



Kiama Municipal Council

# Minnamurra Waste Disposal Depot Annual Groundwater & Surface Water Monitoring Report – 2013 to 2014

Report E2W-059 (R001-v1)

18 November 2014



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Minnamurra Waste Disposal Depot  
(EPL 2013 to 2014)

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## **TABLE OF CONTENTS**

<b>1. INTRODUCTION.....</b>	<b>4</b>
1.1 Background.....	4
1.2 Objectives .....	4
<b>2. SCOPE OF WORK.....</b>	<b>4</b>
<b>3. ENVIRONMENTAL SETTING .....</b>	<b>5</b>
3.1 Climate.....	6
3.2 Topography .....	6
3.3 Geology.....	7
3.4 Hydrogeology and Groundwater Flow Regime.....	7
3.5 Hydrology .....	8
<b>4. LICENCE CRITERIA AND RELEVANT GUIDELINES .....</b>	<b>9</b>
4.1 EPL Requirements .....	9
4.2 Previous Monitoring Results.....	10
<b>5. ENVIRONMENTAL MONITORING.....</b>	<b>11</b>
5.1 Landfill Gas Monitoring .....	11
5.2 Surface and Groundwater Monitoring Locations .....	12
<b>6. MONITORING RESULTS.....</b>	<b>14</b>
6.1 Groundwater Data.....	14
6.1.1 Groundwater Depth.....	15
6.1.2 Field Parameters.....	15
6.1.3 Nutrients (groundwater).....	16
6.1.4 Ammonia Trends .....	17
6.1.5 Hydrogeochemical Indicators .....	19
6.1.6 Inorganic Contaminants (Iron, Manganese and Fluoride) .....	19
6.1.7 Organic Contaminants (DOC, TOC and Phenols- Groundwater) .....	20
6.2 Surface Water.....	20
6.2.1 Physical Parameters .....	21
6.2.2 Nutrients (surface water).....	21
6.2.3 Organic Contaminants (DOC and Phenols).....	22
<b>7. CHEMICALS OF CONCERN AND CONTAMINANT PLUMES.....</b>	<b>22</b>
7.1 Ecological Issues.....	23
<b>8. CONCLUSIONS .....</b>	<b>24</b>
8.1 Recommendations.....	26
<b>9. LIMITATIONS .....</b>	<b>28</b>
<b>10. REFERENCES.....</b>	<b>28</b>

## **TABLES**

Table 5.3: Groundwater and Surface Water Monitoring (2013/14)  
Table GW-1: Summary Analytical Report - Groundwater (2013/14)  
Table SW-1: Summary Analytical Report – Surface Water (2013/14)  
Table SW-2: Rocklow Creek - Historical Ammonia Concentrations (mg/L, 1999 to 2014)

## **GRAPHS**

Graph-1: Groundwater Ammonia Concentrations (mg/L) All Wells (1999 to 2014)  
Graph-2: Deep Groundwater Ammonia Trends (1999 to 2014)  
Graph-3: Shallow Groundwater Ammonia Trends (1999 to 2014)  
Graph-4: Net Increments of Ammonia Between Up & Mid Stream Samples (1999 to 2014)

## **FIGURES**

Figure 1: Site Location  
Figure 2: Monitoring Well Locations & Ammonia Concentrations (2013-2014)

## **APPENDICES**

Appendix A: ALS Environmental Pty Ltd Laboratory Certificates  
Appendix B: Figure 7 from E2W Landfill Closure Plan  
Appendix C: Landfill Gas Monitoring (KMC, Sept 2013, January & June 2014) & Figure 1

## 1. INTRODUCTION

Earth2Water Pty Ltd (E2W) was engaged by Kiama Municipal Council (KMC) to provide the 2013 to 2014 annual surface and groundwater monitoring report 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 (formerly Ecowise) and previous monitoring reports by E2W (2004 - 2013), Eco-engineers Pty Ltd and Forbes Rigby Pty Ltd (pre 2004).

This monitoring report for the MWDD is based on quarterly monitoring results (26 November 2013, 6 February 2014, 6 May 2014, 18 August 2014) 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 (i.e. food waste trial), together with small loads of recyclable materials. All general waste materials are diverted to the waste facility at Shellharbour (Dunmore Waste Disposal Depot).

### 1.2 Objectives

The objective of surface and groundwater monitoring in the 2013 to 2014 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 DECCW with a summary of the monitoring results obtained in the 2013-2014 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 (Ecowise) during 2013 and 2014. The annual reporting period covers four quarterly monitoring events in November 2013, February 2014, May 2014 and August 2014 (Figures 1 & 2).

Each monitoring event comprised the following:

- Sampling of onsite and offsite groundwater wells MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD9C, MD10A, and MD10B<sup>1</sup>.
- Sampling of surface water at three locations along Rocklow Creek (Rocklow-Up, Rocklow-Middle and Rocklow-Down<sup>2</sup>).

Landfill gas monitoring was conducted by KMC (G.Hardy) at gas monitoring wells, biofilter pads and inside buildings. Monitoring was conducted using a calibrated landfill gas meter (GT402).

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 2013 to August 2014) 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.

### 3. ENVIRONMENTAL SETTING

The Minnamurra Waste Disposal and Recycling Depot (MWDD) is located 1 km north of the Minnamurra township (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 (Figure 1).

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<sup>1</sup> MD1B no access, shallow wells MD2A, MD4A, MD6A, MD9A, MD10A dry/insufficient water for sampling during reporting period.

<sup>2</sup> No sample from Rocklow-down due to access restrictions



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 receipt & 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 2013 to July 2014 was **873.0 mm<sup>3</sup>**, which is lower than the previous monitoring periods (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). The higher rainfall in the previous three years is interpreted to influence the ammonia levels at the site.

### 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).

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).

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<sup>3</sup> Note: data from Kiama (Bombo Headland) (Station ID 068242), ~4.5 km SSE of MWDD.

### 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 very 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 (~0.02), and potentially reverses at high tide.

Groundwater discharge at Rocklow Creek and Minnamurra River is influenced by the presence of a fresh groundwater/salt water 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, microbiological processes, surface and groundwater interaction and salinity variations. The groundwater/salt water 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 salt water 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 years after landfill remediation due to the age (1960s) of the waste mound. Improvements in groundwater quality is expected over the short to medium term (up to ~10 years) reflecting the rate of 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 km<sup>2</sup>. 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 km<sup>2</sup> 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 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 marine environment.

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 is to be re-established once access is made available by Council).

#### **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*.

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 considered to be for the protection of aquatic marine and fresh water 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). Exceedances of the ANZECC (2000) trigger values for marine water ecosystems have been highlighted on the tables.

##### **4.1 EPL Requirements**

The Environmental Protection Licence (EPL No. 5958) details 17 monitoring points for the MWDD (two for landfill gas and fifteen for groundwater monitoring). 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 and trenches, however annually for inside buildings.

The frequency of testing of the groundwater monitoring points (MD1B<sup>4</sup>, MD2A, MD2B, MD2C, MD4A, MD4B, MD4C, MD6A, MD6B, MD6C, MD9A, MD9B, MD9C, MD10A, MD10B) is also half yearly (EPL requirement). However, KMC conducts the groundwater monitoring on a quarterly basis (November 2013, February 2014, May 2014 and August 2014 of each reporting period) to establish water quality trends post landfill rehabilitation works.

Some of the groundwater monitoring locations (i.e. MD2A, MD4A, MD6A, MD9A and MD10A) have not been sampled in the monitoring program (i.e. shallow wells have been dry or not 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: Half yearly groundwater analytical suite (as per the EPL)**

Alkalinity (as CaCO <sub>3</sub> )	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 not a requirement of the EPL, however is 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). No access is possible 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 is impeded due to the thick vegetation).

## 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).

<sup>4</sup> No access available to MD-1B

## 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, and 2012-2013). Quarterly sampling in the 2013 to 2014 reporting period was undertaken on the following dates:

- 26 November 2013,
- 6 February 2014,
- 6 May 2014; and
- 18 August 2014.

The procedure for sample collection, storage and handling employed by KMC and Ecowise/ALS are generally in accordance with NEPM (1999) 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 (areas where intermediate or final cover has been placed and inside all buildings within 250 m of the deposited waste) were tested by KMC (September 2013, January 2014, June 2014) during the 2013/14 reporting period (Appendix C).

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).

Monitoring data (2013/2014) from the trenches (biofilter pads, Trench 1 to Trench 7) and gas monitoring wells (Gas 1 to Gas 3, Gas 4) showed similar concentrations to previous years (2010/2011/2012/2013). Methane gas readings were consistent at each sampling event through the monitoring period. The maximum methane (stable) gas reading was 800 ppm at Trench 7 (June 2014). The lowest was 100 ppm at Gas 3 and Gas 4 in June 2014 and at Gas 2 in September 2013. The highest readings at each sampling event were recorded at either Trench 4 or Trench 1. Buildings were sampled for landfill gas in June 2014, 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, no change to the landfill and nature of onsite buildings (well vented or air conditioned office).

## 5.2 Surface and Groundwater Monitoring Locations

Groundwater monitoring was undertaken from up to 9 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 no access was possible to Rocklow-down during 2013-14). Monitoring locations are shown on Figure 2.

The wells and surface water locations sampled in the 2013 and 2014 reporting period are outlined below:

- 26 November 2013. Groundwater wells: MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD9C, MD10B, Surface water: Rocklow-Up, Rocklow-Middle;
- 6 February 2014. Groundwater wells: MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD9C, MD10B, Surface water: Rocklow-Up, Rocklow-Middle;
- 6 May 2014. Groundwater wells: MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD9C, MD10B, Surface water: Rocklow-Up, Rocklow-Middle;
- 18 August 2014. Groundwater wells: MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD9C, MD10B, Surface water: Rocklow-Up, Rocklow-Middle

Wells that were “not” tested in the 2013 and 2014 reporting period, but are part of the EPL include:

- MD1B. No access in all 4 rounds (November 2013, February 2014, May 2014, and August 2014)
- MD2A, MD4A, MD6A, MD9A, MD10A. Dry shallow wells in all 4 rounds (November 2013, February 2014, May 2014, and August 2014)

It is noted that most shallow wells have been dry at time of sampling. One well has been damaged and requires attention (i.e. MD4A).

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 Quality 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 (MD4A/B/C, MD6A/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 2013 to 2014 Reporting Period**

Sample ID	Screen Interval (m AHD) - or Sample Location	Nov 2013	Feb 2014	May 2014	Aug 2014
(MD1A)	0.5 to -0.5				
MD1B	-4.7 to -5.7	No Access	No Access	No Access	No Access
MD2A	0.525 to -0.475	Dry	Dry	Dry	Dry
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	#	#	#	#
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	Dry	Dry	Dry	Dry



Sample ID	Screen Interval (m AHD) - or Sample Location	Nov 2013	Feb 2014	May 2014	Aug 2014
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	Dry	Dry	Dry	Dry
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	No access (no sample)	No access (no sample)	No access (no sample)	No access (no sample)

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 (above) and Table 5.3 (rear of report). 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 2013/14 reporting period are presented in Tables GW-1, and SW-1, SW-2, and SW-3. The ALS field records and laboratory reports are presented in Appendix A.

A summary of all groundwater monitoring data (1999 to 2014) for ammonia (mg/L) is presented in Graph-1, Graph-2 and Graph-3. The graphs highlight ammonia groundwater quality trends over the past ~ 14 years (January 1999 to August 2014). Ammonia is considered to be a 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 waters in and around landfills, 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 2013/14 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, m AHD) is presented in Table GW-1. The inferred 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 from the 2013/14 reporting period are similar to previous years and reflect changes in rainfall and tide levels.

The reduced groundwater levels (m AHD) from the nine wells sampled in 2013/14<sup>5</sup> indicate a relatively low water table elevation (<1.53 m AHD), which is characteristic of the swamp/estuarine environment. The annual rainfall from August 2013 to July 2014 was 873 mm (Bombo Headland), which was lower than the previous monitoring period (1201.8 mm, August 2012 to July 2013)<sup>6</sup>.

Recharge to the aquifer system beneath and surrounding the waste disposal facility mainly occurs from rainfall infiltration and storm water runoff around the footprint. Some minor recharge may be occurring through the landfill mound (<5% of annual rainfall). It is likely infiltration of rainfall is moderate-high around the footprint area (uncapped areas, silty/sandy soils) due to the low elevation and accumulated run-off from the batter slopes and spillways.

### 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 9 wells (MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD9C, MD10B) ranged from pH 6.8 to 7.8 in the 2013-14 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.

<sup>5</sup> Note: MD2A, MD7 and MD10B have no RL measurement.

<sup>6</sup> Note: data from Kiama (Bombo Headland) (Station ID 068242), ~4.5 km SSE of MWDD.

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 ranged from approximately 1.64 to 42.80 mS/cm in the 2013/14 reporting period (MD6B in August 2014 and MD2C in February 2014, respectively). 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/salt water interface and presence of mangroves/sedges (tidal area).

#### **6.1.2.3 Dissolved Oxygen (DO)**

The 9 wells recorded field dissolved oxygen (DO) concentrations ranging between 1.31 to 5.00 mg/L in the 2013/14 reporting period (MD10B in November 2013 and MD4C in August 2014, respectively). The concentrations of dissolved oxygen were 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. 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 2013/14 reporting period (note: Total nitrogen is not an EPL requirement).

All nine wells reported one or more samples with nitrate concentrations above the ANZECC (2000) trigger value for fresh water ecosystems (0.7 mg/L, at 95% protection level). In 2013/2014 concentrations ranged from <0.01 (non-detected/below LOR) to 8.13 mg/L (MD-4B). Nitrate has been detected in more wells in the 2013/2014 monitoring round (nine wells above ANZECC 2000) in comparison to the 2012/2013 monitoring round (eight wells above ANZECC 2000) and the 2011/2012 monitoring round (five wells above ANZECC 2000). The “average” nitrate concentrations for 2013/14 were lowest at MD9B (0.38 mg/L) whilst highest at MD2B

(3.20 mg/L) and MD4B (2.18 mg/L). During 2012/13, wells MD9C (0.01 mg/L) and MD4B (6.68 mg/L) were reported as the lowest and highest average (nitrate) 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). Five of the wells (MD6B, MD6C, MD9B, MD9C, MD10B) 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 all 4 rounds of sampling.

Groundwater from the wells MD4B, MD4C, MD6B, MD6C, MD9B, MD9C and MD10B, located on the north and eastern landfill perimeters (plume centreline path) reported the highest concentrations of ammonia (all  $\geq 20$  mg/L, Figure 2). Well (MD9C) reported the maximum ammonia of 120 mg/L (May 2014), which is comparable to the maximum at MD9C in 2012/13 reporting period (122 mg/L) and the maximum reported in 2010/2011 (118 mg/L). Ammonia trends over time are presented in Graphs 1 to 3. Highest ammonia correlates with the main downgradient area (plume centreline) of the waste mound and above average rainfall conditions (2011).

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. Well locations MD2B, MD2C and MD9B have decreased in maximum ammonia concentrations in 2012/13 in comparison to the previous 2011/12 period.

#### 6.1.4 Ammonia Trends

The groundwater ammonia trends from 1999 to 2014 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 2014)**

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	Overall Decreasing, but variable
MD2B	Overall Decreasing, but variable	MD4C	Overall Decreasing
MD2C	Overall Decreasing, but variable	MD9B	Overall Decreasing, but variable
MD6B	Overall Decreasing, but variable	MD9C	Rising trend & peaks in late 2011, late 2012 and again in mid 2014
MD6C	Overall Decreasing, but variable	MD10B	Irregularly Decreasing

*Note: “B” and “C” denote shallow and deep wells, respectively.*

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

Monitoring reports (eg. E2W, 2008-09, 2009-10, 2010-11, 2011-12, 2012-13) have identified spikes in ammonia concentrations that are interpreted to result from high rainfall in preceding months. 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)<sup>7</sup>. 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)<sup>7</sup>. Rainfall of 289 mm in February and 213.2mm in March (502.2mm combined in 2 months) was followed by rises in ammonia (May 2012, Graph 1-3)<sup>7</sup>. 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.

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

During 2013/14 ammonia generally continues to decrease (variably) in wells compared with previous monitoring periods, but with continued variability (Graph-1 to Graph-3) likely due to rainfall spikes. During the 2013/14 reporting period, 6 wells (MD2B, MD2C, MD4B, MD6C, MD9C and MD10B) showed a temporary rise in ammonia concentrations in May 2014. Five of these wells (all except MD10B) are preceded and followed by, a declining trend in the next sampling round (August 2014).

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 generated would decline following the closure of the landfill and completion of rehabilitation works. The groundwater quality is likely to take years (5+) to show improvements due to the scale of the mound, flat hydraulic gradients (in estuary) and tidal movements (some reversal of gradient a high tide) around the landfill footprint.

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<sup>7</sup> Rainfall data taken from the Kiama (Bombo Headland) Weather Station, (Station ID 068242)

Results from the 2013/14 monitoring period are similar to the 2012/13 monitoring period, and show variable, but generally decreasing ammonia trend and leachate impact. Future monitoring is required to assess ammonia trends and characteristics (declines, variations etc), especially at the MD9B/C well locations (centreline/core of plume).

#### **6.1.4.1 Total Phosphorus (TP, groundwater)**

The total phosphorus (TP) is not an EPL requirement, and was not sampled during the 2013/14 monitoring period (may cause algae in surface water environment). In the 2007/08 monitoring period the majority of TP results from twelve wells exceeded the ANZECC (2000) trigger values for the protection of marine ecosystems.

#### **6.1.5 Hydrogeochemical 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 concentrations.

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 typically associated with marine environments (e.g. salt spray, tidal influence).

#### **6.1.6 Inorganic Contaminants (Iron, Manganese and Fluoride)**

Total iron (filtered at the laboratory) ranges from the LOR (<0.05 mg/L) at MD6C (November 2013) to 19.5 mg/L (MD6C, May 2014). With the exception of MD6B all the groundwater wells reported ANZECC (2000) exceedances (freshwater ecosystems, 0.3 mg/L) in at least one in 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 <0.01 mg/L (at MD2C in February 2014 and August 2014, and MD4C in August 2014) to 0.584 mg/L (at MD9C in February 2014). The ANZECC (2000) guideline for manganese in fresh water is 1.9 mg/L. All results were reported below the ANZECC fresh water guidelines.

The levels of filterable iron and manganese are similar to those reported in previous reporting periods.



Concentrations of fluoride ranged from 0.2 mg/L (MD6C in February 2014) to 0.9 (MD4C in May 2014). 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 levels reported in 2011/12. The results indicate that fluoride levels are generally associated with landfill leachate.

