

Kiama Municipal Council

# **Minnamurra Waste Disposal Depot Annual Groundwater & Surface Water Monitoring Report – 2012 to 2013**

Report E2W-059 (R001)

14 November 2013



**Prepared by: Dino Parisotto (Director)**

BAppSc-Geology (Hons); MAppSc-Groundwater  
Phone: (02) 4234 0829 Fax: (02) 4236 1824  
175 Fern St Gerringong NSW Australia 2534

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

**earth<sub>2</sub>water**  
Pty Ltd  
Environmental & Groundwater Consulting



Client: Kiama Municipal Council

Project: Annual Surface and Groundwater Monitoring Report  
Minnamurra Waste Disposal Depot  
(EPL 2012 to 2013)

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

Report: 14 November 2013  
Ref: E2W-059 R001

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

Prepared By: Earth2Water Pty Ltd



D. Parisotto (Principal Hydrogeologist)  
(BAppSc; Geology *Hons*, MAppSc; Groundwater, Lic Driller DL1977)

175 Fern Street, Gerringong NSW 2534  
Phone: (02) 4234 0829 Fax: (02) 4236 1824

## **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>6</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.....	14
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 .....	20
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 (2012/13)  
Table GW-1: Summary Analytical Report - Groundwater (2012/13)  
Table SW-1: Summary Analytical Report – Surface Water (2012/13)  
Table SW-2: Rocklow Creek - Historical Ammonia Concentrations (mg/L, 1999 to 2013)

## **GRAPHS**

Graph-1: Groundwater Ammonia Concentrations (mg/L) All Wells (1999 to 2013)  
Graph-2: Deep Groundwater Ammonia Trends (1999 to 2013)  
Graph-3: Shallow Groundwater Ammonia Trends (1999 to 2013)  
Graph-4: Net Increments of Ammonia Between Up & Mid/Down Stream Samples (1999 to 2013)

## **FIGURES**

Figure 1: Site Location  
Figure 2: Monitoring Well Locations & Ammonia Concentrations (2012-2013)

## **APPENDICES**

Appendix A: ALS Environmental Pty Ltd Laboratory Certificates  
Appendix B: Figure 7 from E2W Landfill Closure Plan  
Appendix C: Landfill Gas Monitoring (KMC, November 2012) & Figure 1



## 1. INTRODUCTION

Earth2Water Pty Ltd (E2W) was engaged by Kiama Municipal Council (KMC) to provide the 2012 to 2013 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 - 2012), Eco-engineers Pty Ltd and Forbes Rigby Pty Ltd (pre 2004).

This monitoring report for the MWDD is based on quarterly monitoring results (20 November 2012, 18 February 2013, 30 May 2013, 29 August 2013) and NSW EPA Environmental Protection Licence (EPL) conditions (R1.10). Additional water sampling was conducted at selected locations (MD9C – 29 November 2012, and MD9B, MD9C, MD10A, MD10B, West Dam, North Dam, East Dam @ 14 January 2013) to verify the elevated ammonia concentrations reported in May 2011 (MD9C). 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 2012 to 2013 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 2012-2013 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 2012 and 2013. The annual reporting period covers four

quarterly monitoring events in November 2012, February 2013, May 2013 and August 2013 (Figures 1 & 2). E2W note that one location (MD9C) was re-sampled on 29 November 2012, and four locations (MD9B, MD9C, MD10A, MD10B) were re-sampled on 14 Jan 2013 to verify the elevated ammonia concentrations (& increasing trends) at the site.

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 2012 to August 2013) 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.

<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



### 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).

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 2012 to July 2013 was 1201.8 mm<sup>3</sup>, which is slightly lower than the previous monitoring periods (1282.8 mm August 2011 to July 2012, 1308mm August 2010 to July 2011), and all three are moderately higher than the 2009-2010 monitoring period (1054.4 mm). The higher rainfall in the past 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).

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

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

### 3.3 Geology

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

Drill cores by the Geological Survey of NSW in the Rocklow Creek valley predominantly consist of poorly to well-sorted 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 two years). Sampling is undertaken by ALS (formerly Ecowise).

#### **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 2012, February 2013, May 2013 and August 2013 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 2012 to 2013 reporting period was undertaken on the following dates:

- 20 November 2012,
- 18 February 2013,
- 30 May 2013; and
- 29 August 2013.

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 (February 2012, April 2012, July 2012 and October 2012) during the 2012/13 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 (2012/2013) 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). Methane gas readings were consistent at each sampling event through the monitoring period. The maximum methane (stable) gas reading was 810 ppm at Trench 4 (October 2012). The lowest was 180 ppm at Trench 6 (May 2013). The highest readings at each sampling event were recorded at either Trench 4 or Trench 1. Buildings were sampled for landfill gas in October 2012 and May 2013, with all location recording no methane gas readings (non-detectable).

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 2012-13). Monitoring locations are shown on Figure 2.

The wells and surface water locations sampled in the 2012 and 2013 reporting period are outlined below:

- 20 November 2012. Groundwater wells: MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD9C, MD10B, Surface water: Rocklow-Up, Rocklow-Middle;
- 18 February 2013. Groundwater wells: MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD9C, MD10B, Surface water: Rocklow-Up, Rocklow-Middle;
- 30 May 2013. Groundwater wells: MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD9C, MD10B, Surface water: Rocklow-Up, Rocklow-Middle;
- 29 August 2013. Groundwater wells: MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD9C, MD10B, Surface water: Rocklow-Up, Rocklow-Middle

Wells that were “not” tested in the 2012 and 2013 reporting period, but are part of the EPL include:

- MD1B. No access in all 4 rounds (November 2012, February 2013, May 2013, and August 2013)
- MD2A, MD4A, MD6A, MD9A, MD10A. Dry shallow wells in 3 rounds (Nov 2012, Feb 2013, August 2013).
- MD2A, MD4A, MD6A, MD9A, MD10A. Not enough water for sampling (May 2013).

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, $\mu\text{S/cm}$ )	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 2012 to 2013 Reporting Period**

Sample ID	Screen Interval (m AHD) - or Sample Location	Nov 2012	Feb 2013	May 2013	Aug 2013
(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

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 access	No access	No access

*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 2012/13 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 2013) for ammonia (mg/L) is presented in Graph-1, Graph-2 and Graph-3. The graphs highlight ammonia groundwater quality trends over the past ~ 13 years (January 1999 to August 2013). 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 landfill sites, 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 2011/12 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 2012/13 reporting period are similar to previous years and reflect changes in rainfall and tide levels.

The reduced groundwater levels (m AHD) from the ten wells sampled in 2012/13<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 2011 to July 2012 was 1201.8 mm (Bombo Headland), which was slightly lower than the previous monitoring period (1282.8 mm, August 2011 to July 2012)<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 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.

#### **6.1.2.1 Field pH**

The pH from the 10 wells (MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD9C, MD10A, MD10B) ranged from pH 6.1 to 7.6 in the 2012-13 reporting period, indicating relatively neutral groundwater.

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

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

#### **6.1.2.2 Electrical Conductivity (EC)**

The EC in groundwater collected from the site ranged from approximately 1.66 to 43.1 mS/cm (MD6B, MD9B, MD10B in May 2012 and MD2C in February 2012 respectively). The salinity

<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.

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 0.55 to 4.77 mg/L in the 2012/13 reporting period (MD10B in November 2012 and MD2C in August 2013, 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 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 2012/13 reporting period (note: Total nitrogen is not an EPL requirement).

Eight wells (MD2B, MD2C, MD4B, MD4C, MD6B, MD6C, MD9B, MD10B) 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 2012/2013 concentrations ranged from <0.01 (non-detected/below LOR) to 6.68 mg/L. Nitrate has been detected in more wells in the 2012/2013 monitoring round (eight wells above ANZECC 2000) in comparison to the 2011/2012 monitoring round (five wells above ANZECC 2000) however concentrations are lower than previous levels of nitrate in 2011/12. Average nitrate concentrations for 2012/13 were lowest at MD9C (0.01 mg/L) whilst highest at MD2B (4.49 mg/L), MD4B (6.68 mg/L). During 2011/12, wells MD10B (0.09 mg/L) and MD4B (3.23 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). With the exception of MD2C and MD4C, all groundwater samples tested in all four monitoring rounds reported concentrations of ammonia in excess of the ANZECC (2000) trigger value for marine ecosystems (2.84 mg/L, based on a pH of 7.3).

Groundwater from the wells MD4B, 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 122 mg/L (November 2012), which is higher than the maximum at MD9C in 2011/12 reporting period (101 mg/L) but comparable to 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 MD2C, MD6C, MD9B and MD9C and 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 2013 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**

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 & peak in late 2011, then irregularly Decreasing
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) 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.

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 2012/13 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. Over the 2010/11 and 2011/12 monitoring periods, MD9C shows an irregular decreasing ammonia trend in 2012 (although has an increasing trend over 1999-2011 which peaks in late 2011), however during the 2012/13 monitoring period MD9C shows a decreasing trend. During the 2012/13 reporting period, 5 wells (MD2B, MD4C, MD6B, MD6C and MD10B) showed a temporary rise in ammonia concentrations in May 2013. All five wells are preceded and followed by, a declining trend in the next sampling round (August 2013).

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.

Results from the 2012/13 monitoring period are similar to the 2011/12 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).

---

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

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

The total phosphorus (TP) is not an EPL requirement, and was not sampled during the 2012/13 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 2012) to 6.19 mg/L (MD9C, February 2013). With the exception of MD6B all the groundwater wells reported ANZECC (2000) exceedances (freshwater ecosystems, 0.3 mg/L) in a 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 to 0.898 mg/L (MD2C, August 2013 and MD9C, February 2013, respectively). 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 0.4 mg/L (MD6B in November 2012, MD6C in May 2013, and MD9C in all rounds) to 1.0 mg/L (MD10B in November 2012 and February 2013). 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 10 to 132 mg/L in the 2012/13 reporting period (MD6C, November 2012 and MD9C, November 2012, respectively). Concentrations of total organic carbon (TOC) ranged from 9 to 126 mg/L in the 2012/13 reporting period (MD6C, November 2012 and MD9C, November 2012, respectively). 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 2012, February 2013, May 2013 and August 2013). Future groundwater monitoring will determine if phenol concentrations warrant further assessment.

## **6.2 Surface Water**

Surface water sampling was undertaken quarterly during the 2012/13 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.

### **6.2.1 Physical Parameters**

#### **6.2.1.1 pH**

---

<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 2012-13 reporting period.



The pH in Rocklow Creek at the middle and downstream location is generally neutral (7.2 to 7.6) in 2012/13, and has not changed significantly from the 2011/12 reporting period (i.e. 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 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 4.23 to 34.0 mS/cm, and Rocklow-Up 0.87 to 27.5 mS/cm). EC values are marginally higher than results from the 2011/12 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 2012/13 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 0.31 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 2012/13 reporting period show an increase (of up to 0.61 mg/L) in ammonia in the midstream sample compared to the upstream sample. 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 (2012/13) are generally lower than in 2011/12 and 2010/2011 (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 2012/13 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 7 to 17 mg/L in the 2012/13 reporting period (Rocklow-Middle in November 2012 and Rocklow-Up in February 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 2012, February 2013, May 2013 and August 2013).

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 2012-2013 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 2013) 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) 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, and April 2013).

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 0.315 mg/L in the 2012/13 reporting period (Table SW-2).

The net increment in the downstream in 2012/13 (0.315 mg/L) is lower than 2011/12 (0.91 mg/L averaged net increment). Previous net increment averages are: 1.57 mg/L in 2010/2011, 0.11mg/L in 2008/09 and 0.44mg/L in 2009/10 (appears as an overall increasing trend, however this is dependant on tides during sampling).

The ammonia in groundwater (MD-9C and MD-10B) during 2012/13 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 2012/13 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 2012 to August 2013 (EPL reporting period). Monitoring data collected during the 2012/2013 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; MD4B (33.6 mg/L), MD6B (41 mg/L), MD6C (38.8 mg/L), MD9B (33.8 mg/L), MD10B (79.6 mg/L), with the maximum at MD9C (122.0 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 2012/13 reporting period ranged from not detected to 6.68 mg/L (MD4B) and exceeded the (ANZECC 2000 guidelines, 0.7 mg/L). Nitrate concentrations are lower than the previous concentrations reported in 2011/12 (MD9C = 8.17 mg/L) and comparable to 2010/11 (MD1B = 5.23 mg/L).
- Ammonia concentrations in the 2012/13 monitoring period continue to be elevated and variable, however show an 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 2012/13 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 2012/13 reporting period. A minor increase occurs in the downstream sample locations (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).

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



- The net increment of ammonia in the midstream sample (Rocklow-Middle) averaged 0.315 mg/L in the 2012/13 reporting period (Table SW-2). This "net incremental average" is lower than the previous years (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.
- 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 have slightly decreased during the 2012/13 monitoring period. All buildings sampled (within 250 m of the deposited waste) recorded no detectable landfill gas readings in October 2012 and May 2013 (6 monthly annual monitoring).
- KMC (& E2W) are unaware of any complaints from the community arising from rehabilitation works at the MWDD during the 2012/13 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 2012/13 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.

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 requirements). 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. 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 2013 or 2014 (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 2013/14 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	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 2013 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 (2012 to 2013)

Analytes	Groundwater				Surface Water (Rocklow Creek)				Detection Limits	Method Reference
	20/11/2012	18/02/2013	30/05/2013	29/08/2013	20/11/2012	18/02/2013	30/05/2013	29/08/13		
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

Table GW-1: Summary 2012/13 Analytical Results - Minnamurra Waste Disposal Depot

## 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	20/11/12	18/2/13	30/5/13	29/8/13		20/11/12	18/2/13	30/5/13	29/8/13		20/11/12	18/02/13	30/05/13	29/08/13				
RL (mAHD at TOC)			No Access	Overgrown	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	0.69	0.85	0.56	0.85	4	0.56	1.57	4.00
Reduced SWL (mAHD)			-	-	-	-	0	-	-	-	-	0	0.48	0.32	0.61	0.32	0	NA	NA	NA
pH (field)	6.5-8.0 (a)	8-8.4 (a)	-	-	-	-	0	-	-	-	-	0	7.0	7.3	7.2	7.5	4	4.0	6.5	7.5
Temperature			-	-	-	-	0	-	-	-	-	0	16.8	20.2	15.7	14.6	4	4.0	13.6	20.2
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		-	-	-	-	0	-	-	-	-	0	28.40	24.50	25.60	22.20	4	4.0	19.08	25.60
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	-	-	-	-	0	-	-	-	-	0	1.48	3.30	1.41	1.68	4	1.41	2.60	4.00
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	7120	4930	5140	4550	4	4	3656	5140
Potassium (ICP)			-	-	-	-	0	-	-	-	-	0	287	224	236	230	4	4	174	236
Calcium (ICP)			-	-	-	-	0	-	-	-	-	0	438	399	392	396	4	4	298	399
Magnesium (ICP)			-	-	-	-	0	-	-	-	-	0	770	602	633	538	4	4	444	633
Chloride			-	-	-	-	0	-	-	-	-	0	11600	7980	8470	7300	4	4	5939	8470
Sulphate (SO4)			-	-	-	-	0	-	-	-	-	0	1690	1120	1130	1080	4	4	834	1130
<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	688	689	699	721	4	4	528	721
Fluoride			-	-	-	-	0	-	-	-	-	0	0.8	0.9	0.7	0.8	4	0.7	1.6	4.0
Phenols		0.40	-	-	-	-	0	-	-	-	-	0	0.05	0.05	0.05	0.05	4	0.05	1.04	4.00
<b>Metals (mg/L)</b>																				
Iron (ICP)	0.3 (1)		-	-	-	-	0	-	-	-	-	0	1.15	0.83	0.46	0.27	4	0.27	1.39	4.00
Manganese (ICP)	1.90		-	-	-	-	0	-	-	-	-	0	0.113	0.060	0.088	0.069	4	0.060	1.054	4.000
<b>Nutrients (mg/L)</b>																				
Nitrate (NO3 as N)	0.7 (7)		-	-	-	-	0	-	-	-	-	0	0.03	4.49	2.90	3.34	4	2.90	3.68	4.49
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	-	-	-	-	0	-	-	-	-	0	18.20	8.33	12.30	10.20	4	4.00	8.71	12.30
Total Nitrogen	0.5 (3)	0.12 (4)	-	-	-	-	0	-	-	-	-	0	NM	NM	NM	NM	0	NA	NA	NA
Dissolved Organic Carbon (DOC)			-	-	-	-	0	-	-	-	-	0	25	36	18	42	4	4	25	42
Total Organic Carbon (TOC)			-	-	-	-	0	-	-	-	-	0	25	36	17	42	4	4	25	42
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.

