Armidale Regional Landfill
Armidale Dumaresq Council
26-Feb-2016

Water Quality Monitoring Plan

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Client: Armidale Dumaresq Council

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Prepared by

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Abbreviations

ANZECC	The Australian and New Zealand Environment Conservation Council
BOD	Biochemical Oxygen Demand
COC	Chain of Custody
DEWHA	Department of Environment, Water, Heritage and the Arts.
DO	Dissolved Oxygen
DP&E	Department of Environment
DQOs	Data Quality Objectives
EC	Electrical Conductivity
EPA	Environment Protection Authority
FRP	Filterable Reactive Phosphate
GRAWHA	Gondwana Rainforests of Australia World Heritage Area
LEMP	Landfill Environmental Management Plan
NEPM	National Environment Protection Measure
NHNRC	National Health and Nutrition Research Council
NRMMC	National Resource Management Ministerial Council
OC	Organochlorin
OEH	Office of Environment and Heritage
ORP	Oxidation Reduction Potential
STP	Sewage Treatment Plan
SWL	Standing Water Levels
SVOC	Semi Volatile Organic Compound
SWMS	Safe Work Method Statement
TDS	Total Dissolved Salts
TKN	Total Kijedahl Nitrogen
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorus
VOCs	Volatile organic compounds
WLMP	Water and Leachate Management Plan
WQMP	Water Quality Monitoring Plan

1.0 Introduction

1.1 Project Background

Armidale Dumaresq Council (Council) has approval for the construction and operation of a new regional landfill to service the Armidale region. The landfill site is located on Waterfall Way, approximately 12 km east of Armidale.

The Planning Assessment Commission, as delegate for the then NSW Minister for Planning and Infrastructure, granted approval for the project under Section 75J of the *Environmental Planning and Assessment Act 1979*, subject to conditions, on 4 July 2012. The project involves construction and operation of a landfill comprising five cells, each cell with a maximum volume of 211,000 m^3.

AECOM has prepared this Water Quality Monitoring Plan (WQMP) on behalf of Council to identify water monitoring requirements for the new regional landfill.

1.1.1 Consultation

A copy of this Plan was provided to the NSW Environment Protection Authority (EPA) and NSW Department of Primary Industries (DPI) Water (formerly NSW Office of Water) on 23 October 2015 in accordance with consultation requirements under Condition 9 of Schedule 4 of the Project Approval. Additional information (second round of groundwater monitoring results) was also provided to DPI Water on 2 November 2015.

Comments were received from DPI Water on 23 November providing feedback and recommendations for the plan. AECOM, on behalf of Council, responded to the comments raised by DPI Water who responded in further correspondence dated 16 February 2016. A number of recommendations made by DPI Water throughout the consultation process have been incorporated into a revision of this plan. No comments were received from EPA. No formal consultation is required with the local community under this condition.

1.2 Purpose and Scope

1.2.1 Approval Conditions under the NSW Environmental Planning and Assessment Act 1979

Condition 9f / Schedule 4 of the Conditions of Approval requires the preparation of a Leachate Management Plan for the project in consultation with the NSW Office of Environment and Heritage (OEH) and submitted to the Secretary of the (now) Department of Planning and Environment (DP&E) for approval. This Plan is to include a surface and ground water monitoring plan.

The purpose of this document is to respond to the approval condition, ensuring the adequate monitoring and management of water quality. This document, the Water Quality Monitoring Plan, satisfies *Condition 9f*.

This WQMP has been developed to ensure that water quality is both successfully monitored and managed prior to construction and throughout the life of the landfill. The potential impacts on heritage values of the downstream Gondwana Rainforests of Australia World Heritage Area (GRAWHA) are also addressed.

1.2.2 Approval Conditions under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999

Condition 2 of the Conditions of Approval requires the preparation of a Leachate Management Plan to be submitted to the Minister for approval. The plan is to include a surface and ground water monitoring plan.

1.3 Structure of this Plan

This Management Plan is structured as follows:

Section 1.0 – Introduction

Section 2.0 – Statutory Requirements

Section 3.0 – Existing Conditions

Section 4.0 – Water Quality Criteria

Section 5.0 – Roles and Responsibilities

Section 6.0 – Monitoring Program

Section 7.0 – Quality Assurance/Quality Control

Section 8.0 – Contingency Plan

Section 9.0 – Review and Records

Section 10.0 – References

This plan forms part of the project's Landfill Environmental Management Plan (LEMP) as shown in Figure 1.

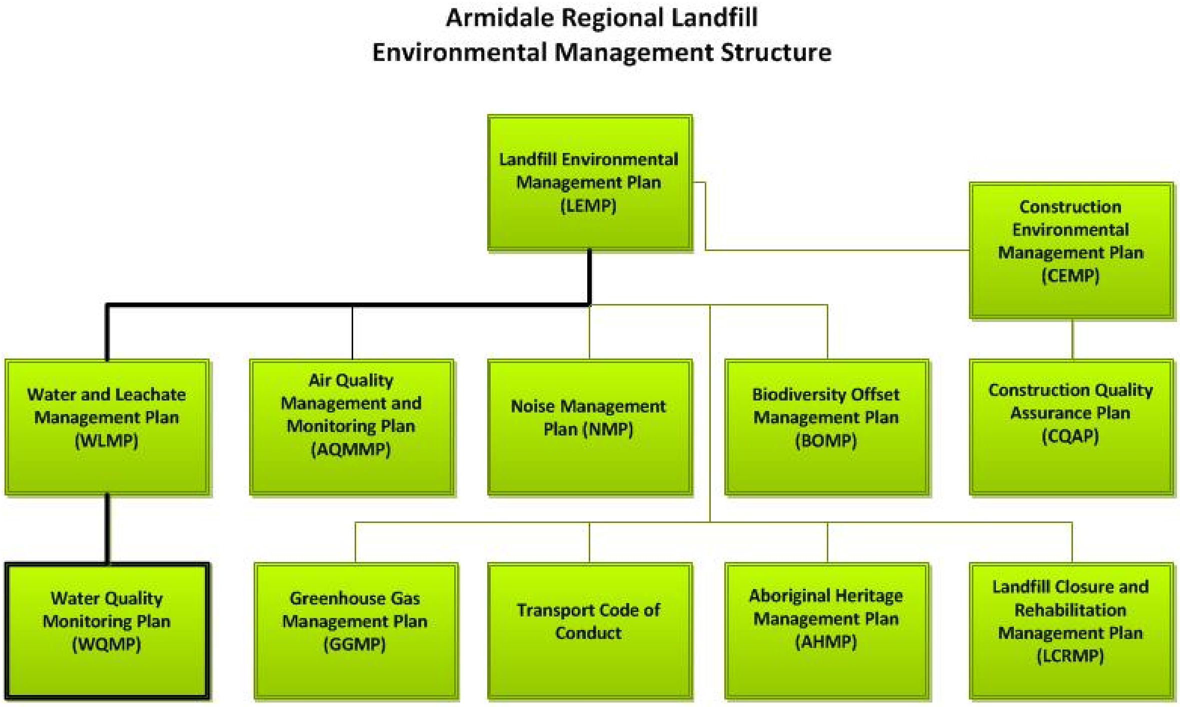


Figure 1 **Environmental Management Structure**

2.0 Statutory Requirements

2.1 Approval Requirements

Condition 9f / Schedule 4 of the Conditions of Approval requires the preparation of a Leachate Management Plan for the project as shown in Table 1.

Table 1 Management Plan Requirements

Project Approval Condition	Plan Section
Condition 9f/Schedule 4	
Include a ground and surface water monitoring plan for the site in consultation with Department of Primary Industries - Water. The plan shall include details on: • the number, design and location for the monitoring bores, including upstream • groundwater bore/s for baseline data collection; • timelines for establishment and sampling regime(s) for the monitoring bores; • monitoring frequency, including monitoring during rainfall; • a schedule of contaminants to be monitored; and • reporting requirements for the sampling results.	This Plan
The plan must be submitted to the Secretary prior to commencement of construction and be endorsed by Department of Primary Industries - Water before submission.	This Plan
The Proponent shall install the baseline monitoring bore and implement the baseline monitoring sampling program obtaining a minimum of two bi-monthly baseline sampling events before commencing construction of the landfill.	Section 6.0 Appendix C
The Proponent shall implement the approved ground and surface water monitoring plan to the satisfaction of the Secretary.	Section 6.0

2.2 Licenses and Permits

The operation of the landfill will require an Environment Protection Licence from the NSW EPA as prescribed under the *Protection of the Environment Operations Act 1997*.

2.3 Relevant Legislation

- The *Protection of the Environment Operations Act (POEO) 1997*
- Project Approval (06_0220) and other relevant project information provided by Council
- *Water Act 1912*
- *Water Management Act 2000*

3.0 Existing Conditions

3.1 Overview

A background review has been conducted to establish the appropriateness of baseline data available for current surface and ground water quality. The review assessed both current surface and ground water monitoring program and available historical data, including:

- Historical data and information obtained during the environmental assessment.
- Currently established ground water monitoring network and surface water sampling locations;
- Local hydrogeological conditions; and
- Available surface and ground water data.

The findings of this review are summarised in this section, and are explained in detail in the appended Surface Water and Groundwater Monitoring Reports (refer Appendix B and Appendix C).

3.2 Oxley Wild Rivers National Park (GRAWHA)

The proposed landfill facility is located approximately 4 km north north-west of Oxley Wild Rivers National Park and 1 km (at its closest point) west of the Gara River which flows into the park. Oxley Wild Rivers National Park forms part of the Gondwana Rainforests of Australia World Heritage Area (GRAWHA).

Pursuant to the EPBC Act, the proximity of the World Heritage Area (Oxley Wild Rivers National Park) to the landfill required that an assessment of matters of National Environmental Significance (NES) be undertaken. This assessment was completed as part of the environmental assessment for the project. The assessment included an assessment of flora and fauna, water quality and consultation with the then Commonwealth Department of Environment, Water, Heritage and the Arts (DEWHA; now Department of the Environment). The results of the assessment have informed the selection of groundwater monitoring well locations and surface water sampling locations incorporated into this WQMP.

3.2.1 Water Quality

The quality of water is the second most existing concern that impacts on the ecological integrity of Oxley Wild Rivers National Park. Water quality monitoring reported by (NSW NPWS, 2005) has found poor water quality to be characteristic of streams such as the Gara River on the tablelands upstream of Oxley Wild Rivers National Park. These same rivers, however, were much cleaner downstream of the Park, indicating that the relatively undisturbed environments of the Park contributed to removal of excess nutrients (NSW NPWS, 2005).

Additional issues identified include the following:

- The New England Highway, Oxley Highway and Waterfall Way cross the headwaters of most of the major streams that flow into Oxley Wild Rivers National Park at points close to the park boundaries. A vehicle accident involving a chemical or fuel spill would also pose a major threat to water quality.
- Armidale’s Sewage Treatment Plant discharges to Commissioners Waters with high concentrations of Phosphates continuously detected in water quality monitoring.
- Algal blooms in the vicinity of Blue Hole are a common occurrence during periods of low flows (pers.comm. Matt Ryan and George Monroe, NWPS, Armidale, 2009).

A review of water quality data in proximity to the landfill site is provided in Section 3.3.2.

3.2.2 Flooding

Concern has been raised in relation to potential contaminants entering the waterways of Oxley Wild Rivers National Park during flood events.

Runoff from the proposed landfill site falls to the north towards a tributary of the Gara River. The proposed landfill is located within the upper reaches of the catchment. No flood studies have been conducted in this area. Instead, calculations using Manning’s equation were used to estimate the 100 year Average Recurrence Interval (ARI) flow and the 100 year flood level in these creeks. The results of these calculations indicate that the proposed landfill site is well outside the extent of the 100 year floodplain.

The design for the landfill, leachate pond, sedimentation basin and dry basin incorporates adequate freeboard to contain a 100 year ARI, 3 day rainfall event on site, without further containment or storage actions needing to be implemented.

Events larger than the 100 year event would be relatively catastrophic for the local area. Washing out of leachate water from the landfill site during events larger than this are likely to be undetectable in comparison to widespread erosion, sediment and debris mobilisation, and influx of contaminants from other point sources (e.g. Armidale STP, and toilet facilities within the Gara Gorge's day facilities).

3.3 Existing Surface Water Environment

3.3.1 Catchment Areas

The proposed landfill site is situated within the Gara River catchment, a major catchment within the local region that covers an area of 41,486 ha, and a sub-catchment of the Macleay River. The Gara River originates approximately 45 km north of the proposed landfill site and flows from north to south, to the east of the proposed landfill site. The minimum or straight line distance between the Gara River and the proposed landfill site is 1.06 km. The River descends into a Gara Gorge approximately 4 km south-south-east of the proposed landfill site, within the Oxley Wild Rivers National Park. The riverbed distance between the closest point to the proposed landfill site and the Oxley Wild Rivers National Park is 8.8 km.

Tributaries of the Gara River (upstream of the Oxley Wild Rivers National Park) include Commissioners Waters, Burying Ground Creek, and a number of minor drainage lines (Figure 2).

Commissioners Waters is located approximately 1.6 km south of the proposed landfill site, and flows into the Gara River approximately 800 m upstream of the Oxley Wild Rivers National Park. Burying Ground Creek enters Commissioners Waters approximately 2 km west of the site. Runoff from the proposed landfill site does not flow to Commissioners Waters or its tributary Burying Ground Creek.

Runoff from the proposed landfill site runs into the Gara River via two unnamed intermittent creeks which have a combined catchment area of 370 ha. These creeks flow onto the site from the west and south west for approximately 200 m before merging to form a single gully that intermittently flows a further 1300 m to the east before joining the Gara River at the north-western corner of the proposed landfill site.

Both drainage lines are regulated by several farm dams, two of which are located within the boundaries of the proposed landfill site and its associated buffer zones.

Land use within the region is predominantly agricultural, with some residential, commercial and industrial areas concentrated around the major urban centres of Guyra and Armidale.

The *Southern New England Tablelands Region State of the Environment Report 2004* (and *Supplementary Report*, 2004/05) identifies the Gara River as a "stressed sub-catchment", exhibiting signs of poor water quality. It also shows signs of "high hydrologic and environmental stress", including:

- Eutrophication (due to high nutrient content); and
- Poor river structure (stream bank erosion and poor riparian habitat).

The *Stressed Rivers Assessment Report 1998*, produced by the former Department of Land and Water Conservation (DLWC), gave the Gara River the highest overall stress classification, indicating that water extraction within the region contributes to the River's environmental stress. Flows within the river are impacted both by the Guyra Shire Council Dams and the Malpas Dam, all of which are close to Guyra. It is noted that a Water Sharing Plan (WSP) is being developed for this catchment, and the final WSP will be reviewed for its applicability to the landfill once available.

The Gara River is a water source regulated by the *Draft Water Sharing Plan for the Macleay Unregulated and Alluvial Water Sources* (2015). Department of Primary Industries –Water prepared Water Source Report Cards to assist in the consultation process for developing the WSP. The Report Card for the Gara River Water Source (prepared October 2014) characterised the Gara River as having medium in-steam value (catchment contains threatened frog species and significant area of National Park), low risk to instream value from extraction and medium economic dependence of the local community on water extracted for irrigation. In addition, the report card characterised the Gara River water source as under high cumulative hydrologic stress as a result of the town water supply extractions from the water source upstream.

3.3.2 Existing Baseline Data

3.3.3 Gara River

A range of baseline surface water sampling has been undertaken at five sites since 2008. Three of these sites are located on the Gara River (GARA1, GARA2 [upstream of the landfill] and GARA4 [downstream of the landfill]) and two sites on the gully running through the proposed landfill site (GARA3 and GARA5) Figure 2 shows the locations of these sites. A total of 14 samples were collected from these sites over the following dates:

- 17 December 2008
- 28 January 2009
- 10 March 2009
- 18 May 2010
- 9 June 2010
- 7 September 2010
- 7 December 2010
- 31 May 2011
- 16 August 2011
- 22 November 2011
- 10 April 2012
- 27 August 2012
- 27 November 2012
- 5 June 2013.

Armidale Sewage Treatment Plant (STP) discharges treated effluent into Commissioners Waters which flows into the Gara River. GARA4 sampling point at Blue Hole is downstream of the confluence of Commissioners Waters and the Gara River. Therefore a sixth sampling site (Gara6) was included in the May 2015 sampling as an additional non-STP influenced Gara River sampling location for comparison purposes. Microbial testing was also added to the analyte list for all ambient surface water sampling points.

An Ambient Surface Water Monitoring Report (CodyHart, 2015a) summarises the results of baseline monitoring conducted between 2007 and 2013 (refer to Appendix B). The report also summarises the results of the most recent round of baseline surface water monitoring conducted in May 2015 at six surface water sampling points. All sampling results to date are tabled in the report to allow comparison of each parameter and analyte's historical results over time. A summary of basic trend observations relevant to analytical results are provided below.

- GARA5 (gully) has on occasion been dry at the time of sampling.
- GARA3 (gully) has often had low flow with resulting elevated salinity and degraded water quality parameters.
- GARA3 and GARA5 show similar water quality characteristics. Both these sites have exhibited elevated levels of trace elements likely due to adjacent land use activities. Some observations include:

  - Elevated Zinc and Copper levels exceeded criteria for most of the sample events, with higher levels of Zinc noted at GARA5.
  - Elevated levels of Nickel at both sampling sites
  - Elevated Chromium levels recorded on some occasions at both sampling sites however was more prevalent at GARA5.
  - Elevated Lead levels recorded on some occasions at both sampling sites however was more prevalent at GARA5.

- The river sites GARA1, GARA2 and GARA4 share similar results for water quality parameters and elevated nutrient concentrations reflecting the nature of the surrounding land use. Some observations include:
  - GARA4, located downstream of the confluence of Commissioners Waters at Blue Water Hole has consistently shown higher total phosphorous (TP) concentrations mainly in the form of filterable reactive phosphate (FRP).
  - A spike in Zinc levels was consistently detected in the sampling events for 7-Sep-10 and 7-Dec-10 for all three river sites.
  - It can be ascertained that concentrations of higher levels of elements upstream (GARA1), dilute downstream as detected downstream (GARA2 and GARA4).
  - GARA4 exhibited elevated levels of Chromium and Copper during some sampling events that were inconsistent with data for GARA1 and GARA2. It can be ascertained that these elements are attributed to inflow from the Commissioners Waters.

3.3.4 Influence of Armidale Sewage Treatment Plant on baseline surface water quality

Armidale STP discharges effluent into Commissioners Waters, which is a tributary of the Gara River. The confluence of Commissioners Waters and the Gara River is approximately 3 km south and downstream of the landfill site.

Monitoring of three creeks, Dumaresq Creek, Tilbuster Creek and Commissioners Waters, in the vicinity of the Council's sewage treatment plant (STP) was undertaken on a three monthly basis from July 2005 to April 2009. Dumaresq Creek and Tilbuster Creek were monitored upstream while Commissioners Waters was monitored downstream of the STP discharge point.

A review of the STP monitoring data identified a significant increase in nutrients in Commissioners Waters downstream from the STP discharge point (EPA Point No. 1). Mean total nitrogen (TN) concentrations of 0.25 mg/L and 0.44 mg/L were recorded in Dumaresq and Tilbuster Creeks respectively, while downstream of the discharge, in Commissioners Waters, mean TN concentration was 1.32 mg/L. Similarly, mean TP concentrations of 0.17 mg/L and 0.20 mg/L were recorded in Dumaresq and Tilbuster Creeks respectively, while downstream of the discharge, in Commissioners Waters, mean TP concentration was 1.65 mg/L.

Baseline surface water quality sampling is continuing to be undertaken prior to construction of the landfill. Surface water sampling will also be undertaken during construction and operation of the landfill. The Surface Water Monitoring Program is detailed in Section 6.

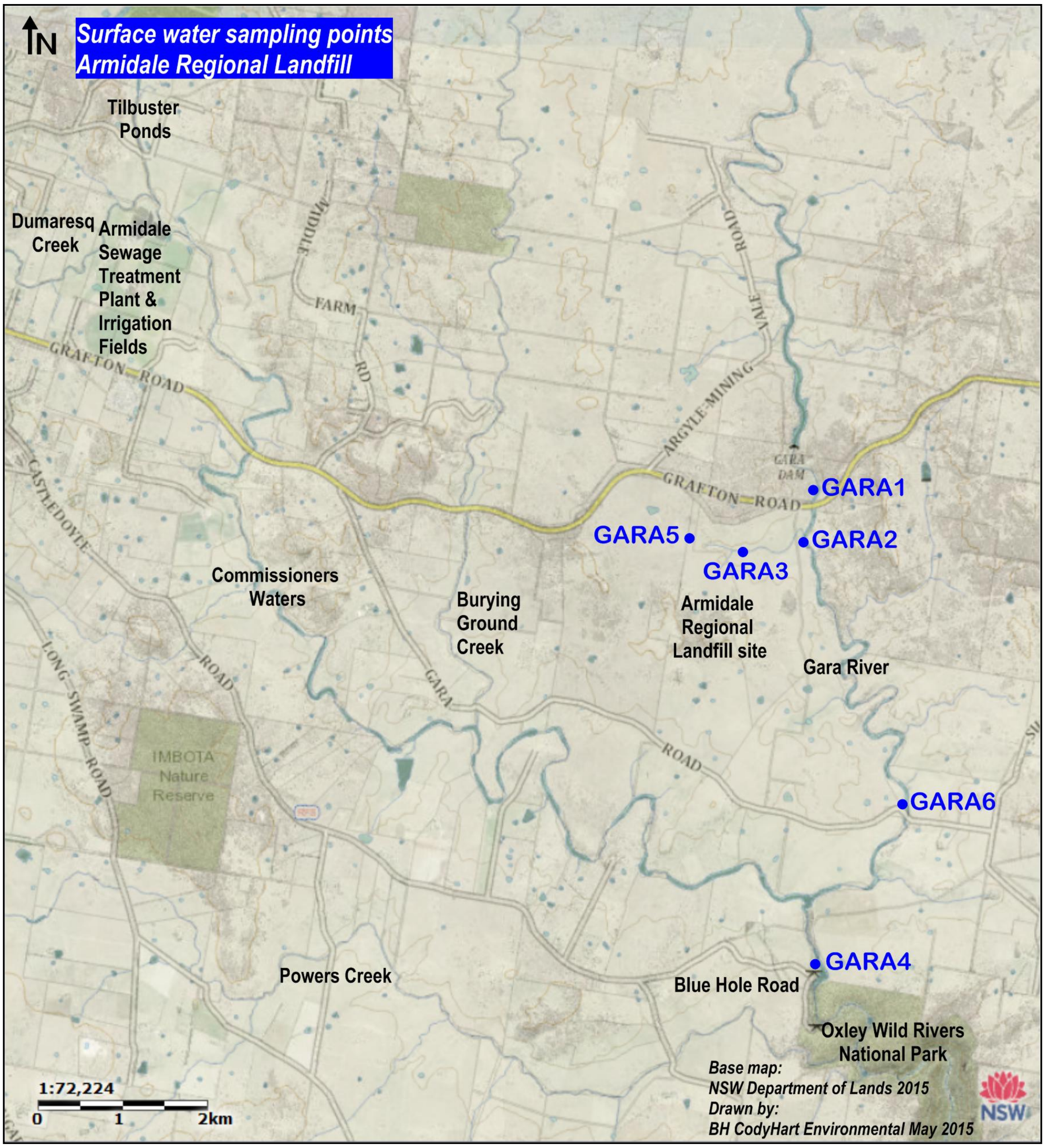


Figure 2.Surface Waters and Location of Surface Water Quality Monitoring

3.4 Existing Groundwater Environment

3.4.1 Previous Groundwater Investigations

Hydrogeological investigations were conducted by EA Systems (2005) and RCA (2006-2007) to:

- Establish the current hydro-geological conditions across the site; and
- Determine the potential impact from the project.

EA Systems drilled and logged five bore holes, into which five piezometers were installed to monitor groundwater level fluctuations. Groundwater monitoring was then carried out from November through to December 2005. While no standing groundwater was detected during the shallow soil drilling investigation, the soil profile had evidence of transient sub-surface flow within the shallower soils. No groundwater was detected in any of the bore holes during the piezometer monitoring period.

Subsequent to the above investigation, RCA conducted hydrogeological studies in October 2006, which included the drilling of 10 bores in depths ranging from 1.0 m to18.0 m, with groundwater monitoring wells installed in 5 bores (two in rock, and three in soil) (Figure 3).

Groundwater samples were collected from the wells in rock (BH4 and BH5) as well as from an existing groundwater bore on a neighbouring property to the west of the landfill site. No groundwater was encountered in any of the bores in soil.

During March 2007, RCA conducted further groundwater investigation in the study site, installing seven groundwater monitoring wells into the bedrock aquifer, including BH4 and BH5 from earlier investigations. Groundwater was encountered in all bores as shown in Table 2.

Table 2 Gauged groundwater depths (RCA, 2007)

Bore No.	RL (m AHD)	Stickup (m)	GW Depth from top of pipe (m)	Screen depth (m) below ground level	GW RL (m, AHD)
4	954.11	0.74	6.35	6.0-18.0	947.76
5	953.13	0.75	5.27	3.6-9.5	947.86
9	1014.03	0.95	46.7	53.5-59.5	967.33
10	993.78	0.67	37.0	41.0-47.0	956.78
11	977.58	0.72	28.0	30.0-36.0	949.58
12	969.79	0.62	21.3	34.0-40.0	948.49
13	961.70	0.60	13.3	16.0-22.0	948.40

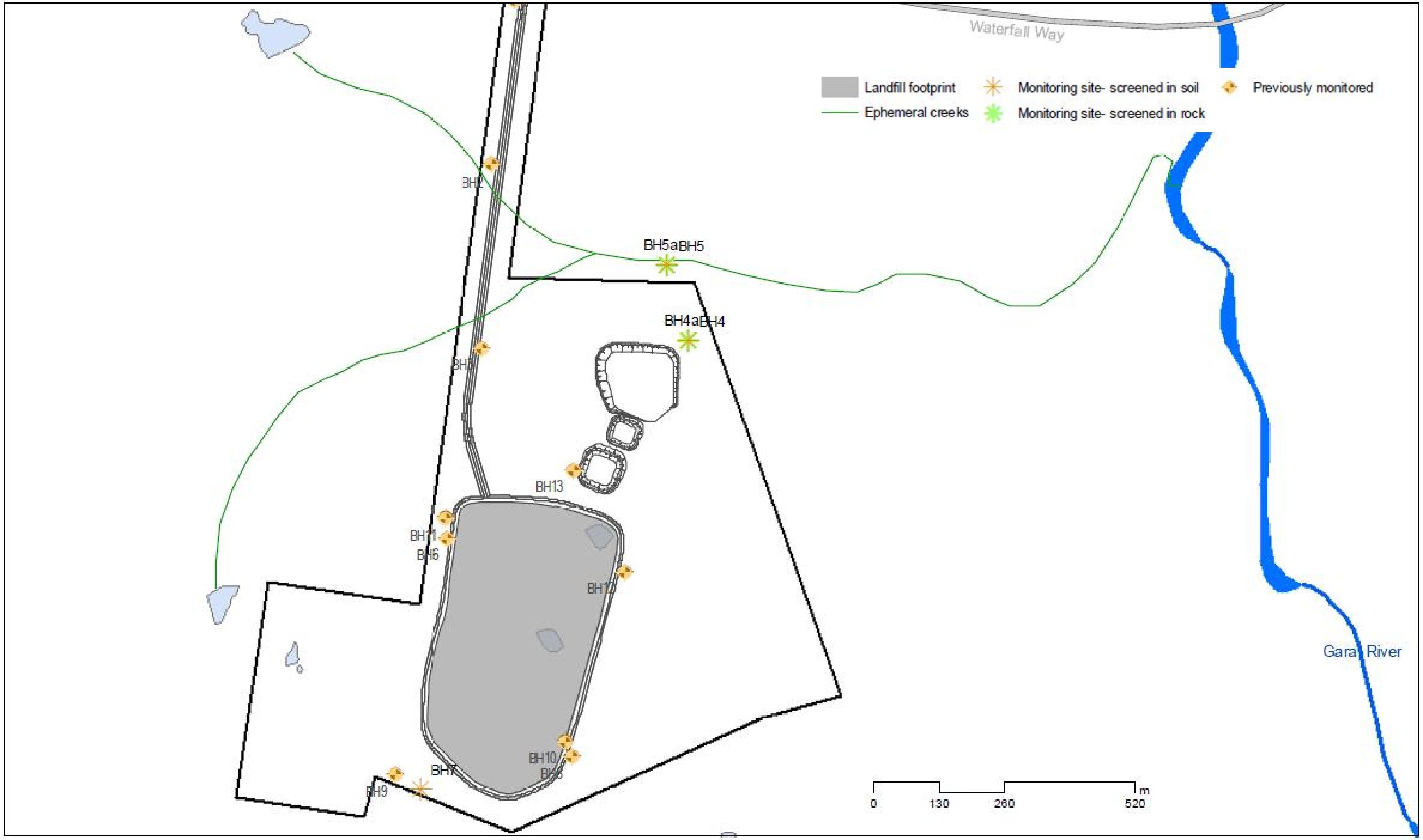


Figure 3. Location of previously monitored groundwater wells

Hydrogeological Conditions

RCA (2007) divided the Sites topography into two distinct sections:

- The southern or upper section which is steep and heavily vegetated, and
- The northern or lower section which is more gently sloping and consists of open paddock and defined by a ridge running east-west at the northern extremity.

Groundwater in the upper or southern section of the site was generally assumed to be toward the north-north east, whereas in the lower or northern section of the site flow was assumed to be more directly north-east. Collectively groundwater is considered to be leaving the site in a predominantly north easterly flow direction, towards the Gara River (refer Figure 4). Summer extraction demand in the Gara River is reported as regularly exceeding available flows in November (DNR 2006), indicating that minimal recharge from groundwater inflows is likely to be occurring.

Hydraulic gradient

The gauging of the groundwater levels (as previously shown in Table 2) allowed the gradient of the groundwater in each section of the site. Table 4 summarises the groundwater hydraulic gradient results.

Table 3 Groundwater hydraulic gradient results (RCA, 2007)

Site section	GW RL (high)	GW RL (low)	Distance	Gradient (m/m)
Upper	967.33 (BH9)	948.49 (BH12)	600m	$3.14x10^{-2}$
Lower	948.49 (BH12)	947.76 (BH4)	485m	$1.51x10^{-3}$

Hydraulic conductivity

Tests for hydraulic conductivity (permeability) were previously undertaken at two bore locations (RCA, 2007). Due to the conditions encountered and project constraints, only one test was undertaken in each bore. Hydraulic conductivity test results are summarised in Table 4.

Table 4 Hydraulic conductivity/Permeability test result summary (RCA, 2007)

Bore number	Test method	Permeability
BH11	Falling Head Piezometer Test (Hvorslev method)	$3.8x10^{-6}$
BH5	Rising Head Test (Hvorslev method)	$4.4x10^{-8}$

* Note: The falling head test was conducted over a relatively short period and has required extrapolation to interpret the permeability.

The aquifer in the well BH11 was encountered and screened in sandstone. The permeability recorded is considered to be consistent with that expected in a highly fractured, sandstone strata.

The aquifer in the well BH5 was encountered and screened in argillite bedrock. The permeability recorded is considered to be consistent with that expected in a slightly fractured, argillite strata.

Given the limitations associated with the permeability data collected to date, it is recommended that the above permeability results be used as indicative values only.

Aquifer characterisation

Groundwater sampling results indicate that the aquifer in the southern or upper section of the site, which is contained within the ridgeline, is predominantly a chloride water type. In the lower or northern section of the site, the flatter topography means that the water is more likely to be influenced by influx of other water types from up gradient or south-west of the site. All groundwater sampled in this section of the site was predominantly a bicarbonate water type, except for the water in well BH5, which was a sulphate water type.

BH5 well is closest to the toe of the ridge at the northern extremity of the site. RCA (2007) observed a significantly lower recovery rate in BH5 than the other wells on the site following purging, and purged groundwater appeared more turbid. This was attributed to a layer of mudstone found immediately above the level of the argillite in BH5, which was not identified in the other bores. The topography in the well's vicinity also suggests that groundwater flows in the opposite direction to the general groundwater.

As a result, RCA (2007) considers it likely that the water sampled from BH5 is representative of, or is being impacted upon, by a separate aquifer to that of the majority of the site, flowing from the north back toward the low point of the site in the vicinity of BH4. Based on the limited number of wells in this section of the site, groundwater flow direction could not be accurately interpolated. However, the estimation of groundwater flow direction, based on the available data and the observed topography, is considered to give a valid representation of the flow direction in the northern section of the site.

Groundwater geochemistry

Groundwater passing through the argillite bedrock is expected to have higher dissolved solids than water discharging from the sandstone or highly weathered argillite layers. Results from analysis of groundwater sampling for ammonia, chloride, sulphate, chloroform, phenols, and total organic carbon are summarised below:

- The ammonia concentration in BH5 was slightly greater (<109%) than the National Health and Nutrition Research Council (NHNRC) and National Resource Management Ministerial Council (NRMMC) 2004 drinking water guidelines. The overall concentration of ammonia across the aquifers encountered could be considered as low, given the high potential for solubility.
- The relatively high concentrations of major ions (chloride and sulphate) detected in groundwater on the site is considered likely to be as a result of the long residence time of the groundwater within the predominantly argillite bedrock, and the solubility of the chemical constituents of the rock.
- Chloroform was detected in very low concentrations in two (2) wells, BH9 and BH11. The wells are on opposite sides of the site and do not have the same geochemical characterisation. Despite the potential source of the chloroform being unknown, the chloroform detected is not considered significant given the low concentrations.
- Phenols have been detected in BH5. However, the concentrations detected do not exceed the site guidelines and are falling. No likely source of phenols was observed in the vicinity of BH5. Contamination of the well due to drilling is not considered to be a likely source as the phenols were detected over several months and the bore has been subjected to repeated rigorous development.
- The Total Organic Carbon concentrations detected in all wells is considered relatively low except for BH5. The TOC concentration in BH5 has risen markedly (740%) from 2006 to 2007 with no apparent reason for this rise observed.

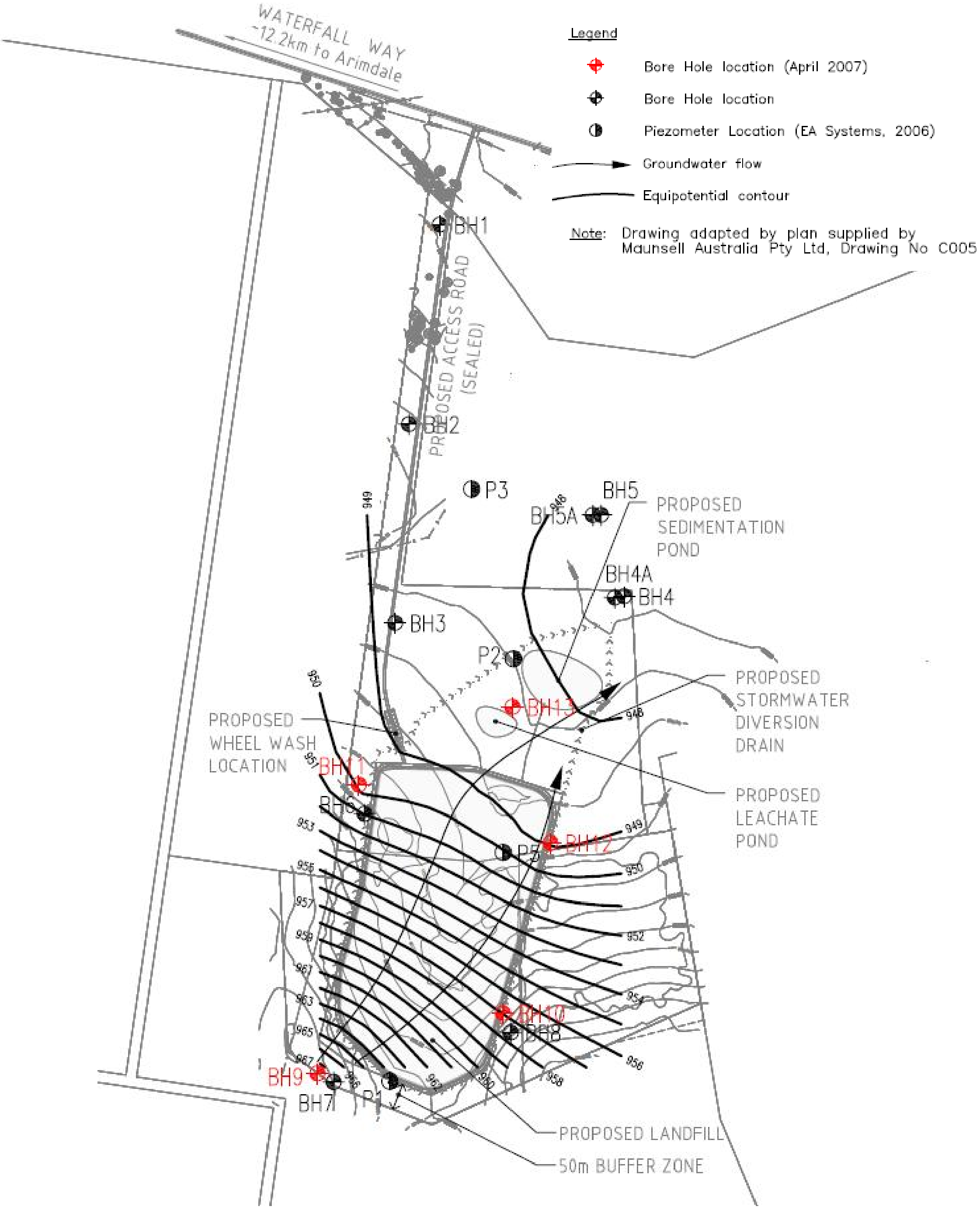


Figure 4 **Borehole Locations and Inferred Groundwater Direction (RCA, 2007)**

3.4.2 Recent Geotechnical Investigation and Monitoring Well Installation

AECOM undertook a geotechnical investigation of the landfill site in October 2014 (AECOM, 2015). The investigation involved:

- Drilling of eight boreholes
- Installation of four additional groundwater monitoring wells
- Excavation of 32 test pits.

Information obtained from the 2014 investigations was combined with geotechnical and hydrological data sourced from previous investigations carried out at the site (refer section 4.4.1 and 4.4.2).

Monitoring wells (piezometers) were installed in four boreholes between the depths of 5.0m and 29.6m to monitor groundwater conditions that may be influential and/or impacted during construction, assess natural seasonal variation, and to regularly assess the groundwater depth and changes to groundwater quality over the life of the proposed landfill. A summary of the wells installed during this investigation is provided in Table 5.

Table 5 Summary of Geotechnical Investigation – Boreholes installed for groundwater monitoring (AECOM, 2015)

BH ID	Date Completed	Easting	Northing	Elevation	Final Depth (m)	Monitoring Well
				RL (m AHD)		
BH02	7/10/14	383744	6619550	955	11.0	YES
BH02A	10/11/14	383748	6619551	955	30.1	YES
BH04	11/11/14	383644	6619659	953	28.3	YES
BH04A	12/11/14	383636	6619659	953	8.0	YES

In addition to the monitoring well installations, approximately 20L of groundwater was extracted from existing groundwater monitoring wells to assess their response and suitability for long term monitoring purposes. Measured groundwater levels before and after extraction, together with corresponding monitoring well depths are provided in Table 6.

Extraction of groundwater from the existing monitoring wells was undertaken during the investigation, and the subsequent limited water level decline shows that the screened sections of the monitoring wells are hydraulically connected to the aquifer. As such, it is considered that these wells are suitable to form part of a groundwater monitoring network to monitor groundwater level fluctuations across the site. It should also be noted that groundwater extracted from the monitoring wells is assessed as being representative of the aquifer intersected, and suitable for groundwater quality analyses. The groundwater monitoring wells selected for long term monitoring are further detailed in the Groundwater Monitoring Program outlined in Section 6.2.

Table 6 Summary of Groundwater Monitoring Results

Borehole Location	Date Installed	Piezometer Depth (m)	Screen Depth (m)	Groundwater Depth (m) [1]	Groundwater Depth (m) [2]	Date Measured
BH4	Oct 2006	18.1	6.0 – 18.0	4.1	4.2 [3]	Oct 2014
BH4A	Oct 2006	2.8	1.0 – 2.8	DRY	-	Oct 2014
BH5	Oct 2006	9.6	3.6 – 9.6	3.1	7.0	Oct 2014
BH5A	Oct 2006	2.5	0.7 – 2.5	DRY	-	Oct 2014
BH7	Oct 2006	1.5	0.5 – 1.5	0.9	DRY [4]	Oct 2014
BH9	Apr 2007	59.5	53.5 – 59.5	43.8	43.8	Oct 2014
BH10	Apr 2007	47.0	41.0 – 47.0	32.5	33.0	Oct 2014
BH11	Apr 2007	36.0	30.0 – 36.0	24.6	24.6	Oct 2014
BH12	Apr 2007	40.0	34.0 – 40.0	18.9	18.9	Oct 2014
BH13	Apr 2007	22.0	16.0 – 22.0	10.9	10.9	Oct 2014
P1	Oct 2005	2.3	0.5 – 2.0	1.9	NA	Oct 2014
BH02	Oct 2014	11.0	5.0 – 11.0	6.9	NA	Nov 2014
BH02A	Nov 2014	29.6	23.6 – 29.6	6.8	NA	Nov 2014
BH04	Nov 2014	28.0	22.0 – 28.0	3.8	NA	Nov 2014
BH04A	Nov 2014	8.0	5.0 – 8.0	6.7	NA	Nov 2014

Notes: 1 - Groundwater level measured before 20L extraction. 2 - Groundwater level measured following 20L extraction. 3 - Groundwater level measured at 3.4m (approx. 6 hours after initial extraction). 4 - Groundwater level measured at 1.2m (approx. 5 hours after initial extraction). NA - No groundwater was extracted at this test location.

3.4.3 Current Groundwater Monitoring and Preliminary Results

Groundwater flow direction

The direction of groundwater flow was revisited by CodyHart in 2015 (Appendix C) to verify previous findings.

Overall, the groundwater flow direction is in sympathy with topographical fall to the Gara River. It flows in a north-northeast direction on the southern, elevated section of the site, then turns easterly on the northern, lower levels of the site to follow the ephemeral stream direction to the Gara River.

Baseline Groundwater Quality

Groundwater quality sampling commenced in July 2015 as part of bi-monthly pre-construction ground water quality sampling program (refer to Section 6.2). Baseline groundwater monitoring reports have been prepared by Council's water quality consultant, which also reviewed the previous RCA results to determine the suitability of baseline data and recommend an appropriate monitoring regime moving forward. These reports are provided in Appendix C.

Overall it was determined that results were typical of slightly saline groundwater in the Armidale Dumaresq area. Metal concentrations were low. Total nitrogen compounds and total organic carbon concentrations were also low.

An anomalous analyte detected from the two rounds of groundwater monitoring conducted to date was trace chloroform in wells ABH9, ABH11 and ABH12, which in July 2015 were respectively 0.005 mg/L, 0.006 mg/L, and 0.001 mg/L. It was also detected in Year 2007 in trace concentrations in wells ABH9 and ABH11. Chloroform is not a naturally occurring substance but is often attributed to chlorinated potable water supplies.

Possible sources of chloroform at the sampling locations could include:

- Introduction of potable water while drilling to reduce dust and facilitate hammer head penetration, or introduction during earlier slug tests
- Use of bleach to decontaminate groundwater sampling pumps or to disinfect wells with iron bacteria.
- A combination of chlorine bleach and acetone. Acetone is a substance that can be naturally occurring from plants, trees, volcanic gases, forest fires (ATDRS 2015) but it is also present in blue 'plumber's glue' sometimes used to glue well casings together.

It is noted that this detection of chloroform prior to the acceptance of solid waste means that the source is not landfill leachate. It is also noted that such prior trace contaminants often dissipate over time.

3.5 Summary

Surface water

Water quality of surface water bodies upstream and downstream of the landfill site has been characterised through baseline monitoring undertaken at 5 locations since 2007. Two of the sampling locations (GARA3 and GARA5) are located in an ephemeral stream characterised by low and intermittent flows. Cattle grazing upgradient of the site also influences surface water quality in the ephemeral stream as well as the Gara River, evidenced by the presence of elevated organic nitrogen in background samples.

The available surface water data for the Gara River and Commissioners Waters identifies the likely impact of the Council STP discharge on the water quality at Blue Hole (GARA4). In order to better quantify the impact of the STP discharge on the water quality of the Gara River an additional sampling site (GARA6) upstream of the confluence of the Gara River and Commissioners Waters has been included in the monitoring program.

Analytical parameters that will be used to monitor the impacts of the landfill construction and operation, and the contribution of the catchment environment, include:

- Total suspended solids (TSS)
- Heavy metals (As, Cr, Cd, Cu, Hg, Pb, Ni, Se, Zn)
- Volatile organic compounds (VOC) and semi-volatile organic compound (sVOC).
- Organochlorine (OC) and organophosphorous (OP) pesticides.
- Nutrients - total nitrogen (TN), total kjledahl nitrogen (TKN), nitrite (NO_2), nitrate (NO_3), total phosphorous (TP) and filterable reactive phosphorous (TRP).
- Major cations and anions

Groundwater

Groundwater within the deep aquifer is inferred to flow north, towards the Gara River. Based on previous hydrogeological investigations carried out at the site, it is understood groundwater is present as both a series of shallow perched aquifers and within a deeper regional aquifer. The perched aquifer is located at the interface of the gravelly - clayey residual soils and/or weathered bedrock, typically within the upper 5.0m. The presence of perched groundwater is likely to be intermittent following rainfall until the water either discharges to the Gara River or infiltrates into the deeper regional aquifer, and is likely to form isolated pockets of groundwater above the regional water table.

Groundwater measured in the deeper regional aquifer ranges at depths in excess of 40.0m in the higher southern elevations to around 10.0m in the flatter central region. The area of elevated topography towards the southern site boundary is likely a local source of groundwater recharge.

It is important to note, however, that groundwater levels and flows are transient, and are affected by such factors as soil and rock permeability, geological structure, earth moving operations, land use practices and preceding climatic conditions.

Limited background data is available with respect to potential landfill contaminants in groundwater. A series of monitoring wells have been installed for this purpose at select locations across the site to supplement the existing monitoring well installed during previous investigations.

Chloroform and phenols have been detected in the groundwater beneath the site, albeit in concentrations only marginally above detection limits. Continued monitoring of VOCs and SVOCs will provide a baseline to assess impacts from the proposed landfill construction and operation. Ammonia (NH3) has been identified at concentrations close to nominated regulatory guidelines. Monitoring of total nitrogen (TN) and ammonia (NH3) is recommended along with a suite of heavy metals (refers Section 6 Monitoring Program).

4.0 Roles and Responsibilities

Roles are responsibilities are consistent with those described in the overarching Landfill Environmental Management Plan. Responsibilities for the implementation of the WQMP are summarised in Table 7.

Table 7 Summary of Responsibilities

Responsibility within Council	Action
Waste Manager	- Overall implementation of the Water Quality Monitoring and Management Plan - Implement methodology for avoiding water quality criteria exceedance. - Authorise and confirm the implementation of remedial measures - Reporting any pollution incidents to the EPA - Engaging suitable Personnel required to undertake monitoring activities
Site Environmental Officer / Superintendant	- Coordinate monitoring and compile reports - Maintain internal records of monitoring - Collate and maintain records of complaints, respond to complainant - Identify Non Conformances and notify Waste Manager - Supervise monitoring activities implemented by this Plan
Personnel / Contractors	- Carrying out activities in accordance with the requirements of this Plan - Notifying the Superintendant of any non-conformances or pollution incidents that occur on the site or during monitoring

4.1 Training and Induction

All Personnel undertaking work on the site are to be inducted in accordance with the LEMP.

All Personnel undertaking sampling work for the landfill will be suitably qualified and have passed the NSW Workcover General Construction Induction or its equivalent. Copies of the cards are to be provided to Council as part of the Safe Work Method Statement.

5.0 Water Quality Criteria

5.1 Surface Water

Surface water analytical results will generally be compared to and assessed against the ANZECC (2000) *Guidelines for Fresh and Marine Water Quality (Appendix A)*.

ANZECC (2000) provides comprehensive information and procedures for setting more specific water quality targets tailored for unique conditions for a range of pollutants or indicators and may be used to further customise water quality targets for local conditions. Once defined, water quality criteria become indicators of management performance and progress towards management goals or attainment of environmental values.

Indicators for water quality include:

- Nutrients (nitrogen and phosphorus).
- Salinity.
- Turbidity and suspended solids.
- River condition, including biological indicators (when established).

Gara River is an ephemeral waterway and subject to significant periodic flows. These flows result in high erosion, sediment transport and disturbance to the creek and surrounding area. Given the dynamic nature of the receiving waters, the 95% level of species protection will be adopted for the WQMP (where laboratory techniques can be quantified to these limits). The 99% species protection criteria will be used for chemicals that bioaccumulate (e.g. PCBs, OC pesticides and some heavy metals including mercury).

The ANZECC guidelines were developed in a manner cognisant that ecosystems may have been modified to various degrees and that different levels of protection are required depending on the ecosystem condition. For the Gara River, trigger values for "slightly to moderately disturbed systems" will be applied. **Table T1** in Appendix A presents the ANZECC (2000) water quality trigger values for protection of environmental values of upland rivers.

The trigger values for 'freshwater aquatic ecosystem' were chosen for comparison to the baseline results because they are designed to protect the most immediate and the most sensitive environmental value. Irrigation and stock uses are also important for the Gara River but the applicable trigger values are less stringent than those for freshwater aquatic ecosystems. Considering the sensitivity of the downstream catchment (Oxley Wild Rivers National Park), the more stringent trigger values for freshwater aquatic ecosystem protection will be applied for the Armidale Regional Landfill surface water monitoring program.

For some analytes, the analytical program may not be able to achieve the ANZECC (2000) 95% criteria, as the criteria are significantly below laboratory limits of reporting. Notwithstanding, the proposed analytical program is sufficient to achieve the nominated Data Quality Objectives (DQOs, refer to Section 7.1), which are focused on the monitoring of groundwater and surface water quality against background data and appropriate trigger levels.

It is also noted that the baseline water quality monitoring results on many occasions show exceedences of the ANZECC (2000) trigger values for the protection of freshwater aquatic ecosystems. The maximum baseline results will therefore supersede the ANZECC (2000) trigger values for these analytes where regular exceedences have been recorded, to reflect the local conditions at the site and to provide a tailored water quality target specific for the site.

Table T2 in Appendix A of this document provides ANZECC (2000) trigger levels / criteria for all analytes. Section 6.3 presents the analytes selected as suitable for inclusion in the monitoring program for a general solid waste landfill as part of the Armidale Regional Landfill surface water monitoring program.

5.2 Groundwater

The ANZECC (2000) guidelines relate to receiving surface water bodies, and not to groundwater. The NSW Office of Environment and Heritage (OEH) *Guidelines for Assessment and Management of Groundwater Contamination* OEH, 2007) provides the framework for best practice management of contaminated groundwater. The OEH guidelines indicate that ANZECC (2000) guidelines can be used as groundwater investigation levels (GILs). The OEH guidelines also recommend that the GILs be used as trigger levels for further investigation. Therefore, ANZECC (2000) 95% values for protection of aquatic ecosystems will be applied for the Armidale groundwater monitoring.

Table T2 in Appendix A of this document provides ANZECC (2000) trigger levels / criteria to be applied to the selected indicators for the surface and groundwater monitoring program. If ANZECC (2000) or other suitable criteria are not available for an analyte, background concentrations (where available) will be used as a guide for identifying the relevant criteria for groundwater monitoring. The detection monitoring parameters / analytes and the ones chosen as ‘detection monitoring indicators’ will be finalised once eight rounds of baseline monitoring are complete (this will be undertaken prior to the commencement of landfill operation - refer to Section 6.0).

6.0 Monitoring Program

6.1 General Requirements

The general requirement of monitoring procedures described by this program is to maintain the integrity of the monitoring program over time. The procedures and approaches, described in the following sections are required to:

- Conduct a technically defendable water quality monitoring program that complies with established standards, scientific monitoring protocols and reporting frameworks, in accordance with the data quality objectives detailed in Section 7.1 of this document;
- Establish baseline physical, chemical and biological properties of groundwater and surface water at the Site;
- Establish baseline hydraulic characteristics of surface water and groundwater at the Site
- Monitor representative physical, chemical and biological parameters, which will provide an indication of trends in ecosystem health and assist with identifying the causes and effects of pollution;
- Efficiently manage surface water and groundwater sampling data, so as to provide easy access and interpretation for future analysis and reporting, establishing trends and reporting anomalies; and
- Ensure Workplace Health and Safety risks, associated with implementation of the program, are identified and mitigated.

6.1.1 Standard Operating Procedures

The WQMP is intended to be used as a guidance document for the surface and groundwater monitoring across the site. It is understood that monitoring will be undertaken by a contractor engaged by Council. The contractor is required to prepare their own Standard Operating Procedure (SOP) that is consistent with the requirements of this Plan. The SOP will generally detail the following:

(i) Preliminary review of regulatory requirements, Council requirements and historical data
(ii) Sampling locations
(iii) Preliminary preparations before sampling event (include decontamination of equipment, form preparation - field parameter, chain of custody)
(iv) Preceding 24 hour preparations (include calibration of field lab/s within 24 hours of sampling)
(v) Site safety
(vi) Groundwater sampling methodology (Make suitable for particular wells and note interface probe measurement of piezometric level, purge method etc. Methodologies are to be justified through reference to documents such as

- *Schedule B2 Guideline on Site Characterisation* NEPM (2013), *Section 8 - Groundwater assessment*
- ASTM 2001 *Standard guide for the selection of purging and sampling devices for ground-water monitoring well, D6634*
- ASTM 2001 *Standard guide for planning and preparing for a groundwater sampling event*, D5903 - 96(2012)
- ASTM 2002 *Standard practices for decontamination of field equipment used at waste sites*, D5608-10
- ASTM 2002 *Standard practice for low-flow purging and sampling for wells and devices used for ground-water quality investigations*, D6771-02 as WK46668
- ASTM 2004, *Standard guide for documenting a ground-water sampling event*, D7069-04(2010)
- ASTM 2005, *Standard guide for purging method for wells used for groundwater quality investigations*, D6452-00(2012)
- Barcelona, MJ, Gibb, JP, Helfrich, JA & Garske, EE 1985, *Practical guide for ground-water sampling*, EPA/600/2-85/104
- Hart, BF, Tomlinson, R & Chaseling, J 2000, ‘Using the stabilization plateau to estimate optimum well purge volume’, *Ground Water Monitoring and Remediation*, vol. 20, no. 3, pp. 113-121.

- ISO 5667-1:2009*, Water quality — Sampling — Part 11: Guidance on sampling of groundwaters*, 2nd edition, www.iso.org

- New South Wales Environment Protection Authority (2015) *DRAFT Environmental Guidelines: Solid Waste Landfills*, Second Edition, published March 2015.
- Nielsen, DM 2005, *Practical handbook of environmental site characterisation and ground-water monitoring,* 2nd edition
- Puls, RW & Barcelona, MJ 1996*, Low flow (minimal drawdown) ground-water sampling procedures,* Ground water issue*,* EPA/540/S-95/504

(vii) Surface water and leachate sampling methodology. Methodologies are to be justified through reference to documents such as

- ANZECC and ARMCANZ (Agriculture and Resource Management Council of Australia and New Zealand) 2000, *Australian and New Zealand guidelines for fresh and marine water quality 2000*
- Csuros, M 1994, *Environmental sampling for technicians*
- ISO 5667-1:2006, *Water quality – Sampling – Part 1: Guidance on the design of sampling programmes and sampling techniques*, 2nd edition
- New South Wales Environment Protection Authority (2015) DRAFT Environmental Guidelines: Solid Waste Landfills, Second Edition, published March 2015.

(viii) Site work completion tasks

(ix) Water sample despatch methodology

(x) Field alkalinity and free carbon dioxide analysis methodology

(xi) Procedure to check on sample arrival at lab

(xii) Style of quarterly monitoring report

(xiii) Procedures to input results into the report's historical tables, to double check and review them, and to discuss any perceived anomalies with the field and laboratory staff

(xiv) Types of calibration certificates and laboratory results for report (include laboratory: sign off of chain of custody form; sample receipt notification (SRN); certificate of analysis; quality control report; and a QA/QC Compliance Assessment for DQO Reporting that summarises the laboratory quality assurance findings

(xv) Style of monitoring data pdf file for Council website as required under the future landfill licence.

(xvi) Completion method for the monitoring section of the landfill's Environment Protection Licence Annual Return

(xvii) Bibliography/Reference List

6.2 Approach

The monitoring program for the Armidale Regional Landfill has been prepared to align with the three phases of monitoring for surface water and groundwater:

1) Site characterisation (baseline monitoring) prior to landfill construction, and initial leachate quality once the landfill is constructed and operating, to serve as a baseline against which to compare future water quality data.

2) Detection monitoring during construction and landfill operation to determine whether or not there has been an impact on surface water and/or groundwater quality from landfill leachate or sediment runoff.

3) Assessment monitoring in the event of detection monitoring criteria being exceeded, to characterise possible contamination (nature, extent, possible future extent and source); and if required, to evaluate and recommend mitigation techniques.

Site characterisation has been completed for surface water and the baseline data collected has been used to inform the criteria for detection monitoring as specified in Section 6.3. Trigger values for assessment monitoring are presented in Appendix A and include:

- If any three of more of the selected geochemical indicators for GARA2 exceed their statistical trigger value/s by more than 20%
- If either GARA3 and/or GARA5 are determined to be in need of assessment monitoring by a person experienced in water quality review
- If inspection of any other water body in the landfill environs is noted as needing water quality review.

Site characterisation for groundwater conditions is currently being completed and the results of the first three rounds of monitoring are presented in Appendix C. The detection monitoring criteria for the 'detection monitoring indicators' will be finalised once eight rounds of baseline monitoring are complete. The criteria will be finalised in conjunction with the EPA as part of the EPL process. This WQMP will be updated to include the detection monitoring criteria once they have been developed.

6.3 Surface Water Monitoring

6.3.1 Purpose

The purpose of the surface water monitoring program is to capture an accurate snapshot of surface water quality as well as environmental factors influencing or associated with the surface water quality at the time of sampling.

6.3.2 Sampling Methodology

The surface water samples will be collected using a grab sampler or by direct filling into the sample bottle. Measures will be taken to minimise potential volatile loss i.e. using a dedicated secondary container to collect samples and fill into VOC sample bottles. Care will be taken to minimise aeration. Surface water samples to be analysed for dissolved metals will be filtered in the field prior to filling appropriate containers.

During sampling, field parameters, such as pH, dissolved oxygen (DO), electrical conductivity (EC), oxidation-reduction potential (ORP), turbidity and water temperature will be measured using calibrated equipment. Each sample will be visually observed and a description of the colour, turbidity, odour and any visible sheen will be recorded in the field notes (Table 8).

Field parameter measuring equipment will be calibrated as required and calibration certificates and records retained.

Table 8 Surface water monitoring field parameters

Type	Parameter
Field Observation	Unique sample location identifier
	GPS coordinates (WGS 84, decimal degrees)
	Photographic Record
	Water body description
	Weather conditions
	Flood level indicator reading (if applicable)
	Estimated flow rate
	Substrate type
	Water colour, light penetration, odour, presence of scum or sheen etc.
	Fish and aquatic flora and fauna observations
	Evidence of bank stability/erosion and feral animal activity
Field Measurement	Time and date
	pH

Type	Parameter
	Oxidation Reduction Potential
	Electrical Conductivity
	Dissolved Oxygen
	Turbidity
	Water Temperature
	Depth of water sample taken from

Sampling will be undertaken in accordance with the Data Quality Objectives (DQOs) outlined in Section 7.1. Demonstration of the DQOs will require the collection of:

- One field duplicate sample for every ten primary samples collected;
- One rinsate blank for each day of sampling; and
- A trip blank for each esky dispatched to the laboratory.

6.3.3 Sampling Locations

The surface water monitoring program will be conducted at the locations detailed in Table 9, and as shown in Figure 2.

Table 9 Surface water sampling locations

Site	Sample Site Description	GPS Position	
		Easting	Northing
GARA1	Located on Gara River, upstream of the confluence of the ephemeral creek (which flows to the north of the landfill site) and the Gara River, north of the Waterfall Way/Gara River road bridge. This site is not influenced by run-off originating from the landfill.	384741.0	6620301.0
GARA2	Located on the Gara River immediately downstream of the confluence of the ephemeral creek (which flows to the north of the landfill site) and the Gara River. This site is 1.2 km from the landfill and represents a monitoring location on the Gara River where potential impact from the landfill facilities might be detected.	384635.0	6619865.0
GARA3	Located on the landfill site gully (ephemeral stream) immediately downstream of the landfill.	383826.0	6619708.0
GARA4	Located on the Gara River, at the Blue Hole (Oxley Wild Rivers National Park) 10 km downstream of the landfill and 21km downstream of Commissioners Water (including potential influences from the Armidale STP).	384915.0	6614748.0
GARA5	Located on the landfill site gully (ephemeral stream) upstream of the landfill site.	383279.0	6619897.0
GARA6	Located on the Gara River, immediately upstream of the confluence of Commissioners Waters and the Gara River, approximately 7.5 km downstream of the landfill site.	385915.0	6616606.0

6.3.4 Sample Frequency and Analytical Regime

Table 10 describes the sampling frequency and the laboratory analytical suite for the surface water monitoring program at the Site.