### **6.1.7 Organic Contaminants (DOC, TOC and Phenols- Groundwater)**

Concentrations of dissolved organic carbon (DOC) ranged from 7 to 99 mg/L in the 2013/14 reporting period (MD6C, May 2014 and MD6C, February 2014, respectively). Concentrations of total organic carbon (TOC) ranged from 10 mg/L (MD6C, May 2014 and November 2014) to 122 mg/L (MD9C, August 2014) in the 2013/14 reporting period. ANZECC (2000) guidelines do not exist for DOC or TOC. The DOC/TOC may relate to landfill leachate and/or naturally occurring organic matter/content associated with lowland/estuary.

Concentrations of phenols were below LOR (0.05 mg/L) and were below marine water trigger values (ANZECC 2000, 0.4 mg/L) at all wells in all monitoring rounds (November 2013, February 2014, May 2014 and August 2014). Future groundwater monitoring will determine if phenol concentrations warrant further assessment (i.e. not required based on current data).

## **6.2 Surface Water**

Surface water sampling was undertaken quarterly during the 2013/14 reporting period (EPL requirement is only six-monthly sampling). Samples were collected from two locations along the estuarine reach of Rocklow Creek (Figure 2). Sample locations Rocklow-Up (upstream at the tidal limit and landfill), and Rocklow-Middle (midstream<sup>8</sup>). No samples were collected from Rocklow-Down (downstream) due to limited access.

The surface water locations are considered limited to assess water quality impacts from the MWDD (i.e. An additional mid-stream sample location is presented in Figure 2). It is noted that impacts to Rocklow Creek water quality may be occurring from Shellharbour Waste Disposal Depot, which is situated on the northern side of Rocklow Creek and from runoff from agricultural and residential land in the catchment.

The three surface water locations are not sampled according to tidal levels (i.e. Rocklow Creek has marine water influences which is a mixture of groundwater discharge and tidal water), therefore nutrients concentrations are likely to vary due to tidal water influence.

The surface water monitoring data is variable and possibly reflecting a combination of tide sampling regimes and influence from the broader catchment area. 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.

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<sup>8</sup> The Rocklow-Middle sample was recommended as part of the landfill closure and to assess if a perimeter bund wall was required to reduce discharges to Rocklow creek. Rocklow-Down was inaccessible and not sampled during the 2013-14 reporting period.

## **6.2.1 Physical Parameters**

### **6.2.1.1 pH**

The pH in Rocklow Creek at the middle and upstream location is generally neutral (6.9 to 7.7) in 2013/14, and has not changed significantly from the 2012/13 reporting period (downstream sample were not collected due to access constraints).

### **6.2.1.2 TDS (and 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 brackish to saline (Rocklow-Middle 6.98 to 37.2 mS/cm, and Rocklow-Up 1.81 to 32.9 mS/cm). EC values are marginally higher than results from the previous 2012/13 monitoring period, however this may be due to the time sampling was taken (tidal range). Sampling at low tide would result in decreased salinity due to an increased baseflow (fresh groundwater) contribution.

## **6.2.2 Nutrients (surface water)**

### **6.2.2.1 Nitrogen**

Rocklow Creek surface water samples collected in the 2013/14 reporting period reported ammonia below the ANZECC (2000) guidelines for marine and fresh water ecosystems (2.84 and 1.88 mg/L, respectively, Tables SW-1 and SW-2). Concentrations of nitrate were all at or below 0.40 mg/L (ANZECC (2000), lower than the trigger value for fresh water ecosystems (0.7 mg/L, at 95% protection level).

Water samples collected from Rocklow Creek during 2013/14 reporting period generally show an increase (of up to 1.44 mg/L) in ammonia in the midstream sample compared to the upstream sample, with the exception of the May 2014 sample (which showed a decrease of 0.10 mg/L). The ammonia increments between the upper and mid stream samples are presented in Table SW-2 and Graph-4 (note: mid-stream location is downgradient to MD-9C and MD-10B which have elevated and irregular ammonia trends).

Ammonia concentrations in Rocklow Creek (2013/14) are generally comparable with 2012/13 and 2011/12 concentrations (Table SW-2).

Increases in ammonia from upstream to downstream of the landfill have been observed over 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 catchment (Shellharbour Landfill, agricultural areas) and nutrients bound in sediments cannot be discounted.

Graph-4 shows the ammonia increments in all monitoring periods since 1999 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-Down show a declining trend (until 2010).

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).

#### **6.2.2.2 Total Phosphorous (surface water)**

Total phosphorus (TP) is not an EPL requirement and were not analysed during the 2013/14 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 (DOC and Phenols)**

Concentrations of dissolved organic carbon (DOC) ranged from 6 to 14 mg/L in the 2013/14 reporting period (Rocklow-Middle in May 2014 and Rocklow-Middle in November 2013, respectively). No recommended ANZECC (2000) guidelines exist for DOC (concentrations could be related to natural waters or leachate).

Concentrations of phenols were below LOR (0.05 mg/L) in all other surface water samples in all monitoring rounds (November 2013, February 2014, May 2014 and August 2014).

The source and nature (possible sample bottles, gloves used for sampling, laboratory contamination) of phenols is not well known (concentrations are below guidelines).

### **7. CHEMICALS OF CONCERN AND CONTAMINANT PLUMES**

The results of 2013/14 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), as this is considered to be the dominant beneficial (environmental) use of local groundwater.

The primary landfill leachate indicator at the site is ammonia. Ammonia represents the analyte which exceeds ANZECC (2000) guidelines in the 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 dissolution of ions from various types of waste material.

Results of the sampling (1999 to 2014) confirm that ammonia concentrations are elevated above background levels. Improvement in groundwater quality (i.e. a decreasing ammonia trend) is evident in six wells (MD2B, MD2C, MD4B, MD4C, MD6B, MD6C) since landfill rehabilitation works commenced (2006). 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 and March-April 2014).

It is likely the leachate plume arising from the landfill mound would migrate radially (local system) with (regional) flow mainly directed towards the north-east and east (MD9 centreline). It is likely that landfill leachate infiltrates the underlying sandy aquifer and consequently migrates under the predominant groundwater flow regime 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 and de-nitrification 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 will 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/salt water 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 and groundwater gradients are steeper. The net increment of ammonia in the midstream sample (Rocklow-Middle) averaged 0.360 mg/L in the 2013/14 reporting period (Table SW-2). This net increment is higher than 2012/13 (0.315 mg/L averaged net increment) but lower than the previous average net increments (0.91 mg/L in 2011/12, 1.57 mg/L in 2010/2011). This increment is dependant on tides during sampling.

The ammonia in groundwater (MD-9C and MD-10B) during 2013/14 may be contributing to the nutrient concentrations detected in the surface water (Rocklow-Middle), however this is not confirmed due to the other potential sources (Dunmore landfill) and no downstream sample (Rocklow-down). Downstream ammonia concentrations have declined 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.

Ammonia and nitrate concentrations in all surface water samples collected in the 2013/14 reporting period were below ANZECC (2000) trigger values for fresh and marine water ecosystems.

## 8. CONCLUSIONS

Surface and groundwater monitoring was undertaken at the Minnamurra Waste Disposal Facility by ALS on a quarterly basis<sup>9</sup> from November 2013 to August 2014 (EPL reporting period). Monitoring data collected during the 2013/2014 period was assessed by E2W 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, in particular ammonia, continue to be detected in groundwater at the site. Ammonia levels reported by the laboratory exceed the ANZECC (2000) guidelines for the protection of fresh and marine water ecosystems at all monitoring wells sampled.
- The impacted wells are located on the footprint (downgradient) of the landfill mound, indicating contaminant migration towards Rocklow Creek and Minnamurra River (north-east and east).
- Elevated ammonia concentrations (above ANZECC 2000) were reported at several wells including; MD2B (13.8 mg/L), MD4B (46.4 mg/L), MD4C (33.6 mg/L), MD6B (30.0 mg/L), MD6C (48.3 mg/L), MD9B (26.0 mg/L), MD10B (87.2 mg/L) and the maximum at MD9C (120.0 mg/L). Elevated ammonia in the groundwater is located on the north and eastern landfill perimeters coinciding with the predominant groundwater flow direction.
- Nitrate concentrations during the 2013/14 reporting period ranged from not detected to 8.13 mg/L (MD4B). All nine wells reported one or more samples with nitrate concentrations above the ANZECC (2000) trigger value for fresh water ecosystems (0.7 mg/L, at 95% protection level). Nitrate concentrations are comparable with those previously reported in 2012/13 (MD4B = 6.68 mg/L) and those reported in 2011/12 (MD9C = 8.17 mg/L).
- Ammonia concentrations in the 2013/14 monitoring period continue to be elevated and variable, however show a clear overall decreasing trend. Variations in ammonia are inferred to reflect seasonal trends (high rainfall resulting in increased concentrations) and decreased leachate generation due to the landfill rehabilitation works.
- During the 2013/14 monitoring period Rocklow-Down (downstream) was not sampled (no access due to heavy mangrove growth), however was substituted by Rocklow-Middle (midstream). Low concentrations of ammonia and nitrate (i.e. below ANZECC 2000 trigger values) were reported from the upstream and mid stream locations on Rocklow Creek during the 2013/14 reporting period. A minor increase occurs in the downstream sample locations

<sup>9</sup> Council has conducted additional monitoring at the site as the EPL only requires 6 monthly sampling.



(or Rocklow-Mid). The actual difference between upstream and downstream concentrations has reduced since 1999 (Graph 4, reflecting reduced leachate migration from the capped waste mound).

- The net increment of ammonia in the midstream sample (Rocklow-Middle) averaged 0.36 mg/L in the 2013/14 reporting period (Table SW-2). This "net incremental average" is higher than the previous years (2012/13 averaged net incremental increase = 0.315 and 2011/12 averaged net incremental increase = 0.91 mg/L). The elevated ammonia in nearby groundwater (MD-9C and MD-10B) may be contributing to the nutrient concentrations in the surface water (Rocklow-Mid), however further monitoring is required to verify this interpretation (possible other sources such as the Dunmore landfill).
- While downstream ammonia concentration increases could be attributable to the discharge of groundwater impacted by ammonia from the MWDD, contribution from other sources of nitrogen input such as polluted runoff from the catchment (Dunmore Landfill, agricultural areas) is not discounted.
- All other water quality indicators were consistent with the results of previous monitoring periods.
- Bimonthly testing of the gas monitoring wells (Gas 1 to 3, Gas 4) and trenches (Trench 1 to Trench 7 -the biofilter pads) indicated that gas levels are comparable with the 2012/13 reporting period. All buildings sampled (within 250 m of the deposited waste) recorded no detectable landfill gas readings on 19 September 2013, 21 January 2014, and 2 June 2014 (annual monitoring).
- KMC (& E2W) are unaware of any complaints from the community arising from rehabilitation works at the MWDD during the 2013/14 reporting period.

The nutrients in the local surface and groundwater are likely to decrease over time due to the landfill closure and rehabilitation works. Given that the landfill capping commenced in August 2006 and completed in January 2008 the leachate generation has substantially decreased. Monitoring data in 2013/14 supports this interpretation and improvement in the local water quality.

The elevated ammonia concentrations reported at MD-9C and MD-10B is interpreted to relate to the remnant deeper centre/core plume migrating from under the landfill mound to the site boundary (other area are showing a decrease in leachate strength associated with landfill closure 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 (& remedial works- as necessary). The landfill closure and capping of the landfill mound would improve the local surface water and groundwater quality.

Close monitoring of the elevated ammonia at wells (MD-9C, MD-10B at centreline of plume) and Rocklow Creek (mid-creek) is recommended to address any remedial requirements (e.g. groundwater extraction and irrigation of the mound). E2W consider that ongoing monitoring (1 year and re-sampling with ammonia spikes/increasing trends over 100 mg/L) to assess ammonia trends and any remedial actions (MD-9C/MD-10B) to minimise impact to the creek (*note: establishing a down stream sample is required to enable assessment of impact to the surface water*). The scale of the landfill mound (6 ha) and generally slow movement of the deeper



groundwater is likely to be influencing results at MD-9C (i.e. the residual core leachate plume is still migrating slowly under the capped part of the mound).

E2W interpret that additional time (3 + years) is required to show a more consistent and widespread improvement in the water quality trends (eg. ammonia) due to landfill rehabilitation works. This interpretation takes in consideration the dilution effects of rainfall recharge, clean water runoff from the mound and subsequent attenuation of the landfill leachate around the landfill footprint. It is noted that the majority of the monitoring wells are situated immediately off the landfill perimeter and readily influenced from the leachate plume migrating under the waste mound.

## 8.1 Recommendations

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

### *Groundwater:*

- Continued monitoring and assessment of the ammonia is required to assess trends in relation to the landfill rehabilitation works.

E2W have initiated concept design of potential groundwater remedial works to address the previous (2011) rising ammonia trend identified at well (MD-9C). Currently, extraction wells and a holding dam are proposed to extract the ammonia enriched groundwater, facilitate biological treatment (via wetland plants) and irrigation to strip the ammonia from the groundwater. Groundwater remedial works are recommended if ammonia concentrations exceed 100 mg/L on two consecutive monitoring rounds in 2014 or 2015 (MD-9C or MD-10B).

Details of the proposed groundwater remedial works will be provided in separate documentation to KMC or NSW EPA (as required).

### *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),
- Sampling of surface water to be timed with a **low 'run out' tide**, and documenting tidal and climatic conditions (i.e. sampling at different tides dilutes the groundwater plume).
- Details regarding the well conditions (eg. damaged). Any damaged wells should be replaced or substituted with nearby wells.
- Sampling of MD-5B/5C (one event) is recommended to assess the extent of ammonia plume detected at MD-10B and MD-9C (i.e. improve plume delineation),

- Collection of an alternative (second) surface water sample in Rocklow Creek in proximity to MD-9B/9C (~50 m downstream of existing Rocklow-Middle) to better assess potential impacts associated with the groundwater ammonia plume (refer to figure 2).

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 also include surface water sampling (two or three locations). The increased monitoring frequency facilitates earlier detection of rising trends and decision making regarding potential remedial works.

E2W recommend the current surface water monitoring program is continued on a quarterly basis for the 2014/15 reporting period (exceeds EPL requirements). Due to the impeded access to the Rocklow-Down sampling location, E2W propose that a second mid-stream sample approximately (50 to 80 m) downstream of existing location (Rocklow-Middle) is collected to assist with the assessment of rising ammonia trend at well (MD-9C), risk assessment and requirements associated groundwater extraction/remedial works.

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

**Table 8.1 - Recommended Groundwater Analytical Program for MWDD (2012/13)**

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-nitrogen	0.01 mg/L	3 monthly	FIA
Nitrate-nitrogen	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
Total 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

Notes: 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

## 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 October/November 2014 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.

## 10. REFERENCES

Hazelton (1992). *Soil Landscapes of the Kiama 1:1,000,000 Sheet, Department of Conservation and Land Management.*

NSW EPA (1996). *Environmental Guidelines: Solid Waste Landfills.*

DUAP (1996). *EIS Practise Guideline: Landfilling*

NSW EPA (1999). *Environmental Guidelines: Assessment, Classification & Management of Liquid & Non-Liquid Wastes.* May 1999.

Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.*

Earth2Water Pty Ltd (October, 2005). *Landfill Closure Plan for the Minnamurra Waste Disposal Facility.*

## Tables

Table 5.3: Groundwater and Surface Water Monitoring (2013 to 2014)

Analytes	Groundwater				Surface Water (Rocklow Creek)				Detection Limits	Method Reference
	26/11/13	6/02/14	6/05/14	18/08/14	26/11/13	6/02/14	6/05/14	18/08/14		
Physical Properties										
pH	X	X	X	X	X	X	X	X	0.01 pH unit	pH meter and probe/ APHA4500-HB
Electrical Conductivity	X	X	X	X	X	X	X	X	0.01 mS/cm	Conductivity meter and probe
Dissolved Oxygen	X	X	X	X	X	X	X	X	0.0001	DO meter and probe
Redox (Orp)									1 mV	Platinum electrode probe - NA
Temperature	X	X	X	X	X	X	X	X	1 °C	Temperature meter and probe
Turbidity									1 NTU	APHA2540D
Nutrients										
Ammonia-nitrogen	X	X	X	X	X	X	X	X	0.01 mg/L	FIA
Total Nitrogen										
Total Phosphorus									2 µg/L	FIA
Hydrochemical										
Calcium	X	X	X	X	X	X	X	X	0.5 mg/L	USEPA 6010 A
Chloride	X	X	X	X	X	X	X	X	0.5 mg/L	diphenol-carbazonel/xylene cyanol FF indicator
Fluoride	X	X	X	X	X	X	X	X	0.1 mg/L	APHA4500-FC
Magnesium	X	X	X	X	X	X	X	X	0.02 mg/L	USEPA 6010 A
Sulphate	X	X	X	X	X	X	X	X	1 mg/L	ICID/MS
Sodium	X	X	X	X	X	X	X	X	0.05 mg/L	USEPA 6010 A
Bicarbonate/Alkalinity	X	X	X	X	X	X	X	X	0.5 mg/L	APHA2340C - "Hardness done by error"
Potassium	X	X	X	X	X	X	X	X	0.05 mg/L	USEPA 6010 A
Organic Contaminants										
Dissolved Organic Carbor	X	X	X	X	X	X	X	X	0.50 mg/L	APHA 5310C
Total Organic Carbon	X	X	X	X	X	X	X	X	0.1 mg/L	APHA 5310C
Inorganic Contaminants										
Iron	X	X	X	X	X	X	X	X	1 µg/L	USEPA 6010 A
Manganese	X	X	X	X	X	X	X	X	1 µg/L	USEPA 6010
Total Phenolics	X	X	X	X	X	X	X	X	1 µg/L	APHA 5530D

Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD 1B	MD 1B	MD 1B	MD 1B	No. Samples	MD2A	MD2A	MD2A	MD2A	No. Samples	MD 2B	MD 2B	MD 2B	MD 2B	No. Sample	Min	Mean	Max
Field Measurements	Freshwater	Marine	26/11/13	6/2/14	6/5/14	18/8/14		26/11/13	6/2/14	6/5/14	18/8/14		26/11/13	6/2/14	6/5/14	18/8/14				
RL (mAHD at TOC)			No Access	Overgrow	No Access	No Access	0	Dry	Dry	Dry	Dry	0	1.17	1.17	1.17	1.17	0	NA	NA	NA
Standing water level (mTOC)			-	-	-	-	0	-	-	-	-	0	0.75	0.79	0.57	0.45	4	0.45	0.64	0.79
Reduced SWL (mAHD)			-	-	-	-	0	-	-	-	-	0	0.42	0.38	0.60	0.72	0	NA	NA	NA
pH (field)	6.5-8.0 (a)	8-8.4 (a)	-	-	-	-	0	-	-	-	-	0	7.3	7.4	7.0	7.4	4	7.0	7.3	7.4
Temperature			-	-	-	-	0	-	-	-	-	0	16.5	18.3	17.6	14.1	4	14.1	16.6	18.3
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		-	-	-	-	0	-	-	-	-	0	21.70	23.00	23.20	19.50	4	19.5	21.85	23.20
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	-	-	-	-	0	-	-	-	-	0	2.33	3.81	3.24	3.10	4	2.33	3.12	3.81
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	-	-	-	-	0	-	-	-	-	0	NM	NM	NM	NM	0	NA	NA	NA
<b>Laboratory Analyses (mg/L)</b>																				
Sodium (ICP)			-	-	-	-	0	-	-	-	-	0	4410	4650	4830	4380	4	4380	4568	4830
Potassium (ICP)			-	-	-	-	0	-	-	-	-	0	252	233	261	240	4	233	247	261
Calcium (ICP)			-	-	-	-	0	-	-	-	-	0	392	385	342	342	4	342	365	392
Magnesium (ICP)			-	-	-	-	0	-	-	-	-	0	522	557	614	532	4	522	556	614
Chloride			-	-	-	-	0	-	-	-	-	0	6820	6720	8120	7500	4	6720	7290	8120
Sulphate (SO4)			-	-	-	-	0	-	-	-	-	0	1030	1030	1410	1260	4	1030	1183	1410
<b>Water Parameters (mg/L)</b>																				
Total Suspended Solids (TSS)			-	-	-	-	0	-	-	-	-	0	NM	NM	NM	NM	0	NA	NA	NA
Alkalinity (as CaCO3)			-	-	-	-	0	-	-	-	-	0	750	687	795	580	4	580	703	795
Fluoride			-	-	-	-	0	-	-	-	-	0	0.7	0.3	0.7	0.7	4	0.3	0.6	0.7
Phenols		0.40	-	-	-	-	0	-	-	-	-	0	0.05	0.05	0.05	0.05	4	0.05	0.05	0.05
<b>Metals (mg/L)</b>																				
Iron (ICP)	0.3 (1)		-	-	-	-	0	-	-	-	-	0	0.30	0.50	1.09	0.50	4	0.30	0.60	1.09
Manganese (ICP)	1.90		-	-	-	-	0	-	-	-	-	0	0.072	0.068	0.088	0.01	4	0.010	0.060	0.088
<b>Nutrients (mg/L)</b>																				
Nitrate (NO3 as N)	0.7 (7)		-	-	-	-	0	-	-	-	-	0	2.30	3.28	0.01	7.20	4	0.01	3.20	7.20
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	-	-	-	-	0	-	-	-	-	0	9.41	7.10	13.80	0.41	4	0.41	7.68	13.80
Total Nitrogen	0.5 (3)	0.12 (4)	-	-	-	-	0	-	-	-	-	0	NM	NM	NM	NM	0	NA	NA	0.00
Dissolved Organic Carbon (DOC)			-	-	-	-	0	-	-	-	-	0	51	35	29	39	4	29	39	51
Total Organic Carbon (TOC)			-	-	-	-	0	-	-	-	-	0	48	35	29	37	4	29	37	48
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	-	-	-	-	0	-	-	-	-	0	NM	NM	NM	NM	0	NA	NA	NA

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
<LOR converted to LOR for statistic purposes
Exceedance of IIWL values or fresh water not highlighted.
Nonpurcheable DOC and TOC



Table GW-1: Summary 2013/14 Analytical Results - Minnamurra Waste Disposal Depot

## Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD 2C	MD 2C	MD 2C	MD 2C	No. Samples	Min	Mean	Max	MD4A	MD4A	MD4A	MD4A	No. of Samples
Field Measurements	Freshwater	Marine	26/11/13	6/2/14	6/5/14	18/8/14					26/11/13	6/2/14	6/5/14	18/8/14	
RL (mAHD at TOC)			1.17	1.17	1.17	1.17	0	NA	NA	NA	Dry	Dry	Dry	Dry	0
Standing water level (mTOC)			0.81	0.84	0.62	0.50	4	0.50	0.69	0.84	-	-	-	-	0
Reduced SWL (mAHD)			0.36	0.33	0.64	0.67	0	NA	NA	NA	-	-	-	-	0
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.4	7.4	7.0	7.3	4	7.0	7.3	7.4	-	-	-	-	0
Temperature			16.7	18.8	16.8	14.2	4	14.2	16.6	18.8	-	-	-	-	0
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		42.50	42.80	36.80	34.30	4	34.30	39.10	42.80	-	-	-	-	0
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	3.66	3.51	2.04	2.90	4	2.04	3.03	3.66	-	-	-	-	0
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0
<b>Laboratory Analyses (mg/L)</b>															
Sodium (ICP)			8860	10100	7320	8870	4	7320	8788	10100	-	-	-	-	0
Potassium (ICP)			483	430	413	363	4	363	422	483	-	-	-	-	0
Calcium (ICP)			474	483	425	421	4	421	451	483	-	-	-	-	0
Magnesium (ICP)			1090	1160	973	1020	4	973	1061	1160	-	-	-	-	0
Chloride			13600	12700	13100	13500	4	12700	13225	13600	-	-	-	-	0
Sulphate (SO4)			2100	2030	2400	2420	4	2030	2238	2420	-	-	-	-	0
<b>Water Parameters (mg/L)</b>															
Total Suspended Solids (TSS)			NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0
Alkalinity (as CaCO3)			494	459	547	439	4	439	485	547	-	-	-	-	0
Fluoride			0.6	0.3	0.7	0.7	4	0.3	0.6	0.7	-	-	-	-	0
Phenols		0.40	0.05	0.05	0.05	0.05	4	0.05	0.05	0.05	-	-	-	-	0
<b>Metals (mg/L)</b>															
Iron (ICP)	0.3 (1)		0.50	0.50	1.32	0.50	4	0.50	0.71	1.32	-	-	-	-	0
Manganese (ICP)	1.90		0.055	0.01	0.135	0.01	4	<0.01	0.053	0.135	-	-	-	-	0
<b>Nutrients (mg/L)</b>															
Nitrate (NO3 as N)	0.7 (7)		0.96	0.06	0.01	1.39	4	0.01	0.61	1.39	-	-	-	-	0
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	0.28	0.09	4.24	0.11	4	0.09	1.18	4.24	-	-	-	-	0
Total Nitrogen	0.5 (3)	0.12 (4)	NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0
Dissolved Organic Carbon (DOC)			22	16	14	19	4	14	18	22	-	-	-	-	0
Total Organic Carbon (TOC)			19	17	13	19	4	13	17	19	-	-	-	-	0
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	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
<LOR converted to LOR for statistic purposes
Exceedance of IIWL values or fresh water not highlighted.
Nonpurcheable DOC and TOC

Table GW-1: Summary 2013/14 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
Field Measurements	Freshwater	Marine	26/11/13	6/2/14	6/5/14	18/8/14					26/11/13	6/2/14	6/5/14	18/8/14				
RL (mAHD at TOC)			1.63	1.63	1.63	1.63	0	NA	NA	NA	1.59	1.59	1.59	1.59	0	NA	NA	NA
Standing water level (mTOC)			1.19	1.25	1.00	0.86	4	0.86	1.08	1.25	1.20	1.26	1.08	1.28	4	1.08	1.21	1.28
Reduced SWL (mAHD)			0.44	0.38	0.63	0.77	0	0.38	0.55	0.77	0.39	0.33	0.51	0.31	0	NA	NA	NA
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.2	7.1	7.0	7.3	4	7.0	7.2	7.3	7.1	7.3	7.0	7.8	4	7.0	7.3	7.8
Temperature			16.3	18.2	17	14.8	4	14.8	16.6	18.2	16.4	18.6	16.3	14.6	4	14.6	16.5	18.6
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		10.3	10.6	9.05	8.43	4	8.4	9.60	10.60	32.9	9.98	33.8	25.6	4	9.98	25.57	33.80
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	2.38	2.19	4.35	2.10	4	2.10	2.76	4.35	2.13	2.93	2.84	5.00	4	2.13	3.23	5.00
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	NM	NM	NM	NM	0	NA	NA	NA	NM	NM	NM	NM	0	NA	NA	NA
<b>Laboratory Analyses (mg/L)</b>																		
Sodium (ICP)			1460	1660	1600	1570	4	1460	1573	1660	6200	7350	6880	6710	4	6200	6785	7350
Potassium (ICP)			129	132	144	156	4	129	140	156	309	313	382	276	4	276	320	382
Calcium (ICP)			402	454	422	382	4	382	415	454	378	414	383	345	4	345	380	414
Magnesium (ICP)			242	247	234	222	4	222	236	247	771	843	890	712	4	712	804	890
Chloride			3040	2910	2980	2940	4	2910	2968	3040	10300	9560	11600	9620	4	9560	10270	11600
Sulphate (SO4)			438	424	441	473	4	424	444	473	1600	1480	1900	1590	4	1480	1643	1900
<b>Water Parameters (mg/L)</b>																		
Total Suspended Solids (TSS)			NM	NM	NM	NM	0	NA	NA	NA	NM	NM	NM	NM	0	NA	NA	NA
Alkalinity (as CaCO3)			831	779	942	700	4	700	813	942	706	665	403	547	4	403	580	706
Fluoride			0.4	0.3	0.5	0.5	4	0.3	0.4	0.5	0.6	0.3	0.9	0.6	4	0.3	0.6	0.9
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
<b>Metals (mg/L)</b>																		
Iron (ICP)	0.3 (1)		3.28	0.50	1.67	0.16	4	0.16	1.40	3.28	0.32	2.25	1.31	0.50	4	0.32	1.10	2.25
Manganese (ICP)	1.90		0.106	0.175	0.092	0.072	4	0.072	0.11	0.18	0.163	0.08	0.163	0.01	4	0.010	0.104	0.163
<b>Nutrients (mg/L)</b>																		
Nitrate (NO3 as N)	0.7 (7)		0.05	0.52	0.01	8.13	4	0.01	2.18	8.13	0.95	0.81	0.01	0.40	4	0.01	0.54	0.95
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	34	0.44	46.4	27.9	4	0.44	27.19	46.40	1.05	33.6	0.79	0.06	4	0.06	8.88	33.60
Total Nitrogen	0.5 (3)	0.12 (4)	NM	NM	NM	NM	0	NA	NA	NA	NM	NM	NM	NM	0	NA	NA	NA
Dissolved Organic Carbon (DOC)			55	27	32	44	4	27	40	55	38	42	8	26	4	8	29	42
Total Organic Carbon (TOC)			50	26	34	43	4	26	38	50	36	42	5	26	4	5	27	42
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	NM	NM	NM	NM	0	NA	NA	NA	NM	NM	NM	NM	0	NA	NA	NA

**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
<LOR converted to LOR for statistic purposes
Exceedance of IIWL values or fresh water not highlighted.
Nonpurchable DOC and TOC

Table GW-1: Summary 2013/14 Analytical Results - Minnamurra Waste Disposal Depot

## Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD6A	MD6A	MD6A	MD6A	No. Samples	MD 6B	MD 6B	MD 6B	MD 6B	No. Samples	Min	Mean	Max
Field Measurements	Freshwater	Marine	26/11/13	6/2/14	6/5/14	18/8/14		26/11/13	6/2/14	6/5/14	18/8/14				
RL (mAHD at TOC)			Dry	Dry	Dry	Dry	0	1.85	1.85	1.85	1.85	0	NA	NA	NA
Standing water level (mTOC)			-	-	-	-	0	1.30	1.40	1.15	1.01	4	1.01	1.22	1.40
Reduced SWL (mAHD)			-	-	-	-	0	0.55	0.45	0.70	0.84	0	0.45	0.64	0.84
pH (field)	6.5-8.0 (a)	8-8.4 (a)	-	-	-	-	0	7.1	7.0	6.8	7.1	4	6.8	7.0	7.1
Temperature			-	-	-	-	0	17.2	18.9	21.8	15.9	4	15.9	18.5	21.8
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		-	-	-	-	0	2.18	2.19	1.98	1.64	4	1.64	2.00	2.19
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	-	-	-	-	0	2.56	3.01	3.90	3.30	4	2.56	3.19	3.90
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	-	-	-	-	0	NM	NM	NM	NM	0	NA	NA	NA
<b>Laboratory Analyses (mg/L)</b>															
Sodium (ICP)			-	-	-	-	0	132	142	159	168	4	132	150	168
Potassium (ICP)			-	-	-	-	0	58	56	78	61	4	56	63	78
Calcium (ICP)			-	-	-	-	0	177	177	192	156	4	156	176	192
Magnesium (ICP)			-	-	-	-	0	74	72	70	66	4	66	71	74
Chloride			-	-	-	-	0	179	172	165	142	4	142	165	179
Sulphate (SO4)			-	-	-	-	0	105	91	76	97	4	76	92	105
<b>Water Parameters (mg/L)</b>															
Total Suspended Solids (TSS)			-	-	-	-	0	NM	NM	NM	NM	0	NA	NA	NA
Alkalinity (as CaCO3)			-	-	-	-	0	873	814	919	718	4	718	831	919
Fluoride			-	-	-	-	0	0.4	0.3	0.4	0.4	4	0.3	0.4	0.4
Phenols		0.40	-	-	-	-	0	0.05	0.05	0.05	0.05	4	0.05	0.05	0.05
<b>Metals (mg/L)</b>															
Iron (ICP)	0.3 (1)		-	-	-	-	0	0.29	0.27	0.30	0.12	4	0.12	0.25	0.30
Manganese (ICP)	1.90		-	-	-	-	0	0.175	0.154	0.147	0.133	4	0.133	0.152	0.175
<b>Nutrients (mg/L)</b>															
Nitrate (NO3 as N)	0.7 (7)		-	-	-	-	0	0.19	0.76	0.02	1.27	4	0.02	0.56	1.27
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	-	-	-	-	0	29.5	30.0	27.3	21.8	4	21.80	27.15	30.00
Total Nitrogen	0.5 (3)	0.12 (4)	-	-	-	-	0	NM	NM	NM	NM	0	NA	NA	NA
Dissolved Organic Carbon (DOC)			-	-	-	-	0	63	46	35	43	4	35	47	63
Total Organic Carbon (TOC)			-	-	-	-	0	58	46	42	43	4	42	47	58
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	-	-	-	-	0	NM	NM	NM	NM	0	NA	NA	NA

**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
<LOR converted to LOR for statistic purposes
Exceedance of IIWL values or fresh water not highlighted.
Nonpurcheable DOC and TOC

Table GW-1: Summary 2013/14 Analytical Results - Minnamurra Waste Disposal Depot

## Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD 6C	MD 6C	MD 6C	MD 6C	No. Samples	Min	Mean	Max	MD9A	MD9A	MD9A	MD9A	No. Samples
Field Measurements	Freshwater	Marine	26/11/13	6/2/14	6/5/14	18/8/14					26/11/13	6/2/14	6/5/14	18/8/14	
RL (mAHD at TOC)			1.86	1.86	1.86	1.86	0	NA	NA	NA	Dry	Dry	Dry	Dry	0
Standing water level (mTOC)			1.41	1.53	1.28	1.14	4	1.14	1.34	1.53	-	-	-	-	0
Reduced SWL (mAHD)			0.45	0.33	0.58	0.72	0	0.33	0.52	0.72	-	-	-	-	0
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.1	7.1	7.2	7.0	4	7.0	7.1	7.2	-	-	-	-	0
Temperature			17.4	18.7	19.0	16.0	4	16.0	17.8	19.0	-	-	-	-	0
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		24.90	24.50	26.00	21.40	4	21.40	24.20	26.00	-	-	-	-	0
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	1.67	2.08	2.40	2.40	4	1.67	2.14	2.40	-	-	-	-	0
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0
<b>Laboratory Analyses (mg/L)</b>															
Sodium (ICP)			4560	5030	5340	5240	4	4560	5043	5340	-	-	-	-	0
Potassium (ICP)			206	201	242	186	4	186	209	242	-	-	-	-	0
Calcium (ICP)			371	386	365	346	4	346	367	386	-	-	-	-	0
Magnesium (ICP)			584	610	702	582	4	582	620	702	-	-	-	-	0
Chloride			7730	7290	8890	7920	4	7290	7958	8890	-	-	-	-	0
Sulphate (SO4)			1130	1100	1530	1360	4	1100	1280	1530	-	-	-	-	0
<b>Water Parameters (mg/L)</b>															
Total Suspended Solids (TSS)			NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0
Alkalinity (as CaCO3)			429	371	451	306	4	306	389	451	-	-	-	-	0
Fluoride			0.4	0.2	0.5	0.4	4	0.2	0.4	0.5	-	-	-	-	0
Phenols		0.40	0.05	0.05	0.05	0.05	4	0.05	0.05	0.05	-	-	-	-	0
<b>Metals (mg/L)</b>															
Iron (ICP)	0.3 (1)		0.05	2.02	19.5	0.50	4	0.05	5.52	19.50	-	-	-	-	0
Manganese (ICP)	1.90		0.073	0.086	0.061	0.035	4	0.035	0.064	0.086	-	-	-	-	0
<b>Nutrients (mg/L)</b>															
Nitrate (NO3 as N)	0.7 (7)		0.05	0.27	0.02	3.3	4	0.02	0.91	3.30	-	-	-	-	0
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	29.5	32.4	48.3	24.4	4	24.40	33.65	48.30	-	-	-	-	0
Total Nitrogen	0.5 (3)	0.12 (4)	NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0
Dissolved Organic Carbon (DOC)			19	13	7	12	4	7	13	19	-	-	-	-	0
Total Organic Carbon (TOC)			17	13	10	10	4	10	13	17	-	-	-	-	0
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	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.