Table GW-1: Summary 2012/13 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	20/11/12	18/02/13	30/05/13	29/08/13					20/11/12	18/02/13	30/05/13	29/08/13	
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)			0.73	0.90	0.62	0.90	4	0.62	0.79	0.90	-	-	-	-	0
Reduced SWL (mAHD)			0.44	0.27	0.55	0.27	0	NA	NA	NA	-	-	-	-	0
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.1	7.3	7.2	7.4	4	7.1	7.3	7.4	-	-	-	-	0
Temperature			16.7	20.5	15.9	14.5	4	14.5	16.9	20.5	-	-	-	-	0
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		40.40	43.10	42.50	42.20	4	40.40	42.05	43.10	-	-	-	-	0
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	1.46	1.53	2.13	4.77	4	1.46	2.47	4.77	-	-	-	-	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)			10400	8390	8500	8650	4	8390	8985	10400	-	-	-	-	0
Potassium (ICP)			389	347	346	417	4	346	375	417	-	-	-	-	0
Calcium (ICP)			476	445	460	471	4	445	463	476	-	-	-	-	0
Magnesium (ICP)			1100	1040	1070	1090	4	1040	1075	1100	-	-	-	-	0
Chloride			16600	13700	14200	14200	4	13700	14675	16600	-	-	-	-	0
Sulphate (SO <sub>4</sub> )			2560	1990	1980	2050	4	1980	2145	2560	-	-	-	-	0
<b>Water Parameters (mg/L)</b>															
Total Suspended Solids (TSS)			NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0
Alkalinity (as CaCO <sub>3</sub> )			472	469	438	465	4	438	461	472	-	-	-	-	0
Fluoride			0.8	0.8	0.7	0.8	4	0.7	0.8	0.8	-	-	-	-	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)		0.96	1.39	0.50	0.50	4	0.50	0.84	1.39	-	-	-	-	0
Manganese (ICP)	1.90		0.101	0.160	0.060	<0.010	4	<0.01	0.107	0.160	-	-	-	-	0
<b>Nutrients (mg/L)</b>															
Nitrate (NO <sub>3</sub> as N)	0.7 (7)		0.5	1.97	2.09	1.75	4	0.51	1.58	2.09	-	-	-	-	0
Ammonia (NH <sub>3</sub> as N)	1.88 (2)	2.84 (2)	3.46	0.84	0.07	0.08	4	0.07	1.11	3.46	-	-	-	-	0
Total Nitrogen	0.5 (3)	0.12 (4)	NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0
Dissolved Organic Carbon (DOC)			15	19	18	19	4	15	18	19	-	-	-	-	0
Total Organic Carbon (TOC)			13	19	17	18	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 (NO<sub>x</sub>) 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.



Table GW-1: Summary 2012/13 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	20/11/12	18/02/13	30/05/13	29/08/13					20/11/12	18/02/13	30/05/13	29/08/13				
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)			1.11	1.29	1.03	1.27	4	1.03	1.18	1.29	1.14	1.30	1.06	1.28	4	1.06	1.20	1.30
Reduced SWL (mAHD)			0.52	0.34	0.60	0.36	0	0.34	0.45	0.60	0.45	0.29	0.53	0.31	0	NA	NA	NA
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.0	7.4	7.0	7.3	4	7.0	7.2	7.4	6.9	7.2	7.2	7.2	4	6.9	7.1	7.2
Temperature			16.3	20.2	16.1	14.8	4	14.8	16.9	20.2	16.5	19.4	16.0	14.7	4	14.7	16.7	19.4
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		11.50	7.85	10.90	10.5	4	7.9	10.19	11.50	37.40	32.10	32.70	32.30	4	32.10	33.63	37.40
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	1.45	2.64	2.76	3.14	4	1.45	2.50	3.14	1.34	2.60	5.98	2.45	4	1.34	3.09	5.98
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)			2060	985	1540	1400	4	985	1496	2060	9360	6880	6490	6660	4	6490	7348	9360
Potassium (ICP)			120	118	133	125	4	118	124	133	355	288	297	326	4	288	317	355
Calcium (ICP)			407	327	331	339	4	327	351	407	502	444	437	429	4	429	453	502
Magnesium (ICP)			256	182	239	233	4	182	228	256	1020	822	845	810	4	810	874	1020
Chloride			4110	1750	3160	3050	4	1750	3018	4110	15400	11600	10600	10700	4	10600	12075	15400
Sulphate (SO4)			596	302	439	436	4	302	443	596	2350	1470	1500	1640	4	1470	1740	2350
<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)			667	762	665	781	4	665	719	781	578	722	666	670	4	578	659	722
Fluoride			0.5	0.6	0.5	0.5	4	0.5	0.5	0.6	0.9	0.8	0.6	0.7	4	0.6	0.8	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)		2.27	0.8	6.06	0.36	4	0.36	2.37	6.06	1.38	<0.50	2.16	0.34	4	0.34	1.29	2.16
Manganese (ICP)	1.90		0.13	0.05	0.10	0.108	4	0.050	0.10	0.13	0.185	0.076	0.154	0.226	4	0.076	0.160	0.226
<b>Nutrients (mg/L)</b>																		
Nitrate (NO3 as N)	0.7 (7)		0.10	6.68	2.27	0.11	4	0.10	2.29	6.68	0.05	1.70	0.47	0.61	4	0.05	0.71	1.70
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	29.00	23.10	21.50	33.60	4	21.50	26.80	33.60	1.77	0.21	3.62	2.94	4	0.21	2.14	3.62
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)			31	42	42	45	4	31	40	45	17	29	27	31	4	17	26	31
Total Organic Carbon (TOC)			28	44	45	47	4	28	41	47	15	29	27	30	4	15	25	30
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.

Table GW-1: Summary 2012/13 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	20/11/12	18/02/13	30/05/13	29/08/13		20/11/12	18/02/13	30/05/13	29/08/13				
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	1.38	1.15	1.36	4	1.15	1.30	1.38
Reduced SWL (mAHD)			-	-	-	-	0	0.55	0.47	0.70	0.49	0	0.47	0.55	0.70
pH (field)	6.5-8.0 (a)	8-8.4 (a)	-	-	-	-	0	7.1	7.2	7.4	7.3	4	7.1	7.3	7.4
Temperature			-	-	-	-	0	17.3	20.4	16.5	15.6	4	15.6	17.5	20.4
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		-	-	-	-	0	1.75	1.72	1.66	2.2	4	1.66	1.82	2.16
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	-	-	-	-	0	1.53	2.47	2.28	1.83	4	1.53	2.03	2.47
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	112	88	88	133	4	88	105	133
Potassium (ICP)			-	-	-	-	0	50	49	53	57	4	49	52	57
Calcium (ICP)			-	-	-	-	0	146	130	123	158	4	123	139	158
Magnesium (ICP)			-	-	-	-	0	52	50	47	66	4	47	54	66
Chloride			-	-	-	-	0	151	117	115	189	4	115	143	189
Sulphate (SO4)			-	-	-	-	0	74	55	51	90	4	51	68	90
<b>Water Parameters (mg/L)</b>															
Total Suspended Solids (TSS)			-	-	-	-	0	NM	NM	NM	NM	0	NA	NA	NA
Alkalinity (as CaCO3)			-	-	-	-	0	679	615	619	789	4	615	676	789
Fluoride			-	-	-	-	0	0.4	0.5	0.5	0.5	4	0.4	0.5	0.5
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	0.24	0.18	0.16	0.17	4	0.16	0.19	0.24
Manganese (ICP)	1.90		-	-	-	-	0	0.140	0.117	0.112	0.152	4	0.112	0.130	0.152
<b>Nutrients (mg/L)</b>															
Nitrate (NO3 as N)	0.7 (7)		-	-	-	-	0	0.02	0.16	1.10	0.43	4	0.02	0.43	1.10
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	-	-	-	-	0	35.50	37.10	41.00	31.10	4	31.10	36.18	41.00
Total Nitrogen	0.5 (3)	0.12 (4)	-	-	-	-	0	NM	NM	NM	NM	0	NA	NA	NA
Dissolved Organic Carbon (DOC)			-	-	-	-	0	26	31	29	42	4	26	32	42
Total Organic Carbon (TOC)			-	-	-	-	0	24	31	30	41	4	24	32	41
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.

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.

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	20/11/12	18/02/13	30/05/13	29/08/13					20/11/12	18/02/13	30/05/13	29/08/13	
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)			1.39	1.53	1.28	1.52	4	1.28	1.43	1.53	-	-	-	-	0
Reduced SWL (mAHD)			0.47	0.33	0.58	0.34	0	0.33	0.43	0.58	-	-	-	-	0
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.2	7.2	7.2	7.2	4	7.2	7.2	7.2	-	-	-	-	0
Temperature			18.1	19.4	17.6	16.3	4	16.3	17.9	19.4	-	-	-	-	0
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		23.50	24.50	25.80	24.90	4	23.50	24.68	25.80	-	-	-	-	0
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	2.15	1.72	2.16	1.53	4	1.53	1.89	2.16	-	-	-	-	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)			5590	5070	4920	5020	4	4920	5150	5590	-	-	-	-	0
Potassium (ICP)			174	175	190	212	4	174	188	212	-	-	-	-	0
Calcium (ICP)			388	388	403	410	4	388	397	410	-	-	-	-	0
Magnesium (ICP)			602	614	662	618	4	602	624	662	-	-	-	-	0
Chloride			9060	8540	8470	8300	4	8300	8593	9060	-	-	-	-	0
Sulphate (SO4)			1340	1150	1200	1200	4	1150	1223	1340	-	-	-	-	0
<b>Water Parameters (mg/L)</b>															
Total Suspended Solids (TSS)			NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0
Alkalinity (as CaCO3)			360	341	346	409	4	341	364	409	-	-	-	-	0
Fluoride			0.5	0.5	0.4	0.5	4	0.4	0.5	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	0.33	0.30	0.06	4	0.05	0.19	0.33	-	-	-	-	0
Manganese (ICP)	1.90		0.062	0.065	0.039	0.078	4	0.039	0.061	0.078	-	-	-	-	0
<b>Nutrients (mg/L)</b>															
Nitrate (NO3 as N)	0.7 (7)		0.99	1.08	0.45	0.1	4	0.10	0.66	1.08	-	-	-	-	0
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	29.40	27.30	38.80	33.90	4	27.30	32.35	38.80	-	-	-	-	0
Total Nitrogen	0.5 (3)	0.12 (4)	NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0
Dissolved Organic Carbon (DOC)			10	13	13	14	4	10	13	14	-	-	-	-	0
Total Organic Carbon (TOC)			9	14	14	15	4	9	13	15	-	-	-	-	0
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	NM	NM	NM	NM	0	NA	NA	NA	-	-	-	-	0
<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.

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.

Table GW-1: Summary 2012/13 Analytical Results - Minnamurra Waste Disposal Depot

**Minnamurra Waste Disposal Depot**

Sample ID	ANZECC, 2000		MD 9B	MD 9B	MD 9B	MD 9B	MD 9B	No. Samples	Min	Mean	Max
Field Measurements	Freshwater	Marine	20/11/12	14/01/13	18/02/13	30/05/12	29/08/13				
RL (mAHD at TOC)			1.35	1.35	1.35	1.35	1.35	0	NA	NA	NA
Standing water level (mTOC)			0.82	NM	0.97	0.71	0.90	4	0.71	0.85	0.97
Reduced SWL (mAHD)			0.53		0.38	0.64	0.45	0	0.38	0.50	0.64
pH (field)	6.5-8.0 (a)	8-8.4 (a)	7.1	7.0	7.1	7.2	7.3	4	7.0	7.1	7.3
Temperature			17.7	18.9	20.5	16.7	15.3	4	15.3	17.8	20.5
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		2.53	2.12	2.66	2.78	2.9	4	2.1	2.59	2.86
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	1.09	1.84	1.61	2.34	2.00	4	1.09	1.78	2.34
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	NM	NM	NM	NM	NM	0	NA	NA	NA
<b>Laboratory Analyses (mg/L)</b>											
Sodium (ICP)			254	NM	210	217	226	4	210	227	254
Potassium (ICP)			97	NM	82	81	80	4	80	85	97
Calcium (ICP)			162	NM	165	161	186	4	161	169	186
Magnesium (ICP)			90	NM	94	91	98	4	90	93	98
Chloride			336	NM	286	312	337	4	286	318	337
Sulphate (SO4)			132	NM	120	123	107	4	107	121	132
<b>Water Parameters (mg/L)</b>											
Total Suspended Solids (TSS)			NM	NM	NM	NM	NM	0	NA	NA	NA
Alkalinity (as CaCO3)			877	NM	866	869	943	4	866	889	943
Fluoride			0.7	NM	0.7	0.7	0.6	4	0.6	0.7	0.7
Phenols		0.40	0.05	NM	0.05	0.05	0.05	4	0.05	0.05	0.05
<b>Metals (mg/L)</b>											
Iron (ICP)	0.3 (1)		4.26	NM	5.65	0.28	0.34	4	0.28	2.63	5.65
Manganese (ICP)	1.90		0.281	NM	0.214	0.094	0.118	4	0.094	0.177	0.281
<b>Nutrients (mg/L)</b>											
Nitrate (NO3 as N)	0.7 (7)		0.02	NM	1.09	1.36	0.57	4	0.02	0.76	1.36
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	33.80	25.20	35.20	31.50	26.30	4	25.20	30.40	35.20
Total Nitrogen	0.5 (3)	0.12 (4)	NM	NM	NM	NM	NM	0	NA	NA	NA
Dissolved Organic Carbon (DOC)			29	NM	41	40	45	4	29	39	45
Total Organic Carbon (TOC)			38	NM	43	40	46	4	38	42	46
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	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.

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.



Table GW-1: Summary 2012/13 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	14/01/13	18/02/13	30/05/13	29/08/13				
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	NM	0.99	0.80	1.02	4	0.80	0.93	1.02
Reduced SWL (mAHD)			0.51	NM	NM	NM	0.41	0.60	0.38	0	0.38	0.48	0.60
pH (field)	6.5-8.0 (a)	8-8.4 (a)	6.9	NM	NM	6.80	7.0	7.1	7.1	4	6.8	7.0	7.1
Temperature			17.5	NM	NM	19.20	21.2	17.2	15.7	4	15.7	18.2	21.2
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		4.69	NM	NM	3.65	3.95	3.80	3.9	4	3.7	4.00	4.69
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	0.93	NM	NM	1.57	1.78	1.61	2.58	4	0.93	1.69	2.58
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	NM	358	326	343	4	326	390	531
Potassium (ICP)			153	NM	NM	NM	131	116	128	4	116	132	153
Calcium (ICP)			208	NM	NM	NM	210	173	206	4	173	199	210
Magnesium (ICP)			95	NM	NM	NM	99	82	96	4	82	93	99
Chloride			892	NM	NM	NM	610	508	549	4	508	640	892
Sulphate (SO4)			1	NM	NM	NM	1	10	10	4	1	6	10
<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	NM	1200	1180	1240	4	1180	1255	1400
Fluoride			0.4	NM	NM	NM	0.4	0.4	0.4	4	0.4	0.4	0.4
Phenols		0.40	0.05	NM	NM	NM	0.05	0.05	0.05	4	0.05	0.05	0.05
<b>Metals (mg/L)</b>													
Iron (ICP)	0.3 (1)		4.96	NM	NM	NM	6.19	0.75	2.46	4	0.75	3.59	6.19
Manganese (ICP)	1.90		0.750	NM	NM	NM	0.898	0.642	0.743	4	0.642	0.758	0.898
<b>Nutrients (mg/L)</b>													
Nitrate (NO3 as N)	0.7 (7)		0.01	NM	NM	NM	0.34	0.01	0.06	4	0.01	0.11	0.34
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	122.00	117.00	117.00	87.20	87.80	76.30	63.00	4	63.00	95.76	122.00
Total Nitrogen	0.5 (3)	0.12 (4)	NM	NM	NM	NM	NM	NM	NM	0	NA	NA	NA
Dissolved Organic Carbon (DOC)			132	NM	NM	NM	94	73	85	4	73	96	132
Total Organic Carbon (TOC)			126	NM	NM	NM	96	71	85	4	71	95	126
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	NM	NM	NM	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.