Table 10 Surface Water Monitoring Program (CodyHart Environmental, 2015)

	Baseline monitoring program	Detection monitoring	Assessment monitoring
Sampling points	GARA1 GARA2 (GARA3 GARA4 GARA5 GARA6	GARA5 (upstream from landfill) GARA3 (downstream from landfill) GARA2 (1.2 km farther downstream from landfill than GARA3)	For impacted sampling point : GARA5, GARA3 and/or GARA2 If GARA2 impacted, add GARA1 and GARA6, or more appropriate upstream and downstream substitutes.
Sampling frequency	Two to six months apart depending if there was flow at GARA3 and GARA5	Bi-monthly during major construction works, quarterly thereafter	Determine by review of need
Parameters & analytes	Field: Depth, volumetric flow, DO, EC, pH, Eh, temp, turbidity, alkalinity, free CO2 Laboratory: SS, Cl, SO4, Ca, Mg, Na, K, Hardness, Nutrients (NH4+ as N, TKN as N, NOx as N, Total Phosphorus), Total metals not filtered [Al, As, Cd, Cr, Cu, Ni, Pb, Zn, Mn, Fe, Se, Hg, Fe (II)-GARA6, Br, B, TOC (filtered), UT PAH, OC&OP pesticides, TPH/TRH, speciated phenolics. Notes: Some extra tests by ADC are not noted above. Highlighted ones added by CodyHart.	Field: Depth, volumetric flow, DO, EC, pH, Eh, temp, turbidity, alkalinity, free CO2 Laboratory: SS, Cl, Nutrients (NH4+ as N, TKN as N, NOx as N, Total Phosphorus), Dissolved metals filtered on site with 0.45 µm filter [Al, As, Cd, Cr, Cu, Ni, Pb, Zn, Mn, Fe, Fe (II)], TOC (filtered).	Field: Depth, volumetric flow, DO, EC, pH, Eh, temp, turbidity, alkalinity, free CO2 Laboratory: SS, Cl, SO4, Ca, Mg, Na, K, Hardness, Nutrients (NH4+ as N, TKN as N, NOx as N, Total Phosphorus), Dissolved metals filtered on site with 0.45 µm filter [Al, As, Cd, Cr, Cu, Ni, Pb, Zn, Mn, Fe, Fe (II)], TOC (filtered), and if sheen, colour, odour indicates it is warranted – test for VOCs, UT PAHs, speciated phenolics.
QA samples to laboratory	1 intra-lab duplicate per 10 sampling points/wells	1 intra-lab duplicate per 10 sampling points/wells	1 intra-lab duplicate per 10 sampling points/wells

6.4 Groundwater Monitoring Program

6.4.1 Purpose

Routine groundwater sampling is required at the landfill site to monitor existing groundwater contamination, identify new groundwater contamination and to demonstrate continuing groundwater quality.

6.4.2 Groundwater Monitoring Well Sampling Methodology

Prior to the sampling of groundwater, standing water levels (SWL) should be measured. Where phase separated hydrocarbon PSH is suspected, an interface probe should be used to measure the apparent thickness of the layer.

Low flow sampling or micro-purge sampling should be used to sample all groundwater monitoring wells. The technique generally utilises an air driven bladder pump, but other methods may be used provided effective decontamination can be achieved. Bladder pumps and low-flow sampling are preferable because this style of pump and methodology are suitable for sampling all water quality analytes including volatile organic compounds.

Low flow sampling is a technique designed to minimise the hydraulic stress on the aquifer during purging and sampling. This is done by using an adjustable rate pump to remove water from the screened zone at a rate that will cause minimal drawdown of the water level in the well. Drawdown is measured in the well concurrent with pumping using a water level meter. Low flow sampling does not require a specific flow rate or purge volume.

In practical terms, allowable drawdown should never exceed the distance between the top of the well screen and the pump intake, which is normally positioned near the mid-point of the screen. To provide a safety factor, drawdown should generally not exceed 25 % of this distance to ensure that no water stored in the casing prior to purging is drawn down into the pump intake and collected as part of the sample. Typically, flow rates during purging in the order of 0.1 to 0.5 L/min are used; however, this is dependent on site-specific and well-specific factors.

Pumping water levels in the monitoring well and water-quality indicator parameters should be monitored during pumping. Water quality parameters including pH, temperature, electrical conductivity (EC), dissolved oxygen (DO) and oxidation-reduction potential (ORP) will be measured using calibrated equipment. Stabilising water quality parameters indicate that purging is complete and sampling can begin. Field parameter measuring equipment will be calibrated as required and calibration certificates and records retained.

Table 11 Criteria for Defining Stabilisation of Water Quality Parameters

Parameter	Stabilisation Criterion
pH	± 0.2 pH units
Electrical Conductivity	± 3% of reading
Dissolved Oxygen	± 10% of reading or ± 0.2 mg/L, whichever is greater
Eh	± 20 mV

All wells have individual characteristics that need to be taken into account when devising their purging and sampling regime. It is important to use the same methodology from sampling round to sampling round to minimise variation in the water quality results that can be caused by variation in purging and sampling methodology.

A sample can be collected after the water level and measured field parameters stabilise over three consecutive readings taken three to five minutes apart. For in-line flow-through cells, the frequency of the measurements should be based on the time required to completely evacuate one volume of the cell to ensure that independent measurements are made. It is important to know the manufacturer’s recommendations for the amount of time required to completely evacuate the cell to allow individual sensors being used to measure field parameters (e.g. dissolved oxygen) to stabilize and to ensure that representative data is collected.

Though not a chemical parameter, turbidity can be indicative of stress and disturbance resulting from pumping. Turbidity should be as low as possible when sampling is undertaken. The stabilisation criterion for turbidity is ± 10 % of the preceding reading or ± 1.0 NTU, whichever is greater.

The flow cell should be disconnected or bypassed during sample collection. Sampling should be completed at a rate where aeration and turbulent filling is minimised, typically less than 0.5 L/min. Generally samples for the most sensitive parameters (e.g. VOCs) and those of greatest interest at the site should be collected first. Samples for analytes that require filtration should be collected last (e.g. heavy metals).

Low-flow purging and sampling can be used to collect samples for all aqueous-phase contaminants and naturally occurring analytes, including volatile and semivolatile organic compounds (VOCs and SVOCs), metals and other inorganics, pesticides, PCBs, other organic compounds, radionuclides and microbiological constituents.

Further detail on low-flow sampling can be obtained from:

- The US EPA publication “Low-flow (minimal draw down) groundwater sampling procedures” (Puls & Barcelona, 1996); and
- The ASTM standard D 6771-02 “Low-Flow Purging and Sampling for Wells and Devices Used for Ground-Water Quality Investigations” (ASTM 2002).

During the groundwater sampling, field observations, field parameters (when stabilisation parameters as specified in Table 11 are met) and photographs should be recorded. Table 12 lists the parameters to be recorded.

Table 12 Groundwater monitoring field paramaters

Type	Parameter
Bore Description	Unique sample location identifier
	GPS coordinates (WGS 84, decimal degrees)
	Photographic Record
	Sample appearance (colour/odour/clarity/visible sheen – if any)
	Bore details (Total Depth, Screen level)
Field Measurement	Time and date
	pH
	Oxidation Reduction Potential
	Electrical Conductivity
	Dissolved Oxygen
	Turbidity, colour and opacity
	Water Temperature
	Standing Water Level

6.4.3 Sampling Locations

The groundwater monitoring program will be conducted at the locations detailed in Table 13 and as shown in Figure 5. Following recommendations from DPI Water, an additional two dual purpose monitoring wells will be considered post landfill construction. These two locations include:

- One upgradient of the landfill to measure piezometric levels and methane; and
- One in between ABH11 and ABH12 at least 50 metres downgradient from the wall of the final landfill cell and upgradient of the leachate pond.

Establishment of these additional locations would be confirmed with EPA, DPI Water and/or DP&E.

Table 13 Groundwater monitoring locations

Monitoring Well ID	Description	Position (MGA94 Zone 56)		RL (m, AHD)		Final Depth (m)
		Easting	Northing			
ABH02	Screened in soil	383744	6619550	955	5.0 – 11.0	11.0
ABH02A	Screened in rock	383748	6619551	955	23.6 – 29.6	30.1
ABH4	Screened in rock	383691	6619577	954	6.0 – 18.0	18.1
ABH4a	Screened in soil	383693	6619577	954	1.0 – 2.8	2.8
ABH04	Screened in rock	383644	6619659	953	22.0 – 28.0	28.3
ABH04A	Screened in soil	383636	6619659	953	5.0 – 8.0	8.0
ABH9	Screened in soil	383129	6618698	1014	53.5 – 59.5	59.5
ABH11	Screened in rock	383205	6619230	978	30.0 – 36.0	36.0
ABH12	Screened in rock	383558	6619123	970	34.0 – 40.0	40.0

RL = reduced level
AHD = Australian Height Datum

Sampling should be undertaken in accordance with the DQOs outlined in Section 7.1. Demonstration of the DQOs will require the collection of:

- One field duplicate sample for every ten primary samples collected;
- One rinsate blank for each day of sampling; and
- A trip blank for each esky dispatched to the laboratory.

Non-routine sampling may be required in response to environmental incidents or as a result of subsequent environmental investigations at the site. Figure 5 provides the locations that should be monitored as part of the program. This list should be reviewed and updated if additional monitoring wells are installed.

6.4.4 Falling Head Tests

The average linear groundwater velocity requires calculating to assist in recommending sampling frequencies during the detection monitoring phase. Calculation of the linear velocity is conducted by the following equation:

The linear or true velocity is calculated by the following equation:

$$V = \frac{Ki}{\Phi} \quad \text{(Carey et al, 2006)}$$

where V= groundwater velocity (m/day)

K = hydraulic conductivity (m/day)

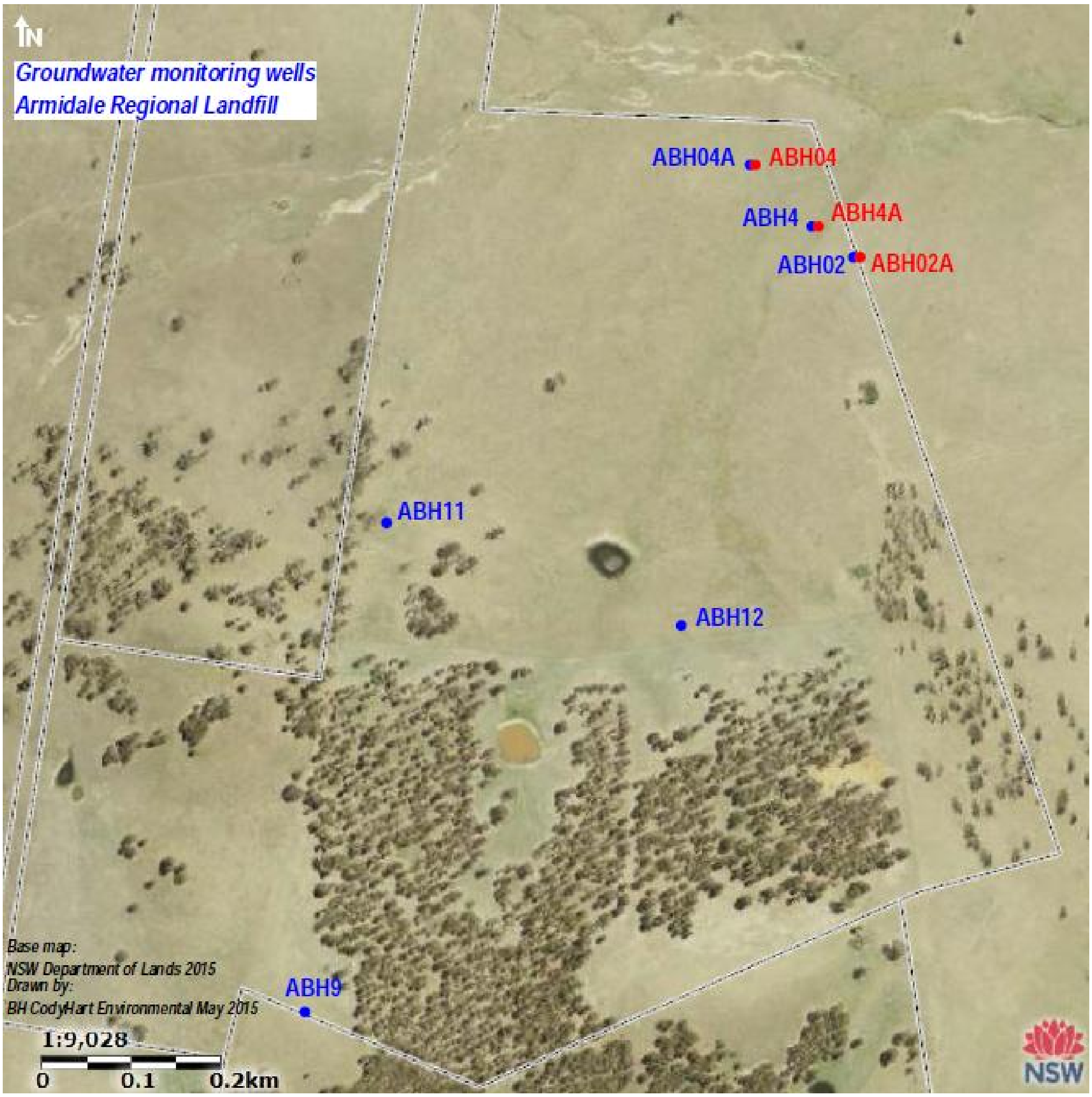
i = hydraulic gradient

Φ = effective porosity (%)

The hydraulic gradient is known and the porosity can be reasonably estimated, however the hydraulic conductivity is unknown at a number of boreholes and it is recommended that falling head tests are conducted to obtain values of hydraulic conductivity. It is recommended at least three falling head tests are conducted as follows:

- Review monitoring well construction details to determine the borehole diameter, screen interval and borehole depth;
- Review site operations to ensure the aquifer is at equilibrium and is not impacted by recent drilling or localised pumping or the water is not impacted by drilling muds;
- Measure the standing water level;
- Suspend the pressure transducer within the monitoring well, position it towards the base of the hole and check that the data logger is monitoring.
- Pour potable water into the borehole with a bucket or pre-constructed slug as quickly as possible and monitor the water level response automatically with the data logger. A maximum of 20 litres of water is sufficient to induce a suitable response in a 50 mm diameter well.
- At the completion of the test, manually monitor the water level in the monitoring well to compare with the datalogger water levels.
- Repeat the test if the data logger data is of poor quality
- Analyse the data using the Bouwer and Rice (1976), Hvorslev (1951) or Cooper, Bredehoeft, Papadopulos (1967) techniques to calculate hydraulic conductivity.

Figure 5 **Groundwater Monitoring Program - Groundwater Monitoring Locations**



Note: Installation of additional two dual purpose, monitoring wells will be considered post landfill construction, in consultation with EPA (refer 6.4.3).

6.4.5 Frequency and Analytical Regime

Table 14 describes the groundwater sample frequency and laboratory analytical suite for ongoing groundwater monitoring at the Site. It is noted that groundwater sampling will be undertaken bi-monthly prior to construction.

Table 14 Groundwater Monitoring Program (CodyHart Environmental, 2015)

	Baseline monitoring program	Detection monitoring	Assessment monitoring
Monitoring wells	ABH02, ABH02A, ABH4, ABH4A (dry), ABH04, ABH04A, ABH11, ABH12 (downgradient of landfill), ABH9 (upgradient of landfill) ABHD (duplicate sample taken at one of the above wells)	ABH02, ABH02A, ABH4, ABH4A (dry), ABH04, ABH04A, ABH11, ABH12 (unless redundancies noted in baseline monitoring) ABH9 (upgradient of landfill) ABHD (duplicate sample taken at one of the above wells)	Wells in which detection monitoring indicates exceedance of three indicator parameter / analytes for three consecutive monitoring rounds.
Sampling frequency	Bi-monthly for eight rounds	Determined from the groundwater average linear velocities for the site based on in-situ hydraulic conductivity estimates. - Moderate groundwater movement – quarterly (mid-gradient wells ABH11 & ABH12); - slow groundwater movement – six monthly (lower gradient ABH02, ABH02A, ABH4, ABH04, ABH04A); - upgradient ABH9 – six monthly - located higher than the landfill cells.	Determine by review of need
Parameters & analytes	Field: Depth, DO, EC, pH, Eh, temp, turbidity, alkalinity, free CO2 Laboratory: Every round: Cl, SO4, Alk, Ca, Mg, Na, K, Nitrogen compounds (NH4+ as N, TKN as N, NOx as N), Filtered [Al, As, Cd, Cr, Cu, Ni, Pb, Zn, Mn, Fe, Se, Hg, Sb, Fe (II)]; TOC (filtered). Every second round: UT VOCs, OC&OP pesticides, UT PAH.	Field: Depth, DO, EC, pH, Eh, temp, turbidity, alkalinity, free CO2 Possible Laboratory: Every round: Cl, SO4, Nitrogen compounds (NH4+ as N, TKN as N, NOx as N), Filtered [Al, As, Cd, Cr, Cu, Ni, Pb, Zn, Mn, Fe, Fe (II)]; TOC (filtered).	Field: Depth, DO, EC, pH, Eh, temp, turbidity, alkalinity, free CO2 Possible Laboratory: Every round: Cl, SO4, Nitrogen compounds (NH4+ as N, TKN as N, NOx as N), Filtered [Al, As, Cd, Cr, Cu, Ni, Pb, Zn, Mn, Fe, Se, Hg, Sb, Fe (II); TOC (filtered). If sheen, colour, odour indicates it is warranted – test UT VOCs, UT PAHs.
QA samples to laboratory	1 intra-lab duplicate per 10 sampling points/wells	1 intra-lab duplicate per 10 sampling points/wells	1 intra-lab duplicate per 10 sampling points/wells

6.5 Leachate Monitoring Program

The monitoring points for the landfill will be the same as the GARA sites for surface water monitoring identified previously in this WQMP.

Onsite leachate monitoring points:

- Leachate Pond stored water (water to be tested for leachate contamination concentrations);
- Sedimentation Basin (water will need to be tested for total suspended solids prior to discharge);
- Dry Basin stored water (water to be tested prior to release to downstream watercourse off-site, water to be tested for potential suspended solids and leachate contamination).

Further details regarding the leachate monitoring program are contained in the Leachate and Water Management Plan (AECOM, 2015), however a brief summary is provided in the following sub-sections.

6.5.1 Purpose

The objectives of the leachate monitoring program are to enable the leachate produced by the landfill to be characterised so that the status of the landfill can be determined (i.e. active landfill) and the storage/use options of the leachate can be assessed.

Leachate will be collected from the leachate collection sump and/or leachate pond. The level of leachate in the pond and leachate collection sump will be recorded at the time the representative samples are taken. The level of leachate in the pond will be monitored to ensure the integrity of the pond's lining.

6.5.2 Performance Indicators

The results of the Leachate Monitoring Program will be analysed to determine if the landfill is producing leachate with characteristics typical of a General Solid Waste (putrescibles) landfill. Leachate in putrescible waste landfills is generally characterised by high nutrient concentrations (in particular nitrogen compounds), high Total Organic Carbon (TOC), elevated Total Dissolved Salts (TDS) and relatively low pH when compared to fresh unpolluted waters. However, the composition of landfill leachate also varies depending on:

- The age of the landfill.
- Phase of decomposition that the landfill is experiencing at the time.
- Type of waste disposed in the landfill.
- Landfill gas generation, in particular the concentration of carbon dioxide.

6.5.3 Sample Frequency and Analytical Regime

Table 15 describes the sampling frequency and the laboratory analytical suite for ongoing leachate monitoring program at the Site.

Table 15 Leachate Sampling Frequency and Analytical Regime

Location	Frequency	Laboratory Analytical Regime
Leachate collection sump and/or leachate pond	Six monthly for four rounds when leachate becomes available, then annually.	Field analytes: • pH • electrical conductivity (EC) • temperature • dissolved oxygen (DO) • redox potential (Eh) • alkalinity • free CO2 (titrations by the end of the sampling day) Laboratory analytes: • 13 metals (As Cd Cr Cu Pb Ni Zn Al Fe Se Hg Mn Sb) • Nitrogen family analytes (NH_4, TKN, NO_x) • Total phosphorus • TOC • Cl and SO_4 (anions) • TPH/TRH(C6-C36 or 40)/BTEX plus VOC • TPH/TRH (C6-C36 or 40)/BTEXN, F1 & F2 (Silica Gel cleanup) • OC&OP Pesticides • PAH

6.6 Additional Requirements

6.6.1 Sample Preservation, Packaging and Shipping

Procedures for containing and preserving groundwater, leachate and surface water samples are as follows.

- The type and size of containers and preservatives used for water samples varies based on the type of analysis to be performed. Samples will be placed and stored in laboratory-supplied sample containers.
- Filtering of groundwater and extraction bore samples to 0.45 m for metals analysis will be conducted using disposable filters prior to preservation (i.e. placement within the preserved laboratory supplied sample bottle).
- All water samples will be placed in a cooler with ice to maintain samples at <6^{o}C prior to analysis.
- Holding times for water samples vary according to the type of analysis that is to be performed. In general, holding times for common types of analyses are as follows:
  - samples to be analysed for *E. Coli* and enterococci can be held a maximum of 1day.
  - samples to be analysed for VOCs can be held a maximum of 14 days.
  - samples to be analysed for other organic chemicals (including TRH, PAHs and phenols) can be held a maximum of 7 days until extraction, and then for 40 days until analysis.
  - samples to be analysed for metals (except mercury) can be held a maximum of 6 months.
- Samples will be labelled with specific details including:
  - date and time of sample collection.
  - project number.
  - name(s) of sampler.
  - sample identification number.

- sample preservatives used.

6.6.2 Chain of Custody (COC) Protocols

Samples collected in the field must be able to be tracked from the time of collection until the analytical laboratory receives them. To document sample possession, Chain of Custody (COC) procedures shall be followed.

COC records shall include the following information:

- Project number.
- Name(s) of sampler.
- Time and date of sample collection.
- Sample type (i.e. water, soil or sediment).
- Number and type of sample containers (including preservatives used).
- Sample identification number.
- Receiving analytical laboratory.
- Required analyses.
- Contact details for questions regarding sample analysis.
- Names, dates, times and signatures documenting all changes in sample possession from:
  - the person collecting the samples in the field; to the –
  - courier transporting the samples to the laboratory; to the -
  - analytical laboratory.

COC records will accompany samples at all times once the samples are collected.

6.6.3 Decontamination

Field personnel are responsible for ensuring that all field equipment is decontaminated prior to use for the collection of samples as required by the WQMP. Decontamination is performed to eliminate the possibility of cross-contamination from previous projects or between sampling locations. In general, decontamination consists of either: a high pressure, hot water wash (steam-cleaning); or, a non-phosphate detergent solution (Decon 90, or Alconox) wash followed by deionized, distilled, or clean water rinse(s).

The decontamination procedures must be performed before initial use of any equipment for sample collection and after each subsequent use.

Decontamination procedures that must be utilised during sampling are as follows:

- Prior to collection of each sample, all sampling and measurement field equipment (e.g. water quality meters etc) will be hand washed with a mixture of water and phosphate free detergent. This will be followed by a double dioinised water rinse. Where possible, equipment will be wiped with disposable paper towel prior to, and after, decontamination as above.
- The air discharge line, fluid line and internal air bladder used in the low flow purging and sampling system will be dedicated (i.e. re-used for subsequent rounds in dedicated location) or replaced between groundwater monitoring wells.

6.7 Data Management and Reporting

Reporting will be required at the completion of each monitoring program. The objectives of the report will be to: interpret the analytical results received; identify any compliance issues; trigger implementation of contingency plan (as described by **Section 6.7**); and, recommend any additional or modified management measures that might be required.

The specific reporting requirements for the WQMP are as follows.

- Verbally report to the Waste Manager any criteria exceedances of the contaminants of concern within 24 hours of obtaining results from the laboratory.
- Provide an environmental monitoring report (EMR) from each sampling event (ie. Quarterly, annually).

6.7.1 Verbal Reporting

All trigger level exceedances will be reported verbally to the Waste Manager. The purpose of the verbal reporting is to enable identification of and proactive management of any changed conditions (for example a leaking pipe or tank) which might have contributed to the trigger level exceedance.

All verbal reporting, including any agreed actions, shall be confirmed in writing by e-mail.

6.7.2 Progress Reporting

Progress reports will be prepared upon completion of each sampling event. Progress reports will include, as minimum requirements:

- The locations of all groundwater monitoring wells and surface water sample sites sampled as part of the sampling event;
- A description of the sampling methodology used and, in particular, any departures from the requirements of this WQMMP;
- Descriptions of all samples collected, including measured field parameters, in accordance with the WQMMP;
- Tabulated comparison of analytical results from the subject sampling event with the trigger levels recommended by the WQMP and with historical sampling results;
- Identification of any trigger level exceedances, sample data anomalies or sample data trends and provision of an explanation (for example changed conditions such as a leaking pipe or a spill event);
- Assessment of the quality of data obtained and achievement of the Data Quality Objectives recommended by the WQMP;
- Recommendation of management actions, including but not limited to triggering of the Contingency Plan described by **Section 8.0**; and
- Recommendations (if any) for modification of the WQMP.

6.7.3 Annual Summary Reporting

Annual summary reports will be prepared upon the conclusion of each calendar year. Annual summary reports will include, as minimum requirements:

- A summary of all groundwater and surface water samples collected during the preceding year;
- Tabulated comparison of analytical results from the subject sampling event with the trigger levels recommended by the WQMP and with historical sampling results;
- Summary of any trigger level exceedances, sample data anomolies or sample data trends and provision of an explanation (for example changed conditions such as a leaking pipe or a spill event);
- Summary of recommended management actions, including but not limited to triggering of the Contingency Plan described by **Section 8.0**;
- Summary of Contingency measures implemented in accordance with **Section 8.0** (if any); and
- Summary of recommendations (if any) for modification of the WQMP.

7.0 Quality Assurance/Quality Control

7.1 Data Quality Objectives

The National Environmental Protection Measure (NEPM, Schedule B[2]) *Guideline on Data Collection, Sample Design and Reporting* (1999), specifies that the nature and quality of the data produced in an investigation will be determined by the Data Quality Objectives (DQOs). As referenced by the NEPM, the DQO process is detailed in the US EPA *Guidance for the Data Quality Objectives Process* (1994), EPA QA/G-4 (EPA 600R96055). The US EPA defines the process as:

> *'a strategic planning approach based on the Scientific Method that is used to prepare for a data collection activity. It provides a systematic procedure for defining the criteria that a data collection design should satisfy, including when to collect samples, where to collect samples, the tolerable level of decision errors for the study, and how many samples to collect'.*

The process of establishing appropriate DQOs is defined by the USEPA according to the following seven steps (Table 16).

Table 16 DQO Steps

Step	Data Quality Objective
1	**State the problem** – define the problem to be addressed, identify the planning team, examine budget and schedule.
2	**Identify the decision** – outline the decision, the study question and alternative actions.
3	**Identify inputs to the decision** – present parameters and inputs for decision, including information sources, basis for trigger/guideline levels, sampling and analysis methodology, etc.
4	**Define the study boundaries** – present spatial and temporal limits for study, sample characteristics and decision making units.
5	**Develop a decision rule** – define a statistical parameter, specify trigger/guideline levels and develop argument for action.
6	**Specify limits on decision errors** – set acceptable limits for decision errors relative to potential consequences such as health, budget, social or environmental impacts.
7	**Optimise the design for obtaining data** – develop an effective sampling and analysis plan that meets resource and performance criteria.

In the context of the WQMP adoption of the DQO process is considered critical to obtaining relevant data for interpretation and development and implementation of associated management or mitigation measures. The DQO process was considered in the development of the WQMP and to address QA/QC measures to be adopted during the program.

The approach adopted relative to the seven steps presented above is discussed below.

7.1.1 Step 1 - State the Problem to be Resolved

The problems to be addressed are whether:

- Any potential groundwater or surface water contamination issues are present.
- Any contamination or performance issues can be effectively managed and what measures can be taken to reduce associated impacts.

7.1.2 Step 2 - Identify the Decision to be Made

The decision identification component of the DQO process represents the key issues that need to be reviewed / considered in order to resolve the problems identified in Step 1. These issues include:

- Are contaminant concentrations above background levels?
- Do the concentrations identified exceed the relevant regulatory guidelines levels?

- Has the extent of any groundwater/surface water contamination been identified?
- Are the current groundwater surface/water monitoring results representative of historical results?
- Do the contaminant concentrations adversely impact upon human health or the environment for the identified receptors of concern?
- Is the investigation approach scientifically suitable and defensible?

7.1.3 Step 3 - Identify Inputs to the Decision

To allow assessment of the data against the objectives listed above, various inputs are considered. The following list presents various inputs considered.

- Relevant regulatory guidelines / trigger levels;
- Landfill performance criteria;
- Aesthetic impacts (odours, sheen, etc);
- Identification of the contaminants of interest for each area, based on previous investigation data;
- The known distribution of surface water / groundwater contamination at and surrounding the site; and
- The previously recorded concentrations of contaminants relative to the guidance levels.

7.1.4 Step 4 - Define the Boundaries of the Investigation

The spatial boundaries (geographical limits) applied for data collection and decision making in the investigations are defined as follows:

- The extent of the sampling locations surrounding the site; and
- The groundwater aquifer to a depth of approximately 60 mBGL

7.1.5 Step 5 - Develop a Decision Rule

Based upon the relevance of all of the data collected, the decision rule for the program is to assess:

- The representativeness of current and historic analytical data;
- Whether the current groundwater and/or surface water controls (if any) are adequate; and
- Whether previous conclusions regarding risk to the environment are still accurate/relevant.

7.1.6 Step 6 - Specify Limits on Decision Errors

A decision error in the context of the decision rule presented above would lead to either underestimation or overestimation of the risk level associated with a particular area. Decision errors may include:

- Limitations based on inaccurate/inadequate data from previous investigations;
- Errors in the WQMP;
- Data not representative of site conditions; and
- Inadequate data quality (refer to Section 7.3).

7.1.7 Step 7 - Optimise the Design for Obtaining Data

The methodology presented represents a program which is designed to meet the objectives of the WQMP and also to achieve the nominated DQOs. Optimisation of the data collection process will be achieved by:

- Targeted sampling based on historical and anecdotal evidence.

7.2 QA/QC Data Assessment

7.2.1 Field QA/QC

All work completed on the site will be conducted in accordance with standard environmental sampling protocols. The essential elements of the QA/QC program are presented in Table 17.

Table 17 Essential elements of the field QA/QC program

Action	Description
Use of Experienced Personnel	Field work will be undertaken by people well trained in surface water and groundwater sampling and workplace health and safety issues, or supervised by someone who is.
Record Keeping	Full records of all field activities including water monitoring data and sample collection will be maintained on standard field logging sheets.
Sample Collection	New nitrile gloves will be worn during water sampling, and replaced between each sample collection.
Sample Labelling	A unique sample number will be used for each sample to clearly specify the sample origin (site/well number and date), preservation standards and analytical requirements.
Chain of Custody	Chain of Custody procedures are required for all sample transfers. Custody sheets should list sample numbers; date of collection and analyses required and be signed by each person transferring and accepting custody.
Sample Storage	The collected water samples will be transferred to approved sampling containers with appropriate preservation as required and then placed in cool storage prior to transfer to a NATA accredited laboratory.
Decontamination	All equipment used in the sampling process will be decontaminated using a phosphate free detergent, followed by rinsing with de-ionised water, prior to mobilisation and between sampling locations to reduce the risks of cross contamination.

Field Duplicates

In addition to the primary samples, quality control field duplicate (inter-laboratory duplicates) samples will be collected to assess aspects of field protocols and laboratory performance and to classify the validity of the laboratory data. Field duplicates will be collected in general accordance with AS 4482.1-2005 guidelines (Standards Australia 2005).

A relative percentage difference (RPD) analysis of primary and duplicate / triplicate samples is used to measure the representativeness and/or precision of duplicate samples. The RPD is calculated from the absolute difference between results of the duplicate pair divided by the mean value of the duplicate pair.

RPD (%) = 100 x (D1-D2) / ((D1+D2) / 2)

where: D1 = primary sample analysis
D2 = duplicate sample analysis

Laboratory quality assurance reports present relevant RPD for each analyte and medium and should be adopted.

7.2.2 Laboratory QA/QC

The laboratory used in the investigations will be National Association of Testing Authorities (NATA) approved for the analyses required. Quality assurance procedures adopted by the analytical laboratory will include analysis of blanks, duplicates, laboratory control samples, matrix spikes and surrogate spikes (for organics).

A description of the laboratory’s minimum quality assurance procedures is presented in Table 18.

Table 18 Description of laboratory quality assurance procedures

QA Procedure	Description
Laboratory Blanks and Controls	The quality control term Method/Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC type is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a known, interference free matrix spiked with target analytes or certified reference material. The purpose of this QC type is to monitor method precision and accuracy independent of sample matrix. Frequency of QC samples 1 in 20.
Laboratory Duplicates	The quality control term Laboratory Duplicate refers to an intra laboratory split sample randomly selected from the sample batch. Laboratory duplicates provide information on method precision and sample heterogeneity. Relative percentage differences (RPDs) are used to assess precision. Frequency of QC samples 1 in 10.
Matrix Spikes	The quality control term Matrix Spike (MS) refers to an intra laboratory split sample spiked with a representative set of target analytes. The purpose of this QC type is to monitor potential matrix effects on analyte recoveries. The samples undergo the same extraction and analysis procedures and the results are used to assess the method precision and bias. Spike recoveries are reported as a percent recovery. Frequency of QC samples 1 in 20.
Surrogate Spikes	The quality control term Surrogate Spike refers to a compound added to a sample aliquot in known amounts before extraction and analysis. The compound should be similar in composition and behaviour to the target analyte but not naturally occurring in the sample. A surrogate is used to monitor the method performance for analysis of organic compounds. Spike recoveries are reported as a percent recovery.

All samples will be received by the laboratory in appropriately pre-treated and preserved containers and within specified holding times.

7.3 Assessment of Data Quality

Based on the outcomes of the DQO process the quality of the data collected in accordance with the WQMP should be assessed according to a range of factors including:

- documentation and data completeness
- data comparability, representativeness and precision and accuracy for sampling and analysis.

The relevant evaluation criteria for each of these issues are presented in Table 19.

Table 19 DQO Evaluation

DQO	Evaluation Criteria
Documentation Completeness	Site conditions properly described
	Investigation area properly described
	Understanding of site history and chemicals of interest presented
	Sampling locations properly described and accurately located
Data Completeness	Samples tested for appropriate chemicals of interest
	Completion of field records, chain of custody forms, laboratory sample receipt and test certificates from NATA registered laboratories.
	Consideration of key receptors of interest
	Monitoring strategies assessed and preferred selection based upon site specific factors

DQO	Evaluation Criteria
Data Comparability	Appropriate sampling techniques, sample storage and transportation of samples used
	Selection of NATA certified laboratory using NEPM testing procedures
	Inter-laboratory duplicate samples
Data Representativeness	Collection of representative samples (and adequate numbers) from each location
	Use of properly trained field personnel
	Assessment of the RPD for laboratory and field duplicate samples (
	Assessment of the analytical results for laboratory quality control samples

Table 20 Acceptance criteria for data quality indicators water analysis

Data Quality Indicator	Acceptance Criteria
Intra laboratory field duplicates (1) (3)	RPD presented in laboratory quality assurance reports.
Laboratory duplicates (2) (3)	RPD less than: 20% for high level laboratory duplicates (i.e. >20 x LOR) 50% for medium level laboratory duplicates (i.e. 10 to 20 x LOR)
Matrix spikes (3) (4)	Recoveries between 70-130% of the theoretical recovery
Method blanks	Less than the laboratory LOR
Laboratory control samples (5)	Recoveries between 70-130%.
Surrogate spikes	See Note 6

1. Potential exceptions to these criteria may occur where sample variation or heterogeneity, rather than poor laboratory performance, is accountable for the poor reproducibility, or where the results are close to the LOR. This typical RPD range is obtained from AS 4482.1-2005 *Guide to the investigation and sampling of sites with potentially contaminated soil*.

2. If the results are close to the LOR, then higher results will be accepted.

3. Criteria for sample duplicate and matrix spike results assume no sample heterogeneity. If samples are found to be heterogeneous with respect to a particular analyte the above criteria does not apply.

4. Assumes that samples are homogeneous and the background analyte level is less than 20% of the spike level (refer to USEPA Method 8000B). Note that there is no requirement for matrix spikes to pass as certain matrices may preclude recovery of spiked compounds. In this case data will be accepted if LCS data meets the acceptance criteria.

5. 80% of the compounds tested must fall within the control limits. Control limits are dynamic and vary for individual tests as per USEPA Method 8000B.

6. Recoveries for surrogates are test dependent and are based on USEPA Method SW846. Control limits are dynamic and vary for individual tests but are within the criteria described in USEPA Method SW846.

8.0 Contingency Plan

The site's Pollution Incident Response Management Plan (PIRMP) will identify procedures for incidents and immediate response actions. Where appropriate the PIRMP will articulate the Triggers, Actions, and Response in place for the landfill with reference to the trigger values and actions within this WQMP.

This contingency plan outlines the measures to be taken in response to:

- An exceedance of the specified guidance levels described in Table T1 in Appendix A (only where those values are not already naturally exceeding as described in Section 3.0); and/or
- An exceedance or change in concentration compared to the baseline data.

The contingency measures, including assessment monitoring, to be taken in the event groundwater and/or surface water detection monitoring results exceed either the guidance levels or historically reported results (as applicable) are described following.

If surface or groundwater pollution is detected, the Waste Manager will take immediate action to contain the pollution, and prepare a report to the EPA detailing the nature and source of the contamination, any actions taken, and future actions that will be carried out to prevent recurrence. The process for groundwater monitoring, assessment and remediation is shown in Figure 6.

8.1 Contingency Measures

8.1.1 Repeat Sampling

A repeat sample will be collected from the same location at which the exceedance was reported. The sample will be collected as soon as possible following receipt of the elevated result to minimise differences in site conditions which might occur over time.

In addition, repeat samples will also be collected upstream / hydraulic gradient and downstream / hydraulic gradient of the subject sample location.

The objectives of the repeat sampling event are to:

- Validate the reported result and demonstrate that the result, and the observed exceedance(s), can be replicated;
- Define the spatial extent of the observed impact; and
- Assist in defining the source of the observed impact.

In the event that repeat sampling does not validate the original result, consideration will be given to:

- Whether the original result was anomalous; or
- Whether a further repeat sample is warranted;
- Whether the monitoring frequency should be increased to provide for detection of temporal variations not otherwise detected by the current program.
- Whether a program of assessment monitoring is required.

In the event that repeat sampling does validate the original result, a detailed conceptual site model and risk assessment will be undertaken.

8.2 Conceptual Site Model and Risk Assessment

A preliminary conceptual site model has been developed (Figure 4 of WLMP) and considers:

- Potential sources of the identified contamination – including changes in site conditions and activities which could have resulted in the observed impact;
- Potential pathways from the potential source to the observed impact and from the observed impact to potential receptors; and
- Potential receptors of the observed impact.

A risk assessment considering the above pathways will be able to further quantify potential impacts to human and environmental health. Should an increase in risk to Armidale Dumaresq Council be identified (i.e. where contamination is likely to result in unacceptable impacts to human or environmental health), consideration will be given in initiation of corrective action as described by Section 8.3.

Should no increase in risk to Armidale Dumaresq Council be identified, consideration will be given to increasing the frequency of monitoring at the subject location such that any future changes are detected in a timely fashion and proactively managed.

8.3 Corrective Action

Depending on the outcomes of the preceding repeat sampling and risk assessment, corrective actions may be warranted. Corrective actions may include:

- Modification of the existing monitoring program
- Implementation of management or remediation strategies (refer Section 8.2 of the WLMP), as appropriate.

The requirement of corrective action will take into consideration: the degree of trigger value exceedance; nature of the contaminant; and, available historical data. In the case of significant exceedances, potentially resulting from spills or leaking infrastructure, immediate management or remediation responses to mitigate the impacts would be considered.

The selected response is particularly important to surface water exceedances at a site boundary sampling location because of the potential to impact off-site receptors.

8.3.1 Monitoring Program Modification

The purpose of any modification to the monitoring program would be to:

- Refine the conceptual site model prepared in respect of the identified impact, including identification of the contamination source;
- Refine the assessment of risk to Armidale Dumaresq Council related to the identified impact;
- Enable design of appropriate management or remediation measures (determined in consultation with EPA); and
- Identify what parameters may be affecting the analytical results (e.g. an increasing water table that encounters soil contamination not previously affecting groundwater quality).

Modifications to the monitoring program might include:

- Inclusion of additional monitoring well/sampling locations,
- Amending the analytes being assessed,
- Lowering the laboratory detection limits (through collection of additional sample, modification of analysis methodology),
- Increasing the frequency of sample collection.
- Implementation of assessment monitoring.

8.3.2 Management Strategies

If groundwater or subsoil contamination is confirmed, a detailed Groundwater Contamination Remediation Plan would be developed in accordance with the Benchmark Technique Number 9.

Procedures to deal with a contamination incident could include techniques such as:

- Modification of current work practices or provision of improved waste management facilities to minimise the future risk of spills and impact to surface water or groundwater.
- Active remediation, such as removal of the primary contaminant source (for example a leaking cell liner) and secondary source (for example impacted soil surrounding the cell liner). Measures may include:
    - Isolation of the source of the contaminant.

ξ Immobilisation of the contaminant.

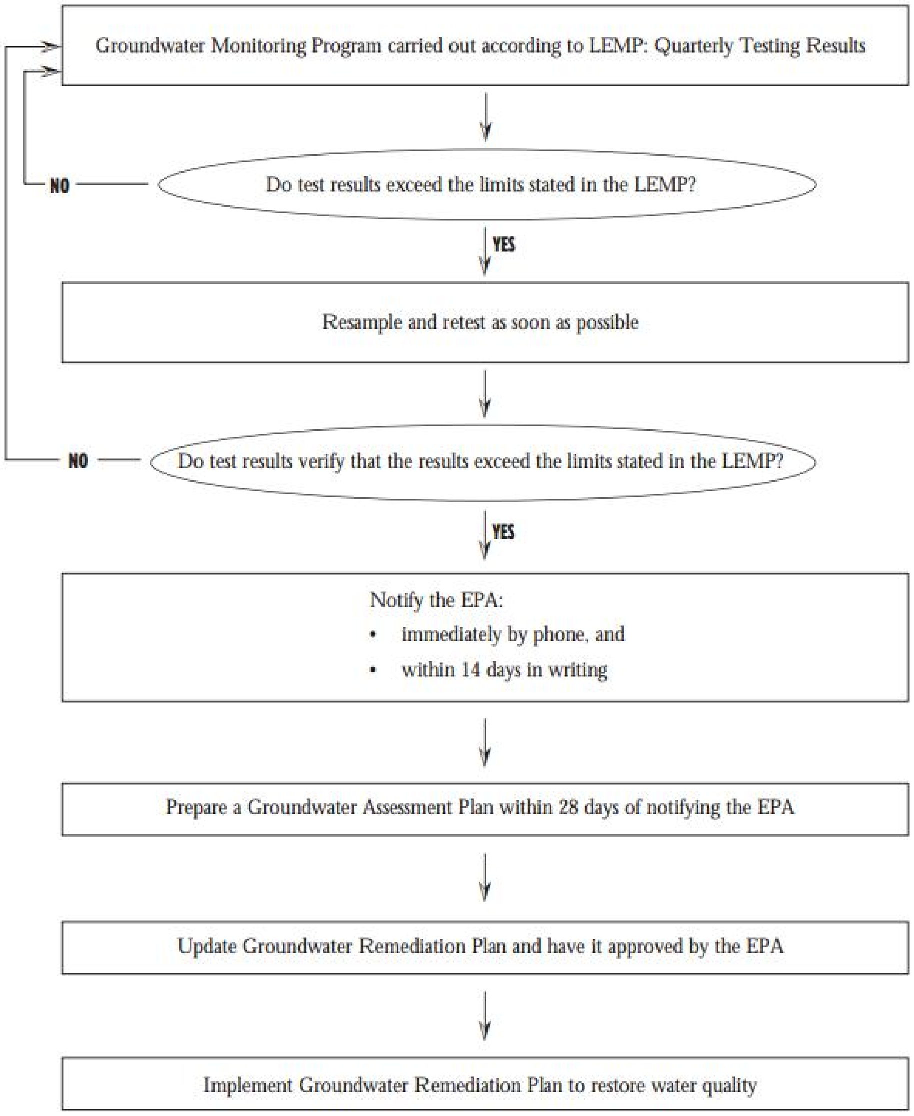
ξ Installation of cut-off bunds, barrier walls or cut-off trenches.

ξ Excavation and repair of capping/liner.

ξ Groundwater extraction, treatment and reinjection.

- Institutional controls, such as fencing, establishment of a groundwater exclusion zone, or implementation of a site management plan, to limit access to identified impact.
- Preparation of a report to the EPA detailing the nature and source of the contamination, any actions taken, and future actions that will be carried out to prevent recurrence.

Techniques implemented will be dependent upon the extent and nature of any contamination incident. Consultation on management techniques is to be undertaken with EPA and DPI Water where required, to achieve the best environmental outcome. Where appropriate, DPI Water should be issued a copy of the Groundwater Assessment and Remediation Plans.



Source: EPA Landfill Guidelines

Figure 6 Process for Groundwater Monitoring, Assessment and Remediation

9.0 Review and Continual Improvement

9.1 Frequency of Review

In accordance with Condition 5 / Schedule 5 of the Conditions of Approval, within three months of a report submission to the Secretary, including the annual report, incident report and independent environmental audit, this WQMP shall be reviewed, and if necessary revised to the satisfaction of the Secretary.

The review would assess all information relevant to the WQMP including but not limited to:

- Historical analytical data
- Changes in land use
- Changes in extraction water use (where applicable)
- Changes in water use (e.g. for recreational activities)
- Changes in guideline criteria
- Outcomes of new environmental assessments
- New contamination issues.

The WQMP would need to be modified to reflect any variation in sampling frequency, addition of new sampling locations or variation in the analytical regime for example, from a new contamination issue being identified on site).

The WQMP would be viewed as a live document and updated as necessary, noting that revision of the WQMP may result in the monitoring regime increasing or decreasing.

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Appendix A

Water Quality Environmental Value Criteria

Appendix A Water Quality Environmental Value Criteria

Table T1: Water Quality Targets - New South Wales / Rivers Upland (µg/L)

Indicator (µg/L)	Environmental Value					
	Aquatic Ecosystem Protection	Recreation	Drinking Water	Livestock Drinking Water	Irrigation (long term targets)	Aquaculture
Total Nitrogen (µg/L as N)	250				5,000	
Nitrogen Oxides (NO_x) (µg/L as N)	15					
Nitrate (µg/L as N)		5,000 *	50,000** (health)	400,000 (health)		50,000
Nitrite (µg/L as N)		300** (primary contact)	3,000** (health)	30,000 (health)		100
Ammonia (µg/L as N)		50 (primary contact)	500 (aesthetic)			20 (pH>8.0)
Total Phosphorus (µg/L as P)	20				50	
Filterable Reactive Phosphate (FRP) (µg/L as P)	15					
Phosphates (µg/L as P)						100
Turbidity (NTU)	2-25***	>1.6 m Secchi depth (primary contact)	5 (aesthetic)	6,000^^^		40 mg/L TSS^
Salinity (µS/cm)	30-350^^					4,500
Sodium (µg/L)		18,000 (primary contact)	180,000 (aesthetic)		115,000#	
Chloride (µg/L)		25,000 (primary contact)	250,000 (aesthetic)		175,000#	
Dissolved Oxygen	<80%					
pH	6 – 8.5					

Notes:

Nitrogen (total nitrogen, ammonia, NOx, nitrate, nitrate) values as µg/L N, except:

* Nitrate as µg/L $N0_3$

** Nitrite as µg/L $N0_2$

*** High turbidity values apply to high flows

^ TSS – Total Suspended Solids

^^ Low values in Highlands; High values in NSW

^^^ Beef cattle, No effect (see Water Quality Targets On-line for other receptors)

Prevention of foliar Injury – most sensitive species

Table T2: ANZECC trigger values for freshwater aquatic ecosystems 95% level of protection for slight to moderately disturbed systems (µg/L)

Chemical	Trigger values for freshwater (µ g/L)
METALS & METALLOIDS	
Aluminium (pH>6.5)	55
Aluminium (pH<6.5)	0.8
Antimony	9
Arsenic (As III)	24
Arsenic (As V)	13
Beryllium	0.13
Bismuth	0.7
Boron	370
Cadmium	0.2
Chromium (Cr III)	3.3
Chromium (Cr VI)	1
Cobalt	2.8
Copper	1.4
Gallium	18
Iron	300
Lanthanum	0.04
Lead	3.4
Manganese	1900
Mercury (inorganic)	0.06
Mercury (methyl)	ID
Molybdenum	34
Nickel	11
Selenium (Total)	5
Selenium (Se IV)	11
Silver	0.05
Thallium	0.03
Tin (inorganic,Sn IV)	3
Tributyltin (as µg/L Sn)	0.002
Uranium	0.5
Vanadium	6
Zinc	8
NON-METALLIC INORGANICS	
Ammonia	900
Chlorine	3

Chemical	Trigger values for freshwater (μ g/L)
Cyanide	7
Nitrate	700
Hydrogen sulfide	1
ORGANIC ALCOHOLS	
Ethanol	1400
Ethylene glycol	330
Isopropyl alcohol	4200
CHLORINATED ALKANES	
Chloromethanes	
Dichloromethane	4000
Chloroform	370
Carbon tetrachloride	240
Chloroethanes	
1,2-dichloroethane	1900
1,1,1-trichloroethane	270
1,1,2-trichloroethane	6500
1,1,2,2-tetrachloroethane	400
Pentachloroethane	80
Hexachloroethane	290
Chloropropanes	
1,1-dichloropropane	500
1,2-dichloropropane	900
1,3-dichloropropane	1100
CHLORINATED ALKENES	
Chloroethylene	100
1,1-dichloroethylene	700
1,1,2-trichloroethylene	330
1,1,2,2-tetrachloroethylene	70
3-chloropropene	3
1,3-dichloropropene	0.1
ANILINES	
Aniline	8
2,4-dichloroaniline	7
2,5-dichloroaniline	3
3,4-dichloroaniline	3
3,5-dichloroaniline	1

Chemical	Trigger values for freshwater (μ g/L)
Benzidine	2.5
Dichlorobenzidine	0.5
AROMATIC HYDROCARBONS	
Benzene	950
Toluene	180
Ethylbenzene	80
o-xylene	350
m-xylene	75
p-xylene	200
m+p-xylene	ID
Cumene (*i*-propyl benzene)	30
Polycyclic Aromatic Hydrocarbons	
Naphthalene	16
Anthracene	0.4
Phenanthrene	2
Fluoranthene	1.4
Benzo(a)pyrene	0.2
Nitrobenzenes	
Nitrobenzene	550
1,2-dinitrobenzene	0.6
1,3-dinitrobenzene	13
1,4-dinitrobenzene	0.6
1,3,5-trinitrobenzene	4
1-methoxy-2-nitrobenzene	130
1-methoxy-4-nitrobenzene	16
1-chloro-2-nitrobenzene	15
1-chloro-3-nitrobenzene	12
1-chloro-4-nitrobenzene	1
1-chloro-2,4-dinitrobenzene	4
1,2-dichloro-3-nitrobenzene	15
1,3-dichloro-5-nitrobenzene	3
1,4-dichloro-2-nitrobenzene	10
2,4-dichloro-2-nitrobenzene	12
1,2,4,5-tetrachloro-3-nitrobenzene	0.3
1,5-dichloro-2,4-dinitrobenzene	0.03
1,3,5-trichloro-2,4-dinitrobenzene	0.2

Chemical	Trigger values for freshwater (μ g/L)
1-fluoro-4-nitrobenzene	28
Nitrotoluenes	
2-nitrotoluene	110
3-nitrotoluene	75
4-nitrotoluene	120
2,3-dinitrotoluene	0.3
2,4-dinitrotoluene	16
2,4,6-trinitrotoluene	140
1,2-dimethyl-3-nitrobenzene	4
1,2-dimethyl-4-nitrobenzene	16
4-chloro-3-nitrotoluene	1.5
Chlorobenzenes and Chloronaphthalenes	
Monochlorobenzene	55
1,2-dichlorobenzene	160
1,3-dichlorobenzene	260
1,4-dichlorobenzene	60
1,2,3-trichlorobenzene	3
1,2,4-trichlorobenzene	85
1,3,5-trichlorobenzene	8
1,2,3,4-tetrachlorobenzene	2
1,2,3,5-tetrachlorobenzene	3
1,2,4,5-tetrachlorobenzene	5
Pentachlorobenzene	1.5
Hexachlorobenzene	0.05
1-chloronaphthalene	1.6
Polychlorinated Biphenyls (PCBs) & Dioxins	
Capacitor 21	0.002
Aroclor 1016	0.001
Aroclor 1221	1
Aroclor 1232	0.3
Aroclor 1242	0.3
Aroclor 1248	0.03
Aroclor 1254	0.01
Aroclor 1260	25
Aroclor 1262	50
Aroclor 1268	50

Chemical	Trigger values for freshwater (µ g/L)
2,3,4'-trichlorobiphenyl	0.07
4,4'-dichlorobiphenyl	0.1
2,2',4,5,5'-pentachloro-1,1'-biphenylB	0.2
2,4,6,2',4',6'-hexachlorobiphenyl	0.15
Total PCBs	ID
2,3,7,8-TCDD	0.00001
PHENOLS and XYLENOLS	
Phenol	320
2,4-dimethylphenol	2
Nonylphenol	0.1
2-chlorophenol	340
3-chlorophenol	4.5
4-chlorophenol	220
2,3-dichlorophenol	31
2,4-dichlorophenol	120
2,5-dichlorophenol	3
2,6-dichlorophenol	34
3,4-dichlorophenol	2
3,5-dichlorophenol	4
2,3,4-trichlorophenol	1
2,3,5-trichlorophenol	2
2,3,6-trichlorophenol	2
2,4,5-trichlorophenol	0.5
2,4,6-trichlorophenol	3
2,3,4,5-tetrachlorophenol	0.2
2,3,4,6-tetrachlorophenol	10
2,3,5,6-tetrachlorophenol	0.2
Pentachlorophenol	3.6
Nitrophenols	
2-nitrophenol	2
3-nitrophenol	1
4-nitrophenol	58
2,4-dinitrophenol	45
2,4,6-trinitrophenol	250
ORGANIC SULFUR COMPOUNDS	
Carbon disulfide	20

Chemical	Trigger values for freshwater (μ g/L)
Isopropyl disulfide	8
n-propyl sulfide	20
Propyl disulfide	3
Tert-butyl sulfide	30
Phenyl disulfide	0.1
Bis(dimethylthiocarbamyl)sulfide	10
Bis(diethylthiocarbamyl)disulfide	1
2-methoxy-4H-1,3,2-benzodioxaphosphorium-2-sulfide	2
Xanthates	
Potassium amyl xanthate	0.5
Potassium ethyl xanthate	0.05
Potassium hexyl xanthate	500
Potassium isopropyl xanthate	15
Sodium ethyl xanthate	0.05
Sodium isobutyl xanthate	5
Sodium isopropyl xanthate	0.05
Sodium sec-butyl xanthate	5
PHTHALATES	
Dimethylphthalate	3700
Diethylphthalate	1000
Dibutylphthalate	9.9
Di(2-ethylhexyl)phthalate	1
MISCELLANEOUS INDUSTRIAL CHEMICALS	
Acetonitrile	160
Acrylonitrile	8
Poly(acrylonitrile-co-butadiene-costyrene)	530
Dimethylformamide	1000
1,2-diphenylhydrazine	2
Diphenylnitrosamine	6
Hexachlorobutadiene	0.04
Hexachlorocyclopentadiene	0.05
Isophorone	120
ORGANOCHLORINE PESTICIDES	
Aldrin	0.001
Chlordane	0.03
DDE	0.03

Chemical	Trigger values for freshwater (μ g/L)
DDT	0.006
Dicofol	0.5
Dieldrin	0.01
Endosulfan	0.03
Endosulfan alpha	0.0002
Endosulfan beta	0.007
Endrin	0.01
Heptachlor	0.01
Lindane	0.2
Methoxychlor	0.005
Mirex	0.04
Toxaphene	0.1
ORGANOPHOSPHORUS PESTICIDES	
Azinphos methyl	0.01
Chlorpyrifos	0.01
Demeton	0.04
Demeton-S-methyl	4
Diazinon	0.01
Dimethoate	0.15
Fenitrothion	0.2
Malathion	0.05
Parathion	0.004
Profenofos	0.02
Temephos	0.05
CARBAMATE & OTHER PESTICIDES	
Carbofuran	0.06
Methomyl	3.5
S-methoprene	0.2
PYRETHROIDS	
Deltamethrin	0.0001
Esfenvalerate	0.001
HERBICIDES & FUNGICIDES	
Bypyridilium herbicides	
Diquat	1.4
Paraquat	0.5
Phenoxyacetic acid herbicides	

Chemical	Trigger values for freshwater (μ g/L)
MCPA	1.4
2,4-D	280
2,4,5-T	36
Sulfonylurea herbicides	
Bensulfuron	800
Metsulfuron	8
Thiocarbamate herbicides	
Molinate	3.4
Thiobencarb	2.8
Thiram	0.01
Triazine herbicides	
Amitrole	22
Atrazine	13
Hexazinone	75
Simazine	3.2
Urea herbicides	
Diuron	0.2
Tebuthiuron	2.2
Miscellaneous herbicides	
Acrolein	0.01
Bromacil	180
Glyphosate	370
Imazethapyr	240
Ioxynil	0.4
Metolachlor	0.02
Sethoxydim	2
Trifluralin	2.6
GENERIC GROUPS OF CHEMICALS	
Surfactants	
Linear alkylbenzene sulfonates (LAS)	280
Alcohol ethoxyolated sulfate (AES)	650
Alcohol ethoxylated surfactants (AE)	140
Oils & Petroleum Hydrocarbons	ID
Oil Spill Dispersants	
BP 1100X	25
Corexit 7664	16

Chemical	Trigger values for freshwater (μ g/L)
Corexit 8667	1200
Corexit 9527	1100
Corexit 9550	140

Trigger values are for the 95% level of protection for slight to moderately disturbed systems where available, exceptions are highlighted as below:

▨	99% level of protection (recommended where chemical may bioaccumulate or 95% provides inadequate protection for test species).
🟨	low reliability trigger value (due to insufficient data), to be used only as an indicative interim working level
🟧	Environmental Concern Level (ECL), to be used only as an indicative interim working level, see ANZECC (2000) 8.3.4.5
🟩	other source
ID	insufficient data

Appendix B

Ambient Surface Water Monitoring Report - July 2015

Helping You Protect Your Environment

AMBIENT
SURFACE WATER MONITORING
REPORT

ARMIDALE REGIONAL LANDFILL

May 2015

Revision 1

for Armidale Dumaresq Council

CodyHart Consulting Pty Ltd ACN: 076 662 989 ABN: 23 809 060 895
Trading as CodyHart Environmental
Groundwater and Landfill Environmental Monitoring Specialists

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Presented by: Barbara Hart
Hydrogeologist & Environmental Scientist
Master of Environmental and Community Health
Master of Science in Hydrogeology and Groundwater Management

Date: 25 May 2015
Report: CodyHart 15.2119.1

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1. INTRODUCTION

The focus of this first initial environmental monitoring report (EMR) for the Armidale Regional Landfill site has been:

- A round of baseline ambient surface water monitoring conducted in May 2015 by CodyHart Environmental. Analyses were performed by Australian Laboratory Services (ALS) at their Brisbane laboratory.
- Fourteen earlier baseline monitoring rounds conducted by Armidale Dumaresq Council. The water was analysed by Lanfax Laboratory, Armidale, and the Australian Government National Measurement Institute, Sydney.

The baseline ambient surface water monitoring results are summarised in tables of this report so that their concentrations and values over time can be easily reviewed.

Interpretation of the results to date and recommendations for future ambient surface water monitoring are provided.

2. OBJECTIVE

The objective of the baseline ambient surface water monitoring program for the Armidale Regional Landfill is

> *to detect any pollution of off-site surface water bodies by leachate or by sediment-laden stormwater from the landfill.* (NSW EPA, 2015, p. 25)

3. SAMPLING LOCATIONS

Two maps and one satellite composite are provided to show the six (6) locations of the ambient surface water sampling points for baseline monitoring (GARA1, GARA2, GARA3, GARA4, GARA5, GARA6).

- Figure 1 is an expansive view to show where the surface water sampling points are located in relation to the water courses that flow into the Gara River.
- Figure 2 is a closer view that frames the six surface water sampling points, GARA1 to GARA6.
- Figure 3 is a composite of close satellite clips for each location.

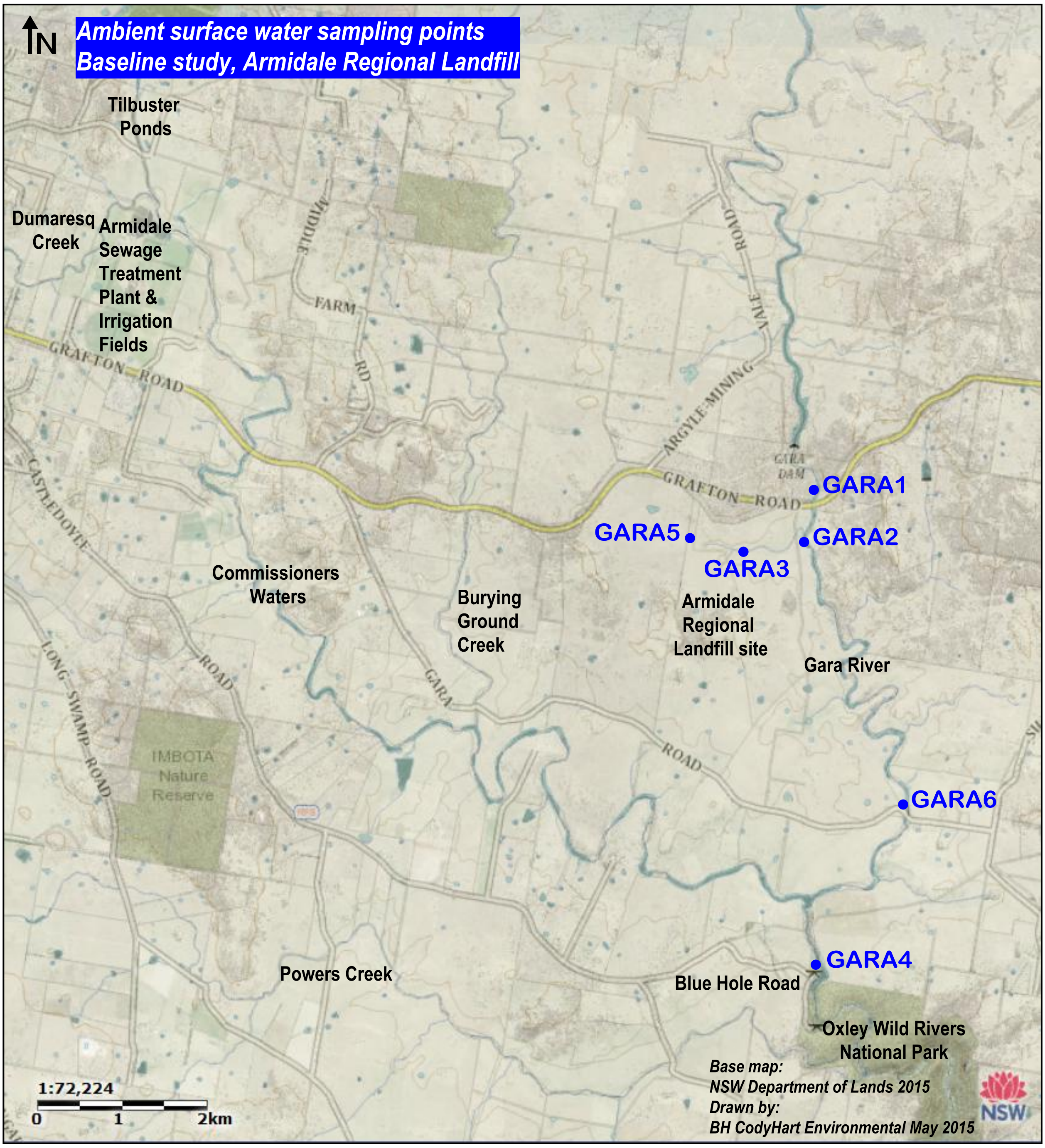
The base maps and the satellite images are from the NSW Department of Land Spatial Information eXchange (SIX) mapping program.