Unsourced well on EPL
Exceeds ANZECC (2000) marine trigger value
<LOR converted to LOR for statistic purposes
Exceedance of IIWL values or fresh water not highlighted.
Nonpurchable DOC and TOC

Table GW-1: Summary 2013/14 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	26/11/13	6/2/14	6/5/14	18/8/14				
RL (mAHD at TOC)			1.35	1.35	1.35	1.35	0	NA	NA	NA
Standing water level (mTOC)			0.89	0.9	0.78	0.62	4	0.62	0.80	0.90
Reduced SWL (mAHD)			0.46	0.45	0.57	0.73	0	0.45	0.55	0.73
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.1	7.0	7.0	7.1	4	7.0	7.1	7.1
Temperature			17.2	19.7	19.9	14.7	4	14.7	17.9	19.9
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		2.70	2.74	2.60	2.32	4	2.32	2.59	2.74
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	2.18	2.02	4.95	3.10	4	2.02	3.06	4.95
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	NM	NM	NM	NM	0	NA	NA	NA
<b>Laboratory Analyses (mg/L)</b>										
Sodium (ICP)			212	230	242	298	4	212	246	298
Potassium (ICP)			73	83	70	76	4	70	76	83
Calcium (ICP)			182	190	134	176	4	134	171	190
Magnesium (ICP)			92	97	97	99	4	92	96	99
Chloride			331	347	329	346	4	329	338	347
Sulphate (SO4)			90	70	52	25	4	25	59	90
<b>Water Parameters (mg/L)</b>										
Total Suspended Solids (TSS)			NM	NM	NM	NM	0	NA	NA	NA
Alkalinity (as CaCO3)			955	898	1130	939	4	898	981	1130
Fluoride			0.6	0.4	0.6	0.5	4	0.4	0.5	0.6
Phenols		0.40	0.05	0.05	0.05	0.05	4	0.05	0.05	0.05
<b>Metals (mg/L)</b>										
Iron (ICP)	0.3 (1)		5.84	7.2	5.36	0.36	4	0.36	4.69	7.20
Manganese (ICP)	1.90		0.297	0.26	0.268	0.113	4	0.113	0.235	0.297
<b>Nutrients (mg/L)</b>										
Nitrate (NO3 as N)	0.7 (7)		0.89	0.51	0.11	0.01	4	0.01	0.38	0.89
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	22	26	24.2	21.9	4	21.90	23.53	26.00
Total Nitrogen	0.5 (3)	0.12 (4)	NM	NM	NM	NM	0	NA	NA	NA
Dissolved Organic Carbon (DOC)			63	47	40	51	4	40	50	63
Total Organic Carbon (TOC)			95	47	40	52	4	40	59	95
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	NM	NM	NM	NM	0	NA	NA	NA
<b>Notes:</b>										

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.

Unsamped well on EPL
Exceeds ANZECC (2000) marine trigger value
<LOR converted to LOR for statistic purposes
Exceedance of IIWL values or fresh water not highlighted.
Nonpurcheable DOC and TOC

Table GW-1: Summary 2013/14 Analytical Results - Minnamurra Waste Disposal Depot

## Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD 9C	MD 9C	MD 9C	MD 9C	MD 9C	MD 9C	MD 9C	No. Samples	Min	Mean	Max
Field Measurements	Freshwater	Marine	20/11/12	29/11/12	30/11/12	26/11/13	6/2/14	6/5/14	18/8/14				
RL (mAHD at TOC)			1.40	1.40	1.40	1.40	1.40	1.40	1.40	0	NA	NA	NA
Standing water level (mTOC)			0.89	NM	NM	0.95	0.99	0.81	0.63	4	0.63	0.85	0.99
Reduced SWL (mAHD)			0.51	NM	NM	0.45	0.41	0.59	0.77	0	0.41	0.56	0.77
pH (field)	6.5-8.0 (a)	8-8.4 (a)	6.9	NM	NM	6.9	7.0	6.9	7.1	4	6.9	7.0	7.1
Temperature			17.5	NM	NM	17	20	20.2	14.7	4	14.7	18.0	20.2
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		4.69	NM	NM	3.85	3.56	3.72	3.18	4	3.2	3.58	3.85
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	0.93	NM	NM	2.25	1.49	2.35	2.1	4	1.49	2.05	2.35
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	NM	NM	NM	NM	NM	NM	NM	0	NA	NA	NA
<b>Laboratory Analyses (mg/L)</b>													
Sodium (ICP)			531	NM	NM	337	334	348	398	4	334	354	398
Potassium (ICP)			153	NM	NM	126	116	152	140	4	116	134	152
Calcium (ICP)			208	NM	NM	213	220	202	178	4	178	203	220
Magnesium (ICP)			95	NM	NM	96	99	91	88	4	88	94	99
Chloride			892	NM	NM	545	508	514	512	4	508	520	545
Sulphate (SO4)			1	NM	NM	10	10	12	10	4	10	11	12
<b>Water Parameters (mg/L)</b>													
Total Suspended Solids (TSS)			NM	NM	NM	NM	NM	NM	NM	0	NA	NA	NA
Alkalinity (as CaCO3)			1400	NM	NM	1270	1300	1480	1200	4	1200	1313	1480
Fluoride			0.4	NM	NM	0.4	0.3	0.6	0.4	4	0.3	0.4	0.6
Phenols		0.40	0.05	NM	NM	0.05	0.05	0.05	0.05	4	0.05	0.05	0.05
<b>Metals (mg/L)</b>													
Iron (ICP)	0.3 (1)		7.29	NM	NM	NM	7.88	9.23	2.27	4	2.27	6.46	9.23
Manganese (ICP)	1.90		0.69	NM	NM	NM	0.584	0.367	0.398	4	0.367	0.450	0.584
<b>Nutrients (mg/L)</b>													
Nitrate (NO3 as N)	0.7 (7)		3.13	NM	NM	NM	1.73	0.02	0.01	4	0.01	0.59	1.73
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	60.9	117.00	117.00	87.20	73.2	120	112	4	73.20	98.10	120.00
Total Nitrogen	0.5 (3)	0.12 (4)	NM	NM	NM	NM	NM	NM	NM	0	NA	NA	NA
Dissolved Organic Carbon (DOC)			127	NM	NM	NM	99	87	98	4	87	95	99
Total Organic Carbon (TOC)			115	NM	NM	NM	98	90	122	4	90	103	122
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	NM	NM	NM	NM	NM	NM	NM	0	NA	NA	NA

**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.

Unsamped well on EPL
Exceeds ANZECC (2000) marine trigger value
<LOR converted to LOR for statistic purposes
Exceedance of IIWL values or fresh water not highlighted.
Nonpurchaseable DOC and TOC



Table GW-1: Summary 2013/14 Analytical Results - Minnamurra Waste Disposal Depot

## Minnamurra Waste Disposal Depot

Sample ID	ANZECC, 2000		MD10A	MD10A	MD10A	MD10A	MD10A	No. Samples	MD 10B	MD 10B	MD 10B	MD 10B	No. Sample	Min	Mean	Max
Field Measurements	Freshwater	Marine	20/11/12	14/01/13	18/02/13	30/05/13	29/08/13		26/11/13	6/2/14	6/5/14	18/8/14				
RL (mAHD at TOC)			Dry	NM	Dry	Dry	Dry	0	NM	NM	NM	NM	0	NA	NA	NA
Standing water level (mTOC)			-	NM	-	-	-	0	0.77	0.71	0.49	0.55	4	0.49	0.63	0.77
Reduced SWL (mAHD)			-	NM	-	-	-	0	NM	NM	NM	NM	0	NA	NA	NA
pH (field)	6.5-8.0 (a)	8-8.4 (a)	-	6.10	-	-	-	0	7.2	7.1	7.2	7.4	4	7.1	7.2	7.4
Temperature			-	22.0	-	-	-	0	18.4	21.8	19.6	15.1	4	15.1	18.7	21.8
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		-	51.60	-	-	-	0	2.38	2.25	2.09	1.85	4	1.9	2.14	2.38
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	-	1.46	-	-	-	0	1.31	1.55	3.75	3.2	4	1.31	2.45	3.75
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	-	NM	-	-	-	0	NM	NM	NM	NM	0	NA	NA	NA
<b>Laboratory Analyses (mg/L)</b>																
Sodium (ICP)			-	NM	-	-	-	0	136	138	147	156	4	136	144	156
Potassium (ICP)			-	NM	-	-	-	0	88	92	106	112	4	88	100	112
Calcium (ICP)			-	NM	-	-	-	0	126	128	134	111	4	111	125	134
Magnesium (ICP)			-	NM	-	-	-	0	45	46	48	45	4	45	46	48
Chloride			-	NM	-	-	-	0	236	261	218	208	4	208	231	261
Sulphate (SO4)			-	NM	-	-	-	0	10	10	24	10	4	10	14	24
<b>Water Parameters (mg/L)</b>																
Total Suspended Solids (TSS)			-	NM	-	-	-	0	NM	NM	NM	NM	0	NA	NA	NA
Alkalinity (as CaCO3)			-	NM	-	-	-	0	798	794	897	745	4	745	809	897
Fluoride			-	NM	-	-	-	0	0.8	0.6	0.9	0.7	4	0.6	0.8	0.9
Phenols		0.40	-	NM	-	-	-	0	0.05	0.05	0.05	0.05	4	0.05	0.05	0.05
<b>Metals (mg/L)</b>																
Iron (ICP)	0.3 (1)		-	NM	-	-	-	0	0.89	0.87	0.54	0.67	4	0.54	0.74	0.89
Manganese (ICP)	1.90		-	NM	-	-	-	0	0.422	0.422	0.335	0.459	4	0.335	0.410	0.459
<b>Nutrients (mg/L)</b>																
Nitrate (NO3 as N)	0.7 (7)		-	NM	-	-	-	0	0.05	1.54	0.01	0.01	4	0.01	0.40	1.54
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	-	0.34	-	-	-	0	66.4	67	82.1	87.2	4	66.40	75.68	87.20
Total Nitrogen	0.5 (3)	0.12 (4)	-	NM	-	-	-	0	NM	NM	NM	NM	0	NA	NA	NA
Dissolved Organic Carbon (DOC)			-	NM	-	-	-	0	78	59	43	58	4	43	60	78
Total Organic Carbon (TOC)			-	NM	-	-	-	0	66	59	48	64	4	48	59	66
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	-	NM	-	-	-	0	NM	NM	NM	NM	0	NA	NA	NA

**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

&lt;LOR converted to LOR for statistic purposes

Exceedance of IIWL values or fresh water not highlighted.

Nonpurcheable DOC and TOC

Table SW-1: Summary Analytical Report - Surface Water (2013-14)

Table SW-1 Minnamurra Waste Disposal Depot (Rocklow Creek)

Sample ID	ANZECC, 2000		Rocklow Up	Rocklow Mid	Rocklow Down	Rocklow Up	Rocklow Mid	Rocklow Down	Rocklow Up	Rocklow Mid	Rocklow Down	Rocklow Up	Rocklow Mid	Rocklow Down
Field Measurements	Freshwater	Marine	26/11/13	26/11/13	26/11/13	6/02/14	6/02/14	6/02/14	6/05/14	6/05/14	6/05/14	18/08/14	18/08/14	18/08/14
pH (field)	6.5-8.0	8-8.4	6.9	7.30	No Access	7.7	7	No Access	6.4	7.2	No Access	7.1	7.3	No Access
Temperature			17.6	16.90	-	18.9	19.4	-	14	14.9	-	13.6	13.1	-
Electrical Conductivity (mS/cm)	0.125-2.2		1.81	6.98	-	32.90	37.20	-	10.30	13.20	-	13.80	7.34	-
Dissolved Oxygen (mg/L)	8.5-11.0	9.0-10.0	6.66	6.04	-	6.94	2.24	-	7.90	7.32	-	7.50	7.00	-
Turbidity (NTU)	6-50 (a)	0.5-10	NM	NM	-	NM	NM	-	NM	NM	-	NM	NM	-
<b>Laboratory Analyses (mg/L)</b>														
Sodium (ICP)			256	1340	-	6440	7890	-	2580	3360	-	3880	1740	-
Potassium (ICP)			12	59	-	291	332	-	98	127	-	184	93	-
Calcium (ICP)			62	88	-	278	330	-	109	130	-	199	87	-
Magnesium (ICP)			42	159	-	763	926	-	281	358	-	425	194	-
Chloride			392	2050	-	9850	11200	-	4160	5140	-	5540	2860	-
Sulphate (SO4)			256	390	-	1490	1700	-	646	798	-	906	484	-
<b>Water Parameters (mg/L)</b>														
Hardness (as CaCO3)			49	112	-	181	208	-	128	169	-	113	65	-
Fluoride			0.20	0.40	-	0.3	0.4	-	0.4	0.7	-	0.5	0.4	-
Phenols		0.40	0.05	0.05	-	0.05	0.05	-	0.05	0.05	-	0.05	0.05	-
<b>Metals (mg/L)</b>														
Iron (ICP)	0.3 (1)		0.890	0.440	-	0.35	0.58	-	2.37	0.83	-	0.53	0.82	-
Manganese (ICP)	1.90		0.670	0.195	-	0.22	0.29	-	0.24	0.25	-	0.170	0.079	-
<b>Nutrients (mg/L)</b>														
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	NM	NM	-	NM	NM	-	NM	NM	-	NM	NM	-
Total Nitrogen	0.5 (3)	0.12 (4)	NM	NM	-	NM	NM	-	NM	NM	-	NM	NM	-
Nitrate (NO3 as N)	0.7 (7)		0.03	0.09	-	0.04	0.03	-	0.03	0.10	-	0.08	0.40	-
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	0.09	0.18	-	0.16	1.60	-	0.39	0.29	-	0.14	0.14	-
Ammonia Increment (from Upper to Mid Rocklow Creek)			-	-	NA			NA			NA			NA
Ammonia Increment (from Upper to Mid Rocklow Creek)			-	-	-			-			-			-
Dissolved Organic Carbon (DOC)			7	14	-	8	8	-	8	6	-	8	10	-
Total Organic Carbon (TOC)			6	13	-	9	8	-	8	7	-	8	12	-

**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.

Table SW-2: Rocklow Creek - Historical Ammonia Concentrations (mg/L) (1999 - 2014)

Table SW-2: Rocklow Creek - Historical Ammonia Concentrations (mg/L) (1999 - 2014)

Sample ID	6/05/1999	17/08/1999	2/12/2000	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	11/02/2003	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	22/05/2007	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	2/11/2011	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)														0.56	0.61	0.38	0.80	<0.1	<0.1	0.27	0.33	5.65	0.56	0.20	0.31	0.58
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	0.42	NM	NM	NM	NM	NM	NM
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

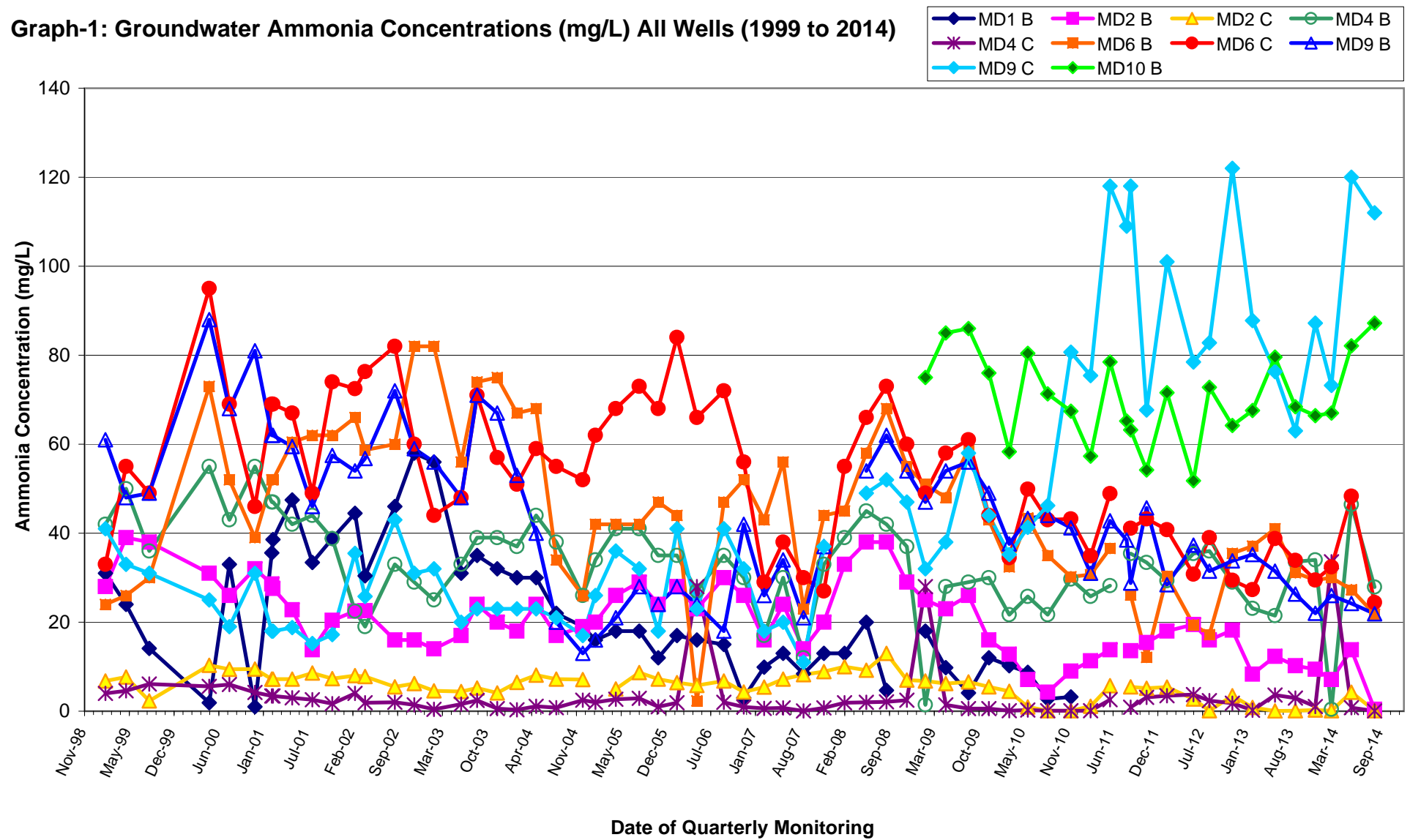
Sample ID	30/05/2012	9/08/2012	20/11/2012	18/02/2013	30/05/2013	29/08/2013	26/11/2013	6/02/2014	6/05/2014	18/08/2014
Upper Rocklow (mg/L)	<0.01	0.04	0.10	0.10	0.12	0.16	0.09	0.16	0.39	0.14
Middle Rocklow (mg/L)	1.06	1.91	0.44	0.71	0.19	0.40	0.18	1.60	0.29	0.14
Lower Rocklow (mg/L)	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Net Increment (mg/L)	1.06	1.87	0.34	0.61	0.07	0.24	0.09	1.44	(0.10)	0.00