Table GW-1: Summary 2012/13 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	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		20/11/12	14/01/13	18/02/13	30/05/13	28/08/13				
RL (mAHD at TOC)			Dry	NM	Dry	Dry	Dry	0	NM	NM	NM	NM	NM	0	NA	NA	NA
Standing water level (mTOC)			-	NM	-	-	-	0	0.61	NM	0.89	0.57	0.76	4	0.57	0.71	0.89
Reduced SWL (mAHD)			-	NM	-	-	-	0	NM	NM	NM	NM	NM	0	NA	NA	NA
pH (field)	6.5-8.0 (a)	8-8.4 (a)	-	6.10	-	-	-	0	7.2	7.0	7.3	7.2	7.6	4	7.0	7.3	7.6
Temperature			-	22.0	-	-	-	0	20.1	21.6	22.6	16.9	15.4	4	15.4	19.3	22.6
Electrical Conductivity (mS/cm)	0.125-2.2 (a)		-	51.60	-	-	-	0	2.22	2.34	2.39	2.31	2.3	4	2.2	2.32	2.39
Dissolved Oxygen (mg/L)	8.5-11.0 (a)	9.0-10.0 (a)	-	1.46	-	-	-	0	0.55	2.25	1.96	2.37	2.27	4	0.55	1.88	2.37
Turbidity (NTU)	6-50 (a)	0.5-10 (a)	-	NM	-	-	-	0	NM	NM	NM	NM	NM	0	NA	NA	NA
<b>Laboratory Analyses (mg/L)</b>																	
Sodium (ICP)			-	NM	-	-	-	0	169	NM	160	146	157	4	146	158	169
Potassium (ICP)			-	NM	-	-	-	0	83	NM	87	86	94	4	83	88	94
Calcium (ICP)			-	NM	-	-	-	0	117	NM	130	109	133	4	109	122	133
Magnesium (ICP)			-	NM	-	-	-	0	51	NM	56	46	48	4	46	50	56
Chloride			-	NM	-	-	-	0	262	NM	217	228	226	4	217	233	262
Sulphate (SO4)			-	NM	-	-	-	0	10	NM	10	10	10	4	10	10	10
<b>Water Parameters (mg/L)</b>																	
Total Suspended Solids (TSS)			-	NM	-	-	-	0	NM	NM	NM	NM	NM	0	NA	NA	NA
Alkalinity (as CaCO3)			-	NM	-	-	-	0	816	NM	810	796		4	796	807	816
Fluoride			-	NM	-	-	-	0	1.0	NM	1.0	0.9		4	0.9	1.0	1.0
Phenols		0.40	-	NM	-	-	-	0	0.05	NM	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	0.18	NM	0.11	0.34	0.64	4	0.11	0.32	0.64
Manganese (ICP)	1.90		-	NM	-	-	-	0	0.218	NM	0.3	0.311	0.380	4	0.218	0.290	0.380
<b>Nutrients (mg/L)</b>																	
Nitrate (NO3 as N)	0.7 (7)		-	NM	-	-	-	0	0.01	NM	1.08	0.01	0.01	4	0.01	0.28	1.08
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	-	0.34	-	-	-	0	64.20	63.60	67.60	79.60	68.40	4	63.60	68.68	79.60
Total Nitrogen	0.5 (3)	0.12 (4)	-	NM	-	-	-	0	NM	NM	NM	NM	NM	0	NA	NA	NA
Dissolved Organic Carbon (DOC)			-	NM	-	-	-	0	43	NM	54	58	62	4	43	54	62
Total Organic Carbon (TOC)			-	NM	-	-	-	0	58	NM	61	59	62	4	58	60	62
Total Phosphorus (TP)	0.05 (5)	0.025 (6)	-	NM	-	-	-	0	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.

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.

Table SW-1: Summary Analytical Report - Surface Water (2012-13)

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	20/11/12	20/11/12	20/11/12	18/02/13	18/02/13	18/02/13	30/05/13	30/05/13	30/05/13	29/08/13	29/08/13	29/08/13
pH (field)	6.5-8.0	8-8.4	7.6	7.1	No Access	7.7	7.2	No Access	7.2	7.2	No Access	7.3	7.3	No Access
Temperature			16.4	19.0	-	24.2	22.3	-	13.0	13.8	-	12.5	13.2	-
Electrical Conductivity (mS/cm)	0.125-2.2		27.5	34.0	-	3.31	9.88	-	0.87	4.23	-	4.620	10.400	-
Dissolved Oxygen (mg/L)	8.5-11.0	9.0-10.0	8.95	3.43	-	11.80	5.75	-	6.39	7.55	-	9.30	6.93	-
Turbidity (NTU)	6-50 (a)	0.5-10	NM	NM	-	NM	NM	-	NM	NM	-	NM	NM	-
Laboratory Analyses (mg/L)														
Sodium (ICP)			5910	7150	-	545	1950	-	111	749	-	809	1840	-
Potassium (ICP)			227	287	-	27	78	-	7	32	-	35	78	-
Calcium (ICP)			276	320	-	69	108	-	28	52	-	67	103	-
Magnesium (ICP)			658	796	-	76	234	-	19	88	-	102	226	-
Chloride			10600	13200	-	876	3940	-	173	1050	-	1230	3460	-
Sulphate (SO4)			1550	2020	-	123	482	-	56	207	-	227	460	-
Water Parameters (mg/L)														
Hardness (as CaCO3)			153	168	-	171	136	-	76	101	-	107	164	-
Fluoride			0.8	1.2	-	0.3	0.6	-	0.1	0.3	-	0.3	0.6	-
Phenols		0.40	0.05	0.05	-	0.05	0.05	-	0.05	0.05	-	0.05	0.05	-
Metals (mg/L)														
Iron (ICP)	0.3 (1)		<0.52	<0.52	-	1.4	1.59	-	1.64	0.94	-	0.94	0.19	-
Manganese (ICP)	1.90		0.234	0.228	-	0.653	1.150	-	0.101	0.096	-	0.130	0.169	-
Nutrients (mg/L)														
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)		0.02	0.11	-	0.31	0.15	-	0.06	0.06	-	0.04	0.13	-
Ammonia (NH3 as N)	1.88 (2)	2.84 (2)	0.10	0.44	-	0.10	0.71	-	0.12	0.19	-	0.16	0.40	-
Ammonia Increment (from Upper to Lower Rocklow Creek)			-	-	NA	-	-	NA	-	-	NA	-	-	NA
Ammonia Increment (from Upper to Middle Rocklow Creek)			-	0.34	-	-	0.61	-	-	0.07	-	-	0.24	-
Dissolved Organic Carbon (DOC)			8	7	-	17	15	-	9	9	-	10	10	-
Total Organic Carbon (TOC)			6	5	-	22	18	-	8	9	-	10	10	-

**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

NM=NOT Measured, NA=Not Available

Exceeds ANZECC (2000) marine trigger value

&lt;LOR converted to LOR for statistic purposes

Exceedance of IIWL values or fresh water not highlighted except for ammonia level.

**Ammonia exceeds ANZECC (2000) freshwater trigger value**

Table SW-2: Rocklow Creek - Historical Ammonia Concentrations (mg/L) (1999 - 2013)

Table SW-2: Rocklow Creek - Historical Ammonia Concentrations (mg/L) (1999 - 2013)

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
Upper Rocklow (mg/L)	<0.01	0.04	0.10	0.10	0.12	0.16
Middle Rocklow (mg/L)	1.06	1.91	0.44	0.71	0.19	0.40
Lower Rocklow (mg/L)	NM	NM	NM	NM	NM	NM
Net Increment (mg/L)	1.06	1.87	0.34	0.61	0.07	0.24

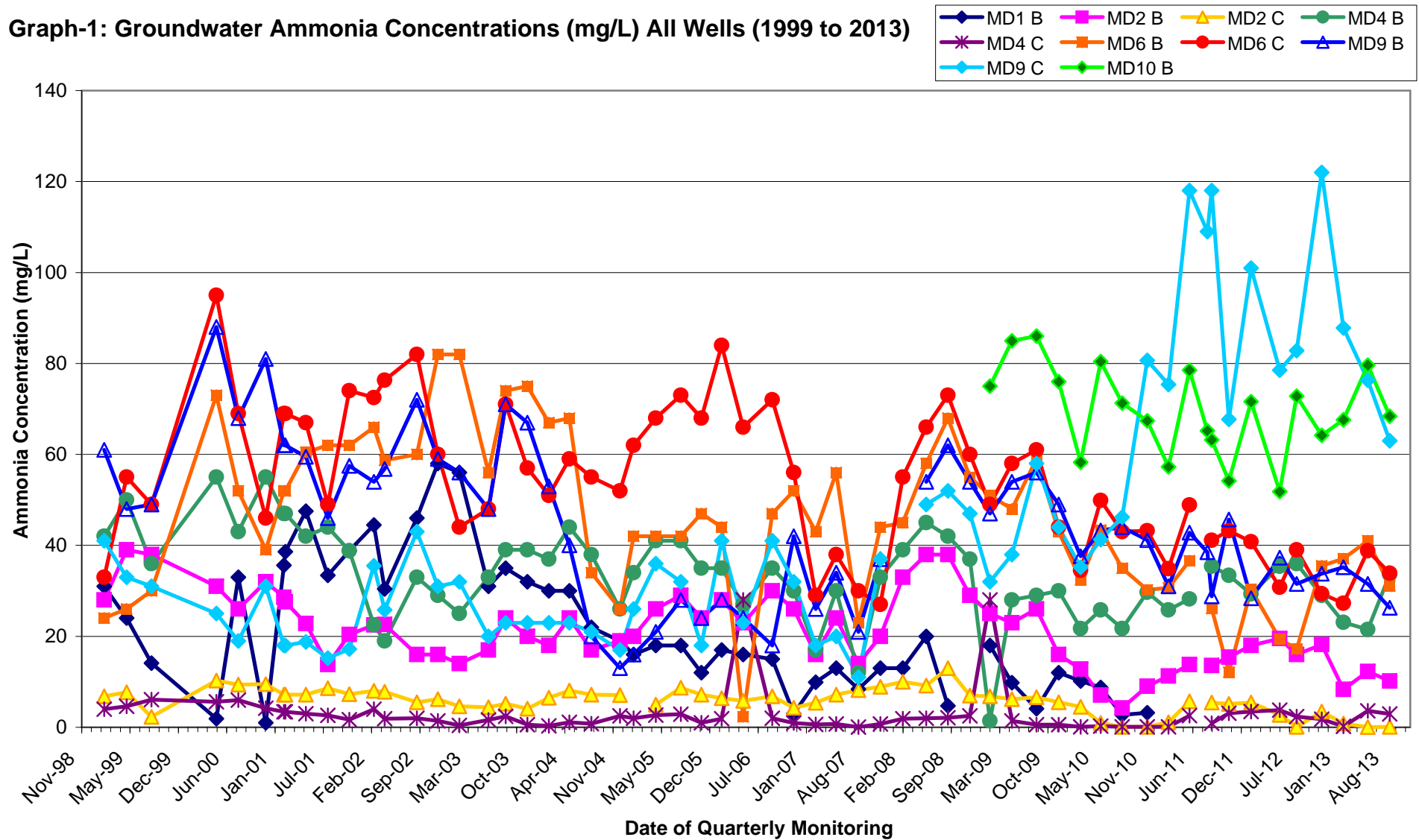
**Legend**

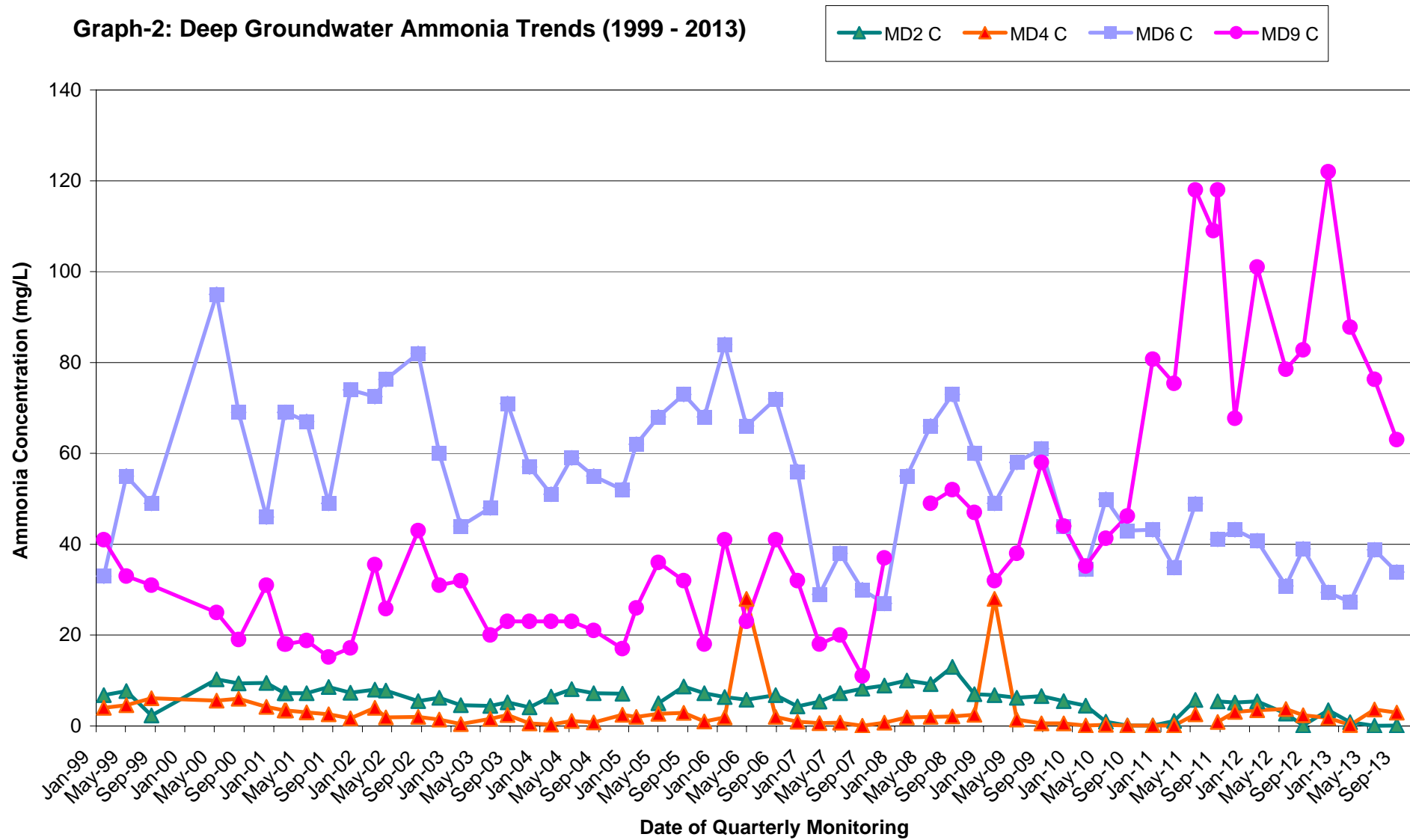
NA = Not Analysed      NM= Not measured

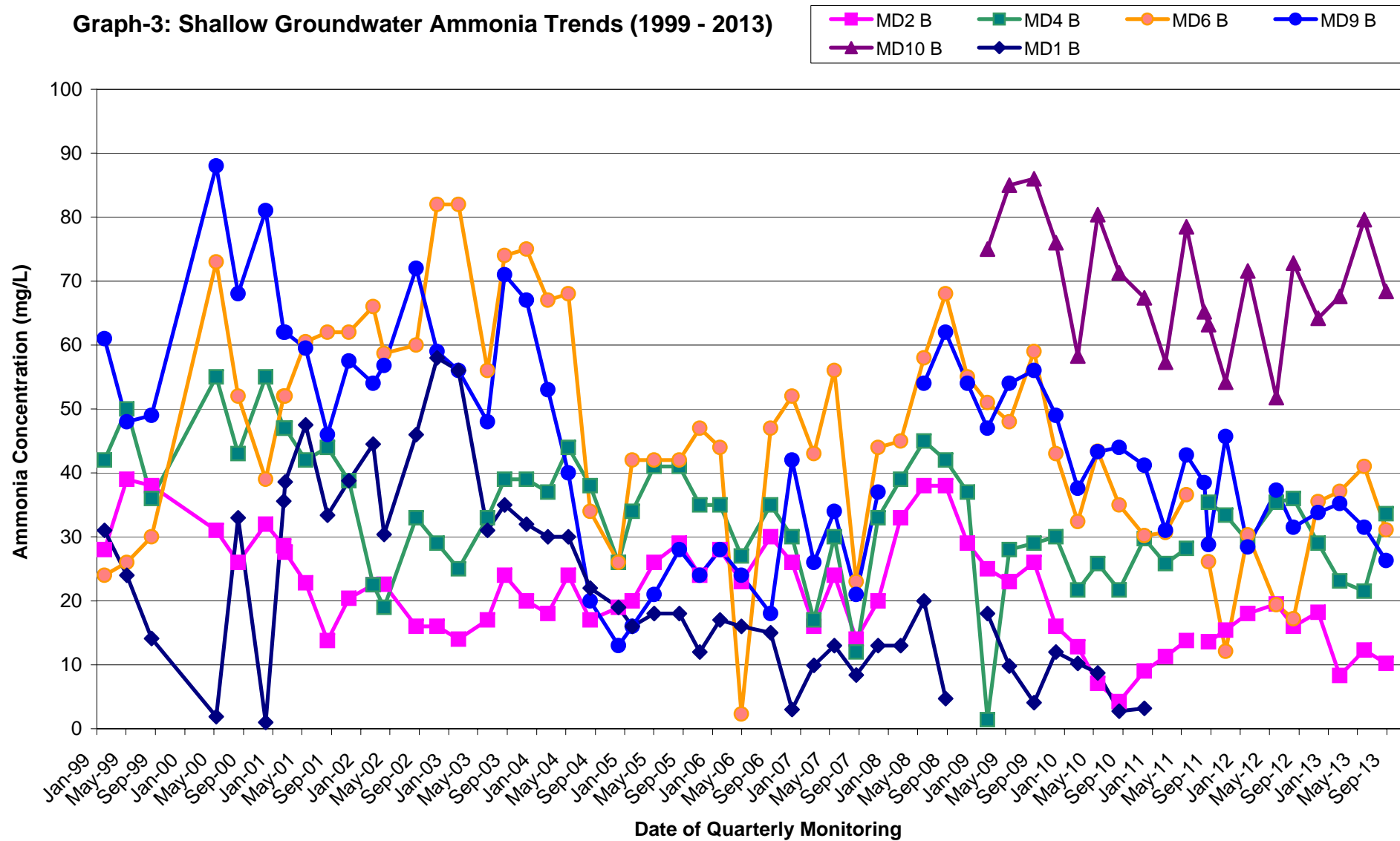
Note: Rocklow Down was inaccessible during the 2010-2013 monitoring periods

