/001: Groundwater Sampling - Depth									
Depth	---	0.01	m	---	1.29	1.29	1.32	1.42	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MD 6C	MD 9A	MD 9B	MD 9C	MD 10A	
Compound	CAS Number	LOR	Unit	Client sampling date / time	21-Nov-2019 13:25	21-Nov-2019 10:25	21-Nov-2019 10:40	21-Nov-2019 10:50	21-Nov-2019 09:50
				Result	Result	Result	Result	Result	Result
EA005FD: Field pH									
pH	---	0.1	pH Unit	7.2	7.0	7.2	7.0	6.8	
EA010FD: Field Conductivity									
Electrical Conductivity (Non Compensated)	---	1	µS/cm	37300	6460	3240	10400	45400	
EA020FD: Field Salinity									
Salinity	---	0.2	g/L	25.6	3.9	1.9	6.6	31.8	
EA116: Temperature									
Temperature	---	0.1	°C	21.5	20.7	19.7	19.7	21.5	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	<1	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	468	1090	975	295	754	
Total Alkalinity as CaCO ₃	---	1	mg/L	468	1090	975	295	754	
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA									
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	1820	236	<1	178	2270	
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L	11000	1460	277	2830	12800	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	401	96	119	218	861	
Magnesium	7439-95-4	1	mg/L	956	140	58	179	1000	
Sodium	7440-23-5	1	mg/L	7260	993	279	1610	7900	
Potassium	7440-09-7	1	mg/L	259	74	125	135	179	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.062	0.026	0.170	0.202	0.216	
Iron	7439-89-6	0.05	mg/L	18.6	0.12	2.85	4.48	<0.10	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	0.1	0.7	0.5	0.5	0.8	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	36.6	8.69	105	63.7	0.36	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.02	<0.01	0.02	0.02	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	0.66	0.11	0.67	0.15	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 6C	MD 9A	MD 9B	MD 9C	MD 10A
		Client sampling date / time		21-Nov-2019 13:25	21-Nov-2019 10:25	21-Nov-2019 10:40	21-Nov-2019 10:50	21-Nov-2019 09:50
Compound	CAS Number	LOR	Unit	EW1905023-011	EW1905023-012	EW1905023-013	EW1905023-014	EW1905023-015
Result								
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	---	0.01	mg/L	<0.01	0.68	0.11	0.69	0.17
EN055: Ionic Balance								
ø Total Anions	---	0.01	meq/L	358	67.9	27.3	89.4	423
ø Total Cations	---	0.01	meq/L	421	61.4	26.0	99.1	473
ø Ionic Balance	---	0.01	%	8.16	5.01	2.34	5.12	5.58
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	---	1	mg/L	<1	20	11	<1	46
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	---	1	mg/L	<1	18	10	20	48
EP025FD: Field Dissolved Oxygen								
Dissolved Oxygen	---	0.01	mg/L	0.85	2.49	2.45	2.17	2.78
Dissolved Oxygen - % Saturation	---	0.1	% saturation	9.4	27.3	26.6	23.8	31.5
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)	---	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
FWI-EN/001: Groundwater Sampling - Depth								
Depth	---	0.01	m	1.60	0.60	0.84	0.92	0.83

Analytical Results

Client sample ID				MD 10B	Rocklow Down	Rocklow Middle	Rocklow Up	BLANK
Compound	CAS Number	LOR	Unit	21-Nov-2019 10:00	21-Nov-2019 08:30	21-Nov-2019 09:20	21-Nov-2019 08:50	21-Nov-2019 08:25
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	---	0.1	pH Unit	7.1	7.1	7.0	7.4	---
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	1940	51000	50500	55200	---
EA020FD: Field Salinity								
Salinity	---	0.2	g/L	1.1	35.2	36.3	39.1	---
EA116: Temperature								
Temperature	---	0.1	°C	20.3	22.8	21.0	22.1	---
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	<1	<1	<1	<1	---
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	<1	<1	<1	<1	---
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	686	228	242	178	---
Total Alkalinity as CaCO ₃	---	1	mg/L	686	228	242	178	---
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	<10	2380	2370	2590	---
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	153	14600	14400	15800	---
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	97	---	---	---	---
Magnesium	7439-95-4	1	mg/L	38	---	---	---	---
Sodium	7440-23-5	1	mg/L	111	---	---	---	---
Potassium	7440-09-7	1	mg/L	69	---	---	---	---
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	---	479	476	501	---
Magnesium	7439-95-4	1	mg/L	---	1220	1190	1300	---
Sodium	7440-23-5	1	mg/L	---	10000	9850	10800	---
Potassium	7440-09-7	1	mg/L	---	363	356	388	---
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	0.378	---	---	---	<0.001
Iron	7439-89-6	0.05	mg/L	0.93	---	---	---	<0.05
EG020T: Total Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	---	0.174	0.208	0.146	---
Iron	7439-89-6	0.05	mg/L	---	0.44	0.51	0.35	---

Analytical Results

Client sample ID				MD 10B	Rocklow Down	Rocklow Middle	Rocklow Up	BLANK
Compound	CAS Number	LOR	Unit	EW1905023-016	EW1905023-017	EW1905023-018	EW1905023-019	EW1905023-020
				Result	Result	Result	Result	Result
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.7	0.8	0.8	0.9	---
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	58.9	1.20	0.90	<0.10	---
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	---
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	---
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	---	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	---
EN055: Ionic Balance								
ø Total Anions	---	0.01	meq/L	18.0	---	---	---	---
ø Total Cations	---	0.01	meq/L	18.8	---	---	---	---
ø Ionic Balance	---	0.01	%	1.99	---	---	---	---
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	---	1	mg/L	31	8	<1	<1	<1
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	---	1	mg/L	37	6	1	<1	---
EP025FD: Field Dissolved Oxygen								
Dissolved Oxygen	---	0.01	mg/L	1.84	4.73	2.09	3.12	---
Dissolved Oxygen - % Saturation	---	0.1	% saturation	20.5	54.8	23.6	35.9	---
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)	---	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	---
FWI-EN/001: Groundwater Sampling - Depth								
Depth	---	0.01	m	0.92	---	---	---	---



CHAIN OF CUSTODY

ALS Laboratory: please tick →

Sydney: 277 Woodpark Rd, Smithfield NSW 2176
Ph: 02 8754 8655 E: samples.sydney@alsenviro.com

Newcastle: 5 Rosegum Rd, Warabrook NSW 2304
Ph: 02 4968 9433 E: samples.newcastle@alsenviro.com

Brisbane: 32 Shand St, Stafford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsenviro.com

Townsville: 14-15 Desma Ct, Bohle QLD 4818
Ph: 07 4796 0600 E: townsville.environmental@alsenviro.com

Melbourne: 2-4 Westall Rd, Springvale VIC 3171
Ph: 03 8549 9600 E: samples.melbourne@alsenviro.com

Adelaide: 2-1 Burma Rd, Pooraka SA 5095
Ph: 08 8359 0690 E: adelaide@alsenviro.com

Perth: 10 Hod Way, Malaga WA 6090
Ph: 08 9209 7655 E: samples.perth@alsenviro.com

Launceston: 27 Wellington St, Launceston TAS 7250
Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT:	Kiama Municipal Council	TURNAROUND REQUIREMENTS :		<input type="checkbox"/> Standard TAT (List due date): <small>(Standard TAT may be longer for some tests e.g. Ultra Trace Organics)</small>		<input type="checkbox"/> Non Standard or urgent TAT (List due date):		FOR LABORATORY USE ONLY (Circle)	
OFFICE:	PO Box 75 Kiama NSW 2533	ALS QUOTE NO.:				COC SEQUENCE NUMBER (Circle)		Custody Seal intact? Yes No N/A	
PROJECT:	Minnamurra Landfill					COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt?	Freeze / frozen ice blocks present upon receipt? Yes No N/A	
ORDER NUMBER:	141275					OF: 1 2 3 4 5 6 7	Other comments:		
PROJECT MANAGER:	Paul Czulowski	CONTACT PH: 4232 0418							
SAMPLER:	SAMPLER MOBILE:	RELINQUISHED BY:		RECEIVED BY:		RELINQUISHED BY:		RECEIVED BY:	
COC emailed to ALS? (YES / NO)		EDD FORMAT (or default):		Robert.		Anita		Environmental Division Wollongong Work Order Reference EW2000787	
Email Reports to (will default to PM if no other addresses are listed): paulc@kiama.nsw.gov.au, juliem@kiama.nsw.gov.au									
Email Invoice to (will default to PM if no other addresses are listed): paulc@kiama.nsw.gov.au, juliem@kiama.nsw.gov.au									

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract)							
	LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	NT-02A (Alkalinity, Cl, SO4 & Fluoride)	NT-01 (Mg, Ca, Na, K)	Nitrate, Ammonia, Total Phenolics	DOC (Filtered)	TOC	(Dissolved Filtered) Fe, (Mn,	(Total) Fe, Mn, (Mg, Ca, Na, K)
		MD 1A	14/2/20 —	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	
		MD 1B	11:15	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
		MD 2A	10:12	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
		MD 2B	10:22	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
		MD 2C	10:30	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
		MD 4A	—	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
		MD 4B	9:48	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
		MD 4C	9:55	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
		MD6A	10:50	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
		MD 6B	10:55	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
		MD 6C	11:00	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
		MD 9A	9:18	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
					TOTAL								

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic

V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphite Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.