The sampling points going forward to the detection monitoring phase will be:

- GARA5 upstream from the landfill in the landfill site ephemeral stream
- GARA3 immediately downstream from the landfill in the landfill site ephemeral stream, and
- GARA2 in the Gara River, just downstream of the confluence of the Gara River and the ephemeral stream that passes through the landfill site. (Figure 4, p. 36)

The other ambient surface water sampling points, GARA1, GARA4 and GARA6, all on the Gara River, were included as precautionary measures for the baseline monitoring phase. GARA1 and GARA6, or upstream and downstream substitutes, will be reinstated if contamination is suspected at GARA2.

Figure 1: Baseline study, ambient surface water sampling locations - expansive view



Coordinates of the surface water sampling points were ascertained using a Sunnto X9 GPS wrist watch which is accurate to one metre. The UTM readings obtained were then matched with GDA94 coordinates on the NSW Department of Lands spatial information exchange (SIX) map.

Figure 2: Baseline study, ambient surface water sampling locations – closer view

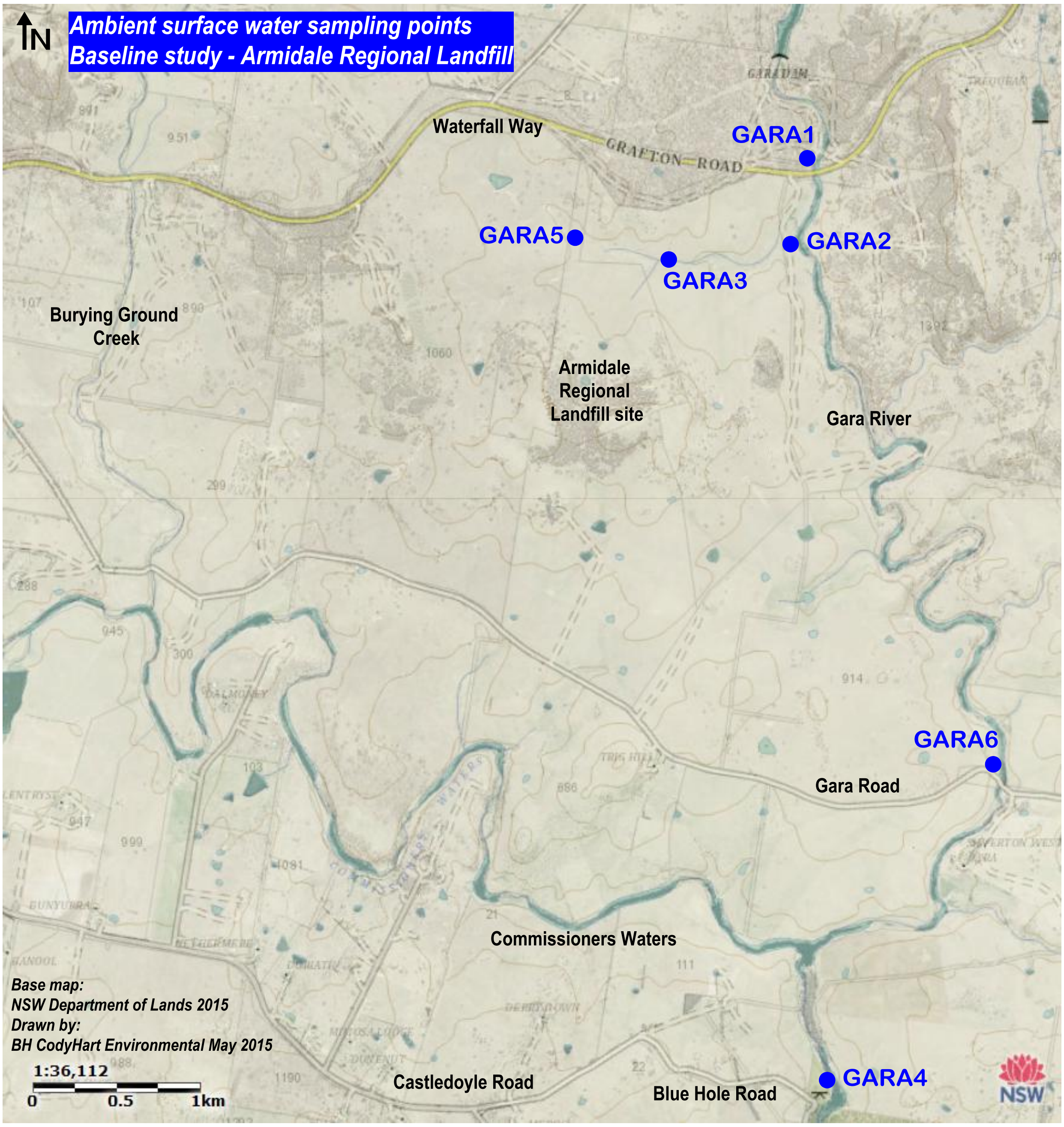


Figure 3: Baseline study ambient surface water sampling points – SIX satellite views

Base satellite views – SIX, NSW Dept of Lands 2015

4. WATER SAMPLING FIELD WORK – MAY 2015

Sampling was conducted on 4 May 2015 at all six ambient surface water sampling points: GARA1, GARA2, GARA3, GARA4, GARA5 and GARA6 according to the standard operating procedure (SOP) devised by CodyHart Environmental using Australian and international standards and guidelines.

The TPS 90FLT field lab used by CodyHart Environmental to take field dissolved oxygen (DO), electrical conductivity (EC), pH, redox potential (Eh), temperature and turbidity readings was calibrated so that sampling was conducted within a few hours of calibration.

Sampling point locations are displayed on Figures 1 to 3.

Samples were collected in a decontaminated beaker on the end of a three metre extension pole. Using an extension pole means that a more representative sample can be reached.

Two field parameter samples were taken, and the values noted on the field parameter form (Appendix A). Sample bottles were filled in order from the most volatile analyte being sampled to the least volatile.

After collection, the samples were immediately put on ice in a chilled esky. The samples were transported in an iced esky to reach the ALS laboratory well within holding times.

An anemometer, thermometer and compass were used to determine air temperature, wind speed and wind direction and their values were noted on each field parameter form (Appendix A).

5. WATER MONITORING QUALITY ASSURANCE – MAY 2015

A number of techniques are used in an endeavour to assure a high quality of sampling and analyses.

- Calibration of the TPS 90FLT field lab was documented. A certificate is provided in Appendix B.
- Sampling procedures documented by in the CodyHart Environmental SOP were followed. These included tests of deionised water and field blanks to assure proper decontamination of equipment.
- Relative percentage differences (RPDs) of field parameters were reviewed. None exceeded a RPD of 20%. (RPD is a standard method of assessing the variability of duplicate samples, in this case the two separate surface water samples. It quantifies the precision and reproducibility of the data.)
- Lack of tampering with the samples on their way to the laboratory is documented through Chain of custody (COC) forms, the transport company's consignment note system, and through the laboratory's sample receipt notification (SRN). The COCs and SRNs are provided in Appendix B. The COC was sealed within the cooler. Security seals, the courier company's consignment notes, and the laboratory's sample receipt notification suffice as evidence of non-tampering with samples. Two courier companies were used: TNT overnight express for the microbial samples to meet the 24 hour holding time requirements by reaching the laboratory by 10:00 am the next morning; and Tamex for next afternoon delivery by road transport for the bulk of the samples whose holding times were not as urgent. Unfortunately, TNT Express did not transit the samples through their

Sydney depot that evening as contracted. SRN for EB1518177 shows the holding time breach. Transport is problematic from regional towns to larger city laboratories that are capable of conducting all the analyses.

- Australian Laboratory Services (ALS), Stafford, Brisbane, conducted the majority of laboratory analyses. They are a global, Australian company who analyses a broad range of analytes and provide good service. In addition to the certificate of analysis and analytical results, ALS provide quality control reports for laboratory duplicates, method blank and laboratory control samples, and matrix spikes; and a QA/QC Compliance Assessment for a data quality objective (DQO) report that summarises the quality assurance findings (Appendix C). The recovery of a laboratory control spike for an organophosphorus pesticide was less than its lower control value. Then there was the holding time breach for the microbial samples. There were no other untoward quality control issues.
- CodyHart conducted laboratory analyses (yellow sheet, Appendix C) that are best conducted on fresh samples – using an APHA (1998) titration method for alkalinity and free carbon dioxide (CO_2).
- The CodyHart sampling team took duplicate samples (GARA-DUP) as split samples (both duplicate and original from one container) at GARA2. Analyses were conducted for all the inorganic analytes tested at GARA2 and for organics TPH and BTEX. The values were within the ALS quality control duplicate criteria values, that is:

  Result < 10 times LOR: No Value; Result between 10 and 20 times LOR: 0% - 50%; Result > 20 times LOR: 0% - 20%. (LOR = Value of reporting)

6. WATER QUALITY RESULTS TO DATE

All results to date are tabled on portrait tables which allow a quick comparison of each parameter and analyte's historical results over time by looking down each column. Maximum historical results are coloured red and highlighted yellow; and minimum historical results are green and underlined. This makes it easier on the eye to review the latest result against historical results.

Some results have been converted from µg/L to mg/L so that all results are in mg/L. This minimises confusion in regard to the concentrations. In addition, some concentrations from the Lanfax Laboratory have been rounded off so that they match the ongoing number of decimal places used by ALS Laboratory, Brisbane.

Appendix C has a copy of the detailed laboratory results for this monitoring round, which include the laboratory QC and DQO assessment reports. The CodyHart field analysis results for alkalinity and free CO_2 follow the QC reports.

Photograph 1: Ambient surface water sampling point GARA1 looking south

GARA1 E 56 384741.0 N 6620301.0

Table 1: Field parameters, water level, flow, sediment, carbon, nutrients – Surface water GARA1

GARA1	***Field parameters***					***Depth, flow & sediment***				***Carbon***				***Nutrients***				
	DO	**EC**	**pH**	**Eh**	**Temp**	**D**	**VFR**	**Turb**	**SS**	**Alk**	**Free CO_2**	**CO_2 + Alk**	**TOC**	**NH_3**	**NO_3 / NO_x**	**TKN**	**TotN**	**TotP**
Measure	mg/L	µS/cm	1-14	mV	°C	m	kL/day	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L	mg/L
Reporting Value	0.01	1	0.01	1	0.1	0.01	1	0.1	1-2	1	1	1	1	0.01 -0.2	0.001-0.01	0.01 -0.1	0.01 -0.1	0.001-0.01
17/12/08	8.51	280	7.13	+267	25.9	NT	NT	NT	3	145	NT	NT	NT	<0.20	0.06	0.6	0.6	0.04
28/01/09	7.64	305	7.62	+267	24.9	NT	NT	NT	5	153	NT	NT	NT	<0.20	0.22	0.6	0.8	0.14
10/03/09	5.77	215	6.19	+266	22.6	NT	NT	NT	10	87	NT	NT	NT	<0.20	0.16	0.6	0.7	0.15
18/05/10	7.01	355	7.57	NT	6.4	NT	NT	NT	4	154	NT	NT	NT	0.13	0.10	0.3	0.4	0.09
09/06/10	6.50	337	7.54	NT	8.8	NT	NT	NT	<2	180	NT	NT	NT	0.13	0.12	<0.2	0.1	0.09
07/09/10	5.92	295	7.54	NT	13.3	NT	NT	NT	2	150	NT	NT	NT	0.08	0.07	0.3	0.4	0.02
07/12/10	5.32	240	7.74	NT	20.0	NT	NT	NT	10	118	NT	NT	NT	<0.02	0.01	1.7	1.7	0.09
31/05/11	3.85	368	7.77	NT	9.5	NT	NT	NT	5	190	NT	NT	NT	0.12	0.22	<0.2	0.2	0.37
16/08/11	5.20	325	8.05	NT	9.3	NT	NT	NT	3	157	NT	NT	NT	<0.02	0.11	0.6	0.7	0.49
22/11/11	5.45	223	7.47	NT	22.0	NT	NT	NT	3	101	NT	NT	NT	<0.20	0.19	0.3	0.5	0.09
10/04/12	5.70	320	7.72	NT	15.8	NT	NT	NT	3	167	NT	NT	NT	<0.01	0.42	0.5	0.9	<0.01
27/08/12	8.57	305	7.95	NT	10.9	NT	NT	NT	<2	170	NT	NT	NT	0.01	0.32	0.3	0.6	0.17
27/11/12	5.84	144	6.92	NT	19.2	NT	NT	NT	20	35	NT	NT	NT	<0.10	0.36	<0.1	0.4	0.28
05/06/13	7.57	685	7.70	NT	7.9	NT	NT	NT	5	180	NT	NT	NT	<0.20	0.17	0.6	0.7	0.26
04/05/15	6.61	300	7.94	+172	16.3	0.35	37800	26.9	13	117	15	27	15	0.06	0.02	1.7	1.7	0.08

Abbreviations: DO = Dissolved Oxygen; EC = Electrical Conductivity also called specific conductance; Eh = Redox Potential; Temp = Temperature; D = Approximate depth of water at sampling point; VFR = Volumetric Flow Rate; Turb = Turbidity; SS = Suspended Solids; Alk = Alkalinity measured as mg/L $CaCO_3$ equivalent; Free CO_2 = Free carbon dioxide; Unfiltered C of (CO_2 + Alk) = 12/44 CO_2 + 12/61 Alk; TOC = Total Organic Carbon; NH_3 = Ammonia as a measure of ammonium ions; NO_3 = Nitrate; NO_x = Nitrite + Nitrate; TKN = Total Kjeldahl Nitrogen (organic nitrogen and ammonia); Tot N = Total Nitrogen; Tot P = Total Phosphorus; NT = Not tested.
Note. From May 2015 onwards, CodyHart and ALS results, and NO_x rather than NO_3.

Table 2: Metals & metalloids – Surface water GARA1

GARA1	**Al**	**Sb**	**As**	**Cd**	**Cr**	**Cu**	**Ni**	**Pb**	**Se**	**Zn**	**Mn**	**Fe**	**Hg**
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	0.005-0.01	0.001	0.001	0.001-0.0001	0.001	0.001	0.001	0.001	0.001-0.01	0.001-005	0.001-0.005	0.005-0.01	0.0001
17/12/08	**0.025**	NT	**0.004**	**<0.001**	**<0.001**	**<0.001**	**0.002**	**<0.001**	**<0.001**	**<0.001**	**0.001**	**0.188**	**<0.0001**
28/01/09	**<0.005**	NT	**0.004**	**<0.001**	**<0.001**	**<0.001**	**0.003**	**<0.001**	**<0.001**	**<0.001**	**<0.005**	**0.096**	**<0.0001**
10/03/09	**0.192**	NT	**0.005**	**<0.001**	**<0.001**	**0.001**	**0.002**	**<0.001**	**<0.001**	**<0.001**	**<0.005**	**0.252**	**<0.0001**
18/05/10	**1.300**	NT	**0.001**	**<0.0001**	**<0.001**	**<0.001**	**0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.005**	**4.480**	**<0.0001**
09/06/10	**<0.005**	NT	**0.002**	**<0.0001**	**<0.001**	**<0.001**	**0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.005**	**0.024**	**<0.0001**
07/09/10	**<0.005**	NT	**0.002**	**<0.0001**	**<0.001**	**0.002**	**0.003**	**<0.001**	**<0.001**	**0.014**	**0.021**	**0.099**	**<0.0001**
07/12/10	**<0.005**	NT	**0.004**	**<0.0001**	**<0.001**	**0.006**	**0.003**	**<0.001**	**<0.001**	**0.010**	**0.015**	**0.199**	**<0.0001**
31/05/11	**0.040**	NT	**0.001**	**<0.0001**	**0.026**	**0.001**	**0.002**	**<0.001**	**<0.001**	**<0.001**	**<0.005**	**<0.005**	**<0.0001**
16/08/11	**<0.005**	NT	**0.002**	**<0.0001**	**<0.001**	**0.001**	**0.002**	**<0.001**	**<0.001**	**<0.001**	**0.019**	**0.173**	**<0.0001**
22/11/11	**0.411**	NT	**0.003**	**<0.0001**	**0.001**	**0.002**	**0.002**	**<0.001**	**<0.001**	**<0.001**	**<0.005**	**0.346**	**<0.0001**
10/04/12	**<0.005**	NT	**0.002**	**<0.0001**	**<0.001**	**0.001**	**0.002**	**<0.001**	**<0.001**	**0.002**	**0.040**	**0.060**	**<0.0001**
27/08/12	**0.014**	NT	**0.001**	**<0.0001**	**<0.001**	**0.001**	**0.002**	**<0.001**	**<0.001**	**<0.001**	**0.011**	**0.015**	**<0.0001**
27/11/12	**1.490**	NT	**0.002**	**<0.0001**	**<0.001**	**0.003**	**0.002**	**<0.001**	**<0.001**	**0.004**	**0.055**	**<0.010**	**<0.0001**
05/06/13	**<0.005**	NT	**0.002**	**<0.0001**	**<0.001**	**<0.001**	**0.002**	**<0.001**	**<0.001**	**<0.001**	**0.050**	**0.161**	**<0.0001**
04/05/15	0.020	<0.001	0.002	<0.0001	<0.001	0.001	0.001	<0.001	<0.010	<0.005	0.046	0.230	<0.0001

Abbreviations: Al = Aluminium; Sb = Antimony; As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Ni = Nickel; Pb = Lead; Se = Selenium; Zn = Zinc; Mn = Manganese; Fe = Iron; Hg = Mercury; NT = Not tested; Bold result = unfiltered.
Notes. CodyHart and ALS results from May 2015 onwards. Metals not filtered and analysed for total metals until May 2015.

Table 3: Extra laboratory analytes and parameters A – baseline only – Surface water GARA1

GARA1	*TDS, anions & cations, boron, reactive phosphorus, microbial*														
	TDS	**Ca**	**Mg**	**Na**	**K**	**SAR**	**Hard**	**Fl**	**Cl**	**S**	**Br**	**B**	**RP**	***E.Coli***	**Enterococci**
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	ratio	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100mL	CFU/100mL
Reporting Value	1	0.1	0.1	0.1	0.01-0.1	0.1	1	0.001	0.01	0.01	0.005-0.01	0.005-0.01	0.005-0.01	1	1
17/12/08	188	22.0	19.8	11.2	2.6	0.4	136	0.159	9.1	1.43	<0.010	<0.005	0.035	NT	NT
28/01/09	205	20.2	11.9	12.9	1.9	0.6	99	0.226	10.8	1.34	<0.005	<0.005	0.028	NT	NT
10/03/09	144	13.0	10.7	12.5	4.3	0.6	77	0.128	14.0	3.82	<0.005	0.026	<0.010	NT	NT
18/05/10	238	26.8	21.4	9.6	3.5	0.3	166	0.105	14.3	1.76	<0.005	<0.005	<0.010	NT	NT
09/06/10	226	29.4	26.2	21.8	1.0	0.7	181	0.114	15.2	0.69	<0.005	<0.005	<0.020	NT	NT
07/09/10	198	22.4	18.7	11.4	3.3	0.4	133	0.102	11.4	2.31	<0.005	0.087	<0.005	NT	NT
07/12/10	161	18.9	15.3	9.1	1.6	0.4	110	0.040	5.5	1.69	<0.005	<0.005	0.061	NT	NT
31/05/11	247	23.8	22.6	16.0	1.3	0.6	153	0.164	14.9	2.96	<0.005	<0.005	<0.020	NT	NT
16/08/11	218	25.6	20.8	13.7	1.3	0.5	149	0.104	12.4	3.30	0.840	0.038	0.028	NT	NT
22/11/11	152	14.6	12.8	11.6	0.8	0.5	89	0.165	7.9	3.79	0.671	0.411	<0.005	NT	NT
10/04/12	214	25.5	22.3	13.6	1.3	0.5	155	0.122	10.1	1.52	1.508	0.010	<0.005	NT	NT
27/08/12	204	23.8	20.0	12.8	1.6	0.5	142	0.074	11.8	2.99	0.554	<0.005	0.067	NT	NT
27/11/12	96	8.1	6.4	9.8	0.2	0.6	46	0.084	9.6	6.75	0.108	0.010	0.185	NT	NT
05/06/13	459	26.7	23.1	18.6	2.8	0.6	162	0.113	26.5	3.83	0.010	<0.005	0.037	NT	NT
04/05/15	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	18	22

Abbreviations: TDS = Total Dissolved Solids; Ca = Calcium; Mg = Magnesium; Na = Sodium; K = Potassium; SAR = Sodium Absorption Ratio; Hard = Hardness; Fl = Fluoride; Cl = Chloride; S = Sulphide; Br = Bromine; B = Boron; RP = Reactive Phosphorus; *E. Coli* = Escherichia coli; NT = Not tested; NC = Not continuing. Note. CodyHart and ALS results from May 2015 onwards.

Table 4: Extra laboratory analytes B – baseline only – Surface water GARA1

GARA1	*Organics*							
	PAH	**OC & OP**	**BTEX**	**TPH** C6-C9	**TPH** C10-C14	**TPH** C15-C28	**TPH** C29-C36	Phenols
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	0.00005-0.0001	0.0005-0.002	0.001-0.002	0.025	0.025	0.1	0.1	various
17/12/08	ND	ND	ND	ND	ND	ND	ND	ND
28/01/09	ND	ND	ND	ND	ND	ND	ND	ND
10/03/09	ND	ND	ND	ND	ND	ND	ND	ND
18/05/10	ND	ND	ND	ND	ND	ND	ND	ND
09/06/10	ND	ND	ND	ND	ND	ND	ND	ND
07/09/10	ND	ND	ND	ND	ND	ND	ND	ND
07/12/10	ND	ND	ND	ND	ND	ND	ND	ND
31/05/11	ND	ND	ND	ND	ND	ND	ND	ND
16/08/11	ND	ND	ND	ND	ND	ND	ND	ND
22/11/11	ND	ND	ND	ND	ND	0.240	ND	ND
10/04/12	ND	ND	ND	ND	ND	ND	ND	ND
27/08/12	ND	ND	ND	ND	ND	ND	ND	ND
27/11/12	ND	ND	ND	ND	ND	0.270	0.100	ND
05/06/13	ND	ND	ND	ND	ND	ND	ND	ND
04/05/15	ND (UT)	ND	ND	ND	ND	ND	ND	NC
	NC	NC	NC	NC	NC	NC	NC	NC

Abbreviations:
PAHs = Polynuclear Aromatic Hydrocarbons; BTEX = Benzene, Tolulene, Ethylbenzene, Xylene compounds; TPH = Total Petroleum Hydrocarbons; ND = Nil detected; UT = Ultra trace; NC = Not continuing. Note. CodyHart and ALS results from May 2015 onwards.

Photograph 2: Ambient surface water sampling point GARA2 looking east

GARA2 E 56 384635.0 N 6619865.0

Table 5: Field parameters, water level, flow, sediment, carbon, nutrients – Surface water GARA2

GARA2	Field parameters					Depth, flow & sediment				Carbon				Nutrients				
	DO	EC	pH	Eh	Temp	D	VFR	Turb	SS	Alk	Free CO_2	CO_2 + Alk	TOC	NH_3	NO_3 / NO_x	TKN	TotN	TotP
Measure	mg/L	µS/cm	1-14	mV	°C	m	kL/day	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L	mg/L
Reporting Value	0.01	1	0.01	1	0.1	0.01	1	0.1	1-5	1	1	1	1	0.01 -0.2	0.001-0.01	0.01 -0.1	0.01 -0.1	0.001-0.01
17/12/08	8.54	290	6.59	+262	21.2	NT	NT	NT	3	160	NT	NT	NT	<0.20	0.01	0.6	0.6	0.05
28/01/09	7.27	305	6.80	+277	25.5	NT	NT	NT	3	162	NT	NT	NT	<0.20	0.21	0.6	0.8	0.15
10/03/09	5.52	222	6.27	+271	23.2	NT	NT	NT	10	90	NT	NT	NT	<0.20	0.14	1.1	1.3	0.13
18/05/10	7.25	355	7.76	NT	9.5	NT	NT	NT	8	179	NT	NT	NT	0.24	0.11	0.6	0.7	0.23
09/06/10	6.52	330	7.62	NT	9.1	NT	NT	NT	2	177	NT	NT	NT	0.24	0.12	0.3	0.4	0.05
07/09/10	5.15	295	7.62	NT	13.3	NT	NT	NT	4	151	NT	NT	NT	0.26	0.26	0.8	0.9	0.02
07/12/10	5.07	237	7.56	NT	19.7	NT	NT	NT	10	118	NT	NT	NT	<0.02	0.06	1.7	1.7	0.09
31/05/11	3.32	365	7.74	NT	9.3	NT	NT	NT	3	185	NT	NT	NT	<0.01	0.22	<0.2	0.2	0.34
16/08/11	3.88	325	7.80	NT	8.8	NT	NT	NT	5	159	NT	NT	NT	<0.02	0.12	0.8	1.0	0.45
22/11/11	5.09	222	7.30	NT	22.5	NT	NT	NT	5	103	NT	NT	NT	<0.20	0.20	0.6	0.8	0.10
10/04/12	4.10	325	7.96	NT	16.8	NT	NT	NT	3	180	NT	NT	NT	<0.01	0.54	0.5	1.0	<0.01
27/08/12	7.10	315	7.45	NT	11.6	NT	NT	NT	5	160	NT	NT	NT	0.07	0.33	0.3	0.6	0.20
27/11/12	4.79	140	6.90	NT	19.0	NT	NT	NT	20	32	NT	NT	NT	<0.10	0.35	<0.1	0.3	0.28
05/06/13	7.79	710	7.75	NT	8.4	NT	NT	NT	5	177	NT	NT	NT	<0.20	0.22	0.6	0.8	0.25
04/05/15	6.88	386	8.24	+168	18.1	~≥2.5	16941	3.6	<5	140	12	31	13	0.03	<0.01	0.9	0.9	0.03

Abbreviations: DO = Dissolved Oxygen; EC = Electrical Conductivity also called specific conductance; Eh = Redox Potential; Temp = Temperature; D = Approximate depth of water at sampling point; VFR = Volumetric Flow Rate; Turb = Turbidity; SS = Suspended Solids; Alk = Alkalinity measured as mg/L $CaCO_3$ equivalent; Free CO_2 = Free carbon dioxide; Unfiltered C of (CO_2 + Alk) = 12/44 CO_2 + 12/61 Alk; TOC = Total Organic Carbon; NH_3 = Ammonia as a measure of ammonium ions; NO_3 = Nitrate; NO_x = Nitrite + Nitrate; TKN = Total Kjeldahl Nitrogen (organic nitrogen and ammonia); Tot N = Total Nitrogen; Tot P = Total Phosphorus; NT = Not tested.
Note. From May 2015 onwards, CodyHart and ALS results, and NO_x rather than NO_3.

Table 6: Metals & metalloids – Surface water GARA2

GARA2	**Al**	**Sb**	**As**	**Cd**	**Cr**	**Cu**	**Ni**	**Pb**	**Se**	**Zn**	**Mn**	**Fe**	**Hg**
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	0.005-0.01	0.001	0.001	0.001-0.0001	0.001	0.001	0.001	0.001	0.001-0.01	0.001-005	0.001-0.005	0.005-0.01	0.0001
17/12/08	**<0.005**	NT	**0.003**	**<0.001**	**<0.001**	**<0.001**	**0.002**	**<0.001**	**<0.001**	**<0.001**	**0.001**	**0.188**	**<0.0001**
28/01/09	**<0.005**	NT	**0.004**	**<0.001**	**<0.001**	**<0.001**	**0.003**	**<0.001**	**<0.001**	**<0.001**	**<0.005**	**0.096**	**<0.0001**
10/03/09	**0.288**	NT	**0.006**	**<0.001**	**0.001**	**0.001**	**0.002**	**<0.001**	**<0.001**	**<0.001**	**<0.005**	**0.252**	**<0.0001**
18/05/10	**<0.005**	NT	**0.002**	**<0.0001**	**<0.001**	**<0.001**	**0.021**	**<0.001**	**<0.001**	**<0.001**	**<0.005**	**4.480**	**<0.0001**
09/06/10	**<0.005**	NT	**0.002**	**<0.0001**	**<0.001**	**<0.001**	**0.001**	**<0.001**	**<0.001**	**0.002**	**<0.005**	**0.024**	**<0.0001**
07/09/10	**0.005**	NT	**0.002**	**<0.0001**	**<0.001**	**0.002**	**0.003**	**<0.001**	**<0.001**	**0.014**	**0.021**	**0.099**	**<0.0001**
07/12/10	**0.068**	NT	**0.004**	**<0.0001**	**0.001**	**0.002**	**0.003**	**<0.001**	**<0.001**	**0.010**	**0.015**	**0.199**	**<0.0001**
31/05/11	**<0.005**	NT	**0.001**	**<0.0001**	**<0.001**	**<0.001**	**0.002**	**<0.001**	**<0.001**	**0.001**	**<0.005**	**<0.005**	**<0.0001**
16/08/11	**<0.005**	NT	**0.002**	**<0.0001**	**<0.001**	**0.001**	**0.002**	**<0.001**	**<0.001**	**<0.001**	**0.019**	**0.173**	**<0.0001**
22/11/11	**0.236**	NT	**0.003**	**<0.0001**	**<0.001**	**0.002**	**0.002**	**<0.001**	**<0.001**	**<0.001**	**<0.005**	**0.346**	**<0.0001**
10/04/12	**0.174**	NT	**0.002**	**<0.0001**	**<0.001**	**0.001**	**0.002**	**<0.001**	**<0.001**	**0.002**	**0.040**	**0.060**	**<0.0001**
27/08/12	**<0.005**	NT	**0.001**	**<0.0001**	**<0.001**	**0.001**	**0.002**	**<0.001**	**<0.001**	**<0.001**	**0.011**	**0.015**	**<0.0001**
27/11/12	1.130	NT	**0.002**	**<0.0001**	**<0.001**	**0.003**	**0.002**	**<0.001**	**<0.001**	**0.003**	**0.055**	**<0.010**	**<0.0001**
05/06/13	**<0.005**	NT	**0.001**	**<0.0001**	**<0.001**	**<0.001**	**0.002**	**<0.001**	**<0.001**	**0.001**	**0.050**	**0.161**	**<0.0001**
04/05/15	<0.010	<0.001	0.002	<0.0001	<0.001	0.001	0.001	<0.001	<0.010	<0.005	0.044	0.090	<0.0001

Abbreviations: Al = Aluminium; Sb = Antimony; As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Ni = Nickel; Pb = Lead; Se = Selenium; Zn = Zinc; Mn = Manganese; Fe = Iron; Hg = Mercury; NT = Not tested; Bold result = unfiltered.

Notes. CodyHart and ALS results from May 2015 onwards. Metals not filtered and analysed for total metals until May 2015.

Table 7: Extra laboratory analytes and parameters A – baseline only – Surface water GARA2

GARA2	TDS, anions & cations, boron, reactive phosphorus, microbial														
	TDS	Ca	Mg	Na	K	SAR	Hard	Fl	Cl	S	Br	B	RP	E.Coli	Enterococci
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	ratio	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100mL	CFU/100mL
Reporting Value	1	0.1	0.1	0.1	0.01-0.1	0.1	1	0.001	0.01	0.01	0.005-0.01	0.005-0.01	0.005-0.01	1	1
17/12/08	194	22.0	20.0	11.9	2.6	0.4	138	0.162	10.5	1.40	<0.010	<0.005	0.017	NT	NT
28/01/09	205	20.5	23.1	12.8	1.8	0.5	146	0.181	11.0	1.29	<0.005	<0.005	<0.010	NT	NT
10/03/09	149	13.2	11.1	13.2	4.3	0.6	79	0.114	14.2	3.76	<0.005	10.000	<0.010	NT	NT
18/05/10	238	27.7	23.1	17.6	2.5	0.6	164	0.202	20.3	1.70	<0.005	<0.005	<0.010	NT	NT
09/06/10	221	29.7	25.9	21.4	0.8	0.7	181	0.114	15.6	0.94	<0.005	<0.005	<0.020	NT	NT
07/09/10	198	22.3	18.5	11.4	3.2	0.4	132	0.102	11.7	2.25	<0.005	0.043	<0.005	NT	NT
07/12/10	157	19.0	15.3	8.7	1.5	0.4	110	0.146	5.7	1.71	<0.005	<0.005	0.035	NT	NT
31/05/11	245	24.0	22.9	16.8	1.2	0.6	154	0.187	16.5	3.11	<0.005	<0.005	<0.020	NT	NT
16/08/11	218	26.1	20.7	14.2	1.4	0.5	150	0.103	12.7	3.37	0.850	0.011	0.028	NT	NT
22/11/11	151	15.0	13.1	11.8	0.8	0.5	92	0.172	7.5	3.82	0.792	0.007	0.021	NT	NT
10/04/12	218	26.2	22.8	14.4	1.3	0.5	159	0.120	10.9	1.59	0.005	<0.005	<0.005	NT	NT
27/08/12	211	24.4	20.2	13.8	1.5	0.5	144	0.121	13.8	3.12	0.567	<0.005	0.023	NT	NT
27/11/12	94	7.9	6.3	8.5	0.2	0.6	45	0.081	9.4	6.51	0.121	<0.010	0.164	NT	NT
05/06/13	476	27.4	23.1	21.9	3.0	0.7	163	0.106	21.8	4.24	0.013	0.010	0.027	NT	NT
04/05/15	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	20	16

Abbreviations: TDS = Total Dissolved Solids; Ca = Calcium; Mg = Magnesium; Na = Sodium; K = Potassium; SAR = Sodium Absorption Ratio; Hard = Hardness; Fl = Fluoride; Cl = Chloride; S = Sulphide; Br = Bromine; B = Boron; RP = Reactive Phosphorus; *E. Coli* = Escherichia coli; NT = Not tested; NC = Not continuing.

Table 8: Extra laboratory analytes B – baseline only – Surface water GARA2

GARA2	Organics							
	PAH	OC & OP	BTEX	TPH C6-C9	TPH C10-C14	TPH C15-C28	TPH C29-C36	Phenols
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	0.00005-0.0001	0.0005-0.002	0.001-0.002	0.025	0.025	0.1	0.1	various
17/12/08	ND	ND	ND	ND	ND	ND	ND	ND
28/01/09	ND	ND	ND	ND	ND	ND	ND	ND
10/03/09	ND	ND	ND	ND	ND	ND	ND	ND
18/05/10	ND	ND	ND	ND	ND	ND	ND	ND
09/06/10	ND	ND	ND	ND	ND	ND	ND	ND
07/09/10	ND	ND	ND	ND	ND	ND	ND	ND
07/12/10	ND	ND	ND	ND	ND	ND	ND	ND
31/05/11	ND	ND	ND	ND	ND	ND	ND	ND
16/08/11	ND	ND	ND	ND	ND	0.400	ND	ND
22/11/11	ND	ND	ND	ND	ND	ND	ND	ND
10/04/12	ND	ND	ND	ND	ND	ND	ND	ND
27/08/12	ND	ND	ND	ND	0.120	ND	ND	ND
27/11/12	ND	ND	ND	ND	0.470	0.420	0.180	ND
05/06/13	ND	ND	ND	ND	ND	ND	ND	ND
04/05/15	ND (UT)	ND	ND	ND	ND	ND	ND	NC
	NC	NC	NC	NC	NC	NC	NC	NC

Abbreviations:
PAHs = Polynuclear Aromatic Hydrocarbons; BTEX = Benzene, Tolulene, Ethylbenzene, Xylene compounds; TPH = Total Petroleum Hydrocarbons; ND = Nil detected; UT = Ultra trace; NC = Not continuing. Note. CodyHart and ALS results from May 2015 onwards.

Photograph 3: Ambient surface water sampling point GARA3 looking west

GARA3 E 56 383826.0 N 6619708.0

Table 9: Field parameters, water level, flow, sediment, carbon, nutrients – Surface water GARA3

GARA3	*Field parameters*					*Depth, flow & sediment*				*Carbon*				*Nutrients*				
	DO	**EC**	**pH**	**Eh**	**Temp**	**D**	**VFR**	**Turb**	**SS**	**Alk**	**Free CO_2**	**CO_2 + Alk**	**TOC**	**NH_3**	**NO_3 / NO_x**	**TKN**	**TotN**	**TotP**
Measure	mg/L	µS/cm	1-14	mV	°C	m	kL/day	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L	mg/L
Reporting Value	0.01	1	0.01	1	0.1	0.01	0.1	0.1	1-5	1	1	1	1	0.01 -0.2	0.001- 0.01	0.01 -0.1	0.01 -0.1	0.001- 0.01
17/12/08	6.54	145	6.27	+317	21.2	NT	NT	NT	135	64	NT	NT	NT	<0.20	0.01	2.0	2.0	0.28
28/01/09	9.72	1360	6.95	+272	26.1	NT	NT	NT	40	287	NT	NT	NT	<0.20	0.62	1.1	1.8	0.14
10/03/09	6.11	188	6.11	+264	25.8	NT	NT	NT	70	65	NT	NT	NT	<0.20	0.12	2.0	2.1	0.19
18/05/10	5.66	150	6.36	NT	7.1	NT	NT	NT	85	24	NT	NT	NT	0.31	0.04	0.8	0.9	0.19
09/06/10	6.19	184	6.84	NT	4.6	NT	NT	NT	180	58	NT	NT	NT	0.31	0.05	1.4	1.5	0.57
07/09/10	4.88	92	6.84	NT	8.3	NT	NT	NT	24	29	NT	NT	NT	0.11	0.11	2.0	2.0	0.11
07/12/10	2.47	77	6.32	NT	17.0	NT	NT	NT	22	35	NT	NT	NT	<0.02	0.01	3.1	3.1	0.10
31/05/11	4.00	215	6.97	NT	7.9	NT	NT	NT	43	52	NT	NT	NT	0.15	<0.02	<0.2	0.2	0.31
16/08/11	3.88	325	6.70	NT	11.4	NT	NT	NT	5	159	NT	NT	NT	<0.02	0.12	0.8	1.0	0.45
22/11/11	2.18	107	6.42	NT	23.1	NT	NT	NT	20	43	NT	NT	NT	<0.20	0.14	1.1	1.3	0.05
10/04/12	4.30	170	6.98	NT	11.4	NT	NT	NT	67	59	NT	NT	NT	0.10	0.36	1.6	2.0	<0.01
27/08/12	7.64	660	6.64	NT	13.7	NT	NT	NT	85	40	NT	NT	NT	0.03	0.15	0.9	1.1	0.28
27/11/12	4.08	660	7.20	NT	19.5	NT	NT	NT	440	113	NT	NT	NT	0.21	0.23	7.0	7.2	0.74
05/06/13	4.34	1180	6.52	NT	5.1	NT	NT	NT	87	29	NT	NT	NT	0.50	0.04	2.2	2.3	0.50
04/05/15	6.35	94	7.58	+209	17.9	0.05	259.2	281	65	20	12	7	16	0.04	<0.01	3.4	3.4	0.36

Abbreviations: DO = Dissolved Oxygen; EC = Electrical Conductivity also called specific conductance; Eh = Redox Potential; Temp = Temperature; D = Approximate depth of water at sampling point; VFR = Volumetric Flow Rate; Turb = Turbidity; SS = Suspended Solids; Alk = Alkalinity measured as mg/L $CaCO_3$ equivalent; Free CO_2 = Free carbon dioxide; Unfiltered C of (CO_2 + Alk) = 12/44 CO_2 + 12/61 Alk; TOC = Total Organic Carbon; NH_3 = Ammonia as a measure of ammonium ions; NO_3 = Nitrate; NO_x = Nitrite + Nitrate; TKN = Total Kjeldahl Nitrogen (organic nitrogen and ammonia); Tot N = Total Nitrogen; Tot P = Total Phosphorus; NT = Not tested.
Note. From May 2015 onwards, CodyHart and ALS results, and NO_x rather than NO_3.

Table 10: Metals & metalloids – Surface water GARA3

GARA3	Al	Sb	As	Cd	Cr	Cu	Ni	Pb	Se	Zn	Mn	Fe	Hg
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	0.005-0.01	0.001	0.001	0.001-0.0001	0.001	0.001	0.001	0.001	0.001-0.01	0.001-005	0.001-0.005	0.005-0.01	0.0001
17/12/08	8.740	NT	0.003	<0.001	0.007	0.008	0.006	0.009	<0.001	0.019	0.216	5.370	<0.0001
28/01/09	0.055	NT	0.002	<0.001	<0.001	0.001	0.002	<0.001	<0.001	0.001	<0.005	0.058	<0.0001
10/03/09	16.400	NT	0.002	<0.001	0.005	0.007	0.004	0.003	<0.001	0.011	0.028	7.180	<0.0001
18/05/10	2.720	NT	0.002	<0.0001	0.003	0.003	0.003	0.002	<0.001	0.006	0.015	2.900	<0.0001
09/06/10	41.200	NT	0.003	<0.0001	0.029	0.021	0.018	0.013	<0.001	0.069	<0.005	17.500	<0.0001
07/09/10	3.012	NT	<0.001	<0.0001	0.002	0.004	0.003	<0.001	<0.001	0.020	<0.005	2.046	<0.0001
07/12/10	1.800	NT	0.003	<0.0001	0.002	0.007	0.004	0.003	<0.001	0.015	0.021	5.040	<0.0001
31/05/11	2.610	NT	<0.001	<0.0001	0.002	0.003	0.002	0.001	<0.001	0.006	0.020	1.240	<0.0001
16/08/11	0.012	NT	<0.001	<0.0001	<0.001	0.001	0.001	<0.001	<0.001	<0.001	0.045	0.181	<0.0001
22/11/11	1.294	NT	0.002	<0.0001	0.001	0.003	0.004	<0.001	<0.001	0.004	<0.005	2.478	<0.0001
10/04/12	5.760	NT	0.002	<0.0001	0.006	0.008	0.006	0.005	0.001	0.014	0.070	3.820	<0.0001
27/08/12	0.287	NT	0.002	<0.0001	0.005	0.004	0.004	0.002	<0.001	0.012	0.112	0.058	<0.0001
27/11/12	0.375	NT	0.005	<0.0001	0.006	0.011	0.012	0.008	0.002	0.021	3.420	0.870	<0.0001
05/06/13	1.370	NT	0.002	<0.0001	0.005	0.007	0.006	0.003	0.004	0.021	0.243	0.827	<0.0001
04/05/15	0.720	<0.001	<0.001	<0.0001	<0.001	0.004	0.002	<0.001	<0.010	0.006	0.013	0.840	<0.0001

Abbreviations: Al = Aluminium; Sb = Antimony; As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Ni = Nickel; Pb = Lead; Se = Selenium; Zn = Zinc; Mn = Manganese; Fe = Iron; Hg = Mercury; NT = Not tested; Bold result = unfiltered.
Notes. CodyHart and ALS results from May 2015 onwards. Metals not filtered and analysed for total metals until May 2015.

Table 11: Extra laboratory analytes and parameters A – baseline only – Surface water GARA3

GARA3	*TDS, anions & cations, boron, reactive phosphorus, microbial*														
	TDS	Ca	Mg	Na	K	SAR	Hard	Fl	Cl	S	Br	B	RP	*E.Coli*	Enterococci
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	ratio	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100mL	CFU/100mL
Reporting Value	1	0.1	0.1	0.1	0.01-0.1	0.1	1	0.001	0.01	0.01	0.005-0.01	0.005-0.01	0.005-0.01	1	1
17/12/08	98	9.7	5.7	11.5	3.8	0.7	48	0.218	9.0	0.61	<0.01	<0.005	0.047	NT	NT
28/01/09	910	53.4	57.5	147.0	7.6	3.3	370	0.474	56.0	34.40	0.524	<0.005	<0.010	NT	NT
10/03/09	126	7.9	5.7	21.4	5.4	1.4	43	0.209	23.6	1.73	0.524	<0.005	<0.010	NT	NT
18/05/10	100	4.9	4.7	14.3	4.6	1.1	32	0.115	40.6	0.22	<0.005	<0.005	<0.010	NT	NT
09/06/10	123	8.7	7.8	32.2	5.1	1.9	54	0.156	31.7	1.21	0.672	<0.005	0.123	NT	NT
07/09/10	62	4.9	3.1	8.6	3.1	0.7	25	0.078	10.6	0.34	<0.005	0.016	0.080	NT	NT
07/12/10	52	2.8	3.7	9.5	0.5	0.9	22	0.212	0.9	0.56	<0.005	<0.005	0.070	NT	NT
31/05/11	144	6.9	4.6	27.9	0.6	2.0	36	0.227	45.6	1.09	<0.005	<0.005	<0.020	NT	NT
16/08/11	218	26.1	20.7	14.2	1.4	0.5	150	0.065	77.4	3.37	0.046	0.049	0.028	NT	NT
22/11/11	73	5.9	4.1	7.7	1.1	0.6	32	0.213	6.8	0.59	0.659	<0.005	0.040	NT	NT
10/04/12	114	7.8	7.8	23.0	1.1	1.5	43	0.190	21.9	0.35	0.005	0.010	<0.005	NT	NT
27/08/12	442	31.6	21.1	68.2	1.7	2.3	166	0.137	202.0	11.10	0.603	<0.005	<0.01	NT	NT
27/11/12	442	38.6	23.0	60.2	0.3	1.9	191	0.275	180.0	6.13	1.310	<0.010	0.210	NT	NT
05/06/13	791	24.6	16.4	62.0	9.4	2.4	129	0.117	182.0	9.35	0.329	0.040	0.137	NT	NT
04/05/15	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	85	190

Abbreviations: TDS = Total Dissolved Solids; Ca = Calcium; Mg = Magnesium; Na = Sodium; K = Potassium; SAR = Sodium Absorption Ratio; Hard = Hardness; Fl = Fluoride; Cl = Chloride; S = Sulphide; Br = Bromine; B = Boron; RP = Reactive Phosphorus; *E. Coli* = Escherichia coli; NT = Not tested; NC = Not continuing.

Table 12: Extra laboratory analytes B – baseline only – Surface water GARA3

GARA3	***Organics***							
	PAH	**OC & OP**	**BTEX**	**TPH** C6-C9	**TPH** C10-C14	**TPH** C15-C28	**TPH** C29-C36	Phenols
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	0.00005-0.0001	0.0005-0.002	0.001-0.002	0.025	0.025	0.1	0.1	various
17/12/08	**0.00069** (Phenanthrene)	**0.00029** (trans-Chlordane)	ND	ND	**0.260**	**0.990**	**0.200**	**ND**
28/01/09	**ND**	**ND**	ND	ND	**ND**	**ND**	**ND**	ND
10/03/09	ND	ND	ND	ND	ND	ND	ND	ND
18/05/10	ND	ND	ND	ND	ND	ND	ND	ND
09/06/10	ND	ND	ND	ND	ND	ND	ND	ND
07/09/10	ND	ND	ND	ND	ND	ND	ND	ND
07/12/10	ND	ND	ND	ND	ND	ND	ND	ND
31/05/11	ND	ND	ND	ND	ND	ND	ND	ND
16/08/11	ND	ND	ND	ND	ND	0.440	0.110	ND
22/11/11	ND	ND	ND	ND	ND	0.120	ND	**0.025** 3-&4-Methylphenols
10/04/12	ND	ND	ND	ND	ND	ND	ND	ND
27/08/12	ND	ND	ND	ND	ND	ND	ND	ND
27/11/12	ND	ND	ND	ND	0.034	0.340	0.140	ND
05/06/13	ND	ND	ND	ND	ND	ND	ND	ND
04/05/15	ND (UT)	ND	ND	ND	ND	ND	ND	NC
	NC	NC	NC	NC	NC	NC	NC	NC

Abbreviations:
PAHs = Polynuclear Aromatic Hydrocarbons; BTEX = Benzene, Tolulene, Ethylbenzene, Xylene compounds; TPH = Total Petroleum Hydrocarbons; ND = Nil detected; UT = Ultra trace; NC = Not continuing. Note. CodyHart and ALS results from May 2015 onwards.

Photograph 4: Ambient surface water sampling point GARA4 looking south

GARA4 E 56 384915.0 N 6614748.0

Table 13: Field parameters, water level, flow, sediment, carbon, nutrients – Surface water GARA4

GARA4	Field parameters					Depth, flow & sediment				Carbon				Nutrients				
	DO	EC	pH	Eh	Temp	D	VFR	Turb	SS	Alk	Free CO_2	CO_2 + Alk	TOC	NH_3	NO_3 / NO_x	TKN	TotN	TotP
Measure	mg/L	µS/cm	1-14	mV	°C	m	kL/day	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L	mg/L
Reporting Value	0.01	1	0.01	1	0.1	0.01	1	0.1	1-5	1	1	1	1	0.01 -0.2	0.001- 0.01	0.01 -0.1	0.01 -0.1	0.001- 0.01
17/12/08	7.95	335	7.27	+247	24.1	NT	NT	NT	18	142	NT	NT	NT	<0.20	0.05	1.1	1.2	0.82
28/01/09	8.23	325	7.60	+260	27.9	NT	NT	NT	5	160	NT	NT	NT	<0.20	0.26	0.6	0.8	0.44
10/03/09	8.47	272	6.80	+215	23.4	NT	NT	NT	8	106	NT	NT	NT	<0.20	0.12	1.1	1.2	1.49
18/05/10	9.45	420	8.02	NT	9.6	NT	NT	NT	8	178	NT	NT	NT	0.08	0.11	0.3	0.4	0.55
09/06/10	6.75	390	7.82	NT	10.2	NT	NT	NT	15	170	NT	NT	NT	0.08	0.11	<0.2	0.1	0.52
07/09/10	5.89	290	7.82	NT	12.8	NT	NT	NT	<2	137	NT	NT	NT	<0.01	0.01	1.1	1.4	0.27
07/12/10	4.63	245	7.61	NT	20.5	NT	NT	NT	15	115	NT	NT	NT	0.83	0.04	1.7	1.7	0.23
31/05/11	4.68	335	8.48	NT	9.9	NT	NT	NT	8	155	NT	NT	NT	<0.10	<0.02	<0.2	<0.2	0.77
16/08/11	4.91	360	8.13	NT	10.4	NT	NT	NT	5	128	NT	NT	NT	<0.02	0.29	2.5	2.8	0.63
22/11/11	4.77	284	7.84	NT	23.6	NT	NT	NT	3	121	NT	NT	NT	<0.20	0.26	0.6	0.5	0.40
10/04/12	5.40	340	7.92	NT	15.3	NT	NT	NT	5	160	NT	NT	NT	0.03	0.40	0.7	1.1	0.07
27/08/12	8.79	365	9.17	NT	11.4	NT	NT	NT	8	147	NT	NT	NT	0.02	0.39	0.3	0.7	0.42
27/11/12	6.34	131	6.93	NT	18.3	NT	NT	NT	52	42	NT	NT	NT	<0.10	0.33	<0.1	0.3	0.25
05/06/13	8.15	790	7.84	NT	9.5	NT	NT	NT	5	161	NT	NT	NT	<0.20	0.50	0.6	1.1	0.24
04/05/15	7.24	413	7.78	+228	14.6	1.0	80000	5.0	<5	117	9	25	10	0.06	<0.01	2.0	2.0	0.54

Abbreviations: DO = Dissolved Oxygen; EC = Electrical Conductivity also called specific conductance; Eh = Redox Potential; Temp = Temperature; D = Approximate depth of water at sampling point; VFR = Volumetric Flow Rate; Turb = Turbidity; SS = Suspended Solids; Alk = Alkalinity measured as mg/L $CaCO_3$ equivalent; Free CO_2 = Free carbon dioxide; Unfiltered C of (CO_2 + Alk) = 12/44 CO_2 + 12/61 Alk; TOC = Total Organic Carbon;NH_3 = Ammonia as a measure of ammonium ions; NO_3 = Nitrate; NO_x = Nitrite + Nitrate; TKN = Total Kjeldahl Nitrogen (organic nitrogen and ammonia); Tot N = Total Nitrogen; Tot P = Total Phosphorus; NT = Not tested.
Note. From May 2015 onwards, CodyHart and ALS results, and NO_x rather than NO_3.

Table 14: *Metals & metalloids – Surface water GARA4*

GARA4	**Al**	**Sb**	**As**	**Cd**	**Cr**	**Cu**	**Ni**	**Pb**	**Se**	**Zn**	**Mn**	**Fe**	**Hg**
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	0.005-0.01	0.001	0.001	0.001-0.0001	0.001	0.001	0.001	0.001	0.001-0.01	0.001-005	0.001-0.005	0.005-0.01	0.0001
17/12/08	**<0.005**	NT	**0.008**	**<0.001**	**0.001**	**0.002**	**0.003**	**<0.001**	**<0.001**	**0.003**	**0.001**	**0.061**	**<0.0001**
28/01/09	**<0.005**	NT	**0.008**	**<0.001**	**<0.001**	**0.003**	**0.002**	**<0.001**	**<0.001**	**<0.001**	**0.008**	**0.054**	**<0.0001**
10/03/09	**0.019**	NT	**0.007**	**<0.001**	**0.002**	**0.003**	**0.003**	**<0.001**	**<0.001**	**0.004**	**0.008**	**0.243**	**<0.0001**
18/05/10	**0.012**	NT	**0.006**	**<0.0001**	**<0.001**	**0.001**	**0.001**	**<0.001**	**<0.001**	**0.007**	**<0.005**	**0.108**	**<0.0001**
09/06/10	**1.050**	NT	**0.005**	**<0.0001**	**0.002**	**0.002**	**0.002**	**<0.001**	**<0.001**	**0.003**	**<0.005**	**2.820**	**<0.0001**
07/09/10	**<0.005**	NT	**0.003**	**<0.0001**	**<0.001**	**0.002**	**0.002**	**<0.001**	**<0.001**	**0.013**	**<0.005**	**0.130**	**<0.0001**
07/12/10	**0.032**	NT	**0.005**	**<0.0001**	**<0.001**	**0.002**	**0.003**	**<0.001**	**<0.001**	**0.010**	**0.009**	**0.153**	**<0.0001**
31/05/11	**0.220**	NT	**0.002**	**<0.0001**	**<0.001**	**0.001**	**0.002**	**<0.001**	**<0.001**	**0.001**	**<0.005**	**0.100**	**<0.0001**
16/08/11	**0.034**	NT	**0.002**	**<0.0001**	**<0.001**	**0.002**	**0.002**	**<0.001**	**<0.001**	**<0.001**	**0.009**	**0.055**	**<0.0001**
22/11/11	**0.048**	NT	**0.003**	**<0.0001**	**<0.001**	**0.001**	**0.002**	**<0.001**	**<0.001**	**<0.001**	**<0.005**	**0.057**	**<0.0001**
10/04/12	**<0.005**	NT	**0.004**	**<0.0001**	**<0.001**	**0.001**	**0.002**	**<0.001**	**<0.001**	**0.002**	**0.030**	**0.080**	**<0.0001**
27/08/12	**<0.005**	NT	**0.003**	**<0.0001**	**<0.001**	**0.002**	**0.002**	**<0.001**	**<0.001**	**0.005**	**0.030**	**<0.005**	**<0.0001**
27/11/12	**0.477**	NT	**0.002**	**<0.0001**	**0.002**	**0.003**	**0.004**	**0.001**	**<0.001**	**0.005**	**0.010**	**0.470**	**<0.0001**
05/06/13	**<0.005**	NT	**0.002**	**<0.0001**	**<0.001**	**0.002**	**0.002**	**<0.001**	**<0.001**	**0.003**	**0.040**	**<0.005**	**<0.0001**
04/05/15	<0.010	<0.001	0.006	<0.0001	<0.001	0.002	<0.001	<0.001	<0.010	<0.005	0.016	<0.005	<0.0001

Abbreviations: Al = Aluminium; Sb = Antimony; As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Ni = Nickel; Pb = Lead; Se = Selenium; Zn = Zinc; Mn = Manganese; Fe = Iron; Hg = Mercury; NT = Not tested; Bold result = unfiltered.
Notes. CodyHart and ALS results from May 2015 onwards. Metals not filtered and analysed for total metals until May 2015.

Table 15: *Extra laboratory analytes and parameters A – baseline only – Surface water GARA4*

GARA4	***TDS, anions & cations, boron, reactive phosphorus, microbial***														
	TDS	**Ca**	**Mg**	**Na**	**K**	**SAR**	**Hard**	**Fl**	**Cl**	**S**	**Br**	**B**	**RP**	***E.Coli***	**Enterococci**
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	ratio	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100mL	CFU/100mL
Reporting Value	1	0.1	0.1	0.1	0.01-0.1	0.1	1	0.001	0.01	0.01	0.005-0.01	0.005-0.01	0.005-0.01	1	1
17/12/08	224	20.3	16.3	29.3	4.7	1.2	118	**0.292**	23.2	4.29	0.045	**<0.005**	0.664	NT	NT
28/01/09	220	18.1	21.1	21.3	4.0	0.8	132	0.285	24.3	2.35	**<0.005**	<0.005	0.305	NT	NT
10/03/09	182	14.5	11.7	21.0	5.6	1.0	84	0.215	24.7	4.91	<0.005	<0.005	**1.245**	NT	NT
18/05/10	280	26.5	17.8	38.8	**6.8**	**1.4**	139	0.260	**45.6**	0.61	<0.005	<0.005	0.211	NT	NT
09/06/10	261	**30.4**	21.9	**42.1**	6.6	1.4	**166**	0.241	39.8	7.22	<0.005	<0.005	0.500	NT	NT
07/09/10	194	20.0	16.0	16.8	3.4	0.7	116	0.134	21.3	3.40	<0.005	0.045	0.260	NT	NT
07/12/10	164	18.5	13.9	12.9	1.5	0.6	106	0.167	**11.6**	2.45	<0.005	<0.005	0.079	NT	NT
31/05/11	224	20.3	17.1	20.9	1.8	0.8	121	0.239	21.8	**9.94**	<0.005	<0.005	0.227	NT	NT
16/08/11	241	25.9	18.7	22.0	1.7	0.8	142	0.139	25.2	4.85	0.490	**0.029**	0.078	NT	NT
22/11/11	193	16.6	14.6	16.2	1.0	0.7	102	0.123	18.6	**0.31**	1.174	0.026	0.060	NT	NT
10/04/12	228	24.5	**24.5**	23.7	1.5	0.9	145	0.164	24.9	3.58	**1.407**	<0.005	0.068	NT	NT
27/08/12	245	24.8	18.5	29.2	2.0	1.1	138	0.200	39.7	7.02	0.373	<0.005	0.100	NT	NT
27/11/12	**88**	**8.2**	**6.4**	**8.2**	**0.1**	**0.5**	**47**	**0.070**	12.7	2.71	0.135	<0.010	0.060	NT	NT
05/06/13	**529**	29.5	20.3	29.5	3.7	1.0	157	0.172	38.1	7.27	0.022	<0.005	**0.030**	NT	NT
04/05/15	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	45	52

Abbreviations: TDS = Total Dissolved Solids; Ca = Calcium; Mg = Magnesium; Na = Sodium; K = Potassium; SAR = Sodium Absorption Ratio; Hard = Hardness; Fl = Fluoride; Cl = Chloride; S = Sulphide; Br = Bromine; B = Boron; RP = Reactive Phosphorus; *E. Coli* = Escherichia coli; NT = Not tested; NC = Not continuing.

Table 16: Extra laboratory analytes B – baseline only – Surface water GARA4

GARA4	Organics							
	PAH	OC & OP	BTEX	TPH C6-C9	TPH C10-C14	TPH C15-C28	TPH C29-C36	Phenols
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	0.00005-0.0001	0.0005-0.002	0.001-0.002	0.025	0.025	0.1	0.1	various
17/12/08	ND	ND	ND	ND	ND	ND	ND	ND
28/01/09	ND	ND	ND	ND	ND	ND	ND	ND
10/03/09	ND	ND	ND	ND	ND	ND	ND	ND
18/05/10	ND	ND	ND	ND	ND	ND	ND	ND
09/06/10	ND	ND	ND	ND	ND	ND	ND	ND
07/09/10	ND	ND	ND	ND	ND	ND	ND	ND
07/12/10	ND	ND	ND	ND	ND	ND	ND	ND
31/05/11	ND	ND	ND	ND	ND	ND	ND	ND
16/08/11	ND	ND	ND	ND	ND	0.240	0.110	ND
22/11/11	ND	ND	ND	ND	ND	0.110	ND	ND
10/04/12	ND	ND	ND	ND	ND	ND	ND	ND
27/08/12	ND	ND	ND	ND	ND	0.110	ND	ND
27/11/12	ND	ND	ND	ND	ND	0.330	0.120	ND
05/06/13	ND	ND	ND	ND	ND	ND	ND	ND
04/05/15	ND (UT)	ND	ND	ND	ND	ND	ND	NC
	NC	NC	NC	NC	NC	NC	NC	NC

Abbreviations:
PAHs = Polynuclear Aromatic Hydrocarbons; BTEX = Benzene, Tolulene, Ethylbenzene, Xylene compounds; TPH = Total Petroleum Hydrocarbons; ND = Nil detected; UT = Ultra trace; NC = Not continuing. Note. CodyHart and ALS results from May 2015 onwards.