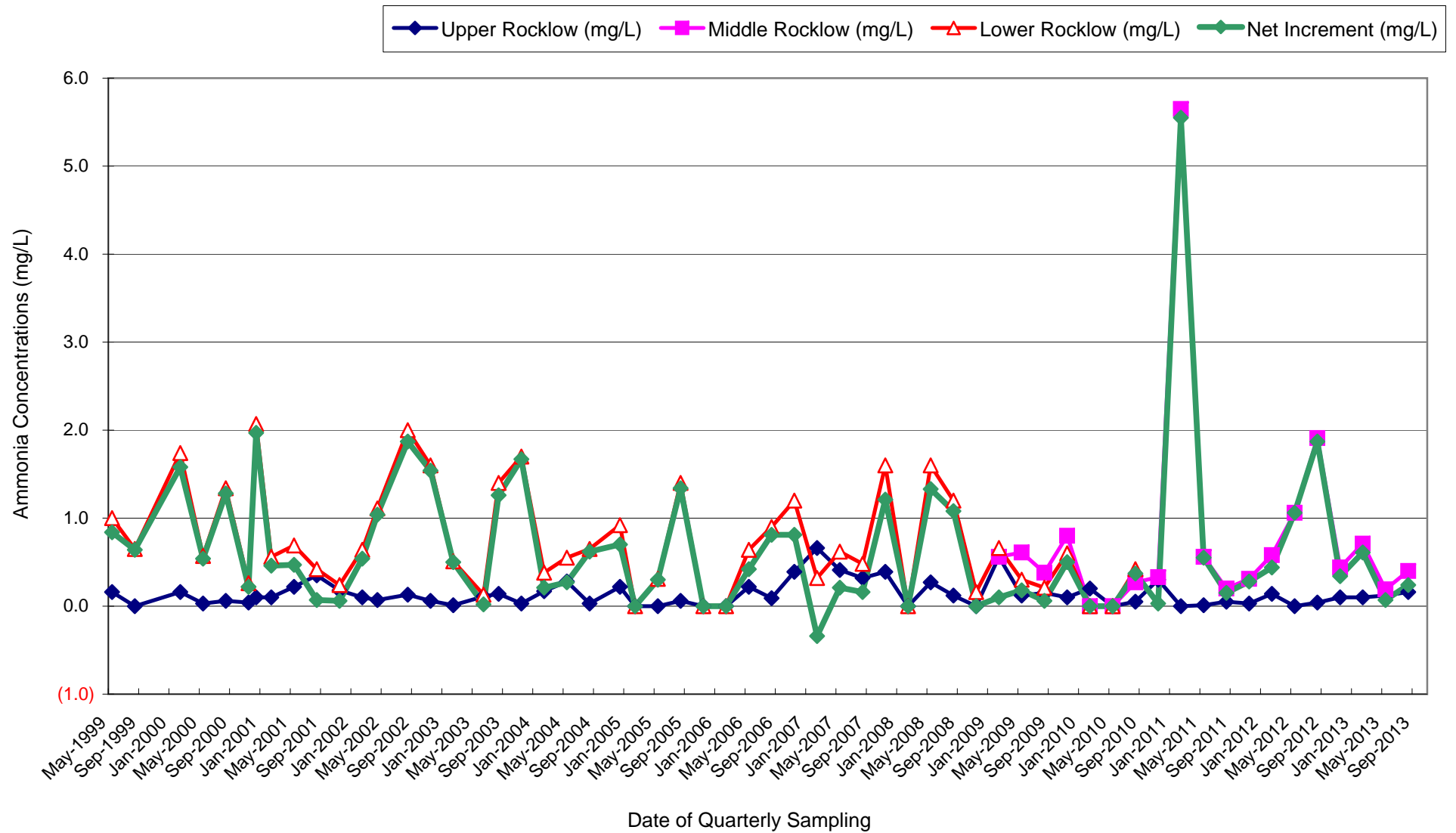
## Graphs



**Graph-1: Groundwater Ammonia Concentrations (mg/L) All Wells (1999 to 2013)**

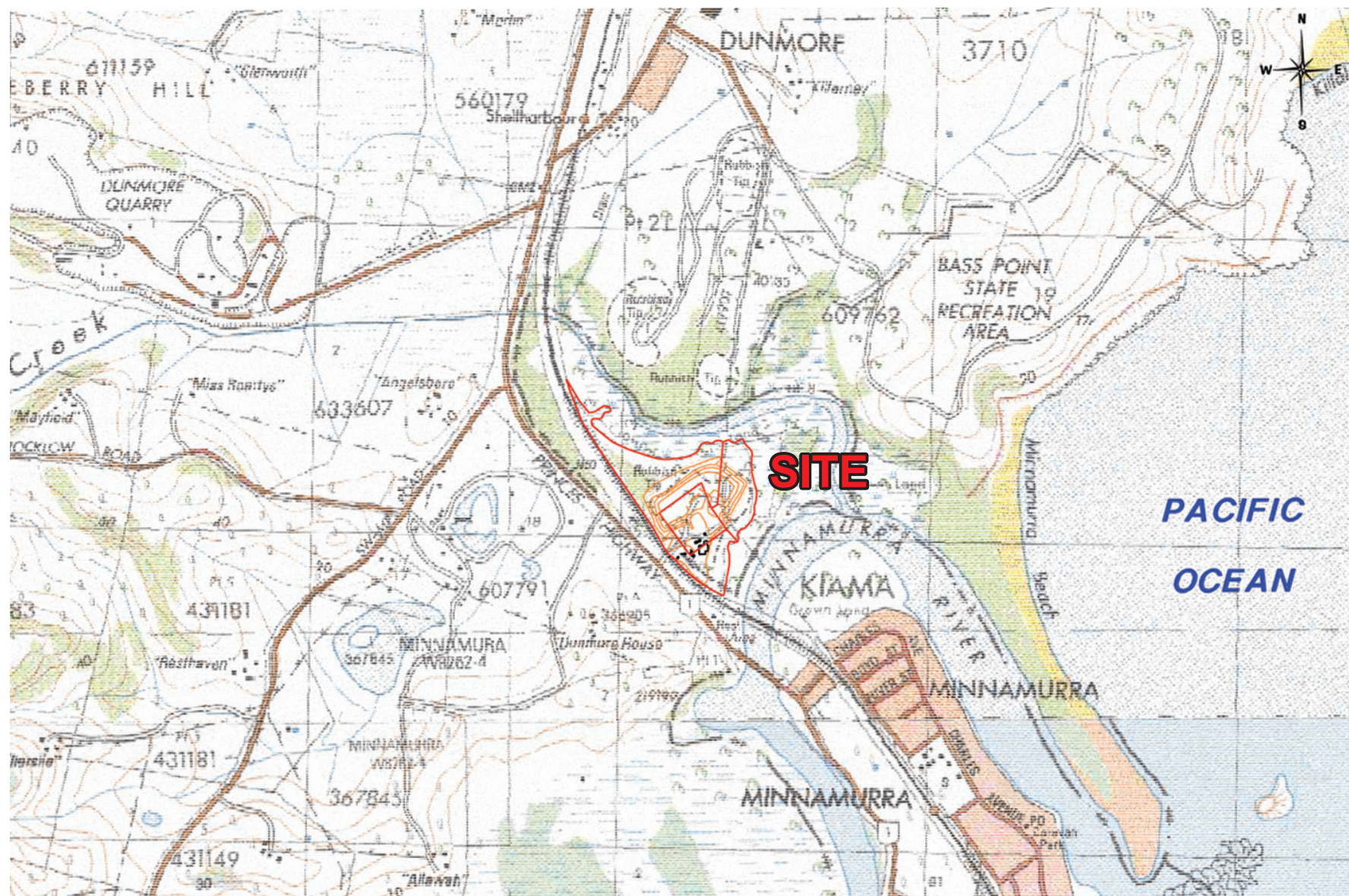
**Graph-2: Deep Groundwater Ammonia Trends (1999 - 2013)**

**Graph-3: Shallow Groundwater Ammonia Trends (1999 - 2013)**

**Graph-04: Net Increments of Ammonia Between Up and Down Stream Samples (1999 to 2013)**

## Figures












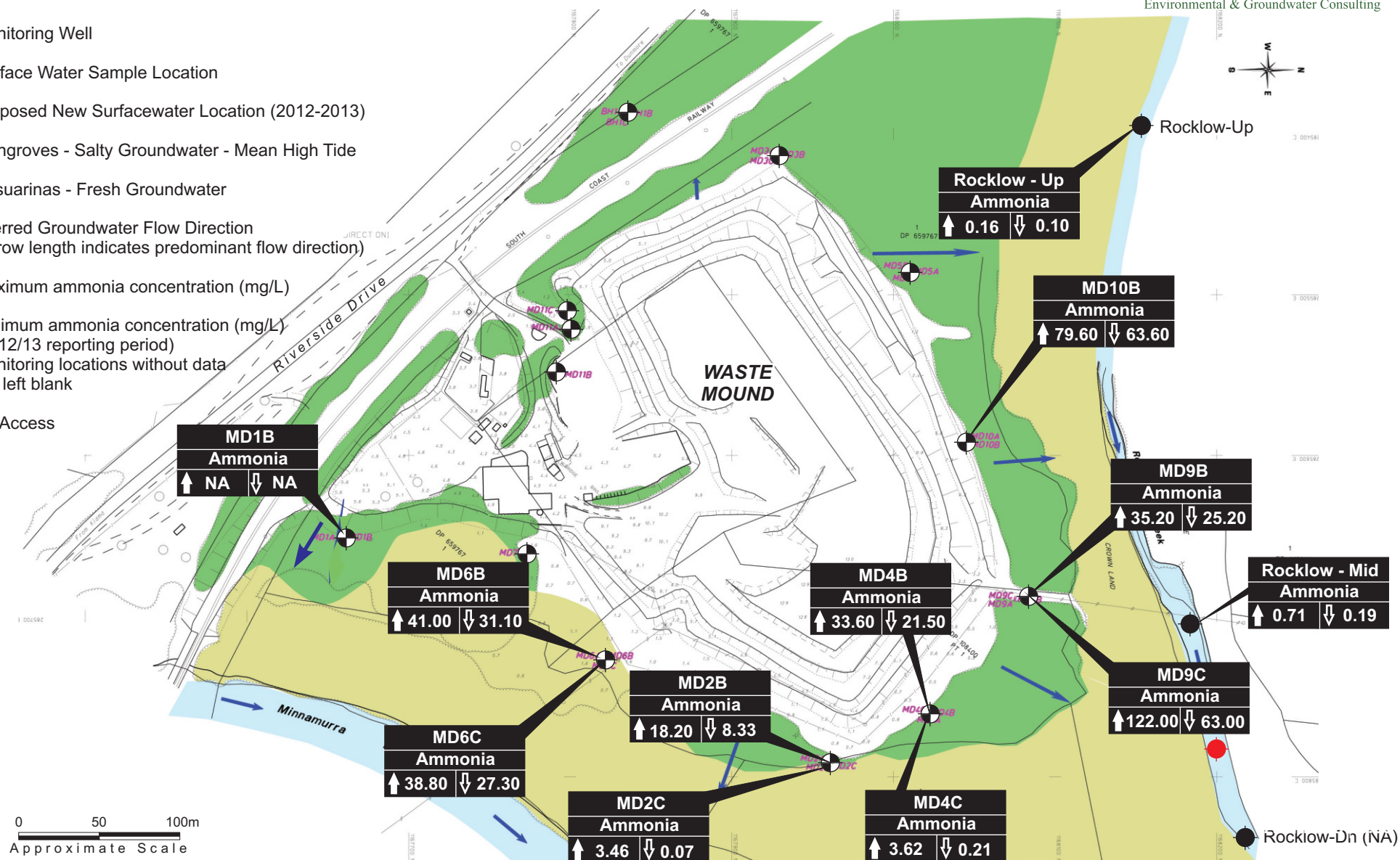


**SITE LOCATION**



# LEGEND

-  Monitoring Well
-  Surface Water Sample Location
-  Proposed New Surfacewater Location (2012-2013)
-  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)  
(2012/13 reporting period)  
Monitoring locations without data are left blank
-  **NA** No Access



Source: Neil Charters Pty Ltd

Date: 4 Nov 2013

Reference: E2W\_059\_04.cdr

## MONITORING WELL LOCATIONS AMMONIA CONCENTRATIONS (2012-2013)

KIAMA COUNCIL - MINNAMURRA ANNUAL MONITORING REPORT (2012-2013)

Figure 2

## Appendix A



## CHAIN OF CUSTODY

ALS Laboratory, please tick →

- ☐ Sydney: 277 Woodpark Rd, Smithfield NSW 2176  
Ph: 02 8784 8555 E: samples.sydney@alsenviro.com  
☐ Newcastle: 5 Rosegum Rd, Warabrook NSW 2304  
Ph: 02 4965 9433 E: samples.newcastle@alsenviro.com  
☐ Brisbane: 32 Stand St, Stafford QLD 4053  
Ph: 07 3243 7222 E: samples.brisbane@alsenviro.com  
☐ Townsville: 14-15 Dasmia Ct, Bohile QLD 4818  
Ph: 07 4796 0600 E: townsville.environmental@alsenviro.com  
☐ Melbourne: 2-4 Westall Rd, Springvale VIC 3171  
Ph: 03 8549 9600 E: samples.melbourne@alsenviro.com  
☐ Adelaide: 2-1 Burma Rd, Pooraka SA 5005  
Ph: 08 8359 0890 E: adelaide@alsenviro.com  
☐ Perth: 10 Hord Way, Malaga  
Ph: 08 9209 7656 E: samples.perth@alsenviro.com  
☐ Launceston: 27 Wellington  
Ph: 03 6331 2158 E: launceston@alsenviro.com

Environmental Division  
NSW South Coast  
Work Order  
**EW1203170**



Telephone : 02 42253125

<b>CLIENT:</b> Kiama Municipal Council		<b>TURNAROUND REQUIREMENTS:</b> <input type="checkbox"/> Standard TAT (List due date): (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)	
<b>OFFICE:</b> PO Box 75 Kiama NSW 2533	<b>CONTACT PH:</b> 4232 0418	<input type="checkbox"/> Non Standard or urgent TAT (List due date):	
<b>PROJECT:</b> Minnamurra Landfill	<b>ALS QUOTE NO.:</b> SY-146-10		
<b>ORDER NUMBER:</b>			
<b>PROJECT MANAGER:</b> Paul Czulowski	<b>SAMPLER MOBILE:</b> 0408 251 560		
<b>SAMPLER:</b> Craig Wilson	<b>EDD FORMAT (or default):</b>		
<b>COC emailed to ALS? (YES / NO)</b>	<b>RELINQUISHED BY:</b> Craig	<b>RECEIVED BY:</b> Aneta	<b>RELINQUISHED BY:</b>
Email Reports to (will default to PM if no other addresses are listed): paul@kiama.nsw.gov.au, julien@kiama.nsw.gov.au	<b>DATE/TIME:</b> 20/11/12 12:15	<b>DATE/TIME:</b> 20/11/12 12:15	<b>DATE/TIME:</b>
Email Invoice to (will default to PM if no other addresses are listed): paul@kiama.nsw.gov.au, julien@kiama.nsw.gov.au			
<b>COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:</b>			

ALS USE ONLY		SAMPLE DETAILS MATRIX: Solid(S) Water(W)		CONTAINER INFORMATION		ANALYSIS REQUIRED INCLUDING SUITES (NB. Suite Codes must be listed to attract suite price) <small>Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).</small>							Additional Information	
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE <small>(refer to codes below)</small>	TOTAL BOTTLES	NT-02A (Alkalinity, Cl, SO4 & Fluoride)	Nitrate, Ammonia, Total Phenolics	DOC (Filtered)	(Dissolved Filtered) Fe, Mn, Ni, Pb, Cu, Na, K	(Total) Fe, Mn, Ni, Pb, Cu, Na, K			Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.	
1	MD 1B	20/11 720	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓				YSI (Field Results) pH, Temp, EC, Sal, DO, Depth	
2	MD 2A	800	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
3	MD 2B	755	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
4	MD 2C	805	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
5	MD 4A	830	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
6	MD 4B	825	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
7	MD 4C	835	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
8	MD 6A	735	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
9	MD 6B	730	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
10	MD 6C	740	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
11	MD 9A	930	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
12	MD 9B	925	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓				YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
					TOTAL									

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

ENFM 2704



# CHAIN OF CUSTODY

ALS Laboratory, please tick →

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

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

☐ Melbourne, 2-4 Westall Rd, Springvale VIC 3171  
Ph: 03 8549 9600 E: samples.melbourne@alsenviro.com  
☐ Adelaide, 2-1 Burma Rd, Poraka SA 5095  
Ph: 08 8359 0890 E: adelaide@alsenviro.com