Telephone : 02 42263125



CHAIN OF CUSTODY

ALS Laboratory: please tick →

Sydney: 277 Woodpark Rd, Smithfield NSW 2176
Ph: 02 8784 8655 E: samples.sydney@alsenviro.com

Newcastle: 5 Rosegum Rd, Warabrook NSW 2304
Ph: 02 4968 9433 E: samples.newcastle@alsenviro.com

Brisbane: 32 Shand St, Stafford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsenviro.com

Townsville: 14-15 Desma Ct, Bohle QLD 4818
Ph: 07 4796 0600 E: townsville.environmental@alsenviro.com

Melbourne: 2-4 Westall Rd, Springvale VIC 3171
Ph: 03 8549 9600 E: samples.melbourne@alsenviro.com

Adelaide: 2-1 Burra Rd, Pooraka SA 5095
Ph: 08 8359 0880 E: adelaide@alsenviro.com

Perth: 10 Had Way, Malaga WA 6090
Ph: 08 9209 7655 E: samples.perth@alsenviro.com

Launceston: 27 Wellington St, Launceston TAS 7250
Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: Kiama Municipal Council				TURNAROUND REQUIREMENTS : <input type="checkbox"/> Standard TAT (List due date): (Standard TAT may be longer for some tests e.g., Ultra Trace Organics) <input type="checkbox"/> Non Standard or urgent TAT (List due date):							FOR LABORATORY USE ONLY (Circle)									
OFFICE: PO Box 75 Kiama NSW 2533											Custody Seal intact? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A									
PROJECT: Minnamurra Landfill				ALS QUOTE NO.:							COC SEQUENCE NUMBER (Circle)									
ORDER NUMBER:											COC: 1 <input type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7	Free ice / frozen ice bricks present upon receipt? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> N/A								
PROJECT MANAGER: Paul Czulowski				CONTACT PH: 4232 0418							OF: 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7	Random Sample Temperature on Receipt: <input type="checkbox"/> C <input type="checkbox"/> F								
SAMPLER: SAMPLER MOBILE:				RELINQUISHED BY: DATE/TIME:							RECEIVED BY: DATE/TIME:			RELINQUISHED BY: DATE/TIME:			RECEIVED BY: DATE/TIME:			
COC emailed to ALS? (YES / NO)											EDD FORMAT (or default):									
Email Reports to (will default to PM if no other addresses are listed):																				
Email Invoice to (will default to PM if no other addresses are listed):																				
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:																				
ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION				ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).									Additional Information			
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)		TOTAL BOTTLES	NT-02A (Alkalinity, Cl, SO ₄ & Fluoride), NT-01 (Mg, Ca, Na, K)	Nitrate, Ammonia, Total Phenolics	DOC (Filtered)	TOC	(Dissolved Filtered) Fe, Mn,	(Total) Fe, Mn, Mg, Ca, Na, K	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.							
	MD 9B	14/2/20 9:24	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓			YSI (Field Results) pH, Temp, EC, Sal, DO.						
	MD 9C	9:33	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth						
	MD 10A	8:55	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth						
	MD 10B	9:00	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth						
	Rocklow Down	8:40	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth						
	Rocklow Middle	8:45	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth						
	Rocklow Up	8:15	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth						
	Blank	7:35	W	VS, N		2			✓		✓									
TOTAL																				

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphite Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfu
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

CERTIFICATE OF ANALYSIS

Work Order	: EW2000787	Page	: 1 of 10
Client	: KIAMA COUNCIL	Laboratory	: Environmental Division NSW South Coast
Contact	: MR PAUL CZULOWSKI	Contact	: Glenn Davies
Address	: 11 MANNING STREET KIAMA NSW, AUSTRALIA 2533	Address	: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW Australia
Telephone	: +61 02 4232 0444	Telephone	: 02 42253125
Project	: Minnamurra Landfill	Date Samples Received	: 14-Feb-2020 13:53
Order number	: 141275	Date Analysis Commenced	: 14-Feb-2020
C-O-C number	: ----	Issue Date	: 24-Feb-2020 16:07
Sampler	: ----		
Site	: Minnamurra Landfill		
Quote number	: WO/029/19		
No. of samples received	: 20		
No. of samples analysed	: 20		

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatures

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

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW



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

General Comments

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

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

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

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

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

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

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

Ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- Analytical work for this work order will be conducted at ALS Sydney.
- EP002: It has been noted that DOC is greater than TOC for samples 3, 4 and 5, however this difference is within the limits of experimental variation.
- Sampling and sample data supplied by ALS Wollongong.
- Sampling completed as per EN/67.11 Groundwater Sampling.
- Sampling completed as per EN/67.6 Rivers and Streams
- Field tests completed on day of sampling/receipt.
- EP 035SF: LOR raised for Phenol sample 12 due to sample matrix.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 1A	MD 1B	MD 2A	MD 2B	MD 2C
Compound	CAS Number	LOR	Unit	14-Feb-2020 00:00	14-Feb-2020 11:15	14-Feb-2020 10:12	14-Feb-2020 10:22	14-Feb-2020 10:30
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	---	0.1	pH Unit	---	7.6	6.9	6.9	7.0
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	---	601	18200	33800	48000
EA020FD: Field Salinity								
Salinity	---	0.2	g/L	---	0.3	10.4	21.3	31.4
EA116: Temperature								
Temperature	---	0.1	°C	---	24.9	26.3	24.7	24.8
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	---	<1	<1	<1	<1
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	---	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	---	222	990	736	543
Total Alkalinity as CaCO ₃	---	1	mg/L	---	222	990	736	543
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	---	16	605	1710	2450
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	---	43	5980	11600	16200
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	---	49	250	496	547
Magnesium	7439-95-4	1	mg/L	---	9	405	782	1080
Sodium	7440-23-5	1	mg/L	---	34	3040	6140	8720
Potassium	7440-09-7	1	mg/L	---	14	176	262	344
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	---	0.057	0.067	0.137	0.143
Iron	7439-89-6	0.05	mg/L	---	0.68	2.75	1.65	1.56
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	---	0.2	0.9	0.6	0.7
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	---	17.0	31.5	14.0	3.42
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	---	<0.01	0.05	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	---	0.06	0.19	<0.01	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 1A	MD 1B	MD 2A	MD 2B	MD 2C
				Client sampling date / time	14-Feb-2020 00:00	14-Feb-2020 11:15	14-Feb-2020 10:12	14-Feb-2020 10:22	14-Feb-2020 10:30
Compound	CAS Number	LOR	Unit	EW2000787-001	EW2000787-002	EW2000787-003	EW2000787-004	EW2000787-005	
				Result	Result	Result	Result	Result	Result
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	---	0.01	mg/L	---	0.06	0.24	<0.01	<0.01	<0.01
EN055: Ionic Balance									
ø Total Anions	---	0.01	meq/L	---	5.98	201	378	519	
ø Total Cations	---	0.01	meq/L	---	6.24	----	----	----	----
ø Total Cations	---	0.01	meq/L	---	----	182	363	504	
ø Ionic Balance	---	0.01	%	---	2.05	----	----	----	----
ø Ionic Balance	---	0.01	%	---	----	4.83	1.98	1.42	
EN67 PK: Field Tests									
Field Observations	---	0.01	--	DESTROYED	----	----	----	----	----
EP002: Dissolved Organic Carbon (DOC)									
Dissolved Organic Carbon	---	1	mg/L	---	7	66	44	26	
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	---	1	mg/L	---	7	65	43	25	
EP025FD: Field Dissolved Oxygen									
Dissolved Oxygen	---	0.01	mg/L	---	2.52	3.69	2.53	2.47	
Dissolved Oxygen - % Saturation	---	0.1	% saturation	---	30.7	45.9	30.8	30.0	
EP035G: Total Phenol by Discrete Analyser									
Phenols (Total)	---	0.05	mg/L	---	<0.05	<0.05	<0.05	<0.05	<0.05
FWI-EN/001: Groundwater Sampling - Depth									
Depth	---	0.01	m	---	1.08	0.21	0.50	0.52	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 4A	MD 4B	MD 4C	MD 6A	MD 6B
Compound	CAS Number	LOR	Unit	14-Feb-2020 00:00	14-Feb-2020 09:48	14-Feb-2020 09:55	14-Feb-2020 10:50	14-Feb-2020 10:55
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	---	0.1	pH Unit	---	7.0	7.0	7.2	7.1
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	---	18100	45900	1530	1520
EA020FD: Field Salinity								
Salinity	---	0.2	g/L	---	10.8	30.2	0.8	0.8
EA116: Temperature								
Temperature	---	0.1	°C	---	24.6	24.4	25.1	25.3
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	---	<1	<1	<1	<1
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	---	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	---	875	618	656	625
Total Alkalinity as CaCO ₃	---	1	mg/L	---	875	618	656	625
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	---	625	2360	39	6
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	---	6220	15400	102	87
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	---	386	523	120	108
Magnesium	7439-95-4	1	mg/L	---	385	1030	46	50
Sodium	7440-23-5	1	mg/L	---	2850	8350	109	94
Potassium	7440-09-7	1	mg/L	---	165	311	43	46
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	---	0.106	0.164	0.049	0.104
Iron	7439-89-6	0.05	mg/L	---	1.80	1.66	1.73	0.22
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	---	0.6	1.0	0.8	0.6
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	---	38.5	2.18	36.0	39.0
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	---	<0.01	<0.01	0.08	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	---	0.03	<0.01	0.62	0.05

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)	Client sample ID			MD 4A	MD 4B	MD 4C	MD 6A	MD 6B
Client sampling date / time			14-Feb-2020 00:00	14-Feb-2020 09:48	14-Feb-2020 09:55	14-Feb-2020 10:50	14-Feb-2020 10:55	
Compound	CAS Number	LOR	Unit	EW2000787-006	EW2000787-007	EW2000787-008	EW2000787-009	EW2000787-010
Result								
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	---	0.01	mg/L	---	0.03	<0.01	0.70	0.05
EN055: Ionic Balance								
ø Total Anions	---	0.01	meq/L	---	206	496	16.8	15.1
ø Total Cations	---	0.01	meq/L	---	179	482	15.6	14.8
ø Ionic Balance	---	0.01	%	---	6.96	1.42	3.64	1.00
EN67 PK: Field Tests								
Field Observations	---	0.01	--	DESTROYED	---	---	---	---
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	---	1	mg/L	---	47	28	35	36
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	---	1	mg/L	---	47	29	36	36
EP025FD: Field Dissolved Oxygen								
Dissolved Oxygen	---	0.01	mg/L	---	2.84	3.31	2.93	2.50
Dissolved Oxygen - % Saturation	---	0.1	% saturation	---	34.1	39.9	35.8	30.8
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)	---	0.05	mg/L	---	<0.05	<0.05	<0.05	<0.05
FWI-EN/001: Groundwater Sampling - Depth								
Depth	---	0.01	m	---	0.90	0.94	0.93	1.05