Photograph 5: Ambient surface water sampling point GARA5 looking west

GARA5 E 56 383279.0 N 6619897.0

Table 17: Field parameters, water level, flow, sediment, carbon, nutrients – Surface water GARA5

GARA5	Field parameters					Depth, flow & sediment				Carbon				Nutrients				
	DO	EC	pH	Eh	Temp	D	VFR	Turb	SS	Alk	Free CO_2	CO_2 + Alk	TOC	NH_3	NO_3 / NO_x	TKN	TotN	TotP
Measure	mg/L	µS/cm	1-14	mV	°C	m	kL/day	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L	mg/L
Reporting Value	0.01	1	0.01	1	0.1	0.01	1	0.1	1-5	1	1	1	1	0.01 -0.2	0.001-0.01	0.01 -0.1	0.01 -0.1	0.001 -0.01
17/12/08	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
28/01/09	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
10/03/09	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
18/05/10	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
09/06/10	6.35	115	7.07	NT	5.6	NT	NT	NT	307	47	NT	NT	NT	0.08	0.04	0.6	0.6	0.21
07/09/10	4.04	81	7.07	NT	9.2	NT	NT	NT	8	25	NT	NT	NT	0.09	0.09	1.7	1.7	0.05
07/12/10	5.58	184	6.83	NT	17.5	NT	NT	NT	12	94	NT	NT	NT	0.05	0.04	3.6	3.7	0.19
31/05/11	2.24	94	6.10	NT	7.1	NT	NT	NT	83	20	NT	NT	NT	0.19	<0.02	1.2	1.2	0.45
16/08/11	4.55	118	6.88	NT	10.4	NT	NT	NT	130	40	NT	NT	NT	<0.02	0.01	0.6	0.6	0.61
22/11/11	2.27	120	6.56	NT	23.7	NT	NT	NT	23	50	NT	NT	NT	<0.20	0.13	1.4	1.5	0.06
10/04/12	1.80	110	6.57	NT	9.2	NT	NT	NT	360	49	NT	NT	NT	0.30	0.55	2.6	2.9	0.05
27/08/12	6.78	100	6.34	NT	8.2	NT	NT	NT	145	24	NT	NT	NT	0.13	0.21	0.8	1.1	0.38
27/11/12	4.07	265	7.04	NT	19.5	NT	NT	NT	145	94	NT	NT	NT	<0.10	0.38	2.0	2.3	0.35
05/06/13	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
04/05/15	5.61	45	8.17	+206	20.4	0.25	270	63.8	17	13	9	5	21	0.03	<0.01	4.6	4.6	0.11

Abbreviations: DO = Dissolved Oxygen; EC = Electrical Conductivity also called specific conductance; Eh = Redox Potential; Temp = Temperature; D = Approximate depth of water at sampling point; VFR = Volumetric Flow Rate; Turb = Turbidity; SS = Suspended Solids; Alk = Alkalinity measured as mg/L $CaCO_3$ equivalent; Free CO_2 = Free carbon dioxide; Unfiltered C of (CO_2 + Alk) = 12/44 CO_2 + 12/61 Alk; TOC = Total Organic Carbon; NH_3 = Ammonia as a measure of ammonium ions; NO_3 = Nitrate; NO_x = Nitrite + Nitrate; TKN = Total Kjeldahl Nitrogen (organic nitrogen and ammonia); Tot N = Total Nitrogen; Tot P = Total Phosphorus; NT = Not tested.
Note. From May 2015 onwards, CodyHart and ALS results, and NO_x rather than NO_3.

Table 18: Metals & metalloids – Surface water GARA5

GARA5	Al	Sb	As	Cd	Cr	Cu	Ni	Pb	Se	Zn	Mn	Fe	Hg
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	0.005-0.01	0.001	0.001	0.001-0.0001	0.001	0.001	0.001	0.001	0.001-0.01	0.001-005	0.001-0.005	0.005-0.01	0.0001
17/12/08	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
28/01/09	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
10/03/09	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
18/05/10	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
09/06/10	**5.170**	**NT**	**0.002**	**<0.0001**	**0.014**	**0.009**	**0.006**	**0.008**	**<0.001**	**0.033**	**<0.005**	**2.200**	**<0.0001**
07/09/10	**1.060**	**NT**	**<0.001**	**<0.0001**	**<0.001**	**0.003**	**0.002**	**<0.001**	**<0.001**	**0.018**	**<0.005**	**0.978**	**<0.0001**
07/12/10	**0.555**	**NT**	**0.005**	**<0.0001**	**0.002**	**0.004**	**0.005**	**0.002**	**<0.001**	**0.015**	**0.305**	**6.590**	**<0.0001**
31/05/11	**3.480**	**NT**	**<0.001**	**<0.0001**	**0.003**	**0.005**	**0.002**	**0.002**	**<0.001**	**0.013**	**0.020**	**1.980**	**<0.0001**
16/08/11	**12.100**	**NT**	**0.002**	**<0.0001**	**0.009**	**0.007**	**0.005**	**0.005**	**<0.001**	**0.023**	**0.027**	**6.497**	**<0.0001**
22/11/11	**0.398**	**NT**	**0.002**	**<0.0001**	**0.001**	**0.003**	**0.003**	**<0.001**	**<0.001**	**0.004**	**<0.005**	**1.189**	**<0.0001**
10/04/12	**14.100**	**NT**	**0.005**	**<0.0001**	**0.012**	**0.013**	**0.010**	**0.013**	**<0.001**	**0.035**	**0.690**	**9.660**	**<0.0001**
27/08/12	**0.514**	**NT**	**0.003**	**<0.0001**	**0.008**	**0.011**	**0.006**	**0.006**	**<0.001**	**0.024**	**0.030**	**0.460**	**0.0002**
27/11/12	**1.810**	**NT**	**0.003**	**<0.0001**	**0.004**	**0.007**	**0.006**	**0.003**	**0.002**	**0.015**	**0.500**	**0.770**	**<0.0001**
05/06/13	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
04/05/15	0.410	<0.001	<0.001	<0.0001	<0.001	0.004	0.001	<0.001	<0.010	0.011	0.004	0.320	<0.0001

Abbreviations: Al = Aluminium; Sb = Antimony; As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Ni = Nickel; Pb = Lead; Se = Selenium; Zn = Zinc; Mn = Manganese; Fe = Iron; Hg = Mercury; NT = Not tested; Bold result = unfiltered.
Notes. CodyHart and ALS results from May 2015 onwards. Metals not filtered and analysed for total metals until May 2015.

Table 19: Extra laboratory parameters and analytes A – baseline only – Surface water GARA5

GARA5	*TDS, anions & cations, boron, reactive phosphorus, microbial*													
	TDS	Ca	Mg	Na	K	SAR	Hard	Fl	Cl	S	Br	B	RP	*E.Coli*	Enterococci
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	ratio	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100mL	CFU/100mL
Reporting Value	1	0.1	0.1	0.1	0.01-0.1	0.1	1	0.001	0.01	0.01	0.005-0.01	0.005-0.01	0.005-0.01	1	1
17/12/08	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
28/01/09	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
10/03/09	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
18/05/10	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
09/06/10	77	2.3	4.0	18.5	2.3	1.7	22	0.157	12.7	0.14	0.532	<0.005	<0.020	NT	NT
07/09/10	54	3.7	2.3	8.3	2.5	0.8	19	0.077	9.5	0.41	<0.005	<0.005	0.037	NT	NT
07/12/10	123	14.8	9.2	9.6	2.3	0.5	75	0.188	4.5	0.55	<0.005	<0.005	0.165	NT	NT
31/05/11	63	2.7	2.7	6.9	4.0	0.8	15	0.069	15.7	0.22	<0.005	<0.005	0.030	NT	NT
16/08/11	79	5.3	3.8	14.6	1.5	1.2	29	0.122	13.4	0.25	0.260	0.037	0.002	NT	NT
22/11/11	82	7.5	4.8	8.3	1.5	0.6	39	0.225	5.9	0.71	0.569	<0.005	<0.005	NT	NT
10/04/12	74	7.2	5.2	10.8	2.0	0.8	39	0.141	6.2	0.16	0.005	<0.005	<0.005	NT	NT
27/08/12	67	4.2	2.6	10.5	1.7	1.0	21	0.090	19.3	0.36	0.216	<0.005	<0.010	NT	NT
27/11/12	178	18.4	12.0	25.0	0.1	1.1	95	0.280	39.9	0.89	1.020	<0.010	0.140	NT	NT
05/06/13	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
04/05/15	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	2800	1300

Abbreviations: TDS = Total Dissolved Solids; Ca = Calcium; Mg = Magnesium; Na = Sodium; K = Potassium; SAR = Sodium Absorption Ratio; Hard = Hardness; Fl = Fluoride; Cl = Chloride; S = Sulphide; Br = Bromine; B = Boron; RP = Reactive Phosphorus; *E. Coli* = Escherichia coli; NT = Not tested; NC = Not continuing.

Table 20: Extra laboratory analytes B – baseline only – Surface water GARA5

GARA5	Organics							
	PAH	OC & OP	BTEX	TPH C6-C9	TPH C10-C14	TPH C15-C28	TPH C29-C36	Phenols
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	0.00005-0.0001	0.0005-0.002	0.001-0.002	0.025	0.025	0.1	0.1	various
17/12/08	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
28/01/09	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
10/03/09	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
18/05/10	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
09/06/10	ND	ND	ND	ND	ND	**ND**	ND	ND
07/09/10	ND	ND	ND	ND	ND	ND	ND	ND
07/12/10	ND	ND	ND	ND	ND	ND	ND	ND
31/05/11	ND	ND	ND	ND	ND	ND	ND	ND
16/08/11	ND	ND	ND	ND	ND	**0.320**	ND	ND
22/11/11	ND	ND	ND	ND	ND	ND	ND	ND
10/04/12	ND	ND	ND	ND	ND	ND	ND	ND
27/08/12	ND	ND	ND	ND	ND	ND	ND	ND
27/11/12	ND	ND	ND	ND	ND	0.270	ND	ND
05/06/13	DRY	DRY	DRY	DRY	DRY	DRY	DRY	DRY
04/05/15	ND (UT)	ND	ND	ND	ND	ND	ND	NC
	NC	NC	NC	NC	NC	NC	NC	NC

Abbreviations:
PAHs = Polynuclear Aromatic Hydrocarbons; BTEX = Benzene, Tolulene, Ethylbenzene, Xylene compounds; TPH = Total Petroleum Hydrocarbons; ND = Nil detected; UT = Ultra trace; NC = Not continuing. Note. CodyHart and ALS results from May 2015 onwards.

Photograph 6: Ambient surface water sampling point GARA6

GARA6 E 56 385915.0 N 6616606.0

Table 21: Field parameters, water level, flow, sediment, carbon, nutrients – Surface water GARA6

GARA6	***Field parameters***					***Depth, flow & sediment***				***Carbon***				***Nutrients***				
	DO	**EC**	**pH**	**Eh**	**Temp**	**D**	**VFR**	**Turb**	**SS**	**Alk**	**Free CO_2**	**CO_2 + Alk**	**TOC**	**NH_3**	**NO_x**	**TKN**	**TotN**	**TotP**
Measure	mg/L	µS/cm	1-14	mV	°C	m	kL/day	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L	mg/L
Reporting Value	0.01	1	0.01	1	0.1	0.01	1	0.1	1-5	1	1	1	1	0.01	0.01	0.1	0.1	0.01
04/05/15	7.05	396	8.12	+208	15.2	0.45	2304	7.2	<5	150	6	31	13	0.04	0.01	2.0	2.0	0.05

Abbreviations: DO = Dissolved Oxygen; EC = Electrical Conductivity also called specific conductance; Eh = Redox Potential; Temp = Temperature; D = Approximate depth of water at sampling point; VFR = Volumetric Flow Rate; Turb = Turbidity; SS = Suspended Solids; Alk = Alkalinity measured as mg/L $CaCO_3$ equivalent; Free CO_2 = Free carbon dioxide; Unfiltered C of (CO_2 + Alk) = 12/44 CO_2 + 12/61 Alk; TOC = Total Organic Carbon; NH_3 = Ammonia as a measure of ammonium ions; NO_x = Nitrite + Nitrate; TKN = Total Kjeldahl Nitrogen (organic nitrogen and ammonia); Tot N = Total Nitrogen; Tot P = Total Phosphorus. Note. No sampling prior to May 2015.

Table 22: Metals & metalloids – Surface water GARA6

GARA6	**Al**	**Sb**	**As**	**Cd**	**Cr**	**Cu**	**Ni**	**Pb**	**Se**	**Zn**	**Mn**	**Fe**	**Hg**
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	0.01	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.01	0.005	0.001	0.05	0.0001
04/05/15	<0.01	<0.001	0.002	<0.0001	<0.001	0.001	0.002	<0.001	<0.01	<0.005	0.013	0.12	<0.0001

Abbreviations: Al = Aluminium; Sb = Antimony; As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Ni = Nickel; Pb = Lead; Se = Selenium; Zn = Zinc; Mn = Manganese; Fe = Iron; Hg = Mercury; NT = Not tested. Notes. Metals filtered. No sampling prior to May 2015.

Table 23: Extra laboratory parameters and analytes A – baseline only – Surface water GARA6

GARA6	***Organics***							***Microbial***	
	PAH	**OC & OP**	**BTEX**	**TPH** C6-C9	**TPH** C10-C14	**TPH** C15-C28	**TPH** C29-C36	***E.Coli***	**Enterococci**
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100mL	CFU/100mL
Reporting Value	0.00005-0.0001	0.0005-0.002	0.001-0.002	0.025	0.025	0.1	0.1	1	1
04/05/15	ND (UT)	ND	ND	ND	ND	ND	ND	~10	~8

Abbreviations:
PAHs = Polynuclear Aromatic Hydrocarbons; BTEX = Benzene, Tolulene, Ethylbenzene, Xylene compounds; TPH = Total Petroleum Hydrocarbons; *E. Coli* = Escherichia coli; ND = Nil detected; UT = Ultra trace. Note. No sampling prior to May 2015.

7. WATER QUALITY COMPARISONS

Table 24 devised by CodyHart is provided to aid review of environmental health risks.

Table 24: Environmental health warning values ***surface water*** *- some landfill parameters & analytes*

Parameter	***Reason for Inclusion***	***Aquatic*** 1	***Human*** 2	***Irrigation*** 3	***Livestock*** 4
Temperature	Biodegradation of waste increases temperature. Temp + EC have successfully defined a leachate plume (Scrudato & Pagano, 1994).	>80%ile <20%ile	NR	NR	NR
pH	varies from acidic to alkaline as waste decomposition progresses (Andreottola & Cannas, 1992:72). But pH levels in groundwater are often naturally low.	6.5 to 8.0 (2000); 6.5 – 9.0 (1992)	6.5 to 8.5 (A)	>6 values corrosion of pipes	NR
Electric Conductivity (EC)	a general indicator that summarises the general trend of major cation and anion concentrations.	30 -350 μS/cm (2000); ≤1500 μS/cm (1992)	≤938 μS/cm (A) >1875 μS/cm (unpalatable)	varies, e.g., ≤1,000μS/cm carrots	≥3582 μS/cm analyse for specific ions which may affect
Analyte	***Reason for Inclusion***	***Aquatic*** 1	***Human*** 2	***Irrigation*** 3	***Livestock*** 4
Alkalinity	Measures acid-neutralising capacity, a solution's ability to buffer, that is stop pH changing. Often high in leachate, but some groundwaters can also have high alkalinity.	NR	NR	NR	NR
Boron	High mobility in clay. Good tracer. Found in leachate (Bagchi, 1994:52). Found in fireproofing agents, preservatives, antiseptics, glass, enamels, cosmetics, cements, carpets, soaps, powders and ointments. Some crops are intolerant to boron (ANZECC, 1992:5-13). However, low in northern NSW leachate (Hart, 2015)	≤0.37 mg/L	≤4.0 mg/L	≤0.5 mg/L (long term)	≤5mg/L
Bromide	Leachate indicator if leachate high in sea salt (Baker1993; Hart 1994). Used in bleaches; dyes; pharmaceuticals; pesticides; solvents for waxes, greases & oils; additives for motor oil & fuels; used in photograph development. Bromate generated from bromides in water (Wikipedia). Bromate is carcinogenic. Relatively low in northern NSW leachates (Hart, 2015)	NR	Bromate ≤0.02 mg/L forms bromide as a by-product	NR	NR
Ammonium ions	From decaying plants and animals. May be high in leachate (Hancock & Phillips, 1992:22). Toxic to fish (ANZECC, 1992:2-30).	Table 8.3.7 ≤0.18 mg/L as N for pH 9.0; ≤0.9 mg/L as N pH 8.0; ≤2.18 mg/L pH 7.0; ≤2.57 mg/L pH 6.	≤0.04 mg/L as N (A – corrosion of copper pipes)	Nitrogen ≤5 mg/L (long term; 25-125 mg/L (short term – up to 20 years)	NR
Nitrate	From final stage of plant and animal decomposition or fertilisers. May be high in leachate (Canter, 1997:6). Toxic to infants and livestock (ANZECC, 1992:4-10, 5-23).	(Table 3.3.2 eutro - NO_x as N ≤0.015 mg/L; TN ≤0.25 mg/L; Table 3.4.1 Toxic ≤0.158 NO_x as N	≤11.3 mg/L as N for up to 3 month bottle fed babies. Others ≤22.6 mg/L as N.	As for ammonia	≤ 90 mg/L as N; Nitrite ≤9 mg/L as N
Phosphorus	Csuros (1994:228-229) explains that phosphorus occurs in animal, plant and mineral kingdoms. Its discharge to streams may stimulate growth of photosynthetic organisms especially if it is the nutrient whose low values are valueing the primary productivity of the water.	Total P ≤0.02 mg/L	NR	≤0.05 mg/L (long term to prevent clogging irrig equipment; ≤0.8-12 mg/L (short term)	NR
VOCs / BTEX	Good indicators of man-made pollutants found in landfill leachate (USEPA, 1991:51075). Toxic and carcinogenic to animals and humans.	varies for different compounds	varies for different compounds	NR	NR
PAH	In old coal gasification plant coal tar waste. From incomplete burning of oil, wood, gas, garbage, meat. Rarely detected in northern NSW landfills.	e.g., Naphthalene ≤0.016 mg/L	Benzo-(a)-pyrene ≤0.00001 mg/L	NR	as per human
Phenolics	Rarely detected in landfill leachate in northern NSW. If they are detected, they are at trace levels (NSW EPA, 2015, p. 78)	Total phenols ≤0.32 mg/L	e.g., Pentachloro phenol ≤0.01 mg/L	NR	as per human

Table 24 continued:

Analyte	**Reason for Inclusion**	**Aquatic** 1	**Human** 2	**Irrigation** 3	**Livestock** 4
Iron and manganese	High iron concentrations affect plant growth and high manganese concentrations clog irrigation equipment and are toxic to plants (ANZECC, 1992:5-15, 5-16).	Fe NR (2000), ≤1 mg/L (1992), Mn≤1.9mg/L	Fe 0.3 mg/L (A) Mn 0.1 mg/L (A), Health 0.5 mg/L	Fe & Mn 0.2 mg/L long term, 10 mg/L short term	not sufficiently toxic (2000); ≤17 mg/L for dairy cattle (1992)
Aluminium for pH>6.5	Aluminium (and iron) >1mg/L indicates the presence of suspended clay minerals (Thorbjornsen & Myers 2007:26) that are naturally occurring. Aluminium results therefore assist review of metal results to determine if source is natural due to clay presence (Hart 2011).	≤0.055 mg/L	≤0.2 (A)	≤5 mg/L long term; ≤20mg/L short term	≤5 mg/L
Arsenic	Found naturally in soils & in cattle dip soils; toxic, possibly carcinogenic (Manahan, 1990:150), toxic to livestock in high concentrations (ANZECC, 1992:5-25)	≤0.024 mg/L (III) form; ≤0.05 aquaculture	≤0.01 mg/L	≤0.1 mg/L long term; ≤2 mg/L short term	0.5 to 5 mg/L tolerated
Cadmium	Causes high blood pressure, kidney damage, destroys testicular tissue and red blood cells, toxic to aquatic biota (Manahan, 1990:150), toxic and carcinogenic to livestock (ANZECC, 1992:5-26)	≤0.0002 mg/L – if 'hard' water ≤0.00084 mg/L	≤0.002 mg/L	≤0.01 mg/L long term; ≤0.05 mg/L short term	≤0.01 mg/L
Chromium	Cr^{+6} is possibly carcinogenic and is toxic to humans (anaemia, kidney disease, nervous system) (Manahan, 1990:150), reduces crop yield (ANZECC, 1992:5-14).	≤0.001 mg/L for Cr^{+6}	≤0.05 mg/L (Cr^{+6})	≤0.1 mg/L long term; ≤1 mg/L short term	≤1 mg/L
Copper	Essential in small concentrations for plant growth and animals (ANZECC, 1992:5-15&5-27). Toxic to sensitive plants and animals and bioaccumulated.	0.0014 mg/L – if 'hard' water ≤0.00546 mg/L	≤2 mg/L (Health) ≤1 mg/L (A)	≤0.2 mg/L long term; ≤5 mg/L short term	<0.4 mg/L sheep, <1 mg/L cattle; <5 mg/L pigs & poultry
Lead	Wildlife destruction (Manahan, 1990:151). Reduces plant growth (ANZECC, 1992:5-16). Decreases human intelligence, growth (Csuros, 1994:210).	≤0.0034 mg/L – if 'hard' water ≤0.02584 mg/L	≤0.01 mg/L	≤2 mg/L long term; ≤5 mg/L short term	≤0.1 mg/L
Mercury	Very toxic to humans - numbness, deafness, loss of muscle control (Csuros, 1994:212); toxic to fish (ANZECC, 1992:2-38).	NR (2000); ≤0.0001 mg/L (1992)	≤0.001 mg/L	≤0.002 mg/L	≤0.002mg/L
Nickel	Commonly on metal analyte suite lists. Occurs naturally and is ubiquitous in soils. Found in foods: cocoa, soy beans and some cereals (NHMRC 2015:861).	≤0.011 mg/L – if 'hard' water ≤0.0429 mg/L	≤0.02 mg/L	≤0.2 mg/L long term; ≤2.0mg/L short term	≤1 mg/L
Selenium	Toxic to cattle, fish and humans (Manahan, 1990:151) Used in electronics, glass, ceramics, pigments, rubber (Csuros, 1994:213).	≤0.005 mg/L	≤0.01 mg/L	≤0.02 mg/L long term; ≤0.05 mg/L short term	≤0.02 mg/L
Zinc	Found both naturally (weathering & erosion) and from anthropogenic sources (ANZECC, 1992:2-42). Zinc coating used to protect iron, steel and brass; used in dry batteries, construction materials, printing processes (Csuros, 1994:215). One of seven analytes with greatest percentage increase from 71 unlined landfills in North Carolina, USA (Borden and Yanoschak, 1990:269).	≤0.008 mg/L – if 'hard' water ≤0.0312 mg/L	≤3 mg/L (A)	≤2 mg/L long term; ≤5 mg/L short term	≤20 mg/L

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1. from Tables 3.3.1, 3.3.2, 3.3.3 - Default trigger values for aquatic ecosystems in upland rivers of south-east Australia which are slightly-moderately disturbed; Tables 3.4.1 trigger values for toxicants 95% level of aquatic ecosystem protection; and Table 3.4.4 Hardness factors for select metals in *'Australian and New Zealand Guidelines for Fresh and Marine Water Quality',* ANZECC & ARMCANZ 2000.
2. from *'Australian Drinking Water Guidelines 6'* NHMRC & NRMMC 2011, updated March 2015. <http://www.nhmrc.gov.au/guidelines/publications/eh52/>.
3. from Tables 4.2.5, 4.2.10, 4.2.11, 4.2.14 and 4.2.15 *'Australian and New Zealand Guidelines for Fresh and Marine Water Quality',* ANZECC & ARMCANZ 2000.
4. from page 4.3-3 – 4.3-5 *'Australian and New Zealand Guidelines for Fresh and Marine Water Quality',* ANZECC & ARMCANZ 2000.

NR - No recommendation; (A) aesthetic guideline rather than an environmental health guideline; (1992) refers to the 1992 edition of the *'Australian and New Zealand Guidelines for Fresh and Marine Water Quality'*.

8. REVIEW OF BASELINE AMBIENT SURFACE WATER MONITORING

Armidale Dumaresq Council commenced the baseline ambient surface water monitoring program in December 2008. They conducted 14 sampling rounds at sampling points GARA1, GARA2, GARA3, GARA4 and GARA5. Two of these sampling points (GARA3 and GARA5) are on the ephemeral stream on the Armidale Regional Landfill site. The other sampling points are on the Gara River (Figures 1 & 2).

CodyHart conducted the latest round, the fifteenth round, in May 2015. A new sampling point, GARA6, and microbial testing had been added to the program. The CodyHart hands-on field work allowed field assessment, as well as a desktop review of the baseline ambient surface water monitoring program to date. From this it has been possible to:

- Note field practicalities.
- Review the baseline monitoring for completeness.
- Detail any further monitoring that is needed to complete the baseline monitoring.
- Recommend detection monitoring sampling points, sampling frequencies, parameters and analytes, and quality assurance.
- Recommend assessment monitoring parameters and analytes in case they are ever required.

Council has tested for a very full suite of water quality analytes and parameters. The list included ones applicable to landfill leachate as well as others which generally assess surface water quality.

Before the last round in May 2015, it was decided to add an additional sampling point, GARA6, and microbial testing at all sampling points. So there has been only one round of testing at GARA6, and only one round of microbial testing at all sampling points.

8.1 Field practicalities

8.1.1 Photographic records and GPS noted for each sampling point

Craig Smith of Armidale Dumaresq Council took CodyHart personnel on a guided tour to point out the ambient surface water sampling locations sampled by Armidale Dumaresq Council personnel. To assure that future sampling is conducted at the same locations, CodyHart photographed the sampling points, measured their northings and eastings with GPS, and then noted them on Spatial Information eXchange (SIX) satellite images. This sampling location information is provided in this report as Figures 1, 2, 3 and 4.

8.1.2 Low flows in ephemeral stream – low risk of leachate impacts

A major observation is the low flow volumes of the ephemeral stream just downgradient of the landfill site in comparison to that of the Gara River. At GARA5, upstream on the landfill site ephemeral stream, and the downstream GARA3, the rough estimate of flow volumes was 260-270 kL/day. In comparison, the rough estimate of the flow volume was 19,940 kL/day at GARA2, which is situated on the Gara River approximately 45 metres downstream of the confluence of the landfill site ephemeral creek and the Gara River. After rain, the flows in the Gara River are therefore approximately 75 times greater than in the landfill site ephemeral stream. Remember too that most times there is no flow in the ephemeral stream.

Pollution dilution is not the focus of the preceding flow comparison. It merely illustrates that the degree of risk to the Gara River from landfill leachate is very low due to the small flows from the landfill site ephemeral stream into the far greater flows of the Gara River.

Couple this low risk due to small flow volumes with considered design, construction and operation of the Armidale Regional Landfill, and then the likelihood of a landfill leachate discharge occurrence to the Gara River becomes very unlikely. Construction works will improve the ephemeral stream erosion control. The landfill will be operated to minimise the open working face and therefore the likelihood of rainfall ingress to create leachate. Rain resistant cover will be applied to the small operating cell at the end of each working day. Leachate will be reinjected into the landfill to reduce the volume of concentrated leachate being held in the leachate sump and pond.

The on-site ponds have been designed so that overflows will rarely occur. If they do occur, the volumes and concentrations will be minimal due to the leachate management process planned. Let's be pessimistic and say that a leachate discharge did occur during an extreme rainfall event. Nitrogen compounds in landfill leachate are the greatest risk to surrounding water quality. The dilution effect of rain onto the ephemeral stream catchment would reduce an original 28.8 mg/L total nitrogen concentration typical in a leachate dam affected by rainfall, two thousand fold to 0.014 mg/L by the time it reaches the Gara River. Given the baseline minimum concentration of total nitrogen of 0.2 mg/L at GARA2, there would be no consequences for the Gara River water quality. Very low likelihood of leachate escape and no consequences to the Gara River, means the overall risk from leachate discharge is very low.

8.1.3 Cattle dung and urine increase on-site total nitrogen concentrations

Following on from the low flows is the observation that cattle graze both on the landfill site itself, and on the upgradient property from which rainfall flows overland to the landfill ephemeral stream (Photograph 7).

Photograph 7: Looking northwest to cattle grazing on landfill site May 2015

The catchment of the landfill ephemeral stream is the valley that passes through the background of Photograph 7. Cattle will continue to graze on the upgradient property post landfill development.

Cattle grazing effects on the ephemeral stream are indicated in the baseline results. Of all the ambient surface water sampling points, the maximum total nitrogen results were at GARA3 (7.2 mg/L) and GARA5 (4.6 mg/L) – both on the landfill site ephemeral stream. The predominant nitrogen compound in the total nitrogen was organic nitrogen. When a plant or animal dies or an animal expels waste, the initial form of nitrogen is organic nitrogen. Cattle dung and urine were the sources of organic nitrogen at GARA3 and GARA5. This will remain the case because cattle grazing will continue upgradient of the ephemeral stream's catchment.

The principle forms of dissolved organic nitrogen are urea, uric acid and amino acids (Allan 1996, p. 286). Bacteria or fungi convert the organic nitrogen into ammonium (NH_4^+), a process called ammonification or mineralization (Wikipedia). NH_4 is then converted by bacteria into nitrite which is then transformed into nitrate, a process called nitrification. Nitrification occurs when the environment is aerobic. When the environment is anaerobic the nitrate undergoes denitrification in which nitrate is reduced to nitrogen gas. In nitrification and denitrification '*bacteria obtain energy by using ammonia as a fuel or nitrate as an oxidising agent*' (Allan 1996, p. 288).

Due to the nitrogen cycle detailed above, it is best to test for a full range of nitrogen compounds; otherwise the full potential environmental impact over time cannot be quantified.

- NH_4^+ as ammonia (NH_3 as N)
- Total kjeldahl nitrogen (TKN as N) because TKN - NH_4^+ = organic nitrogen
- NO_x as N which equals nitrite (NO_2^- as N) + nitrate (NO_3^- as N). (Nitrite is typically only a trace, so NO_x is sufficient and is more practical because it has a 28 day holding time rather than the 2 day holding time of nitrite and nitrate as separate entities.)

8.1.4 Faecal coliforms testing unwarranted

Some concern was raised that the new Armidale Regional Landfill may be noted as a cause of faecal contamination when the source may be the Armidale sewage treatment plant (STP). The Armidale STP discharges treated effluent into Commissioners Waters which flows into the Gara River. GARA4 sampling point at *Blue Hole* is downstream of the confluence of Commissioners Waters and the Gara River. It was thought that any contaminated water here in the mixed waters may lead to the new landfill being blamed as the source of contamination. Hence in the last sampling round of May 2015, GARA6 was inserted as another, non-STP affected sampling point and microbial testing was added to the parameter/analyte list for all ambient surface water sampling points.

E. Coli and enterococci were the microbial tests chosen as evidence of faecal contamination. *E. Coli* is the recommended test for Australian drinking water (NHMRC 2015, p. 264). *E. Coli* is an indicator microorganism for other pathogens that may be present in faeces. The Australian recreational water guidelines (NHMRC 2008, Table 5.7, p. 72) prefer the use of intestinal enterococci as a screening level because dose-response relationships are available in the literature. No *E. Coli* or enterococci should be present in drinking water. However, NHMRC (2015, p. 265, 269) cautions that neither *E. Coli* nor enterococci are '*effective indicators for the presence of enteric protozoa or viruses'*.

E. Coli is a subgroup that forms 97% of thermotolerant coliforms commonly called faecal coliforms (ANZECC & ARMCANZ 2000, p. 5-4). The Australian National Health and Medical Research Council (NHMRC) (2015, p. 264) explains that coliforms

> *are found in large numbers in the faeces of humans and other warm-blooded animals.... Thermotolerant coliforms are a sub-group of coliforms that are able to grow at 44.5 ± 0.2°C. E. coli is the most common thermotolerant coliform present in faeces and is regarded as the most specific indicator of recent faecal contamination because generally it is not capable of growth in the environment.... E. coli is considered a superior indicator for detecting faecal contamination.... E. coli is a normal inhabitant of the intestine, generally present in high numbers in human and animal faeces, and it generally does not grow in natural waters.*

The NHMRC (2015, p. 268) describes intestinal enterococci as

> *a functional group of organisms from the Enterococcus and Streptococcus genera that are excreted in human and animal waste.*

There are flaws in the argument that microbial tests should be undertaken as part of the baseline monitoring or during detection monitoring at ambient surface water sampling points, in case the landfill is construed as the source of the faecal contamination rather than the Armidale STP:

- Sources of faecal contamination are multiple. The best parameters available for indicating faecal contamination apply to any warm blooded animal - treated human waste from the STP, cattle, sheep, kangaroos or birds etc. Even at the Armidale STP discharge point the source may be confused. There are hundreds of cattle grazing at the Armidale STP and upstream along the banks of Commissioners Waters. The source of *Blue Hole* water microbial content may be from a close-by source such as the many ducks that frolic in the waterbody, or the cattle grazing upstream. So any positive microbial results at *Blue Hole* cannot be directly attributed to the Armidale STP.
- The considerable distances and variety of catchments between the Armidale STP and *Blue Hole* multiplies the faecal coliform source confusion and the futility in monitoring for faecal coliforms long term. For example, the watercourse distance from the STP to *Blue Hole* GARA4 sampling point is 21 km (SIX measurement). By the time the treated effluent reaches *Blue Hole* it would have undergone natural water treatment and have had more faecal inputs from animals and birds. Another example is the watercourse distance from GARA2 to the new sampling point GARA6 of 6.3 km, and from GARA2 to *Blue Hole* of 9.2 km. The same distance and variety of catchments problem of not being able to directly attribute the faecal contamination source to particularly the landfill, animals or birds recurs on the Gara River.

There are flaws with the argument that microbial tests should be undertaken as part of stormwater or ambient surface water monitoring during construction and operational stages of the landfill.

- Positive faecal coliform counts from the landfill ephemeral stream may be construed as a landfill management problem when a positive result is highly likely to be simply due to cattle, sheep, kangaroos or birds etc. The first baseline faecal coliform results for the landfill ephemeral stream in May 2015 are relatively high, not due to the landfill which is not constructed yet, but definitely due to cattle dung and urine. The worst was GARA5, the upstream sampling point on the landfill ephemeral stream. The *E. Coli* count was 2,800 CFU/100mL. This is 4.4 times greater than the maximum result at the Armidale STP discharge point from monthly sampling over the last four years. [Faecal coliform (E Coli ~97% subset) Armidale STP discharge point maximum of 640 CFU/100mL and a minimum of 8 CFU/100mL.]
- The days have long gone since ‘nightsoil’ was deposited in trenches at landfills.
- No biosolids are received at the current landfill for Armidale, the Long Swamp Road Landfill, and will not be received at the Armidale Regional Landfill.
- Armidale Dumaresq Council actively promotes that residents place their animal manures in their organic bins for the Council’s *City to Soil* composting program. This capturing of pet manures rather than landfilling them is working well (Turnell, 2015).
- Faecal coliforms desiccate in dry conditions and biodegrade in moist conditions (Redlinger et al. 2001). Ware (1980, p.55-59) cited a number of studies concerning the decline of faecal coliform counts in municipal solid waste and landfill leachate. An example was the study by Engelbrecht (1974) who found that faecal coliforms persisted for 40 to 60 days, and then rapidly disappeared. Therefore, any faecal coliforms in the municipal solid waste, such as in nappies, will be treated in the landfill environment.

- The new NSW EPA *Draft Environmental Guidelines: Solid Waste Landfills* (March 2015) discuss thermotolerant (faecal) coliforms testing to meet a ≤600 cfu/100mL criteria for discharges from sediment basins '*where required*', and suggest their testing for ambient surface water monitoring. Faecal coliform testing as referenced in their source, *Managing Urban Stormwater: Harvesting and Reuse* (NSW DEC, 2006) is applicable to urban settings or irrigation of food crops. Landfill settings are quite different. There are no urban pets, no sewer pipes or septic tanks that may overflow into stormwater pipes or drains, and no above ground food crops such as lettuce or cauliflower being irrigated. The faecal contamination from cattle, kangaroos and birds has been proven to be present before landfill construction and nothing can be done or should be done to stop it in this normal rural setting. There is therefore no point in microbial testing at the Armidale Regional Landfill site.
- In addition, microbial tests for faecal coliforms in regional areas are problematic due to the 24 hour holding time before they should be counted at a lab NATA registered to count them. The problem with TNT Express not on-sending the Armidale Regional Landfill samples from Sydney to Brisbane overnight as contracted in this May 2015 sampling round is a good example of these problems.

8.2 Baseline ambient surface water monitoring completeness

To review the completeness of the baseline ambient surface water monitoring, three questions are asked:

1. Are the ambient surface water sampling points sufficient?
2. Have there been a sufficient number of sampling rounds at adequate frequency?
3. Do the parameters and analytes tested give a good indication of the general surface water quality, and in particular are parameters and analytes included whose concentrations will increase due to landfill leachate intrusion?

8.2.1 Number and locations of sampling points

The NSW EPA *Draft Environmental Waste Guidelines: Solid Waste Landfills* (2015, p. 26) recommend at least one upstream and one downstream ambient surface water sampling point.

In comparison, six ambient surface water sampling points have been included in the Armidale Regional Landfill baseline ambient surface water monitoring program (Figures 1, 2, 3).

The sampling points in close proximity to the landfill are the most applicable:

GARA5 – upstream of the yet to be constructed landfill
GARA3 – downstream of the yet to be constructed landfill
GARA2 – just downstream of the confluence of the landfill site ephemeral stream and the Gara River.

To be thorough and precautionary, upstream and downstream sampling points on the Gara River have been included in the baseline study due to the Gara River flowing into the Oxley Wild Rivers National Park:

GARA1 – upstream of the confluence of the landfill site ephemeral stream and the Gara River
GARA6 – the first downstream sampling point after GARA2
GARA4 – the second downstream sampling point after GARA2 and located in the northern end of the Oxley Wild Rivers National Park at *Blue Hole*.

The number and locations of the baseline ambient surface water sampling points are sufficient due to the mix of sampling points. The most applicable sampling points during the detection monitoring phase are GARA5, GARA3 and GARA2 due to their close proximity to the future landfill. GARA1, GARA6 and GARA4 were precautionary ones during the baseline monitoring due to conservation concerns for the Gara River. There is a very low likelihood of landfill leachate entering the Gara River. There are no consequences to the water quality due to dilution by rainwater before it reaches the Gara River. So overall the risk to the Gara River is extremely low. Consequently, results from GARA1, GARA6 and GARA4 sampling during the detection monitoring phase would be of no use. One is upstream of the confluence of the landfill site ephemeral stream and the Gara River, and the other two are too distant for landfill leachate to be detected.

8.2.2 Sampling rounds and frequency

Fifteen sampling rounds have been conducted at GARA1 to GARA5. Sampling frequencies between December 2008 and June 2013 were predominately 2 to 3 months apart with a few 5 to 7 months apart. This range of frequencies is common when waiting for water flows in ephemeral streams. There has been a two year gap between Council's fourteen rounds and sampling and the last sampling round in May 2015 conducted by CodyHart.

GARA6 has only been sampled once (May 2015).

It is common to suggest 8 rounds of baseline sampling over two years before the construction of a landfill. It can therefore be said that there has been a sufficient number of sampling rounds at an adequate frequency for sampling points GARA1 to GARA5.

A further seven baseline monitoring rounds at GARA6 are recommended to gain an understanding of its quality over time.

8.2.3 Parameter and analyte results review

'An analyte is a substance whose chemical constituents are being identified and measured' (Oxford Dictionary). 'Parameter' is an applicable term when not referring to chemical analysis. The term 'parameter' in water quality monitoring refers to a measure taken either with a probe, measured manually with a tape measure or scales, or counted visually. Parameters include dissolved oxygen (DO), electrical conductivity (EC), pH, redox potential (Eh), temperature, turbidity, water depth, water flow rate for volumetric flow estimation, suspended solids or microbial counts.

Parameters and analytes used in the baseline program thoroughly tested the general surface water quality at the ambient surface water sampling sites:

- A range of field parameters allowed review of general water quality health: DO, EC, pH, Eh, temperature, and the analyte, alkalinity. All these parameters and one analyte are useful in detecting landfill leachate ingress into surface water (Table 24).

  Dissolved oxygen readings were predominantly above the 'rule of thumb' 5 mg/L, which indicates reasonably oxygenated waters.

  Two EC values at GARA3 exceeded 1,000 µS/cm. These values were probably due to low-flow conditions in this relatively low lying area that is frequented by cattle that disturb the clays. In addition, there were many instances when Gara River EC values exceeded the ≤350 µS/cm recommended as the salt level value for upland NSW rivers

(ANZECC & ARMCANZ 2000, Table 3.3.3, p. 3.3-11). The pH upper value of 7.5 (ANZECC & ARMCANZ 2000, Table 3.3.2, p. 3.3-10) was exceeded on many occasions at all sampling points. This is common in New England surface water bodies.

- Individual anions and cations gave a full overview of the salts present. These are useful to have for baseline in case they need to be tested again during the assessment monitoring phase as a comparison. In the detection monitoring phase, they are made redundant by EC which gives a general, and sufficient indication of the salts present.
- A full suite of nitrogen compounds was needed so that organic nitrogen was not excluded. Nitrogen compounds are the major indication of landfill leachate contamination of surface water and groundwater. Their analyses need to continue into the detection monitoring phase.

  The maximum total nitrogen concentrations (due to cattle dung and urine) of 7.2 mg/L at GARA3 and 4.6 mg/L at GARA5 far exceeded the recommended 0.25 mg/L toxicity concentration by ANZECC & ARMCANZ 2000 (Table 3.4.1, p. 3.4-5). Most nitrate concentrations from GARA1 to GARA5 exceeded the recommended eutrophication safeguard of 0.015 mg/L nitrate as N (ANZECC & ARMCANZ 2000, Table 3.3.2, p. 3.3-10).
- Total phosphorus is a basis for detection monitoring eutrophication review. This analyte assists understanding of eutrophication, a process where water bodies receive excess nutrients that stimulate excessive plant growth. Phosphorus values the effect of nitrogen inputs in the eutrophication process and therefore stimulation of algae and plant growth.

  All total phosphorus concentrations, except three concentrations, at all the GARA1 to GARA6 sampling points, exceeded the ≤0.02 mg/L trigger value recommended for NSW upland rivers (ANZECC & ARMCANZ 2000, p. 8.2-42).
- Sediment load was tested by measuring total suspended solids (SS). ANZECC & ARMCANZ (2000, p. 8.2-13), explain that while in suspension, suspended solids '*reduce light penetration and thus affect primary production*'. Fish gills may be impaired. Benthic organisms and their habitats can be smothered when the suspended solids settle. Sediment load in a water body needs to be monitored in both baseline and detection phases of ambient surface water monitoring as a means of assessing erosion controls.

  SS was excessive (≥50 mg/L) at only the landfill site ephemeral stream locations, GARA3 and GARA5, and were so on many sampling occasions.

  Turbidity is an alternative indicator for quantifying sediment load and is particularly effective when there are clays in suspension as colloids. It is measured in the field with a nephelometer that measures '*the cloudiness of a water sample due to light deflection by the suspended particles*' (NSW EPA 2015, p. 22). It gives an immediate indication in the field rather than having to wait for a suspended solids result from the laboratory. This assists decision-making especially if water needs to be released from a sedimentation dam into receiving waters.

  Turbidity was measured for the first time in May 2015. A 2-25 NTU range is normal for an upland NSW river (ANZECC & ARMCANZ 2000, Table 3.3.3, p. 3.3-11). All the Gara River sampling points except GARA1 were within this range. Both landfill site sampling point waters (GARA3 and GARA5) exceeded the recommended range.
- Metals were tested by using a range of metals commonly used in water quality testing. Comments on the importance of the metals tested are found in Table 24.

  In a number of instances, the naturally occurring metal concentrations of the baseline study exceeded the 95% protection of aquatic ecosystem trigger values. Let's take GARA2, the sampling point that needs the most protection from the landfill perspective. It has only two metals (aluminium and iron) with concentrations that exceed the ANZECC & ARMCANZ (2000, Table 3.4.1, p. 3.4-5) trigger values for 95% protection of freshwater aquatic ecosystems. [Copper at GARA2 is not an exceedance. The water is classified as "hard" which reduces the metal's bioavailability and allows the 0.0014 mg/L trigger value to be multiplied by 3.9 (Table 3.4.3, p. 3.4-21)]. In contrast, the worst overall results were at the landfill site GARA3 where five metals (Al, Cu, Zn, Mn and Fe) exceeded the trigger values for 95% protection.

Antimony was sampled in May 2015 due to it being mined in the area. None was detected at any sampling point so its testing will be discontinued.

Metal samples for the first 14 rounds were not filtered and were tested for total metals. Filtering the metal samples in the field in the May 2015 sampling round and testing for dissolved metals has reduced the number of exceedances. For example, GARA3 metals only had one exceedance, aluminium.

Whether or not metal samples and TOC are filtered needs to be defined for the ambient surface water monitoring plan going forward. There are arguments for and against filtering. If a surface water sample is laden with sediment, it is difficult to filter. The easiest choice is not to filter metals or TOC in the baseline monitoring phase. If the concentrations exceed the ANZECC & ARMCANZ (2000) trigger values, then filtering can be undertaken in the detection monitoring phase. Dissolved metals results are admissible for comparisons against ANZECC & ARMCANZ (2000) trigger values for freshwater aquatic ecosystems because '*the major toxic effect of metals comes from the dissolved fraction'* (ANZECC & ARMCANZ, 2000, p. 3.4-15).

The foremost comment in regard to the preceding review is that the baseline results on many occasions exceed the ANZECC & ARMCANZ (2000) trigger values for the protection of freshwater aquatic ecosystems. The maximum baseline results therefore supersede the ANZECC & ARMCANZ (2000) trigger values. However, it needs to be taken into account that the baseline study provides just a snapshot of results that may not have revealed the true maximum natural concentrations or values. [The freshwater aquatic ecosystem trigger values were chosen as a comparison to the baseline results because it is the most immediate beneficial use (environmental value) to be protected and the most sensitive. Irrigation and stock uses are also important for the Gara River but the applicable concentrations are less stringent than those for freshwater aquatic ecosystems.]

The analytes and parameters tested included those whose values may show substantial variation due to landfill leachate intrusion or sediment load from site soil runoff. These were:

- Field: DO, EC, pH, Eh, alkalinity
- Nitrogen compounds
- Metals, especially iron (Fe) and manganese (Mn)
- Suspended solids and turbidity.

There were some extraneous inclusions in the parameter and analyte list. They were tested as a precaution and to broaden the understanding of the ambient surface water quality. Examples include:

- Sodium absorption ratio (SAR) is relevant to irrigation effects on soil. It indicates if soil may be affected by sodicity, that is, the presence of a high proportion of sodium (Na^+) ions relative to calcium (Ca_2^+) and magnesium (Mg_2^+) ions in soil or water. Sodicity degrades soil structure by breaking down clay aggregates.

  All SAR results in the baseline testing were reasonable for irrigation. Of particular note is the very low maximum 0.7 SAR at GARA2, which is protective of this most critical ambient surface water sampling point.

- Reactive phosphorus (RP) is the available portion of phosphorus to plants. Concentrations at GARA1 to GARA5 exceeded the ANZECC & ARMCANZ (2000, Table 3.3.2, p. 3.3-10) recommended 0.015 mg/L for NSW upland rivers. So RP is contributing to the plant growth in the Gara River. However, RP testing will not be carried out in the detection monitoring phase due to its holding time of only two (2) days before it must be analysed by the laboratory. Total phosphorus analysis suffices because RP is a subset of total phosphorus, which has a 28 day holding time.
- Fluoride is a secondary ion and a component of an anion cation balance used in laboratory quality control. Like some other major anions and cations, it is not needed in the detection monitoring phase because EC makes them redundant.
- Hardness is often tested for home purposes. It is applicable to suds in washing water and calcification build up on home appliances such as kettles, dishwashers, and water heaters and the installation of water softeners. Its use in stream water quality monitoring is valueed due to insufficient research data, but there are algorithms available to modify the trigger values for the protection of freshwater aquatic ecosystems of some metals [Cd, Cr(III), Cu, Pb Ni and Zn].

  The hardness results for the Gara River sampling points (GARA1, GARA2, GARA4) are classified as 'hard' because they are in the 120-179 mg/L as $CaCO_3$ range. Table 3.4.3 of ANZECC & ARMCANZ (2000, p. 3.4-21) indicates that the ANZECC & ARMCANZ (2000, Table 3.4.1, p. 3.4-5) trigger values can be increased for: Cd X 4.2; Cr (III) X 3.7; Cu X 3.9' Pb X 7.6; Ni X 3.9; and Zn X 3.9. The resulting trigger value concentrations for these metals are provided in Table 24.

  Sufficient information for varying metals trigger values has been obtained in the baseline study. Hardness testing will be discontinued in the detection monitoring phase.
- Total dissolved solids are the solids that remain after a sample is placed in a dish to evaporate. Electrical conductivity (EC) is commonly used to estimate an approximation. As EC is measured in the field it gives immediate answers concerning changes that may indicate landfill leachate contamination of surface water. TDS is therefore redundant and not needed in detection monitoring.
- Organochlorine (OC) and Organophosphorus (OP) pesticides were checked in case there are residuals from farming practices.

  The only pesticide detected was trans-Chlordane at GARA3 on the landfill site. At 0.00029 mg/L it was only a very low trace. Pesticides are very rarely detected in landfill leachate. Testing for pesticides should only be conducted in landfill leachate. There is no point in testing for OC & OP pesticides in groundwater or surface water if they are not present in high concentrations in leachate – which they are not. Only two, low trace OC & OP pesticides have been detected in concentrated landfill leachate results from four northern NSW landfills over the past 15 years (Hart 2015).
- Total petroleum hydrocarbons (TPH) can result from naturally occurring oils as well as petroleum products. Their inclusion in the baseline monitoring list was precautionary.

  A few traces were detected but not retested with silica gel cleanup to identify if they were natural or man-made. TPH or total recoverable hydrocarbons (TRH) are general tests that do not identify individual compounds.

  It is better to review specific hydrocarbon compounds which are landfill leachate contaminants of concern, for example, BTEX and PAH compounds.
- Phenols are usually not detected in rural landfill leachate. If they are, they are at trace levels (NSW EPA, 2015, p. 78). The ubiquity of phenols use and their trace levels in landfill leachate means that the phenols detected in surface water can never be directly attributed to landfill leachate.

The only phenol detected throughout the baseline ambient surface water monitoring was 3-&4-Methylphenols (a cresol) at GARA3 on the landfill site. This cresol could have been naturally occurring or evident due to its use in the manufacture of many compounds and materials including plastics, pesticides, pharmaceuticals and dyes (Wikipedia).

- Polynuclear aromatic compounds (PAHs) are rarely found in landfill leachate. PAHs are found in coal tar, crude oil, creosote, and roofing tar, but a few are used in medicines or to make dyes, plastics, and pesticides. They can also be due to incomplete burning, e.g., car exhaust fumes, burning wood, or even grilled meat.

  Only one was detected, and only once at GARA3 on the landfill site. Phenathrene was detected as a trace 0.00069 mg/L. Phenathrene is used to make dyes, plastics and pesticides, explosives and drugs. It has also been used to make bile acids, cholesterol and steroids. It is also found in cigarette smoke and occurs naturally in the mineral, ravatite (Wikipedia). (U.S. EPA fact sheet, http://www.epa.gov/osw/hazard/wastemin/minimize/factshts/phenanth.pdf)

There were some omissions that will assist interpretation of water quality if they are included in the detection monitoring program:

- Depth estimate of the water at the point at which the sample is taken.
- An estimate of the daily flow volume at each sampling point.
- Free carbon dioxide (CO_2) which is a field titration. Added to alkalinity, free CO_2 allows quantification of the major forms of inorganic carbon in the water sample. High free carbon dioxide in surface water provides an indication of a possible contamination problem on the day of sampling.
- Total organic carbon (TOC) is typically far less in surface water than in landfill leachate.

The above parameters and analytes were included for the first time in the May 2015 sampling round.

The preceding review indicates that the analytes and parameters used for the baseline monitoring were thorough. They provided:

- A full spectrum of understanding of the general ambient surface water quality; and
- A basis against which detection monitoring phase parameter and analyte values can be compared to note changes in water quality that may be due to landfill leachate or sediment load ingress.

8.3 Baseline ambient surface water monitoring to complete

It is concluded from the review in Sections 8.1 and 8.2 that sufficient baseline ambient surface water monitoring has been conducted at sampling points GARA1 to GARA5.

It is recommended that:

- Ambient surface water monitoring at GARA1 and GARA4 cease. A full baseline study is complete for these sampling points. Their monitoring was included in the baseline study as a precautionary measure. These sampling points are not directly relevant to the landfill site.
  - GARA2 is the sampling point whose water quality needs the most protection. There is now a full baseline study available to act as a comparison for its detection monitoring results. GARA1 is not needed as a comparison. It would only be necessary to retest GARA1 if assessment monitoring is triggered, when it would be needed to eliminate upstream water as the source of suspect results at GARA2.

  - GARA4 is approximately 10.4 km watercourse distance from the landfill site and therefore cannot be affected by landfill site events.
- Seven more quarterly baseline ambient surface water sampling rounds are conducted at GARA6 to gain an understanding of its quality over time.
- Detection monitoring commences at GARA2, GARA3 and GARA5. This should include the collection of two (2) more microbial data sets in the initial detection monitoring rounds to validate that faecal contamination is present from cattle dung and urine. These additional tests are to endorse the discontinuation of microbial testing in future site monitoring.

9. DETECTION MONITORING RECOMMENDATIONS

There are three phases to water monitoring at landfill sites:

1. ***Site characterisation*** of surface water and groundwater prior to landfill construction, and initial leachate quality once the landfill is constructed and operating, to serve as a ***baseline*** against which to compare future water quality data
2. ***Detection monitoring*** to determine whether or not there has been an impact on surface water and/or groundwater quality from landfill leachate or sediment runoff
3. ***Assessment monitoring*** in the event of impacts, to characterize possible surface water or groundwater contamination (nature, extent, possible future extent and source); and if required, to evaluate and recommend mitigation techniques.

(in keeping with Sara & Gibbons 2006)

The first two are essential for the operation of an environmentally responsible landfill. The third is undertaken after suspected impact.

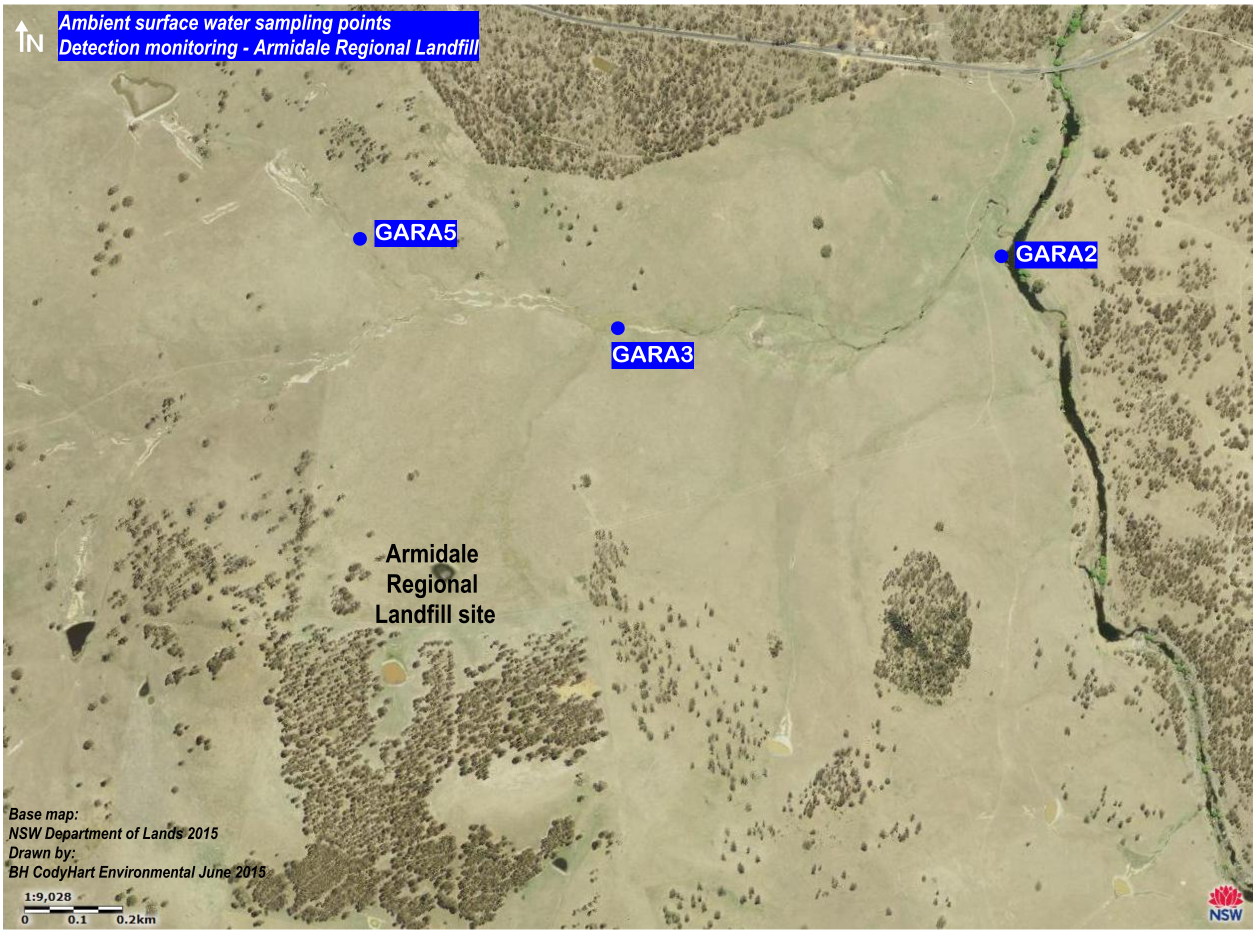
The baseline ambient surface water monitoring already conducted for the Armidale Regional Landfill has given a thorough overview of the ambient surface water quality in the area surrounding the landfill and on the landfill site. Continuing the ambient water quality monitoring at GARA6 for seven more quarterly rounds will complete the baseline sampling.

The detection monitoring phase for ambient surface water quality monitoring extends through the construction and operational phases of the landfill.

9.1 Detection monitoring ambient surface water sampling points

The on-site sampling points (GARA3 and GARA5) are the most relevant during the operational and post-operational stages of the landfill. These are the closest sampling points at which to detect sediment or landfill leachate problems affecting the ephemeral stream. The closest downstream sampling point on the Gara River, GARA2, is also of importance, not only due to its location as a detection point for impacts, but also due to this reach of the river being a platypus habitat. Figure 4 shows the three ambient surface water sampling points recommended for detection monitoring.

Figure 4: Detection monitoring ambient surface water sampling points – recommended



These locations are in keeping with the recommendations in the NSW EPA *Draft Environmental Waste Guidelines: Solid Waste Landfills* (2015, p. 26) for ambient surface water sampling points.

> *For each potentially affected surface water body, there should be at least one monitoring point downstream of the landfill (for flowing or perennial waters such as rivers and creeks) or near the landfill (for still waters such as lakes and dams).*
>
> *There should also be one monitoring point upstream of the landfill (for flowing waters) or distant from the landfill (for still waters) to establish the background, or unimpacted, surface water quality in the locality.*

Rather than one sampling point downstream of the landfill, two are proposed: GARA3 and GARA2.

9.2 Detection monitoring ambient surface water sampling frequency

Bi-monthly ambient surface water quality monitoring is proposed while major earthworks are ongoing, and thereafter, quarterly. Weather forecasts will be watched to ascertain when ephemeral stream water flow is likely at GARA5 and GARA3 and the sampling times adjusted accordingly. They will be sampled even if only isolated pools of water remain.

9.3 Detection monitoring ambient surface water parameters and analytes

The review of the baseline water quality analytes and parameters in Sections 8.1 and 8.2 was a precursor to the following selection of parameters and analytes for detection monitoring.

- Field parameters: Depth, volumetric flow, DO, EC, pH, Eh, temperature, turbidity
- Field analytes: Alkalinity, free CO_2
- Chloride
- Nutrients (NH_4^+ as N, TKN as N, NO_x as N, Total Phosphorus)
- Total organic carbon (TOC) (Filter on-site)
- Metals [Al, As, Cd, Cr, Cu, Ni, Pb, Zn, Mn, Fe, Fe (II)] (Filter on-site)
- Suspended solids

The metals tested are reduced from those in the baseline study to:

- those found in higher concentrations in a number of northern NSW landfills and Brisbane Landfill concentrated leachate samples over the past 20 years, with
- the addition of aluminium due to its presence in clays, and
- ferrous iron [Fe (II)]because it is a soluble by-product of iron reduction as biodegradation progresses (Dinicola, Simonds & Defawe 2005, p. 15; Wiedemeier et al. 2006, p. 582).

From the above parameters and analytes, the following are chosen as the geochemical parameters and analytes likely to have at least a 20% immediate increase on the baseline maximum due to landfill leachate intrusion: EC, pH, alkalinity, TOC, total nitrogen, chloride.

In many instances these geochemical indicators would increase GARA2 concentrations between 1.5 and 4.8 times if landfill leachate intruded, and the increases would occur in relative unison. Exceedances would be very obvious. This conclusion has been reached by reviewing data from landfill ponds that receive minimal and diluted landfill leachate at other northern NSW landfills, and comparing that data to GARA2 baseline results (Hart 2015). In many instances there was at least 15 years data for a thorough review.

9.4 Detection monitoring quality assurance

The Armidale Regional Landfill is not a contaminated site. The extensive number and type of quality assurance tests used during contaminated site assessment are not appropriate or warranted.

A range of methodologies and tests assure that the data being obtained is representative of the ambient surface water quality. These have already been explained in Section 5 of this report.

9.5 Detection monitoring water quality comparisons

Comparing results as they come to hand with historical results is essential to complete the objective of landfill detection monitoring - to determine whether or not there has been an impact on surface water and/or groundwater quality by landfill leachate or sediment runoff.

The following process will be followed:

1. Prepare statistical trigger values for GARA2 geochemical indicator parameters or analytes (EC, pH, alkalinity, TOC, total nitrogen, chloride). Take 6 samples of each geochemical analyte or parameter in the next round of sampling at GARA2. Use these

samples to add an estimate of within-event variation that is possible at each sampling event. (Taking only one sample per round does not reveal the maximum or minimum value possible for that round. A far higher maximum than that detected may actually be the fact. Variation in results is normal and should be taken into account). Use Chebyshev's Theorem theory to estimate and add-on an estimate of the within-event variation to the maximum, or subtract from the minimum pH, of each selected geochemical indicator for GARA2.

The preceding methodology was devised with the assistance of a statistician and implemented by Hart (2000) and accepted by EPA Grafton office. It is the basis of the statistical trigger values detailed in Environment Protection Licence L7186 for the Grafton Regional Landfill.

GARA2 is the aquatic habitat to be protected. Concentrating on knowing its water quality characteristics and quickly taking action if there are any concerns is paramount. Note that the parameter and analyte values at the ephemeral stream sampling points GARA3 and GARA5 during the baseline study show considerable variation. This is probably due to the sample volume being valued on some sampling occasions, and exposed clay being entrained in turbid samples. Clay in samples increases EC values and total metal concentrations. There would be little confidence in trigger values based on these variable results.