☐ Perth, 10 Hot Way, Malaga WA 6090  
Ph: 08 9209 7655 E: samples.perth@alsenviro.com  
☐ Launceston, 27 Wellington St, Launceston TAS 7250  
Ph: 03 6331 2158 E: launceston@alsenviro.com

<b>CLIENT:</b> Klamia Municipal Council		<b>TURNAROUND REQUIREMENTS:</b> <input type="checkbox"/> Standard TAT (List due date): (Standard TAT may be longer for some tests e.g. Ultra Trace Organics)		<b>FOR LABORATORY USE ONLY (Circle)</b>	
<b>OFFICE:</b> PO Box 75 Klamia NSW 2533		<input type="checkbox"/> Non Standard or urgent TAT (List due date):		<b>Custody Seal intact?</b>	Yes No
<b>PROJECT:</b> Minnamurra Landfill		<b>ALS QUOTE NO.:</b> SY-146-10		<b>Free ice / frozen ice bricks present upon receipt?</b>	Yes No
<b>ORDER NUMBER:</b>				<b>Random Sample Temperature on Receipt:</b>	°C
<b>PROJECT MANAGER:</b> Paul Czulowski	<b>CONTACT PH:</b> 4232 0418			<b>Other comment:</b>	
<b>SAMPLER:</b> Craig Wilson	<b>SAMPLER MOBILE:</b> 0408 251 560			<b>RECEIVED BY:</b>	
<b>COC emailed to ALS? ( YES / NO )</b>	<b>EDD FORMAT (or default):</b>			<b>RECEIVED BY:</b>	
<b>Email Reports to (will default to PM if no other addresses are listed):</b>				<b>DATE/TIME:</b>	
<b>Email Invoice to (will default to PM if no other addresses are listed):</b>				<b>DATE/TIME:</b>	
<b>COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:</b>					

ALS USE ONLY		SAMPLE DETAILS MATRIX: Solid(S) Water(W)		CONTAINER INFORMATION		ANALYSIS REQUIRED INCLUDING SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).							Additional Information	
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	NT-02A (Alkalinity, Cl, SO4 & Fluoride)	Nitrate, Ammonia, Total Phenolics	DOC (Filtered)	TOC	(Dissolved Filtered) Fe, Mn, Ni, NT-01 (Mg, Ca, Na, K)	(Total) Fe, Mn, Mg, Ca, Na, K		Comments on likely contaminant levels dilutions, or samples requiring specific QC analysis etc.	
13	MD 9C	20/11 935	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
14	MD 10A	850	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓		DRY	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
15	MD 10B	855	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓			YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
16	Rocklow Down	915	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓	No Access	YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
17	Rocklow Middle	910	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
18	Rocklow Up	710	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	✓		YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
19	Blank	715	W	VS, N	2			✓					YSI (Field Tests) pH, Temp, EC, Sal, DO, Depth	
TOTAL														

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



## Environmental Division

# CERTIFICATE OF ANALYSIS

Work Order	: <b>EW1203170</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 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 20-NOV-2012
C-O-C number	: ----	Issue Date	: 28-NOV-2012
Sampler	: Craig Wilson	No. of samples received	: 19
Site	: ----	No. of samples analysed	: 19
Quote number	: Minnamurra Landfill WL/083/11		

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



## 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 Sulphate analysis on sample ID:MD 10B due to sample matrix.**
- **EG020A: Some samples were diluted and reanalysed due to matrix interference (High sample salinity). LORs have been raised accordingly.**
- **EG020A-F: Positive results for sample E1203170 # 019 have been confirmed by reanalysis.**
- **EK055G: LOR raised for Ammonia on sample ID (Rocklow Up) due to sample matrix.**
- **EP002: It has been noted that DOC is greater than TOC for various samples, however, these differences are within the limits of experimental variation.**
- **Sites MD2A, MD4A, MD6A, MD9A and MD10A - Dry at time of sampling.**



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
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Glenn Davies	Environmental Services Representative	Laboratory - Wollongong
Raymond Commodor	Instrument Chemist	Sydney Inorganics
Sarah Millington	Senior Inorganic Chemist	Sydney Inorganics



## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				20-NOV-2012 07:20	20-NOV-2012 08:00	20-NOV-2012 07:55	20-NOV-2012 08:05	20-NOV-2012 08:30
Compound	CAS Number	LOR	Unit	EW1203170-001	EW1203170-002	EW1203170-003	EW1203170-004	EW1203170-005
<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	----	----	688	472	----
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	----	688	472	----
<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	----	----	1690	2560	----
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	----	11600	16600	----
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	----	438	476	----
Magnesium	7439-95-4	1	mg/L	----	----	770	1100	----
Sodium	7440-23-5	1	mg/L	----	----	7120	10400	----
Potassium	7440-09-7	1	mg/L	----	----	287	389	----
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	----	0.113	0.101	----
Iron	7439-89-6	0.05	mg/L	----	----	1.15	0.96	----
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	----	0.8	0.8	----
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	----	18.2	3.46	----
<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	----	----	0.03	0.51	----
<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	0.51	----
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	----	376	531	----
Total Cations	----	0.01	meq/L	----	----	402	577	----
Ionic Balance	----	0.01	%	----	----	3.34	4.10	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	----	7.0	7.1	----



## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				20-NOV-2012 07:20	20-NOV-2012 08:00	20-NOV-2012 07:55	20-NOV-2012 08:05	20-NOV-2012 08:30
Compound	CAS Number	LOR	Unit	EW1203170-001	EW1203170-002	EW1203170-003	EW1203170-004	EW1203170-005
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	----	28400	40400	----
Dissolved Oxygen	----	0.01	mg/L	----	----	1.48	1.46	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	----	15.6	15.4	----
Temperature	----	0.1	°C	----	----	16.8	16.7	----
Salinity	----	0.2	g/L	----	----	21.2	31.3	----
Depth	----	0.01	m	----	----	0.69	0.73	----
Field Observations	----	0.01	--	NO ACCESS	DRY	----	----	DRY
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	----	25	15	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	----	25	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
				20-NOV-2012 08:25	20-NOV-2012 08:35	20-NOV-2012 07:35	20-NOV-2012 07:30	20-NOV-2012 07:40
Compound	CAS Number	LOR	Unit	EW1203170-006	EW1203170-007	EW1203170-008	EW1203170-009	EW1203170-010
<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	667	578	----	679	360
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	667	578	----	679	360
<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	596	2350	----	74	1340
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	4110	15400	----	151	9060
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	407	502	----	146	388
Magnesium	7439-95-4	1	mg/L	256	1020	----	52	602
Sodium	7440-23-5	1	mg/L	2060	9360	----	112	5590
Potassium	7440-09-7	1	mg/L	120	355	----	50	174
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.128	0.185	----	0.140	0.062
Iron	7439-89-6	0.05	mg/L	2.27	1.38	----	0.24	<0.05
<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	29.0	1.77	----	35.5	29.4
<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	0.10	0.05	----	0.02	0.99
<b>EK059G: Nitrite plus Nitrate as N (NO<sub>x</sub>) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	0.10	0.05	----	0.02	0.99
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	142	495	----	19.4	291
Total Cations	----	0.01	meq/L	134	525	----	17.7	316
Ionic Balance	----	0.01	%	2.77	2.96	----	4.44	4.24
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	7.0	6.9	----	7.1	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
				20-NOV-2012 08:25	20-NOV-2012 08:35	20-NOV-2012 07:35	20-NOV-2012 07:30	20-NOV-2012 07:40
Compound	CAS Number	LOR	Unit	EW1203170-006	EW1203170-007	EW1203170-008	EW1203170-009	EW1203170-010
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	11500	37400	----	1750	23600
Dissolved Oxygen	----	0.01	mg/L	1.45	1.34	----	1.53	2.15
Dissolved Oxygen - % Saturation	----	0.1	% saturation	15.2	14.0	----	16.4	23.2
Temperature	----	0.1	°C	16.3	16.5	----	17.3	18.1
Salinity	----	0.2	g/L	8.1	28.9	----	1.0	16.7
Depth	----	0.01	m	1.11	1.14	----	1.30	1.39
Field Observations	----	0.01	--	----	----	DRY	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	31	17	----	26	10
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	28	15	----	24	9
<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					20-NOV-2012 09:30	20-NOV-2012 09:25	20-NOV-2012 09:35	20-NOV-2012 08:50	20-NOV-2012 08:55
Compound	CAS Number	LOR	Unit		EW1203170-011	EW1203170-012	EW1203170-013	EW1203170-014	EW1203170-015
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		----	877	1400	----	816
Total Alkalinity as CaCO3	----	1	mg/L		----	877	1400	----	816
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		----	132	<1	----	<10
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		----	336	892	----	262
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		----	162	208	----	117
Magnesium	7439-95-4	1	mg/L		----	90	95	----	51
Sodium	7440-23-5	1	mg/L		----	254	531	----	169
Potassium	7440-09-7	1	mg/L		----	97	153	----	83
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L		----	0.281	0.750	----	0.218
Iron	7439-89-6	0.05	mg/L		----	4.26	4.96	----	0.18
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		----	0.7	0.4	----	1.0
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		----	33.8	122	----	64.2
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L		----	<0.01	<0.01	----	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		----	0.02	<0.01	----	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		----	0.02	<0.01	----	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		----	29.8	53.1	----	23.7
Total Cations	----	0.01	meq/L		----	29.0	----	----	----
Total Cations	----	0.01	meq/L		----	----	53.5	----	24.1
Ionic Balance	----	0.01	%		----	1.24	----	----	----
Ionic Balance	----	0.01	%		----	----	0.38	----	0.84
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
				20-NOV-2012 09:30	20-NOV-2012 09:25	20-NOV-2012 09:35	20-NOV-2012 08:50	20-NOV-2012 08:55
Compound	CAS Number	LOR	Unit	EW1203170-011	EW1203170-012	EW1203170-013	EW1203170-014	EW1203170-015
<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	----	2530	4690	----	2220
Dissolved Oxygen	----	0.01	mg/L	----	1.09	0.93	----	0.55
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	11.6	9.9	----	6.1
Temperature	----	0.1	°C	----	17.7	17.5	----	20.1
Salinity	----	0.2	g/L	----	1.5	3.0	----	1.3
Depth	----	0.01	m	----	0.82	0.89	----	0.61
Field Observations	----	0.01	--	DRY	----	----	DRY	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	29	132	----	43
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	38	126	----	58
<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					20-NOV-2012 09:15	20-NOV-2012 09:10	20-NOV-2012 07:10	20-NOV-2012 07:15	----
Compound	CAS Number	LOR	Unit	EW1203170-016	EW1203170-017	EW1203170-018	EW1203170-019		----
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	----	168	153	----		----
Total Alkalinity as CaCO3	----	1	mg/L	----	168	153	----		----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	2020	1550	----		----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L	----	13200	10600	----		----
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	----	320	276	----		----
Magnesium	7439-95-4	1	mg/L	----	796	658	----		----
Sodium	7440-23-5	1	mg/L	----	7150	5910	----		----
Potassium	7440-09-7	1	mg/L	----	287	227	----		----
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	----	----	0.003		----
Iron	7439-89-6	0.05	mg/L	----	----	----	<0.05		----
EG020T: Total Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	----	0.228	0.234	----		----
Iron	7439-89-6	0.05	mg/L	----	<0.52	<0.52	----		----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	----	1.2	0.8	----		----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	----	0.44	<0.10	----		----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L	----	0.02	<0.01	----		----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	----	0.11	0.02	----		----
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	----
				20-NOV-2012 09:15	20-NOV-2012 09:10	20-NOV-2012 07:10	20-NOV-2012 07:15	----
Compound	CAS Number	LOR	Unit	EW1203170-016	EW1203170-017	EW1203170-018	EW1203170-019	----
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.13	0.02	----	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	7.1	7.6	----	----
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	34000	27500	----	----
Dissolved Oxygen	----	0.01	mg/L	----	3.43	8.95	----	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	36.8	92.6	----	----
Temperature	----	0.1	°C	----	19.0	16.4	----	----
Salinity	----	0.2	g/L	----	24.5	20.6	----	----
Field Observations	----	0.01	--	NO ACCESS	----	----	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	7	8	<1	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	5	6	----	----
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	<0.05	<0.05	----	----

## Environmental Division

# CERTIFICATE OF ANALYSIS

Work Order	: <b>EW1203304</b>	Page	: 1 of 3
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 Resample	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 29-NOV-2012
C-O-C number	: ----	Issue Date	: 04-DEC-2012
Sampler	: Craig Wilson	No. of samples received	: 1
Site	: ----	No. of samples analysed	: 1
Quote number	: Minnamurra Landfill WL/083/11		

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
Ashesh Patel	Inorganic Chemist	Sydney Inorganics

Address 99 Kenny Street, Wollongong 2500

Environmental Division NSW South Coast, Unit 4 / 13 Geary Place, PO Box 3105, North Nowra 2541, Australia. 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.

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

- 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

Compound	CAS Number	LOR	Unit	MD9C	----	----	----	----
				29-NOV-2012 11:00	----	----	----	----
				EW1203304-001	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	117	----	----	----	----



## Environmental Division

# CERTIFICATE OF ANALYSIS

Work Order	: <b>EW1300467</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 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 18-FEB-2013
C-O-C number	: ----	Issue Date	: 01-MAR-2013
Sampler	: ----	No. of samples received	: 19
Site	: ----	No. of samples analysed	: 19
Quote number	: Minnamurra Landfill WL/083/11		

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



## 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 10B) due to sample matrix.
- EG020A: Some samples were diluted and reanalysed due to matrix interference (High sample salinity). LORs have been raised accordingly.
- Sites MD 1B & Rocklow Down - Sites to overgrown can't access.
- Sites MD2A, MD4A, MD6A, MD9A and MD10A - Dry at time of sampling.



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
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Benjamin Nicholson	Metals Chemist	Perth Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Craig Wilson	Sampler / Login Officer	Laboratory - Wollongong
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics
Eric Chau	Metals Team Leader	Melbourne Inorganics
Herman Lin	Laboratory Coordinator	Melbourne Inorganics
Nikki Stepniewski	Senior Inorganic Instrument Chemist	Melbourne Inorganics
Scott James	Laboratory Manager	Perth Inorganics



## 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-FEB-2013 12:40	18-FEB-2013 10:55	18-FEB-2013 11:00	18-FEB-2013 11:05	18-FEB-2013 11:20
Compound	CAS Number	LOR	Unit	EW1300467-001	EW1300467-002	EW1300467-003	EW1300467-004	EW1300467-005
<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	----	----	689	469	----
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	----	689	469	----
<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	----	----	1120	1990	----
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	----	7980	13700	----
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	----	399	445	----
Magnesium	7439-95-4	1	mg/L	----	----	602	1040	----
Sodium	7440-23-5	1	mg/L	----	----	4930	8390	----
Potassium	7440-09-7	1	mg/L	----	----	224	347	----
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	----	0.060	0.160	----
Iron	7439-89-6	0.05	mg/L	----	----	0.83	1.39	----
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	----	0.9	0.8	----
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	----	8.33	0.84	----
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	----	0.06	0.02	----
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	----	----	4.49	1.97	----
<b>EK059G: Nitrite plus Nitrate as N (NO<sub>x</sub>) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	----	4.55	1.99	----
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	----	262	437	----
Total Cations	----	0.01	meq/L	----	----	290	482	----
Ionic Balance	----	0.01	%	----	----	4.96	4.81	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	----	7.3	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-FEB-2013 12:40	18-FEB-2013 10:55	18-FEB-2013 11:00	18-FEB-2013 11:05	18-FEB-2013 11:20
Compound	CAS Number	LOR	Unit	EW1300467-001	EW1300467-002	EW1300467-003	EW1300467-004	EW1300467-005
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	----	24500	43100	----
Dissolved Oxygen	----	0.01	mg/L	----	----	3.30	1.53	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	----	37.3	17.2	----
Temperature	----	0.1	°C	----	----	20.2	20.5	----
Salinity	----	0.2	g/L	----	----	16.6	30.7	----
Depth	----	0.01	m	----	----	0.85	0.90	----
Field Observations	----	0.01	--	Overgrown	DRY	----	----	DRY
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	----	36	19	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	----	36	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-FEB-2013 11:25	18-FEB-2013 11:30	18-FEB-2013 10:30	18-FEB-2013 10:35	18-FEB-2013 10:40
Compound	CAS Number	LOR	Unit	EW1300467-006	EW1300467-007	EW1300467-008	EW1300467-009	EW1300467-010
<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	762	722	----	615	341
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	762	722	----	615	341
<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	302	1470	----	55	1150
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	1750	11600	----	117	8540
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	327	444	----	130	388
Magnesium	7439-95-4	1	mg/L	182	822	----	50	614
Sodium	7440-23-5	1	mg/L	985	6880	----	88	5070
Potassium	7440-09-7	1	mg/L	118	288	----	49	175
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	0.050	0.076	----	0.117	0.065
Iron	7439-89-6	0.05	mg/L	0.80	<0.50	----	0.18	0.33
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	0.6	0.8	----	0.5	0.5
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	23.1	0.21	----	37.1	27.3
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	0.09	0.04	----	0.26	0.10
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	6.68	1.70	----	0.16	1.08
<b>EK059G: Nitrite plus Nitrate as N (NO<sub>x</sub>) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	6.77	1.74	----	0.42	1.18
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	70.9	372	----	16.7	272
Total Cations	----	0.01	meq/L	77.2	396	----	15.7	295
Ionic Balance	----	0.01	%	4.24	3.13	----	3.23	4.09
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	7.4	7.2	----	7.2	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
				18-FEB-2013 11:25	18-FEB-2013 11:30	18-FEB-2013 10:30	18-FEB-2013 10:35	18-FEB-2013 10:40
Compound	CAS Number	LOR	Unit	EW1300467-006	EW1300467-007	EW1300467-008	EW1300467-009	EW1300467-010
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	7850	32100	----	1720	24500
Dissolved Oxygen	----	0.01	mg/L	2.64	2.60	----	2.47	1.72
Dissolved Oxygen - % Saturation	----	0.1	% saturation	29.7	29.5	----	27.9	19.6
Temperature	----	0.1	°C	20.2	19.4	----	20.4	19.4
Salinity	----	0.2	g/L	4.8	22.7	----	1.0	16.9
Depth	----	0.01	m	1.29	1.30	----	1.38	1.53
Field Observations	----	0.01	--	----	----	DRY	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	42	29	----	31	13
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	44	29	----	31	14
<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-FEB-2013 12:20	18-FEB-2013 12:25	18-FEB-2013 12:30	18-FEB-2013 11:45	18-FEB-2013 11:50
Compound	CAS Number	LOR	Unit	EW1300467-011	EW1300467-012	EW1300467-013	EW1300467-014	EW1300467-015
<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	----	866	1200	----	810
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	866	1200	----	810
<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	----	120	<1	----	<10
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	286	610	----	217
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	165	210	----	130
Magnesium	7439-95-4	1	mg/L	----	94	99	----	56
Sodium	7440-23-5	1	mg/L	----	210	358	----	160
Potassium	7440-09-7	1	mg/L	----	82	131	----	87
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	0.214	0.898	----	0.252
Iron	7439-89-6	0.05	mg/L	----	5.65	6.19	----	0.11
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	0.7	0.4	----	1.0
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	35.2	87.8	----	67.6
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	0.06	0.03	----	0.10
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	----	1.09	0.34	----	1.08
<b>EK059G: Nitrite plus Nitrate as N (NO<sub>x</sub>) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	1.15	0.37	----	1.18
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	27.9	41.2	----	22.3
Total Cations	----	0.01	meq/L	----	27.2	37.6	----	20.3
Ionic Balance	----	0.01	%	----	1.21	4.61	----	4.75
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	7.1	7.0	----	7.3