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MD 6C	MD 9A	MD 9B	MD 9C	MD 10A
Compound	CAS Number	LOR	Unit	14-Feb-2020 11:00	14-Feb-2020 09:18	14-Feb-2020 09:24	14-Feb-2020 09:33	14-Feb-2020 08:55
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	---	0.1	pH Unit	7.1	7.0	7.1	7.0	6.6
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	38800	4400	3250	13700	49200
EA020FD: Field Salinity								
Salinity	---	0.2	g/L	25.0	2.3	1.7	7.9	29.6
EA116: Temperature								
Temperature	---	0.1	°C	24.5	25.2	24.4	24.7	28.8
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	386	670	1210	864	250
Total Alkalinity as CaCO ₃	---	1	mg/L	386	670	1210	864	250
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	2070	106	<1	345	2840
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	13200	1080	378	4470	16600
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	426	118	114	258	1060
Magnesium	7439-95-4	1	mg/L	936	120	59	253	1090
Sodium	7440-23-5	1	mg/L	7270	590	300	2200	8500
Potassium	7440-09-7	1	mg/L	256	67	126	149	196
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	0.066	0.029	0.160	0.222	0.610
Iron	7439-89-6	0.05	mg/L	20.2	0.08	2.82	5.94	0.64
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.6	0.2	0.7	0.6	0.6
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	42.8	23.5	116	92.0	0.19
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	0.04	0.09	0.04

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 6C	MD 9A	MD 9B	MD 9C	MD 10A
		Client sampling date / time		14-Feb-2020 11:00	14-Feb-2020 09:18	14-Feb-2020 09:24	14-Feb-2020 09:33	14-Feb-2020 08:55
Compound	CAS Number	LOR	Unit	EW2000787-011	EW2000787-012	EW2000787-013	EW2000787-014	EW2000787-015
Result								
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	---	0.01	mg/L	<0.01	<0.01	0.04	0.09	0.04
EN055: Ionic Balance								
ø Total Anions	---	0.01	meq/L	423	46.0	34.8	150	532
ø Total Cations	---	0.01	meq/L	----	----	----	141	----
ø Total Cations	---	0.01	meq/L	421	43.1	26.8	----	517
ø Ionic Balance	---	0.01	%	----	----	----	3.11	----
ø Ionic Balance	---	0.01	%	0.25	3.27	13.0	----	1.43
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	---	1	mg/L	13	50	66	64	62
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	---	1	mg/L	14	50	71	64	62
EP025FD: Field Dissolved Oxygen								
Dissolved Oxygen	---	0.01	mg/L	1.82	1.31	2.37	1.64	4.52
Dissolved Oxygen - % Saturation	---	0.1	% saturation	22.3	16.0	28.6	20.0	58.8
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)	---	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
FWI-EN/001: Groundwater Sampling - Depth								
Depth	---	0.01	m	1.18	0.26	0.66	0.63	0.78

Analytical Results

Client sample ID				MD 10B	Rocklow Down	Rocklow Middle	Rocklow Up	BLANK
Compound	CAS Number	LOR	Unit	14-Feb-2020 09:00	14-Feb-2020 07:40	14-Feb-2020 08:45	14-Feb-2020 08:15	14-Feb-2020 07:35
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	---	0.1	pH Unit	7.1	7.2	7.1	6.6	---
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	1880	3010	2670	1610	---
EA020FD: Field Salinity								
Salinity	---	0.2	g/L	0.9	1.4	1.3	0.8	---
EA116: Temperature								
Temperature	---	0.1	°C	26.6	28.6	29.2	28.4	---
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	<1	<1	<1	<1	---
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	<1	<1	<1	<1	---
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	710	80	79	41	---
Total Alkalinity as CaCO ₃	---	1	mg/L	710	80	79	41	---
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	<1	186	169	86	---
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	185	900	781	493	---
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	104	---	---	---	---
Magnesium	7439-95-4	1	mg/L	43	---	---	---	---
Sodium	7440-23-5	1	mg/L	124	---	---	---	---
Potassium	7440-09-7	1	mg/L	75	---	---	---	---
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	---	54	52	22	---
Magnesium	7439-95-4	1	mg/L	---	57	51	34	---
Sodium	7440-23-5	1	mg/L	---	444	386	238	---
Potassium	7440-09-7	1	mg/L	---	20	18	17	---
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	0.365	---	---	---	<0.001
Iron	7439-89-6	0.05	mg/L	0.89	---	---	---	<0.05
EG020T: Total Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	---	0.066	0.068	0.086	---
Iron	7439-89-6	0.05	mg/L	---	0.88	0.99	0.98	---

Analytical Results

Client sample ID				MD 10B	Rocklow Down	Rocklow Middle	Rocklow Up	BLANK
Compound	CAS Number	LOR	Unit	14-Feb-2020 09:00	14-Feb-2020 07:40	14-Feb-2020 08:45	14-Feb-2020 08:15	14-Feb-2020 07:35
				Result	Result	Result	Result	Result
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.9	0.3	0.3	0.2	---
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	0.14	0.23	0.16	0.15	---
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.02	0.02	0.02	---
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	0.60	0.57	0.57	0.43	---
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	---	0.01	mg/L	0.60	0.59	0.59	0.45	---
EN055: Ionic Balance								
ø Total Anions	---	0.01	meq/L	19.4	---	---	---	---
ø Total Cations	---	0.01	meq/L	16.0	---	---	---	---
ø Ionic Balance	---	0.01	%	9.49	---	---	---	---
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	---	1	mg/L	51	16	16	24	<1
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	---	1	mg/L	53	16	17	25	---
EP025FD: Field Dissolved Oxygen								
Dissolved Oxygen	---	0.01	mg/L	2.42	6.65	6.28	4.84	---
Dissolved Oxygen - % Saturation	---	0.1	% saturation	30.3	85.3	81.6	28.2	---
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)	---	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	---
FWI-EN/001: Groundwater Sampling - Depth								
Depth	---	0.01	m	0.67	---	---	---	---

CHAIN OF CUSTODY

S Laboratory: please tick →

- Sydney: 277 Woodpark Rd, Smithfield NSW 2176
Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
- Brisbane: 32 Shand St, Stafford QLD 4053
Ph: 07 3243 7222 E:samples.brisbane@alsenviro.com
- Melbourne: 2-4 Westall Rd, Springvale VIC 3171
Ph: 03 8549 9600 E:samples.melbourne@alsenviro.com
- Perth: 10 Hed Way, Malaga WA 6090
Ph: 08 9209 7655 E:samples.perth@alsenviro.com
- Newcastle: 5 Rossouw Rd, Warabrook NSW 2304
Ph: 02 4968 9433 E:samples.newcastle@alsenviro.com
- Townsville: 14-15 Dasma Ct, Bohle QLD 4818
Ph: 07 4796 0000 E:townsville.environmental@alsenviro.com
- Adelaide: 2-1 Burma Rd, Paraoka SA 5095
Ph: 08 8359 0890 E:adelaide@alsenviro.com
- Launceston: 27 Wellington St, Launceston TAS 7250
Ph: 03 6331 2158 E:launceston@alsenviro.com

Kaima Municipal Council PO Box 75 Kaima NSW 2533				TURNAROUND REQUIREMENTS : <input type="checkbox"/> Standard TAT (List due date): (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics) <input type="checkbox"/> Non Standard or urgent TAT (List due date):								FO Out For Rec Rank				
PROJECT:	Minnamurra Landfill			ALS QUOTE NO.:				COC SEQUENCE NUMBER (Circle)								
ORDER NUMBER:	141275							COC:	1	2	3	4	5	6	7	
PROJECT MANAGER:	Paul Czulowski			CONTACT PH: 4232 0418				OF:	1	2	3	4	5	6	7	
SAMPLER:	SAMPLER MOBILE:			RELINQUISHED BY:				RECEIVED BY:	RELINQUIS							
COC emailed to ALS? (YES / NO)				EDD FORMAT (or default):				DATE/TIME:	Aneta				DATE/TIME:			
Email Reports to (will default to PM if no other addresses are listed): paulc@kaima.nsw.gov.au, juliem@kaima.nsw.gov.au								28/5/20 13:30	28/5/20				DATE/TIME:			
Email Invoice to (will default to PM if no other addresses are listed): paulc@kaima.nsw.gov.au, juliem@kaima.nsw.gov.au																
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:																
ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION			ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed in order of priority) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information	
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	NT-02A (Alkalinity, Cl, SO4 & Fluoride) NT-01(Mg, Ca, Na, K)	Nitrate, Ammonia, Total Phenolics	DOC (Filtered)	TOC	(Dissolved Filtered) Fe, (Mn,	(Total) Fe, Mn, Mg, Ca, Na, K		Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.			
														YSI (Field Results) pH, Temp, EC, Sal, DO, Depth		
	MD 1A	28/5/20 —	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
	MD 1B	12:40	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
	MD 2A	11:40	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
	MD 2B	11:45	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
	MD 2C	11:50	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
	MD 4A	—	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
	MD 4B	11:40	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
	MD 4C	11:20	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
	MD6A	12:10	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
	MD 6B	12:15	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
	MD 6C	12:20	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
	MD 9A	10:37	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth		
				TOTAL												

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphite Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

Environmental Division
Wollongong
Work Order Reference
EW2002501

Telephone: 02 42262125





CHAIN OF CUSTODY

ALS Laboratory: please tick →

- Sydney: 277 Woodpark Rd, Smithfield NSW 2176
Ph: 02 8764 8555 E:samples.sydney@alsenviro.com
- Brisbane: 32 Shand St, Stafford QLD 4053
Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
- Melbourne: 2-4 Westall Rd, Springvale VIC 3171
Ph:03 8545 9600 E:samples.melbourne@alsenviro.com
- Perth: 10 Hed Way, Malaga WA 6090
Ph: 08 9209 7655 E:samples.perth@alsenviro.com
- Newcastle: 5 Rosegum Rd, Warabrook NSW 2304
Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
- Townsville: 14-15 Dicme Ct, Bohle QLD 4818
Ph:07 4796 0600 E:townsville.environmental@alsenviro.com
- Adelaide: 2-1 Birra Rd, Pooraka SA 5095
Ph: 08 8389 0890 E:adelaide@alsenviro.com

- Launceston: 27 Wellington St, Launceston TAS 7250
Ph: 03 6331 2158 E:launceston@alsenviro.com