GARA3 and GARA5 results are to be reviewed by a person experienced in water quality review, such as a landfill hydrogeologist who is aware of the site conditions and possible sediment load and leachate ingress scenarios.

2. When field and laboratory results become available, input them into the historical tables on that day, or the day after.
3. Compare the latest results through a vertical scan of each parameter and analyte in the tables and note if any are greater than the baseline maximum value or statistical trigger value for GARA2 - or in the case of pH if also less than the minimum value. (Remember to review pH from a logarithmic scale perspective.)
4. If anomalies may be a clerical or laboratory mistake, have the results double checked.
5. If any three or more of the selected geochemical indicators for GARA2 exceed their statistical trigger values/s by more than 20%, then commence assessment monitoring within 5 business days or sooner.
6. If suspended solids ≥50 mg/L at any sampling point, review if upstream erosion remediation is warranted, or if the results at GARA3 and GARA5 are simply due to low sample depth and exposed clay in a colloidal sample.

10. ASSESSMENT MONIITORING RECOMMENDATIONS

Assessment monitoring will come into play:

- If any three or more of the selected geochemical indicators for GARA2 exceed their statistical trigger value/s by more than 20%
- If either GARA3 and/or GARA5 are determined to be in need of assessment monitoring by a person experienced in water quality review
- If inspection of any other water body in the landfill environs is noted as needing water quality review.

The watercourse upstream and downstream of the suspected contamination will be inspected to decide the most appropriate sampling points for investigating the nature, extent, possible future extent and source of the contamination. In the process, possible mitigation techniques will be identified for evaluation with Council personnel.

If GARA2 is the impacted sampling point, then assessment monitoring will include GARA1 and GARA6, or more appropriate upstream and downstream substitutes, as well as GARA2.

The parameters and analytes to be tested are similar but slightly varied from those used in baseline monitoring.

- Field: Depth, volumetric flow, DO, EC, pH, Eh, temp, turbidity, alkalinity, free CO_2
- Laboratory:
  - SS
  - Cl, SO_4, Ca, Mg, Na, K, Hardness
  - Nutrients (NH_4^+ as N, TKN as N, NO_x as N, Total Phosphorus)
  - Dissolved metals filtered on site with 0.45 µm filter [Al, As, Cd, Cr, Cu, Ni, Pb, Zn, Mn, Fe, Fe (II)]
  - TOC (filtered)
  - Organics – VOCs, ultra trace (UT) PAHs, speciated phenols – only if sheen, colour, odour indicates that testing for these is worthwhile.

The sampling frequency will be determined by a person experienced in water quality review.

Desktop review will involve:

- Assessment of results against the baseline values of parameters and analytes for each of the sampling points or nearby sampling points
- Assessment of geochemical results for GARA2 against the statistical trigger values derived from baseline data
- Assessment of all results against trigger values for metals and organics as detailed in ANZECC & ARMCANZ (2000) tables – metals & organic compounds against the toxicity table 3.4.1, with the metal trigger values adjusted for hardness as detailed on Table 3.4.4.

Armidale Dumaresq Council management will be informed throughout the assessment process and advised of the surface water contamination nature, extent, possible future extent, and source. Mitigation techniques will be discussed with and evaluated by Council.

11. AMBIENT SURFACE WATER MONITORING PROGRAM OVERVIEW

The following table provides an overview of the Armidale Regional Landfill ambient surface water monitoring program as detailed in the preceding sections of this report.

Table 25: Ambient surface water monitoring program - Armidale Regional Landfill

Baseline monitoring *(GARA1-GARA6)*	**Detection monitoring** *(GARA2, GARA3, GARA5)*	**Assessment monitoring** *(GARA2, GARA3, GARA5 + appropriate)*
Sampling points (Figures 1, 2, 3) ***GARA1*** (upstream Gara River) ***GARA2*** (on Gara River, 1.2 km downstream from landfill) ***GARA3*** (on landfill site ephemeral stream, just downstream from the landfill) **GARA4** ("Blue Hole", Oxley Wild Rivers National Park, 10.4 km downstream from landfill, 21.0 km downstream from Armidale STP) ***GARA5*** (on landfill site ephemeral stream, upstream from landfill) ***GARA6*** (6.3km downstream from GARA2, 7.5 km downstream from the landfill)	***Sampling points*** (Figure 4) ***GARA5*** (upstream from landfill) ***GARA3*** (downstream from landfill) ***GARA2*** (1.2 km farther downstream from landfill than GARA3)	***Sampling points*** (Figures 1, 2, 3) **For impacted sampling point : GARA5, GARA3 and/or GARA2** If GARA2 impacted, add GARA1 and GARA6, or more appropriate upstream and downstream substitutes.
Sampling frequency Two to six months apart depending if there was flow at GARA3 and GARA5	***Sampling frequency*** Bi-monthly during major construction works, quarterly thereafter	***Sampling frequency*** Determine by review of need
Parameters & analytes Field: Depth, volumetric flow, DO, EC, pH, Eh, temp, turbidity, alkalinity, free CO_2 Laboratory: SS, Cl, SO_4, Ca, Mg, Na, K, Hardness, Nutrients (NH_4^+ as N, TKN as N, NO_x as N, Total Phosphorus), Total metals not filtered [Al, As, Cd, Cr, Cu, Ni, Pb, Zn, Mn, Fe, Se, Hg, Fe (II)-GARA6, Br, B, TOC (filtered), UT PAH, OC&OP pesticides, TPH/TRH, speciated phenolics. Notes: Some extra tests by ADC are not noted above. Highlighted ones added by CodyHart.	***Parameters & analytes*** Field: Depth, volumetric flow, DO, EC, pH, Eh, temp, turbidity, alkalinity, free CO_2 Laboratory: SS, Cl, Nutrients (NH_4^+ as N, TKN as N, NO_x as N, Total Phosphorus), Dissolved metals filtered on site with 0.45 µm filter [Al, As, Cd, Cr, Cu, Ni, Pb, Zn, Mn, Fe, Fe (II)], TOC (filtered).	***Parameters & analytes*** Field: Depth, volumetric flow, DO, EC, pH, Eh, temp, turbidity, alkalinity, free CO_2 Laboratory: SS, Cl, SO_4, Ca, Mg, Na, K, Hardness, Nutrients (NH_4^+ as N, TKN as N, NO_x as N, Total Phosphorus), Dissolved metals filtered on site with 0.45 µm filter [Al, As, Cd, Cr, Cu, Ni, Pb, Zn, Mn, Fe, Fe (II)], TOC (filtered), and if sheen, colour, odour indicates it is warranted – test for VOCs, UT PAHs, speciated phenolics.
QA samples to laboratory 1 intra-lab duplicate per 10 sampling points	***QA samples to laboratory*** 1 intra-lab duplicate per 10 sampling points	***QA samples to laboratory*** 1 intra-lab duplicate per 10 sampling points
Comparisons Baseline results against 95% protection of freshwater aquatic ecosystems (ANZECC & ARMCANZ 2000, Table 3.4.1, p. 3.4-5) and other tables 3.3.2, 3.4.4 and 8.3.7. If two baseline values greater than ANZECC & ARMCANZ (2000), then devise new comparison method based on review of landfill leachate values at other sites. **Note** (June 2015): To complete the baseline monitoring, conduct 7 more quarterly rounds at GARA6; and *E Coli & enterococci* two more times at GARA5, GARA3 and GARA2.	***Comparisons*** GARA3 & GARA5 – review by water monitoring specialist GARA2 – If any three or more of the geochemical indicators exceed their statistical trigger value/s by 20% or more, then commence assessment monitoring within 5 working days or sooner. [Selected indicators: EC, pH, alkalinity, TOC, total nitrogen, chloride.] If any sampling point SS ≥50 mg/L then review upstream erosion & sediment control measures.	***Comparisons*** GARA2 - Review against statistical trigger values of selected geochemical indicators and acceptable values for metals & organic compounds ANZECC & ARMCANZ (2000) toxicity Table 3.4.1, and combine with Hardness Table 3.4.4 for metals. *© CodyHart Environmental 2015*

12. CONCLUSION

This report has detailed and interpreted the baseline ambient surface water results for the Armidale Regional Landfill.

There are six baseline ambient surface sampling as displayed on Figures 1, 2 and 3: GARA1, GARA2, GARA3, GARA4, GARA5, GARA6.

GARA1, GARA4 and GARA6 were included as precautionary sampling points to ascertain the water quality state of the Gara River, which flows through the Oxley Wild Rivers National Park.

A recent baseline sampling round was conducted by CodyHart in May 2015 and has been described in this report. Prior to that, fourteen rounds of baseline monitoring, which commenced in December 2008, were undertaken by Armidale Dumaresq Council at all sampling points - except for GARA6, which was sampled for the first time in May 2015.

Results from all sampling rounds have been input into historical tables in this report.

It is concluded that baseline monitoring is complete for GARA1 to GARA5.

It is recommended that seven (7) more quarterly baseline monitoring rounds be conducted at GARA6.

It is also recommended that *E. Coli* and enterococci be sampled twice more at GARA3 and GARA5 located on the landfill site ephemeral stream. These faecal coliform indicators were sampled only once at all sampling points - in May 2015. The results were high at GARA3 and GARA5 due to cattle dung and urine. The extra samples are recommended prior to landfill operation to validate the high results and endorse their removal from both the ambient and stormwater surface water monitoring program. The high faecal coliforms are due to cattle dung and urine from both on-site grazing which will cease, and from grazing on the upgradient property which will continue post landfill installation. The faecal coliforms will never be attributable to landfill site works or landfill leachate.

It is recommended that the detection monitoring program commence when major works on the site begins.

A quarterly detection monitoring program is recommended for GARA2, GARA3 and GARA5 (Figure 4). Two of these sampling points (GARA3 and GARA2) are downstream of the landfill. This is one more downstream ambient surface water sampling point than required in the NSW EPA *Draft Environmental Guidelines: Solid Waste Landfills* (March 2015).

Data from landfill ponds that receive minimal and diluted landfill leachate at other northern NSW landfills were compared to GARA2 baseline results by Hart (2015). This review resulted in a succinct list of parameters and analytes for the detection monitoring program.

From within this list, six traditional, geochemical parameters and analytes (EC, pH, alkalinity, TOC, total nitrogen and chloride) were selected due to their early and noticeable response to leachate intrusion in surface water. Statistically derived trigger values will be calculated for these indicators for the GARA2 sampling point only. The GARA2 indicator statistical trigger values will be calculated using the methodology devised by Hart (2000) in conjunction with a statistician and approved by NSW EPA Grafton for the Grafton Regional Landfill. If GARA2 statistical trigger values, for three or more indicators, are exceeded by 20% or more, then the assessment monitoring program will commence within five working days or sooner.

The data at GARA3 and GARA5 are too variable to devise meaningful trigger values. This is due to their location in the ephemeral stream where sample volumes are limited and often colloidal. Judicious review of each round's results by a water monitoring specialist is advisable.

For the ambient surface water assessment monitoring program, additional parameters and analytes are added to those tested in the detection monitoring program: major anions and cations, hardness, and if sheen, colour or odour indicates it is warranted – tests for VOCs, UT PAHs, and speciated phenolics. Appropriate sampling points will be sampled to determine the nature, extent, possible future extent, and source of the contamination.

Table 25 summarises the three phases of the ambient surface water monitoring program for the Armidale Regional Landfill: baseline monitoring, detection monitoring and assessment monitoring.

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APPENDIX A

Field Parameter Forms

SURFACE WATER FIELD PARAMETER FORM

Project: Armidale Regional Landfill

Sample Point ID: GARA1
E 56 384741.0 **N** 6620301.0

SAMPLING INFORMATION

Pretest of deionised water 1·22 µS/cm at 25°C

Field blank EC 3·16 µs/cm at 25°C

	DO mg/L	EC µs/cm	pH (STD)	Eh (mV)	Temp (°C)	Turbidity (NTU)
	7•24	303	7•95	+177	16•1	26•1
	5•98	296	7•93	+166	16•5	27•6
$\bar{X}$ =	6·61	300	7·94	+172	16·3	26·9
RPD	✓	✓	✓	✓	✓	✓

Sample composited (Y/N): N

Beaker material: polypropylene

Sample date: 04 / 05 / 15 **Start sample:** 11:30 (2400 hr clock)

Weather: (5 min. max. at ground level at GARA6) Rain N, Temp 17·2°C, Cloud cover 40%

Wind direction 80°, Wind Speed 1·04 m/s Upwind Activities river bank

Sample appearance: Colour yellow translucent Notes riffle just upstream

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LOCATION INFORMATION

Grab sample with 3 m extension pole from Gara River – ~45 m north of Gara River Bridge on Waterfall Way.

DEPTH INFORMATION

A. Estimated depth of water at sampling point (m) 0 . 35 m

Estimates for volumetric flow rate (kL/day): D 0·35 *m* X W 5·0 *m* X 1 m in 4 *secs*
= 1·75 *m*^{3} in 4 *secs*
= 0·4375 *m*^{3} *in 1 sec* = 37,800 kL/day

Non-conformances of sampling point (see *'Field checks'*) **and equipment (Y/N)** : N (If yes, write details and remedy or arrange remedy.)

Details:

Sampling procedures were those detailed by CodyHart Consulting Pty Ltd.

Sampler's name: Barbara Hart Signature: B Hart Date: 4/5/15 Time: 11:45

metals
☑ Filtered ☐ Not filtered

Tick on metals bottle: ☑ Dissolved ☐ Total

EC standard 2760 µS/cm

Field lab: TPS 90FL + Turbidity

SURFACE WATER FIELD PARAMETER FORM

Project: Armidale Regional Landfill

Sample Point ID: GARA2
E 56 384635.0 N 6619865.0

SAMPLING INFORMATION

Pretest of deionised water 1.22 µS/cm at 25°C

Field blank EC 2.78 µs/cm at 25°C

	DO (mg/L)	**EC** (µs/cm)	**pH** (STD)	**Eh** (mV)	**Temp** (°C)	**Turbidity** (NTU)
	6.72	390	8.16	+176	18.0	3.5
	7.03	382	8.31	+162	18.1	3.7
$\bar{X}$ =	6.88	386	8.24	+168	18.1	3.6
RPD	✓	✓	✓	✓	✓	✓

Sample composited (Y/N): N

Beaker material: polypropylene

Sample date: 04/05/15 **Start sample:** 12:30 (2400 hr clock)

Weather: (5 min. max. at ground level at GARA6) Rain N, Temp 17.2°C, Cloud cover 40%

Wind direction 80°, Wind Speed 1.04 m/s Upwind Activities river

Sample appearance: Colour very light translucent yellow Notes Platypus

LOCATION INFORMATION

Grab sample with 3 m extension pole from Gara River ~45 m south confluence landfill site creek & Gara River.

DEPTH INFORMATION

A. Estimated depth of water at sampling point (m) ~≥2.50 m

Estimates for volumetric flow rate (kL/day): D 2.5 *m* X W 20 *m* X 1 m in 255 *secs*
= 50 *m*³ in 255 *secs*
= 0.196784*m*³ *in 1 sec* = 16,941 kL/day

Non-conformances of sampling point (see *'Field checks'*) **and equipment (Y/N)** : N (If yes, write details and remedy or arrange remedy.)

Details:

Sampling procedures were those detailed by CodyHart Consulting Pty Ltd.

Sampler's name: Barbara Hart Signature: B Hart Date: 4/5/15 Time: 12:45

metals

☑ Filtered ☐ Not filtered

Tick on metals bottle: ☑ Dissolved ☐ Total

EC standard 2760 µS/cm

Field lab: TPS 90FL + Turbidity

CodyHart Environmental

SURFACE WATER & LEACHATE FIELD PARAMETER FORM

Project: Armidale Regional Landfill **SAMPLE POINT ID:** GARA3

E56 383826.0 **N** 6619708.0

SAMPLING INFORMATION

Pretest of deionised water 1·22 µS/cm at 25°C

Field blank EC 2·78 µs/cm at 25°C

	DO (mg/L)	**EC** (µs/cm)	**pH** (STD)	**Eh** (mV)	**Temp** (°C)	**Turbidity** (NTU)
	6.53	99·2	7.49	+205	17.9	281
	6.17	89·5	7.66	+212	17.8	281
X̄ =	6.35	94·4	7·58	+209	17·9	281
RPD	✓	✓	✓	✓	✓	✓

Sample composited (Y/N): N

Beaker material: polypropylene

Sample date: 04/05/15 **Start sample:** 13:30 (2400 hr clock)

Weather: (5 min. max. at ground level at GARA 6) Rain N , Temp 17·2°C , Cloud cover 40%

Wind direction 80° , Wind Speed 1·04 m/s Upwind Activities paddock

Sample appearance: Colour yellow-brown Notes sediment laden cattle grazing

---

LOCATION INFORMATION

Grab sample with 3 m extension pole from landfill ephemeral stream – water hole ~10 m upstream of small waterfall - in line between BH02 and 2 stringy bark gums on northern side of stream. Downstream from proposed outlet for dissipation basin.

DEPTH INFORMATION

A. Estimated depth of water at sampling point (m) 0 . 50 m

Estimates for volumetric flow rate (kL/day): D 0·5 *m* X W 0·15 *m* X 1 m in 25 *secs*

= 0075 *m*³ in 25 *secs*

= 0·0001 *m*³ *in 1 sec* = 259·2 kL/day

Non-conformances of sampling point (see *'Field checks'*) **and equipment (Y/N)** : N (If yes, write details and remedy or arrange remedy.)

Details:

Sampling procedures were those detailed by CodyHart Consulting Pty Ltd.

Sampler's name: Barbara Hart Signature: B Hart Date: 4/5/15 Time: 13:45

metals

☑ Filtered ☐ Not filtered

Tick on metals bottle: ☑ Dissolved ☐ Total

EC standard 2760 µS/cm

Field lab: TPS 90FL + Turbidity

CodyHart Environmental

SURFACE WATER FIELD PARAMETER FORM

Project: Armidale Regional Landfill

Sample Point ID: GARA4
E56 384915.0 N 6614748.0

SAMPLING INFORMATION

Pretest of deionised water 1·22 µS/cm at 25°C

Field blank EC 3·16 µs/cm at 25°C

	DO (mg/L)	**EC** (µs/cm)	**pH** (STD)	**Eh** (mV)	**Temp** (°C)	**Turbidity** (NTU)
	7·27	444	7·31	+238	14·5	3·5
	7·21	382	8·24	+218	14·6	6·4
$\bar{X}$ =	7·24	413	7·78	+228	14·6	5·0
RPD	✓	✓	✓	✓	✓	✓

Sample composited (Y/N): N

Beaker material: polypropylene

Sample date: 04/05/15 **Start sample:** 10:30 (2400 hr clock)

Weather: (5 min. max. at ground level at GARA6) Rain N , Temp 17·2°C , Cloud cover 40%

Wind direction 80° , Wind Speed 1·04m/s Upwind Activities Blue Hole

Sample appearance: Colour translucent light yellow Notes duckweed ducks

LOCATION INFORMATION

Grab sample with 3 m extension pole from Gara River post Commissioners Waters confluence – flat area on Gara River edge ~65 m northeast of picnic shed at Blue Hole.

DEPTH INFORMATION

A. Estimated depth of water at sampling point (m) ~1.00 m

Estimates for volumetric flow rate (kL/day): D 1·0 m X W 25·0 m X 1 m in 27 secs
= 25·0 m³ in 27 secs
= 0·9259259 m³ in 1 sec = 80,000 kL/day

Non-conformances of sampling point (see *'Field checks'*) **and equipment (Y/N) :** N (If yes, write details and remedy or arrange remedy.)

Details:

Sampling procedures were those detailed by CodyHart Consulting Pty Ltd.

Sampler's name: Barbara Hart Signature: B Hart Date: 4/5/15 Time: 10:45

metals
☑ Filtered ☐ Not filtered

Tick on metals bottle: ☑ Dissolved ☐ Total

EC standard 2760 µS/cm

Field lab: TPS 90FL + Turbidity

CodyHart Environmental

SURFACE WATER FIELD PARAMETER FORM

Project: Armidale Regional Landfill

Sample Point ID: GARA5

E56 383279.0 N 6619897.0

SAMPLING INFORMATION

Pretest of deionised water 1.22 µS/cm at 25°C

Field blank EC 2.78 µs/cm at 25°C

	DO (mg/L)	**EC** (µs/cm)	**pH** (STD)	**Eh** (mV)	**Temp** (°C)	**Turbidity** (NTU)
	5.69	45.8	8.23	+207	20.6	62.5
	5.52	43.9	8.11	+204	20.1	65.1
$\bar{X}$ =	5.61	44.9	8.17	+206	20.4	63.8
RPD	✓	✓	✓	✓	✓	✓

Sample composited (Y/N): N

Beaker material: polypropylene

Sample date: 04/05/15 **Start sample:** 13:00 (2400 hr clock)

Weather: (5 min. max. at ground level at GARA6) Rain N, Temp 17.2°C, Cloud cover 40%

Wind direction 80°, Wind Speed 1.04m/s Upwind Activities track + paddock

Sample appearance: Colour yellow brown Notes cattle grazing + some erosion upstream

---

LOCATION INFORMATION

Grab sample with 3 m extension pole from east side of fence line, most northern ephemeral stream branch, as one drives in from Waterfall Way.

DEPTH INFORMATION

A. Estimated depth of water at sampling point (m) 0 . 25 m

Estimates for volumetric flow rate (kL/day): D 0.25 *m* X W 1.0 *m* X ~~1~~ 0.5 m in 40 *secs*

= 0.125 *m*^{3} in 40 *secs*

= 0.003125 *m*^{3} *in 1 sec* = 270 kL/day

Non-conformances of sampling point (see *'Field checks'*) **and equipment (Y/N)** : N (If yes, write details and remedy or arrange remedy.)

Details:

Sampling procedures were those detailed by CodyHart Consulting Pty Ltd.

Sampler's name: Barbara Hart Signature: B Hart Date: 4/5/15 Time: 13:15

metals

☑ Filtered ☐ Not filtered

Tick on metals bottle: ☑ Dissolved ☐ Total

EC standard 2760 µS/cm

Field lab: TPS 90FL + Turbidity

CodyHart Environmental

SURFACE WATER FIELD PARAMETER FORM

Project: Armidale Regional Landfill

Sample Point ID: GARA6
E56 385915.0 N 6616606.0

SAMPLING INFORMATION

Pretest of deionised water 1·22 µS/cm at 25°C

Field blank EC 3·16 µs/cm at 25°C

	DO (mg/L)	**EC** (µs/cm)	**pH** (STD)	**Eh** (mV)	**Temp** (°C)	**Turbidity** (NTU)
	7·06	405	8·02	+213	15·1	6·4
	7·03	387	8·22	+202	15·3	8·0
X =	7·05	396	8·12	+208	15·2	7·2
RPD	✓	✓	✓	✓	✓	✓

Sample composited (Y/N): N

Beaker material: polypropylene

Sample date: 4 / 5 / 15 **Start sample:** 11:00 (2400 hr clock)

Weather: (5 min. max. at ground level at GARA6) Rain N , Temp 17·2°C , Cloud cover 40%

Wind direction 80° , Wind Speed 1·04 m/s Upwind Activities river

Sample appearance: Colour translucent yellow Notes healthy water plants + duck weed

LOCATION INFORMATION

Grab sample with 3 m extension pole from Gara River near Gara Station ~15 m north of causeway on western bank.

DEPTH INFORMATION

A. Estimated depth of water at sampling point (m) 0 . 45 m

Measured flow at causeway

Estimates for volumetric flow rate (kL/day): D 0·01 *m* X W 8·0*m* X 1 m in 3 *secs*
= 0·08 *m*³ in 3 *secs*
= 0·0266666*m*³ *in 1 sec* = 2,304 kL/day

Non-conformances of sampling point (see *'Field checks'*) **and equipment (Y/N) :** N (If yes, write details and remedy or arrange remedy.)

Details:

Sampling procedures were those detailed by CodyHart Consulting Pty Ltd.

Sampler's name: Barbara Hart Signature: B Hart Date: 4/5/15 Time: 11:15

metals
☑ Filtered ☐ Not filtered

Tick on metals bottle: ☑ Dissolved ☐ Total

EC standard 2760 µS/cm

Field lab: TPS 90FL + Turbidity

APPENDIX B

Chain of Custody Forms
and
Calibration Certificate

CodyHart COC to Site & Calibration Certificate

Chain of Custody for sample containers - laboratory to site

CodyHart ordered sample containers from ALS laboratory, Stafford, Brisbane. When they were received they were stored in the locked and security monitored CodyHart office at Burleigh Heads, Queensland.

CodyHart labels were adhered to appropriate containers. The containers for each sampling point were placed into self sealing plastic bags, which were then labelled with the sampling point identity. The containers for each sampling point were then placed into CodyHart eskies and transported to the Armidale Regional Landfill by CodyHart.

It is certified that the sample bottles were received in unbroken sealed containers from ALS, and that no tampering with the sample containers occurred when in CodyHart hands.

B F Hart 04/05/15

Calibration certificate for field lab

A TPS 90-FL Series field lab was used by CodyHart to take field dissolved oxygen (DO), electrical conductivity (EC), pH, redox potential (Eh), and temperature readings.

A yearly maintenance service is conducted on the TPS field lab by TPS Pty Ltd, Brisbane.

It is certified that the field lab used was calibrated daily at Armidale so that sampling was conducted within 24 hours of its calibration. The pH probe was recalibrated if any probe drift was noticed. The calibration processes were documented and are available on request.

B F Hart 04/05/15

CHAIN OF CUSTODY TO LAB

BATCH 1 of 2

CodyHart Environmental
Monitoring & Management

CLIENT: *CodyHart Environmental*
ADDRESS / OFFICE: 3/29 Township Drive, BURLEIGH HEADS 4220 (PO Box 1073 BURLEIGH HEADS 4220)
PROJECT MANAGER (PM): Barbara Hart
PROJECT ID: Armidale Regional 2119
SITE: [redacted], Armidale Regional Landfill P.O. NO.:
RESULTS REQUIRED (Date): QUOTE NO: **BNBQ/052/14**

SAMPLER: B. Hart
MOBILE: 042 777 5120
PHONE:
EMAIL REPORT TO: pelican@codyhart.com.au
EMAIL INVOICE TO: (above)

COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:

1. PLEASE SCAN THIS FORM ON DAY OF ARRIVAL & EMAIL.
2. PLEASE GLASS-FIBRE FILTER SEMI-VOL SAMPLES IF TURBID.

ANALYSES REQUIRED:

SAMPLE INFORMATION (note: S = Soil, W=Water)					CONTAINER INFORMATION												
ALS ID	SAMPLE ID	MATRIX	DATE	Time	TYPE	No. bottles	EA025 - Water Suspended Solids	EK055A - Water Ammonia as N	NT-11 Water NOx TKN Tot P	W-30-F - ICP/MS Dissolved **PLUS Mn & Sb**	EP005 - Water Total Organic Carbon (TOC)	W-4 - Water TPH/TRH (C6-C36or40)BTEXN F1&F2	W-4 **SG** Water TPH/TRH (C6-C36or40)BTEXN F1&F2	EP132B PAH UT	W-12 - Water OC/OP Pesticides	MW06 - Water E.Coli by MF	MW023 - Water Enterococci by MF
1	GARA1	W	4/5/15	11:30	500mLGreen; 60mLRed; 3x40m,125mLPurple; 2X100 & 1x500 mL Orange	9	x	x	x	x	x	x	x	x	x		
2	GARA2	W	4/5/15	12:30	500mLGreen; 60mLRed; 3x40m,125mLPurple; 2X100 & 1x500 mL Orange	9	x	x	x	x	x	x	x	x	x		
3	GARA3	W	4/5/15	13:30	500mLGreen; 60mLRed; 3x40m,125mLPurple; 2X100 & 1x500 mL Orange	9	x	x	x	x	x	x	x	x	x		
4	GARA4	W	4/5/15	10:30	500mLGreen; 60mLRed; 3x40m,125mLPurple; 2X100 & 1x500 mL Orange	9	x	x	x	x	x	x	x	x	x		
5	GARA5	W	4/5/15	13:00	500mLGreen; 60mLRed; 3x40m,125mLPurple; 2X100 & 3x500 mL Orange	11	x	x	x	x	x	x	x	x	x		
6	GARA6	W	4/5/15	11:00	500mLGreen; 60mLRed; 3x40m,125mLPurple; 2X100 & 1x500 mL Orange	9	x	x	x	x	x	x	x	x	x		
7	GARA-DUP	W	4/5/15	NA	500mLGreen; 60mLRed; 3x40m,125mLPurple; 1X100 Orange	7	x	x	x	x	x	x	x				

<--2 extra 2x500 mL semi vol bottles for lab dup & matrix spike

Environmental Division
Brisbane
Work Order Reference
EB1518173
Telephone : +61-7-3243 7222

MV

RELINQUISHED BY:
Name: *Barbara Hart* Date: 4/5/15
Of: *CodyHart Environmental* Time: 16:00
Signature: *B F Hart*

RECEIVED BY:
Name: C. PERRY Date: 5/5/15
Of: ALS Laboratory, Brisbane Time: 14.40
Signature:

METHOD OF SHIPMENT
Transport Co: *Tamex*
Con Note No: 6152653
ALS security seal nos:
A336859-A336864

Samples were despatched in CodyHart Esky/Eskies numbered: 1, 11, 30 plus 12 small & 3 large CodyHart gel bricks

PLEASE HOLD CODYHART ESKIES & GEL BRICKS UNTIL RETURN REQUESTED.

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EB1518173**

Client	: **CODYHART CONSULTING PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS BARBARA HART	Contact	: Customer Services EB
Address	: P O BOX 1073 BURLEIGH HEADS QLD, AUSTRALIA 4220	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: pelican@codyhart.com.au	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: +61 55205532	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 55206531	Facsimile	: +61-7-3243 7218
Project	: Armidale Regional 2119	Page	: 1 of 3
Order number	: ----	Quote number	: EB2014CODCON0251 (BNBQ/052/14)
C-O-C number	: ----	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Site	: Armidale Regional Landfill		
Sampler	: BARBARA HART		

Dates

Date Samples Received	: 05-May-2015	Issue Date	: 07-May-2015
Client Requested Due Date	: 12-May-2015	Scheduled Reporting Date	: **12-May-2015**

Delivery Details

Mode of Delivery	: Carrier	Security Seal	: Intact.
No. of coolers/boxes	: 3	Temperature	: <6°C - Ice present
Receipt Detail	:	No. of samples received / analysed	: 7 / 7

General Comments

- This report contains the following information:
    - Sample Container(s)/Preservation Non-Compliances
    - Summary of Sample(s) and Requested Analysis
    - Proactive Holding Time Report
    - Requested Deliverables
- **Please be advised that a Preliminary Report will be submitted and the Ultra Trace PAH is expected by 15/5/15.**
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- **Ultra Trace PAH analysis will be conducted by ALS Environmental, Sydney, NATA accreditation no. 825, Site No. 10911 (Micro site no. 14913).**
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of work order.
- Please direct any queries related to sample condition / numbering / breakages to John Pickering (John.Pickering@alsglobal.com).
- Analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818 (Micro site no. 18958).
- **Sample(s) requiring volatile organic compound analysis received in airtight containers (ZHE).**
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - EA025H Suspended Solids (High Level)	WATER - EG020F Dissolved Metals by ICPMS	WATER - EK055G Ammonia as N By Discrete Analyser	WATER - EP132(PAH) Ultra Trace Polynuclear Aromatic Compounds	WATER - NT-11 Total Nitrogen and Total Phosphorus	WATER - W-12 OC/OP Pesticides	WATER - W-30 11 Metals
EB1518173-001	04-May-2015 11:30	GARA1	✓	✓	✓	✓	✓	✓	✓
EB1518173-002	04-May-2015 12:30	GARA2	✓	✓	✓	✓	✓	✓	✓
EB1518173-003	04-May-2015 13:30	GARA3	✓	✓	✓	✓	✓	✓	✓
EB1518173-004	04-May-2015 10:30	GARA4	✓	✓	✓	✓	✓	✓	✓
EB1518173-005	04-May-2015 13:00	GARA5	✓	✓	✓	✓	✓	✓	✓
EB1518173-006	04-May-2015 11:00	GARA6	✓	✓	✓	✓	✓	✓	✓
EB1518173-007	[04-May-2015]	GARA-DUP	✓	✓	✓		✓		✓

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - EP005 Total Organic Carbon (TOC)	WATER - EP071SG TRH Silica Gel Clean Up	WATER - W-04 TRH/BTEXN
EB1518173-001	04-May-2015 11:30	GARA1	✓	✓	✓
EB1518173-002	04-May-2015 12:30	GARA2	✓	✓	✓
EB1518173-003	04-May-2015 13:30	GARA3	✓	✓	✓
EB1518173-004	04-May-2015 10:30	GARA4	✓	✓	✓
EB1518173-005	04-May-2015 13:00	GARA5	✓	✓	✓
EB1518173-006	04-May-2015 11:00	GARA6	✓	✓	✓
EB1518173-007	[04-May-2015]	GARA-DUP	✓	✓	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

BARBARA HART

- *AU Certificate of Analysis - NATA (COA)	Email	pelican@codyhart.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	pelican@codyhart.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	pelican@codyhart.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	pelican@codyhart.com.au
- A4 - AU Tax Invoice (INV)	Email	pelican@codyhart.com.au
- Chain of Custody (CoC) (COC)	Email	pelican@codyhart.com.au
- EDI Format - ENMRG (ENMRG)	Email	pelican@codyhart.com.au
- EDI Format - XTab (XTAB)	Email	pelican@codyhart.com.au

CHAIN OF CUSTODY TO LAB

CodyHart Environmental
Monitoring & Management

CLIENT: *CodyHart Environmental*
ADDRESS / OFFICE: 3/29 Township Drive, BURLEIGH HEADS 4220 (PO Box 1073 BURLEIGH HEADS 4220)
PROJECT MANAGER (PM): Barbara Hart
PROJECT ID: Armidale Regional 2119
SITE: [redacted], Armidale Regional Landfill P.O. NO.:
RESULTS REQUIRED (Date): QUOTE NO: **BNBQ/052/14**

SAMPLER: B. Hart
MOBILE: 042 777 5120
PHONE:
EMAIL REPORT TO: pelican@codyhart.com.au
EMAIL INVOICE TO: (above)

ANALYSES REQUIRED:

FOR LABORATORY USE ONLY
COOLER SEAL (circle appropriate)
Intact: Yes No N/A
SAMPLE TEMPERATURE
°C

COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:
1. PLEASE SCAN THIS FORM ON DAY OF ARRIVAL & EMAIL.

SAMPLE INFORMATION (note: S = Soil, W=Water)					CONTAINER INFORMATION														
ALS ID	SAMPLE ID	MATRIX	DATE	Time	TYPE	No. bottles	EA025 - Water Suspended Solids	EK055A - Water Ammonia as N	NT-11 Water NOx TKN Tot P	W-30-F - ICP/MS Dissolved PLUS Mn & Sb	EP005 - Water Total Organic Carbon (TOC)	W-4 - Water TPH/TRH (C6-C36or40)BTEXN F1&F2	W-4 SG Water TPH/TRH (C6-C36or40)BTEXN F1&F2	EP132B PAH UT	W-12 - Water OC/OP Pesticides	MW06 - Water E.Coli by MF	MW023 - Water Enterococci by MF		
1	GARA1	W	4/5/15	11:30	Black 125 mL sealed	1										x	x		
2	GARA2	W	"	12:30	Black 125 mL sealed	1										x	x		
3	GARA3	W	"	13:30	Black 125 mL sealed	1										x	x		
4	GARA4	W	"	10:30	Black 125 mL sealed	1										x	x		
5	GARA5	W	"	13:00	Black 125 mL sealed	1										x	x		
6	GARA6	W	"	11:00	Black 125 mL sealed	1										x	x		

Environmental Division
Brisbane
Work Order Reference
EB1518177
Telephone : +61-7-3243 7222

SCANNED

HT E coli & Enterococci 24 hrs
up by *10:30 Tuesday 5th*

RELINQUISHED BY:
Name: *Barbara Hart* Date: *4/5/15*
Of: *CodyHart Environmental* Time: *16:00*
Signature: *B J Hart* B Hart

RECEIVED BY:
Name: J.H Date: 6.5.15
Of: ALS Laboratory, Brisbane Time: 8.50
Signature:

METHOD OF SHIPMENT
Transport Co: TNT Express
Con Note No:
ALS security seal nos:

Samples were despatched in CodyHart Esky/Eskies numbered: 3023 **plus / small & large CodyHart gel bricks**

PLEASE HOLD CODYHART ESKIES & GEL BRICKS UNTIL RETURN REQUESTED.

CodyHart Consulting Pty Ltd trading as *CodyHart Environmental*

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EB1518177**

Client	: **CODYHART CONSULTING PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS BARBARA HART	Contact	: Customer Services EB
Address	: P O BOX 1073 BURLEIGH HEADS QLD, AUSTRALIA 4220	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: pelican@codyhart.com.au	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: +61 55205532	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 55206531	Facsimile	: +61-7-3243 7218
Project	: Armidale Regional 2119	Page	: 1 of 3
Order number	: ----	Quote number	: EB2014CODCON0251 (BNBQ/052/14)
C-O-C number	: ----	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Site	: Armidale Regional Landfill		
Sampler	: BARBARA HART		

Dates

Date Samples Received	: 06-May-2015	Issue Date	: 06-May-2015
Client Requested Due Date	: 13-May-2015	Scheduled Reporting Date	: **13-May-2015**

Delivery Details

Mode of Delivery	: Carrier	Security Seal	: Intact.
No. of coolers/boxes	: 1	Temperature	: 14.3°C - Ice present
Receipt Detail	: SMALL ESKY	No. of samples received / analysed	: 6 / 6

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of work order.
- Please direct any queries related to sample condition / numbering / breakages to John Pickering (John.Pickering@alsglobal.com).
- Analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818 (Micro site no. 18958).
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

Method *Client sample ID*	Sample Container Received	Preferred Sample Container for Analysis
Enumeration of Enterococci by Membrane Filtration : MW023		
GARA1	- Plastic specimen jar	- Sterile Plastic Jar
GARA2	- Plastic specimen jar	- Sterile Plastic Jar
GARA4	- Plastic specimen jar	- Sterile Plastic Jar
GARA5	- Plastic specimen jar	- Sterile Plastic Jar
GARA6	- Plastic specimen jar	- Sterile Plastic Jar
Thermotolerant Coliforms & E.coli by Membrane Filtration : MW006		
GARA1	- Plastic specimen jar	- Sterile Plastic Jar
GARA2	- Plastic specimen jar	- Sterile Plastic Jar
GARA4	- Plastic specimen jar	- Sterile Plastic Jar
GARA5	- Plastic specimen jar	- Sterile Plastic Jar
GARA6	- Plastic specimen jar	- Sterile Plastic Jar

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - MW006 (Ec) E.coli by Membrane Filtration	WATER - MW023 Enterococci - Enumeration by Membrane
EB1518177-001	04-May-2015 11:30	GARA1	✓	✓
EB1518177-002	04-May-2015 12:30	GARA2	✓	✓
EB1518177-003	04-May-2015 13:30	GARA3	✓	✓
EB1518177-004	04-May-2015 10:30	GARA4	✓	✓
EB1518177-005	04-May-2015 13:00	GARA5	✓	✓
EB1518177-006	04-May-2015 11:00	GARA6	✓	✓

Proactive Holding Time Report

The following table summarises breaches of recommended holding times that have occurred prior to samples/instructions being received at the laboratory.

Matrix: **WATER**

Evaluation: ✗ = Holding time breach ; ✓ = Within holding time.

Method Client Sample ID(s)	Container	Due for extraction	Due for analysis	Samples Received		Instructions Received	
				Date	Evaluation	Date	Evaluation
MW006: Thermotolerant Coliforms & E.coli by Membrane Filtration							
GARA1	Plastic specimen jar	----	05-May-2015	06-May-2015	✗	----	----
GARA2	Plastic specimen jar	----	05-May-2015	06-May-2015	✗	----	----
GARA3	Sterile Plastic Bottle - Sodium Th	----	05-May-2015	06-May-2015	✗	----	----
GARA4	Plastic specimen jar	----	05-May-2015	06-May-2015	✗	----	----
GARA5	Plastic specimen jar	----	05-May-2015	06-May-2015	✗	----	----
GARA6	Plastic specimen jar	----	05-May-2015	06-May-2015	✗	----	----
MW023: Enumeration of Enterococci by Membrane Filtration							
GARA1	Plastic specimen jar	----	05-May-2015	06-May-2015	✗	----	----
GARA2	Plastic specimen jar	----	05-May-2015	06-May-2015	✗	----	----
GARA3	Sterile Plastic Bottle - Sodium Th	----	05-May-2015	06-May-2015	✗	----	----
GARA4	Plastic specimen jar	----	05-May-2015	06-May-2015	✗	----	----
GARA5	Plastic specimen jar	----	05-May-2015	06-May-2015	✗	----	----
GARA6	Plastic specimen jar	----	05-May-2015	06-May-2015	✗	----	----

Requested Deliverables

BARBARA HART

- *AU Certificate of Analysis - NATA (COA)	Email	pelican@codyhart.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	pelican@codyhart.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	pelican@codyhart.com.au
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- EDI Format - ENMRG (ENMRG)	Email	pelican@codyhart.com.au
- EDI Format - XTab (XTAB)	Email	pelican@codyhart.com.au

APPENDIX C

Laboratory Reports

CERTIFICATE OF ANALYSIS

Work Order	: **EB1518173**	Page	: 1 of 12
Client	: **CODYHART CONSULTING PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS BARBARA HART	Contact	: Customer Services EB
Address	: P O BOX 1073 BURLEIGH HEADS QLD, AUSTRALIA 4220	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: pelican@codyhart.com.au	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: +61 55205532	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 55206531	Facsimile	: +61-7-3243 7218
Project	: Armidale Regional 2119	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 05-May-2015 14:40
C-O-C number	: ----	Date Analysis Commenced	: 08-May-2015
Sampler	: BARBARA HART	Issue Date	: 12-May-2015 17:19
Site	: Armidale Regional Landfill		
		No. of samples received	: 7
Quote number	: ----	No. of samples analysed	: 7

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

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*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics
Greg Vogel	Laboratory Manager	Brisbane Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Organics
Ryan Story	2IC Organic Instrument Chemist	Brisbane Organics

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
ø = ALS is not NATA accredited for these tests.

- Total PAH reported as the sum of Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene and Benzo(g,h,i)perylene.

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)	*Client sample ID*			**GARA1**	**GARA2**	**GARA3**	**GARA4**	**GARA5**
	Client sampling date / time			04-May-2015 11:30	04-May-2015 12:30	04-May-2015 13:30	04-May-2015 10:30	04-May-2015 13:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1518173-001**	**EB1518173-002**	**EB1518173-003**	**EB1518173-004**	**EB1518173-005**
				Result	Result	Result	Result	Result
EA025: Suspended Solids								
^ **Suspended Solids (SS)**	----	5	mg/L	**13**	<5	**65**	<5	**17**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.02**	<0.01	**0.72**	<0.01	**0.41**
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	**0.002**	**0.002**	<0.001	**0.006**	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.001**	**0.001**	**0.004**	**0.002**	**0.004**
Nickel	7440-02-0	0.001	mg/L	**0.001**	**0.001**	**0.002**	<0.001	**0.001**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	**0.006**	<0.005	**0.011**
Manganese	7439-96-5	0.001	mg/L	**0.046**	**0.044**	**0.013**	**0.016**	**0.004**
Iron	7439-89-6	0.05	mg/L	**0.23**	**0.09**	**0.84**	<0.05	**0.32**
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.06**	**0.03**	**0.04**	**0.06**	**0.03**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.02**	<0.01	<0.01	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**1.7**	**0.9**	**3.4**	**2.0**	**4.6**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**1.7**	**0.9**	**3.4**	**2.0**	**4.6**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.08**	**0.03**	**0.36**	**0.54**	**0.11**
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**15**	**13**	**16**	**10**	**21**
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Client sample ID	**GARA1**	**GARA2**	**GARA3**	**GARA4**	**GARA5**
			Client sampling date / time	04-May-2015 11:30	04-May-2015 12:30	04-May-2015 13:30	04-May-2015 10:30	04-May-2015 13:00
Compound	CAS Number	LOR	Unit	**EB1518173-001**	**EB1518173-002**	**EB1518173-003**	**EB1518173-004**	**EB1518173-005**
				Result	Result	Result	Result	Result
EP068A: Organochlorine Pesticides (OC) - Continued								
Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDT	50-29-3	2	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Methoxychlor	72-43-5	2	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
^ **Total Chlordane (sum)**	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of DDD + DDE + DDT**	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of Aldrin + Dieldrin**	309-00-2/60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Monocrotophos	6923-22-4	2	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Parathion-methyl	298-00-0	2	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Parathion	56-38-2	2	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

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

			Client sample ID	**GARA1**	**GARA2**	**GARA3**	**GARA4**	**GARA5**
			Client sampling date / time	04-May-2015 11:30	04-May-2015 12:30	04-May-2015 13:30	04-May-2015 10:30	04-May-2015 13:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1518173-001**	**EB1518173-002**	**EB1518173-003**	**EB1518173-004**	**EB1518173-005**
				Result	Result	Result	Result	Result
EP068B: Organophosphorus Pesticides (OP) - Continued								
Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
EP071 SG: Total Petroleum Hydrocarbons - Silica gel cleanup								
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
^ **C10 - C36 Fraction (sum)**	----	50	µg/L	<50	<50	<50	<50	<50
EP071 SG: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Silica gel cleanup								
>C10 - C16 Fraction	>C10_C16	100	µg/L	<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L	<100	<100	<100	<100	<100
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L	<100	<100	<100	<100	<100
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
^ **C10 - C36 Fraction (sum)**	----	50	µg/L	<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	<20	<20
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L	<20	<20	<20	<20	<20
>C10 - C16 Fraction	>C10_C16	100	µg/L	<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L	<100	<100	<100	<100	<100
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L	<100	<100	<100	<100	<100
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L	<2	<2	<2	<2	<2

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**GARA1**	**GARA2**	**GARA3**	**GARA4**	**GARA5**
			Client sampling date / time	04-May-2015 11:30	04-May-2015 12:30	04-May-2015 13:30	04-May-2015 10:30	04-May-2015 13:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1518173-001**	**EB1518173-002**	**EB1518173-003**	**EB1518173-004**	**EB1518173-005**
				Result	Result	Result	Result	Result
EP080: BTEXN - Continued								
Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	<2
^ **Total Xylenes**	1330-20-7	2	µg/L	<2	<2	<2	<2	<2
^ **Sum of BTEX**	----	1	µg/L	<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	<5
EP132B: Polynuclear Aromatic Hydrocarbons								
3-Methylcholanthrene	56-49-5	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
2-Methylnaphthalene	91-57-6	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
7.12-Dimethylbenz(a)anthracene	57-97-6	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	83-32-9	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	208-96-8	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	120-12-7	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Benz(a)anthracene	56-55-3	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(a)pyrene	50-32-8	0.05	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(e)pyrene	192-97-2	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g.h.i)perylene	191-24-2	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	207-08-9	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	218-01-9	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Coronene	191-07-1	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenz(a.h)anthracene	53-70-3	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	206-44-0	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	86-73-7	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Indeno(1.2.3.cd)pyrene	193-39-5	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
N-2-Fluorenyl Acetamide	53-96-3	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Naphthalene	91-20-3	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Perylene	198-55-0	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	85-01-8	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	129-00-0	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Sum of PAHs	----	0.05	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(a)pyrene TEQ (zero)	----	0.05	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.5	%	**66.2**	**69.2**	**64.5**	**64.1**	**62.0**
EP068T: Organophosphorus Pesticide Surrogate								

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**GARA1**	**GARA2**	**GARA3**	**GARA4**	**GARA5**
			Client sampling date / time	04-May-2015 11:30	04-May-2015 12:30	04-May-2015 13:30	04-May-2015 10:30	04-May-2015 13:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1518173-001**	**EB1518173-002**	**EB1518173-003**	**EB1518173-004**	**EB1518173-005**
				Result	Result	Result	Result	Result
EP068T: Organophosphorus Pesticide Surrogate - Continued								
DEF	78-48-8	0.5	%	**64.0**	**66.9**	**63.0**	**64.1**	**61.6**
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**96.6**	**90.7**	**98.6**	**100**	**104**
Toluene-D8	2037-26-5	2	%	**109**	**110**	**100**	**92.8**	**107**
4-Bromofluorobenzene	460-00-4	2	%	**110**	**93.4**	**92.0**	**90.5**	**95.5**
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	**85.9**	**78.0**	**70.4**	**80.0**	**84.6**
Anthracene-d10	1719-06-8	0.1	%	**80.2**	**72.6**	**70.0**	**75.5**	**81.1**
4-Terphenyl-d14	1718-51-0	0.1	%	**107**	**98.9**	**93.3**	**102**	**110**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**GARA6**	**GARA-DUP**	----	----	----
			Client sampling date / time	04-May-2015 11:00	[04-May-2015]	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1518173-006**	**EB1518173-007**	--------	--------	--------
				Result	Result	Result	Result	Result
EA025: Suspended Solids								
^ Suspended Solids (SS)	----	5	mg/L	<5	<5	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.002**	**0.002**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.001**	**0.005**	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.002**	**0.001**	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.013**	**0.044**	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.12**	**0.09**	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.04**	**0.04**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.01**	<0.01	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**2.0**	**0.8**	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ Total Nitrogen as N	----	0.1	mg/L	**2.0**	**0.8**	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.05**	**0.03**	----	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**13**	**12**	----	----	----
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	----	----	----	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	----	----	----	----
beta-BHC	319-85-7	0.5	µg/L	<0.5	----	----	----	----
gamma-BHC	58-89-9	0.5	µg/L	<0.5	----	----	----	----
delta-BHC	319-86-8	0.5	µg/L	<0.5	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**GARA6**	**GARA-DUP**	**----**	**----**	**----**
			Client sampling date / time	04-May-2015 11:00	[04-May-2015]	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1518173-006**	**EB1518173-007**	**--------**	**--------**	**--------**
				Result	Result	Result	Result	Result
EP068A: Organochlorine Pesticides (OC) - Continued								
Heptachlor	76-44-8	0.5	µg/L	<0.5	----	----	----	----
Aldrin	309-00-2	0.5	µg/L	<0.5	----	----	----	----
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	----	----	----	----
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	----	----	----	----
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	----	----	----	----
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	----	----	----	----
Dieldrin	60-57-1	0.5	µg/L	<0.5	----	----	----	----
4.4`-DDE	72-55-9	0.5	µg/L	<0.5	----	----	----	----
Endrin	72-20-8	0.5	µg/L	<0.5	----	----	----	----
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	----	----	----	----
4.4`-DDD	72-54-8	0.5	µg/L	<0.5	----	----	----	----
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	----	----	----	----
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	----	----	----	----
4.4`-DDT	50-29-3	2	µg/L	<2.0	----	----	----	----
Endrin ketone	53494-70-5	0.5	µg/L	<0.5	----	----	----	----
Methoxychlor	72-43-5	2	µg/L	<2.0	----	----	----	----
^ **Total Chlordane (sum)**	----	0.5	µg/L	<0.5	----	----	----	----
^ **Sum of DDD + DDE + DDT**	----	0.5	µg/L	<0.5	----	----	----	----
^ **Sum of Aldrin + Dieldrin**	309-00-2/60-57-1	0.5	µg/L	<0.5	----	----	----	----
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.5	µg/L	<0.5	----	----	----	----
Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	----	----	----	----
Monocrotophos	6923-22-4	2	µg/L	<2.0	----	----	----	----
Dimethoate	60-51-5	0.5	µg/L	<0.5	----	----	----	----
Diazinon	333-41-5	0.5	µg/L	<0.5	----	----	----	----
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	----	----	----	----
Parathion-methyl	298-00-0	2	µg/L	<2.0	----	----	----	----
Malathion	121-75-5	0.5	µg/L	<0.5	----	----	----	----
Fenthion	55-38-9	0.5	µg/L	<0.5	----	----	----	----
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	----	----	----	----
Parathion	56-38-2	2	µg/L	<2.0	----	----	----	----
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	----	----	----	----
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	----	----	----	----
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	----	----	----	----
Fenamiphos	22224-92-6	0.5	µg/L	<0.5	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Client sample ID	**GARA6**	**GARA-DUP**	**----**	**----**	**----**
			Client sampling date / time	04-May-2015 11:00	[04-May-2015]	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1518173-006**	**EB1518173-007**	--------	--------	--------
				Result	Result	Result	Result	Result
EP068B: Organophosphorus Pesticides (OP) - Continued								
Prothiofos	34643-46-4	0.5	µg/L	<0.5	----	----	----	----
Ethion	563-12-2	0.5	µg/L	<0.5	----	----	----	----
Carbophenothion	786-19-6	0.5	µg/L	<0.5	----	----	----	----
Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	----	----	----	----
EP071 SG: Total Petroleum Hydrocarbons - Silica gel cleanup								
C10 - C14 Fraction	----	50	µg/L	<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	----	----	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L	<50	<50	----	----	----
EP071 SG: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Silica gel cleanup								
>C10 - C16 Fraction	>C10_C16	100	µg/L	<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L	<100	<100	----	----	----
>C34 - C40 Fraction	----	100	µg/L	<100	<100	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L	<100	<100	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L	<100	<100	----	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	----	----	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L	<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	----	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L	<20	<20	----	----	----
>C10 - C16 Fraction	>C10_C16	100	µg/L	<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L	<100	<100	----	----	----
>C34 - C40 Fraction	----	100	µg/L	<100	<100	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L	<100	<100	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L	<100	<100	----	----	----
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	----	----	----
Toluene	108-88-3	2	µg/L	<2	<2	----	----	----

Analytical Results

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

			Client sample ID	**GARA6**	**GARA-DUP**	**----**	**----**	**----**
			Client sampling date / time	04-May-2015 11:00	[04-May-2015]	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1518173-006**	**EB1518173-007**	**--------**	**--------**	**--------**
				Result	Result	Result	Result	Result
EP080: BTEXN - Continued								
Ethylbenzene	100-41-4	2	µg/L	<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L	<2	<2	----	----	----
^ **Total Xylenes**	1330-20-7	2	µg/L	<2	<2	----	----	----
^ **Sum of BTEX**	----	1	µg/L	<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L	<5	<5	----	----	----
EP132B: Polynuclear Aromatic Hydrocarbons								
3-Methylcholanthrene	56-49-5	0.1	µg/L	<0.1	----	----	----	----
2-Methylnaphthalene	91-57-6	0.1	µg/L	<0.1	----	----	----	----
7.12-Dimethylbenz(a)anthracene	57-97-6	0.1	µg/L	<0.1	----	----	----	----
Acenaphthene	83-32-9	0.1	µg/L	<0.1	----	----	----	----
Acenaphthylene	208-96-8	0.1	µg/L	<0.1	----	----	----	----
Anthracene	120-12-7	0.1	µg/L	<0.1	----	----	----	----
Benz(a)anthracene	56-55-3	0.1	µg/L	<0.1	----	----	----	----
Benzo(a)pyrene	50-32-8	0.05	µg/L	<0.05	----	----	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.1	µg/L	<0.1	----	----	----	----
Benzo(e)pyrene	192-97-2	0.1	µg/L	<0.1	----	----	----	----
Benzo(g.h.i)perylene	191-24-2	0.1	µg/L	<0.1	----	----	----	----
Benzo(k)fluoranthene	207-08-9	0.1	µg/L	<0.1	----	----	----	----
Chrysene	218-01-9	0.1	µg/L	<0.1	----	----	----	----
Coronene	191-07-1	0.1	µg/L	<0.1	----	----	----	----
Dibenz(a.h)anthracene	53-70-3	0.1	µg/L	<0.1	----	----	----	----
Fluoranthene	206-44-0	0.1	µg/L	<0.1	----	----	----	----
Fluorene	86-73-7	0.1	µg/L	<0.1	----	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	0.1	µg/L	<0.1	----	----	----	----
N-2-Fluorenyl Acetamide	53-96-3	0.1	µg/L	<0.1	----	----	----	----
Naphthalene	91-20-3	0.1	µg/L	<0.1	----	----	----	----
Perylene	198-55-0	0.1	µg/L	<0.1	----	----	----	----
Phenanthrene	85-01-8	0.1	µg/L	<0.1	----	----	----	----
Pyrene	129-00-0	0.1	µg/L	<0.1	----	----	----	----
Sum of PAHs	----	0.05	µg/L	<0.05	----	----	----	----
Benzo(a)pyrene TEQ (zero)	----	0.05	µg/L	<0.05	----	----	----	----
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.5	%	**56.4**	----	----	----	----
EP068T: Organophosphorus Pesticide Surrogate								

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER)**			Client sample ID	**GARA6**	**GARA-DUP**	**----**	**----**	**----**
			Client sampling date / time	04-May-2015 11:00	[04-May-2015]	----	----	----
Compound	CAS Number	LOR	Unit	**EB1518173-006**	**EB1518173-007**	**--------**	**--------**	**--------**
				Result	Result	Result	Result	Result
EP068T: Organophosphorus Pesticide Surrogate - Continued								
DEF	78-48-8	0.5	%	**53.7**	**----**	**----**	**----**	**----**
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**96.5**	**105**	**----**	**----**	**----**
Toluene-D8	2037-26-5	2	%	**110**	**108**	**----**	**----**	**----**
4-Bromofluorobenzene	460-00-4	2	%	**103**	**95.2**	**----**	**----**	**----**
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	**75.2**	**----**	**----**	**----**	**----**
Anthracene-d10	1719-06-8	0.1	%	**71.4**	**----**	**----**	**----**	**----**
4-Terphenyl-d14	1718-51-0	0.1	%	**94.1**	**----**	**----**	**----**	**----**

QUALITY CONTROL REPORT

Work Order : **EB1518173**

Client : **CODYHART CONSULTING PTY LTD**
Contact : MS BARBARA HART
Address : P O BOX 1073
BURLEIGH HEADS QLD, AUSTRALIA 4220
E-mail : pelican@codyhart.com.au
Telephone : +61 55205532
Facsimile : +61 07 55206531
Project : Armidale Regional 2119
Order number : ----
C-O-C number : ----
Sampler : BARBARA HART
Site : Armidale Regional Landfill
Quote number : ----

Page : 1 of 14

Laboratory : Environmental Division Brisbane
Contact : Customer Services EB
Address : 2 Byth Street Stafford QLD Australia 4053
E-mail : ALSEnviro.Brisbane@alsglobal.com
Telephone : +61-7-3243 7222
Facsimile : +61-7-3243 7218
QC Level : NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Date Samples Received : 05-May-2015
Date Analysis Commenced : 08-May-2015
Issue Date : 12-May-2015
No. of samples received : 7
No. of samples analysed : 7

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

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 ir compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics
Greg Vogel	Laboratory Manager	Brisbane Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Organics
Ryan Story	2IC Organic Instrument Chemist	Brisbane Organics

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

Key :
Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
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
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA025: Suspended Solids (QC Lot: 94965)									
EB1518022-001	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	19	18	8.22	No Limit
EB1518173-001	GARA1	EA025H: Suspended Solids (SS)	----	5	mg/L	13	11	20.8	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 94699)									
EB1518099-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.005	0.005	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.993	0.980	1.22	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.014	0.015	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.26	0.25	5.40	No Limit
EB1518082-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0009	0.0009	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.035	0.035	0.00	0% - 20%
		EG020A-F: Lead	7439-92-1	0.001	mg/L	0.015	0.015	0.00	0% - 50%
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.654	0.655	0.184	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.033	0.033	0.00	0% - 20%
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.182	0.177	2.69	0% - 20%
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	0.03	0.03	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	0.03	0.03	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 94703)									
EB1518258-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.006	0.007	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG020F: Dissolved Metals by ICP-MS (QC Lot: 94703) - continued									
EB1518258-001	Anonymous	EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.27	0.27	0.00	No Limit
EB1518173-004	GARA4	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.006	0.006	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.016	0.014	9.72	0% - 50%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 94701)									
EB1518099-002	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EB1518082-001	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 94704)									
EB1518173-004	GARA4	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 95120)									
EB1518173-001	GARA1	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.06	0.02	93.9	No Limit
EB1518208-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.12	0.10	21.9	0% - 50%
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 95119)									
EB1518173-001	GARA1	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.02	0.02	0.00	No Limit
EB1518208-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 95044)									
EB1518129-026	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EB1518173-003	GARA3	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	3.4	3.4	0.00	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 95045)									
EB1518129-026	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.05	0.05	0.00	No Limit
EB1518173-003	GARA3	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.36	0.34	5.65	0% - 20%
EP005: Total Organic Carbon (TOC) (QC Lot: 96780)									
EB1518173-001	GARA1	EP005: Total Organic Carbon	----	1	mg/L	15	12	18.0	0% - 50%
EB1518216-002	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	<5	<5	0.00	No Limit
EP068A: Organochlorine Pesticides (OC) (QC Lot: 94985)									
EB1518173-001	GARA1	EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP068A: Organochlorine Pesticides (OC) (QC Lot: 94985) - continued									
EB1518173-001	GARA1	EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	<2.0	0.00	No Limit
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 94985)									
EB1518173-001	GARA1	EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP068: Parathion	56-38-2	2	µg/L	<2.0	<2.0	0.00	No Limit
EP071 SG: Total Petroleum Hydrocarbons - Silica gel cleanup (QC Lot: 94987)									
EB1518173-001	GARA1	EP071SG: C15 - C28 Fraction	----	100	µg/L	<100	<100	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP071 SG: Total Petroleum Hydrocarbons - Silica gel cleanup (QC Lot: 94987) - continued									
EB1518173-001	GARA1	EP071SG: C10 - C14 Fraction	----	50	µg/L	<50	<50	0.00	No Limit
		EP071SG: C29 - C36 Fraction	----	50	µg/L	<50	<50	0.00	No Limit
EP071 SG: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Silica gel cleanup (QC Lot: 94987)									
EB1518173-001	GARA1	EP071SG: >C10 - C16 Fraction	>C10_C16	100	µg/L	<100	<100	0.00	No Limit
		EP071SG: >C16 - C34 Fraction	----	100	µg/L	<100	<100	0.00	No Limit
		EP071SG: >C34 - C40 Fraction	----	100	µg/L	<100	<100	0.00	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 94775)									
EB1518157-001	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.00	No Limit
EB1518157-011	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	1040	1010	3.07	0% - 50%
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 94986)									
EB1518173-002	GARA2	EP071: C15 - C28 Fraction	----	100	µg/L	<100	<100	0.00	No Limit
		EP071: C10 - C14 Fraction	----	50	µg/L	<50	<50	0.00	No Limit
		EP071: C29 - C36 Fraction	----	50	µg/L	<50	<50	0.00	No Limit
EB1518173-001	GARA1	EP071: C15 - C28 Fraction	----	100	µg/L	<100	<100	0.00	No Limit
		EP071: C10 - C14 Fraction	----	50	µg/L	<50	<50	0.00	No Limit
		EP071: C29 - C36 Fraction	----	50	µg/L	<50	<50	0.00	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 94775)									
EB1518157-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EB1518157-011	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	920	890	3.16	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 94986)									
EB1518173-002	GARA2	EP071: >C10 - C16 Fraction	>C10_C16	100	µg/L	<100	<100	0.00	No Limit
		EP071: >C16 - C34 Fraction	----	100	µg/L	<100	<100	0.00	No Limit
		EP071: >C34 - C40 Fraction	----	100	µg/L	<100	<100	0.00	No Limit
EB1518173-001	GARA1	EP071: >C10 - C16 Fraction	>C10_C16	100	µg/L	<100	<100	0.00	No Limit
		EP071: >C16 - C34 Fraction	----	100	µg/L	<100	<100	0.00	No Limit
		EP071: >C34 - C40 Fraction	----	100	µg/L	<100	<100	0.00	No Limit
EP080: BTEXN (QC Lot: 94775)									
EB1518157-001	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit
EB1518157-011	Anonymous	EP080: Benzene	71-43-2	1	µg/L	391	357	9.02	0% - 20%
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	31	33	4.80	0% - 50%
		EP080: ortho-Xylene	95-47-6	2	µg/L	28	29	5.82	0% - 50%