## 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-FEB-2013 12:20	18-FEB-2013 12:25	18-FEB-2013 12:30	18-FEB-2013 11:45	18-FEB-2013 11:50
Compound	CAS Number	LOR	Unit	EW1300467-011	EW1300467-012	EW1300467-013	EW1300467-014	EW1300467-015
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	2660	3950	----	2390
Dissolved Oxygen	----	0.01	mg/L	----	1.61	1.78	----	1.96
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	18.5	20.6	----	23.3
Temperature	----	0.1	°C	----	20.5	21.2	----	22.6
Salinity	----	0.2	g/L	----	1.5	2.3	----	1.3
Depth	----	0.01	m	----	0.97	0.99	----	0.89
Field Observations	----	0.01	--	DRY	----	----	DRY	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	41	94	----	54
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	43	96	----	61
<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					18-FEB-2013 12:00	18-FEB-2013 12:10	18-FEB-2013 12:55	18-FEB-2013 10:40	----
Compound	CAS Number	LOR	Unit	EW1300467-016	EW1300467-017	EW1300467-018	EW1300467-019		----
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	----	136	171	----		----
Total Alkalinity as CaCO3	----	1	mg/L	----	136	171	----		----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	482	123	----		----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L	----	3490	876	----		----
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	----	108	69	----		----
Magnesium	7439-95-4	1	mg/L	----	234	76	----		----
Sodium	7440-23-5	1	mg/L	----	1950	545	----		----
Potassium	7440-09-7	1	mg/L	----	78	27	----		----
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	----	1.15	0.653	----		----
Iron	7439-89-6	0.05	mg/L	----	1.59	1.40	----		----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	----	0.6	0.3	----		----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	----	0.71	0.10	----		----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L	----	0.02	<0.01	----		----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	----	0.15	0.31	----		----
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-FEB-2013 12:00	18-FEB-2013 12:10	18-FEB-2013 12:55	18-FEB-2013 10:40	----
Compound	CAS Number	LOR	Unit	EW1300467-016	EW1300467-017	EW1300467-018	EW1300467-019	----
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.17	0.31	----	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	7.2	7.7	----	----
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	9880	3310	----	----
Dissolved Oxygen	----	0.01	mg/L	----	5.75	11.8	----	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	67.5	143	----	----
Temperature	----	0.1	°C	----	22.3	24.2	----	----
Salinity	----	0.2	g/L	----	5.9	1.8	----	----
Field Observations	----	0.01	--	Overgrown	----	----	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	15	17	<1	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	18	22	----	----
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	<0.05	<0.05	----	----



# CHAIN OF CUSTODY

ALS Laboratory, please tick →

□ Sydney 2777 Woodpark Rd, Smithfield NSW 2176  
Ph: 02 8764 8555 E: samples.sydney@alsenviro.com  
□ Newcastle 5 Rosegum Rd, Warabrook NSW 2304  
Ph: 02 4866 9433 E: samples.newcastle@alsenviro.com

□ Brisbane 32 Strand St, Stafford QLD 4053  
Ph: 07 3243 7222 E: samples.brisbane@alsenviro.com  
□ Townsville 14-15 Derrin Ct, Bohle QLD 4818  
Ph: 07 4786 0600 E: samples.townsville@alsenviro.com

□ Melbourne 2-4 Westall Rd, Springvale VIC 3171  
Ph: 03 8545 9600 E: samples.melbourne@alsenviro.com  
□ Adelaide 2-1 Burma Rd, Port Adelaide SA 5005  
Ph: 08 8359 0890 E: samples.adelaide@alsenviro.com

□ Perth 10 Hot Way, Malaga WA 6000  
Ph: 08 9209 7655 E: samples.perth@alsenviro.com  
□ Launceston 27 Wallington St, Launceston TAS 7250  
Ph: 03 6331 2158 E: samples.launceston@alsenviro.com

CLIENT: Kiama Municipal Council

OFFICE: PO Box 75 Kiama NSW 2533

PROJECT: Minnamurra Landfill

ORDER NUMBER:

PROJECT MANAGER: Paul Czuliowski

SAMPLER: Craig Wilson

COC emailed to ALS? ( YES / NO )

Email Reports to (will default to PM if no other addresses are listed): paulc@kiama.nsw.gov.au, juliem@kiama.nsw.gov.au

Email Invoices to (will default to PM if no other addresses are listed): paulc@kiama.nsw.gov.au, juliem@kiama.nsw.gov.au

COMMENT/SPECIAL HANDLING/STORAGE OR DISPOSAL:

TURNAROUND REQUIREMENTS : ☐ Standard TAT (List due date):

(Standard TAT may be longer for some tests e.g. Ultra Trace Organics)

ALS QUOTE NO.: SY-146-10

CONTACT PH: 4232 0418

SAMPLER MOBILE: 0408 261 660

EDD FORMAT (or default):

RELINQUISHED BY: Craig

DATE/TIME: 18/2/13 15:30

RECEIVED BY: Aneta

DATE/TIME: 18.2.13 15:30

FOR LABORATORY USE ONLY (Circle)

Custody Seal Intact? Yes No N/A

Free ice receipt? Yes No N/A

COC SEQUENCE NUMBER (Circle)

1 2 3 4 5 6 7

Other

RELINQUISH

DATE/TIME:

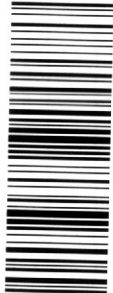
DATE/TIME:

Environmental Division  
NSW South Coast

Work Order

EW1300467

Telephone : 02 42253125



analysis etc.

YSI (Field Results)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

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



# CHAIN OF CUSTODY

ALS Laboratory, please tick →

□ Sydney 277 Woodpark Rd, Smithfield NSW 2176  
Ph: 02 8784 8565 E: samples.syd@alsenviro.com  
□ Newcastle 5 Rosegum Rd, Warabrook NSW 2204  
Ph: 02 4969 9433 E: samples.newcastle@alsenviro.com

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

□ Melbourne 24 Westall Rd, Springvale VIC 3171  
Ph: 03 9549 9600 E: samples.melbourne@alsenviro.com  
□ Adelaide 2-4 Burma Rd, Pootaka SA 5095  
Ph: 08 8359 0890 E: adelaide@alsenviro.com

□ Perth 10 Hot Way, Wangara WA 6100  
Ph: 08 9209 7655 E: samples.perth@alsenviro.com  
□ Launceston 27 Vaelington St, Launceston TAS 7250  
Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: Kiama Municipal Council

OFFICE: PO Box 75 Kiama NSW 2533

PROJECT: Minnamurra Landfill

ORDER NUMBER:

PROJECT MANAGER: Paul Czuiowski

SAMPLER: Craig Wilson

COC emailed to ALS? (YES / NO)

Email Reports to (will default to PM if no other addresses are listed):

Email Invoice to (will default to PM if no other addresses are listed):

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

TURNAROUND REQUIREMENTS: □ Standard TAT (List due date):

(Standard TAT may be longer for some tests e.g. Ultra Trace Organics)

ALS QUOTE NO.:

SY-146-10

CONTACT PH: 4232 0418

SAMPLER MOBILE: 0408 261 680

EDD FORMAT (or default):

RELINQUISHED BY: Craig

DATE/TIME: 18/2/13 1530

FOR LABORATORY USE ONLY (Circle)

Custody Seal Intact? Yes No N/A

Free Ice / frozen ice bricks present upon receipt? Yes No N/A

Random Sample Temperature on Receipt: °C

Other comment:

RECEIVED BY:

DATE/TIME:

RECEIVED BY:

DATE/TIME:

ALS USE ONLY

SAMPLE DETAILS  
MATRIX: Solid(S) Water(W)

CONTAINER INFORMATION

ANALYSIS REQUIRED INCLUDING SUITES (NB Suite Codes must be listed to attract suite price)  
Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (acid filtered bottle required)

Additional Information

LAB ID

SAMPLE ID

DATE / TIME

MATRIX

TYPE & PRESERVATIVE  
(refer to codes below)

TOTAL BOTTLES

NT-02A (Alkalinity, Cl, SO4 & Fluoride)

Nitrate, Ammonia, Total Phenolics

DOC (Filtered)

TOC

(Dissolved Filtered) Fe, Mn, NT-01 (Mg, Ca, Na, K)

(Total) Fe, Mn, Mg, Ca, Na, K

YSI (Field Results)  
pH, Temp, EC, Sal, DO, DO<sub>2</sub>

Comments on likely contaminant levels, dilutions or samples requiring specific QC analysis etc.

13

MD 9C

18/2 12:30

W

500mL, SP, 2 X VS, N

5

✓

✓

✓

✓

✓

✓

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

14

MD 10A

11:45

W

500mL, SP, 2 X VS, N

5

✓

✓

✓

✓

✓

✓

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

15

MD 10B

11:50

W

500mL, SP, 2 X VS, N

5

✓

✓

✓

✓

✓

✓

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

16

Rocklow Down

12:00

W

500mL, SP, 2 X VS, N

5

✓

✓

✓

✓

✓

✓

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

17

Rocklow Middle

12:10

W

500mL, SP, 2 X VS, N

5

✓

✓

✓

✓

✓

✓

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

18

Rocklow Up

12:55

W

500mL, SP, 2 X VS, N

5

✓

✓

✓

✓

✓

✓

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

19

Blank

10:40

W

VS, N

2

✓

✓

✓

✓

✓

✓

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

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

V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulfate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airtight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl Preserved Plastic; HS = HCl Preserved Speciation bottle; SP = Sulfuric

Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulfate Soils; B = Unpreserved Bag

## Environmental Division

# CERTIFICATE OF ANALYSIS

Work Order	: <b>EW1301509</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 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 30-MAY-2013
C-O-C number	: ----	Issue Date	: 06-JUN-2013
Sampler	: Craig Wilson	No. of samples received	: 19
Site	: ----	No. of samples analysed	: 19
Quote number	: Minnamurra Landfill WL/083/11		

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
Raymond Commodor	Instrument Chemist	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.

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: Some samples were diluted and rerun due to matrix interference and LOR's have been raised accordingly. (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.**
- **Sites MD2A, MD4A, MD6A, MD9A and MD10A - Insufficient Sample at time of sampling.**  
**Sites MD1B & Rocklow Down - No Access to sites.**



## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				30-MAY-2013 10:15	30-MAY-2013 08:25	30-MAY-2013 08:30	30-MAY-2013 08:40	30-MAY-2013 08:00
Compound	CAS Number	LOR	Unit	EW1301509-001	EW1301509-002	EW1301509-003	EW1301509-004	EW1301509-005
<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	----	----	699	438	----
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	----	699	438	----
<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	----	----	1130	1980	----
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	----	8470	14200	----
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	----	392	460	----
Magnesium	7439-95-4	1	mg/L	----	----	633	1070	----
Sodium	7440-23-5	1	mg/L	----	----	5140	8500	----
Potassium	7440-09-7	1	mg/L	----	----	236	346	----
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	----	0.088	0.060	----
Iron	7439-89-6	0.05	mg/L	----	----	0.46	<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	----	----	12.3	0.07	----
<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	----	----	2.90	2.09	----
<b>EK059G: Nitrite plus Nitrate as N (NO<sub>x</sub>) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	----	2.90	2.09	----
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	----	276	450	----
Total Cations	----	0.01	meq/L	----	----	301	490	----
Ionic Balance	----	0.01	%	----	----	4.29	4.14	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	----	7.2	7.2	----





## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 1B	MD 2A	MD 2B	MD 2C	MD 4A
				30-MAY-2013 10:15	30-MAY-2013 08:25	30-MAY-2013 08:30	30-MAY-2013 08:40	30-MAY-2013 08:00
Compound	CAS Number	LOR	Unit	EW1301509-001	EW1301509-002	EW1301509-003	EW1301509-004	EW1301509-005
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	----	25600	42500	----
Dissolved Oxygen	----	0.01	mg/L	----	----	1.41	2.13	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	----	14.3	21.8	----
Temperature	----	0.1	°C	----	----	15.7	15.9	----
Salinity	----	0.2	g/L	----	----	19.4	33.8	----
Depth	----	0.01	m	----	----	0.56	0.62	----
Field Observations	----	0.01	--	No Access	Insufficient Sample	----	----	Insufficient Sample
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	----	36	18	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	----	36	17	----
<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	MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
					30-MAY-2013 08:05	30-MAY-2013 08:15	30-MAY-2013 07:35	30-MAY-2013 07:40	30-MAY-2013 07:50
Compound	CAS Number	LOR	Unit	EW1301509-006	EW1301509-007	EW1301509-008	EW1301509-009	EW1301509-010	
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	665	666	----	619	346	
Total Alkalinity as CaCO3	----	1	mg/L	665	666	----	619	346	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	439	1500	----	51	1200	
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L	3160	10600	----	115	8470	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	331	437	----	123	403	
Magnesium	7439-95-4	1	mg/L	239	845	----	47	662	
Sodium	7440-23-5	1	mg/L	1540	6490	----	88	4920	
Potassium	7440-09-7	1	mg/L	133	297	----	53	190	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.097	0.154	----	0.112	0.039	
Iron	7439-89-6	0.05	mg/L	6.06	2.16	----	0.16	0.30	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	0.5	0.6	----	0.5	0.4	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	21.5	3.62	----	41.0	38.8	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L	0.02	<0.01	----	0.11	0.01	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	2.27	0.47	----	1.10	0.45	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	2.29	0.47	----	1.21	0.46	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	112	344	----	16.7	271	
Total Cations	----	0.01	meq/L	----	381	----	----	293	
Total Cations	----	0.01	meq/L	108	----	----	18.1	----	
Ionic Balance	----	0.01	%	----	----	----	----	4.00	
Ionic Balance	----	0.01	%	1.58	4.96	----	4.11	----	
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
				30-MAY-2013 08:05	30-MAY-2013 08:15	30-MAY-2013 07:35	30-MAY-2013 07:40	30-MAY-2013 07:50
Compound	CAS Number	LOR	Unit	EW1301509-006	EW1301509-007	EW1301509-008	EW1301509-009	EW1301509-010
<b>EN67 PK: Field Tests - Continued</b>								
pH	----	0.1	pH Unit	7.0	7.2	----	7.4	7.2
Electrical Conductivity (Non Compensated)	----	1	µS/cm	10900	32700	----	1660	25800
Dissolved Oxygen	----	0.01	mg/L	2.76	5.98	----	2.28	2.16
Dissolved Oxygen - % Saturation	----	0.1	% saturation	28.3	61.1	----	23.5	22.6
Temperature	----	0.1	°C	16.1	16.0	----	16.5	17.6
Salinity	----	0.2	g/L	7.6	25.2	----	1.0	18.7
Depth	----	0.01	m	1.03	1.06	----	1.15	1.28
Field Observations	----	0.01	--	----	----	Insufficient Sample	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	42	27	----	29	13
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	45	27	----	30	14
<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
				30-MAY-2013 09:45	30-MAY-2013 09:50	30-MAY-2013 10:00	30-MAY-2013 09:15	30-MAY-2013 09:20
Compound	CAS Number	LOR	Unit	EW1301509-011	EW1301509-012	EW1301509-013	EW1301509-014	EW1301509-015
<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	----	869	1180	----	796
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	869	1180	----	796
<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	----	123	<10	----	<10
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	312	508	----	228
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	161	173	----	109
Magnesium	7439-95-4	1	mg/L	----	91	82	----	46
Sodium	7440-23-5	1	mg/L	----	217	326	----	146
Potassium	7440-09-7	1	mg/L	----	81	116	----	86
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	0.094	0.642	----	0.311
Iron	7439-89-6	0.05	mg/L	----	0.28	0.75	----	0.34
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	0.7	0.4	----	0.9
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	31.5	76.3	----	79.6
<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	----	1.36	<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	----	1.38	<0.01	----	<0.01
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	28.7	37.9	----	22.3
Total Cations	----	0.01	meq/L	----	29.3	38.0	----	23.5
Ionic Balance	----	0.01	%	----	0.93	0.06	----	2.42
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	7.2	7.1	----	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
				30-MAY-2013 09:45	30-MAY-2013 09:50	30-MAY-2013 10:00	30-MAY-2013 09:15	30-MAY-2013 09:20
Compound	CAS Number	LOR	Unit	EW1301509-011	EW1301509-012	EW1301509-013	EW1301509-014	EW1301509-015
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	2780	3800	----	2310
Dissolved Oxygen	----	0.01	mg/L	----	2.34	1.61	----	2.37
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	24.2	16.9	----	24.9
Temperature	----	0.1	°C	----	16.7	17.2	----	16.9
Salinity	----	0.2	g/L	----	1.7	2.4	----	1.4
Depth	----	0.01	m	----	0.71	0.80	----	0.57
Field Observations	----	0.01	--	Insufficient Sample	----	----	Insufficient Sample	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	40	73	----	58
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	40	71	----	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	30-MAY-2013 09:35	30-MAY-2013 09:05	30-MAY-2013 07:20	30-MAY-2013 07:45	----
Compound	CAS Number	LOR	Unit	EW1301509-016	EW1301509-017	EW1301509-018	EW1301509-019	----	
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	----	101	76	----	----	
Total Alkalinity as CaCO3	----	1	mg/L	----	101	76	----	----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	207	56	----	----	
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L	----	1050	173	----	----	
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	----	52	28	----	----	
Magnesium	7439-95-4	1	mg/L	----	88	19	----	----	
Sodium	7440-23-5	1	mg/L	----	749	111	----	----	
Potassium	7440-09-7	1	mg/L	----	32	7	----	----	
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	----	0.096	0.101	----	----	
Iron	7439-89-6	0.05	mg/L	----	0.94	1.64	----	----	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	----	0.3	0.1	----	----	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	----	0.19	0.12	----	----	
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	----	0.06	0.06	----	----	
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	----
				30-MAY-2013 09:35	30-MAY-2013 09:05	30-MAY-2013 07:20	30-MAY-2013 07:45	----
Compound	CAS Number	LOR	Unit	EW1301509-016	EW1301509-017	EW1301509-018	EW1301509-019	----
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.07	0.06	----	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	7.2	7.2	----	----
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	4230	873	----	----
Dissolved Oxygen	----	0.01	mg/L	----	7.55	6.39	----	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	73.7	61.1	----	----
Temperature	----	0.1	°C	----	13.8	13.0	----	----
Salinity	----	0.2	g/L	----	2.9	<0.2	----	----
Field Observations	----	0.01	--	No Access	----	----	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	9	9	<1	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	9	8	----	----
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	<0.05	<0.05	----	----





## CHAIN OF CUSTODY

ALS Laboratory: please tick →

CLIENT: Kiama Municipal Council

PO Box 75 Kiama NSW 2533

PROJECT: Minamamura Landfill

ORDER NUMBER:

**PROJECT MANAGER:** Paul Czulowski

**SAMPLER:**

COC emailed to ALS? ( YES / NO)

Email Reports to (will default to PM if no other addresses are listed)

Email Invoice to (will default to PM if no other addresses are listed)

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL

**SAMPLE DETAILS**  
MATRIX: Solid(S) Water(W)

### CONTAINER INFORMATION

Where Metals are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).

### Additional Information

Comments on likely contaminant levels, dilutions, or samples requiring specific GC analysis etc.

YSI (Field Results)  
pH, Temp, EC, Sal, DO

YSI (Field Tests)

pH, Temp, EC, Sal, DO, Depth

pH, Temp, EC, Sal, DO, Depth

pH, Temp, EC, Sal, DO, Depth

pH, Temp, EC, Sal, DO, Depth

pH, Temp, EC, Sal, DO, Depth

1

ENFM 204

V = Vial Holder; Cased = Vial Cap; PS = Unpreserved Plastic; N = Nitric Preserved Plastic; OAC = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airtight Unpreserved Plastic  
V = VOA; Vali HCl Preserv = VOA Via Glacial Acetic Acid Preserved; YS = Airtight Unpreserved Via SG = Sulfuric Preserved Amber Glass; H = HOI preserved Plastic; HS = HOI preserved Speciation bottle; SP = Sulu  
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag

## Environmental Division

# CERTIFICATE OF ANALYSIS

Work Order	: <b>EW1302478</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	: 29-AUG-2013
Sampler	: Craig Wilson	Issue Date	: 10-SEP-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 Unit 4 / 13 Geary Place, PO Box 3105, North Nowra 2541

[www.alsglobal.com](http://www.alsglobal.com)

RIGHT SOLUTIONS RIGHT PARTNER



## 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 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.**
- **Sites MD2A, MD4A, MD6A, MD9A and MD10A - Dry at time of sampling.**  
**Sites MD1B & Rocklow Down - No Access 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
				29-AUG-2013 10:10	29-AUG-2013 08:10	29-AUG-2013 08:15	29-AUG-2013 08:25	29-AUG-2013 08:50
Compound	CAS Number	LOR	Unit	EW1302478-001	EW1302478-002	EW1302478-003	EW1302478-004	EW1302478-005
<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	----	----	721	465	----
Total Alkalinity as CaCO <sub>3</sub>	----	1	mg/L	----	----	721	465	----
<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	----	----	1080	2050	----
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	----	7300	14200	----
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	----	396	471	----
Magnesium	7439-95-4	1	mg/L	----	----	538	1090	----
Sodium	7440-23-5	1	mg/L	----	----	4550	8650	----
Potassium	7440-09-7	1	mg/L	----	----	230	417	----
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	----	0.069	<0.010	----
Iron	7439-89-6	0.05	mg/L	----	----	0.27	<0.50	----
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	----	0.8	0.8	----
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	----	10.2	0.08	----
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	----	0.03	<0.01	----
<b>EK058G: Nitrate as N by Discrete Analyser</b>								
Nitrate as N	14797-55-8	0.01	mg/L	----	----	3.34	1.75	----
<b>EK059G: Nitrite plus Nitrate as N (NO<sub>x</sub>) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	----	3.37	1.75	----
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	----	243	452	----
Total Cations	----	0.01	meq/L	----	----	268	500	----
Ionic Balance	----	0.01	%	----	----	4.89	4.98	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	----	7.5	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
				29-AUG-2013 10:10	29-AUG-2013 08:10	29-AUG-2013 08:15	29-AUG-2013 08:25	29-AUG-2013 08:50
Compound	CAS Number	LOR	Unit	EW1302478-001	EW1302478-002	EW1302478-003	EW1302478-004	EW1302478-005
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	----	22200	42200	----
Dissolved Oxygen	----	0.01	mg/L	----	----	1.68	4.77	----
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	----	16.7	47.5	----
Temperature	----	0.1	°C	----	----	14.6	14.5	----
Salinity	----	0.2	g/L	----	----	16.3	32.4	----
Depth	----	0.01	m	----	----	0.85	0.90	----
Field Observations	----	0.01	--	No Access	DRY	----	----	DRY
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	----	42	19	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	----	42	18	----
<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	MD 4B	MD 4C	MD 6A	MD 6B	MD 6C
					29-AUG-2013 08:45	29-AUG-2013 08:35	29-AUG-2013 07:45	29-AUG-2013 07:50	29-AUG-2013 08:00
Compound	CAS Number	LOR	Unit	EW1302478-006	EW1302478-007	EW1302478-008	EW1302478-009	EW1302478-010	
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	781	670	----	789	409	
Total Alkalinity as CaCO3	----	1	mg/L	781	670	----	789	409	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	436	1640	----	90	1200	
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L	3050	10700	----	189	8300	
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L	339	429	----	158	410	
Magnesium	7439-95-4	1	mg/L	233	810	----	66	618	
Sodium	7440-23-5	1	mg/L	1400	6660	----	133	5020	
Potassium	7440-09-7	1	mg/L	125	326	----	57	212	
EG020F: Dissolved Metals by ICP-MS									
Manganese	7439-96-5	0.001	mg/L	0.108	0.226	----	0.152	0.078	
Iron	7439-89-6	0.05	mg/L	0.36	0.34	----	0.17	0.06	
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L	0.5	0.7	----	0.5	0.5	
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L	33.6	2.94	----	31.1	33.9	
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	----	<0.01	0.08	
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L	0.11	0.61	----	0.43	0.10	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L	0.11	0.61	----	0.43	0.18	
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L	111	349	----	23.0	267	
Total Cations	----	0.01	meq/L	100	386	----	----	295	
Total Cations	----	0.01	meq/L	----	----	----	22.7	----	
Ionic Balance	----	0.01	%	5.00	4.98	----	----	4.93	
Ionic Balance	----	0.01	%	----	----	----	0.62	----	
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
				29-AUG-2013 08:45	29-AUG-2013 08:35	29-AUG-2013 07:45	29-AUG-2013 07:50	29-AUG-2013 08:00
Compound	CAS Number	LOR	Unit	EW1302478-006	EW1302478-007	EW1302478-008	EW1302478-009	EW1302478-010
<b>EN67 PK: Field Tests - Continued</b>								
pH	----	0.1	pH Unit	7.3	7.2	----	7.3	7.2
Electrical Conductivity (Non Compensated)	----	1	µS/cm	10500	32300	----	2160	24900
Dissolved Oxygen	----	0.01	mg/L	3.14	2.45	----	1.83	1.53
Dissolved Oxygen - % Saturation	----	0.1	% saturation	31.4	24.6	----	18.5	15.8
Temperature	----	0.1	°C	14.8	14.7	----	15.6	16.3
Salinity	----	0.2	g/L	7.5	24.0	----	<2.0	17.8
Depth	----	0.01	m	1.27	1.28	----	1.36	1.52
Field Observations	----	0.01	--	----	----	DRY	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	45	31	----	42	14
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	47	30	----	41	15
<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
				29-AUG-2013 09:30	29-AUG-2013 09:34	29-AUG-2013 09:45	29-AUG-2013 09:00	29-AUG-2013 09:05
Compound	CAS Number	LOR	Unit	EW1302478-011	EW1302478-012	EW1302478-013	EW1302478-014	EW1302478-015
<b>ED037P: Alkalinity by PC Titrator</b>								
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	----	943	1240	----	776
Total Alkalinity as CaCO3	----	1	mg/L	----	943	1240	----	776
<b>ED041G: Sulfate (Turbidimetric) as SO4 2- by DA</b>								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	----	107	<10	----	<10
<b>ED045G: Chloride Discrete analyser</b>								
Chloride	16887-00-6	1	mg/L	----	337	549	----	226
<b>ED093F: Dissolved Major Cations</b>								
Calcium	7440-70-2	1	mg/L	----	186	206	----	133
Magnesium	7439-95-4	1	mg/L	----	98	96	----	48
Sodium	7440-23-5	1	mg/L	----	226	343	----	157
Potassium	7440-09-7	1	mg/L	----	80	128	----	94
<b>EG020F: Dissolved Metals by ICP-MS</b>								
Manganese	7439-96-5	0.001	mg/L	----	0.118	0.743	----	0.380
Iron	7439-89-6	0.05	mg/L	----	0.34	2.46	----	0.64
<b>EK040P: Fluoride by PC Titrator</b>								
Fluoride	16984-48-8	0.1	mg/L	----	0.6	0.4	----	0.8
<b>EK055G: Ammonia as N by Discrete Analyser</b>								
Ammonia as N	7664-41-7	0.01	mg/L	----	26.3	63.0	----	68.4
<b>EK057G: Nitrite as N by Discrete Analyser</b>								
Nitrite as N	----	0.01	mg/L	----	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	----	0.57	0.06	----	0.01
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.58	0.06	----	0.01
<b>EN055: Ionic Balance</b>								
Total Anions	----	0.01	meq/L	----	30.6	40.3	----	21.9
Total Cations	----	0.01	meq/L	----	29.2	36.4	----	19.8
Ionic Balance	----	0.01	%	----	2.26	----	----	4.93
Ionic Balance	----	0.01	%	----	----	4.98	----	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	7.3	7.1	----	7.6



## Analytical Results

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

Client sample ID

Client sampling date / time

				MD 9A	MD 9B	MD 9C	MD 10A	MD 10B
				29-AUG-2013 09:30	29-AUG-2013 09:34	29-AUG-2013 09:45	29-AUG-2013 09:00	29-AUG-2013 09:05
Compound	CAS Number	LOR	Unit	EW1302478-011	EW1302478-012	EW1302478-013	EW1302478-014	EW1302478-015
<b>EN67 PK: Field Tests - Continued</b>								
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	2860	3930	----	2330
Dissolved Oxygen	----	0.01	mg/L	----	2.00	2.58	----	2.27
Dissolved Oxygen - % Saturation	----	0.1	% saturation	----	20.0	26.1	----	23.0
Temperature	----	0.1	°C	----	15.3	15.7	----	15.4
Salinity	----	0.2	g/L	----	<2.0	2.6	----	<2.0
Depth	----	0.01	m	----	0.90	1.02	----	0.76
Field Observations	----	0.01	--	DRY	----	----	DRY	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	45	85	----	62
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	46	85	----	62
<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					29-AUG-2013 09:50	29-AUG-2013 09:20	29-AUG-2013 07:20	29-AUG-2013 07:30	----
Compound	CAS Number	LOR	Unit		EW1302478-016	EW1302478-017	EW1302478-018	EW1302478-019	----
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		----	164	107	----	----
Total Alkalinity as CaCO3	----	1	mg/L		----	164	107	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		----	460	227	----	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		----	3460	1230	----	----
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		----	103	67	----	----
Magnesium	7439-95-4	1	mg/L		----	226	102	----	----
Sodium	7440-23-5	1	mg/L		----	1840	809	----	----
Potassium	7440-09-7	1	mg/L		----	78	35	----	----
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		----	0.169	0.130	----	----
Iron	7439-89-6	0.05	mg/L		----	0.19	0.94	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		----	0.6	0.3	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		----	0.40	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		----	0.13	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	----
				29-AUG-2013 09:50	29-AUG-2013 09:20	29-AUG-2013 07:20	29-AUG-2013 07:30	----
Compound	CAS Number	LOR	Unit	EW1302478-016	EW1302478-017	EW1302478-018	EW1302478-019	----
<b>EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser - Continued</b>								
Nitrite + Nitrate as N	----	0.01	mg/L	----	0.13	0.04	----	----
<b>EN67 PK: Field Tests</b>								
pH	----	0.1	pH Unit	----	7.3	7.3	----	----
Electrical Conductivity (Non Compensated)	----	1	µS/cm	----	10400	4620	----	----
Dissolved Oxygen	----	0.01	mg/L	----	6.93	9.30	----	----
Temperature	----	0.1	°C	----	13.2	12.5	----	----
Salinity	----	0.2	g/L	----	7.7	3.3	----	----
Field Observations	----	0.01	--	No Access	----	----	----	----
<b>EP002: Dissolved Organic Carbon (DOC)</b>								
Dissolved Organic Carbon	----	1	mg/L	----	10	10	<1	----
<b>EP005: Total Organic Carbon (TOC)</b>								
Total Organic Carbon	----	1	mg/L	----	10	10	----	----
<b>EP035G: Total Phenol by Discrete Analyser</b>								
Phenols (Total)	----	0.05	mg/L	----	<0.05	<0.05	----	----



## CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ Sydney 277 Woodpark Rd, Smithfield NSW 2176  
Ph: 02 8784 8555 E: samples.syd@alsenviro.com  
☐ Newcastle: 5 Raequon Rd, Warabrook NSW 2304  
Ph: 02 4988 9433 E: samples.newcastle@alsenviro.com

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

☐ Melbourne 2-4 Westall Rd, Springvale VIC 3171  
Ph: 03 8549 9600 E: samples.melbourne@alsenviro.com  
☐ Adelaide: 2-1 Burma Rd, Pooraka SA 5095  
Ph: 08 8359 0890 E: adelaide@alsenviro.com