CLIENT: Kiama Municipal Council		TURNAROUND REQUIREMENTS: <input type="checkbox"/> Standard TAT (List due date): (Standard TAT may be longer for some tests e.g., Ultra Trace Organics) <input type="checkbox"/> Non Standard or urgent TAT (List due date):												FOR LABORATORY USE ONLY (Circle)				
OFFICE: PO Box 75 Kiama NSW 2533	PROJECT: Minnamurra Landfill	ALS QUOTE NO.:												Customer Seal intact? <input type="checkbox"/> YES <input type="checkbox"/> NO	Freeze / frozen ice blocks present upon receipt? <input type="checkbox"/> YES <input type="checkbox"/> NO	Random Sample Temperature on Receipt? <input type="checkbox"/> YES <input type="checkbox"/> NO		
ORDER NUMBER:	PROJECT MANAGER: Paul Czulowski	CONTACT PH: 4232 0418												COC SEQUENCE NUMBER (Circle)	COC: 1 <input checked="" type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7	OF: 1 <input checked="" type="checkbox"/> 2 <input type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7	Other comments:	
SAMPLER: SAMPLER MOBILE:	COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	RELINQUISHED BY:		RECEIVED BY:		RELINQUISHED BY:		RECEIVED BY:									
Email Reports to (will default to PM if no other addresses are listed):	DATE/TIME:		DATE/TIME:		DATE/TIME:		DATE/TIME:		DATE/TIME:									
Email Invoice to (will default to PM if no other addresses are listed):																		
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:																		
ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION			ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information			
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)		TOTAL BOTTLES	NT-02A (Alkalinity, Cl, SO ₄ & Fluoride) NT-01(Mg, Ca, Na, K)	Nitrate, Ammonia, Total Phenolics	DOC (Filtered)	TOC	(Dissolved Filtered) Fe, Mn,	(Total) Fe, Mn, Mg, Ca, Na, K			Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.			
	MD 9B	26/5/20 10:45	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓				YSI (Field Results) pH, Temp, EC, Sal, DO,			
	MD 9C	10:52	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth			
	MD 10A	10:12	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth			
	MD 10B	10:20	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth			
	Rocklow Down	9:00	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓		✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth			
	Rocklow Middle	9:55	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓		✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth			
	Rocklow Up	9:40	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓		✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth			
	Blank	8:55	W	VS, N		2			✓		✓							
TOTAL																		
<p>Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphite Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulphuric Acid Preserved Plastic; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.</p>																		

CERTIFICATE OF ANALYSIS

Work Order	: EW2002501	Page	: 1 of 10
Client	: KIAMA COUNCIL	Laboratory	: Environmental Division NSW South Coast
Contact	: MS JULIE MILEVSKI	Contact	: Glenn Davies
Address	: 11 MANNING STREET KIAMA NSW, AUSTRALIA 2533	Address	: 1/19 Ralph Black Dr, North Wollongong 2500 4/13 Geary Pl, North Nowra 2541 Australia NSW Australia
Telephone	: +61 02 4232 0557	Telephone	: 02 42253125
Project	: Minnamurra Landfill	Date Samples Received	: 28-May-2020 13:46
Order number	: 141275	Date Analysis Commenced	: 28-May-2020
C-O-C number	: ----	Issue Date	: 04-Jun-2020 15:46
Sampler	: Arrian Zautsen, Robert DaLio		
Site	: Minnamurra Landfill		
Quote number	: WO/029/19		
No. of samples received	: 20		
No. of samples analysed	: 20		

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatures

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

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW



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

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

Ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- Analytical work for this work order will be conducted at ALS Sydney.
- ED041G: LOR raised for Sulfate on samples 13 and 16 due to sample matrix.
- EK057G: LOR raised for Nitrite on various samples due to sample matrix.
- EK058G/EK059G: LOR raised for Nitrate and NOx on various samples due to sample matrix.
- EP002: It has been noted that DOC is greater than TOC for various samples, however this difference is within the limits of experimental variation.
- pH performed by ALS Wollongong via in-house method EA005FD and EN67 PK.
- Electrical conductivity performed by ALS Wollongong via in-house method EA010FD and EN67 PK.
- Sampling and groundwater depth measurements completed by ALS Wollongong via inhouse sampling method EN/67.11 Groundwater Sampling.
- Sampling completed by ALS Wollongong in accordace with in-house sampling method EN/67.6 Rivers and Streams.
- Temperature performed by ALS Wollongong via in-house method EA016 and EN67 PK.
- Dissolved oxygen (DO) performed by ALS Wollongong via in-house method EA025FD and EN67 PK.
- Salinity performed by ALS Wollongong via in-house method EA020FD and EN67 PK.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Client sample ID				MD 1A	MD 1B	MD 2A	MD 2B	MD 2C
Compound	CAS Number	LOR	Unit	28-May-2020 00:00	28-May-2020 12:40	28-May-2020 11:40	28-May-2020 11:45	28-May-2020 11:50
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	---	0.1	pH Unit	---	7.6	7.1	6.9	6.9
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	---	611	1840	35500	48500
EA020FD: Field Salinity								
Salinity	---	0.2	g/L	---	0.3	11.2	22.4	31.7
EA116: Temperature								
Temperature	---	0.1	°C	---	20.7	17.2	17.8	17.4
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	---	<1	<1	<1	<1
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	---	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	---	226	973	739	586
Total Alkalinity as CaCO ₃	---	1	mg/L	---	226	973	739	586
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	---	17	705	1740	2440
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	---	42	5220	12100	16200
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	---	52	297	433	512
Magnesium	7439-95-4	1	mg/L	---	9	410	811	1180
Sodium	7440-23-5	1	mg/L	---	34	3010	6420	9600
Potassium	7440-09-7	1	mg/L	---	14	182	268	363
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	---	0.054	0.066	0.115	0.138
Iron	7439-89-6	0.05	mg/L	---	0.76	0.47	1.28	1.53
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	---	0.2	0.8	0.6	0.6
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	---	11.7	21.2	9.74	3.40
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	---	<0.01	<0.10	<0.10	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	---	<0.01	3.65	<0.10	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 1A	MD 1B	MD 2A	MD 2B	MD 2C
		Client sampling date / time		28-May-2020 00:00	28-May-2020 12:40	28-May-2020 11:40	28-May-2020 11:45	28-May-2020 11:50
Compound	CAS Number	LOR	Unit	EW2002501-001	EW2002501-002	EW2002501-003	EW2002501-004	EW2002501-005
Result								
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	---	0.01	mg/L	---	<0.01	3.65	<0.10	<0.01
EN055: Ionic Balance								
ø Total Anions	---	0.01	meq/L	---	6.05	181	392	519
ø Total Cations	---	0.01	meq/L	---	6.01	---	---	---
ø Total Cations	---	0.01	meq/L	---	---	184	374	550
ø Ionic Balance	---	0.01	%	---	0.42	---	---	---
ø Ionic Balance	---	0.01	%	---	---	0.76	2.33	2.81
EN67 PK: Field Tests								
Field Observations	---	0.01	--	DESTROYED	---	---	---	---
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	---	1	mg/L	---	4	37	28	18
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	---	1	mg/L	---	5	46	30	16
EP025FD: Field Dissolved Oxygen								
Dissolved Oxygen	---	0.01	mg/L	---	1.23	0.79	0.40	0.41
Dissolved Oxygen - % Saturation	---	0.1	% saturation	---	13.8	8.7	4.8	5.2
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)	---	0.05	mg/L	---	<0.05	<0.05	<0.05	<0.05
FWI-EN/001: Groundwater Sampling - Depth								
Depth	---	0.01	m	---	1.34	0.22	0.57	0.59

Analytical Results

Client sample ID				MD 4A	MD 4B	MD 4C	MD 6A	MD 6B
Compound	CAS Number	LOR	Unit	28-May-2020 00:00	28-May-2020 11:10	28-May-2020 11:20	28-May-2020 12:10	28-May-2020 12:15
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	---	0.1	pH Unit	---	6.7	6.9	7.4	7.0
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	---	24800	47100	1850	1600
EA020FD: Field Salinity								
Salinity	---	0.2	g/L	---	15.1	30.7	0.9	0.8
EA116: Temperature								
Temperature	---	0.1	°C	---	17.9	17.6	19.9	20.3
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	---	<1	<1	<1	<1
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	---	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	---	877	750	732	808
Total Alkalinity as CaCO ₃	---	1	mg/L	---	877	750	732	808
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	---	1120	2370	78	40
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	---	9280	16900	189	85
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	---	450	510	130	117
Magnesium	7439-95-4	1	mg/L	---	524	1130	46	46
Sodium	7440-23-5	1	mg/L	---	4020	8900	148	94
Potassium	7440-09-7	1	mg/L	---	190	337	50	45
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	---	0.130	0.133	0.037	0.101
Iron	7439-89-6	0.05	mg/L	---	2.31	1.42	0.28	0.20
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	---	0.5	0.8	0.7	0.5
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	---	30.5	2.16	24.8	31.1
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	---	<0.10	<0.10	0.05	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	---	<0.10	<0.10	2.63	0.02

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 4A	MD 4B	MD 4C	MD 6A	MD 6B
		Client sampling date / time		28-May-2020 00:00	28-May-2020 11:10	28-May-2020 11:20	28-May-2020 12:10	28-May-2020 12:15
Compound	CAS Number	LOR	Unit	EW2002501-006	EW2002501-007	EW2002501-008	EW2002501-009	EW2002501-010
			Result		Result	Result	Result	Result
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	---	0.01	mg/L	---	<0.10	<0.10	2.68	0.02
EN055: Ionic Balance								
ø Total Anions	---	0.01	meq/L	---	303	541	21.6	19.4
ø Total Cations	---	0.01	meq/L	---	247	----	----	17.1
ø Total Cations	---	0.01	meq/L	---	----	514	18.0	----
ø Ionic Balance	---	0.01	%	---	10.0	----	----	6.32
ø Ionic Balance	---	0.01	%	---	----	2.54	9.08	----
EN67 PK: Field Tests								
Field Observations	---	0.01	--	DESTROYED	---	---	---	---
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	---	1	mg/L	---	22	23	26	15
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	---	1	mg/L	---	33	22	26	22
EP025FD: Field Dissolved Oxygen								
Dissolved Oxygen	---	0.01	mg/L	---	2.02	2.34	1.65	1.62
Dissolved Oxygen - % Saturation	---	0.1	% saturation	---	23.3	29.5	18.2	18.0
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)	---	0.05	mg/L	---	<0.05	<0.05	<0.05	<0.05
FWI-EN/001: Groundwater Sampling - Depth								
Depth	---	0.01	m	---	0.98	1.00	1.03	1.13