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP080: BTEXN (QC Lot: 94775) - continued									
EB1518157-011	Anonymous	EP080: Toluene	108-88-3	2	µg/L	6	6	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EA025: Suspended Solids (QCLot: 94965)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	94.1	83	120
				<5	1000 mg/L	93.4	83	120
EG020F: Dissolved Metals by ICP-MS (QCLot: 94699)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	100	79	118
EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	0.1 mg/L	99.0	87	113
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	97.9	88	116
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	97.8	88	108
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	100	87	113
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	103	88	114
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	101	82	114
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	95.0	89	110
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	99.9	89	120
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	102	89	113
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	97.6	83	112
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	98.1	87	113
EG020F: Dissolved Metals by ICP-MS (QCLot: 94703)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	98.7	79	118
EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	0.1 mg/L	97.5	87	113
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	98.3	88	116
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	97.4	88	108
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	99.2	87	113
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	102	88	114
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	101	82	114
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	100	89	110
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	98.4	89	120
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	101	89	113
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	98.4	83	112
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	97.8	87	113
EG035F: Dissolved Mercury by FIMS (QCLot: 94701)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	97.5	84	118
EG035F: Dissolved Mercury by FIMS (QCLot: 94704)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	93.7	84	118
EK055G: Ammonia as N by Discrete Analyser (QCLot: 95120)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	92.3	86	112

Sub-Matrix: **WATER**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 95119)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	98.7	89	115
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 95044)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	92.2	70	111
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 95045)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	97.5	77	109
EP005: Total Organic Carbon (TOC) (QCLot: 96780)								
EP005: Total Organic Carbon	----	1	mg/L	<1 <1	10 mg/L 100 mg/L	102 102	79 79	113 113
EP068A: Organochlorine Pesticides (OC) (QCLot: 94985)								
EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	5 µg/L	61.0	52	124
EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	5 µg/L	83.6	56	122
EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	5 µg/L	71.1	35	131
EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	5 µg/L	61.3	52	123
EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	5 µg/L	62.6	45	125
EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	5 µg/L	59.5	54	128
EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	5 µg/L	60.3	39	122
EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	5 µg/L	62.3	50	126
EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	5 µg/L	68.8	51	125
EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	5 µg/L	59.1	53	112
EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	5 µg/L	61.9	50	124
EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	5 µg/L	60.0	37	124
EP068: Endrin	72-20-8	0.5	µg/L	<0.5	5 µg/L	84.3	47	129
EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	5 µg/L	86.0	49	131
EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	5 µg/L	70.3	45	129
EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	5 µg/L	58.3	42	119
EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	5 µg/L	85.0	45	118
EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	5 µg/L	69.4	52	124
EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	5 µg/L	62.1	41	121
EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	5 µg/L	63.5	32	135
EP068: Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L	<0.5	----	----	----	----
EP068: Sum of DDD + DDE + DDT	----	0.5	µg/L	<0.5	----	----	----	----
EP068: Total Chlordane (sum)	----	0.5	µg/L	<0.5	----	----	----	----
EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	5 µg/L	70.0	48	125
EP068B: Organophosphorus Pesticides (OP) (QCLot: 94985)								
EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	5 µg/L	47.3	44	130
EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	5 µg/L	68.3	52	124
EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	5 µg/L	68.6	48	128

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP068B: Organophosphorus Pesticides (OP) (QCLot: 94985) - continued								
EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	5 µg/L	74.1	50	127
EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	5 µg/L	64.3	54	119
EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	5 µg/L	71.9	50	118
EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	5 µg/L	68.5	44	118
EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	5 µg/L	56.1	44	129
EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	5 µg/L	64.7	49	115
EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	5 µg/L	65.6	41	111
EP068: Ethion	563-12-2	0.5	µg/L	<0.5	5 µg/L	78.6	50	127
EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	5 µg/L	64.3	43	121
EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	5 µg/L	67.2	49	121
EP068: Malathion	121-75-5	0.5	µg/L	<0.5	5 µg/L	72.9	51	122
EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	5 µg/L	# 3.92	16	49
EP068: Parathion	56-38-2	2	µg/L	<2.0	5 µg/L	73.7	43	123
EP068: Parathion-methyl	298-00-0	----	µg/L	----	5 µg/L	66.7	50	118
EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	5 µg/L	69.9	52	126
EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	5 µg/L	76.3	53	126
EP071 SG: Total Petroleum Hydrocarbons - Silica gel cleanup (QCLot: 94987)								
EP071SG: C10 - C14 Fraction	----	50	µg/L	<50	1211 µg/L	57.6	34	110
EP071SG: C15 - C28 Fraction	----	100	µg/L	<100	2103 µg/L	53.7	43	105
EP071SG: C29 - C36 Fraction	----	50	µg/L	<50	----	----	----	----
EP071 SG: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Silica gel cleanup (QCLot: 94987)								
EP071SG: >C10 - C16 Fraction	>C10_C16	100	µg/L	<100	1696 µg/L	56.6	34	110
EP071SG: >C16 - C34 Fraction	----	100	µg/L	<100	1496 µg/L	56.5	43	110
EP071SG: >C34 - C40 Fraction	----	100	µg/L	<100	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons (QCLot: 94775)								
EP080: C6 - C9 Fraction	----	20	µg/L	<20	160 µg/L	85.1	76	122
EP080/071: Total Petroleum Hydrocarbons (QCLot: 94986)								
EP071: C10 - C14 Fraction	----	50	µg/L	<50	1211 µg/L	58.6	38	114
EP071: C15 - C28 Fraction	----	100	µg/L	<100	2103 µg/L	56.6	50	132
EP071: C29 - C36 Fraction	----	50	µg/L	<50	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 94775)								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	185 µg/L	85.5	75	123
EP080: C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 94986)								
EP071: >C10 - C16 Fraction	>C10_C16	100	µg/L	<100	1696 µg/L	60.2	43	119
EP071: >C16 - C34 Fraction	----	100	µg/L	<100	1496 µg/L	55.9	49	134
EP071: >C34 - C40 Fraction	----	100	µg/L	<100	----	----	----	----

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EP080: BTEXN (QCLot: 94775)								
EP080: Benzene	71-43-2	1	µg/L	<1	10 µg/L	88.0	77	119
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	107	78	119
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	20 µg/L	116	77	121
EP080: Naphthalene	91-20-3	5	µg/L	<5	10 µg/L	91.7	75	120
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	114	76	121
EP080: Sum of BTEX	----	1	µg/L	<1	----	----	----	----
EP080: Toluene	108-88-3	2	µg/L	<2	10 µg/L	115	78	122
EP080: Total Xylenes	1330-20-7	2	µg/L	<2	----	----	----	----
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 95325)								
EP132: 2-Methylnaphthalene	91-57-6	0.1	µg/L	<0.1	2 µg/L	98.2	59	123
EP132: 3-Methylcholanthrene	56-49-5	0.1	µg/L	<0.1	2 µg/L	97.0	60	120
EP132: 7.12-Dimethylbenz(a)anthracene	57-97-6	0.1	µg/L	<0.1	2 µg/L	102	12	156
EP132: Acenaphthene	83-32-9	0.1	µg/L	<0.1	2 µg/L	112	64	122
EP132: Acenaphthylene	208-96-8	0.1	µg/L	<0.1	2 µg/L	100	62	124
EP132: Anthracene	120-12-7	0.1	µg/L	<0.1	2 µg/L	110	66	124
EP132: Benz(a)anthracene	56-55-3	0.1	µg/L	<0.1	2 µg/L	114	64	130
EP132: Benzo(a)pyrene	50-32-8	0.05	µg/L	<0.05	2 µg/L	107	64	126
EP132: Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.1	µg/L	<0.1	2 µg/L	112	62	126
EP132: Benzo(e)pyrene	192-97-2	0.1	µg/L	<0.1	2 µg/L	108	62	126
EP132: Benzo(g.h.i)perylene	191-24-2	0.1	µg/L	<0.1	2 µg/L	101	56	126
EP132: Benzo(k)fluoranthene	207-08-9	0.1	µg/L	<0.1	2 µg/L	111	63	127
EP132: Chrysene	218-01-9	0.1	µg/L	<0.1	2 µg/L	114	64	128
EP132: Coronene	191-07-1	0.1	µg/L	<0.1	2 µg/L	90.1	35	133
EP132: Dibenz(a.h)anthracene	53-70-3	0.1	µg/L	<0.1	2 µg/L	102	58	128
EP132: Fluoranthene	206-44-0	0.1	µg/L	<0.1	2 µg/L	116	65	127
EP132: Fluorene	86-73-7	0.1	µg/L	<0.1	2 µg/L	107	64	124
EP132: Indeno(1.2.3.cd)pyrene	193-39-5	0.1	µg/L	<0.1	2 µg/L	102	57	127
EP132: N-2-Fluorenyl Acetamide	53-96-3	0.1	µg/L	<0.1	2 µg/L	93.9	54	131
EP132: Naphthalene	91-20-3	0.1	µg/L	<0.1	2 µg/L	99.0	60	124
EP132: Perylene	198-55-0	0.1	µg/L	<0.1	2 µg/L	110	64	124
EP132: Phenanthrene	85-01-8	0.1	µg/L	<0.1	2 µg/L	109	65	125
EP132: Pyrene	129-00-0	0.1	µg/L	<0.1	2 µg/L	114	66	128

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 94699)							
EB1518086-001	Anonymous	EG020A-F: Aluminium	7429-90-5	0.5 mg/L	95.3	70	130
		EG020A-F: Antimony	7440-36-0	0.1 mg/L	89.4	70	130
		EG020A-F: Arsenic	7440-38-2	0.1 mg/L	97.3	70	130
		EG020A-F: Cadmium	7440-43-9	0.1 mg/L	96.9	70	130
		EG020A-F: Chromium	7440-47-3	0.1 mg/L	94.7	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	98.5	70	130
		EG020A-F: Lead	7439-92-1	0.1 mg/L	89.4	70	130
		EG020A-F: Manganese	7439-96-5	0.1 mg/L	92.8	70	130
		EG020A-F: Nickel	7440-02-0	0.1 mg/L	94.9	70	130
		EG020A-F: Selenium	7782-49-2	0.1 mg/L	94.6	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	95.1	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 94703)							
EB1518173-005	GARA5	EG020A-F: Aluminium	7429-90-5	0.5 mg/L	93.1	70	130
		EG020A-F: Antimony	7440-36-0	0.1 mg/L	86.6	70	130
		EG020A-F: Arsenic	7440-38-2	0.1 mg/L	95.1	70	130
		EG020A-F: Cadmium	7440-43-9	0.1 mg/L	93.6	70	130
		EG020A-F: Chromium	7440-47-3	0.1 mg/L	94.2	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	99.6	70	130
		EG020A-F: Lead	7439-92-1	0.1 mg/L	93.3	70	130
		EG020A-F: Manganese	7439-96-5	0.1 mg/L	95.5	70	130
		EG020A-F: Nickel	7440-02-0	0.1 mg/L	96.9	70	130
		EG020A-F: Selenium	7782-49-2	0.1 mg/L	92.6	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	98.1	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 94701)							
EB1518086-001	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	91.0	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 94704)							
EB1518173-005	GARA5	EG035F: Mercury	7439-97-6	0.01 mg/L	89.7	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 95120)							
EB1518173-002	GARA2	EK055G: Ammonia as N	7664-41-7	0.4 mg/L	84.3	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 95119)							
EB1518173-002	GARA2	EK059G: Nitrite + Nitrate as N	----	0.4 mg/L	88.9	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 95044)							
EB1518129-027	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	94.0	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 95045)							
EB1518129-027	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	103	70	130
EP005: Total Organic Carbon (TOC) (QCLot: 96780)							
EB1518173-002	GARA2	EP005: Total Organic Carbon	----	100 mg/L	102	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EP068A: Organochlorine Pesticides (OC) (QCLot: 94985)							
EB1518173-005	GARA5	EP068: 4.4`-DDT	50-29-3	4 µg/L	108	70	130
		EP068: Aldrin	309-00-2	1 µg/L	121	70	130
		EP068: Dieldrin	60-57-1	1 µg/L	118	70	130
		EP068: Endrin	72-20-8	4 µg/L	118	70	130
		EP068: gamma-BHC	58-89-9	1 µg/L	130	70	130
		EP068: Heptachlor	76-44-8	1 µg/L	122	70	130
EP068B: Organophosphorus Pesticides (OP) (QCLot: 94985)							
EB1518173-005	GARA5	EP068: Bromophos-ethyl	4824-78-6	1 µg/L	120	70	130
		EP068: Chlorpyrifos-methyl	5598-13-0	1 µg/L	118	70	130
		EP068: Diazinon	333-41-5	1 µg/L	118	70	130
		EP068: Pirimphos-ethyl	23505-41-1	1 µg/L	128	70	130
		EP068: Prothiofos	34643-46-4	1 µg/L	122	70	130
EP071 SG: Total Petroleum Hydrocarbons - Silica gel cleanup (QCLot: 94987)							
EB1518173-005	GARA5	EP071SG: C10 - C14 Fraction	----	1211 µg/L	77.9	70	130
		EP071SG: C15 - C28 Fraction	----	2103 µg/L	77.9	70	130
EP071 SG: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Silica gel cleanup (QCLot: 94987)							
EB1518173-005	GARA5	EP071SG: >C10 - C16 Fraction	>C10_C16	1696 µg/L	78.2	70	130
		EP071SG: >C16 - C34 Fraction	----	1496 µg/L	78.4	70	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 94775)							
EB1518157-002	Anonymous	EP080: C6 - C9 Fraction	----	40 µg/L	94.8	70	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 94986)							
EB1518173-005	GARA5	EP071: C10 - C14 Fraction	----	1211 µg/L	78.0	70	130
		EP071: C15 - C28 Fraction	----	2103 µg/L	74.1	70	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 94775)							
EB1518157-002	Anonymous	EP080: C6 - C10 Fraction	C6_C10	40 µg/L	91.4	70	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 94986)							
EB1518173-005	GARA5	EP071: >C10 - C16 Fraction	>C10_C16	1696 µg/L	78.0	70	130
		EP071: >C16 - C34 Fraction	----	1496 µg/L	74.3	70	130
EP080: BTEXN (QCLot: 94775)							
EB1518157-002	Anonymous	EP080: Benzene	71-43-2	10 µg/L	81.5	70	130
		EP080: Toluene	108-88-3	10 µg/L	93.7	70	130
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 95325)							
EB1518173-005	GARA5	EP132: 2-Methylnaphthalene	91-57-6	2 µg/L	82.9	46	120
		EP132: 3-Methylcholanthrene	56-49-5	2 µg/L	110	59	115
		EP132: 7.12-Dimethylbenz(a)anthracene	57-97-6	2 µg/L	122	21	135
		EP132: Acenaphthene	83-32-9	2 µg/L	102	62	114

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 95325) - continued							
EB1518173-005	GARA5	EP132: Acenaphthylene	208-96-8	2 µg/L	95.7	61	119
		EP132: Anthracene	120-12-7	2 µg/L	109	68	116
		EP132: Benz(a)anthracene	56-55-3	2 µg/L	113	67	122
		EP132: Benzo(a)pyrene	50-32-8	2 µg/L	106	72	114
		EP132: Benzo(b+j)fluoranthene	205-99-2 205-82-3	2 µg/L	110	69	119
		EP132: Benzo(e)pyrene	192-97-2	2 µg/L	105	71	119
		EP132: Benzo(g.h.i)perylene	191-24-2	2 µg/L	95.4	49	133
		EP132: Benzo(k)fluoranthene	207-08-9	2 µg/L	106	71	124
		EP132: Chrysene	218-01-9	2 µg/L	111	70	118
		EP132: Coronene	191-07-1	2 µg/L	84.4	29	138
		EP132: Dibenz(a.h)anthracene	53-70-3	2 µg/L	96.2	60	122
		EP132: Fluoranthene	206-44-0	2 µg/L	115	65	121
		EP132: Fluorene	86-73-7	2 µg/L	103	63	118
		EP132: Indeno(1.2.3.cd)pyrene	193-39-5	2 µg/L	96.4	57	123
		EP132: N-2-Fluorenyl Acetamide	53-96-3	2 µg/L	106	29	212
		EP132: Naphthalene	91-20-3	2 µg/L	83.3	53	115
		EP132: Perylene	198-55-0	2 µg/L	109	71	118
		EP132: Phenanthrene	85-01-8	2 µg/L	106	67	120
		EP132: Pyrene	129-00-0	2 µg/L	113	70	117

QA/QC Compliance Assessment for DQO Reporting

Work Order	: **EB1518173**	Page	: 1 of 8
Client	: **CODYHART CONSULTING PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS BARBARA HART	Telephone	: +61-7-3243 7222
Project	: Armidale Regional 2119	Date Samples Received	: 05-May-2015
Site	: Armidale Regional Landfill	Issue Date	: 12-May-2015
Sampler	: BARBARA HART	No. of samples received	: 7
Order number	: ----	No. of samples analysed	: 7

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Matrix Spike outliers occur.**
- **Laboratory Control outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	**Analyte**	CAS Number	Data	Limits	**Comment**
Laboratory Control Spike (LCS) Recoveries							
EP068B: Organophosphorus Pesticides (OP)	QC-94985-002	----	**Monocrotophos**	6923-22-4	3.92 %	16-49%	**Recovery less than lower control limit**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	0	6	0.00	10.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA025: Suspended Solids							
Clear Plastic Bottle - Natural (EA025H) GARA1, GARA2, GARA3, GARA4, GARA5, GARA6, GARA-DUP	**04-May-2015**	**----**	----	----	**08-May-2015**	11-May-2015	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) GARA1, GARA2, GARA3, GARA4, GARA5, GARA6, GARA-DUP	**04-May-2015**	**----**	----	----	**08-May-2015**	31-Oct-2015	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) GARA1, GARA2, GARA3, GARA4, GARA5, GARA6, GARA-DUP	**04-May-2015**	**----**	----	----	**08-May-2015**	01-Jun-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method *Container / Client Sample ID(s)*	*Sample Date*	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) GARA1, GARA2, GARA3, GARA4, GARA5, GARA6, GARA-DUP	**04-May-2015**	**----**	----	----	**08-May-2015**	01-Jun-2015	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) GARA1, GARA2, GARA3, GARA4, GARA5, GARA6, GARA-DUP	**04-May-2015**	**----**	----	----	**08-May-2015**	01-Jun-2015	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) GARA1, GARA2, GARA3, GARA4, GARA5, GARA6, GARA-DUP	**04-May-2015**	**08-May-2015**	01-Jun-2015	✓	**11-May-2015**	01-Jun-2015	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) GARA1, GARA2, GARA3, GARA4, GARA5, GARA6, GARA-DUP	**04-May-2015**	**08-May-2015**	01-Jun-2015	✓	**11-May-2015**	01-Jun-2015	✓
EP005: Total Organic Carbon (TOC)							
Amber TOC Vial - Sulfuric Acid (EP005) GARA1, GARA2, GARA3, GARA4, GARA5, GARA6, GARA-DUP	**04-May-2015**	**----**	----	----	**12-May-2015**	01-Jun-2015	✓
EP068A: Organochlorine Pesticides (OC)							
Amber Glass Bottle - Unpreserved (EP068) GARA1, GARA2, GARA3, GARA4, GARA5, GARA6	**04-May-2015**	**08-May-2015**	11-May-2015	✓	**09-May-2015**	17-Jun-2015	✓
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071) GARA1, GARA2, GARA3, GARA4, GARA5, GARA6, GARA-DUP	**04-May-2015**	**08-May-2015**	11-May-2015	✓	**09-May-2015**	17-Jun-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method *Container / Client Sample ID(s)*	*Sample Date*	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EP071 SG: Total Petroleum Hydrocarbons - Silica gel cleanup							
Amber Glass Bottle - Unpreserved (EP071SG) GARA1, GARA2, GARA3, GARA4, GARA5, GARA6, GARA-DUP	**04-May-2015**	**08-May-2015**	11-May-2015	✓	**09-May-2015**	17-Jun-2015	✓
EP080S: TPH(V)/BTEX Surrogates							
Amber VOC Vial - Sulfuric Acid (EP080) GARA1, GARA2, GARA3, GARA4, GARA5, GARA6, GARA-DUP	**04-May-2015**	**08-May-2015**	18-May-2015	✓	**11-May-2015**	18-May-2015	✓
EP132A: Phenolic Compounds							
Amber Glass Bottle - Unpreserved (EP132) GARA1, GARA2, GARA3, GARA4, GARA5, GARA6	**04-May-2015**	**08-May-2015**	11-May-2015	✓	**11-May-2015**	17-Jun-2015	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Ammonia as N by Discrete analyser	EK055G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	17	**11.76**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	6	**16.67**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	0	6	**0.00**	**10.00**	✗	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Suspended Solids (High Level)	EA025H	2	19	**10.53**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Organic Carbon	EP005	2	11	**18.18**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	2	15	**13.33**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Total Recoverable Hydrocarbons - Silica Gel C	EP071SG	1	7	**14.29**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH Volatiles/BTEX	EP080	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	17	**5.88**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Suspended Solids (High Level)	EA025H	2	19	**10.53**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Organic Carbon	EP005	2	11	**18.18**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	1	15	**6.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Total Recoverable Hydrocarbons - Silica Gel C	EP071SG	1	7	**14.29**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	17	**5.88**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Suspended Solids (High Level)	EA025H	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Total Organic Carbon	EP005	1	11	**9.09**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	1	15	**6.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Total Recoverable Hydrocarbons - Silica Gel C	EP071SG	1	7	**14.29**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	17	**5.88**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Organic Carbon	EP005	1	11	**9.09**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	1	15	**6.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Total Recoverable Hydrocarbons - Silica Gel C	EP071SG	1	7	**14.29**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45 um filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM (2013) Schedule B(3)
Pesticides by GCMS	EP068	WATER	USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
TRH - Total Recoverable Hydrocarbons - Silica Gel C	EP071SG	WATER	(USEPA SW 846 - 8015A) Sample extracts are analysed by Capillary GC/FID and quantified against alkane standards over the range C10 - C36. This method is compliant with NEPM (2013) Schedule B(3) (Method 506.1)
TRH Volatiles/BTEX	EP080	WATER	USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	WATER	USEPA 3640 (GPC Cleanup), 8270 GCMS Capiliary column, SIM mode. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
TKN/TP Digestion	EK061/EK067	WATER	APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

CERTIFICATE OF ANALYSIS

Work Order	: **EB1518177**	Page	: 1 of 4
Client	: **CODYHART CONSULTING PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS BARBARA HART	Contact	: Customer Services EB
Address	: P O BOX 1073 BURLEIGH HEADS QLD, AUSTRALIA 4220	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: pelican@codyhart.com.au	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: +61 55205532	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 55206531	Facsimile	: +61-7-3243 7218
Project	: Armidale Regional 2119	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 06-May-2015 08:50
C-O-C number	: ----	Date Analysis Commenced	: 06-May-2015
Sampler	: BARBARA HART	Issue Date	: 13-May-2015 08:53
Site	: Armidale Regional Landfill		
		No. of samples received	: 6
Quote number	: ----	No. of samples analysed	: 6

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

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*
Megan Brine	Microbiology and Phycology Team Leader	Brisbane Microbiological

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
ø = ALS is not NATA accredited for these tests.

- Microbiological Comment: Accordance with ALS work instruction QWI-MIC/04, membrane filtration result is reported an approximate (~) when the count of colonies on the filtered membrane is outside the range of 10 - 100cfu.
- MW023 is ALS's internal code and is equivalent to AS4276.9.
- MW006 is ALS's internal code and is equivalent to AS4276.7.

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Client sample ID	**GARA1**	**GARA2**	**GARA3**	**GARA4**	**GARA5**
			Client sampling date / time	04-May-2015 11:30	04-May-2015 12:30	04-May-2015 13:30	04-May-2015 10:30	04-May-2015 13:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1518177-001**	**EB1518177-002**	**EB1518177-003**	**EB1518177-004**	**EB1518177-005**
				Result	Result	Result	Result	Result
MW006: Faecal Coliforms & E.coli by MF								
Escherichia coli	----	1	CFU/100mL	**18**	**20**	**85**	**45**	**2800**
MW023: Enterococci by Membrane Filtration								
Enterococci	----	1	CFU/100mL	**22**	**16**	**190**	**52**	**1300**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Client sample ID	**GARA6**	**----**	**----**	**----**	**----**
			Client sampling date / time	04-May-2015 11:00	----	----	----	----
Compound	CAS Number	LOR	Unit	**EB1518177-006**	**--------**	**--------**	**--------**	**--------**
				Result	Result	Result	Result	Result
MW006: Faecal Coliforms & E.coli by MF								
Escherichia coli	----	1	CFU/100mL	**~10**	**----**	**----**	**----**	**----**
MW023: Enterococci by Membrane Filtration								
Enterococci	----	1	CFU/100mL	**~8**	**----**	**----**	**----**	**----**

QUALITY CONTROL REPORT

Work Order	: **EB1518177**	Page	: 1 of 4
Client	: **CODYHART CONSULTING PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS BARBARA HART	Contact	: Customer Services EB
Address	: P O BOX 1073 BURLEIGH HEADS QLD, AUSTRALIA 4220	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: pelican@codyhart.com.au	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: +61 55205532	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 55206531	Facsimile	: +61-7-3243 7218
Project	: Armidale Regional 2119	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 06-May-2015
C-O-C number	: ----	Date Analysis Commenced	: 06-May-2015
Sampler	: BARBARA HART	Issue Date	: 13-May-2015
Site	: Armidale Regional Landfill	No. of samples received	: 6
Quote number	: ----	No. of samples analysed	: 6

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

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 ir compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Megan Brine	Microbiology and Phycology Team Leader	Brisbane Microbiological

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

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
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
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:0% - 20%.

- **No Laboratory Duplicate (DUP) Results are required to be reported.**

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

- **No Method Blank (MB) or Laboratory Control Spike (LCS) Results are required to be reported.**

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

- **No Matrix Spike (MS) or Matrix Spike Duplicate (MSD) Results are required to be reported.**

QA/QC Compliance Assessment for DQO Reporting

Work Order	: **EB1518177**	Page	: 1 of 5
Client	: **CODYHART CONSULTING PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS BARBARA HART	Telephone	: +61-7-3243 7222
Project	: Armidale Regional 2119	Date Samples Received	: 06-May-2015
Site	: Armidale Regional Landfill	Issue Date	: 13-May-2015
Sampler	: BARBARA HART	No. of samples received	: 6
Order number	: ----	No. of samples analysed	: 6

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **NO Matrix Spike outliers occur.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **NO Quality Control Sample Frequency Outliers exist.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method **Container** / Client Sample ID(s)	*Extraction / Preparation* *Date extracted*	 *Due for extraction*	 **Days overdue**	*Analysis* *Date analysed*	 *Due for analysis*	 **Days overdue**
MW006: Faecal Coliforms & E.coli by MF						
Sterile Plastic Bottle - Sodium Thiosulfate GARA3	----	----	----	06-May-2015	05-May-2015	**1**
Sterile Plastic Jar GARA1, GARA2, GARA4, GARA5, GARA6	----	----	----	06-May-2015	05-May-2015	**1**
MW023: Enterococci by Membrane Filtration						
Sterile Plastic Bottle - Sodium Thiosulfate GARA3	----	----	----	06-May-2015	05-May-2015	**1**
Sterile Plastic Jar GARA1, GARA2, GARA4, GARA5, GARA6	----	----	----	06-May-2015	05-May-2015	**1**

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: ✗ = Holding time breach ; ✓ = Within holding time.

Method *Container / Client Sample ID(s)*	***Sample Date***	*Extraction / Preparation* ***Date extracted***	 *Due for extraction*	 *Evaluation*	*Analysis* ***Date analysed***	 *Due for analysis*	 *Evaluation*
MW006: Faecal Coliforms & E.coli by MF							
Sterile Plastic Bottle - Sodium Thiosulfate (MW006) GARA3	**04-May-2015**	**----**	----	----	**06-May-2015**	05-May-2015	✗
Sterile Plastic Jar (MW006) GARA1, GARA2, GARA4, GARA5, GARA6	**04-May-2015**	**----**	----	----	**06-May-2015**	05-May-2015	✗

Matrix: **WATER**

Evaluation: ✗ = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
MW023: Enterococci by Membrane Filtration							
Sterile Plastic Bottle - Sodium Thiosulfate (MW023) GARA3	**04-May-2015**	**----**	----	----	**06-May-2015**	05-May-2015	✗
Sterile Plastic Jar (MW023) GARA1, GARA2, GARA4, GARA5, GARA6	**04-May-2015**	**----**	----	----	**06-May-2015**	05-May-2015	✗

Quality Control Parameter Frequency Compliance

- **No Quality Control data available for this section.**

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Thermotolerant Coliforms & E.coli by Membrane Filtration	MW006	WATER	In house: Referenced to AS 4276.7 2007
Enumeration of Enterococci by Membrane Filtration	MW023	WATER	In house: Referenced to AS4276.9: - 2007

CodyHart Environmental Analyses

Due to holding time problems if sent to a NATA registered laboratory, CodyHart conducts laboratory analyses for alkalinity and free CO_2 on-site or on the evening of the sampling day. The analyses are more accurate when conducted on fresh samples. Alkalinity has always been regarded as a 'field analyte' in the literature.

- For alkalinity, CodyHart uses titration and/or colour change, on site or on the evening of sampling, to endpoint pH 4.5 as detailed in APHA (1998) section 2320, which is the NSW EPA approved method. The colour change method adopted uses a mixed indicator alkalinity (Bromocresol Green – Methyl Red) indicator solution (APHA 1992, 2-25, 2-27) which in combination with titration changes the sample colour from blue to wild moss green at approximately pH 4.5.
- High concentrations of free CO_2 indicate that landfill gas may be permeating groundwater. The APHA 4500-CO_2 C titration method is used as detailed in *Standard Methods for the Examination of Water and Wastewater,* 18th edition 1992:4-17, and/or a phenolphthalein indicator colour method which in combination with titration changes the sample colour from clear to mid-pink (APHA 1992, 2-25, 2-27) at pH 8.3.

Results 04/05/15

Surface water

	GARA1	**GARA2**	**GARA3**	**GARA4**	**GARA5**	**GARA6**
Alkalinity (mg/L) (titration & colour change)	117	140	20	117	13	150
Free CO_2 (mg/L) (titration & colour change)	15	12	12	9	9	6

Appendix C

Baseline Groundwater Monitoring Report - July 2015

Appendix C Baseline Groundwater Monitoring Report - July 2015

Helping You Protect Your Environment

BASELINE GROUNDWATER & GARA6 MONITORING

ARMIDALE REGIONAL LANDFILL

July 2015
Revision 2

for Armidale Dumaresq Council

CodyHart Consulting Pty Ltd ACN: 076 662 989 ABN: 23 809 060 895
Trading as CodyHart Environmental
Groundwater and Landfill Environmental Monitoring Specialists

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APPENDICES

Presented by: Barbara Hart
Hydrogeologist & Environmental Scientist
Master of Environmental and Community Health
Master of Science in Hydrogeology and Groundwater Management

Date: 9 September 2015
Report: CodyHart 15.2119.2

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CodyHart Consulting Pty Ltd has taken due care in ensuring the accuracy and applicability of its monitoring work, and the content, interpretation and advice provided in this report for the client.

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1. INTRODUCTION

This Armidale Regional Landfill monitoring report concerns:

- Well development that was conducted in May 2015 to clean out the groundwater monitoring wells in preparation for slug tests and the first round of baseline monitoring
- Slug tests conducted in July 2015 to estimate in-situ hydraulic conductivity, one of the major coefficients in estimating groundwater flow average linear velocity and consequently groundwater monitoring sampling frequency
- The first round of groundwater monitoring in wells ABH02, ABH02A, ABH4, ABH04, ABH04A, ABH9, ABH11, and ABH12. (The letter 'A', refers to Armidale. It has been added to differentiate these wells from those at other sites. Well ABH4A was dry.)
- The second round of baseline monitoring at ambient surface water sampling point, GARA6 located downstream from the landfill on the Gara River.
- Recommendations for progression through the three phases of groundwater monitoring for a general solid waste landfill: 1) site characterisation (baseline), 2) detection monitoring, and 3) assessment monitoring.
- Groundwater flow direction plots.

Two revisions have been made to this report.

1.1 Revision 1

To meet Armidale Regional Landfill approval milestones, Revision 1 changed the baseline groundwater monitoring from quarterly to bi-monthly. This is in reference to the revised Project Approval for groundwater monitoring, condition 9(f) of schedule 4, second last dot point, which now requires

> *obtaining a minimum of two bi-monthly baseline sampling events before commencing construction of the landfill.*

The baseline groundwater monitoring program will exceed these requirements. Rather than just the required two bi-monthly rounds, it will consist of eight bi-monthly rounds in total:

- Four (4) bi-monthly rounds are planned prior to construction of the intersection from the Waterfall Way Highway into the site in late January 2016. (The intersection is on a different groundwater flow path to that which underlies the proposed landfill cells themselves, so intersection construction will have no impact on the groundwater quality in monitoring wells surrounding the proposed landfill cells.) The first round was conducted in late July 2015, and the next three (3) rounds will be conducted in September and November 2015, then January 2016.
- Another four (4) bi-monthly baseline groundwater monitoring rounds will be conducted in March, May, July and September 2016.

This baseline groundwater monitoring program of eight (8) rounds will be complete a number of months prior to the opening of the Armidale Regional Landfill for solid waste acceptance.

By having eight rounds of baseline ambient groundwater monitoring, there are eight rounds of data from which to estimate trigger values that indicate that a particular well/s may need to progress from detection monitoring phase to assessment monitoring phase.

1.2 Revision 2

This report is Revision 2. It includes groundwater flow direction plots based on a recent survey.

2. OBJECTIVES

The objective of the baseline ambient groundwater monitoring program for the Armidale Regional Landfill is to establish ambient groundwater quality so that in the detection monitoring phase comparisons can be made

> *to detect any pollution of groundwater by leachate.* (NSW EPA, 2015, p. 27)

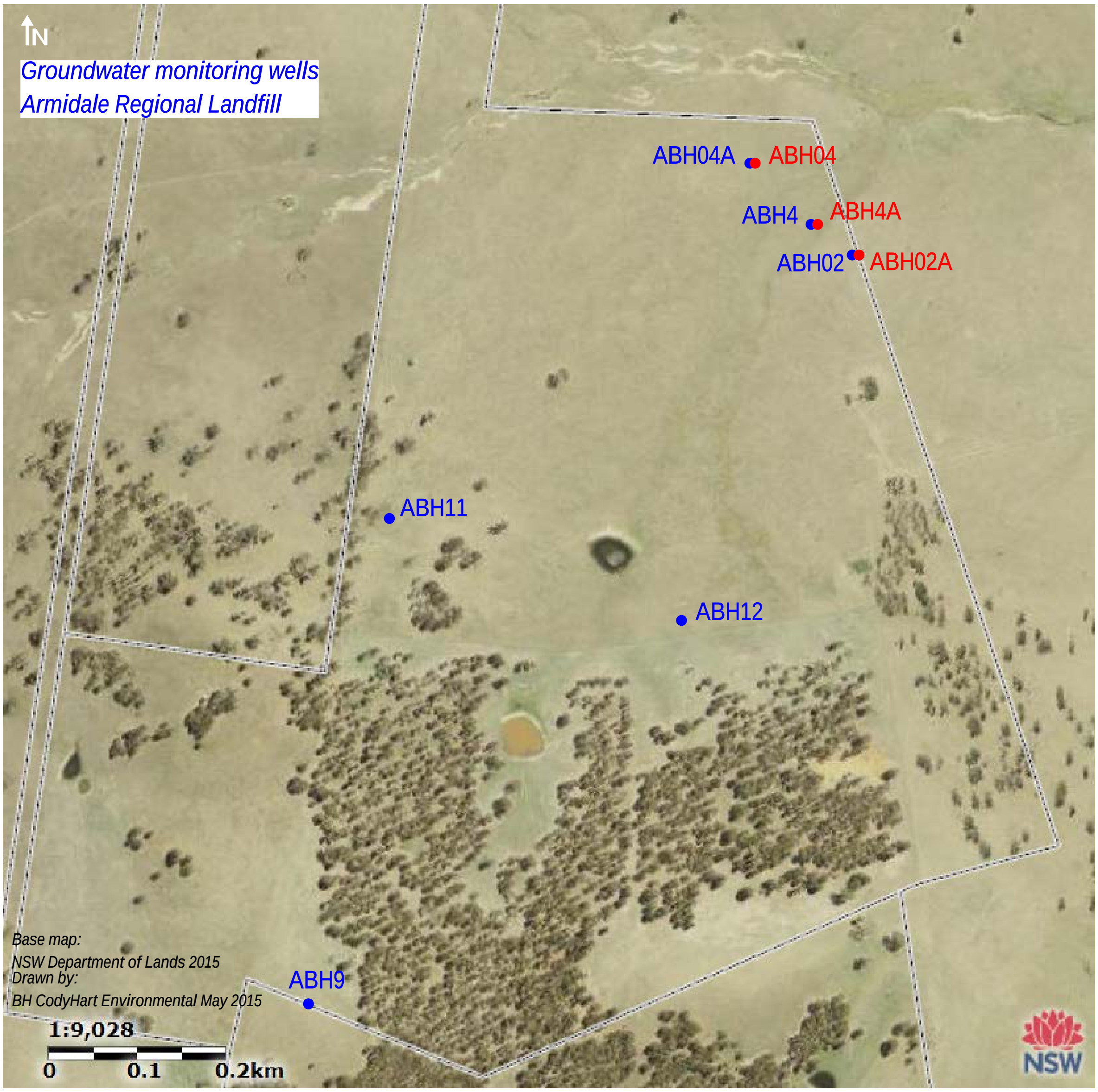
The objective of the baseline ambient surface water monitoring program for the Armidale Regional Landfill is to establish ambient surface water quality so that in the detection monitoring phase comparisons can be made

> *to detect any pollution of off-site surface water bodies by leachate or by sediment-laden stormwater from the landfill.* (NSW EPA, 2015, p. 25)

3. GROUNDWATER SAMPLING LOCATIONS

The monitoring well locations are superimposed on a satellite image of the site in Figure 1.

Figure 1: Groundwater monitoring well locations, Armidale Regional Landfill site



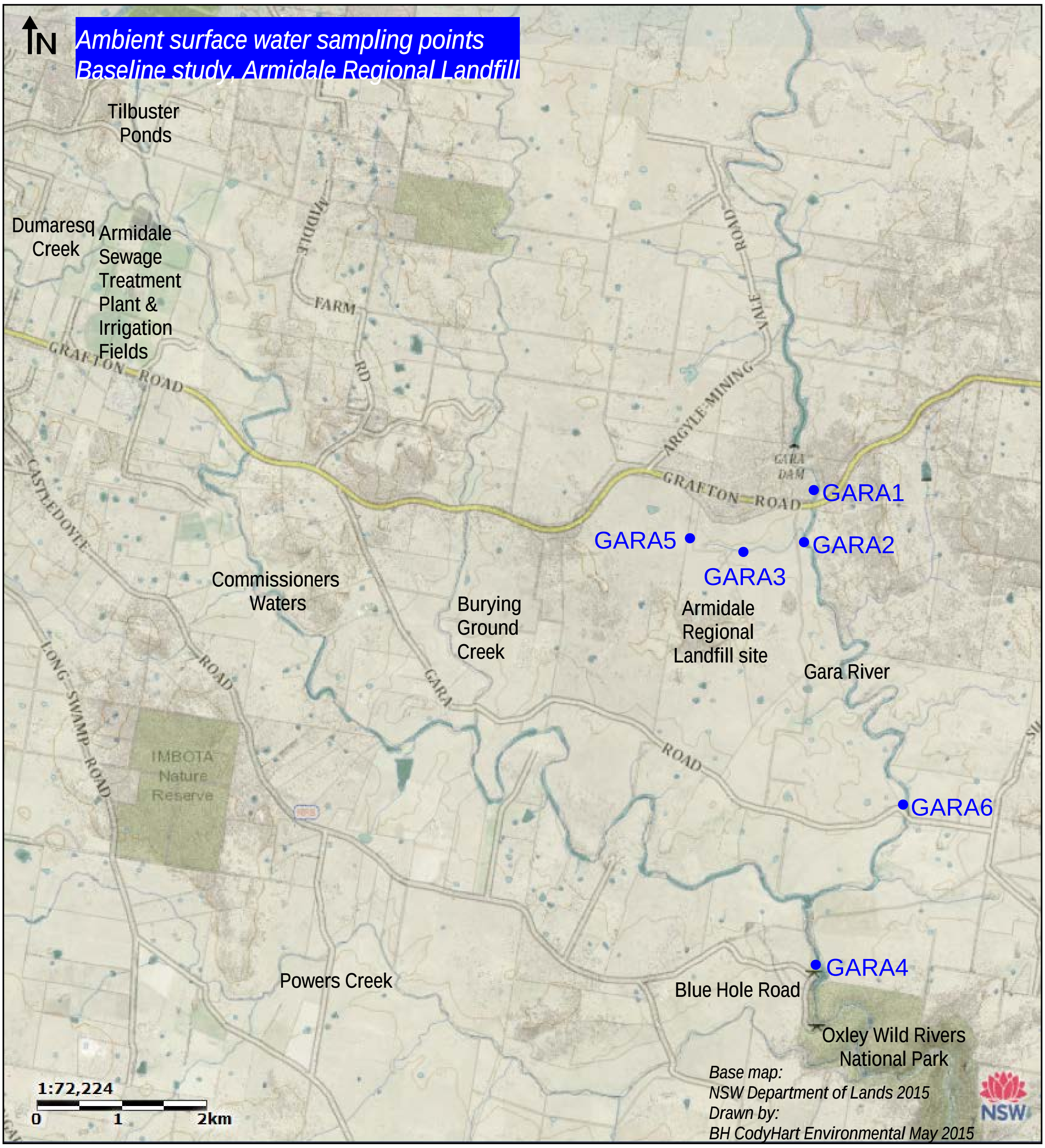
ABH9 is the upgradient well. All the other wells will be downgradient of the landfill.

4. BASELINE AMBIENT SURFACE WATER SAMPLING LOCATIONS

Baseline monitoring is complete for five ambient surface water sampling points, GARA1 to GARA5. There are not yet eight rounds of monitoring for GARA6, which was added later as an ambient surface water monitoring point.

Figure 2 is included in this report because the GARA6 ambient surface water sampling point is being sampled in the same sampling rounds as the baseline groundwater monitoring.

Figure 2: Baseline study, ambient surface water sampling locations



5. WELL DEVELOPMENT

Well development is a process whereby drilling fines caught between filter sand pack grains surrounding the well screen are cleaned out and skins on the drill hole walls within the screen are broken down. The aim is to have relatively clear groundwater by the end of well development so that relatively clear groundwater samples will be available for the future sampling program.

A number of groundwater monitoring authors stress the importance of well development. Barcelona et al. (1985) explain that well development is essential prior to hydraulic conductivity testing. Puls and Barcelona (1996) explain that a well needs to be left for at least a week after well development before sampling. ASCE (1996) recommends at least 14 days. They explain that if sampling commences too early after well installation and development, water levels and analyte concentrations may not reflect the true nature of the surrounding groundwater regime.

There was no mention in prior documentation of air development of the monitoring wells. There was no detail concerning development of wells by pumping.

CodyHart therefore undertook well development by surging and pumping or bailing in April/May 2015 prior to the first round of groundwater sampling. A Solinist double valve pump operated with compressed air was lowered into the deeper wells (ABH02A, ABH04, ABH9, ABH11, and ABH12) to develop them. A battery operated twister pump was lowered to mid-depth in well ABH4, which is 18 metres deep from the top of the well casing. A bailer was used to develop and hand retrieve the dirty groundwater from shallow wells ABH02 and ABH04A.

Pump out is a gentler well development method than air lifting. No air or groundwater is blown into the filter pack surrounding the screen as occurs during airlifting. Groundwater is only extracted. For the pumped wells, pump out is conducted at a number of levels within the screen. Movement of the pump up and down the screen between each level pump out, gently moves the filter pack and dislodges the fines into the well column, increasing the turbidity of the column water for the next pump out. An example of turbid water removed during pump out is shown in Photograph 1.

Photograph 1: Well development by pump out

The left hand photograph shows dirty groundwater being extracted from a well at another site. One of the tubes down the well is for compressed air, the other for the groundwater being forced to the surface.

The right hand photograph shows clear water in the tubing being pumped at the end of well development at well ABH12, Armidale Regional Landfill.

Although the aim of well development is to have relatively clear water at the end of the well development process, this is sometimes not achieved, but at least a large portion of turbid water caused by the well installation has been removed. Details of the May 2015 well development is provided on the well development forms in Appendix D. Summary particulars for each well are as follows.

- Well ABH02 – 22.5 L extracted (1 well volume 16.2 L). Bailed. Groundwater brown and highly turbid at start; and cloudy white, low turbidity by the end of bail out.
- Well ABH02A – 60 L extracted (1 well volume 57.7 L). Solinst double valve pump. Groundwater dark grey and highly turbid at start; and cloudy very light grey, low turbidity by the end of pump out.
- Well ABH4 – 70 L extracted (1 well volume 52.4 L). Twister pump. Groundwater cloudy dark grey and highly turbid at start; and cloudy white, low turbidity by the end of pump out.
- Well ABH4A was dry.
- Well ABH04 – 60 L extracted (1 well volume 66.6 L). Solinst double valve pump. Groundwater cloudy grey and highly turbid at start; and very light grey, low turbidity by the end of pump out.
- Well ABH04A – 32 L extracted (1 well volume 15.4 L). Bailed. Groundwater dark grey and highly turbid at start; and cloudy light brown white, moderate turbidity by the end of bail out.
- Well ABH9 – 30 L extracted (1 well volume 47.7 L). Solinst double valve pump. Groundwater orange and moderate turbidity at start; and very light orange, low turbidity by the end of pump out.
- Well ABH11 – 60 L extracted (1 well volume 36.7 L). Solinst double valve pump. Groundwater brown and high turbidity at start; and almost clear, low turbidity by the end of pump out.
- Well ABH12 – 60 L extracted (1 well volume 52.3 L). Solinst double valve pump. Groundwater dark grey and high turbidity at start; and clear, low turbidity by the end of pump out.

The wells were left for more than two months to settle before slug testing and the first round of monitoring was conducted at the end of July 2015.

6. GEOLOGICAL EVIDENCE OF GROUNDWATER FLOW RATES

From site investigations, various sedimentary soils and rock were classified - sand, clay, sandstone, argillite (lithified muds and oozes containing variable amounts of silt-sized particles), greywacke (an argillaceous sandstone), mudstone, clay and chert (sedimentary rock made of silica, particularly quartz) (Ashley 2005, Ashley 2006, RCA 2007). Fractures in the rocks provide passageways for groundwater. Silts, clays and mudstones with minimal fracturing provide barriers that limit groundwater flow.

Ashley (2005) logged a 5 m to 26 m diamond drilled core from a vertical borehole approximately 87 m to the west of monitoring well ABH12 (Figure 1). The two primary rock types in the core were 'medium grained, rather massive greywacke (quartz-feldspar-lithic sandstone)' and 'mud chip greywacke'.

Groundwater flow within these rocks would occur weakly through foliation (weak cleavage) that develops into fractures. Weathering was observed around fractures in the deeper part of the core indicating oxidising groundwater penetration. Fractures were 'more abundant where weathering effects are stronger'.

> *Zones of strong fracturing and clay development in the weathered zone might have the potential for considerable groundwater transmission.* (Ashley 2005)

Ashley's comment about considerable groundwater transmission is consistent with the relatively speedy recharge in the deep monitoring wells noted by CodyHart during well development and slug testing.

7. SLUG TESTS

Slug tests are used to estimate the hydraulic conductivity (*K*) (in-situ permeability) of the well screen strata. They are a popular method for estimating *K* in low permeable material such as clay and silt where wells have a slow recovery, and provide a more realistic estimate than laboratory tests for *K* (Campbell et al. 1990, p. 86). The *K* value is needed in the estimation of seepage rates (Watson & Burnett 1995, pp. 94-100), that is, groundwater flow rate, and for prediction of contaminant concentrations in fate and transport models. In turn, groundwater flow rate is a basis for determining an appropriate sampling frequency.

7.1 Characteristics of the wells slug tested

Slug tests were conducted on 27 and 28 July 2015 at four wells, ABH02, ABH02A, ABH04A and ABH12, which are downgradient of the proposed landfill cells, and act as sentinels between the landfill and the water environment that may be at risk, the Gara River. Wells ABH02 and ABH04A are shallow wells and ABH02A and ABH12 are deeper wells. Information gained from borelogs and piezometric levels immediately before the slug tests were commenced is as follows:

- The screen of shallow well ABH02 (3.6 m to 11.0 m below ground) intercepted from the top: silty clay, red-brown; then clay, yellow-brown with a combined thickness of 2.2 metres within the screen level and above; argillite, fine grained, light brown; and lastly greywacke, fine-grained, yellow-brown. Due to the confining clays surrounding the top of the screen and the shallow depth of the well, it was assumed that the water response would be slow to moderate. The piezometric level was midway down the screen at approximately 7.1 m below ground.
- The screen of shallow well ABH04A (4.5 m to 8.0 m below ground) intercepted similar strata to that of ABH02 except the screen was positioned about 1 metre lower. There is a 2.2 metre band of confining clay, but only the clay, yellow-brown is within the screen level. There is no argillite. The rock type within the screen level is greywacke, fine-grained, yellow-brown. Due to the confining clays surrounding the tops of the screen and the shallow depth of the well, it was assumed that the water response would be slow to moderate. The piezometric level was approximately 10 cm above the top of the screen.

- The screen of deeper well ABH02A (23.1 m to 29.6 m below ground) intercepted only one rock stratum: greywacke, fine to coarse grained, grey. Its upper level strata were similar to those in well ABH02, which means there is a high level confining layer, but it is approximately 18 metres above the screen. Moisture was noted while drilling as high as 1.25 m below ground and continued as drilling continued. This indicates groundwater upthrust from confining layers. Piezometric level was at approximately the same level as in well ABH02, which means that the piezometric level is well above the screen. If there are weathered fractures within the greywacke as discussed by Ashley (2005), it was assumed that the water response would be moderate.
- The screen of deeper well ABH12 (34.0 m to 40.0 m below ground) intercepted only one rock stratum: argillite, dry, discrete fragments, hard rock, with powdery fines, grey. If there are weathered fractures, it was assumed that the water response would be moderate. The borelog describes dry rock down from the surface clays and a non-dated piezometric level of 35.0 m below ground. In comparison, the piezometric level in July 2015 was 19.25 m below ground which indicates a confined aquifer.

7.2 Slug test methodology

A closed bar ‘slug’ was used for the ‘slug-in’ and ‘slug-out’ tests in each well. The battery of the transducer data logger taken to site failed, so rise and fall measurements were taken with an electronic dip meter. In some instances, water level change was fast. So some slug tests were repeated to assure the quality of the data.

7.2.1 Falling-head test – ‘Slug-in’

The water level of the well to be tested was measured. A slug made of a disposable bailer filled with sand and sealed with gaffa tape was positioned about 20 cm above the water level. The electronic dip meter was taped at the likely initial water level rise measurement, then positioned in the well just above the slug. The slug was lowered gently but quickly into the well. One person called out the measurements while the other manually logged each measurement against the stop watch time. The logger and slug were kept in position until the water level returned to its original level and if not, for one hour.

7.2.2 Rising-head test – ‘Slug-out’

The electronic dip meter was taped at the likely initial water level fall measurement. The slug was quickly and smoothly removed from the well. The electronic dip meter was reeled into the well as quickly as possible and the measurements and stop watch readings manually logged. If the water level had not returned to its water level prior to the withdrawal of the slug, the logging was discontinued after one hour.

7.3 Literature information re analysis of slug test data

Four methods available for analysing slug test data in the software program *Super Slug* (Pittenger 1995) were used to estimate the hydraulic conductivity from the slug test data of the Armidale Regional Landfill wells. This section reviews the applicability of each of the available four methods.

For each method to be applicable, various assumptions about the hydrogeological location of the well and its screen are preferred. Whether or not site wells meet these assumptions can be determined by answering the following questions:

- Is the well and its screen in a confined or unconfined aquifer?
  - From the confining clay above the screen or at the top level of the well screens, and the rise of groundwater level after drilling, it can be assumed that we are dealing with a confined aquifer.
- Does the well screen partially or fully penetrate the aquifer under confined conditions?
  - The depth of the aquifer is unknown. No clay confining layer was noted in the borelogs under the fractured rock. Ashley's (2005) drill core logs of a borehole approximately 87 m west of ABH12 detailed many small fractures to a depth of 26 m. Clay (2010) assumed a 25 m deep saturated zone or aquifer at the site. The pressure heads from some of the deep wells suggest that this is a reasonable assumption. For example, downgradient well ABH12 piezometric level on the Year 2007 (RCA) drilling borelog was 35 m below ground. In July 2015, it was 19.25 m below ground. This pressure head difference since drilling is therefore 15.75 m and there is likely to be more groundwater encountered if drilling had been continued to a greater depth.
- Is the screen located in a stratum that is radially infinite, homogeneous and isotropic?
  - The screen is definitely not in a simple stratum as detailed in the above question. The fractures drawn by Ashley (2005) show that the aquifer is anisotropic (does not move equally in all directions), and the soils and rock are heterogeneous.
- How much is known about the ratio of horizontal hydraulic conductivity (K_h) to vertical hydraulic conductivity (K_z)?
  - Some Hvorslev analysis tests require input of K_h: K_z. No reviews have been undertaken of the site K_h: K_z. Due to common heterogeneity of site geology and groundwater flow patterns, K_h: K_z is commonly determined from literature references, or in groundwater modeling from trial and error to fit the available data. Lade (2001, p. 54) explains that K_h in homogeneous deposits is '*typically between 1.0 and 1.5 times'* K_z, but Armidale Regional Landfill deposits are not homogeneous. Lade (2001) then states that in stratified and varied clays K_h can be much higher than K_z. In his expert witness statement in regard to the Adani Coal Mine in Queensland Merrick (2015, p.7) discusses his findings concerning K_h: K_z during groundwater modeling of sedimentary deposits.

    > *To counteract uncertainty, a common practice in groundwater modelling is to err on the side of caution - in other words, to make a conservative assumption, in the sense of a predicted impact being worse than is likely……. The assumption of vertical hydraulic conductivity being a tenth of the horizontal value is a conservative assumption, as the model would allow easier vertical flow of water and would offer less resistance to propagation of mining effects to land surface and streams. In my experience, based on similar coal mine situations, the vertical hydraulic conductivity (in a model) is more likely to be a hundredth or a thousandth of the horizontal value. This means that the GHD model is likely to overestimate environmental impacts, based on this one assumption*.

  From the preceding review, a K_h: K_z 90:10 (0.90) is accepted as a conservative, precautionary estimate for the Armidale Regional Landfill site because it probably overestimates the K_z and the chance of vertical flow from the landfill or leachate dams.
- Is the screen some distance below the upper confining layer?
  - This is the case for all wells slug tested, except for well ABH04A. (The piezometric level in well ABH02 is midway in the screen, so the screen is assumed to be below the confining layer.)

Applying the above review to the four wells slug tested:

1. The Ferris-Knowles method is provided as an auto-solve method in *Super Slug*. Assumptions for the method are that the well is fully penetrating the aquifer under confined conditions, radially infinite, homogeneous and isotropic (Campbell et al. 1990, p. 90). However, Campbell et al. (1990, pp. 90, 91) state that the Cooper *et al*. method has essentially replaced the Ferris and Knowles method and that it only applies to a plot that produces a straight line as the levels approach zero. None of the wells appear to fully penetrate the aquifer and the aquifer is not radially infinite, homogeneous and isotropic. The Ferris-Knowles method is therefore not applicable.
2. The Cooper, Bredehoeft, Papadopulos method is for use in confined aquifers that are fully penetrated by the well screen. Because moisture was not encountered in the deep well ABH12 while drilling until 35 m below ground, and that the piezometric level has risen 15 m since, it is assumed that the confined aquifer is not fully penetrated by the well screen in any of the slug tested wells. The Cooper, Bredehoeft, Papadopulos method is therefore not applicable.
3. The Hvorslev method 'is restricted to estimates of hydraulic conductivity within the screened zone of a well and can be applied to confined and unconfined aquifers' (Weight & Sonderegger 2001, p. 456). Campbell et al. (1990, p. 89) state that it is used widely due to historical precedence rather than technical justification. *Super Slug* can solve using the Hvorslev method two ways: auto-solve or graphically. In auto-solve, because the ratio of horizontal conductivity to vertical conductivity (K_h: K_z) is unknown and not inputted, *Super Slug* uses the default Hvorslev C case. This case assumes that the well screen fully penetrates the aquifer (Pittenger 1995, p. 26). So the auto-solve Hvorslev C case version is not applicable for Armidale Regional Landfill wells. However, when K_h: K_z is inputted, the Hvorslev graphical version applies to either fully or partially penetrating wells (Pittenger 1995, p. 27). So the Hvorslev method is applicable.
4. The Bouwer and Rice method is the most preferred in the literature because 'it gives consistent results under a variety of conditions' (Campbell et al. (1995, p. 93). Pittenger (1995, p. 32) states that the aquifer can be either fully penetrated or partially penetrated by the screened portion of the well. Although designed for unconfined aquifer scenarios, it gives reasonable results for confined or leaky aquifers. However, Campbell et al. (1990, p. 92) state that for this method to be applicable to confined or stratified aquifers, the top of the screen needs to be some distance below the upper confining layer. This is the case for all wells slug tested, except for well ABH04A. So the Bouwer and Rice method is applicable to all wells except for well ABH04A.

Most of the wells at the Armidale Regional Landfill fulfil the assumptions of the Hvorslev graphical method and the Bouwer and Rice method. In addition, Duffield (2015a) advises that '*despite different underlying assumptions'* the Bouwer and Rice method and the Hvorslev method *'yield very similar estimates of K*'.

Effective screen length (L) input into analysis methods is also contentious. Duffield (2015a) explains that Fetter (2001) advises using the length of the gravel pack in low-permeable aquifers; however, Butler (1998) advises use of the screen length (L) only, because the gravel pack above the screen is difficult to penetrate during well development, and the wellbore wall adjacent remains undeveloped and therefore contributes little flow during a slug test.

Duffield (2015) also cautions regarding '*a double straight line*' in the graphed analysis which occurs when a well is '*screened across the water table*'. He explains that Bouwer (1989) states that the second straight line is '*more indicative of flow into the well from the aquifer*' because the first straight line is indicative of '*drainage into the well from a permeable gravel pack*'.

From the complications reviewed above it can be seen that the results from slug test analyses are not likely to be precise and the choice of appropriate method requires consideration. Add to this the Campbell et al. (1990, p. 96) warning that where fine grained materials are concerned, there is inherent variability in the subsurface, and slug test results '*should only be considered valid over a range of one order of magnitude for contaminant transport studies*'. Then there is the common lack of homogeneity in the groundwater environment. Groundwater often cannot move equally in all directions (it is anisotropic) due to the heterogeneous physical nature of the surrounding strata; well diameters vary vertically due to varying diameters of the pack's gravel envelope; and, as explained by Butler (1997, p. 4, 16) well development is often quite minimal resulting in partially or unevenly removed low hydraulic skins not representative of the formation on the bore walls. Bouwer (1989) explains slug test result inaccuracies in terms of vulnerability to aquifer heterogeneities and to inaccuracies in estimating effective well diameters. Hyder and Butler (1995, p. 21) give examples of over-prediction of hydraulic conductivity by 100% and under-prediction by 50%.

Input and interpretation tips given by Weight & Sonderegger (2001, p. 466) are taken into account in the slug test analyses: (1) Use the radius, not the diameter. (2) Include the sand pack in the screen length. (No – Butler and Bouwer advise otherwise.) (3) Be careful not to average the data into a single best-fit line – unless the data are in a straight line. Including the tail in the best-fit line will result in underestimating the hydraulic conductivity (or in the case of the Hvorslev graphical method using equally weighting of all data points for the best fit line, overestimating K). They suggest getting your face close to the plot 'to detect the appropriate straight-line section from which to draw the line'.

7.4 Hydraulic conductivity estimation

The manually logged data was input into the software program *Super Slug*. Detailed results for each well are provided in Appendix E. Using a software package which includes graphing allows fast review of slug test data using various analysis methods and quick adjustment of data to suit 'best fit' lines on graphs. By clicking the bottom arrows, data points from the beginning and/or end of the data can be dropped out of the analysis to 'eye-ball' the best fit line.

One of the 'best fit graphs' provided in Appendix E is repeated as Figure 3. Summarised hydraulic conductivity (K) estimations are provided in Table 1.