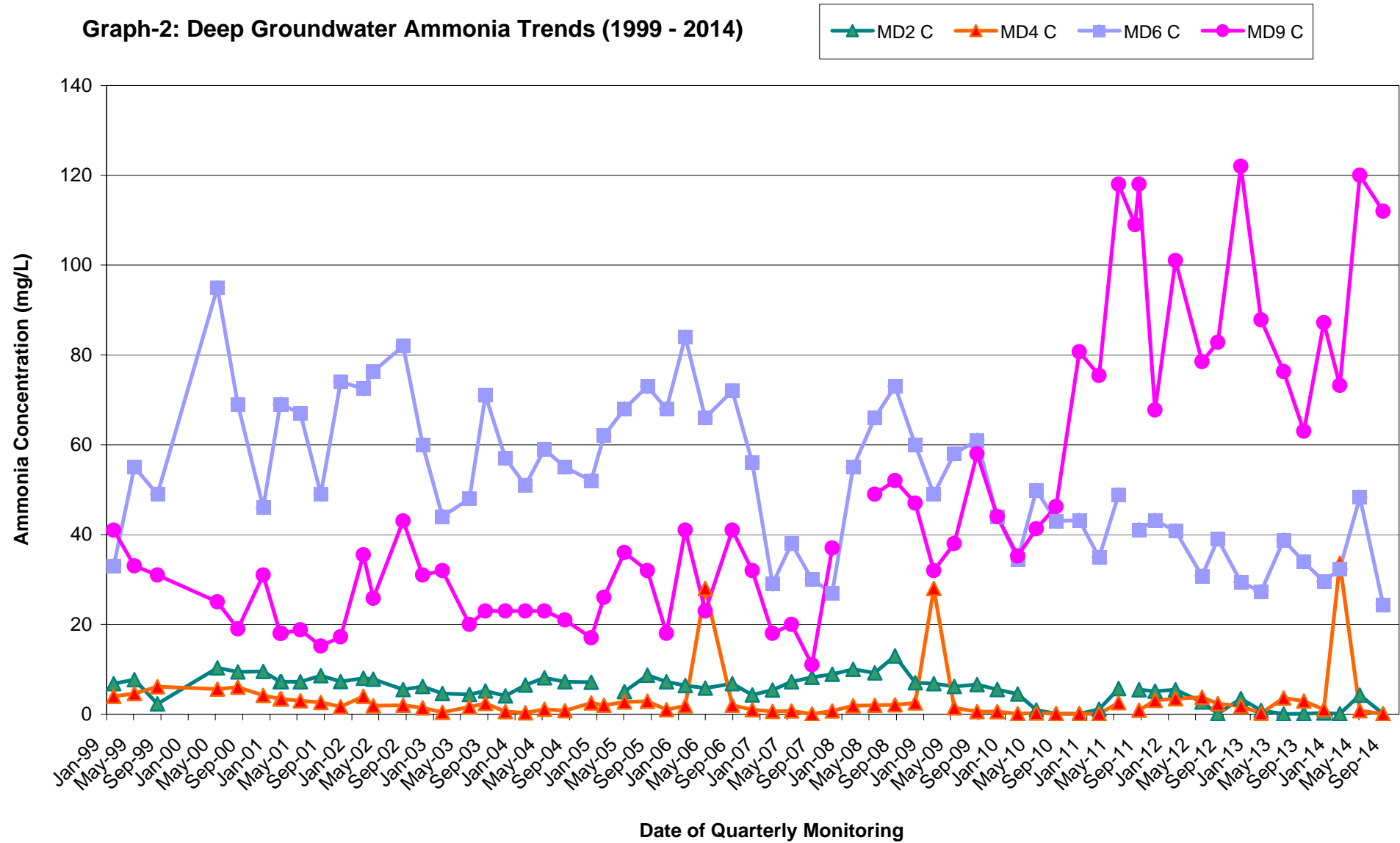
**Legend**

NA = Not Analysed    NM= Not measured

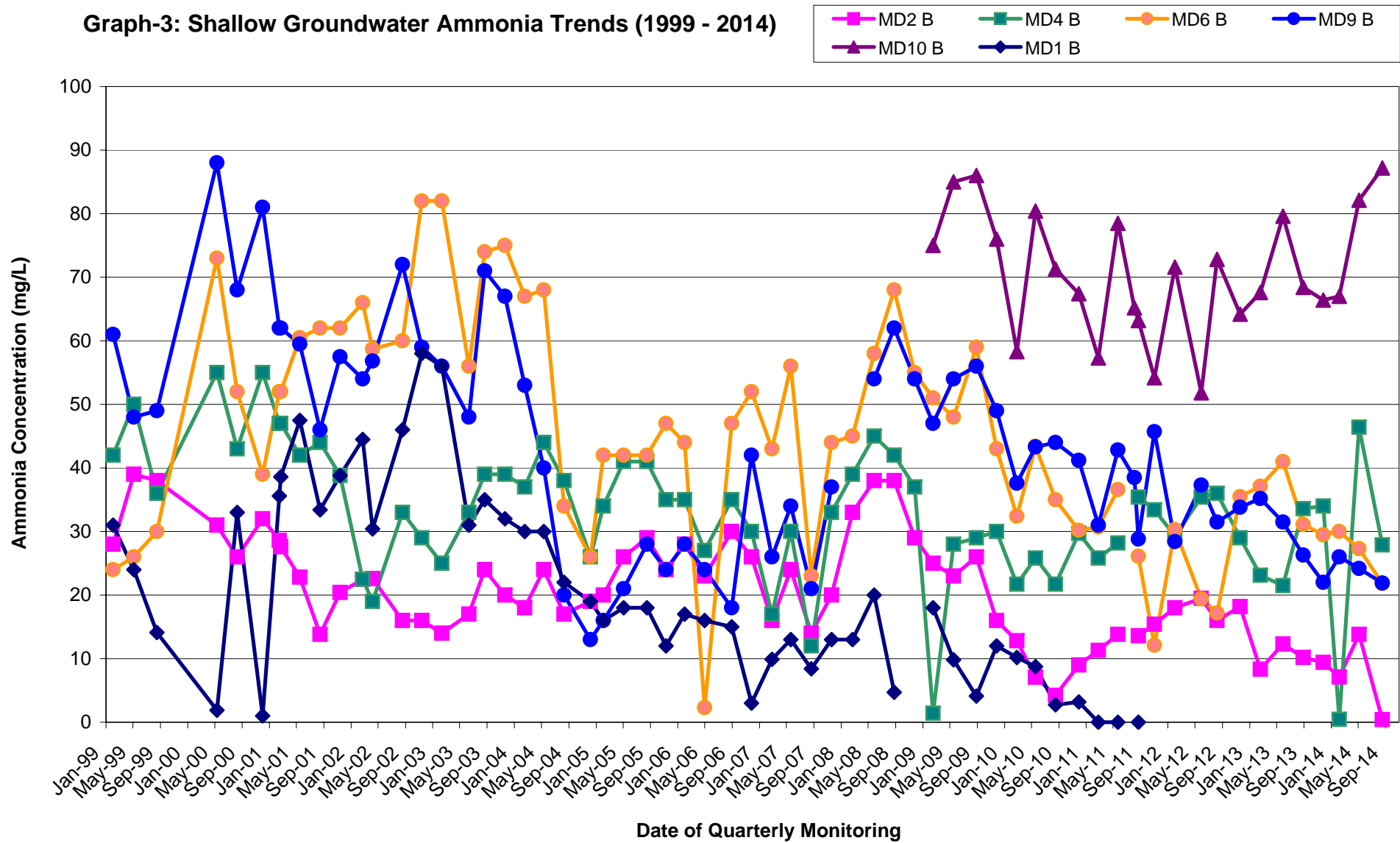
Note: Rocklow Down was inaccessible during the 2010-2014 monitoring periods

## Graphs

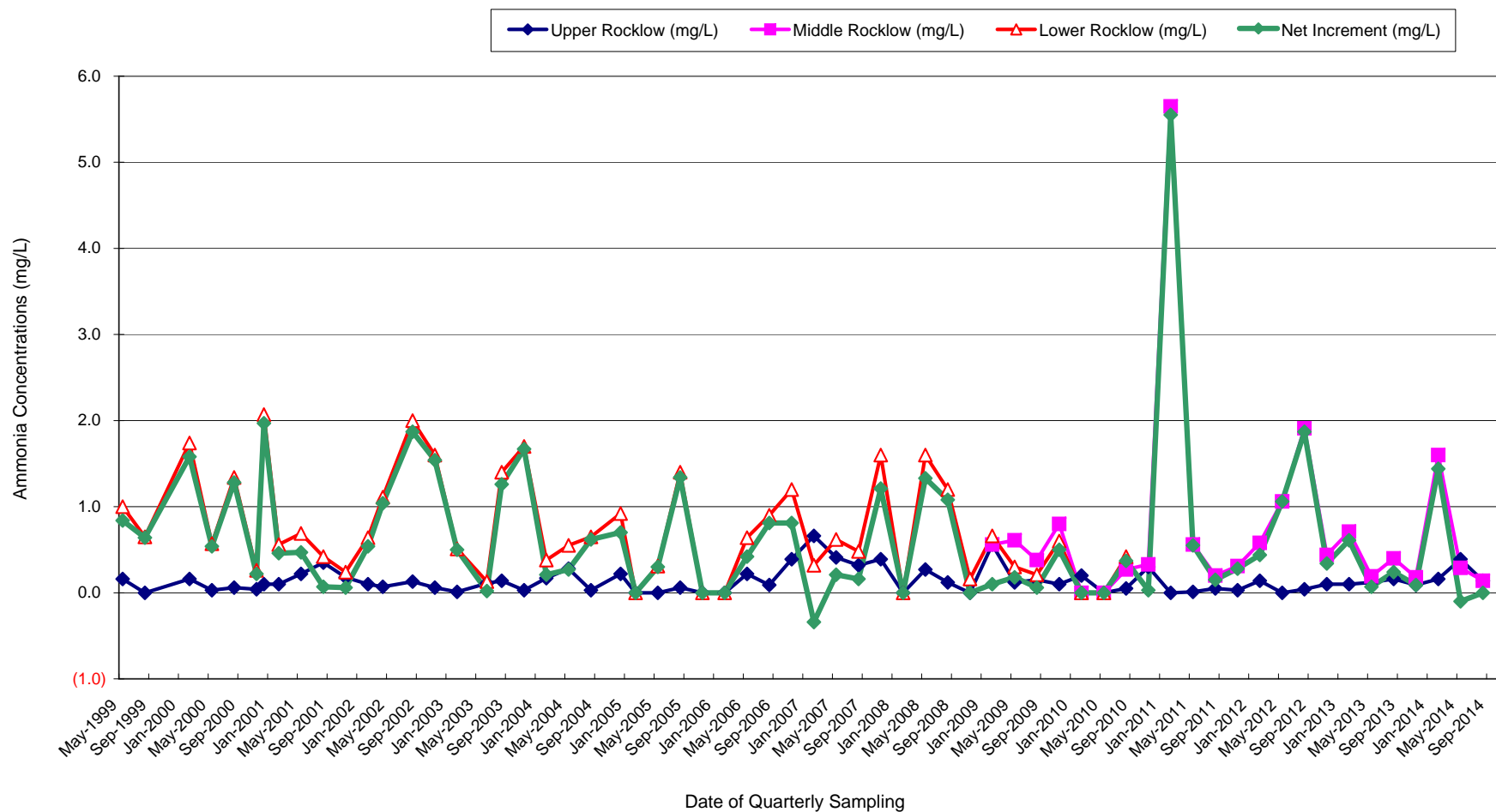
**Graph-1: Groundwater Ammonia Concentrations (mg/L) All Wells (1999 to 2014)**

**Graph-2: Deep Groundwater Ammonia Trends (1999 - 2014)**



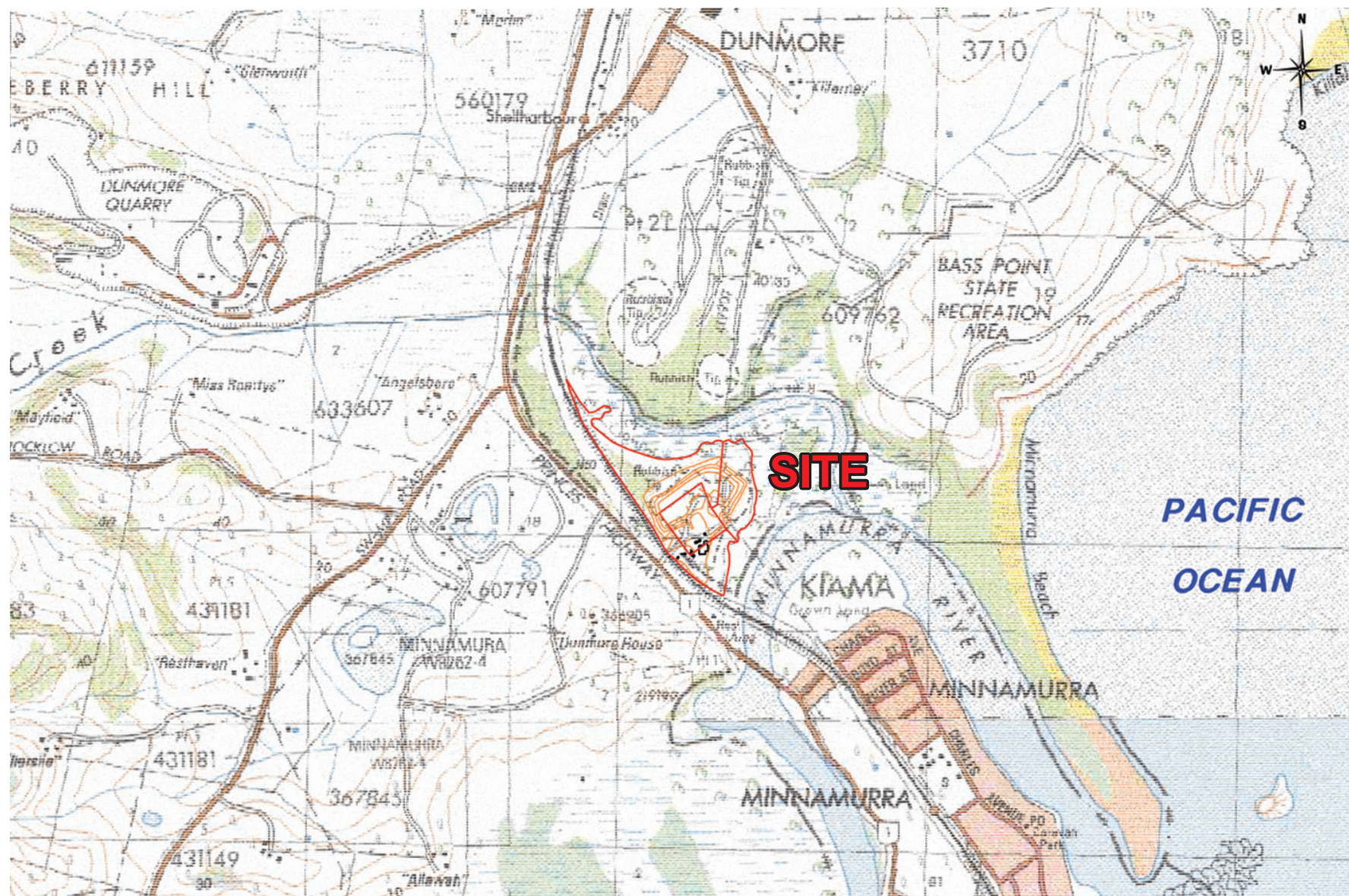
**Graph-3: Shallow Groundwater Ammonia Trends (1999 - 2014)**

**Graph-04: Net Increments of Ammonia Between Up and Down Stream Samples (1999 to 2014)**



## Figures












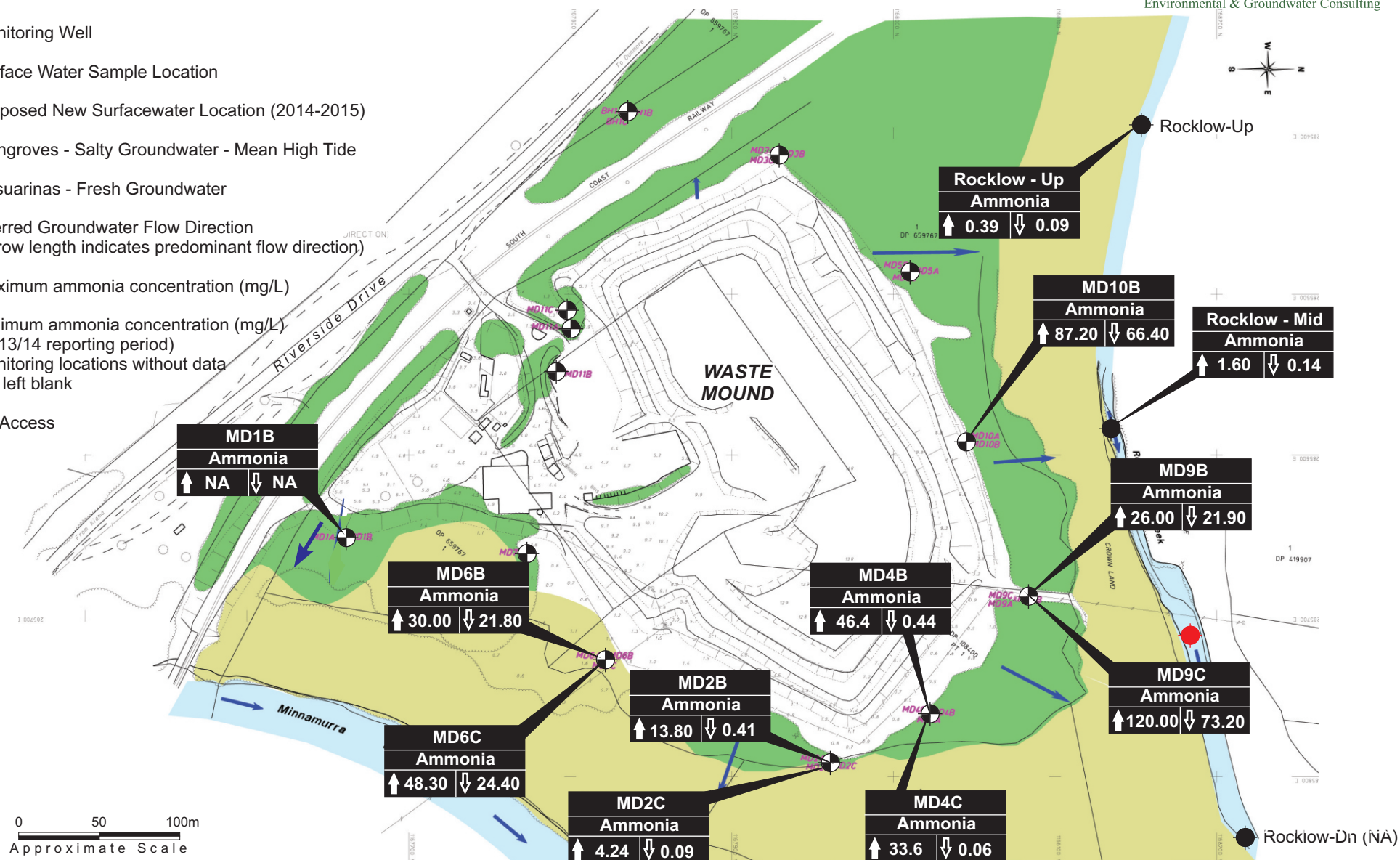


**SITE LOCATION**



# LEGEND

-  Monitoring Well
-  Surface Water Sample Location
-  Proposed New Surfacewater Location (2014-2015)
-  Mangroves - Salty Groundwater - Mean High Tide
-  Casuarinas - Fresh Groundwater
-  Inferred Groundwater Flow Direction  
(Arrow length indicates predominant flow direction)
-  **↑ 3.2** Maximum ammonia concentration (mg/L)
-  **↓ 0.4** Minimum ammonia concentration (mg/L)  
(2013/14 reporting period)  
Monitoring locations without data are left blank
-  **NA** No Access