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MD 6C	MD 9A	MD 9B	MD 9C	MD 10A
Compound	CAS Number	LOR	Unit	28-May-2020 12:20	28-May-2020 10:37	28-May-2020 10:45	28-May-2020 10:52	28-May-2020 10:12
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	---	0.1	pH Unit	7.2	7.2	7.0	7.0	7.0
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	38500	6490	3210	14000	34500
EA020FD: Field Salinity								
Salinity	---	0.2	g/L	24.6	3.6	1.7	8.1	21.7
EA116: Temperature								
Temperature	---	0.1	°C	19.1	18.1	19.0	18.9	17.7
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	410	474	1250	1030	455
Total Alkalinity as CaCO ₃	---	1	mg/L	410	474	1250	1030	455
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	1920	253	<10	349	1790
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	12700	1930	350	4540	12800
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	384	112	143	256	658
Magnesium	7439-95-4	1	mg/L	926	124	73	229	688
Sodium	7440-23-5	1	mg/L	7200	970	270	2100	5950
Potassium	7440-09-7	1	mg/L	248	74	108	155	162
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	0.050	0.017	0.180	0.186	0.451
Iron	7439-89-6	0.05	mg/L	18.6	<0.05	2.88	4.93	1.00
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.4	0.1	0.6	0.5	0.6
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	35.4	7.96	77.9	106	0.28
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.10	<0.10	<0.10	<0.10
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	1.38	0.26	0.15	3.17

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 6C	MD 9A	MD 9B	MD 9C	MD 10A
		Client sampling date / time		28-May-2020 12:20	28-May-2020 10:37	28-May-2020 10:45	28-May-2020 10:52	28-May-2020 10:12
Compound	CAS Number	LOR	Unit	EW2002501-011	EW2002501-012	EW2002501-013	EW2002501-014	EW2002501-015
Result								
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	---	0.01	mg/L	<0.01	1.38	0.26	0.15	3.17
EN055: Ionic Balance								
ø Total Anions	---	0.01	meq/L	406	69.2	34.8	156	407
ø Total Cations	---	0.01	meq/L	---	---	33.2	---	---
ø Total Cations	---	0.01	meq/L	415	59.9	---	127	352
ø Ionic Balance	---	0.01	%	---	---	2.44	---	---
ø Ionic Balance	---	0.01	%	1.03	7.21	---	10.2	7.24
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	---	1	mg/L	10	54	53	66	56
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	---	1	mg/L	10	55	52	67	54
EP025FD: Field Dissolved Oxygen								
Dissolved Oxygen	---	0.01	mg/L	0.55	3.92	1.44	1.08	5.25
Dissolved Oxygen - % Saturation	---	0.1	% saturation	6.9	42.5	15.6	12.2	62.8
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)	---	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05
FWI-EN/001: Groundwater Sampling - Depth								
Depth	---	0.01	m	1.28	0.28	0.67	0.74	0.38

Analytical Results

Client sample ID				MD 10B	Rocklow Down	Rocklow Middle	Rocklow Up	BLANK
Compound	CAS Number	LOR	Unit	28-May-2020 10:20	28-May-2020 09:00	28-May-2020 09:55	28-May-2020 09:40	28-May-2020 08:55
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	---	0.1	pH Unit	7.1	7.0	7.1	7.3	---
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	1880	32700	32500	22000	---
EA020FD: Field Salinity								
Salinity	---	0.2	g/L	1.0	20.5	20.3	13.3	---
EA116: Temperature								
Temperature	---	0.1	°C	20.6	14.5	14.8	14.9	---
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	<1	<1	<1	<1	---
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	<1	<1	<1	<1	---
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	697	159	153	103	---
Total Alkalinity as CaCO ₃	---	1	mg/L	697	159	153	103	---
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	<10	1580	1730	606	---
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	199	10800	12000	5660	---
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	86	---	---	---	---
Magnesium	7439-95-4	1	mg/L	35	---	---	---	---
Sodium	7440-23-5	1	mg/L	120	---	---	---	---
Potassium	7440-09-7	1	mg/L	70	---	---	---	---
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	---	272	286	138	---
Magnesium	7439-95-4	1	mg/L	---	720	748	324	---
Sodium	7440-23-5	1	mg/L	---	5880	6220	2670	---
Potassium	7440-09-7	1	mg/L	---	215	228	100	---
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	0.283	---	---	---	<0.001
Iron	7439-89-6	0.05	mg/L	0.68	---	---	---	<0.05
EG020T: Total Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	---	0.055	0.057	0.048	---
Iron	7439-89-6	0.05	mg/L	---	0.28	0.23	0.55	---

Analytical Results

Client sample ID				MD 10B	Rocklow Down	Rocklow Middle	Rocklow Up	BLANK
Compound	CAS Number	LOR	Unit	EW2002501-016	EW2002501-017	EW2002501-018	EW2002501-019	EW2002501-020
				Result	Result	Result	Result	Result
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.9	0.7	0.6	0.4	---
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	63.1	1.03	0.58	0.06	---
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.10	0.01	<0.01	<0.01	---
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.10	0.02	0.04	0.02	---
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	---	0.01	mg/L	<0.10	0.03	0.04	0.02	---
EN055: Ionic Balance								
ø Total Anions	---	0.01	meq/L	19.5	---	---	---	---
ø Total Cations	---	0.01	meq/L	18.7	---	---	---	---
ø Ionic Balance	---	0.01	%	2.28	---	---	---	---
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	---	1	mg/L	33	8	9	4	<1
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	---	1	mg/L	32	8	13	3	---
EP025FD: Field Dissolved Oxygen								
Dissolved Oxygen	---	0.01	mg/L	1.90	5.39	4.53	7.67	---
Dissolved Oxygen - % Saturation	---	0.1	% saturation	21.3	59.9	50.7	82.3	---
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)	---	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	---
FWI-EN/001: Groundwater Sampling - Depth								
Depth	---	0.01	m	0.70	---	---	---	---



CHAIN OF CUSTODY

ALS Laboratory: please tick →

- Sydney: 277 Woodpark Rd, Smithfield NSW 2176
Ph: 02 8784 8555 E: samples.sydney@alsenviro.com
- Newcastle: 5 Rosegum Rd, Warabrook NSW 2304
Ph: 02 4968 9433 E: samples.newcastle@alsenviro.com

- Brisbane: 32 Shand St, Stafford QLD 4053
Ph: 07 3243 7222 E: samples.brisbane@alsenviro.com
- Townsville: 14-15 Desma Ct, Bohle QLD 4818
Ph: 07 4796 0600 E: townsville.environmental@alsenviro.com

- Melbourne: 2-4 Westall Rd, Springvale VIC 3171
Ph: 03 8549 9600 E: samples.melbourne@alsenviro.com
- Adelaide: 2-1 Burma Rd, Pooraka SA 5096
Ph: 08 8359 0890 E: adelaide@alsenviro.com

- Perth: 10 Hod Way, Malaga WA 6090
Ph: 08 9209 7655 E: samples.perth@alsenviro.com
- Launceston: 27 MacBride St, Launceston TAS 7250
Ph: 03 6222 2222 E: launceston@alsenviro.com

CLIENT: Kiama Municipal Council	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	<input type="checkbox"/> Standard TAT (List due date): <input type="checkbox"/> Non Standard or urgent TAT (List due date):														
OFFICE: PO Box 75 Kiama NSW 2533	ALS QUOTE NO.:	COC SEQUENCE NUMBER (Circle) COC: <table border="1" style="display: inline-table;"><tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr><tr><td>OF:</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr></table>	1	2	3	4	5	6	7	OF:	1	2	3	4	5	6
1	2		3	4	5	6	7									
OF:	1	2	3	4	5	6										
PROJECT: Minnamurra Landfill	ORDER NUMBER: 141275															
PROJECT MANAGER: Paul Czulowski	CONTACT PH: 4232 0418															
SAMPLER: 	SAMPLER MOBILE: 	RELINQUISHED BY: <i>Robert</i> DATE/TIME: <i>28.8.20 13:40</i>														
COC emailed to ALS? (YES / NO) EDD FORMAT (or default):																
Email Reports to (will default to PM if no other addresses are listed): paulc@kiama.nsw.gov.au, juliem@kiama.nsw.gov.au		RECEIVED BY: <i>Aneta</i> DATE/TIME: <i>28/8/20</i>														
Email Invoice to (will default to PM if no other addresses are listed): paulc@kiama.nsw.gov.au, juliem@kiama.nsw.gov.au																

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).							Additional Information	
	LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	NT-02A (Alkalinity, Cl, SO4 & Fluoride)	NT-01 (Mg, Ca, Na, K)	Nitrate, Ammonia, Total Phanolics	DOC (Filtered)	TOC	(Dissolved Filtered) Fe,	(Total) Fe, Mn, Mg, Ca, Na, K	
	MD 1A	<i>28.8.20 12:25</i>	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓	✓	✓	<i>Destroyed</i>
	MD 1B	<i>12:30</i>	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
	MD 2A	<i>11:20</i>	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
	MD 2B	<i>11:23</i>	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
	MD 2C	<i>11:29</i>	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
	MD 4A	<i>10:45</i>	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
	MD 4B	<i>10:50</i>	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
	MD 4C	<i>11:00</i>	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
	MD6A	<i>11:55</i>	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
	MD 6B	<i>11:57</i>	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
	MD 6C	<i>12:06</i>	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
	MD 9A	<i>10:15</i>	W	500mL,2X SP, 2 X VS, N		6	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth
					TOTAL									

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic

V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulfate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