Figure 3: Hydraulic conductivity estimation using the Hvorslev method ABH04A

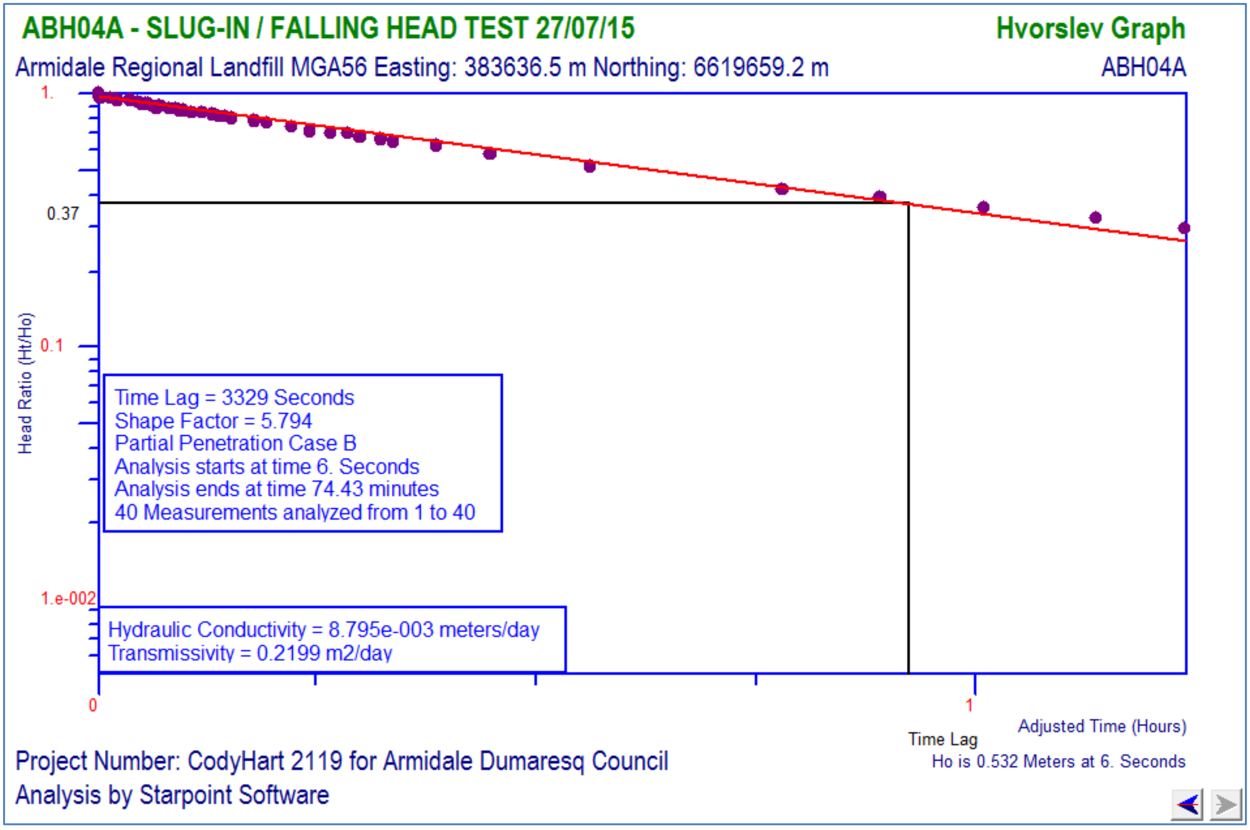


Table 1: Hydraulic conductivity (K) estimates from slug tests, July 2015

Well	Slug–in / rising head Bouwer & Rice *K*	Slug–in / rising head Hvorslev *K*	Slug–out / falling head Bouwer & Rice *K*	Slug–out / falling head Hvorslev *K*	Geometric means fastest slug-in & slug-out *Ks*
ABH02	0.1452 m/day	0.1541 m/day	0.07 m/day	0.11 m/day	0.13 m/day
ABH02A	0.0935 m/day	0.1319 m/day	0.1276 m/day	0.1336 m/day	0.13 m/day
ABH04A	0.0053 m/day	0.0088 m/day	0.0034 m/day	0.0056 m/day	0.007 m/day
ABH12	1.053 m/day	1.141 m/day			Slug in only 1.14 m/day

Notes:
Bouwer (1978, pp. 132-133) and Sevee (2006, p. 933) recommend that the best estimate of *K* is the geometric mean of the falling and rising heads: *K* = $(K_{RH}.K_{FH})^{1/2}$, [that is, $\sqrt{(K_{RH} \times K_{FH})}$].

RCA (2007) estimated that the *K* of well ABH11 was 3.8 x 10 $^{-6}$ m/s (0.33 m/day), approximately three times less than that of well ABH12 as determined in July 2015.

Slug tests showed that wells in the mid-gradient portion of the Armidale Regional Landfill site (ABH11, ABH12) have faster *Ks* than the lower gradient wells to the north, which are located below the yet to be constructed leachate and sediment ponds (ABH02, ABH02A, and ABH04A).

8. GROUNDWATER FLOW RATE (VELOCITY)

K is an input into the calculation of groundwater velocity rates.

A simple equation often used is groundwater average linear velocity where:

$V = (K \times i) / Ne$

Where V = average linear velocity
K = saturated hydraulic conductivity
i = hydraulic gradient
Ne = effective porosity Sara (1993, p. 5-55)

8.1 Saturated hydraulic conductivity (K)

The hydraulic conductivity (*K)* in a well refers to the ability of aquifer/aquitard soil or rock to transmit water and is expressed as distance/time. Slug tests used to estimate *K* provide a localised measure of K of the surrounding soil/rock. The *K* does not take into account slope (gradient) of groundwater over distance, nor the effective porosity - *the portion of total interconnected pore space through which flow of water takes place* (Sara, 1993, p. 7-40).

A number of *K* in-situ values have been calculated by CodyHart (Table 1) and a falling head from RCA (2007) data for well ABH11 at 3.8 x 10 $^{-6}$ m/s (0.33 m/day) is also of interest.

Taking a precautionary approach, the greatest K in the downgradient wells as a geometric mean of both falling head and rising head tests is 0.13 m/day (1.5 x 10 $^{-6}$ m/s) in both wells ABH02 and ABH02A.

Wells ABH11 and ABH12 can be referred to as mid-gradient wells. Extra slug-in and slug-out tests are recommended for these wells. The recoveries in both wells were similar during low-flow water quality sampling by CodyHart in which they both exhibited no drawdown. However, their calculated *Ks* from solely slug-in / rising head slug tests are quite different. The *K* of well ABH11 (3.8 x 10^{-6} m/s = 0.32832 m/day = 120 m / year) (RCA 2007) was three times slower than well ABH12 (1.3 x 10^{-5} m/s = 1.141 m/day = 416 m/year).

The slug-in methods used by CodyHart (2015) and RCA (2007) were quite different. In well ABH12, CodyHart used a one meter closed bar slug for the test. For well ABH11, it appears that RCA (2007, Appendix E) poured down a slug of water that raised the water level by 5.63 m. CodyHart noted 8 water level measurements. The graph from RCA (2007) results only indicate two water level measurements, one just after the slug of water was poured down, and the final one 11 minutes later when the well had almost recovered.

Only slug-in / falling head tests have been conducted in both these wells and no slug-out / rising head tests. Weight & Sonderegger (2000, p. 455) prefer the slug-out / rising head test '*because the water that is displaced must come from the aquifer, rather than pushed out into the aquifer as is done in a falling head test*'. Slug-out / rising-head tests are more difficult to conduct in wells ABH11 and ABH12 because their piezometric water levels are deep - 25.72 m and 19.83 m respectively below the top of PVC casing in July 2015. Using a data logger / pressure transducer for both slug-in / falling head tests and slug-out / rising head tests will provide assurance that *K* values are reliable. This will be done after a later baseline sampling round.

Review of the site *K* values against *Connected Water* (2010) *K* categories (Table 2 indicates that we are dealing with *Ks* that are slow to moderate.

Table 2: Hydraulic conductivity categories

Description	metres/day (m/d)	metres/second (m/s)
Extremely slow	0.000001	$1.5741x10^{-11}$
Very Slow	0.0001	$1.5741x10^{-9}$
Slow	0.01	$1.5741x10^{-7}$
Moderate	1	$1.5741x10^{-5}$
Fast	10	$1.5741x10^{-4}$
Very Fast	100	$1.5741x10^{-3}$

(Connected Water 2010)

8.2 Hydraulic gradient (i)

Water flow depends on the hydraulic gradient. The steeper the slope, the faster water flows. (Vertical at 1.0 is fastest.)

The hydraulic gradient is estimated by calculating the relative level difference in the piezometric levels of two wells, then dividing it by the topographical distance between the two wells. This is a m/m estimate, which is presented as a unit-less value. The two wells chosen are usually a considerable distance apart on the site and representative of flow direction.

RCA (2007, Drawing 1) plotted the groundwater flow direction as northeast, and the wells chosen for their hydraulic gradient estimations approximated this general flow direction.

RCA (2007, p. 11) estimated two hydraulic gradients, an upper one between ABH9 and ABH12 (3.14×10^{-2}), and a lower one between ABH12 and ABH4 (1.51×10^{-3}). The piezometric levels were probably taken soon after drilling before the piezometric levels had stabilised. As of July 2015, the levels have increased in height with the lower well ABH4 approximately 1.1 m higher, and wells ABH9 and ABH12 approximately 1.5 m higher.

From July 2015 piezometric levels:

- the upper hydraulic gradient is estimated for ABH9 to ABH12 (968.75 m RL – 949.96 m RL = 18.79 m) / 654 m distance estimated on SIX map) = 0.0287 (~3.0×10^{-2}).
- the lower hydraulic gradient is estimated for ABH12 to ABH4 (949.96 m RL – 948.88 m RL = 1.08 m) / 535 m estimated on SIX map) = 0.002 (2.0×10^{-3}).

The upper hydraulic gradient of 0.03 is appropriate for estimating groundwater flow rate to the wells in the upper section of the site – wells ABH9, ABH11, and ABH12.

The lower hydraulic gradient of 0.002 is appropriate for estimating groundwater flow rate to the wells in the lower section of the site – wells ABH02, ABH02A, ABH4, ABH4A, ABH02, and ABH04A.

8.3 Effective porosity (Ne)

Total porosity is the ratio of void space of a rock or unconsolidated material to its total volume. *The portion of interconnected pore space through which flow of water takes place is called 'effective porosity'* (Roscoe Moss Company (RMC) 1990, p. 7). The portion of groundwater that drains by gravity from a soil and/or rock is called specific yield. Specific yield is less than effective porosity because some of the effective porosity groundwater remains inside the rock and/or soil after drainage due to surface tension within the soil and/or rock (RMC 1990, p. 7).

Measuring effective porosity from field samples is complex (Sara 1993, pp. 5-54 to 5-56, 7-40) and even then only a small fragment of the aquitard or aquifer is assessed. As a result, effective porosity values provided in various texts are often used as a substitute.

Clay (2010) based effective porosity for the Armidale Regional Landfill leachate movement model on the specific yield of sandstone, 0.21 from Zheng and Bennett (2002).

Laboratory effective porosities for New Zealand greywacke were 0.02 and 0.05 (McNamara, Faulkner & McCarney 2014). However, this effective porosity did not take fractures into account. As we are dealing with fractured, fine-grained greywacke in most instances within the screened intervals of the wells slug tested, it is more circumspect to use the more commonly available effective porosity for sandstone, as greywacke is a form of sandstone. In the literature, sandstone effective porosity varies considerably from 0.1 to 0.4 (Sara 2003 derived from Walton 1987 and Domenico & Schwartz 1990).

Due to the difficulties involved in determining what effective porosity to use, the Australian Groundwater Modelling Guidelines (Barnett et al 2012, p. 142) recommend that

> *a sensible approach would be to start with the value of the total porosity and adjust the parameter to lower values, if needed, during the calibration stage.*

They quote total porosity for sandstone ranges from 5% to 30% (0.05 to 0.3) (2012, p. 141) derived from Domenico and Schwartz (1990). As full scale modeling is costly and time consuming and also has inherent uncertainties, another approach is to use the 0.21 arithmetic mean of effective porosity for fine sandstone which ranges from 0.02 to 0.40 (Yu et al. 1993, sourced from McWorter and Sunada 1977).

So we have come back full circle to an effective porosity 0.21 used for site leachate modeling by Clay (2010), even though it was a specific yield value. The preceding literature review indicates that 0.21 is a reasonable effective porosity considering the many unknowns. A mid-range value appears precautionary because a greater effective porosity reduces the estimated groundwater flow rate (average linear velocity).

8.4 Estimated groundwater velocities – Armidale Regional Landfill

Two groundwater velocities are calculated from the preceding data due to:

- the faster K values in wells ABH11 and ABH12 compared to the lower wells (ABH02, ABH02A, ABH4, ABH04, ABH04A), and
- the greater hydraulic gradient (0.03) in the southern, higher portion of the site from well ABH9 down to mid-gradient wells ABH11 and ABH12, versus the lower hydraulic gradient (0.002) from the mid-gradient wells down to the lower wells.

The average linear velocity generally estimates the groundwater flow rate and therefore provides an estimate of the time it would take for any leachate that may seep out of the landfill reaching the wells being monitored. In each case the greatest *K* estimate is used in the formula to take a precautionary approach to groundwater flow rate and consequently ambient surface water protection.

Upper well (ABH9) to mid-gradient wells (ABH11 & ABH12)
V = (K x i) / Ne
= (1.14 m/day x 0.03) / 0.21
= 0.16 m/day = 59.4 m /year

Mid-gradient wells (ABH11 & ABH12) to lower gradient wells (ABH02, ABH02A, ABH4, ABH04, ABH04A)

V = (K x i) / Ne
= (0.13 m/day x 0.002) / 0.21
= 0.001 m/day = 0.45 m /year

From the above calculations and other observations, it appears wise during the detection monitoring phase to sample

- mid-gradient wells ABH11 and ABH12 quarterly due to their faster average linear velocity
- lower gradient wells ABH02, ABH02A, ABH4, ABH04 six-monthly due to their slow average linear velocity (slower *K* and lower hydraulic gradient)
- upgradient well ABH9 six monthly because it is upgradient to the highest proposed landfill cell, and groundwater rarely flows uphill.

(Note: Eight (8) rounds of quarterly monitoring are needed prior to detection monitoring to establish baseline ambient groundwater quality.)

9. PUMP SETTINGS

A peristaltic pump will work in wells ABH02 and ABH04A because a peristaltic pump can pump from a depth of ~12.0 m. All other wells at the Armidale Regional Landfill site require the use of a bladder pump, which is the best type of pump for low-flow sampling. A bladder pump has been found to be the most effective in limiting volatilisation of volatile analytes such as BTEX (benzene, toluene, ethybenzene and xylene) compounds.

Depth at which to position each bladder pump or peristaltic pump within each well was determined from the borelogs and the height of the water column. The pump must be positioned within the well screen. In general, the pump's position long term is often approximately mid-screen, or lower if the water column is not sufficient for a bladder pump to function efficiently.

The bladder pump discharge/refill rates and psi were selected based on CodyHart experience with wells of similar depths and through some adjustments to suit well dynamics in this first round of sampling.

Table 3 provides a summary of the pump depths to be kept constant over time, and settings to attain a low-flow sampling rate over time. Continuing to use these settings in future groundwater sampling rounds will reduce variation in groundwater quality results. Consistent pump type and settings over time means it is more likely that contamination from landfill leachate, or not, can be correctly identified.

Table 3: Pump type and settings for each monitoring well

Well	Pump type	Pump position (m)	psi (bladder pump)	Refill/discharge rate (bladder pump)	Controller dial position (peristaltic pump)	Pump rate mL/min	Purge volume (L)
ABH02	peristaltic	9.0			2.25	200	4
ABH02A	bladder	27.0	55	15/15		200	4
ABH4	bladder	16.0	35	30/30		100	4
ABH4A	DRY	WELL					
ABH04	bladder	26.0	50	15/15		200	4
ABH04A	peristaltic	7.0			2.25	200	4
ABH9	bladder	57.5	90	30/30		100	4
ABH11	bladder	34.0	60	15/15		200	4
ABH12	bladder	38.0	70	15/15		200	4

A preliminary four litre purge volume was decided upon for each well (Table 3). This is thorough considering the findings of Hart (2000) research re stabilisation of electrical conductivity readings and fifteen years' experience with groundwater purge quality behaviour since that research.

Stabilisation of field parameters for each well was verified in the first sampling round. After filling of sample bottles was complete, groundwater being pumped was reflowed through the flow-through cell and manually recorded on the field parameter forms (Appendix A). Field parameter readings, from 7.5 L volume onwards, were similar to those from 2.0 litres onwards – except for redox potential (Eh) in well ABH9 (Field parameter forms, Appendix A).

10. WATER SAMPLING FIELD WORK – JULY 2015

This section relates to

- groundwater baseline sampling at wells ABH02, ABH02A, ABH4, ABH04A, ABH04A, ABH9, ABH11, and ABH12; and
- ambient surface water sampling at GARA6 at which baseline monitoring is not yet complete.

Sampling was conducted on 28, 29 and 30 July 2015 according to the standard operating procedure (SOP) devised by CodyHart Environmental using Australian and international standards and guidelines.

The TPS 90FLT field lab used by CodyHart Environmental to take field dissolved oxygen (DO), electrical conductivity (EC), pH, redox potential (Eh), temperature and turbidity readings was calibrated so that sampling was conducted within a few hours of calibration.

Groundwater monitoring well locations are displayed on Figure 1, and the ambient surface water sampling point GARA6 is displayed on Figure 2.

At GARA6, samples were collected in a decontaminated beaker on the end of a three metre extension pole. Using an extension pole means that a more representative sample can be reached.

Two field parameter samples were taken at GARA6, and the values noted on the field parameter form (Appendix A). Sample bottles were filled in order from the most volatile analyte being sampled to the least volatile. Metal and total organic carbon (TOC) samples were filtered.

For groundwater sampling, the water level was measured in each well using an electronic dip meter and noted on the field parameter forms (Appendix A).

Due to their shallow depths, a peristaltic pump was used in wells ABH02 and ABH04A. Bladder pumps were used in the other wells that are too deep for a peristaltic pump to operate.

The many bladder pumps used by CodyHart and the lengths of silicone tubing for the peristaltic pump were decontaminated prior to the site visit according to the ASTM 2002a decontamination guide.

Dedicated tubing for each well was cut to length. A tape mark was placed on the tubing where it should be held at the top of the PVC casing so that the pump would sit at its designated position within the screen. There is only one tube for each well in which peristaltic pumps are used. Each decontaminated, stainless steel, bladder pump was attached to ¼ inch OD LDPE tubing for compressed air and ¼ inch OD LDPE tubing for groundwater.

A set peristaltic pump controller position, and a set bladder pump position, discharge/refill rate and psi, and purge volume are used each sampling round to suit each well’s hydraulic characteristics. All pump rates were slow at ≤200mL/min. The aim is to minimise water level drawdown in a method called ‘low-flow’ groundwater sampling. Minimal drawdown means that the groundwater is less disturbed and samples are more likely to be representative of true groundwater quality.

A flow-through cell is used to house field probes for measuring field analytes (EC/Temp, pH, Eh and DO) values which are manually recorded on each well’s field parameter form (Appendix A). Turbidity is tested once separately in a dark container as recommended and provided by TPS.

When purging was complete, sample containers were filled generally from the most volatile analyte to be sampled to the least. All metals and total organic carbon (TOC) samples were filtered as they were discharged into sample containers.

After collection, the samples were immediately put on ice in a chilled esky. The samples were transported in an iced esky to reach the ALS laboratory well within holding times.

An anemometer, thermometer and compass were used to determine air temperature, wind speed and wind direction and their values were noted on each field parameter form (Appendix A).

11. WATER MONITORING QUALITY ASSURANCE

A number of techniques are used in an effort to maintain a high quality of sampling and analyses.

- Standard operating procedures documented by CodyHart Environmental were followed. These include tests of deionised water and field blanks to assure proper decontamination of equipment.
- Calibration of the TPS field lab used for sampling was documented. A certificate is provided in Appendix B.
- Relative percentage difference (RPD) is a standard method of assessing the variability of duplicate samples, in this case the minimum and maximum of the last four recorded field parameter readings on each monitoring well field parameter form, and the two field parameter readings for GARA6 (Appendix A). RPDs quantify the precision and reproducibility of the data. RPDs of field parameters are reviewed. The dissolved oxygen (DO) RPD was in exceedance in wells ABH02, ABH4, ABH04A, and ABH12. Redox potential (Eh) was in exceedance at well ABH9. (DO and Eh are likely to vary more than other field parameters when groundwater is extracted from its low oxygen environment.)
- Lack of tampering with the samples on their way to the laboratory is documented through Chain of custody (COC) forms, the transport company's consignment note system, and through the laboratory's sample receipt notification (SRN). The COCs and SRNs are provided in Appendix B. The COC was sealed within the cooler and a copy emailed to the lab for prelogging. Security seals, the courier company's consignment notes, and the laboratory's sample receipt notification suffice as evidence of non-tampering with samples. The Tamex transport company is used for road transporting the samples overnight to ALS Brisbane due to their better road freight network for samples to Brisbane from northern New South Wales.
- Australian Laboratory Services (ALS), Stafford, Brisbane, conducted the majority of laboratory analyses. ALS is a global, Australian company who analyses a broad range of analytes and provides good service. They are NATA registered for the analyses conducted. In addition to the certificate of analysis and analytical results, ALS provide quality control reports for laboratory duplicates, method blank and laboratory control samples, matrix spikes, and an interpretive quality control report that summarises the quality assurance findings (Appendix C). There were a number of laboratory control spike recovery recoveries less than their preferred lower control limits. A couple of required laboratory quality control sample frequencies were not met. Extraction of ABH04 and ABHD PAH samples for analysis were one day overdue. There were no other untoward quality control issues.
- CodyHart conducted laboratory analyses (yellow sheet, Appendix C) that are best conducted on fresh samples – colour change titrations for alkalinity and free CO_2 using APHA (1998). Alkalinity analyses were also requested from the laboratory. Field and laboratory results were very close. More field alkalinity results were greater than laboratory results, which is to be expected because of their earlier analysis.
- A duplicate sample was taken at well ABH02A for all analytes. The duplicate was a split sample taken from the same aliquot of groundwater – except for the VOCs which were replicate samples so that they could be poured directly into their sampling vials from the discharge hose thus minimising volatilisation of the sample. The laboratory was not given the time of sampling or the duplicate sampling point name. This assists impartial analysis because laboratory personnel do not know the duplicate's sampling point origin. The analyte values were within the ALS quality control duplicate criteria values, that is:

  Result < 10 times LOR: No Value; Result between 10 and 20 times LOR: 0% - 50%;
  Result > 20 times LOR: 0% - 20%. (LOR = Value of reporting)

12. WATER QUALITY RESULTS TO DATE

All results to date for the groundwater monitoring wells and GARA6 are tabled on portrait tables which allow a quick comparison of each parameter and analyte's historical results over time by looking down each column.

Some results have been converted from µg/L to mg/L so that all results are in mg/L. This minimises confusion about concentrations.

Maximum historical results are, or will be, coloured red and highlighted yellow; and minimum historical results are green and underlined. This makes it easier on the eye to review the latest result against historical results.

Appendix C has a copy of the detailed laboratory results for this monitoring round preceding the laboratory QC reports. CodyHart laboratory results follow the QC reports.

Table 4: Field parameters, piezometric levels, carbon, nitrogen – Groundwater ABH02

ABH02	*Field parameters*					*Depth & sediment*			*Carbon*				*Nutrients*			
	DO	EC	pH	Eh	Temp	D	RL	Turb	Alk	Free CO_2	CO_2 + Alk	TOC	NH_3	NO_3 / NO_x	TKN	TotN
Measure	mg/L	µ µS/cm	1-14	mV	°C	m	m	NTU	mg/L	mg/L	mg/L	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L
Reporting Value	0.01	1	0.01	1	0.1	0.01	0.01	1	1	1	1	1	0.01	0.01	0.1	0.1
29/07/15	0.47	2326	6.83	+116	17.5	7.86	945.894	12	540	176	154	7	<0.01	0.94	0.2	1.1
29/07/15								LAB	544							

Abbreviations: DO = Dissolved Oxygen; EC = Electrical Conductivity also called specific conductance; Eh = Redox Potential; Temp = Temperature; D = Depth to water from top of internal well casing; RL = water level converted to Reduced Level relative to site base mark (top of PVC casing RL = 953.754 m). Turb = Turbidity; Alk = Alkalinity measured as mg/L $CaCO_3$ equivalent; Free CO_2 = Free carbon dioxide; Unfiltered C of (CO_2 + Alk) = 12/44 CO_2 + 12/61 Alk; TOC = Total Organic Carbon (Bold TOC = unfiltered); NH_3 = Ammonia as a measure of ammonium ions; NO_3 = Nitrate; NO_x = Nitrite + Nitrate; TKN = Total Kjeldahl Nitrogen (organic nitrogen and ammonia); Tot N = Total Nitrogen.
Council Coordinates Sept 2015: MGA56 E 383691.412; N 6619577.588. Well depth from top of PVC casing = 11.15 m.

Table 5: Metals & metalloids – Groundwater ABH02

ABH02	Al	Sb	As	Cd	Cr	Cu	Ni	Pb	Se	Zn	Mn	Fe	Hg	Fe(II)
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Reporting Value	0.01	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.01	005	0.001	0.05	0.0001	0.05
29/07/15	<0.01	<0.001	<0.001	<0.0001	<0.001	0.001	0.004	<0.001	<0.01	0.009	0.107	<0.05	<0.0001	<0.05

Abbreviations: Al = Aluminium; Sb = Antimony; As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Ni = Nickel; Pb = Lead; Se = Selenium; Zn = Zinc; Mn = Manganese; Fe = Iron; Hg = Mercury; Fe (II) = Ferrous Iron; Bold result = unfiltered.

Table 6: Ionic and anthropogenic leachate indicators – Groundwater ABH02

ABH02	Cations & anions						Possible carcinogens and/or toxic compounds		
	SO_4	Cl	Ca	Mg	Na	K	OC & OP	UT PAH	UT VOCs
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	1	1	1	1	1	1	0.0005-0.002	0.00005-0.0001	0.0003-0.01
29/07/15	174	419	181	80	199	<1	ND	ND	ND

Abbreviations: SO_4 = Sulphate; Cl = Chloride; Ca = Calcium; Mg = Magnesium; Na = Sodium; K = Potassium; OC&OP = Organochlorine & Organophosphorus pesticides; UT PAHs = Ultra trace Polynuclear Aromatic Hydrocarbons; UT VOCs = Ultra trace Volatile Organic Compounds; ND = Nil detected.

Table 7: Field parameters, piezometric levels, carbon, nitrogen – Groundwater ABH02A

ABH02A	Field parameters					Depth & sediment			Carbon				Nutrients			
	DO	EC	pH	Eh	Temp	D	RL	Turb	Alk	Free CO_2	CO_2 + Alk	TOC	NH_3	NO_3 / NO_x	TKN	TotN
Measure	mg/L	µ µS/cm	1-14	mV	°C	m	m	NTU	mg/L	mg/L	mg/L	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L
Reporting Value	0.01	1	0.01	1	0.1	0.01	0.01	1	1	1	1	1	0.01	0.01	0.1	0.1
28/07/15	0.55	1785	6.93	+293	16.7	7.71	946.279	20	576	182	163	3	<0.01	0.62	<0.1	0.6
28/07/15								LAB	525							

Abbreviations: DO = Dissolved Oxygen; EC = Electrical Conductivity also called specific conductance; Eh = Redox Potential; Temp = Temperature; D = Depth to water from top of internal well casing; RL = water level converted to Reduced Level relative to site base mark (top of PVC casing RL = 953.989 m). Turb = Turbidity; Alk = Alkalinity measured as mg/L $CaCO_3$ equivalent; Free CO_2 = Free carbon dioxide; Unfiltered C of (CO_2 + Alk) = 12/44 CO_2 + 12/61 Alk; TOC = Total Organic Carbon (Bold TOC = unfiltered); NH_3 = Ammonia as a measure of ammonium ions; NO_3 = Nitrate; NO_x = Nitrite + Nitrate; TKN = Total Kjeldahl Nitrogen (organic nitrogen and ammonia); Tot N = Total Nitrogen.
Council Coordinates Sept 2015: MGA56 E 383693.119; N 6619557.668. Well depth from top of PVC casing = 30.83 m.

Table 8: Metals & metalloids – Groundwater ABH02A

ABH02A	Al	Sb	As	Cd	Cr	Cu	Ni	Pb	Se	Zn	Mn	Fe	Hg	Fe(II)
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Reporting Value	0.01	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.01	005	0.001	0.05	0.0001	0.05
28/07/15	<0.01	<0.001	<0.001	<0.0001	<0.001	0.001	<0.001	<0.001	<0.01	0.009	0.003	<0.05	<0.0001	<0.05

Abbreviations: Al = Aluminium; Sb = Antimony; As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Ni = Nickel; Pb = Lead; Se = Selenium; Zn = Zinc; Mn = Manganese; Fe = Iron; Hg = Mercury; Fe (II) = Ferrous Iron; Bold result = unfiltered.

Table 9: Ionic and anthropogenic leachate indicators – Groundwater ABH02A

ABH02A	Cations & anions						Possible carcinogens and/or toxic compounds		
	SO_4	Cl	Ca	Mg	Na	K	OC & OP	UT PAH	UT VOCs
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	1	1	1	1	1	1	0.0005-0.002	0.00005-0.0001	0.0003-0.01
28/07/15	160	231	168	67	134	<1	ND	ND	ND

Abbreviations: SO_4 = Sulphate; Cl = Chloride; Ca = Calcium; Mg = Magnesium; Na = Sodium; K = Potassium; OC&OP = Organochlorine & Organophosphorus pesticides; UT PAHs = Ultra trace Polynuclear Aromatic Hydrocarbons; UT VOCs = Ultra trace Volatile Organic Compounds; ND = Nil detected.

Table 10: Field parameters, piezometric levels, carbon, nitrogen – Groundwater ABH4

ABH4	*Field parameters*					*Depth & sediment*			*Carbon*				*Nutrients*			
	DO	EC	pH	Eh	Temp	D	RL	Turb	Alk	Free CO_2	CO_2 + Alk	TOC	NH_3	NO_3 / NO_x	TKN	TotN
Measure	mg/L	µS/cm	1-14	mV	°C	m	m	NTU	mg/L	mg/L	mg/L	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L
Reporting Value	0.01	1	0.01	1	0.1	0.01	0.01	1	1	1	1	1	0.01	0.01	0.1	0.1
20/04/07	0.55	1670	6.77		17.9	6.35	947.864	535	577			6	0.158	0.182		
29/07/15	0.61	1693	6.98	+85	14.1	5.03	948.984	12	587	176	163	2	0.01	0.49	<0.1	0.5
29/07/15								LAB	584							

Abbreviations: DO = Dissolved Oxygen; EC = Electrical Conductivity also called specific conductance; Eh = Redox Potential; Temp = Temperature; D = Depth to water from top of internal well casing; RL = water level converted to Reduced Level relative to site base mark (top of PVC casing RL = 954.014 m – sawed off 20 cm 27 July 15). Turb = Turbidity; Alk = Alkalinity measured as mg/L $CaCO_3$ equivalent; Free CO_2 = Free carbon dioxide; Unfiltered C of (CO_2 + Alk) = 12/44 CO_2 + 12/61 Alk; TOC = Total Organic Carbon (Bold TOC = unfiltered); NH_3 = Ammonia as a measure of ammonium ions; NO_3 = Nitrate; NO_x = Nitrite + Nitrate; TKN = Total Kjeldahl Nitrogen (organic nitrogen and ammonia); Tot N = Total Nitrogen.
Council Coordinates Sept 2015: MGA56 E 383636.348; N 6619659.327. Well depth from top of PVC casing = 18.00 m. Sawed 20 cm off top of casing July 2015.

Table 11: Metals & metalloids – Groundwater ABH4

ABH4	Al	Sb	As	Cd	Cr	Cu	Ni	Pb	Se	Zn	Mn	Fe	Hg	Fe(II)
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Reporting Value	0.01	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.01	005	0.001	0.05	0.0001	0.05
20/04/07											1.400	1.30		
29/07/15	<0.01	<0.001	<0.001	<0.0001	<0.001	0.005	0.013	0.002	<0.01	0.035	0.117	<0.05	<0.0001	<0.05

Abbreviations: Al = Aluminium; Sb = Antimony; As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Ni = Nickel; Pb = Lead; Se = Selenium; Zn = Zinc; Mn = Manganese; Fe = Iron; Hg = Mercury; Fe (II) = Ferrous Iron; Bold result = unfiltered.

Table 12: Ionic and anthropogenic leachate indicators – Groundwater ABH4

ABH4	Cations & anions						Possible carcinogens and/or toxic compounds			
	SO_4	Cl	Ca	Mg	Na	K	Total phenolics	OC & OP	UT PAH	UT VOCs
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	1	1	1	1	1	1	0.05	0.0005-0.002	0.00005-0.0001	0.0003-0.01
18/04/07	149	141	135	52	178	1	<0.05			ND
29/07/15	163	163	148	56	166	<1	NC	ND	ND	ND

Abbreviations: SO_4 = Sulphate; Cl = Chloride; Ca = Calcium; Mg = Magnesium; Na = Sodium; K = Potassium; OC&OP = Organochlorine & Organophosphorus pesticides; UT PAHs = Ultra trace Polynuclear Aromatic Hydrocarbons; UT VOCs = Ultra trace Volatile Organic Compounds; NC = Not continuing; ND = Nil detected.

NOTE: WELL ABH4A WAS DRY.

Council Coordinates Sept 2015: MGA56 E 383643.523; N 6619658.965. Well depth from top of PVC casing = 3.16 m. Top of PVC casing RL = 953.929 m. Sawed 8 cm off top of casing July 2015.

Table 13: Field parameters, piezometric levels, carbon, nitrogen – Groundwater ABH04

ABH04	Field parameters					Depth & sediment			Carbon				Nutrients			
	DO	EC	pH	Eh	Temp	D	RL	Turb	Alk	Free CO_2	CO_2 + Alk	TOC	NH_3	NO_3 / NO_x	TKN	TotN
Measure	mg/L	µ µS/cm	1-14	mV	°C	m	m	NTU	mg/L	mg/L	mg/L	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L
Reporting Value	0.01	1	0.01	1	0.1	0.01	0.01	1	1	1	1	1	0.01	0.01	0.1	0.1
28/07/15	0.14	2278	6.91	-243	16.2	5.01	948.141	16	567	235	175	4	<0.01	<0.01	<0.1	<0.1
28/07/15								LAB	566							

Abbreviations: DO = Dissolved Oxygen; EC = Electrical Conductivity also called specific conductance; Eh = Redox Potential; Temp = Temperature; D = Depth to water from top of internal well casing; RL = water level converted to Reduced Level relative to site base mark (top of PVC casing RL =953.151 m). Turb = Turbidity; Alk = Alkalinity measured as mg/L $CaCO_3$ equivalent; Free CO_2 = Free carbon dioxide; Unfiltered C of (CO_2 + Alk) = 12/44 CO_2 + 12/61 Alk; TOC = Total Organic Carbon (Bold TOC = unfiltered); NH_3 = Ammonia as a measure of ammonium ions; NO_3 = Nitrate; NO_x = Nitrite + Nitrate; TKN = Total Kjeldahl Nitrogen (organic nitrogen and ammonia); Tot N = Total Nitrogen.
Council Coordinates Sept 2015: MGA56 E 383650.965; N 6619727.630. Well depth from top of PVC casing = 29.32 m.

Table 14: Metals & metalloids – Groundwater ABH04

ABH04	Al	Sb	As	Cd	Cr	Cu	Ni	Pb	Se	Zn	Mn	Fe	Hg	Fe(II)
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Reporting Value	0.01	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.01	005	0.001	0.05	0.0001	0.05
29/07/15	<0.01	<0.001	0.001	<0.0001	<0.001	<0.001	0.001	<0.001	<0.01	0.026	1.40	0.89	<0.0001	1.16

Abbreviations: Al = Aluminium; Sb = Antimony; As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Ni = Nickel; Pb = Lead; Se = Selenium; Zn = Zinc; Mn = Manganese; Fe = Iron; Hg = Mercury; Fe (II) = Ferrous Iron; Bold result = unfiltered.

Table 15: Ionic and anthropogenic leachate indicators – Groundwater ABH04

ABH04	Cations & anions						Possible carcinogens and/or toxic compounds		
	SO_4	Cl	Ca	Mg	Na	K	OC & OP	UT PAH	UT VOCs
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	1	1	1	1	1	1	0.0005-0.002	0.00005-0.0001	0.0003-0.01
28/07/15	340	369	294	67	170	2	ND	ND	ND

Abbreviations: SO_4 = Sulphate; Cl = Chloride; Ca = Calcium; Mg = Magnesium; Na = Sodium; K = Potassium; OC&OP = Organochlorine & Organophosphorus pesticides; UT PAHs = Ultra trace Polynuclear Aromatic Hydrocarbons; UT VOCs = Ultra trace Volatile Organic Compounds; ND = Nil detected.

Table 16: Field parameters, piezometric levels, carbon, nitrogen – Groundwater ABH04A

ABH04A	*Field parameters*					*Depth & sediment*			*Carbon*				*Nutrients*			
	DO	EC	pH	Eh	Temp	D	RL	Turb	Alk	Free CO_2	CO_2 + Alk	TOC	NH_3	NO_3 / NO_x	TKN	TotN
Measure	mg/L	µ µS/cm	1-14	mV	°C	m	m	NTU	mg/L	mg/L	mg/L	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L
Reporting Value	0.01	1	0.01	1	0.1	0.01	0.01	1	1	1	1	1	0.01	0.01	0.1	0.1
29/07/15	1.87	1646	7.23	+56	17.0	5.04	947.929	12	548	102	136	7	0.02	0.19	0.2	0.4
29/07/15								LAB	541							

Abbreviations: DO = Dissolved Oxygen; EC = Electrical Conductivity also called specific conductance; Eh = Redox Potential; Temp = Temperature; D = Depth to water from top of internal well casing; RL = water level converted to Reduced Level relative to site base mark (top of PVC casing RL = 952.969 m). Turb = Turbidity; Alk = Alkalinity measured as mg/L $CaCO_3$ equivalent; Free CO_2 = Free carbon dioxide; Unfiltered C of (CO_2 + Alk) = 12/44 CO_2 + 12/61 Alk; TOC = Total Organic Carbon (Bold TOC = unfiltered); NH_3 = Ammonia as a measure of ammonium ions; NO_3 = Nitrate; NO_x = Nitrite + Nitrate; TKN = Total Kjeldahl Nitrogen (organic nitrogen and ammonia); Tot N = Total Nitrogen.
Council Coordinates Sept 2015: MGA56 E 383649.842; N 6619727.525. Well depth from top of PVC casing = 8.80 m.

Table 17: Metals & metalloids – Groundwater ABH04A

ABH04A	Al	Sb	As	Cd	Cr	Cu	Ni	Pb	Se	Zn	Mn	Fe	Hg	Fe(II)
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Reporting Value	0.01	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.01	005	0.001	0.05	0.0001	0.05
29/07/15	<0.01	<0.001	0.001	<0.0001	<0.001	0.001	0.003	<0.001	<0.01	0.02	0.391	<0.05	<0.0001	<0.05

Abbreviations: Al = Aluminium; Sb = Antimony; As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Ni = Nickel; Pb = Lead; Se = Selenium; Zn = Zinc; Mn = Manganese; Fe = Iron; Hg = Mercury; Fe (II) = Ferrous Iron; Bold result = unfiltered.

Table 18: Ionic and anthropogenic leachate indicators – Groundwater ABH04A

ABH04A	Cations & anions						Possible carcinogens and/or toxic compounds		
	SO_4	Cl	Ca	Mg	Na	K	OC & OP	UT PAH	UT VOCs
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	1	1	1	1	1	1	0.0005-0.002	0.00005-0.0001	0.0003-0.01
29/07/15	335	36	87	46	257	1	ND	ND	ND

Abbreviations: SO_4 = Sulphate; Cl = Chloride; Ca = Calcium; Mg = Magnesium; Na = Sodium; K = Potassium; OC&OP = Organochlorine & Organophosphorus pesticides; UT PAHs = Ultra trace Polynuclear Aromatic Hydrocarbons; UT VOCs = Ultra trace Volatile Organic Compounds; ND = Nil detected.

Table 19: Field parameters, piezometric levels, carbon, nitrogen – Groundwater ABH9

ABH9	Field parameters					Depth & sediment			Carbon				Nutrients			
	DO	EC	pH	Eh	Temp	D	RL	Turb	Alk	Free CO_2	CO_2 + Alk	TOC	NH_3	NO_3 / NO_x	TKN	TotN
Measure	mg/L	µ µS/cm	1-14	mV	°C	m	m	NTU	mg/L	mg/L	mg/L	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L
Reporting Value	0.01	1	0.01	1	0.1	0.01	0.01	1	1	1	1	1	0.01	0.01	0.1	0.1
18/04/07	6.33	1260	6.82		20.3	46.20	967.83	31	219			3	0.175	0.833		
30/07/15	2.18	1464	6.14	+31	17.5	45.28	968.75	50	93	85	41	1	0.01	0.39	0.2	0.6
30/07/15								LAB	108							

Abbreviations: DO = Dissolved Oxygen; EC = Electrical Conductivity also called specific conductance; Eh = Redox Potential; Temp = Temperature; D = Depth to water from top of internal well casing; RL = water level converted to Reduced Level relative to site base mark (top of PVC casing RL = 1014.03 m). Turb = Turbidity; Alk = Alkalinity measured as mg/L $CaCO_3$ equivalent; Free CO_2 = Free carbon dioxide; Unfiltered C of (CO_2 + Alk) = 12/44 CO_2 + 12/61 Alk; TOC = Total Organic Carbon (Bold TOC = unfiltered); NH_3 = Ammonia as a measure of ammonium ions; NO_3 = Nitrate; NO_x = Nitrite + Nitrate; TKN = Total Kjeldahl Nitrogen (organic nitrogen and ammonia); Tot N = Total Nitrogen.
Coordinates: MGA56 E 383128.77; N 6618697.86. Well depth from top of PVC casing = 60.50 m.

Table 20: Metals & metalloids – Groundwater ABH9

ABH9	Al	Sb	As	Cd	Cr	Cu	Ni	Pb	Se	Zn	Mn	Fe	Hg	Fe(II)
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Reporting Value	0.01	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.01	005	0.001	0.05	0.0001	0.05
18/04/07											0.350	<0.05		
30/07/15	<0.01	<0.001	<0.001	<0.0001	<0.001	0.001	0.007	<0.001	<0.01	0.034	0.882	0.05	<0.0001	<0.05

Abbreviations: Al = Aluminium; Sb = Antimony; As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Ni = Nickel; Pb = Lead; Se = Selenium; Zn = Zinc; Mn = Manganese; Fe = Iron; Hg = Mercury; Fe (II) = Ferrous Iron; Bold result = unfiltered.

Table 21: Ionic and anthropogenic leachate indicators – Groundwater ABH9

ABH9	Cations & anions						Possible carcinogens and/or toxic compounds			
	SO_4	Cl	Ca	Mg	Na	K	Total phenolics	OC & OP	UT PAH	UT VOCs
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	1	1	1	1	1	1	0.05	0.0005-0.002	0.00005-0.0001	0.0003-0.01
18/04/07	56	260	58	68	75	8	<0.05			Chloroform 0.006
30/07/15	127	388	64	82	89	5	NC	ND	ND	Chloroform 0.005

Abbreviations: SO_4 = Sulphate; Cl = Chloride; Ca = Calcium; Mg = Magnesium; Na = Sodium; K = Potassium; OC&OP = Organochlorine & Organophosphorus pesticides; UT PAHs = Ultra trace Polynuclear Aromatic Hydrocarbons; UT VOCs = Ultra trace Volatile Organic Compounds; NC = Not continuing; ND = Nil detected.

Table 22: Field parameters, piezometric levels, carbon, nitrogen – Groundwater ABH11

ABH11	Field parameters					Depth & sediment			Carbon				Nutrients			
	DO	EC	pH	Eh	Temp	D	RL	Turb	Alk	Free CO_2	CO_2 + Alk	TOC	NH_3	NO_3 / NO_x	TKN	TotN
Measure	mg/L	µ µS/cm	1-14	mV	°C	m	m	NTU	mg/L	mg/L	mg/L	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L
Reporting Value	0.01	1	0.01	1	0.1	0.01	0.01	1	1	1	1	1	0.01	0.01	0.1	0.1
19/04/07	5.21	1180	6.84		18.6	27.70	949.88	144	388			3	0.111	0.311		
30/07/15	4.10	1221	6.89	+116	17.5	25.72	951.84	21	323	97	90	1	<0.01	0.44	0.2	0.6
30/07/15								LAB	338							

Abbreviations: DO = Dissolved Oxygen; EC = Electrical Conductivity also called specific conductance; Eh = Redox Potential; Temp = Temperature; D = Depth to water from top of internal well casing; RL = water level converted to Reduced Level relative to site base mark (top of PVC casing RL = 977.56 m – 2 cm sawed off 30/7/15) .Turb = Turbidity; Alk = Alkalinity measured as mg/L $CaCO_3$ equivalent; Free CO_2 = Free carbon dioxide; Unfiltered C of (CO_2 + Alk) = 12/44 CO_2 + 12/61 Alk; TOC = Total Organic Carbon (Bold TOC = unfiltered); NH_3 = Ammonia as a measure of ammonium ions; NO_3 = Nitrate; NO_x = Nitrite + Nitrate; TKN = Total Kjeldahl Nitrogen (organic nitrogen and ammonia); Tot N = Total Nitrogen.
Coordinates: MGA56 E 383204.64; N 6619230.01. Well depth from top of PVC casing = 37.00 m.

Table 23: Metals & metalloids – Groundwater ABH11

ABH11	Al	Sb	As	Cd	Cr	Cu	Ni	Pb	Se	Zn	Mn	Fe	Hg	Fe(II)
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Reporting Value	0.01	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.01	005	0.001	0.05	0.0001	0.05
18/04/07											0.047	<0.05		
30/07/15	<0.01	<0.001	<0.001	<0.0001	<0.001	0.001	<0.001	0.001	<0.01	0.013	<0.001	<0.05	<0.0001	<0.05

Abbreviations: Al = Aluminium; Sb = Antimony; As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Ni = Nickel; Pb = Lead; Se = Selenium; Zn = Zinc; Mn = Manganese; Fe = Iron; Hg = Mercury; Fe (II) = Ferrous Iron; Bold result = unfiltered.

Table 24: Ionic and anthropogenic leachate indicators – Groundwater ABH11

ABH11	Cations & anions						Possible carcinogens and/or toxic compounds			
	SO_4	Cl	Ca	Mg	Na	K	Total phenolics	OC & OP	UT PAH	UT VOCs
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	1	1	1	1	1	1	0.05	0.0005-0.002	0.00005-0.0001	0.0003-0.01
18/04/07	104	116	89	49	103	<1	<0.05			Chloroform 0.006
30/07/15	100	164	91	50	100	<1	NC	ND	ND	Chloroform 0.006

Abbreviations: SO_4 = Sulphate; Cl = Chloride; Ca = Calcium; Mg = Magnesium; Na = Sodium; K = Potassium; OC&OP = Organochlorine & Organophosphorus pesticides; UT PAHs = Ultra trace Polynuclear Aromatic Hydrocarbons; UT VOCs = Ultra trace Volatile Organic Compounds; NC = Not continuing; ND = Nil detected.

Table 25: Field parameters, piezometric levels, carbon, nitrogen – Groundwater ABH12

ABH12	Field parameters					Depth & sediment			Carbon				Nutrients			
	DO	EC	pH	Eh	Temp	D	RL	Turb	Alk	Free CO_2	CO_2 + Alk	TOC	NH_3	NO_3 / NO_x	TKN	TotN
Measure	mg/L	µ µS/cm	1-14	mV	°C	m	m	NTU	mg/L	mg/L	mg/L	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L
Reporting Value	0.01	1	0.01	1	0.1	0.01	0.01	1	1	1	1	1	0.01	0.01	0.1	0.1
19/04/07	1.89	1320	6.74		18.8	21.32	948.47	30	547			4	0.131	0.112		
30/07/15	0.64	1376	6.77	+126	16.9	19.83	949.96	5	577	176	161	1	<0.01	0.13	0.2	0.3
30/07/15								LAB	555							

Abbreviations: DO = Dissolved Oxygen; EC = Electrical Conductivity also called specific conductance; Eh = Redox Potential; Temp = Temperature; D = Depth to water from top of internal well casing; RL = water level converted to Reduced Level relative to site base mark (top of PVC casing RL = 969.79 m). Turb = Turbidity; Alk = Alkalinity measured as mg/L $CaCO_3$ equivalent; Free CO_2 = Free carbon dioxide; Unfiltered C of (CO_2 + Alk) = 12/44 CO_2 + 12/61 Alk; TOC = Total Organic Carbon (Bold TOC = unfiltered); NH_3 = Ammonia as a measure of ammonium ions; NO_3 = Nitrate; NO_x = Nitrite + Nitrate; TKN = Total Kjeldahl Nitrogen (organic nitrogen and ammonia); Tot N = Total Nitrogen.
Coordinates: MGA56 E 383558.08; N 6619122.94. Well depth from top of PVC casing = 40.60 m.

Table 26: Metals & metalloids – Groundwater ABH12

ABH12	Al	Sb	As	Cd	Cr	Cu	Ni	Pb	Se	Zn	Mn	Fe	Hg	Fe(II)
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Reporting Value	0.01	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.01	005	0.001	0.05	0.0001	0.05
19/04/07											0.042	<0.05		
30/07/15	<0.01	<0.001	<0.001	<0.0001	<0.001	0.002	0.001	0.001	<0.01	0.035	0.027	<0.05	<0.0001	<0.05

Abbreviations: Al = Aluminium; Sb = Antimony; As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Pb = Lead; Mn = Manganese; Ni = Nickel; Se = Selenium; Zn = Zinc; Fe = Iron; Hg = Mercury; Fe (II) = Ferrous Iron; Bold result = unfiltered.

Table 27: Ionic and anthropogenic leachate indicators – Groundwater ABH12

ABH12	Cations & anions						Possible carcinogens and/or toxic compounds			
	SO_4	Cl	Ca	Mg	Na	K	Total phenolics	OC & OP	UT PAH	UT VOCs
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Reporting Value	1	1	1	1	1	1	0.05	0.0005-0.002	0.00005-0.0001	0.0003-0.01
19/04/07	87	77	114	43	131	1	<0.05			ND
30/07/15	111	82	121	46	127	1	NC	ND	ND	Chloroform 0.001

Abbreviations: SO_4 = Sulphate; Cl = Chloride; Ca = Calcium; Mg = Magnesium; Na = Sodium; K = Potassium; OC&OP = Organochlorine & Organophosphorus pesticides; UT PAHs = Ultra trace Polynuclear Aromatic Hydrocarbons; UT VOCs = Ultra trace Volatile Organic Compounds; NC = Not continuing; ND = Nil detected.

Photograph 2: Ambient surface water sampling point GARA6

GARA6 E 56 385915.0 N 6616606.0

Table 28: Field parameters, water level, flow, sediment, carbon, nutrients – Surface water GARA6

GARA6	*Field parameters*					*Depth, flow & sediment*				*Carbon*				*Nutrients*				
	DO	EC	pH	Eh	Temp	D	VFR	Turb	SS	Alk	Free CO_2	CO_2 + Alk	TOC	NH_3	NO_x	TKN	TotN	TotP
Measure	mg/L	µ µS/cm	1-14	mV	°C	m	kL/day	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L as N	mg/L as N	mg/L as N	mg/L	mg/L
Reporting Value	0.01	1	0.01	1	0.1	0.01	1	0.1	1-5	1	1	1	1	0.01	0.01	0.1	0.1	0.01
04/05/15	7.05	396	8.12	+208	15.2	0.45	2304	7.2	<5	150	6	31	13	0.04	0.01	2.0	2.0	0.05
29/07/15	11.65	411	7.59	+244	7.9	0.40	1210	1.5	<5	143	9	31	8	0.01	<0.01	1.2	1.2	0.02
29/07/15									LAB	154								

Abbreviations: DO = Dissolved Oxygen; EC = Electrical Conductivity also called specific conductance; Eh = Redox Potential; Temp = Temperature; D = Approximate depth of water at sampling point; VFR = Volumetric Flow Rate; Turb = Turbidity; SS = Suspended Solids; Alk = Alkalinity measured as mg/L $CaCO_3$ equivalent; Free CO_2 = Free carbon dioxide; Unfiltered C of (CO_2 + Alk) = 12/44 CO_2 + 12/61 Alk; TOC = Total Organic Carbon; NH_3 = Ammonia as a measure of ammonium ions; NO_x = Nitrite + Nitrate; TKN = Total Kjeldahl Nitrogen (organic nitrogen and ammonia); Tot N = Total Nitrogen; Tot P = Total Phosphorus. Note. No sampling prior to May 2015.

Table 29: Metals & metalloids – Surface water GARA6

GARA6	Al	Sb	As	Cd	Cr	Cu	Ni	Pb	Se	Zn	Mn	Fe	Hg	Fe II
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Reporting Value	0.01	0.001	0.001	0.0001	0.001	0.001	0.001	0.001	0.01	0.005	0.001	0.05	0.0001	0.05
04/05/15	<0.01	<0.001	0.002	<0.0001	<0.001	0.001	0.002	<0.001	<0.01	<0.005	0.013	0.12	<0.0001	NT
29/07/15	<0.01	NT	<0.001	<0.0001	<0.001	0.002	0.001	<0.001	<0.01	<0.005	0.002	<0.05	<0.0001	<0.05

Abbreviations: Al = Aluminium; Sb = Antimony; As = Arsenic; Cd = Cadmium; Cr = Chromium; Cu = Copper; Ni = Nickel; Pb = Lead; Se = Selenium; Zn = Zinc; Mn = Manganese; Fe = Iron; Hg = Mercury; Fe (II) = Ferrous Iron; NT = Not tested.
Notes. Metals filtered. No sampling prior to May 2015.

Table 30: Extra laboratory analytes and parameters A – baseline only – Surface water GARA6

GARA6	*Extra inorganics*											
	TDS	SO_4	Cl	Ca	Mg	Na	K	SAR	Hard	Fl	Br	B
Measure	mg/L		mg/L	mg/L	mg/L	mg/L	mg/L	ratio	mg/L	mg/L	mg/L	mg/L
Reporting Value	1	1	1	1	1	1	1	0.1	1	0.1	0.001	0.01
29/07/15	212	36	22	27	21	22	3	0.77	154	0.2	0.029	<0.05

Abbreviations: TDS = Total Dissolved Solids; SO_4 – Sulphate; Cl = Chloride; Ca = Calcium; Mg = Magnesium; Na = Sodium; K = Potassium; SAR = Sodium Absorption Ratio; Hard = Hardness; Fl = Fluoride; Br = Bromine; B = Boron.

Table 31: Extra laboratory parameters and analytes A – baseline only – Surface water GARA6

GARA6	*Organics*								*Microbial*	
	PAH	OC & OP	BTEX	TPH C6-C9	TPH C10-C14	TPH C15-C28	TPH C29-C36	*Phenolics*	*E.Coli*	Enterococci
Measure	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	CFU/100mL	CFU/100mL
Reporting Value	0.00005-0.0001	0.0005-0.002	0.001-0.002	0.025	0.025	0.1	0.1	0.001-0.002	1	1
04/05/15	ND (UT)	ND	ND	ND	ND	ND	ND	NT	~10	~8
29/07/15	ND (UT)	ND	ND	ND	ND	ND	ND	ND	NC	NC

Abbreviations: PAHs = Polynuclear Aromatic Hydrocarbons; BTEX = Benzene, Tolulene, Ethylbenzene, Xylene compounds; TPH = Total Petroleum Hydrocarbons; *E. Coli* = Escherichia coli; ND = Nil detected; UT = Ultra trace; NC = Not continuing.

13. WATER QUALITY COMPARISONS

Table 32 devised by CodyHart is provided to aid review of environmental health risks. It was also provided in the *Ambient Surface Water Monitoring Report, May 2015*. It is emphasised that Table 32 relates to **surface** water and any groundwater brought to the surface for the beneficial uses in the four last columns. Residents and farmers in the area of the Armidale Regional Landfill have already made judgments about the groundwater quality for beneficial uses they seek. Borelogs of bores surrounding the site have been installed for stock, domestic and irrigation purposes. The groundwater in the area is too salty for humans to drink, and any groundwater seepage into the Gara River would be considerably diluted and has been going on since time immemorial anyway. You can use the groundwater to wash clothes, but rainwater is best for drinking water and food preparation.

You cannot use aquatic ecosystem trigger values to indicate if you have a groundwater contamination problem from landfill leachate. Groundwater naturally has far higher concentrations of anions and cations due to its long term residence within soil and rock. It can have elevated concentrations of nitrogen compounds due to seepage in rainwater or irrigation water from fertilisers on farmer's crops or the dung of grazing cattle, sheep and kangaroos. Hence the importance of conducting eight rounds of baseline groundwater monitoring before there is the chance of landfill leachate affecting the groundwater quality. This is being done. The aim is to have a reliable snapshot of groundwater qualities to compare against groundwater quality results in the detection monitoring phase so as to determine if landfill leachate is contaminating the groundwater.

Table 32: Environmental health warning values ***surface water*** *- some landfill parameters & analytes*

Parameter	*Reason for Inclusion*	*Aquatic* 1	*Human* 2	*Irrigation* 3	*Livestock* 4
Temperature	Biodegradation of waste increases temperature. Temp + EC have successfully defined a leachate plume (Scrudato & Pagano, 1994).	>80%ile <20%ile	NR	NR	NR
pH	varies from acidic to alkaline as waste decomposition progresses (Andreottola & Cannas, 1992:72). But pH levels in groundwater are often naturally low.	6.5 to 8.0 (2000); 6.5 – 9.0 (1992)	6.5 to 8.5 (A)	>6 values corrosion of pipes	NR
Electric Conductivity (EC)	a general indicator that summarises the general trend of major cation and anion concentrations.	30 -350 µS/cm (2000); ≤1500 µS/cm (1992)	≤938 µS/cm (A) >1875 µS/cm (unpalatable)	varies, e.g., ≤1,000µS/cm carrots	≥3582 µS/cm analyse for specific ions which may affect
Analyte	*Reason for Inclusion*	*Aquatic* 1	*Human* 2	*Irrigation* 3	*Livestock* 4
Alkalinity	Measures acid-neutralising capacity, a solution's ability to buffer, that is stop pH changing. Often high in leachate, but some groundwaters can also have high alkalinity.	NR	NR	NR	NR
Boron	High mobility in clay. Good tracer. Found in leachate (Bagchi, 1994:52). Found in fireproofing agents, preservatives, antiseptics, glass, enamels, cosmetics, cements, carpets, soaps, powders and ointments. Some crops are intolerant to boron (ANZECC, 1992:5-13). However, low in northern NSW leachate (Hart, 2015)	≤0.37 mg/L	≤4.0 mg/L	≤0.5 mg/L (long term)	≤5mg/L
Bromide	Leachate indicator if leachate high in sea salt (Baker1993; Hart 1994). Used in bleaches; dyes; pharmaceuticals; pesticides; solvents for waxes, greases & oils; additives for motor oil & fuels; used in photograph development. Bromate generated from bromides in water (Wikipedia). Bromate is carcinogenic. Relatively low in northern NSW leachates (Hart, 2015)	NR	Bromate ≤0.02 mg/L forms bromide as a by-product	NR	NR
Ammonium ions	From decaying plants and animals. May be high in leachate (Hancock & Phillips, 1992:22). Toxic to fish (ANZECC, 1992:2-30).	Table 8.3.7 ≤0.18 mg/L as N for pH 9.0; ≤0.9 mg/L as N pH 8.0; ≤2.18 mg/L pH 7.0; ≤2.57 mg/L pH 6.	≤0.04 mg/L as N (A – corrosion of copper pipes)	Nitrogen ≤5 mg/L (long term; 25-125 mg/L (short term – up to 20 years)	NR
Nitrate	From final stage of plant and animal decomposition or fertilisers. May be high in leachate (Canter, 1997:6). Toxic to infants and livestock (ANZECC, 1992:4-10, 5-23).	(Table 3.3.2 eutro - NO_x as N ≤0.015 mg/L; TN ≤0.25 mg/L; Table 3.4.1 Toxic ≤0.158 NO_x as N	≤11.3 mg/L as N for up to 3 month bottle fed babies. Others ≤22.6 mg/L as N.	As for ammonia	≤ 90 mg/L as N; Nitrite ≤9 mg/L as N
Phosphorus	Csuros (1994:228-229) explains that phosphorus occurs in animal, plant and mineral kingdoms. Its discharge to streams may stimulate growth of photosynthetic organisms especially if it is the nutrient whose low values are valueing the primary productivity of the water.	Total P ≤0.02 mg/L	NR	≤0.05 mg/L (long term to prevent clogging irrig equipment; ≤0.8-12 mg/L (short term)	NR
VOCs / BTEX	Good indicators of man-made pollutants found in landfill leachate (USEPA, 1991:51075). Toxic and carcinogenic to animals and humans.	varies for different compounds	varies for different compounds	NR	NR
PAH	In old coal gasification plant coal tar waste. From incomplete burning of oil, wood, gas, garbage, meat. Rarely detected in northern NSW landfills.	e.g., Naphthalene ≤0.016 mg/L	Benzo-(a)-pyrene ≤0.00001 mg/L	NR	as per human
Phenolics	Rarely detected in landfill leachate in northern NSW. If they are detected, they are at trace levels (NSW EPA, 2015, p. 78)	Total phenols ≤0.32 mg/L	e.g., Pentachloro phenol ≤0.01 mg/L	NR	as per human

Table 32 continued:

Analyte	*Reason for Inclusion*	*Aquatic* 1	*Human* 2	*Irrigation* 3	*Livestock* 4
Iron and manganese	High iron concentrations affect plant growth and high manganese concentrations clog irrigation equipment and are toxic to plants (ANZECC, 1992:5-15, 5-16).	Fe NR (2000), ≤1 mg/L (1992), Mn≤1.9mg/L	Fe 0.3 mg/L (A) Mn 0.1 mg/L (A), Health 0.5 mg/L	Fe & Mn 0.2 mg/L long term, 10 mg/L short term	not sufficiently toxic (2000); ≤17 mg/L for dairy cattle (1992)
Aluminium for pH>6.5	Aluminium (and iron) >1mg/L indicates the presence of suspended clay minerals (Thorbjornsen & Myers 2007:26) that are naturally occurring. Aluminium results therefore assist review of metal results to determine if source is natural due to clay presence (Hart 2011).	≤0.055 mg/L	≤0.2 (A)	≤5 mg/L long term; ≤20mg/L short term	≤5 mg/L
Arsenic	Found naturally in soils & in cattle dip soils; toxic, possibly carcinogenic (Manahan, 1990:150), toxic to livestock in high concentrations (ANZECC, 1992:5-25)	≤0.024 mg/L (III) form; ≤0.05 aquaculture	≤0.01 mg/L	≤0.1 mg/L long term; ≤2 mg/L short term	0.5 to 5 mg/L tolerated
Cadmium	Causes high blood pressure, kidney damage, destroys testicular tissue and red blood cells, toxic to aquatic biota (Manahan, 1990:150), toxic and carcinogenic to livestock (ANZECC, 1992:5-26)	≤0.0002 mg/L – if 'hard' water ≤0.00084 mg/L	≤0.002 mg/L	≤0.01 mg/L long term; ≤0.05 mg/L short term	≤0.01 mg/L
Chromium	Cr^{+6} is possibly carcinogenic and is toxic to humans (anaemia, kidney disease, nervous system) (Manahan, 1990:150), reduces crop yield (ANZECC, 1992:5-14).	≤0.001 mg/L for Cr^{+6}	≤0.05 mg/L (Cr^{+6})	≤0.1 mg/L long term; ≤1 mg/L short term	≤1 mg/L
Copper	Essential in small concentrations for plant growth and animals (ANZECC, 1992:5-15&5-27). Toxic to sensitive plants and animals and bioaccumulated.	0.0014 mg/L – if 'hard' water ≤0.00546 mg/L	≤2 mg/L (Health) ≤1 mg/L (A)	≤0.2 mg/L long term; ≤5 mg/L short term	<0.4 mg/L sheep, <1 mg/L cattle; <5 mg/L pigs & poultry
Lead	Wildlife destruction (Manahan, 1990:151). Reduces plant growth (ANZECC, 1992:5-16). Decreases human intelligence, growth (Csuros, 1994:210).	≤0.0034 mg/L – if 'hard' water ≤0.02584 mg/L	≤0.01 mg/L	≤2 mg/L long term; ≤5 mg/L short term	≤0.1 mg/L
Mercury	Very toxic to humans - numbness, deafness, loss of muscle control (Csuros, 1994:212); toxic to fish (ANZECC, 1992:2-38).	NR (2000); ≤0.0001 mg/L (1992)	≤0.001 mg/L	≤0.002 mg/L	≤0.002mg/L
Nickel	Commonly on metal analyte suite lists. Occurs naturally and is ubiquitous in soils. Found in foods: cocoa, soy beans and some cereals (NHMRC 2015:861).	≤0.011 mg/L – if 'hard' water ≤0.0429 mg/L	≤0.02 mg/L	≤0.2 mg/L long term; ≤2.0mg/L short term	≤1 mg/L
Selenium	Toxic to cattle, fish and humans (Manahan, 1990:151) Used in electronics, glass, ceramics, pigments, rubber (Csuros, 1994:213).	≤0.005 mg/L	≤0.01 mg/L	≤0.02 mg/L long term; ≤0.05 mg/L short term	≤0.02 mg/L
Zinc	Found both naturally (weathering & erosion) and from anthropogenic sources (ANZECC, 1992:2-42). Zinc coating used to protect iron, steel and brass; used in dry batteries, construction materials, printing processes (Csuros, 1994:215). One of seven analytes with greatest percentage increase from 71 unlined landfills in North Carolina, USA (Borden and Yanoschak, 1990:269).	≤0.008 mg/L – if 'hard' water ≤0.0312 mg/L	≤3 mg/L (A)	≤2 mg/L long term; ≤5 mg/L short term	≤20 mg/L

1. from Tables 3.3.1, 3.3.2, 3.3.3 - Default trigger values for aquatic ecosystems in upland rivers of south-east Australia which are slightly-moderately disturbed; Tables 3.4.1 trigger values for toxicants 95% level of aquatic ecosystem protection; and Table 3.4.4 Hardness factors for select metals in '*Australian and New Zealand Guidelines for Fresh and Marine Water Quality*', ANZECC & ARMCANZ 2000.
2. from '*Australian Drinking Water Guidelines 6*' NHMRC & NRMMC 2011, updated March 2015. <http://www.nhmrc.gov.au/guidelines/publications/eh52/>.
3. from Tables 4.2.5, 4.2.10, 4.2.11, 4.2.14 and 4.2.15 '*Australian and New Zealand Guidelines for Fresh and Marine Water Quality*', ANZECC & ARMCANZ 2000.
4. from page 4.3-3 – 4.3-5 '*Australian and New Zealand Guidelines for Fresh and Marine Water Quality*', ANZECC & ARMCANZ 2000.