Source: Neil Charters Pty Ltd

## MONITORING WELL LOCATIONS & MAXIMUM & MINIMUM AMMONIA CONCENTRATION (2013-2014)

Date: 17 Nov 2014

KIAMA COUNCIL - MINNAMURRA ANNUAL MONITORING REPORT (2013-2014)

Reference: E2W\_059\_04.cdr

Figure 2

## Appendix A





Environmental

## CERTIFICATE OF ANALYSIS

Work Order	: <b>EW1303365</b>	Page	: 1 of 10
Client	: <b>KIAMA COUNCIL</b>	Laboratory	: Environmental Division NSW South Coast
Contact	: MR PAUL CZULOWSKI	Contact	: Glenn Davies
Address	: 11 MANNING STREET KIAMA NSW, AUSTRALIA 2533	Address	: 99 Kenny Street, Wollongong 2500 Unit 4 / 13 Geary Place, PO Box 3105, North Nowra 2541 AUSTRALIA
E-mail	: paulc@kiama.nsw.gov.au	E-mail	: glenn.davies@alsglobal.com
Telephone	: +61 02 4232 0444	Telephone	: 02 4225 3125
Facsimile	: +61 02 4232 0555	Facsimile	: 02 4225 3128
Project	: Minnamurra Landfill	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 26-NOV-2013
Sampler	: Craig Wilson	Issue Date	: 04-DEC-2013
Site	: ----		
Quote number	: Minnamurra Landfill WL/083/11	No. of samples received	: 19
		No. of samples analysed	: 19

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

Accredited for compliance with  
ISO/IEC 17025.

### Signatories

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

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong

Address 99 Kenny Street, Wollongong 2500

Environmental Division NSW South Coast, PO Box 3105, North Nowra 2541, Australia. An ALS Limited Company

Environmental

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## 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.

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

- **ED041G: LOR raised for Sulfate analysis on sample ID(MD 9C & MD 10B) due to sample matrix.**
- **EG020: Sample EW1303365 - 4 was diluted and rerun due to matrix interference and LOR's have been raised accordingly.**
- **EP002: It has been noted that DOC is greater than TOC for various samples, however this difference is within the limits of experimental variation.**
- **Ionic Balance out of acceptable limits for samples 3 and 4 due to analytes not quantified in this report.**
- **Sites MD2A, MD4A, MD6A, MD9A and MD10A - Dry at time of sampling.**  
**Sites MD1B & Rocklow Down - No Access due to site overgrown**



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				26-NOV-2013 10:20	26-NOV-2013 08:20	26-NOV-2013 08:23	26-NOV-2013 08:30	26-NOV-2013 08:44
Compound	CAS Number	LOR	Unit	EW1303365-001	EW1303365-002	EW1303365-003	EW1303365-004	EW1303365-005
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	----	----	<1	<1	----
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	----	----	<1	<1	----
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	----	----	750	494	----
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	----	750	494	----
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	----	----	1030	2100	----
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	----	6820	13600	----
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	----	392	474	----
Magnesium	7439-95-4	1	mg/L	----	----	522	1090	----
Sodium	7440-23-5	1	mg/L	----	----	4410	8860	----
Potassium	7440-09-7	1	mg/L	----	----	252	483	----
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	----	0.072	0.055	----
Iron	7439-89-6	0.05	mg/L	----	----	0.30	<0.50	----
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	----	0.7	0.6	----
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	----	9.41	0.28	----
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	----	0.10	<0.01	----
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	----	----	2.30	0.96	----
<b>EK059G: Nitrite plus Nitrate as N (NO<sub>x</sub>) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	----	2.40	0.96	----
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	----	229	437	----
Total Cations	----	0.01	meq/L	----	----	261	511	----
Ionic Balance	----	0.01	%	----	----	6.52	7.78	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	----	7.3	7.4	----



## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				26-NOV-2013 10:20	26-NOV-2013 08:20	26-NOV-2013 08:23	26-NOV-2013 08:30	26-NOV-2013 08:44
Compound	CAS Number	LOR	Unit	EW1303365-001	EW1303365-002	EW1303365-003	EW1303365-004	EW1303365-005
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	----	21700	42500	----
Dissolved Oxygen	----	0.01	mg/L	----	----	2.33	3.66	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	----	24.4	38.1	----
Temperature	----	0.1	°C	----	----	16.5	16.7	----
Salinity	----	0.2	g/L	----	----	14.8	30.8	----
Depth	----	0.01	m	----	----	0.75	0.81	----
Field Observations	----	0.01	--	NO ACCESS	DRY	----	----	DRY
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	----	51	22	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	----	48	19	----
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	----	<0.05	<0.05	----

## Sub-Matrix: WATER (Matrix: WATER)

*Client sample ID*

*Client sampling date / time*

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
Client sampling date / time				26-NOV-2013 08:46	26-NOV-2013 08:55	26-NOV-2013 07:47	26-NOV-2013 07:50	26-NOV-2013 08:05	
Compound	CAS Number	LOR	Unit	EW1303365-006	EW1303365-007	EW1303365-008	EW1303365-009	EW1303365-010	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	<1	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	<1	<1	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	831	706	----	873	429	
Total Alkalinity as CaCO3	----	1	mg/L	831	706	----	873	429	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	438	1600	----	105	1130	
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L	3040	10300	----	179	7730	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	402	378	----	177	371	
Magnesium	7439-95-4	1	mg/L	242	771	----	74	584	
Sodium	7440-23-5	1	mg/L	1460	6200	----	132	4560	
Potassium	7440-09-7	1	mg/L	129	309	----	58	206	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.106	0.163	----	0.175	0.073	
Iron	7439-89-6	0.05	mg/L	3.28	0.32	----	0.29	<0.05	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	0.4	0.6	----	0.4	0.4	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	34.0	1.05	----	29.5	29.5	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L	0.03	0.02	----	0.04	0.05	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.05	0.95	----	0.19	0.05	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.08	0.97	----	0.23	0.10	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	111	338	----	24.7	250	
Total Cations	----	0.01	meq/L	107	360	----	----	270	
Total Cations	----	0.01	meq/L	----	----	----	24.2	----	
Ionic Balance	----	0.01	%	2.15	3.13	----	----	3.84	
Ionic Balance	----	0.01	%	----	----	----	0.97	----	
EN67 PK: Field Tests									



## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
				26-NOV-2013 08:46	26-NOV-2013 08:55	26-NOV-2013 07:47	26-NOV-2013 07:50	26-NOV-2013 08:05
Compound	CAS Number	LOR	Unit	EW1303365-006	EW1303365-007	EW1303365-008	EW1303365-009	EW1303365-010
<b>EN67 PK: Field Tests - Continued</b>								
pH	----	0.1	pH Unit	7.2	7.1	----	7.1	7.1
Electrical Conductivity (Non Compensated)	----	1	µS/cm	10300	32900	----	2180	24900
Dissolved Oxygen	----	0.01	mg/L	2.38	2.13	----	2.56	1.67
Dissolved Oxygen - % Saturation	----	0.1	% saturation	24.6	22.1	----	26.9	17.9
Temperature	----	0.1	°C	16.3	16.4	----	17.2	17.4
Salinity	----	0.2	g/L	7.1	23.4	----	<2.0	16.9
Depth	----	0.01	m	1.19	1.20	----	1.30	1.41
Field Observations	----	0.01	--	----	----	DRY	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	55	38	----	63	19
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	50	36	----	58	17
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	<0.05	<0.05	----	<0.05	<0.05



## Sub-Matrix: WATER (Matrix: WATER)

*Client sample ID*

Client sampling date / time

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
Client sampling date / time				26-NOV-2013 09:40	26-NOV-2013 09:44	26-NOV-2013 10:00	26-NOV-2013 09:21	26-NOV-2013 09:25	
Compound	CAS Number	LOR	Unit	EW1303365-011	EW1303365-012	EW1303365-013	EW1303365-014	EW1303365-015	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	----	<1	<1	----	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	----	<1	<1	----	<1	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	----	955	1270	----	798	
Total Alkalinity as CaCO3	----	1	mg/L	----	955	1270	----	798	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	90	<10	----	<10	
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L	----	331	545	----	236	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	182	213	----	126	
Magnesium	7439-95-4	1	mg/L	----	92	96	----	45	
Sodium	7440-23-5	1	mg/L	----	212	337	----	136	
Potassium	7440-09-7	1	mg/L	----	73	126	----	88	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	0.297	0.690	----	0.422	
Iron	7439-89-6	0.05	mg/L	----	5.84	7.29	----	0.89	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	----	0.6	0.4	----	0.8	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	----	22.0	60.9	----	66.4	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L	----	0.02	0.01	----	0.02	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	----	0.89	3.13	----	0.05	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.91	3.14	----	0.07	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	----	30.3	40.8	----	22.6	
Total Cations	----	0.01	meq/L	----	27.7	----	----	----	
Total Cations	----	0.01	meq/L	----	----	40.7	----	22.9	
Ionic Balance	----	0.01	%	----	4.39	----	----	----	
Ionic Balance	----	0.01	%	----	----	0.12	----	0.51	
EN67 PK: Field Tests									



## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
				26-NOV-2013 09:40	26-NOV-2013 09:44	26-NOV-2013 10:00	26-NOV-2013 09:21	26-NOV-2013 09:25
Compound	CAS Number	LOR	Unit	EW1303365-011	EW1303365-012	EW1303365-013	EW1303365-014	EW1303365-015
<b>EN67 PK: Field Tests - Continued</b>								
pH	----	0.1	pH Unit	----	7.1	6.9	----	7.2
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	2700	3850	----	2380
Dissolved Oxygen	----	0.01	mg/L	----	2.18	2.25	----	1.31
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	23.1	23.7	----	14.4
Temperature	----	0.1	°C	----	17.2	17.0	----	18.4
Salinity	----	0.2	g/L	----	<2.0	2.4	----	<2.0
Depth	----	0.01	m	----	0.89	0.95	----	0.77
Field Observations	----	0.01	--	DRY	----	----	DRY	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	63	127	----	78
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	95	115	----	66
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	<0.05	<0.05	----	<0.05

## Sub-Matrix: WATER (Matrix: WATER)

*Client sample ID*

Client sampling date / time

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
Client sampling date / time					26-NOV-2013 10:10	26-NOV-2013 09:10	26-NOV-2013 07:35	26-NOV-2013 08:00	----
Compound	CAS Number	LOR	Unit		EW1303365-016	EW1303365-017	EW1303365-018	EW1303365-019	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		----	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		----	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		----	112	49	----	----
Total Alkalinity as CaCO3	----	1	mg/L		----	112	49	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		----	390	256	----	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		----	2050	392	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		----	----	----	<1	----
Magnesium	7439-95-4	1	mg/L		----	----	----	<1	----
Sodium	7440-23-5	1	mg/L		----	----	----	<1	----
Potassium	7440-09-7	1	mg/L		----	----	----	<1	----
ED093T: Total Major Cations									
Calcium	7440-70-2	1	mg/L		----	88	62	----	----
Magnesium	7439-95-4	1	mg/L		----	159	42	----	----
Sodium	7440-23-5	1	mg/L		----	1340	256	----	----
Potassium	7440-09-7	1	mg/L		----	59	12	----	----
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L		----	----	----	<0.001	----
Iron	7439-89-6	0.05	mg/L		----	----	----	<0.05	----
EG020T: Total Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L		----	0.195	0.670	----	----
Iron	7439-89-6	0.05	mg/L		----	0.44	0.89	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		----	0.4	0.2	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		----	0.18	0.09	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L		----	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		----	0.09	0.03	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									



## Analytical Results

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

Client sample ID

Client sampling date / time

				Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
				26-NOV-2013 10:10	26-NOV-2013 09:10	26-NOV-2013 07:35	26-NOV-2013 08:00	----
Compound	CAS Number	LOR	Unit	EW1303365-016	EW1303365-017	EW1303365-018	EW1303365-019	----
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.09	0.03	----	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	7.3	6.9	----	----
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	6980	1810	----	----
Dissolved Oxygen	----	0.01	mg/L	----	6.04	6.66	----	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	63.5	70.7	----	----
Temperature	----	0.1	°C	----	16.9	17.6	----	----
Salinity	----	0.2	g/L	----	4.6	<2.0	----	----
Field Observations	----	0.01	--	NO ACCESS	----	----	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	14	7	<1	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	13	6	----	----
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	<0.05	<0.05	----	----

## CERTIFICATE OF ANALYSIS

Work Order	: <b>EW1400213</b>	Page	: 1 of 10
Client	: <b>KIAMA COUNCIL</b>	Laboratory	: Environmental Division NSW South Coast
Contact	: MR PAUL CZULOWSKI	Contact	: Glenn Davies
Address	: 11 MANNING STREET KIAMA NSW, AUSTRALIA 2533	Address	: 99 Kenny Street, Wollongong 2500 Unit 4 / 13 Geary Place, PO Box 3105, North Nowra 2541 AUSTRALIA
E-mail	: paulc@kiama.nsw.gov.au	E-mail	: glenn.davies@alsglobal.com
Telephone	: +61 02 4232 0444	Telephone	: 02 4225 3125
Facsimile	: +61 02 4232 0555	Facsimile	: 02 4225 3128
Project	: Minnamurra Landfill	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 06-FEB-2014
Sampler	: Craig Wilson	Issue Date	: 17-FEB-2014
Site	: ----		
Quote number	: Minnamurra Landfill WL/083/11	No. of samples received	: 19
		No. of samples analysed	: 19

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

Accredited for compliance with  
ISO/IEC 17025.

### Signatories

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

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong
Raymond Commodor	Instrument Chemist	Sydney Inorganics
Shobhna Chandra	Metals Coordinator	Sydney Inorganics

Address 99 Kenny Street, Wollongong 2500

Environmental Division NSW South Coast, PO Box 3105, North Nowra 2541

An ALS Limited Company



## 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

- Dissolved Organic Carbon by EP002 is conducted by ALS Melbourne, NATA accreditation no. 825, site no 13778.
- ED041G:LOR raised for Sulfate analysis on sample ID(MD 9C & MD 10B) due to sample matrix.
- ED093: An aliquot from the acid preserved bottle was used, as no natural bottle was supplied for analysis.
- Ionic Balance out of acceptable limits for various samples due to analytes not quantified in this report.
- It is recognised that total organic carbon is less than dissolved organic carbon for samples #6. However, the difference is within experimental variation of the methods.
- Sites MD2A, MD4A, MD6A, MD9A and MD10A - Dry at time of sampling.  
Sites MD1B and Rocklow Down - Sites overgrown no access at time of sampling.
- Total Organic Carbon by EP005 is conducted by ALS Melbourne, NATA accreditation no. 825, site no 13778.