Environmental Division

Wollongong

Work Order Reference

EW2003899

No	N/A
No	N/A



Telephone : 02 42253125



CHAIN OF CUSTODY

ALS Laboratory: please tick →

- Sydney:** 277 Woodpark Rd, Smithfield NSW 2176
Ph: 02 8794 8655 E:samples.sydney@alsenviro.com
- Brisbane:** 32 Shand St, Stafford QLD 4053
Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
- Newcastle:** 5 Rosegum Rd, Warabrook NSW 2304
Ph:02 4988 9433 E:samples.newcastle@alsenviro.com
- Melbourne:** 24 Westall Rd, Springvale VIC 3171
Ph:03 6549 9600 E:samples.melbourne@alsenviro.com
- Townsville:** 14-15 Desma Ct, Bohle QLD 4818
Ph:07 4796 0600 E:townsville.environmental@alsenviro.com
- Perth:** 10 Hod Way, Mataga WA 6090
Ph: 08 9209 7655 E:samples.perth@alsenviro.com
- Adelaide:** 2-1 Burna Rd, Pooraka SA 5095
Ph: 08 8369 0690 E:adelaide@alsenviro.com
- Launceston:** 27 Wellington St, Launceston TAS 7250
Ph: 03 6331 2158 E:launceston@alsenviro.com

CLIENT: Kiama Municipal Council				TURNAROUND REQUIREMENTS : <input type="checkbox"/> Standard TAT (List due date): <small>(Standard TAT may be longer for some tests e.g. Ultra Trace Organics)</small>								FOR LABORATORY USE ONLY (Circle)												
OFFICE: PO Box 75 Kiama NSW 2533				ALS QUOTE NO.: _____								COC SEQUENCE NUMBER (Circle)												
PROJECT: Minnamurra Landfill												COC: 1 <input type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7												
ORDER NUMBER:												OF: 1 <input type="checkbox"/> 2 <input checked="" type="checkbox"/> 3 <input type="checkbox"/> 4 <input type="checkbox"/> 5 <input type="checkbox"/> 6 <input type="checkbox"/> 7												
PROJECT MANAGER: Paul Czulowski CONTACT PH: 4232 0418																								
SAMPLER: SAMPLER MOBILE:				RELINQUISHED BY: DATE/TIME:								RECEIVED BY:				RELINQUISHED BY:				RECEIVED BY:				
COC emailed to ALS? (YES / NO)												EDD FORMAT (or default):				DATE/TIME:				DATE/TIME:				DATE/TIME:
Email Reports to (will default to PM if no other addresses are listed):																								
Email Invoice to (will default to PM if no other addresses are listed):																								
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:																								
ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)				CONTAINER INFORMATION				ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) <small>Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).</small>												Additional Information			
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE <small>(refer to codes below)</small>				TOTAL BOTTLES	NT-02A (Alkalinity, Cl, SO4 & Fluoride)	NT-01 (Mg, Ca, Na, K)	Nitrate, Ammonia, Total Phenolics	DOC (Filtered)	TOC	(Dissolved Filtered) Fe,	(Total) Fe, Mn, Mg, Ca, Na, K	Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.								
MD 9B	28.8.20 10:30	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	YSI (Field Results) pH, Temp, EC, Sal, DO, Depth									
MD 9C	10:37	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth									
MD 10A	9:50	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth									
MD 10B	10:05	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth									
Rocklow Down	8:40	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth									
Rocklow Middle	9:30	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth									
Rocklow Up	9:10	W	500mL,2X SP, 2 X VS, N	6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth									
Blank	8:30	W	VS, N	2																				
TOTAL																								

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphite Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Acid Preserved Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

CERTIFICATE OF ANALYSIS

Work Order : **EW2003899**
 Client : **KIAMA COUNCIL**
 Contact : MS JULIE MILEVSKI
 Address : 11 MANNING STREET
 KIAMA NSW, AUSTRALIA 2533
 Telephone : +61 02 4232 0557
 Project : Minnamurra Landfill
 Order number : 141275
 C-O-C number : ----
 Sampler : Robert DaLio
 Site : Minnamurra Landfill
 Quote number : WO/029/19
 No. of samples received : 20
 No. of samples analysed : 20

Page : 1 of 10
 Laboratory : Environmental Division NSW South Coast
 Contact : Glenn Davies
 Address : 1/19 Ralph Black Dr, North Wollongong 2500
 4/13 Geary Pl, North Nowra 2541
 Australia NSW Australia
 Telephone : 02 42253125
 Date Samples Received : 28-Aug-2020 14:03
 Date Analysis Commenced : 28-Aug-2020
 Issue Date : 04-Sep-2020 18:37



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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

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

Signatures

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

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Ashesh Patel	Senior Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong, NSW
Ivan Taylor	Analyst	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by ALS have been developed from established internationally recognised procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are fully validated and are often at the client request.

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

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

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

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

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

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

^ = This result is computed from individual analyte detections at or above the level of reporting

Ø = ALS is not NATA accredited for these tests.

~ = Indicates an estimated value.

- Analytical work for this work order will be conducted at ALS Sydney.
- ED041G: LOR raised for Sulfate on sample 16 due to sample matrix.
- EK057G: LOR raised for Nitrite on sample 12 due to sample matrix.
- EG020/ED093: LOR's have been raised due to matrix interference. (High Total Dissolved Solids)
- EP002 : It has been noted that DOC is greater than TOC for various samples, however this difference is within the limits of experimental variation.
- pH performed by ALS Wollongong via in-house method EA005FD and EN67 PK.
- Electrical conductivity performed by ALS Wollongong via in-house method EA010FD and EN67 PK.
- Sampling and groundwater depth measurements completed by ALS Wollongong via inhouse sampling method EN/67.11 Groundwater Sampling.
- Sampling completed by ALS Wollongong in accordace with in-house sampling method EN/67.6 Rivers and Streams.
- Temperature performed by ALS Wollongong via in-house method EA016 and EN67 PK.
- Dissolved oxygen (DO) performed by ALS Wollongong via in-house method EA025FD and EN67 PK.
- All field analysis performed by ALS Wollongong were completed at the time of sampling.
- Salinity performed by ALS Wollongong via in-house method EA020FD and EN67 PK.
- Sodium Adsorption Ratio (where reported): Where results for Na, Ca or Mg are <LOR, a concentration at half the reported LOR is incorporated into the SAR calculation. This represents a conservative approach for Na relative to the assumption that <LOR = zero concentration and a conservative approach for Ca & Mg relative to the assumption that <LOR is equivalent to the LOR concentration.

Analytical Results

Client sample ID				MD 1A	MD 1B	MD 2A	MD 2B	MD 2C
Compound	CAS Number	LOR	Unit	EW2003899-001	EW2003899-002	EW2003899-003	EW2003899-004	EW2003899-005
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	---	0.1	pH Unit	---	7.6	7.3	6.9	7.1
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	---	594	21200	30200	46100
EA020FD: Field Salinity								
Salinity	---	0.2	g/L	---	0.3	16.3	22.8	36.0
EA116: Temperature								
Temperature	---	0.1	°C	---	21.2	14.5	16.6	17.1
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	---	<1	<1	<1	<1
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	---	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	---	220	867	838	616
Total Alkalinity as CaCO ₃	---	1	mg/L	---	220	867	838	616
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	---	20	721	1330	2220
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	---	42	5900	8620	14500
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	---	46	288	392	479
Magnesium	7439-95-4	1	mg/L	---	8	450	627	995
Sodium	7440-23-5	1	mg/L	---	34	3410	4690	8000
Potassium	7440-09-7	1	mg/L	---	12	188	219	323
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	---	0.049	0.071	0.101	0.150
Iron	7439-89-6	0.05	mg/L	---	0.60	0.37	1.09	1.60
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	---	0.2	0.9	0.6	0.8
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	---	10.7	18.1	8.57	3.98
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	---	<0.01	0.03	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	---	0.26	3.11	0.08	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 1A	MD 1B	MD 2A	MD 2B	MD 2C
		Client sampling date / time		28-Aug-2020 12:25	28-Aug-2020 12:30	28-Aug-2020 11:20	28-Aug-2020 11:23	28-Aug-2020 11:29
Compound	CAS Number	LOR	Unit	EW2003899-001	EW2003899-002	EW2003899-003	EW2003899-004	EW2003899-005
Result								
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	---	0.01	mg/L	---	0.26	3.14	0.08	<0.01
EN055: Ionic Balance								
ø Total Anions	---	0.01	meq/L	---	6.00	199	288	468
ø Total Cations	---	0.01	meq/L	---	5.49	---	---	---
ø Total Cations	---	0.01	meq/L	---	---	204	281	462
ø Ionic Balance	---	0.01	%	---	4.40	---	---	---
ø Ionic Balance	---	0.01	%	---	---	1.43	1.20	0.59
EN67 PK: Field Tests								
Field Observations	---	0.01	--	DESTROYED	---	---	---	---
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	---	1	mg/L	---	10	66	61	24
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	---	1	mg/L	---	7	76	52	24
EP025FD: Field Dissolved Oxygen								
Dissolved Oxygen	---	0.01	mg/L	---	0.78	1.05	0.72	0.52
Dissolved Oxygen - % Saturation	---	0.1	% saturation	---	8.7	10.1	7.2	5.2
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)	---	0.05	mg/L	---	<0.05	<0.05	<0.05	<0.05
FWI-EN/001: Groundwater Sampling - Depth								
Depth	---	0.01	m	---	1.32	0.39	0.65	0.68

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 4A	MD 4B	MD 4C	MD 6A	MD 6B
Compound	CAS Number	LOR	Unit	28-Aug-2020 10:45	28-Aug-2020 10:50	28-Aug-2020 11:00	28-Aug-2020 11:55	28-Aug-2020 11:59
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	---	0.1	pH Unit	---	7.0	6.8	7.3	7.0
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	---	12900	47000	2000	1700
EA020FD: Field Salinity								
Salinity	---	0.2	g/L	---	8.8	37.0	1.2	1.0
EA116: Temperature								
Temperature	---	0.1	°C	---	17.5	16.8	19.3	19.8
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	---	<1	<1	<1	<1
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	---	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	---	871	848	641	658
Total Alkalinity as CaCO ₃	---	1	mg/L	---	871	848	641	658
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	---	405	2110	99	61
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	---	3590	13900	222	108
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	---	321	497	135	127
Magnesium	7439-95-4	1	mg/L	---	249	962	48	47
Sodium	7440-23-5	1	mg/L	---	1930	7410	153	114
Potassium	7440-09-7	1	mg/L	---	131	301	47	40
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	---	0.078	0.177	0.041	0.117
Iron	7439-89-6	0.05	mg/L	---	0.94	1.85	0.15	0.22
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	---	0.6	1.0	0.7	0.5
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	---	39.0	3.24	17.6	19.5
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	---	<0.01	<0.01	0.19	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	---	0.31	<0.01	4.01	0.05