☐ Perth: 10 Hoot Wvey, Malaga WA 6060  
Ph: 08 9209 7655 E: samples.perth@alsenviro.com  
☐ Launceston: 27 Wellington St, Launceston TAS 7250  
Ph: 03 6331 2158 E: launceston@alsenviro.com

### FOR LABORATORY USE ONLY (Circle)

Custody Seal intact? Yes No N/A

Free ice / frozen ice bricks present upon receipt? Yes No N/A

Random Sample Temperature on Receipt: °C

TURNAROUND REQUIREMENTS : ☐ Standard TAT (List due date):  
☐ Non Standard or urgent TAT (List due date):

(Standard TAT may be longer for some tests e.g. Ultra Trace Organics)

COC SEQUENCE NUMBER (Circle)

COC: 1 2 3 4 5 6 7

OF: 1 2 3 4 5 6 7

Other comment:

CLIENT:	Kiama Municipal Council	CONTACT PH: 4232 0418
OFFICE:	PO Box 75 Kiama NSW 2533	SAMPLER MOBILE: 0408 261 560
PROJECT:	Minnamurra Landfill	ALS QUOTE NO.:
ORDER NUMBER:		SY-146-10
PROJECT MANAGER:	Paul Czulowski	RELINQUISHED BY: Craig Wilson
SAMPLER:	Craig Wilson	EDD FORMAT (or default):
COC emailed to ALS? (YES / NO)		DATE/TIME: 29/8/13
Email Reports to (will default to PM if no other addresses are listed)	pauc@kiama.nsw.gov.au, juliem@kiama.nsw.gov.au	DATE/TIME: 29-8-13 12:10
Email Invoice to (will default to PM if no other addresses are listed)	pauc@kiama.nsw.gov.au, juliem@kiama.nsw.gov.au	DATE/TIME:

### COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)	CONTAINER INFORMATION	ANALYSIS REQUIRED including SUITES (NB: Suite Codes must be listed to attract Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle)
--------------	---	-----------------------	--

LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	NT-02A (Alkalinity, Cl, SO4 & Fluoride)	Nitrate, Ammonia, Total Phenolics	DOC (Filtered)	TOC	(Dissolved Filtered) Fe, Mn, NT-01 (Mg, Ca, Na, K)	(Total) Fe, Mn, Mg, Ca, Na, K
1	MD 1B	29/8/13 1010	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	No Access
2	MD 2A	810	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	DRY
3	MD 2B	815	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	
4	MD 2C	825	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	
5	MD 4A	850	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	DRY
6	MD 4B	845	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	
7	MD 4C	835	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	DRY
8	MD 6A	745	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	DRY
9	MD 6B	750	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	
10	MD 6C	800	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	
11	MD 9A	970	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	DRY
12	MD 9B	934	W	500mL, SP, 2 X VS, N	5	✓	✓	✓	✓	✓	
TOTAL											

Telephone : 02 42253125



Environmental Division  
NSW South Coast  
Work Order  
EW1302478

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



# CHAIN OF CUSTODY

ALS Laboratory: please tick →

□ Sydney 277 Woodpark Rd, Smithfield NSW 2176  
Ph: 02 8784 8555 E: samples.syd@alsenviro.com  
□ Newcastle 5 Roesgum Rd, Waratah NSW 2204  
Ph: 02 4968 5433 E: samples.newcastle@alsenviro.com  
□ Brisbane 32 Strand St, Stafford QLD 4053  
Ph: 07 3243 7222 E: samples.brisbane@alsenviro.com  
□ Townsville 14-15 Dasma Ct, Bohle QLD 4818  
Ph: 07 4796 0000 E: townsville@alsenviro.com  
□ Melbourne 2-4 Westall Rd, Springvale VIC 3171  
Ph: 03 8549 9600 E: samples.melbourne@alsenviro.com  
□ Adelaide 2-1 Burma Rd, Pooraka SA 5095  
Ph: 08 8359 0890 E: adelaide@alsenviro.com  
□ Perth 10 Hood Way, Miraga WA 6300  
Ph: 08 9209 7655 E: samples.perth@alsenviro.com  
□ Launceston 27 Wellington St, Launceston TAS 7250  
Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: Kiama Municipal Council

OFFICE: PO Box 75 Kiama NSW 2533

PROJECT: Minnamurra Landfill

ORDER NUMBER:

PROJECT MANAGER: Paul Czuiowski

SAMPLER: Craig Wilson

COC emailed to ALS? ( YES / NO )

Email Reports to (will default to PM if no other addresses are listed):

Email Invoice to (will default to PM if no other addresses are listed):

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

TURNAROUND REQUIREMENTS:

(Standard TAT may be longer for some tests e.g. Ultra Trace Organics)

ALS QUOTE NO.:

CONTACT PH: 4232 0418

SAMPLER MOBILE: 0408 261 560

EDD FORMAT (or default):

RELINQUISHED BY:

DATE/TIME:

RECEIVED BY:

DATE/TIME:

FOR LABORATORY USE ONLY (Circle)

Custody Seal intact? Yes No N/A

Free ice / frozen ice bricks present upon receipt? Yes No N/A

Random Sample Temperature on Receipt: °C

Other comment:

RECEIVED BY:

DATE/TIME:

## SAMPLE DETAILS

MATRIX: Solid(S) Water(W)

## CONTAINER INFORMATION

ANALYSIS REQUIRED INCLUDING SUITES (NB: Suite Codes must be listed to attract suite price)  
Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (filtered bottle required)

## Additional Information

Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.

YSI (Field Results)  
pH, Temp, EC, Sal, DO,

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

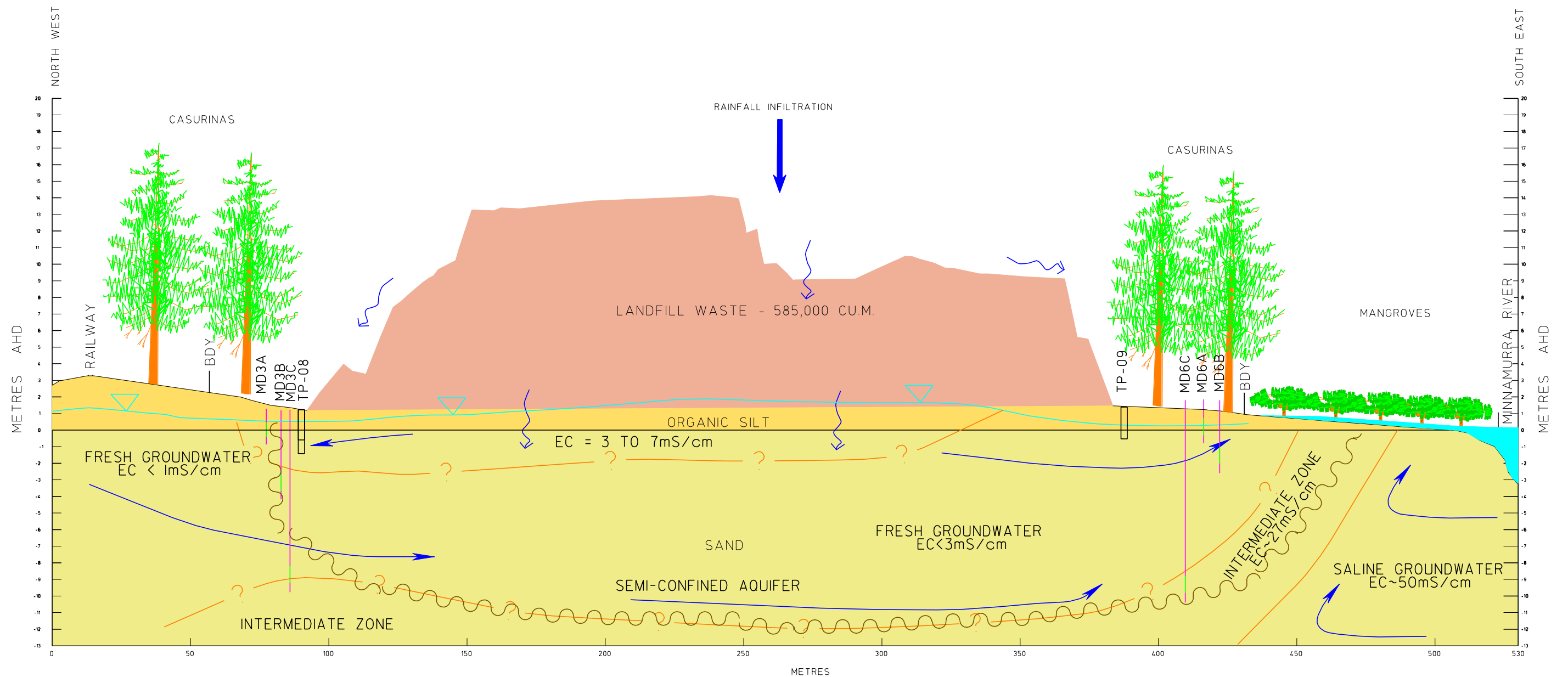
YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

YSI (Field Tests)  
pH, Temp, EC, Sal, DO, Depth

TOTAL

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

## 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



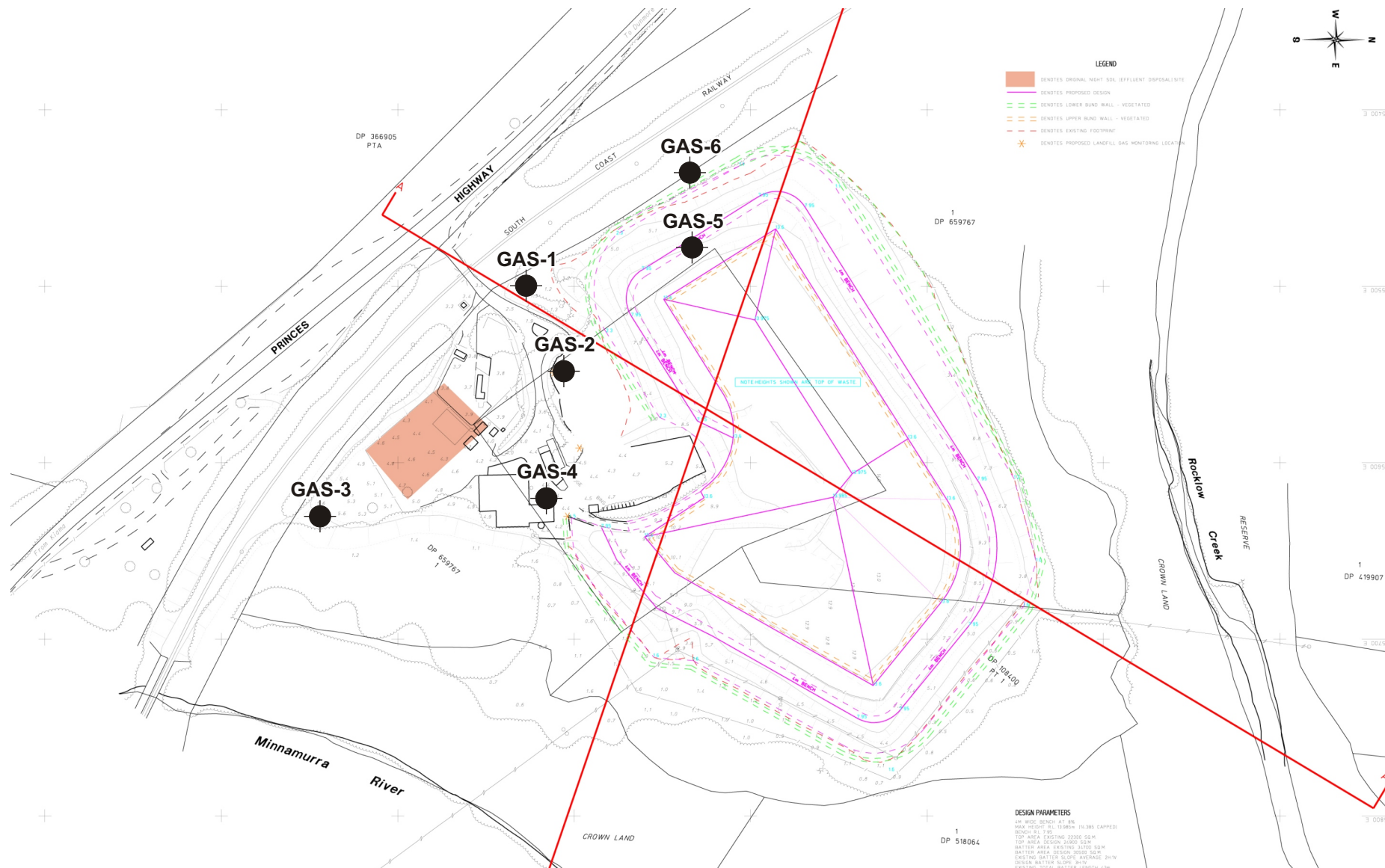
## LANDFILL GAS MONITORING

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	2-Feb-12	1000	100	4,700		890	Good readings
Trench 1	2-Feb-12	1005	100	1,100		600	" " " " " " " "
Trench 2	2-Feb-12	1010		1,200		250	" " " " " " " "
Trench 3	2-Feb-12	1015	100	3,500		620	" " " " " " " "
Trench 6	2-Feb-12	1020		700		200	" " " " " " " "
Trench 5	2-Feb-12	1025	100	1,100		250	" " " " " " " "
Trench 7	2-Feb-12	1030	100	1,550		470	" " " " " " " "
Gas 1	2-Feb-12	1035		370		200	" " " " " " " "
Gas 2	2-Feb-12	1040		210		160	" " " " " " " "
Gas 3	2-Feb-12	1045		200		180	" " " " " " " "
Gas 5	2-Feb-12						
Gas 4	2-Feb-12	1055		450		210	" " " " " " " "
Gas 6	2-Feb-12						
Trench 4	23-Apr-12	915	100	4,000		520	Damp Conditions
Trench 1	23-Apr-12	920	100	760		190	" " " " " " " "
Trench 2	23-Apr-12	930		590		110	" " " " " " " "
Trench 3	23-Apr-12	940	100	1,900		100	" " " " " " " "
Trench 6	23-Apr-12	945		400		120	" " " " " " " "
Trench 5	23-Apr-12	950	95	700		240	" " " " " " " "
Trench 7	23-Apr-12	955	95	690		290	" " " " " " " "
Gas 1	23-Apr-12	1000		290		180	" " " " " " " "
Gas 2	23-Apr-12	1005		300		200	" " " " " " " "
Gas 3	23-Apr-12	1010		300		290	" " " " " " " "
Gas 5	23-Apr-12						
Gas 4	23-Apr-12	1020		210		150	" " " " " " " "
Gas 6	23-Apr-12						
Trench 4	17-Jul-12		100	4,800		770	Good readings
Trench 1	17-Jul-12		100	1,000		190	" " " " " " " "
Trench 2	17-Jul-12			800		210	" " " " " " " "
Trench 3	17-Jul-12		100	4,800		280	Small Pocket
Trench 6	17-Jul-12		87	660		260	" " " " " " " "
Trench 5	17-Jul-12		100	990		340	" " " " " " " "
Trench 7	17-Jul-12		100	1,380		800	" " " " " " " "
Gas 1	17-Jul-12			310		250	" " " " " " " "
Gas 2	17-Jul-12			280		200	" " " " " " " "
Gas 3	17-Jul-12			270		240	" " " " " " " "
Gas 5	17-Jul-12						
Gas 4	17-Jul-12			490		190	" " " " " " " "
Gas 6	17-Jul-12						
Trench 4	25-Oct-12	1320	100	5,000		810	Good Readings
Trench 1	25-Oct-12	1325	100	1,080		470	" " " " " " " "
Trench 2	25-Oct-12	1340	69	810		230	" " " " " " " "
Trench 3	25-Oct-12	1350	100	2,000		600	" " " " " " " "
Trench 6	25-Oct-12	1355	89	790		220	" " " " " " " "
Trench 5	25-Oct-12	1400	100	1,000		380	" " " " " " " "
Trench 7	25-Oct-12	1405	100	1,350		470	" " " " " " " "
Gas 1	25-Oct-12	1415		320		210	" " " " " " " "
Gas 2	25-Oct-12	1420		200		190	" " " " " " " "
Gas 3	25-Oct-12	1425		240		170	" " " " " " " "
Gas 5	25-Oct-12						
Gas 4	25-Oct-12	1430		480		200	" " " " " " " "
Gas 6	25-Oct-12						
Weighbridge	25-Oct-12	1230		0		0	All Buildings no reading at all
Cleaning Shed	25-Oct-12	1240		0		0	" " " " " " " "
MRF	25-Oct-12	1245		0		0	" " " " " " " "
Lunchroom	25-Oct-12	1250		0		0	" " " " " " " "
Ute Shed	25-Oct-12	1300		0		0	" " " " " " " "

**CALIBRATED WITH SPAN GAS:**

AppC



Source: Neil Charters Pty Ltd

## GAS WELL MONITORING LOCATIONS

KIAMA MUNICIPAL COUNCIL - MINNAMURRA LANDFILL

Date: 7 August 2006

Reference: E2W\_047\_10.cdr

Figure 1