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				06-FEB-2014 10:35	06-FEB-2014 08:25	06-FEB-2014 08:30	06-FEB-2014 08:40	06-FEB-2014 08:55
Compound	CAS Number	LOR	Unit	EW1400213-001	EW1400213-002	EW1400213-003	EW1400213-004	EW1400213-005
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	----	----	<1	<1	----
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	----	----	<1	<1	----
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	----	----	687	459	----
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	----	687	459	----
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	----	----	1030	2030	----
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	----	6720	12700	----
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	----	385	483	----
Magnesium	7439-95-4	1	mg/L	----	----	557	1160	----
Sodium	7440-23-5	1	mg/L	----	----	4650	10100	----
Potassium	7440-09-7	1	mg/L	----	----	233	430	----
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	----	0.068	<0.010	----
Iron	7439-89-6	0.05	mg/L	----	----	<0.50	<0.50	----
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	----	0.3	0.3	----
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	----	7.10	0.09	----
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	----	0.10	<0.01	----
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	----	----	3.28	0.06	----
<b>EK059G: Nitrite plus Nitrate as N (NO<sub>x</sub>) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	----	3.38	0.06	----
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	----	225	410	----
Total Cations	----	0.01	meq/L	----	----	273	570	----
Ionic Balance	----	0.01	%	----	----	9.74	16.3	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	----	7.4	7.4	----





## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				06-FEB-2014 10:35	06-FEB-2014 08:25	06-FEB-2014 08:30	06-FEB-2014 08:40	06-FEB-2014 08:55
Compound	CAS Number	LOR	Unit	EW1400213-001	EW1400213-002	EW1400213-003	EW1400213-004	EW1400213-005
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	----	23000	42800	----
Dissolved Oxygen	----	0.01	mg/L	----	----	3.81	3.51	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	----	41.7	38.1	----
Temperature	----	0.1	°C	----	----	18.3	18.8	----
Salinity	----	0.2	g/L	----	----	14.6	29.1	----
Depth	----	0.01	m	----	----	0.79	0.84	----
Field Observations	----	0.01	--	NO ACCESS	DRY	----	----	DRY
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	----	35	16	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	----	35	17	----
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	----	<0.05	<0.05	----



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
				06-FEB-2014 09:00	06-FEB-2014 09:10	06-FEB-2014 08:00	06-FEB-2014 08:05	06-FEB-2014 08:15
Compound	CAS Number	LOR	Unit	EW1400213-006	EW1400213-007	EW1400213-008	EW1400213-009	EW1400213-010
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	<1	<1	----	<1	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	<1	<1	----	<1	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	779	665	----	814	371
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	779	665	----	814	371
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	424	1480	----	91	1100
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	2910	9560	----	172	7290
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	454	414	----	177	386
Magnesium	7439-95-4	1	mg/L	247	843	----	72	610
Sodium	7440-23-5	1	mg/L	1660	7350	----	142	5030
Potassium	7440-09-7	1	mg/L	132	313	----	56	201
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.175	0.080	----	0.154	0.086
Iron	7439-89-6	0.05	mg/L	<0.50	2.25	----	0.27	2.02
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.3	0.3	----	0.3	0.2
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	0.44	33.6	----	30.0	32.4
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	0.03	<0.01	----	0.09	0.08
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	0.52	0.81	----	0.76	0.27
<b>EK059G: Nitrite plus Nitrate as N (NO<sub>x</sub>) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	0.55	0.81	----	0.85	0.35
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	106	314	----	23.0	236
Total Cations	----	0.01	meq/L	118	418	----	22.4	293
Ionic Balance	----	0.01	%	5.37	14.2	----	1.41	10.8
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	7.1	7.3	----	7.0	7.1



## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
				06-FEB-2014 09:00	06-FEB-2014 09:10	06-FEB-2014 08:00	06-FEB-2014 08:05	06-FEB-2014 08:15
Compound	CAS Number	LOR	Unit	EW1400213-006	EW1400213-007	EW1400213-008	EW1400213-009	EW1400213-010
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	10600	9980	----	2190	24500
Dissolved Oxygen	----	0.01	mg/L	2.19	2.93	----	3.01	2.08
Dissolved Oxygen - % Saturation	----	0.1	% saturation	23.8	32.0	----	32.8	22.6
Temperature	----	0.1	°C	18.2	18.6	----	18.9	18.7
Salinity	----	0.2	g/L	6.4	6.5	----	<2.0	15.9
Depth	----	0.01	m	1.25	1.26	----	1.40	1.53
Field Observations	----	0.01	--	----	----	DRY	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	27	42	----	46	13
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	26	42	----	46	13
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	<0.05	<0.05	----	<0.05	<0.05

## Sub-Matrix: WATER (Matrix: WATER)

*Client sample ID*

Client sampling date / time

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
Client sampling date / time				06-FEB-2014 10:00	06-FEB-2014 10:05	06-FEB-2014 10:15	06-FEB-2014 09:40	06-FEB-2014 09:45	
Compound	CAS Number	LOR	Unit	EW1400213-011	EW1400213-012	EW1400213-013	EW1400213-014	EW1400213-015	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	----	<1	<1	----	<1	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	----	<1	<1	----	<1	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	----	898	1300	----	794	
Total Alkalinity as CaCO3	----	1	mg/L	----	898	1300	----	794	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	70	<10	----	<10	
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L	----	347	508	----	261	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	190	220	----	128	
Magnesium	7439-95-4	1	mg/L	----	97	99	----	46	
Sodium	7440-23-5	1	mg/L	----	230	334	----	138	
Potassium	7440-09-7	1	mg/L	----	83	116	----	92	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	0.260	0.584	----	0.422	
Iron	7439-89-6	0.05	mg/L	----	7.20	7.88	----	0.87	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	----	0.4	0.3	----	0.6	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	----	26.0	73.2	----	67.0	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L	----	0.03	<0.01	----	0.20	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	----	0.51	1.73	----	1.54	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.54	1.73	----	1.74	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	----	29.2	40.3	----	23.2	
Total Cations	----	0.01	meq/L	----	29.6	36.6	----	----	
Total Cations	----	0.01	meq/L	----	----	----	----	23.3	
Ionic Balance	----	0.01	%	----	0.69	4.79	----	----	
Ionic Balance	----	0.01	%	----	----	----	----	0.15	
EN67 PK: Field Tests									



## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
				06-FEB-2014 10:00	06-FEB-2014 10:05	06-FEB-2014 10:15	06-FEB-2014 09:40	06-FEB-2014 09:45
Compound	CAS Number	LOR	Unit	EW1400213-011	EW1400213-012	EW1400213-013	EW1400213-014	EW1400213-015
<b>EN67 PK: Field Tests - Continued</b>								
pH	----	0.1	pH Unit	----	7.0	7.0	----	7.1
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	2740	3560	----	2250
Dissolved Oxygen	----	0.01	mg/L	----	2.02	1.49	----	1.55
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	22.7	16.7	----	18.0
Temperature	----	0.1	°C	----	19.7	20.0	----	21.8
Salinity	----	0.2	g/L	----	<2.0	2.1	----	<2.0
Depth	----	0.01	m	----	0.90	0.99	----	0.71
Field Observations	----	0.01	--	DRY	----	----	DRY	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	47	99	----	59
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	47	98	----	59
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	<0.05	<0.05	----	<0.05

## Sub-Matrix: WATER (Matrix: WATER)

*Client sample ID*

Client sampling date / time

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
Client sampling date / time					06-FEB-2014 10:25	06-FEB-2014 09:30	06-FEB-2014 07:30	06-FEB-2014 09:20	----
Compound	CAS Number	LOR	Unit		EW1400213-016	EW1400213-017	EW1400213-018	EW1400213-019	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		----	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		----	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		----	208	181	----	----
Total Alkalinity as CaCO3	----	1	mg/L		----	208	181	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		----	1700	1490	----	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		----	11200	9850	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		----	----	----	<1	----
Magnesium	7439-95-4	1	mg/L		----	----	----	<1	----
Sodium	7440-23-5	1	mg/L		----	----	----	<1	----
Potassium	7440-09-7	1	mg/L		----	----	----	<1	----
ED093T: Total Major Cations									
Calcium	7440-70-2	1	mg/L		----	330	278	----	----
Magnesium	7439-95-4	1	mg/L		----	926	763	----	----
Sodium	7440-23-5	1	mg/L		----	7890	6440	----	----
Potassium	7440-09-7	1	mg/L		----	332	291	----	----
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L		----	----	----	<0.001	----
Iron	7439-89-6	0.05	mg/L		----	----	----	<0.05	----
EG020T: Total Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L		----	0.291	0.216	----	----
Iron	7439-89-6	0.05	mg/L		----	0.58	0.35	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		----	0.4	0.3	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		----	1.60	0.16	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L		----	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		----	0.03	0.04	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									



## Analytical Results

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

Client sample ID

Client sampling date / time

				Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
				06-FEB-2014 10:25	06-FEB-2014 09:30	06-FEB-2014 07:30	06-FEB-2014 09:20	----
Compound	CAS Number	LOR	Unit	EW1400213-016	EW1400213-017	EW1400213-018	EW1400213-019	----
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.03	0.04	----	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	7.0	7.7	----	----
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	37200	32900	----	----
Dissolved Oxygen	----	0.01	mg/L	----	2.24	6.94	----	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	25.0	75.1	----	----
Temperature	----	0.1	°C	----	19.4	18.9	----	----
Salinity	----	0.2	g/L	----	24.8	21.7	----	----
Field Observations	----	0.01	--	NO ACCESS	----	----	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	8	8	<1	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	8	9	----	----
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	<0.05	<0.05	----	----



## CERTIFICATE OF ANALYSIS

Work Order	: <b>EW1401339</b>	Page	: 1 of 10
Client	: <b>KIAMA COUNCIL</b>	Laboratory	: Environmental Division NSW South Coast
Contact	: MS JULIE MILEVSKI	Contact	: Glenn Davies
Address	: 11 MANNING STREET KIAMA NSW, AUSTRALIA 2533	Address	: 99 Kenny Street, Wollongong 2500 Unit 4 / 13 Geary Place, PO Box 3105, North Nowra 2541 AUSTRALIA
E-mail	: juliem@kiama.nsw.gov.au	E-mail	: glenn.davies@alsglobal.com
Telephone	: +61 02 4232 0444	Telephone	: 02 4225 3125
Facsimile	: +61 02 4232 0555	Facsimile	: 02 4225 3128
Project	: Minnamurra Landfill	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 06-MAY-2014
Sampler	: Craig Wilson	Issue Date	: 14-MAY-2014
Site	: ----		
Quote number	: Minnamurra Landfill WL/083/11	No. of samples received	: 19
		No. of samples analysed	: 19

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

Accredited for compliance with  
ISO/IEC 17025.

### Signatories

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

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong
Shobhna Chandra	Metals Coordinator	Sydney Inorganics
Wisam Marassa	Inorganics Coordinator	Sydney Inorganics

Address 99 Kenny Street, Wollongong 2500

Environmental Division NSW South Coast, PO Box 3105, North Nowra 2541

An ALS Limited Company



## 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

- **EK057G: Poor spike recovery for Nitrite due to matrix interferences (confirmed by re-analysis)**
- **EP002 : It has been noted that DOC is greater than TOC for sample ID MD 2C and MD 4C, however this difference is within the limits of experimental variation.**
- **EP005 : NPOC analysis was carried out for various samples due to high inorganic carbon content.**
- **Ionic Balance out of acceptable limits due to analytes not quantified in this report.**
- **It has been noted that Nitrie is greater than NOx for sample ID (MD 10B) , however this difference is within the limits of experimental variation.**
- **Sampling and sample data supplied by ALS Wollongong.**
- **Sites MD1B & Rocklow Down - No Access site too overgrown**  
**Sites MD2A, MD4A, MD6A, MD9A and MD10A - Dry at time of sampling.**



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				06-MAY-2014 11:46	06-MAY-2014 10:07	06-MAY-2014 10:10	06-MAY-2014 10:18	06-MAY-2014 10:30
Compound	CAS Number	LOR	Unit	EW1401339-001	EW1401339-002	EW1401339-003	EW1401339-004	EW1401339-005
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	----	----	<1	<1	----
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	----	----	<1	<1	----
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	----	----	795	547	----
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	----	795	547	----
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	----	----	1410	2400	----
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	----	8120	13100	----
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	----	342	425	----
Magnesium	7439-95-4	1	mg/L	----	----	614	973	----
Sodium	7440-23-5	1	mg/L	----	----	4830	7320	----
Potassium	7440-09-7	1	mg/L	----	----	261	413	----
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	----	0.088	0.135	----
Iron	7439-89-6	0.05	mg/L	----	----	1.09	1.32	----
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	----	0.7	0.7	----
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	----	13.8	4.24	----
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	----	<0.01	<0.01	----
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	----	----	<0.01	<0.01	----
<b>EK059G: Nitrite plus Nitrate as N (NO<sub>x</sub>) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	----	<0.01	<0.01	----
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	----	274	430	----
Total Cations	----	0.01	meq/L	----	----	284	430	----
Ionic Balance	----	0.01	%	----	----	1.79	0.03	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	----	7.0	7.0	----



## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				06-MAY-2014 11:46	06-MAY-2014 10:07	06-MAY-2014 10:10	06-MAY-2014 10:18	06-MAY-2014 10:30
Compound	CAS Number	LOR	Unit	EW1401339-001	EW1401339-002	EW1401339-003	EW1401339-004	EW1401339-005
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	----	23200	36800	----
Dissolved Oxygen	----	0.01	mg/L	----	----	3.24	2.04	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	----	37.6	25.0	----
Temperature	----	0.1	°C	----	----	17.6	16.8	----
Salinity	----	0.2	g/L	----	----	16.6	28.2	----
Depth	----	0.01	m	----	----	0.57	0.64	----
Field Observations	----	0.01	--	NO ACCESS	DRY	----	----	DRY
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	----	29	14	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	----	29	13	----
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	----	<0.05	<0.05	----



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
				06-MAY-2014 10:32	06-MAY-2014 10:40	06-MAY-2014 09:48	06-MAY-2014 09:50	06-MAY-2014 09:55
Compound	CAS Number	LOR	Unit	EW1401339-006	EW1401339-007	EW1401339-008	EW1401339-009	EW1401339-010
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	<1	<1	----	<1	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	<1	<1	----	<1	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	942	403	----	919	451
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	942	403	----	919	451
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	441	1900	----	76	1530
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	2980	11600	----	165	8890
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	422	383	----	192	365
Magnesium	7439-95-4	1	mg/L	234	890	----	70	702
Sodium	7440-23-5	1	mg/L	1600	6880	----	159	5340
Potassium	7440-09-7	1	mg/L	144	382	----	78	242
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.092	0.163	----	0.147	0.061
Iron	7439-89-6	0.05	mg/L	1.67	1.31	----	0.30	19.5
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.5	0.9	----	0.4	0.5
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	46.4	0.79	----	27.3	48.3
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	----	<0.01	<0.01
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	----	0.02	0.02
<b>EK059G: Nitrite plus Nitrate as N (NO<sub>x</sub>) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	----	0.02	0.02
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	112	375	----	24.6	292
Total Cations	----	0.01	meq/L	114	401	----	24.2	314
Ionic Balance	----	0.01	%	0.68	3.41	----	0.70	3.75
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	7.0	7.0	----	6.8	7.2



## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
				06-MAY-2014 10:32	06-MAY-2014 10:40	06-MAY-2014 09:48	06-MAY-2014 09:50	06-MAY-2014 09:55
Compound	CAS Number	LOR	Unit	EW1401339-006	EW1401339-007	EW1401339-008	EW1401339-009	EW1401339-010
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	9050	33800	----	1980	26000
Dissolved Oxygen	----	0.01	mg/L	4.35	2.84	----	3.90	2.40
Dissolved Oxygen - % Saturation	----	0.1	% saturation	46.7	34.0	----	45.4	29.0
Temperature	----	0.1	°C	17.0	16.3	----	21.8	19.0
Salinity	----	0.2	g/L	6.1	26.0	----	1.1	18.1
Depth	----	0.01	m	1.00	1.08	----	1.15	1.28
Field Observations	----	0.01	--	----	----	DRY	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	8	----	35	7
Nonpurgeable Dissolved Organic Carbon	----	1	mg/L	32	----	----	----	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	5	----	----	10
Nonpurgeable Organic Carbon	----	1	mg/L	34	----	----	42	----
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	<0.05	<0.05	----	<0.05	<0.05



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
				06-MAY-2014 11:27	06-MAY-2014 11:29	06-MAY-2014 11:35	06-MAY-2014 10:50	06-MAY-2014 10:54
Compound	CAS Number	LOR	Unit	EW1401339-011	EW1401339-012	EW1401339-013	EW1401339-014	EW1401339-015
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	----	<1	<1	----	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	----	<1	<1	----	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	----	1130	1480	----	897
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	1130	1480	----	897
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	----	52	12	----	24
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	329	514	----	218
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	134	202	----	134
Magnesium	7439-95-4	1	mg/L	----	97	91	----	48
Sodium	7440-23-5	1	mg/L	----	242	348	----	147
Potassium	7440-09-7	1	mg/L	----	70	152	----	106
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	0.268	0.367	----	0.335
Iron	7439-89-6	0.05	mg/L	----	5.36	9.23	----	0.54
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	0.6	0.6	----	0.9
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	24.2	120	----	82.1
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	<0.01	<0.01	----	0.02
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	----	0.11	0.02	----	<0.01
<b>EK059G: Nitrite plus Nitrate as N (NO<sub>x</sub>) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.11	0.02	----	0.01
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	32.9	44.3	----	24.6
Total Cations	----	0.01	meq/L	----	29.0	45.2	----	25.6
Ionic Balance	----	0.01	%	----	6.39	0.91	----	2.03
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	7.0	6.9	----	7.2





## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
				06-MAY-2014 11:27	06-MAY-2014 11:29	06-MAY-2014 11:35	06-MAY-2014 10:50	06-MAY-2014 10:54
Compound	CAS Number	LOR	Unit	EW1401339-011	EW1401339-012	EW1401339-013	EW1401339-014	EW1401339-015
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	2600	3720	----	2090
Dissolved Oxygen	----	0.01	mg/L	----	4.95	2.35	----	3.75
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	54.8	26.2	----	41.3
Temperature	----	0.1	°C	----	19.9	20.2	----	19.6
Salinity	----	0.2	g/L	----	1.5	2.2	----	1.2
Depth	----	0.01	m	----	0.78	0.81	----	0.49
Field Observations	----	0.01	--	DRY	----	----	DRY	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Nonpurgeable Dissolved Organic Carbon	----	1	mg/L	----	40	87	----	43
<b>EP005: Total Organic Carbon (TOC)</b>								
Nonpurgeable Organic Carbon	----	1	mg/L	----	40	90	----	48
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	<0.05	<0.05	----	<0.05

## Sub-Matrix: WATER (Matrix: WATER)

*Client sample ID*

*Client sampling date / time*

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
Client sampling date / time					06-MAY-2014 11:20	06-MAY-2014 11:03	06-MAY-2014 09:28	06-MAY-2014 09:32	----
Compound	CAS Number	LOR	Unit	EW1401339-016	EW1401339-017	EW1401339-018	EW1401339-019		----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	----	<1	<1	----		----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	----	<1	<1	----		----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	----	169	128	----		----
Total Alkalinity as CaCO3	----	1	mg/L	----	169	128	----		----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	798	646	----		----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L	----	5140	4160	----		----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	----	----	<1		----
Magnesium	7439-95-4	1	mg/L	----	----	----	<1		----
Sodium	7440-23-5	1	mg/L	----	----	----	<1		----
Potassium	7440-09-7	1	mg/L	----	----	----	<1		----
ED093T: Total Major Cations									
Calcium	7440-70-2	1	mg/L	----	130	109	----		----
Magnesium	7439-95-4	1	mg/L	----	358	281	----		----
Sodium	7440-23-5	1	mg/L	----	3360	2580	----		----
Potassium	7440-09-7	1	mg/L	----	127	98	----		----
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	----	----	<0.001		----
Iron	7439-89-6	0.05	mg/L	----	----	----	<0.05		----
EG020T: Total Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	0.250	0.239	----		----
Iron	7439-89-6	0.05	mg/L	----	0.83	2.37	----		----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	----	0.7	0.4	----		----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	----	0.29	0.39	----		----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L	----	0.02	0.03	----		----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	----	0.10	0.03	----		----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									



## Analytical Results

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

Client sample ID

Client sampling date / time

				Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
				06-MAY-2014 11:20	06-MAY-2014 11:03	06-MAY-2014 09:28	06-MAY-2014 09:32	----
Compound	CAS Number	LOR	Unit	EW1401339-016	EW1401339-017	EW1401339-018	EW1401339-019	----
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.12	0.06	----	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	7.2	6.4	----	----
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	13200	10300	----	----
Dissolved Oxygen	----	0.01	mg/L	----	7.32	7.90	----	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	77.0	80.0	----	----
Temperature	----	0.1	°C	----	14.9	14.0	----	----
Salinity	----	0.2	g/L	----	9.6	7.5	----	----
Field Observations	----	0.01	--	NO ACCESS	----	----	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	6	8	<1	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	7	8	----	----
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	<0.05	<0.05	----	----



Environmental

## CERTIFICATE OF ANALYSIS

Work Order	: <b>EW1402491</b>	Page	: 1 of 10
Client	: <b>KIAMA COUNCIL</b>	Laboratory	: Environmental Division NSW South Coast
Contact	: MR PAUL CZULOWSKI	Contact	: Glenn Davies
Address	: 11 MANNING STREET KIAMA NSW, AUSTRALIA 2533	Address	: 99 Kenny Street, Wollongong 2500 Unit 4 / 13 Geary Place, PO Box 3105, North Nowra 2541 AUSTRALIA
E-mail	: paulc@kiama.nsw.gov.au	E-mail	: glenn.davies@alsglobal.com
Telephone	: +61 02 4232 0444	Telephone	: 02 4225 3125
Facsimile	: +61 02 4232 0555	Facsimile	: 02 4225 3128
Project	: Minnamurra Landfill	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 18-AUG-2014
Sampler	: ----	Issue Date	: 28-AUG-2014
Site	: ----		
Quote number	: Minnamurra Landfill WL/083/11	No. of samples received	: 19
		No. of samples analysed	: 19

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results



NATA Accredited Laboratory 825

Accredited for compliance with  
ISO/IEC 17025.