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)	Client sample ID			MD 4A	MD 4B	MD 4C	MD 6A	MD 6B
Client sampling date / time			28-Aug-2020 10:45	28-Aug-2020 10:50	28-Aug-2020 11:00	28-Aug-2020 11:55	28-Aug-2020 11:59	
Compound	CAS Number	LOR	Unit	EW2003899-006	EW2003899-007	EW2003899-008	EW2003899-009	EW2003899-010
Result								
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	---	0.01	mg/L	---	0.31	<0.01	4.20	0.05
EN055: Ionic Balance								
ø Total Anions	---	0.01	meq/L	---	127	453	21.1	17.5
ø Total Cations	---	0.01	meq/L	---	124	434	18.5	16.2
ø Ionic Balance	---	0.01	%	---	1.31	2.14	6.52	3.79
EN67 PK: Field Tests								
Field Observations	---	0.01	--	DESTROYED	---	---	---	---
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	---	1	mg/L	---	69	52	48	52
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	---	1	mg/L	---	57	48	50	52
EP025FD: Field Dissolved Oxygen								
Dissolved Oxygen	---	0.01	mg/L	---	0.64	0.78	2.35	0.53
Dissolved Oxygen - % Saturation	---	0.1	% saturation	---	6.5	17.8	24.7	5.7
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)	---	0.05	mg/L	---	<0.05	<0.05	<0.05	<0.05
FWI-EN/001: Groundwater Sampling - Depth								
Depth	---	0.01	m	---	1.07	1.08	10.5	1.12

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)		Client sample ID		MD 6C	MD 9A	MD 9B	MD 9C	MD 10A
Compound	CAS Number	LOR	Unit	28-Aug-2020 12:06	28-Aug-2020 10:15	28-Aug-2020 10:30	28-Aug-2020 10:37	28-Aug-2020 09:50
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	---	0.1	pH Unit	7.2	7.2	7.0	7.1	7.1
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	29800	7390	3420	12000	37400
EA020FD: Field Salinity								
Salinity	---	0.2	g/L	21.0	5.1	2.2	7.9	30.2
EA116: Temperature								
Temperature	---	0.1	°C	19.2	15.1	17.0	18.8	14.8
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	406	310	1170	1040	440
Total Alkalinity as CaCO ₃	---	1	mg/L	406	310	1170	1040	440
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	1650	331	<1	202	1890
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	10300	2150	458	2730	11500
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	391	72	141	183	820
Magnesium	7439-95-4	1	mg/L	720	121	70	157	821
Sodium	7440-23-5	1	mg/L	5590	1160	271	1470	5640
Potassium	7440-09-7	1	mg/L	204	66	106	139	141
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	0.073	0.021	0.197	0.145	0.249
Iron	7439-89-6	0.05	mg/L	19.4	0.07	3.02	3.22	<0.10
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.5	0.1	0.7	0.6	0.7
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	30.0	7.68	59.9	79.3	0.14
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.10	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	0.26	0.10	<0.01	0.19	0.24

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 6C	MD 9A	MD 9B	MD 9C	MD 10A	
Client sampling date / time				28-Aug-2020 12:06	28-Aug-2020 10:15	28-Aug-2020 10:30	28-Aug-2020 10:37	28-Aug-2020 09:50		
Compound	CAS Number	LOR	Unit	EW2003899-011	EW2003899-012	EW2003899-013	EW2003899-014	EW2003899-015		
				Result		Result		Result		
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser										
Nitrite + Nitrate as N		---	0.01	mg/L	0.26	0.10	<0.01	0.19	0.24	
EN055: Ionic Balance										
ø Total Anions		---	0.01	meq/L	333	73.7	36.3	102	372	
ø Total Cations		---	0.01	meq/L	---	----	31.6	----	----	
ø Total Cations		---	0.01	meq/L	327	65.7	----	89.5	357	
ø Ionic Balance		---	0.01	%	----	----	6.96	----	----	
ø Ionic Balance		---	0.01	%	0.89	5.76	----	6.50	2.07	
EP002: Dissolved Organic Carbon (DOC)										
Dissolved Organic Carbon		---	1	mg/L	26	143	81	90	64	
EP005: Total Organic Carbon (TOC)										
Total Organic Carbon		---	1	mg/L	36	147	83	84	65	
EP025FD: Field Dissolved Oxygen										
Dissolved Oxygen		---	0.01	mg/L	1.13	0.79	0.35	1.46	2.61	
Dissolved Oxygen - % Saturation		---	0.1	% saturation	12.1	7.7	3.6	15.4	25.3	
EP035G: Total Phenol by Discrete Analyser										
Phenols (Total)		---	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	
FWI-EN/001: Groundwater Sampling - Depth										
Depth		---	0.01	m	1.32	0.32	0.66	0.68	0.51	

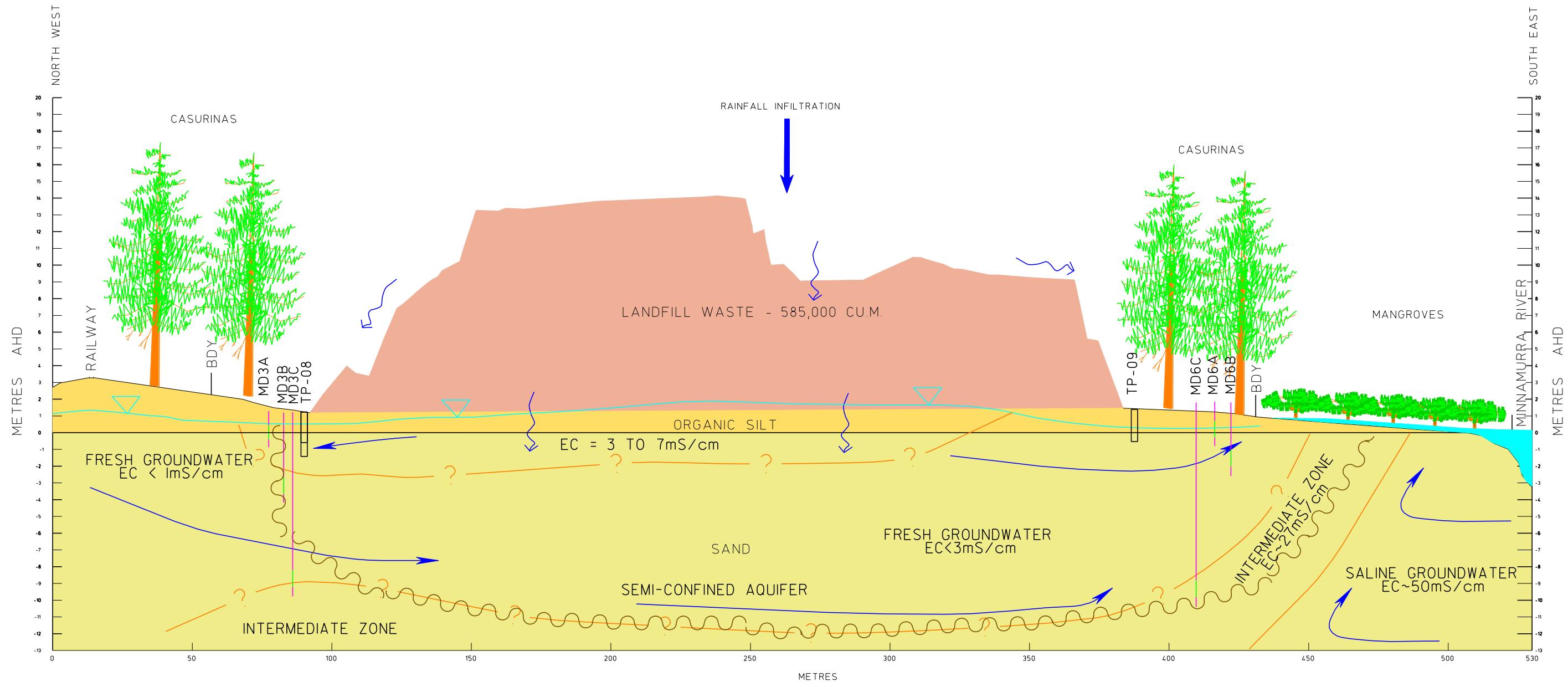
Analytical Results

Client sample ID				MD 10B	Rocklow Down	Rocklow Middle	Rocklow Up	BLANK
Compound	CAS Number	LOR	Unit	28-Aug-2020 10:00	28-Aug-2020 08:40	28-Aug-2020 09:30	28-Aug-2020 09:10	28-Aug-2020 08:30
				Result	Result	Result	Result	Result
EA005FD: Field pH								
pH	---	0.1	pH Unit	7.0	7.2	7.3	7.4	---
EA010FD: Field Conductivity								
Electrical Conductivity (Non Compensated)	---	1	µS/cm	1860	6240	6310	2250	---
EA020FD: Field Salinity								
Salinity	---	0.2	g/L	1.1	4.6	4.6	1.6	---
EA116: Temperature								
Temperature	---	0.1	°C	18.9	12.6	12.4	12.0	---
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO ₃	DMO-210-001	1	mg/L	<1	<1	<1	<1	---
Carbonate Alkalinity as CaCO ₃	3812-32-6	1	mg/L	<1	<1	<1	<1	---
Bicarbonate Alkalinity as CaCO ₃	71-52-3	1	mg/L	662	118	123	97	---
Total Alkalinity as CaCO ₃	---	1	mg/L	662	118	123	97	---
ED041G: Sulfate (Turbidimetric) as SO₄ 2- by DA								
Sulfate as SO ₄ - Turbidimetric	14808-79-8	1	mg/L	<10	306	314	111	---
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	195	1540	1520	565	---
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	80	---	---	---	---
Magnesium	7439-95-4	1	mg/L	34	---	---	---	---
Sodium	7440-23-5	1	mg/L	98	---	---	---	---
Potassium	7440-09-7	1	mg/L	67	---	---	---	---
ED093T: Total Major Cations								
Calcium	7440-70-2	1	mg/L	---	77	78	34	---
Magnesium	7439-95-4	1	mg/L	---	120	120	42	---
Sodium	7440-23-5	1	mg/L	---	950	956	327	---
Potassium	7440-09-7	1	mg/L	---	35	35	12	---
EG020F: Dissolved Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	0.295	---	---	---	<0.001
Iron	7439-89-6	0.05	mg/L	0.71	---	---	---	<0.05
EG020T: Total Metals by ICP-MS								
Manganese	7439-96-5	0.001	mg/L	---	0.048	0.058	0.049	---
Iron	7439-89-6	0.05	mg/L	---	0.61	0.68	1.26	---

Analytical Results

Client sample ID				MD 10B	Rocklow Down	Rocklow Middle	Rocklow Up	BLANK
Compound	CAS Number	LOR	Unit	EW2003899-016	EW2003899-017	EW2003899-018	EW2003899-019	EW2003899-020
				Result	Result	Result	Result	Result
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	0.9	0.3	0.4	0.2	---
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	52.5	0.31	0.21	0.04	---
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.02	0.01	<0.01	---
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	0.22	0.24	0.02	---
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	---	0.01	mg/L	<0.01	0.24	0.25	0.02	---
EN055: Ionic Balance								
ø Total Anions	---	0.01	meq/L	18.7	---	---	---	---
ø Total Cations	---	0.01	meq/L	16.6	---	---	---	---
ø Ionic Balance	---	0.01	%	6.10	---	---	---	---
EP002: Dissolved Organic Carbon (DOC)								
Dissolved Organic Carbon	---	1	mg/L	52	11	5	7	<1
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	---	1	mg/L	54	7	6	7	----
EP025FD: Field Dissolved Oxygen								
Dissolved Oxygen	---	0.01	mg/L	0.62	8.63	8.96	10.5	----
Dissolved Oxygen - % Saturation	---	0.1	% saturation	6.5	80.6	83.1	97.4	----
EP035G: Total Phenol by Discrete Analyser								
Phenols (Total)	---	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	----
FWI-EN/001: Groundwater Sampling - Depth								
Depth	---	0.01	m	0.71	---	---	---	----

Appendix B



Appendix C

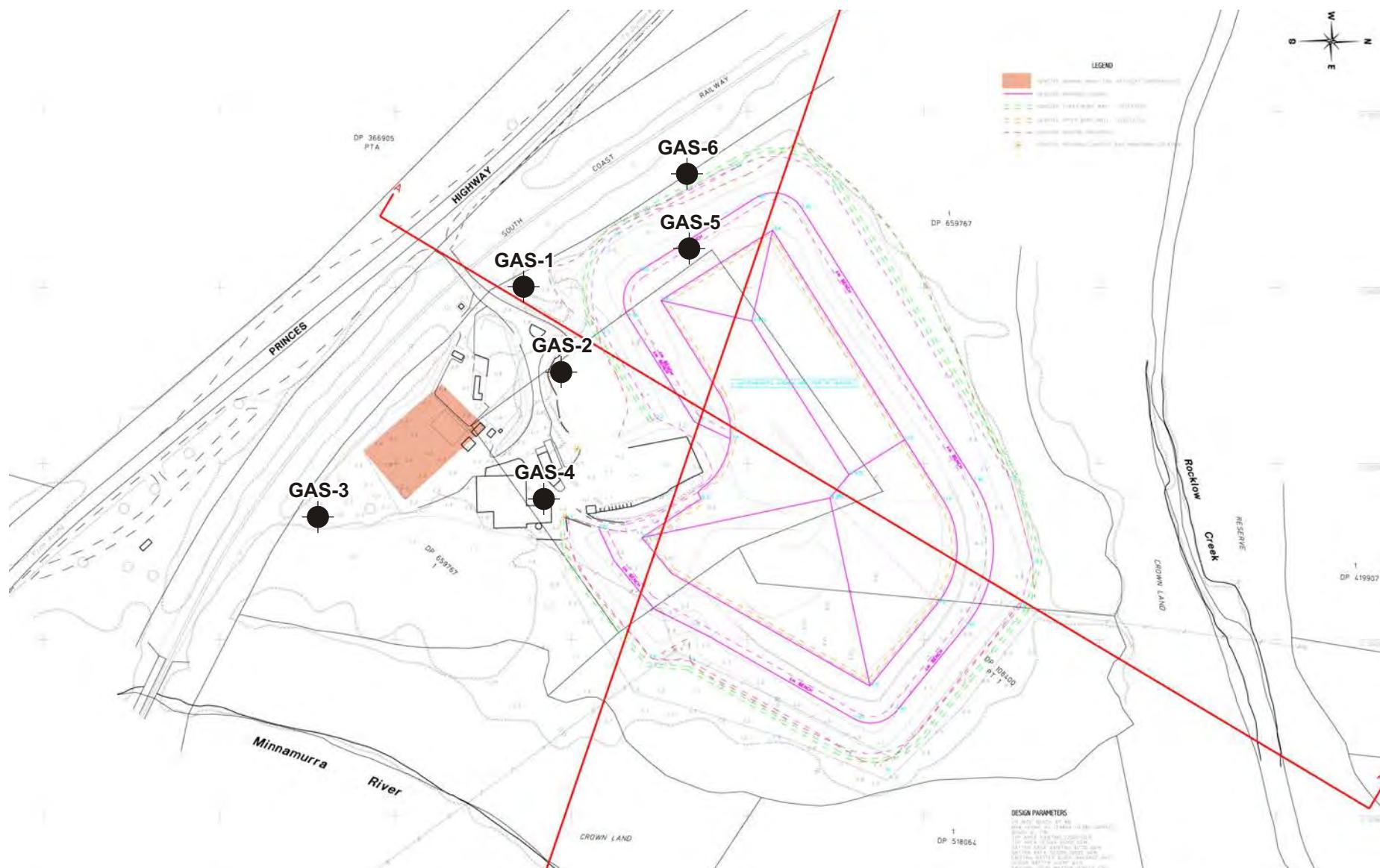
LANDFILL GAS MONITORING- Minnamurra Landfill

GAS 1	Site Entrance
GAS 2	40m South of Landfill (Removed CRC)
GAS 3	Carpark South of Landfill
GAS 4	Next to Secondhand Shop
TRENCH 1	West Bank
TRENCH 2	North Bank West Side
TRENCH 3	North Bank Middle
TRENCH 4	South Bank Side
TRENCH 5	East Bank Side
TRENCH 6	North Bank East Side
TRENCH 7	Lower Level South Side

2020 - Monitoring by Greg Hardy @
Kiama Council

LEL % from inside trench pipe cap.
This is normally not needed, but
wanted to keep a record.

WELL ID	DATE	TIME	LEL PPM				COMMENTS	
			MAX		STABLE			
			LEL%	PPM	LEL%	PPM		
Trench 4	4-Feb-20	1030		1,100		430	Good Readings	
Trench 1	4-Feb-20	1035	100	720		300	*****	
Trench 2	4-Feb-20	1040		490		200	*****	
Trench 3	4-Feb-20	1045	100	1,100		260	*****	
Trench 6	4-Feb-20	1050		700		210	*****	
Trench 5	4-Feb-20	1055	100	1,200		155	*****	
Trench 7	4-Feb-20	1100	95	1,050		210	*****	
Gas 1	4-Feb-20	1105		300		110	*****	
Gas 3	4-Feb-20	1110		310		110	*****	
Gas 4	4-Feb-20	1120		330		120	*****	
Weighbridge	4-Feb-20	1130		0		0	All Building with clear readings	
Cleaning Shed	4-Feb-20	1135		0		0	*****	
MRF	4-Feb-20	1140		0		0	*****	
Lunchroom	4-Feb-20	1145		0		0	*****	
Ute Shed	4-Feb-20	1150		0		0	*****	
Trench 4	16-May-20	850		1,050		350	Good Readings Damp Conditions	
Trench 1	16-May-20	855	100	700		270	*****	
Trench 2	16-May-20	900		480		190	*****	
Trench 3	16-May-20	905	90	1,000		200	*****	
Trench 6	16-May-20	910		670		200	*****	
Trench 5	16-May-20	915	100	980		220	*****	
Trench 7	16-May-20	920	100	880		190	*****	
Gas 1	16-May-20	925		290		100	*****	
Gas 3	16-May-20	930		330		140	*****	
Gas 4	16-May-20	935		290		100	*****	
Weighbridge	16-May-20	940		0		0	All Building with clear readings	
Cleaning Shed	16-May-20	945		0		0	*****	
MRF	16-May-20	950		0		0	*****	
CRC Lunchroom	16-May-20	955		0		0	*****	
Ute Shed	16-May-20	1000		0		0	*****	
Trench 4	15-Sep-20	1250		1,200		440	Good Readings Clear day	
Trench 1	15-Sep-20	1255	95	790		290	*****	
Trench 2	15-Sep-20	100		580		200	*****	
Trench 3	15-Sep-20	105	95	1,350		390	*****	
Trench 6	15-Sep-20	110		890		220	*****	
Trench 5	15-Sep-20	115	100	1,210		450	*****	
Trench 7	15-Sep-20	120	95	1,290		420	*****	
Gas 1	15-Sep-20	125		320		140	*****	
Gas 3	15-Sep-20	130		410		130	*****	
Gas 4	15-Sep-20	135		390		120	*****	
Weighbridge	15-Sep-20	150		0		0	All Building with clear readings	
Cleaning Shed	15-Sep-20	155		0		0	*****	
MRF	15-Sep-20	200		0		0	*****	
Lunchroom	15-Sep-20	205		0		0	*****	
Ute Shed	15-Sep-20	210		0		0	*****	
CALIBRATED WITH SPAN GAS:								



Source: Neil Charters Pty Ltd

Date: 7 August 2006

Reference: E2W_047_10.cdr

GAS WELL MONITORING LOCATIONS

KIAMA MUNICIPAL COUNCIL - MINNAMURRA LANDFILL

Figure 1