### Signatories

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

Signatories	Position	Accreditation Category
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Dian Dao		Sydney Inorganics
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong



## 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

- **ED041G:LOR raised for Sulfate analysis on sample ID(MD 9C & MD 10B) due to sample matrix.**
- **EG020: 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.**
- **Ionic Balance out of acceptable limits due to analytes not quantified in this report.**
- **Sites MD2A, MD4A, MD6A, MD9A and MD10A - Dry at time of sampling.**



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				18-AUG-2014 10:25	18-AUG-2014 08:41	18-AUG-2014 08:47	18-AUG-2014 08:54	18-AUG-2014 09:02
Compound	CAS Number	LOR	Unit	EW1402491-001	EW1402491-002	EW1402491-003	EW1402491-004	EW1402491-005
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	----	----	<1	<1	----
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	----	----	<1	<1	----
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	----	----	580	439	----
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	----	580	439	----
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	----	----	1260	2420	----
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	----	7500	13500	----
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	----	342	421	----
Magnesium	7439-95-4	1	mg/L	----	----	532	1020	----
Sodium	7440-23-5	1	mg/L	----	----	4380	8870	----
Potassium	7440-09-7	1	mg/L	----	----	240	363	----
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	----	0.010	<0.010	----
Iron	7439-89-6	0.05	mg/L	----	----	<0.50	<0.50	----
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	----	0.7	0.7	----
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	----	0.41	0.11	----
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	----	0.15	0.02	----
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	----	----	7.20	1.39	----
<b>EK059G: Nitrite plus Nitrate as N (NO<sub>x</sub>) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	----	7.35	1.41	----
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	----	249	440	----
Total Cations	----	0.01	meq/L	----	----	258	500	----
Ionic Balance	----	0.01	%	----	----	1.59	6.38	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	----	7.4	7.3	----



## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				18-AUG-2014 10:25	18-AUG-2014 08:41	18-AUG-2014 08:47	18-AUG-2014 08:54	18-AUG-2014 09:02
Compound	CAS Number	LOR	Unit	EW1402491-001	EW1402491-002	EW1402491-003	EW1402491-004	EW1402491-005
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	----	19500	34300	----
Dissolved Oxygen	----	0.01	mg/L	----	----	3.10	2.90	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	----	33.2	33.8	----
Temperature	----	0.1	°C	----	----	14.1	14.2	----
Salinity	----	0.2	g/L	----	----	15.0	27.9	----
Depth	----	0.01	m	----	----	0.45	0.50	----
Field Observations	----	0.01	--	0	0	----	----	0
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	----	39	19	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	----	37	19	----
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	----	<0.05	<0.05	----





## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
				18-AUG-2014 09:06	18-AUG-2014 09:13	18-AUG-2014 08:15	18-AUG-2014 08:19	18-AUG-2014 08:27
Compound	CAS Number	LOR	Unit	EW1402491-006	EW1402491-007	EW1402491-008	EW1402491-009	EW1402491-010
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	<1	<1	----	<1	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	<1	<1	----	<1	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	700	547	----	718	306
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	700	547	----	718	306
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	473	1590	----	97	1360
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	2940	9620	----	142	7920
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	382	345	----	156	346
Magnesium	7439-95-4	1	mg/L	222	712	----	66	582
Sodium	7440-23-5	1	mg/L	1570	6710	----	168	5240
Potassium	7440-09-7	1	mg/L	156	276	----	61	186
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.072	<0.010	----	0.133	0.035
Iron	7439-89-6	0.05	mg/L	0.16	<0.50	----	0.12	<0.50
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.5	0.6	----	0.4	0.4
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	27.9	0.06	----	21.8	24.4
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	0.55	<0.01	----	0.14	0.09
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	8.13	0.40	----	1.27	3.30
<b>EK059G: Nitrite plus Nitrate as N (NO<sub>x</sub>) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	8.68	0.40	----	1.41	3.39
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	107	315	----	20.4	258
Total Cations	----	0.01	meq/L	110	375	----	22.1	298
Ionic Balance	----	0.01	%	1.31	8.58	----	4.03	7.19
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	7.3	7.8	----	7.1	7.0



## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
				18-AUG-2014 09:06	18-AUG-2014 09:13	18-AUG-2014 08:15	18-AUG-2014 08:19	18-AUG-2014 08:27
Compound	CAS Number	LOR	Unit	EW1402491-006	EW1402491-007	EW1402491-008	EW1402491-009	EW1402491-010
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	8430	25600	----	1640	21400
Dissolved Oxygen	----	0.01	mg/L	2.10	5.00	----	3.30	2.40
Dissolved Oxygen - % Saturation	----	0.1	% saturation	21.4	55.3	----	33.7	26.2
Temperature	----	0.1	°C	14.8	14.6	----	15.9	16.0
Salinity	----	0.2	g/L	5.9	20.0	----	1.0	15.8
Depth	----	0.01	m	0.86	0.89	----	1.01	1.14
Field Observations	----	0.01	--	----	----	0	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	44	26	----	43	12
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	43	26	----	43	10
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	<0.05	<0.05	----	<0.05	<0.05



## Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Client sample ID

Client sampling date / time

				MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
				18-AUG-2014 09:55	18-AUG-2014 10:00	18-AUG-2014 10:05	18-AUG-2014 09:30	18-AUG-2014 09:36
Compound	CAS Number	LOR	Unit	EW1402491-011	EW1402491-012	EW1402491-013	EW1402491-014	EW1402491-015
<b>ED037P: Alkalinity by PC Titrator</b>								
Hydroxide Alkalinity as CaCO <sub>3</sub>	DMO-210-001	1	mg/L	----	<1	<1	----	<1
Carbonate Alkalinity as CaCO <sub>3</sub>	3812-32-6	1	mg/L	----	<1	<1	----	<1
Bicarbonate Alkalinity as CaCO <sub>3</sub>	71-52-3	1	mg/L	----	939	1200	----	745
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	939	1200	----	745
<b>ED041G: Sulfate (Turbidimetric) as SO<sub>4</sub> 2- by DA</b>								
Sulfate as SO <sub>4</sub> - Turbidimetric	14808-79-8	1	mg/L	----	25	<10	----	<10
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	346	512	----	208
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	176	178	----	111
Magnesium	7439-95-4	1	mg/L	----	99	88	----	45
Sodium	7440-23-5	1	mg/L	----	298	398	----	156
Potassium	7440-09-7	1	mg/L	----	76	140	----	112
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	0.113	0.398	----	0.459
Iron	7439-89-6	0.05	mg/L	----	0.36	2.27	----	0.67
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	0.5	0.4	----	0.7
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	21.9	112	----	87.2
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	0.02	<0.01	----	0.01
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	----	0.01	<0.01	----	0.01
<b>EK059G: Nitrite plus Nitrate as N (NO<sub>x</sub>) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.03	<0.01	----	0.02
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	29.0	38.4	----	20.8
Total Cations	----	0.01	meq/L	----	31.8	37.0	----	18.9
Ionic Balance	----	0.01	%	----	4.58	1.86	----	4.69
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	7.1	7.1	----	7.4



## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
				18-AUG-2014 09:55	18-AUG-2014 10:00	18-AUG-2014 10:05	18-AUG-2014 09:30	18-AUG-2014 09:36
Compound	CAS Number	LOR	Unit	EW1402491-011	EW1402491-012	EW1402491-013	EW1402491-014	EW1402491-015
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	2320	3180	----	1850
Dissolved Oxygen	----	0.01	mg/L	----	3.10	2.10	----	3.20
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	30.4	20.5	----	31.5
Temperature	----	0.1	°C	----	14.7	14.7	----	15.1
Salinity	----	0.2	g/L	----	1.5	2.1	----	1.2
Depth	----	0.01	m	----	0.62	0.63	----	0.55
Field Observations	----	0.01	--	0	----	----	0	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	51	98	----	58
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	52	122	----	64
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	<0.05	<0.05	----	<0.05

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
Client sampling date / time				18-AUG-2014 10:20	18-AUG-2014 09:46	18-AUG-2014 08:05	18-AUG-2014 08:07	----	
Compound	CAS Number	LOR	Unit	EW1402491-016	EW1402491-017	EW1402491-018	EW1402491-019	----	
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	----	<1	<1	----	----	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	----	<1	<1	----	----	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	----	65	113	----	----	
Total Alkalinity as CaCO3	----	1	mg/L	----	65	113	----	----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	484	906	----	----	
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L	----	2860	5540	----	----	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	----	----	----	<1	----	
Magnesium	7439-95-4	1	mg/L	----	----	----	<1	----	
Sodium	7440-23-5	1	mg/L	----	----	----	<1	----	
Potassium	7440-09-7	1	mg/L	----	----	----	<1	----	
ED093T: Total Major Cations									
Calcium	7440-70-2	1	mg/L	----	87	199	----	----	
Magnesium	7439-95-4	1	mg/L	----	194	425	----	----	
Sodium	7440-23-5	1	mg/L	----	1740	3880	----	----	
Potassium	7440-09-7	1	mg/L	----	93	184	----	----	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	----	----	<0.001	----	
Iron	7439-89-6	0.05	mg/L	----	----	----	<0.05	----	
EG020T: Total Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	0.079	0.170	----	----	
Iron	7439-89-6	0.05	mg/L	----	0.82	0.53	----	----	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	----	0.4	0.5	----	----	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	----	0.14	0.14	----	----	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L	----	0.01	<0.01	----	----	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	----	0.40	0.08	----	----	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									



## Analytical Results

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

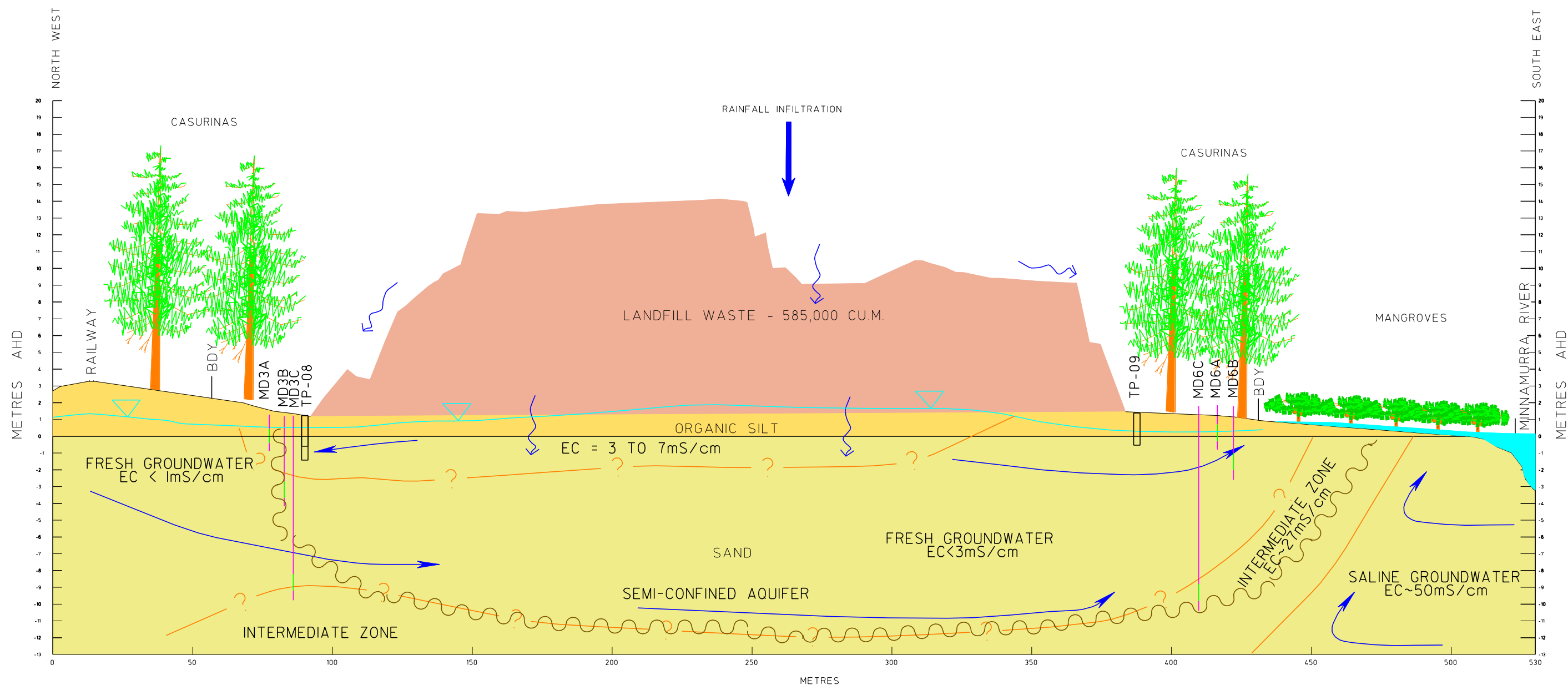
Client sample ID

Client sampling date / time

				Rocklow Down	Rocklow Middle	Rocklow Up	Blank	----
				18-AUG-2014 10:20	18-AUG-2014 09:46	18-AUG-2014 08:05	18-AUG-2014 08:07	----
Compound	CAS Number	LOR	Unit	EW1402491-016	EW1402491-017	EW1402491-018	EW1402491-019	----
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.41	0.08	----	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	7.3	7.1	----	----
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	7340	13800	----	----
Dissolved Oxygen	----	0.01	mg/L	----	7.00	7.50	----	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	69.4	77.1	----	----
Temperature	----	0.1	°C	----	13.1	13.6	----	----
Salinity	----	0.2	g/L	<0.2	5.4	10.4	----	----
Field Observations	----	0.01	--	0	----	----	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	10	8	<1	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	12	8	----	----
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	<0.05	<0.05	----	----

## Appendix B





SECTION B - B1

- LEGEND**
- INFERRED EXTENT OF LEACHATE PLUME
  - INFERRED LEACHATE MOVEMENT
  - INFERRED GROUNDWATER LEVEL
  - INFERRED LOCAL REGIONAL GROUNDWATER FLOW
  - EXTENT OF HIGH TIDE LEVEL (& SALINE LEVEL)
  - MONITORING WELL
  - WELL SCREEN INTERVAL

## Appendix C

## LANDFILL GAS MONITORING

GAS 1	Site Entrance
GAS 2	40m South of Landfill
GAS 3	Carpark South of Landfill
GAS 4	Next to Secondhand Shop
GAS 5	Landfill West Bank, Bench
GAS 6	Landfill West Bank, Bund Wall
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

WELL ID	DATE	TIME	LEL PPM				COMMENTS
			MAX		STABLE		
			LEL%	PPM	LEL%	PPM	
Trench 4	21-Jan-14	1030	100	4,000		750	Good Readings
Trench 1	21-Jan-14	1035	100	1,100		400	
Trench 2	21-Jan-14	1040		900		250	
Trench 3	21-Jan-14	1045	100	2,000		500	
Trench 6	21-Jan-14	1050		750		200	
Trench 5	21-Jan-14	1055	100	990		340	
Trench 7	21-Jan-14	1100	100	1,200		480	
Gas 1	21-Jan-14	1115		340		200	
Gas 2	21-Jan-14	1120		250		120	
Gas 3	21-Jan-14	1125		260		150	
Gas 5	21-Jan-14						
Gas 4	21-Jan-14	1130		400		200	
Gas 6	21-Jan-14						
Trench 4	2-Jun-14	930	100	2,600		400	Slightly windy
Trench 1	2-Jun-14	935		900		170	
Trench 2	2-Jun-14	940		370		170	
Trench 3	2-Jun-14	945	100	1,000		200	
Trench 6	2-Jun-14	950		410		230	
Trench 5	2-Jun-14	955		700		420	
Trench 7	2-Jun-14	1000	100	900		800	
Gas 1	2-Jun-14	1010		370		220	
Gas 2	2-Jun-14	1015		350		130	
Gas 3	2-Jun-14	1020		290		100	
Gas 5	2-Jun-14						
Gas 4	2-Jun-14	1025		140		100	
Gas 6	2-Jun-14						
Weighbridge	2-Jun-14	1310		0		0	All Building with clear readings
Cleaning Shed	2-Jun-14	1315		0		0	
MRF	2-Jun-14	1320		0		0	
Lunchroom	2-Jun-14	1325		0		0	
Ute Shed	2-Jun-14	1330		0		0	
Trench 4	19-Sep-13	1230	100	2,800		500	Good Readings
Trench 1	19-Sep-13	1235		600		210	
Trench 2	19-Sep-13	1240		450		100	
Trench 3	19-Sep-13	1245	100	900		110	
Trench 6	19-Sep-13	1250		400		100	
Trench 5	19-Sep-13	1300		380		180	
Trench 7	19-Sep-13	1305	90	900		220	
Gas 1	19-Sep-13	1310		180		0	
Gas 2	19-Sep-13	1315		250		100	
Gas 3	19-Sep-13	1320		480		110	
Gas 5	19-Sep-13						
Gas 4	19-Sep-13	1325		350		130	
Gas 6	19-Sep-13						

**CALIBRATED WITH SPAN GAS:**

**KIAMA MUNICIPAL COUNCIL - MINNAMURRA LANDFILL**

**Figure 1**

**Reference:** E2W\_047\_10.cdr

LAST PAGE OF REPORT



*Thank you for the opportunity to work with  
Kiama Council.*

Feedback is Welcomed at Earth2Water  
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