NR - No recommendation; (A) aesthetic guideline rather than an environmental health guideline; (1992) refers to the 1992 edition of the '*Australian and New Zealand Guidelines for Fresh and Marine Water Quality*'.

14. REVIEW OF BASELINE GROUNDWATER QUALITY TO DATE

This section reviews the groundwater quality results detailed in Tables 4 to 27 for the groundwater wells. The tables summarise the groundwater quality results from groundwater sampling conducted by RCA in Year 2007 and the first full round of groundwater monitoring conducted by CodyHart from 28 to 30 July 2015.

Seven more rounds of baseline groundwater monitoring for the Armidale Regional Landfill are yet to be conducted on a bi-monthly basis.

The only untoward analyte from the two rounds of groundwater monitoring conducted to date is trace chloroform detections in wells ABH9, ABH11 and ABH12, which in July 2015 were respectively 0.005 mg/L, 0.006 mg/L, and 0.001 mg/L. It was also detected in Year 2007 in trace concentrations in wells ABH9 and ABH11. Chloroform is not a naturally occurring substance. It was previously used as an anaesthetic for operations.

Chloroform is a common contaminant in United States wells often attributed to chlorinated potable water supplies. Possible sources of chloroform include:

- Leaking potable water pipes
- Introduction of potable (tap) water while drilling to reduce dust and facilitate hammer head penetration, or introduction during earlier slug tests
- Use of bleach to decontaminate groundwater sampling pumps or to disinfect wells with iron bacteria. In comparison, CodyHart uses trisodium phosphate to clean pumps if organic compound contamination is known or suspected, and for general cleaning, non-phosphate detergent (ASTM 2002a).
- A combination of chlorine bleach and acetone. Acetone is a substance that can be naturally occurring from plants, trees, volcanic gases, forest fires (ATDRS 2015) but it is also present in blue ‘plumber’s glue’ sometimes used to glue well casings together. (Non-glued, screw joints are best.)

This detection of chloroform prior to the acceptance of solid waste means that the source is not landfill leachate. Such prior trace contaminants often dissipate over time.

Other results were typical of slightly saline groundwater in the Armidale Dumaresq area. Metal concentrations were low. Total nitrogen compounds and total organic carbon concentrations were low. These results will provide good comparisons if concentrations increase due to landfill leachate contamination of groundwater.

15. GARA6 BASELINE AMBIENT SURFACE WATER QUALITY

Sampling at GARA6 is needed to complete the ambient surface water monitoring program.

There were no untoward results this sampling round. Dissolved oxygen was high due to the cold temperature. Copper at 0.002 mg/L was slightly more than the ANZECC & ARMCANZ (2000, Table 3.4.1, p. 3.4-5) 0.0014 mg/L trigger value for 95% protection of freshwater aquatic ecosystems. However, this copper concentration is acceptable as the hardness (154 mg/L) of the GARA6 water reduces the metal’s bioavailability. With a ‘hard’ classification the 0.0014 mg/L trigger value is multiplied by 3.9 (Table 3.4.3, p. 3.4-21)] resulting in 0.005 mg/L as an acceptable copper concentration. The total nitrogen concentration was relatively low for a stream around which cattle and sheep grazing occurs.

16. THREE PHASES OF GROUNDWATER MONITORING

There are three phases to groundwater monitoring at landfill sites:

1. ***Site characterisation*** of groundwater quality prior to landfill construction or chance of leachate ingress into groundwater - to serve as a ***baseline*** against which to compare future groundwater quality data
2. ***Detection monitoring*** to determine whether or not there has been an impact on groundwater quality from landfill leachate or sediment runoff
3. ***Assessment monitoring*** in the event of impacts, to characterize possible groundwater contamination (nature, extent, possible future extent and source); and if required, to evaluate and recommend mitigation techniques.

(in keeping with Sara & Gibbons 2006)

The first two are essential for the operation of an environmentally responsible landfill. The third is undertaken after suspected impact.

17. GROUNDWATER MONITORING PROGRAM OVERVIEW

Table 33 provides an overview of the recommended Armidale Regional Landfill groundwater monitoring program. Only the first full baseline monitoring round is complete. Seven more are needed.

The detection monitoring parameters / analytes and the ones chosen as 'detection monitoring indicators' will be finalised once eight (8) rounds of baseline monitoring are complete. Justification for the choice of analytes was provided in the *Ambient Surface Water Monitoring Report May 2015.*

The statistical analysis methodology for estimating trigger values for the selected indicator analytes of the detection monitoring phase was described in the *Ambient Surface Water Monitoring Report May 2015.*

The Armidale Regional Landfill is not a contaminated site. The extensive number and type of quality assurance tests used during contaminated site assessment are not appropriate or warranted. They are not required in NSW EPA licences for landfills. A range of methodologies and tests assure that the data being obtained is representative of the ambient groundwater and surface water quality. These have already been explained in Section 11 of this report.

Table 33: Groundwater monitoring program - Armidale Regional Landfill

Baseline monitoring *(ABH02, ABH02A, ABH4, ABH4A, ABH04, ABH04A, ABH9, ABH11, ABH12 & ABHD)*	Detection monitoring *(ABH02, ABH02A, ABH4, ABH4A, ABH04, ABH04A, ABH9, ABH11, ABH12 & ABHD)*	Assessment monitoring *(Any well with 3 parameters / analytes exceeding their trigger values for 3 consecutive monitoring rounds)*
Monitoring wells (Figure 1) *ABH02, ABH02A, ABH4, ABH4A* (dry), *ABH04, ABH04A, ABH11, ABH12* (downgradient of landfill) *ABH9* (upgradient of landfill) *ABHD* (duplicate sample taken at one of the above wells)	*Monitoring wells* (Figure 1) *ABH02, ABH02A, ABH4, ABH4A* (dry), *ABH04, ABH04A, ABH11, ABH12* (unless redundancies noted in baseline monitoring) *ABH9* (upgradient of landfill) *ABHD* (duplicate sample taken at one of the above wells)	*Monitoring wells* Wells on Figure 1 in which detection monitoring indicates exceedance of three indicator parameter / analytes for three consecutive monitoring rounds.
Sampling frequency Bi-monthly for eight rounds	*Sampling frequency* Determined from the groundwater average linear velocities for the site based on in-situ hydraulic conductivity estimates. Moderate groundwater movement – quarterly (mid-gradient wells ABH11 & ABH12); slow groundwater movement – six monthly (lower gradient ABH02, ABH02A, ABH4, ABH04, ABH04A); upgradient ABH9 – six monthly - located higher than the landfill cells.	*Sampling frequency* Determine by review of need
Parameters & analytes Field: Depth, DO, EC, pH, Eh, temp, turbidity, alkalinity, free CO_2 Laboratory: Every round: Cl, SO_4, Alk, Ca, Mg, Na, K, Nitrogen compounds (NH_4^+ as N, TKN as N, NO_x as N), Filtered [Al, As, Cd, Cr, Cu, Ni, Pb, Zn, Mn, Fe, Se, Hg, Sb, Fe (II)]; TOC (filtered). Every second round: UT VOCs, OC&OP pesticides, UT PAH.	*Parameters & analytes* Field: Depth, DO, EC, pH, Eh, temp, turbidity, alkalinity, free CO_2 Possible Laboratory: Every round: Cl, SO_4, Nitrogen compounds (NH_4^+ as N, TKN as N, NO_x as N), Filtered [Al, As, Cd, Cr, Cu, Ni, Pb, Zn, Mn, Fe, Fe (II)]; TOC (filtered).	*Parameters & analytes* Field: Depth, DO, EC, pH, Eh, temp, turbidity, alkalinity, free CO_2 Possible Laboratory: Every round: Cl, SO_4, Nitrogen compounds (NH_4^+ as N, TKN as N, NO_x as N), Filtered [Al, As, Cd, Cr, Cu, Ni, Pb, Zn, Mn, Fe, Se, Hg, Sb, Fe (II); TOC (filtered). If sheen, colour, odour indicates it is warranted – test UT VOCs, UT PAHs.
QA samples to laboratory 1 intra-lab duplicate per 10 sampling points/wells	*QA samples to laboratory* 1 intra-lab duplicate per 10 sampling points/wells	*QA samples to laboratory* 1 intra-lab duplicate per 10 sampling points
Comparisons Initial baseline results can only be given a general review by comparing results against environmental values for groundwater uses in surrounding bores (domestic, stock drinking water, irrigation). [Note: Aquatic ecosystem guideline values are not a suitable comparison due to groundwater geological regimes.] Stock: ANZECC & ARMCANZ 2000, pp. 4.3-2 – 4.3-5. Irrigation: ANZECC & ARMCANZ 2000, Tables 4.2.5, 4.2.10, 4.2.11, 4.2.14 and 4.2.15. Quarterly or bi-monthly groundwater monitoring rounds are needed to obtain 8 observations for each water quality parameter / analyte at each well. In the eighth round of monitoring, six observations for select detection monitoring parameters / analytes will be taken in each well to add 'within-event' variation to the maximum baseline value. This max + within-event variation becomes the detection monitoring trigger value for assessment monitoring to commence.	*Comparisons* Ongoing results are to be compared against detection monitoring indicator analytes / parameters trigger values statistically derived for individual wells from baseline data. At any individual well, if any three trigger values are exceeded or are outside their range for three consecutive monitoring rounds, then assessment monitoring is to commence. (as per Grafton Regional Landfill Licence L7186).	*Comparisons* Review results against trigger values of detection monitoring indicator parameters / analytes, and acceptable values for stock and irrigation water (see baseline references). *© CodyHart Environmental 2015*

18. GROUNDWATER FLOW DIRECTION

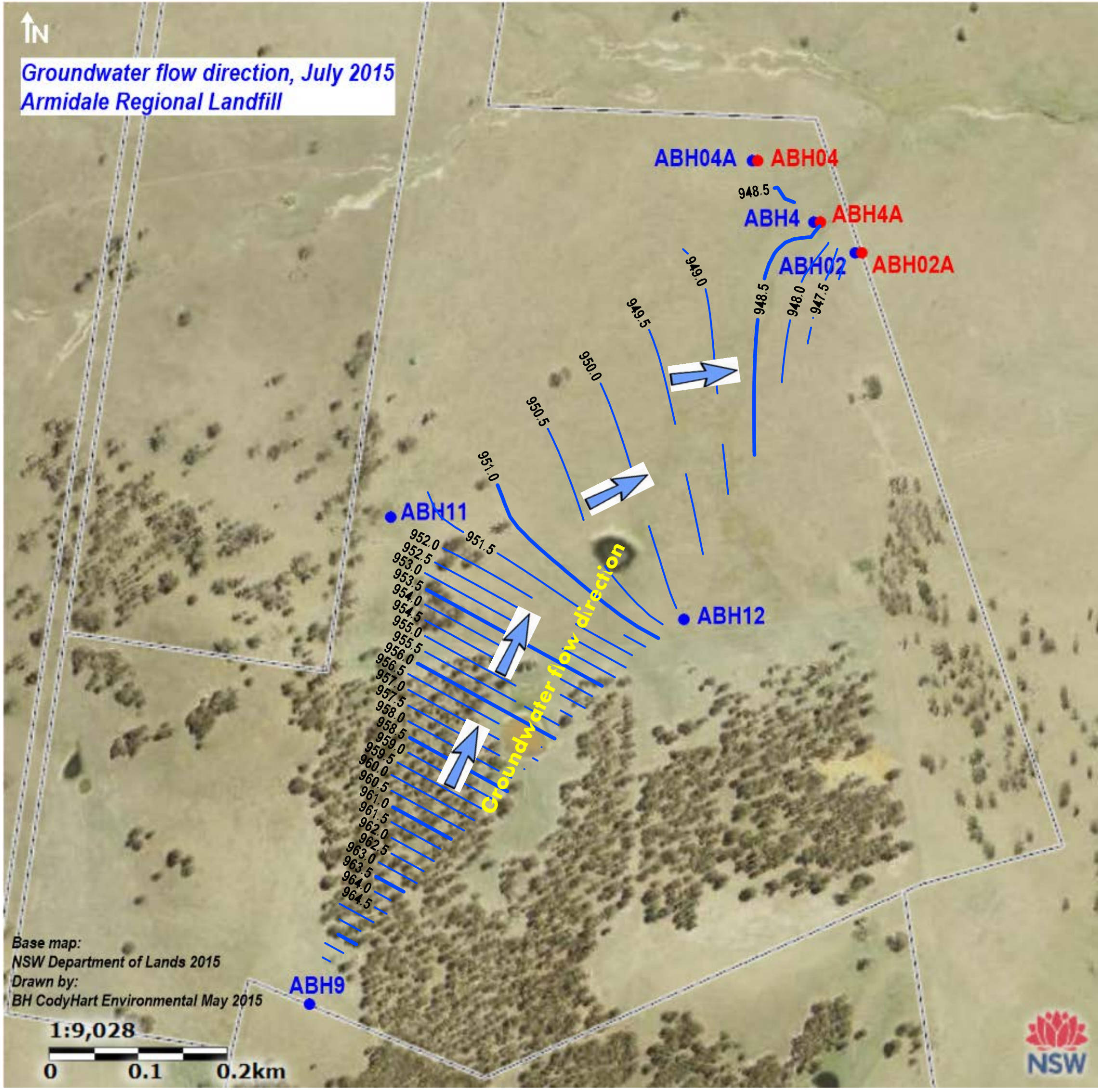
In early September 2015, Council used a GPS station to resurvey the lower wells on the northern section of the site: ABH04, ABH04A, ABH4, ABH4A, ABH02 and ABH02A (Figure 4). The corrected relative levels (RLs) at the top of the PVC casings are provided under the first table for each well in Section 12.

The depth to groundwater was subtracted from the top of the PVC casing RL to obtain the RL of the piezometric level in each well to be used in the groundwater flow direction plot.

Groundwater flow direction plots are made from wells screened within the same aquifer so that hydraulic pressures from other aquifers cannot misrepresent the flow direction. The first plot (Figure 4) for the Armidale Regional Landfill was therefore for wells ABH9, ABH11, ABH12, ABH02A, ABH4 and ABH04. All of these wells, except for well ABH4, are approximately 30 metres deep or deeper. Well ABH4 is only 18 metres deep.

Contour plots for the groundwater relative levels were drawn using a 'natural neighbour' algorithm in the software program, *Surfer*. General groundwater flow direction is at right angles to the contours (Figure 4).

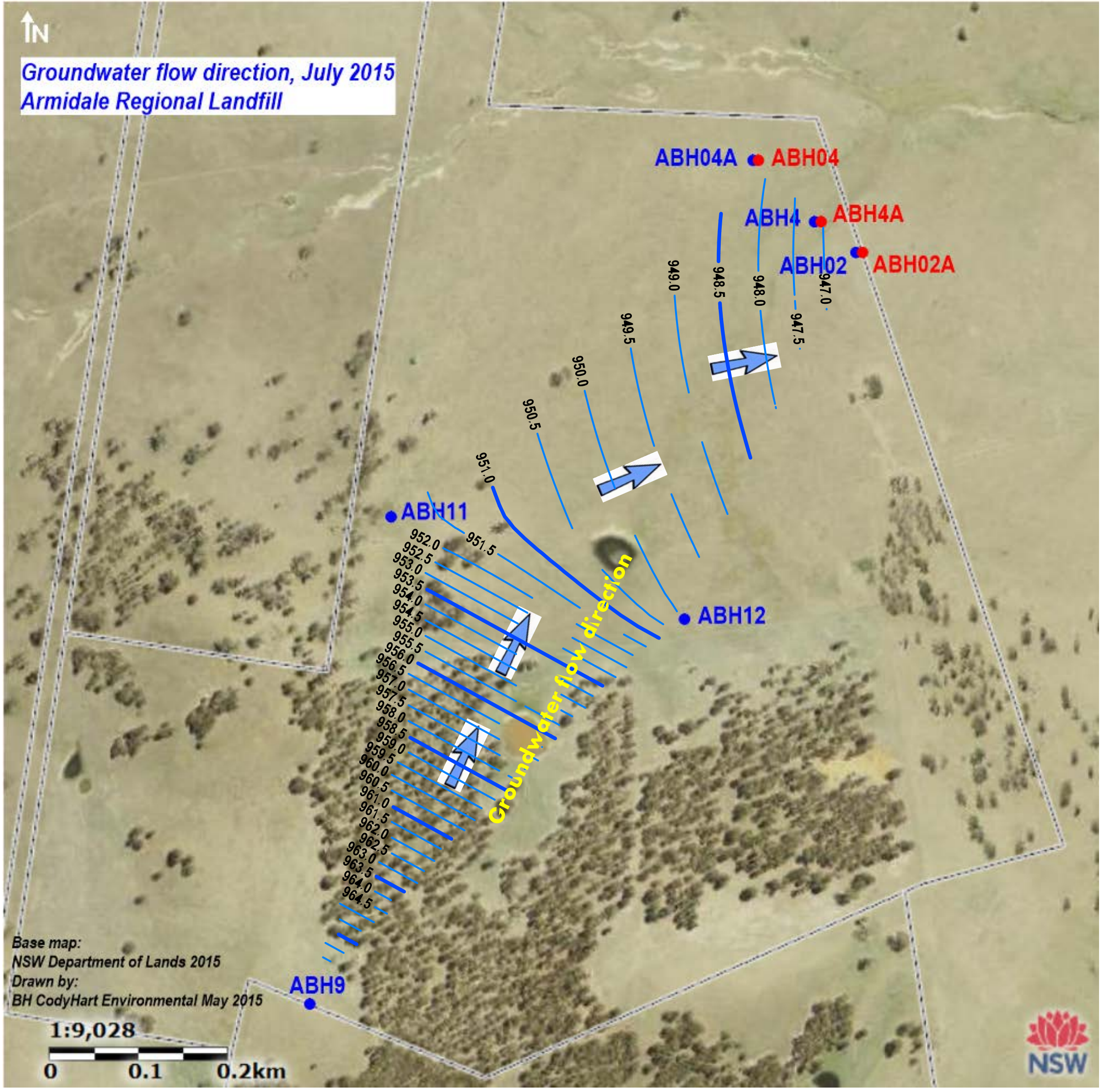
Figure 4: Groundwater flow direction with ABH4 (a shallower well) included



Note the curve in the 948.5 m relative level (RL) contour line at well ABH4.

By excluding the piezometric RL of ABH4, the shallower well from the plot, the curve at well ABH4 disappears (Figure 5).

Figure 5: Groundwater flow direction with ABH4 (a shallower well) ex<u>*ex*</u>*cluded*



The Figure 5 plot shows a smooth transition from the landfill site.

The difference between these two plots illustrates that well piezometric levels only indicate a generalised flow direction. It cannot be assumed that a plotted direction is correct for all points within the plot. Groundwater may flow in various directions along bedding planes, fissures and rock fractures, and in greater volume through more permeable rocks such sandstone. Low permeable clay layers may 'perch' isolated pockets of groundwater above confining clays. Groundwater flow direction may vary over time due to variations in precipitation intensity and spatial coverage and the varying underground characteristics that groundwater encounters as a result.

ABH4 is a case in point in regard to localised variation. Figure 4 gives the perception of a perched water table. However, the likely cause is its longer 10 metre screen in argillite (sandstone), which is more permeable than the greywacke of the screened intervals in wells ABH02A and ABH04. This observation is corroborated by faster recharge in well ABH4 during the July 2015 sampling event.

Overall, the groundwater flow direction is in sympathy with topographical fall to the Gara River. It flows in a north-northeast direction on the southern, elevated section of the site, then turns easterly on the northern, lower levels of the site to follow the ephemeral stream direction to the Gara River.

19. CONCLUSION

This report details preliminary work conducted on groundwater monitoring wells, and the first full round of groundwater monitoring at the Armidale Regional Landfill site.

In May 2015, well development by surging, then pumping or bailing was conducted to clean the drill hole walls and to clean out drilling fines caught between the filter pack surrounding each well screen. Well development is essential prior to hydraulic conductivity testing and to obtain low turbidity groundwater quality samples. The groundwater of all wells was of low turbidity by the end of the development, except well ABH04A, which was bailed dry three times.

The wells were allowed to settle after well development before slug tests were conducted on 27 and 28 July 2015. Slug tests are used to estimate in-situ hydraulic conductivity, one of the major coefficients in estimating groundwater flow average linear velocity and consequently groundwater monitoring sampling frequency.

The slug tests were conducted in mid-gradient well ABH12, and lower gradient wells ABH02, ABH02A and ABH04A. Table 1, page 11 provides the hydraulic conductivity *(K)* results. Overall the site *Ks* are slow to moderate. The results show that wells in the mid-gradient portion of the Armidale Regional Landfill site (ABH11, ABH12) have faster *Ks* than the lower gradient wells to the north, located below the yet to be constructed leachate and sediment ponds (ABH02, ABH02A, ABH4, ABH04, ABH04A).

The groundwater average linear velocity (flow rate) is faster (59.4 m/year) in the elevated southern portion of the site, and slow (0.45 m/year) in the northern, lower section of the site. This is a result of greater hydraulic gradient and *K* values in the elevated, southern portion of the site.

As a result, the following sampling frequencies during the detection monitoring phase are recommended:

- mid-gradient wells ABH11 and ABH12 - quarterly due to their faster groundwater average linear velocity
- lower gradient wells ABH02, ABH02A, ABH4, ABH04, ABH04A - six-monthly due to their slow groundwater average linear velocity (slower *K* and lower hydraulic gradient)
- upgradient well ABH9 - six monthly because it is upgradient to the highest proposed landfill cell, and groundwater rarely flows uphill.

Well development and slug testing provided information on well hydraulics from which ongoing pump type and settings for future water quality monitoring were made (Table 3, page 16).

Figure 5, page 35 illustrates that the general groundwater flow direction is in sympathy with topographical fall to the Gara River. It flows in a north-northeast direction on the southern, elevated section of the site, then turns easterly on the northern, lower levels of the site to follow the ephemeral stream direction to the Gara River.

Water quality monitoring results are tabled:

- Some groundwater quality results for wells sampled by RCA in Year 2007
- The first full round of baseline groundwater monitoring in wells ABH02, ABH0A, ABH4, ABH04, ABH04A, ABH9, ABH11, and ABH12 conducted on 29 and 30 July 2015 by CodyHart. (The letter 'A', refers to Armidale, and was added to differentiate these wells from those at other sites. Well ABH4A was dry.)
- The second round of baseline monitoring at ambient surface water sampling point, GARA6 located downstream from the landfill on the Gara River.

The only untoward groundwater analyte was trace chloroform detected in wells ABH9, ABH11 and ABH12. Chloroform is a common contaminant in United States wells often attributed to chlorinated potable water supplies. Possible sources include: leaking potable water pipes; potable (tap) water introduced to the borehole while drilling to reduce dust and facilitate the hammer head penetration while drilling or introduced during earlier slug tests; use of bleach to decontaminate sampling pumps during earlier sampling or to disinfect wells with iron bacteria; and reaction of naturally occurring acetone or in glue used in well casing joints and potable water. Such trace contaminants prior to solid waste acceptance often dissipate over time.

GARA6 ambient surface water quality results were typical for the Gara River and not a concern.

A groundwater monitoring program for a landfill consists of three possible phases: definitely (1) site characterisation (baseline) and (2) detection monitoring; and possibly (3) assessment monitoring.

Eight rounds of quarterly, baseline groundwater monitoring are commonly recommended. Seven baseline rounds remain for the Armidale Regional Landfill site wells. These will be conducted bi-monthly to assure that the baseline groundwater monitoring is complete before solid waste acceptance commences at the Armidale Regional Landfill.

By having eight rounds of baseline ambient groundwater monitoring, there are eight rounds of data from which to estimate trigger values that indicate that a particular well/s may need to progress from detection monitoring phase to assessment monitoring phase.

Table 33, page 33 is an overview of the recommended Armidale Regional Landfill groundwater monitoring program for the three phases of groundwater monitoring.

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APPENDIX A

Field Parameter Forms

CodyHart Environmental

GROUNDWATER FIELD PARAMETER FORM (Monitoring wells)

Project: Armidale Dumaresq Council – Armidale Regional Landfill **SAMPLE POINT ID: ABH02**

PURGING INFORMATION

Pump type: Peristaltic **Tubing:** LDPE

Total well depth (from top of casing) (m) **11 • 15**

Air controller: None

Depth to groundwater (m) 7 • 86
(from top of PVC casing) (RL top of internal casing = m)

Position end tube at: 9.00 m (from top of PVC casing)

WATER COLUMN DEPTH (m) 3 • 29
(well depth minus depth to groundwater)

Dial position: 2.25:

Purge volume: 4 L Date: 29/7/15 **Start time:** 15:10 (24 hr clock) **Cycle vol:** NA mL **Pump rate:** 200 mL/min

FIELD ANALYTE VALUES

Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)	Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)
7.5	0.56	2331	6.80	+111	17.0	←7.88	0.5	1.04	2309	6.77	+133	17.4	
8.0	0.41	2315	6.84	+109	17.0.		1.0	0.73	2319	6.82	+121	17.6	
							1.5	0.74	2317	6.79	+118	17.7	
							2.0	0.62	2317	6.79	+116	17.6	
							2.5	0.58	2335	6.82	+117	17.7	
							3.0	0.48	2332	6.84	+116	17.6	
							3.5	0.44	2320	6.83	+115	17.3	
							4.0	0.39	2315	6.81	+115	17.6	

	DO	EC	pH	Eh	Temp
Mean of last four values (sampling mean)	0.47	2326	6.83	+116	17.5
RPD	X	✓	✓	✓	✓

Notes:

Pump brand Solinst - peristaltic

☑ Filtered TOC + metals ☐ Not filtered

Tick on metals bottle: ☑ Dissolved ☐ Total

EC standard 2760 µS/cm

SAMPLING INFORMATION

Pretest of deionised water 2.38 µS/cm at 25°C

Field blank EC 2.76 µs/cm at 25°C

Beaker material: polypropylene **Sample composited (Y/N):** N **Start sample:** 15:30 (2400 hr clock)

Weather: (5 min. max. at ground level at ABH4) Rain Nil, Temp 11.2°C, Cloud cover 10%.

Wind direction 130°, Wind Speed 2.52 m/s Upwind Activities paddock.

Sample appearance: Odour -. Colour clear Turbidity 12.2 NTU

Non-conformances of well condition (see *'Field checks'*) **and equipment (Y/N) :** N (If yes, write details and remedy or arrange remedy.)

Details:

Purging and sampling procedures were those detailed by CodyHart Consulting Pty Ltd.

Name: Barbara Hart Signature: B Hart Date: 29/7/15 Time: 16:30

CodyHart Environmental

GROUNDWATER FIELD PARAMETER FORM (Monitoring wells)

Project: Armidale Dumaresq Council – Armidale Regional Landfill **SAMPLE POINT ID: ABH02A**

PURGING INFORMATION

Pump type: Bladder **Tubing:** LDPE

Total well depth (from top of casing) (m) 30 • 83

Air controller: QED MP10

Depth to groundwater (m) (from top of PVC casing) (RL top of internal casing = m) 7 • 71

Position pump at: 27 .00 m (from top of PVC casing)

WATER COLUMN DEPTH (m) (well depth minus depth to groundwater) 23 • 12

Refill / discharge rate (secs): 15/15 **psi:** 55

Purge volume: 4 L Date: 28/07/15 **Start time:** 13:40 (24 hr clock) **Cycle vol:** 100 mL **Pump rate:** 200 mL/min

→ 12L

FIELD ANALYTE VALUES

Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)	Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)
8.0	0.63	1764	6.96	+289	17.0		0.5	2.96	1664	6.87	+302	16.0	
8.5	0.69	1765	6.97	+296	16.8		1.0	1.47	1748	6.89	+297	16.3	
9.0	0.67	1755	6.97	+301	16.8	← 7.76	1.5	0.88	1779	6.91	+299	16.7	
9.5	0.58	1745	6.99	+307	16.8		2.0	0.69	1784	6.92	+300	16.8	
10.0	0.55	1742	6.99	+309	16.8		2.5	0.58	1791	6.93	+297	16.7	
10.5	0.53	1735	7.00	+312	16.8		3.0	0.57	1792	6.93	+295	16.7	
11.0	0.52	1735	7.00	+315	16.7		3.5	0.53	1780	6.93	+293	16.6	
11.5	0.52	1723	7.00	+314	16.7		4.0	0.53	1778	6.93	+287	16.6	
12.0	0.48	1713	6.99	+310	16.8								

	DO	EC	pH	Eh	Temp
Mean of last four values (sampling mean)	0.55	1785	6.93	+293	16.7
RPD	✓	✓	✓	✓	✓

Notes:

Pump brand T1250 - QED Bladder

TOC & metals

☑ Filtered ☐ Not filtered

Tick on metals bottle: ☑ Dissolved ☐ Total

EC standard 2760 µS/cm TPS Lab with turbidity

SAMPLING INFORMATION

Pretest of deionised water 2.30 µS/cm at 25°C

Field blank EC 3.16 µs/cm at 25°C

Beaker material: polypropylene **Sample composited (Y/N):** N **Start sample:** 14:00 (2400 hr clock)

Weather: (5 min. max. at ground level at ABH02A) Rain nil, Temp 13.2°C, Cloud cover nil,

Wind direction 110°, Wind Speed 1.80 m/s Upwind Activities paddock

Sample appearance: Odour – Colour slight white cloudiness Turbidity 19.8 NTU

Non-conformances of well condition (see *'Field checks'*) **and equipment (Y/N):** N (If yes, write details and remedy or arrange remedy.)

Details:

Purging and sampling procedures were those detailed by CodyHart Consulting Pty Ltd.

Name: Barbara Hart Signature: B Hart Date: 28/7/15 Time: 15:00

Duplicate as split except for VOCs.

CodyHart Environmental

GROUNDWATER FIELD PARAMETER FORM (Monitoring wells)

Project: Armidale Dumaresq Council – Armidale Regional Landfill **SAMPLE POINT ID: ABH4**

PURGING INFORMATION

Pump type: Bladder **Tubing:** LDPE

Total well depth (from top of casing) (m) 18 • 00

Air controller: QED MP10

Depth to groundwater (m) 5 • 03
(from top of PVC casing) (RL top of internal casing = m)

Position pump at: 16.00 m (from top of PVC casing)

WATER COLUMN DEPTH (m) 12 • 97
(well depth minus depth to groundwater)

Refill / discharge rate (secs): 30/30 **psi:** 35

Purge volume: 4 L Date: 29/7/15 **Start time:** 11:20 (24 hr clock) **Cycle vol:** 100 mL **Pump rate:** 100 mL/min

FIELD ANALYTE VALUES

Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)	Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)
							0.5	0.89	1686	6.90	+112	13.8	
7.5	0.80	1678	6.95	+76	14.7		1.0	0.70	1680	6.96	+108	13.7	
8.0	0.71	1676	6.94	+74	14.6		1.5	0.91	1697	6.97	+101	13.8	
							2.0	0.81	1691	6.94	+96	14.5	
							2.5	0.74	1695	7.00	+91	14.4	
							3.0	0.58	1691	6.97	+88	13.8	
							3.5	0.55	1697	6.99	+82	14.0	
							4.0	0.56	1689	6.96	+79	14.2	
							7.0						5.02
Mean of last four values (sampling mean)								0.61	1693	6.98	+85	14.1	
RPD								×	✓	✓	✓	✓	

Notes:

Pump brand CodyHart Bladder Pump

TOC + metals

☑ Filtered ☐ Not filtered

Tick on metals bottle: ☑ Dissolved ☐ Total

EC standard 2760 µS/cm

SAMPLING INFORMATION

Pretest of deionised water 2.38 µS/cm at 25°C

Field blank EC 2.98 µs/cm at 25°C

Beaker material: polypropylene **Sample composited (Y/N):** N **Start sample:** 12:00 (2400 hr clock)

Weather: (5 min. max. at ground level at ABH4) Rain Nil, Temp 11.2°C, Cloud cover 10%,

Wind direction 130°, Wind Speed 2.52m/s Upwind Activities paddock

Sample appearance: Odour – Colour clear Turbidity 11.9 NTU

Non-conformances of well condition (see *'Field checks'*) **and equipment (Y/N)** : N (If yes, write details and remedy or arrange remedy.)

Details:

Purging and sampling procedures were those detailed by CodyHart Consulting Pty Ltd.

Name: Barbara Hart Signature: BHart Date: 29/7/15 Time: 13:00

ABH4A was dry.

CodyHart Environmental

GROUNDWATER FIELD PARAMETER FORM (Monitoring wells)

Project: Armidale Dumaresq Council – Armidale Regional Landfill **SAMPLE POINT ID: ABH04**

PURGING INFORMATION

Pump type: Bladder **Tubing:** LDPE

Total well depth (from top of casing) (m) 2 9 • 3 2

Air controller: QED MP10

Depth to groundwater (m) 5 • 01
(from top of PVC casing) (RL top of internal casing = m)

Position pump at: 26.00 m (from top of PVC casing)

WATER COLUMN DEPTH (m) 24 • 31
(well depth minus depth to groundwater)

Refill / discharge rate (secs): 15/15 **psi:** 50

Purge volume: 4 L Date: 28/7/15 **Start time:** 15:40 (24 hr clock) **Cycle vol:** 100 mL **Pump rate:** 200 mL/min

FIELD ANALYTE VALUES

Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)	Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)
8.0	0.25	2362	6.92	-201	16.2		0.5	1.77	2323	6.89	-24	16.3	
8.5	0.10	2325	6.93	-200	16.2		1.0	0.57	2334	6.89	-100	16.2	
9.0	0.12	2308	6.92	-210	16.3		1.5	0.27	2308	6.92	-175	16.2	
9.5	0.07	2354	6.93	-209	16.3		2.0	0.23	2289	6.91	-219	16.1	
10.0	0.07	2291	6.93	-204	16.2		2.5	0.20	2298	6.91	-238	16.2	
10.5	0.10	2299	6.94	-202	16.1		3.0	0.16	2284	6.89	-244	16.2	
11.0	0.10	2302	6.94	-203	16.2		3.5	0.10	2271	6.93	-246	16.2	
11.5	0.09	2319	6.94	-203	16.2		4.0	0.10	2257	6.91	-243	16.3	5.04
12.0		TANK	RAN	OUT OF	AIR								

Mean of last four values (sampling mean)	0.14	2278	6.91	-243	16.2
RPD	✓	✓	✓	✓	✓

ALS criteria

Notes:

Pump brand T1250 QED

TOC + metals

☑ Filtered ☐ Not filtered

Tick on metals bottle: ☑ Dissolved ☐ Total

EC standard 2760 µS/cm TPS lab with turbidity

SAMPLING INFORMATION

Pretest of deionised water 2.34 µS/cm at 25°C

Field blank EC 3.16 µs/cm at 25°C

Beaker material: polypropylene **Sample composited (Y/N):** N **Start sample:** 16:00 (2400 hr clock)

Weather: (5 min. max. at ground level at ABH02A) Rain nil, Temp 13.2°C, Cloud cover nil,

Wind direction 110°, Wind Speed 1.80 m/s Upwind Activities paddock

Sample appearance: Odour sulphur? Colour clear Turbidity 16.4 NTU

Non-conformances of well condition (see *'Field checks'*) **and equipment (Y/N)**: N (If yes, write details and remedy or arrange remedy.)

Details:

Purging and sampling procedures were those detailed by CodyHart Consulting Pty Ltd.

Name: Barbara Hart Signature: B Hart Date: 28/7/15 Time: 16:30

CodyHart Environmental

GROUNDWATER FIELD PARAMETER FORM (Monitoring wells)

Project: Armidale Dumaresq Council – Armidale Regional Landfill **SAMPLE POINT ID: ABH04A**

PURGING INFORMATION

Pump type: Peristaltic **Tubing:** LDPE

Total well depth (from top of casing) (m) 8 • 8 $\overset{1}{0}$

Air controller: None

Depth to groundwater (m) 5 • 94
(from top of PVC casing) (RL top of internal casing = m)

Position tube end at: 7.00 m (from top of PVC casing)

WATER COLUMN DEPTH (m) 3 • 7 $\overset{6}{\_}$
(well depth minus depth to groundwater)

Dial position: 2.25

Purge volume: 4 L Date: 29/7/15 **Start time:** 13:40 (24 hr clock) **Cycle vol:** NA mL **Pump rate:** ~200 mL/min

FIELD ANALYTE VALUES

Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)	Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)
7.5	0.96	1648	7.17	-200	17.3		0.5	2.94	1654	7.08	+72	16.7	
8.0	0.88	1649	7.18	-210	17.3		1.0	2.70	1651	7.21	+66	16.7	
8.5	0.82	1645	7.20	-191	17.1		1.5	2.57	1646	7.23	+64	16.7	
9.0	0.80	1649	7.20	-150	17.1	← 7.00 m ∴ down to inlet. Later – 6.81m ∴ recovered 0.2m in 15 mins ∴ not worth slowing down next round	2.0	2.60	1648	7.23	+63	16.7	
							2.5	2.44	1645	7.24	+62	16.9	
							3.0	2.27	1646	7.23	+60	17.0	
							3.5	1.42	1648	7.21	+52	17.1	
							4.0	1.33	1645	7.23	+50	16.9	
Mean of last four values (sampling mean)								1.87	1646	7.23	+56	17.0	
RPD								X	✓	✓	✓	✓	

Notes:

Pump brand Solinst peristaltic

TOC + metals
☑ Filtered ☐ Not filtered

Tick on metals bottle: ☑ Dissolved ☐ Total

EC standard 2760 µS/cm

SAMPLING INFORMATION

Pretest of deionised water 2.38 µS/cm at 25°C

Field blank EC 2.76 µs/cm at 25°C

Beaker material: polypropylene **Sample composited (Y/N):** N **Start sample:** 14:00 (2400 hr clock)

Weather: (5 min. max. at ground level at ABH4) Rain Nil, Temp 11.2°C, Cloud cover 10%,

Wind direction 130°, Wind Speed 2.52m/s Upwind Activities paddock

Sample appearance: Odour – Colour clear Turbidity 11.7 NTU

Non-conformances of well condition (see *'Field checks'*) **and equipment (Y/N):** N (If yes, write details and remedy or arrange remedy.)

Details:

Purging and sampling procedures were those detailed by CodyHart Consulting Pty Ltd.

Name: Barbara Hart Signature: BHart Date: 29/7/15 Time: 14:50

CodyHart Environmental

GROUNDWATER FIELD PARAMETER FORM (Monitoring wells)

Project: Armidale Dumaresq Council – Armidale Regional Landfill **SAMPLE POINT ID: ABH9**

PURGING INFORMATION

Pump type: Bladder **Tubing:** LDPE

Total well depth (from top of casing) (m) 60 • 50

Air controller: QED MP10

Depth to groundwater (m) 45 • 28
(from top of PVC casing) (RL top of internal casing = 1014.03 m)

Position pump at: 57.50 m (from top of PVC casing)

WATER COLUMN DEPTH (m) 15 • 22
(well depth minus depth to groundwater)

Refill / discharge rate (secs): 30/30 **psi:** 90

Purge volume: 4 L Date: 30/7/15 **Start time:** 11:20 (24 hr clock) **Cycle vol:** 100 mL **Pump rate:** 100 mL/min

FIELD ANALYTE VALUES

Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)	Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)
7.5	2.28	1412	6.17	+118	17.4		0.5	2.98	1469	6.18	-140	17.1	
8.0	2.29	1415	6.12	+119	17.4		1.0	2.50	1492	6.21	-111	17.2	
							1.5	2.10	1487	6.21	-55	17.3	
							2.0	2.15	1483	6.19	-32	17.4	
							2.5	2.10	1475	6.16	+9	17.5	
							3.0	2.15	1469	6.16	+14	17.4	
							3.5	2.22	1457	6.12	+37	17.6	
							4.0	2.25	1454	6.10	+64	17.3	45.27
							Mean of last four values (sampling mean)	2.18	1464	6.14	+31	17.5	
							RPD	✓	✓	✓	X	✓	

Notes:

Pump brand T1250 QED

TOC + metals

☑ Filtered ☐ Not filtered

Tick on metals bottle: ☑ Dissolved ☐ Total

EC standard 2760 µS/cm

SAMPLING INFORMATION

Pretest of deionised water 2.57 µS/cm at 25°C

Field blank EC 2.83 µs/cm at 25°C

Beaker material: polypropylene **Sample composited (Y/N):** N **Start sample:** 12:00 (2400 hr clock)

Weather: (5 min. max. at ground level at ABH9) Rain Nil, Temp 26.7°C, Cloud cover nil.

Wind direction 260°, Wind Speed 4.25m/s Upwind Activities paddock

Sample appearance: Odour — Colour V. lt. tan at beginning of purge clear by sampling Turbidity 50.2 NTU

Non-conformances of well condition (see *'Field checks'*) and equipment (Y/N) : N (If yes, write details and remedy or arrange remedy.)

Details:

Purging and sampling procedures were those detailed by CodyHart Consulting Pty Ltd.

Name: Barbara Hart Signature: B Hart Date: 30/7/15 Time: 13:00

CodyHart Environmental

GROUNDWATER FIELD PARAMETER FORM (Monitoring wells)

Project: Armidale Dumaresq Council – Armidale Regional Landfill **SAMPLE POINT ID: ABH11**

PURGING INFORMATION

Pump type: Bladder **Tubing:** LDPE

Total well depth (from top of casing) (m) 3 7 • 0 0

Air controller: QED MP10

Depth to groundwater (m) 25 • 72
(from top of PVC casing) (RL top of internal casing = 977.58 m)

Position pump at: 34.00 m (from top of PVC casing)

WATER COLUMN DEPTH (m) 11 • 28
(well depth minus depth to groundwater)

Refill / discharge rate (secs): 15/15 **psi:** 60

Purge volume: 4 L Date: 30/7/15 **Start time:** 9:40 (24 hr clock) **Cycle vol:** 100 mL **Pump rate:** 200 mL/min

FIELD ANALYTE VALUES

Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)	Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)
7.5	4.08	1252	6.88	+119	17.0		0.5	5.21	1250	6.79	+124	16.5	
8.0	4.07	1248	6.88	+116	17.0		1.0	4.70	1241	6.85	+119	17.0	
8.5	4.06	1238	6.87	+117	17.1		1.5	4.50	1240	6.86	+117	17.1	
9.0	4.16	1236	6.88	+117	17.1		2.0	4.38	1239	6.88	+116	17.0	
9.5	4.21	1238	6.89	+117	17.0		2.5	4.16	1229	6.88	+117	17.5	
10.0	4.26	1238	6.88	+117	17.1		3.0	4.15	1225	6.90	+116	17.5	
10.5	4.34	1244	6.89	+117	17.1		3.5	4.04	1214	6.89	+115	17.4	
11.0	4.41	1234	6.89	+116	17.1		4.0	4.03	1214	6.89	+116	17.4	
11.5	4.41	1248	6.89	+116	17.2								
12.0	4.41	1238	6.89	+116	17.1								
							5.5						25.72

Mean of last four values (sampling mean)	4.10	1221	6.89	+116	17.5
RPD	✓	✓	✓	✓	✓

Notes:

Pump brand T1250 QED.

TOC + metals

☑ Filtered ☐ Not filtered

Tick on metals bottle: ☑ Dissolved ☐ Total

EC standard 2760 µS/cm

SAMPLING INFORMATION

Pretest of deionised water 2.57 µS/cm at 25°C

Field blank EC 2.83 µs/cm at 25°C

Beaker material: polypropylene **Sample composited (Y/N):** N **Start sample:** 10:00 (2400 hr clock)

Weather: (5 min. max. at ground level at ABH11) Rain Nil, Temp 14.7°C, Cloud cover 0%.

Wind direction 40°, Wind Speed 0.81m/s Upwind Activities paddock

Sample appearance: Odour – Colour Clear Turbidity 21.4 NTU

Non-conformances of well condition (see *'Field checks'*) **and equipment (Y/N)** : N (If yes, write details and remedy or arrange remedy.)

Details:

Purging and sampling procedures were those detailed by CodyHart Consulting Pty Ltd.

Name: Barbara Hart Signature: B Hart Date: 30/7/15 Time: 10:45

CodyHart Environmental

GROUNDWATER FIELD PARAMETER FORM (Monitoring wells)

Project: Armidale Dumaresq Council – Armidale Regional Landfill **SAMPLE POINT ID: ABH12**

PURGING INFORMATION

Pump type: Bladder **Tubing:** LDPE

Total well depth (from top of casing) (m) 4 0 • 6 0

Air controller: QED MP10

Depth to groundwater (m) 19 • 83
(from top of PVC casing) (RL top of internal casing = 969.79 m)

Position pump at: 38.00 m (from top of PVC casing)

WATER COLUMN DEPTH (m) 29 • 77
(well depth minus depth to groundwater)

Refill / discharge rate (secs): 15/15 **psi:** 70

Purge volume: 4 L Date: 30/7/15 **Start time:** 13:40 (24 hr clock) **Cycle vol:** 100 mL **Pump rate:** 200 mL/min

FIELD ANALYTE VALUES

Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)	Vol (L)	DO (mg/L)	EC (µS/cm)	pH (STD)	Eh (mV)	Temp (°C)	WL (m)
7.5	0.63	1367	6.69	+128	16.9		0.7	1.53	1386	6.76	+150	16.8	
8.0	0.60	1362	6.72	+126	16.8		1.0	1.12	1388	6.78	+146	16.7	
8.5	0.58	1358	6.71	+124	16.9		1.5	0.83	1385	6.79	+137	16.7	
9.0	0.56	1357	6.70	+123	16.9		2.0	0.77	1383	6.79	+127	16.6	
9.5	0.56	1354	6.70	+123	16.9		2.5	0.72	1381	6.78	+127	16.9	
10.0	0.55	1354	6.70	+123	16.9		3.0	0.66	1377	6.77	+125	16.9	
10.5	0.62	1357	6.71	+123	16.9		3.5	0.60	1375	6.77	+122	16.9	
11.0	0.62	1358	6.71	+123	16.8		4.0	0.58	1369	6.74	+128	16.9	
							4.5						19.82

	DO	EC	pH	Eh	Temp
Mean of last four values (sampling mean)	0.64	1376	6.77	+126	16.9
RPD	X	✓	✓	✓	✓

Notes:

Pump brand T1250 QED

TOC + metals

☑ Filtered ☐ Not filtered

Tick on metals bottle: ☑ Dissolved ☐ Total

EC standard 2760 µS/cm

SAMPLING INFORMATION

Pretest of deionised water 2.57 µS/cm at 25°C

Field blank EC 2.83 µs/cm at 25°C

Beaker material: polypropylene **Sample composited (Y/N):** N **Start sample:** 14:00 (2400 hr clock)

Weather: (5 min. max. at ground level at ABH9) Rain Nil, Temp 26.7°C, Cloud cover nil,

Wind direction 260°, Wind Speed 4.25 m/s Upwind Activities paddock

Sample appearance: Odour – Colour clear Turbidity 5.1 NTU

Non-conformances of well condition (see *'Field checks'*) **and equipment (Y/N) :** N (If yes, write details and remedy or arrange remedy.)

Details:

Purging and sampling procedures were those detailed by CodyHart Consulting Pty Ltd.

Name: Barbara Hart Signature: B Hart Date: 30/7/15 Time: 14:50

CodyHart Environmental

SURFACE WATER FIELD PARAMETER FORM

Project: Armidale Regional Landfill

Sample Point ID: GARA6
E56 385915.0 **N** 6616606.0

SAMPLING INFORMATION

Pretest of deionised water 2.38 µS/cm at 25°C

Field blank EC 2.98 µs/cm at 25°C

	DO (mg/L)	**EC** (µs/cm)	**pH** (STD)	**Eh** (mV)	**Temp** (°C)	**Turbidity** (NTU)
	11.72	413	7.58	+245	7.6	1.7
	11.57	409	7.59	+242	8.1	1.2
X =	11.65	411	7.59	+244	7.9	1.5
RPD	✓	✓	✓	✓	✓	✓

Sample composited (Y/N): N

Beaker material: polypropylene

Sample date: 29 / 7 / 15 **Start sample:** 10:00 (2400 hr clock)

Weather: (5 min. max. at ground level at GARA6) Rain nil , Temp 4.9°C , Cloud cover nil

Wind direction none , Wind Speed 0 m/s Upwind Activities NA

Sample appearance: Colour clear Notes healthy water plants & duckweed

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LOCATION INFORMATION

Grab sample with 3 m extension pole from Gara River near Gara Station ~15 m north of causeway on western bank.

DEPTH INFORMATION

A. Estimated depth of water at sampling point (m) 0.40 m

Estimates for volumetric flow rate (kL/day): D 0.01 *m* X W 7.0 *m* X 1 m in 5 *secs*
= 0.07 *m*^{3} in 5 *secs*
= 0.014 *m*^{3} *in 1 sec* = 1,210 kL/day

Non-conformances of sampling point (see *'Field checks'*) **and equipment (Y/N)** : N (If yes, write details and remedy or arrange remedy.)

Details:

Sampling procedures were those detailed by CodyHart Consulting Pty Ltd.

Sampler's name: Barbara Hart Signature: B Hart Date: 29/7/15 Time: 10:30

TOC + metals
☑ Filtered ☐ Not filtered

Tick on metals bottle: ☑ Dissolved ☐ Total

EC standard 2760 µS/cm

Field lab: TPS 90FL + Turbidity

APPENDIX B

Chain of Custody Forms
and
Calibration Certificate

CodyHart COC to Site & Calibration Certificate

Chain of Custody for sample containers - laboratory to site

CodyHart ordered sample containers from ALS laboratory, Stafford, Brisbane. When they were received they were stored in the locked and security monitored CodyHart office at Burleigh Heads, Queensland.

CodyHart labels were adhered to appropriate containers. The containers for each sampling point were placed into self sealing plastic bags, which were then labelled with the sampling point identity. The containers for each sampling point were then placed into CodyHart eskies and transported to the Armidale Regional Landfill by CodyHart.

It is certified that the sample bottles were received in unbroken sealed containers from ALS, and that no tampering with the sample containers occurred when in CodyHart hands.

B F Hart 28/07/15

Calibration certificate for field lab

A TPS 90-FL Series field lab was used by CodyHart to take field dissolved oxygen (DO), electrical conductivity (EC), pH, redox potential (Eh), temperature, and turbidity readings.

A yearly maintenance service is conducted on the TPS field lab by TPS Pty Ltd, Brisbane.

It is certified that the field lab used was calibrated daily at Armidale so that sampling was conducted within 24 hours of its calibration. The pH probe was recalibrated if any probe drift was noticed. The calibration processes were documented and are available on request.

B F Hart 30/07/15

CHAIN OF CUSTODY TO LAB

BATCH 2 of 2

CLIENT: *CodyHart Environmental*
ADDRESS / OFFICE: 3/29 Township Drive, BURLEIGH HEADS 4220 (PO Box 1073 BURLEIGH HEADS 4220)
PROJECT MANAGER (PM): Barbara Hart
PROJECT ID: Armidale Regional 2119
SITE: Armidale Regional Landfill P.O. NO.:
RESULTS REQUIRED (Date): QUOTE NO: **BNBQ/052/14**

SAMPLER: B. Hart
MOBILE: 042 777 5120
PHONE:
EMAIL REPORT TO: pelican@codyhart.com.au
EMAIL INVOICE TO: (above)

CodyHart Environmental
Monitoring & Management

[redacted]

COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:

1. PLEASE SCAN THIS FORM ON DAY OF ARRIVAL & EMAIL.

2. PLEASE GLASS-FIBRE FILTER SEMI-VOL SAMPLES IF TURBID.

ANALYSES REQUIRED:

SAMPLE INFORMATION (note: S = Soil, W=Water)					CONTAINER INFORMATION													
ALS ID	SAMPLE ID	MATRIX	DATE	Time	TYPE	No. bottles	ED040F - Water Sulphate	ED045P - Water Chloride (PC)	NT-1 (Ca Mg Na K)	NT-2 (Cl SO4 Alk)	EK055A - Water Ammonia as N	NT-5 Water Total Nitrogen (TKN NOx)	W-30-F - ICP/MS Dissolved **PLUS Mn & Sb**	EG051 - Water FE II	EP005 - Water Total Organic Carbon (TOC)	EP074-WF (A-H) VOC UT (71)	W-12 - Water OC/OP Pesticides	EP132B PAH UT
1	ABH02	W	29/7/15	15:30	250 mL Green; 60mLRed; 60mL Maroon; 3x40m,125mL Purple; 2x100 mL Orange	9			x	x	x	x	x	x	x	x	x	x
2	ABH02A	W	28/7/15	14:00	250 mL Green; 60mLRed; 60mL Maroon; 3x40m,125mL Purple; 2x100 mL Orange	9			x	x	x	x	x	x	x	x	x	x
3	ABH4	W	29/7/15	12:00	250 mL Green; 60mLRed; 60mL Maroon; 3x40m,125mL Purple; 2x100mL Orange	9			x	x	x	x	x	x	x	x	x	x
4	ABH04	W	28/7/15	16:00	250 mL Green; 60mLRed; 60mL Maroon; 3x40m,125mL Purple; 2x100 mL Orange	9			x	x	x	x	x	x	x	x	x	x
5	ABH04A	W	29/7/15	14:00	250 mL Green; 60mLRed; 60mL Maroon; 3x40m,125mL Purple; 2x100mL Orange	9			x	x	x	x	x	x	x	x	x	x
6	ABHD	W	28/7/15	NA	250 mL Green; 60mLRed; 60mL Maroon; 3x40m,125mL Purple; 2x100mL Orange	9			x	x	x	x	x	x	x	x	x	x

PLUS 2 X 100 mL orange for lab dup & matrix spike

HT Fe II 7 days. So HT up by Tuesday 4 August

Environmental Division
Brisbane
CP
Work Order Reference
EB1524519

Telephone : +61-7-3243 7222

RELINQUISHED BY:		RECEIVED BY:		METHOD OF SHIPMENT
Name: *Barbara Hart*	Date: 297/15	Name: JUSTIN	Date: 30/07/15	Transport Co: *Tamex*
Of: *CodyHart Environmental*	Time: 17:00	Of: ALS Laboratory, Brisbane	Time: 15:00	Con Note No:
Signature: *B F Hart*		Signature:		ALS security seal nos:

Samples were despatched in CodyHart Esky/Eskies numbered: 19 & 20 plus 4 small & 1 large CodyHart gel bricks + 2 towels

1

COC Page 1 of 1

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EB1524519**

Client : **CODYHART CONSULTING PTY LTD**
Contact : MS BARBARA HART
Address : P O BOX 1073
BURLEIGH HEADS QLD, AUSTRALIA
4220

E-mail : pelican@codyhart.com.au
Telephone : +61 55205532
Facsimile : +61 07 55206531

Project : Armidale Regional 2119
Order number : ----
C-O-C number : ----

Site : Armidale Regional Landfill
Sampler : BARBARA HART

Laboratory : Environmental Division Brisbane
Contact : Customer Services EB
Address : 2 Byth Street Stafford QLD Australia
4053

E-mail : ALSEnviro.Brisbane@alsglobal.com
Telephone : +61-7-3243 7222
Facsimile : +61-7-3243 7218

Page : 1 of 3
Quote number : EB2014CODCON0251 (BNBQ/052/14)
QC Level : NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received : 30-Jul-2015 3:00 PM
Client Requested Due Date : 11-Aug-2015

Issue Date : 01-Aug-2015
Scheduled Reporting Date : **11-Aug-2015**

Delivery Details

Mode of Delivery : Carrier
No. of coolers/boxes : 2
Receipt Detail : MEDIUM ESKIES

Security Seal : Intact.
Temperature : <6°C - Ice present
No. of samples received / analysed : 6 / 6

General Comments

- This report contains the following information:
    - Sample Container(s)/Preservation Non-Compliances
    - Summary of Sample(s) and Requested Analysis
    - Proactive Holding Time Report
    - Requested Deliverables
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- **Ultratrace VOC analysis will be conducted by ALS Environmental, Melbourne, NATA accreditation No. 825, Site No. 13778.**
- **Ultratrace PAH analysis will be conducted by ALS Environmental, Sydney, NATA accreditation no. 825, Site No. 10911 (Micro site no. 14913).**
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of work order.
- Please direct any queries related to sample condition / numbering / breakages to John Pickering (John.Pickering@alsglobal.com).
- Analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818 (Micro site no. 18958).
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - EG020F Dissolved Metals by ICPMS	WATER - EG051G Ferrous Iron by Discrete Analyser	WATER - EK055G Ammonia as N By Discrete Analyser	WATER - NT-01 & 02 Ca, Mg, Na, K, Cl, SO4, Alkalinity	WATER - NT-05 Total Nitrogen	WATER - W-12 OC/OP Pesticides	WATER - W-30 11 Metals
EB1524519-001	29-Jul-2015 15:30	ABH02	✓	✓	✓	✓	✓	✓	✓
EB1524519-002	29-Jul-2015 14:00	ABH02A	✓	✓	✓	✓	✓	✓	✓
EB1524519-003	29-Jul-2015 12:00	ABH4	✓	✓	✓	✓	✓	✓	✓
EB1524519-004	28-Jul-2015 16:00	ABH04	✓	✓	✓	✓	✓	✓	✓
EB1524519-005	29-Jul-2015 14:00	ABH04A	✓	✓	✓	✓	✓	✓	✓
EB1524519-006	[28-Jul-2015]	ABHD	✓	✓	✓	✓	✓	✓	✓

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - EP005 Total Organic Carbon (TOC)	WATER - EP074-WF Full VOCs with WF DL incl DCM & Acetone	WATER - EP132(PAH) Ultra Trace Polynuclear Aromatic Compounds
EB1524519-001	29-Jul-2015 15:30	ABH02	✓	✓	✓
EB1524519-002	29-Jul-2015 14:00	ABH02A	✓	✓	✓
EB1524519-003	29-Jul-2015 12:00	ABH4	✓	✓	✓
EB1524519-004	28-Jul-2015 16:00	ABH04	✓	✓	✓
EB1524519-005	29-Jul-2015 14:00	ABH04A	✓	✓	✓
EB1524519-006	[28-Jul-2015]	ABHD	✓	✓	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

BARBARA HART

- *AU Certificate of Analysis - NATA (COA)	Email	pelican@codyhart.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	pelican@codyhart.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	pelican@codyhart.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	pelican@codyhart.com.au
- A4 - AU Tax Invoice (INV)	Email	pelican@codyhart.com.au
- Chain of Custody (CoC) (COC)	Email	pelican@codyhart.com.au
- EDI Format - ENMRG (ENMRG)	Email	pelican@codyhart.com.au
- EDI Format - XTab (XTAB)	Email	pelican@codyhart.com.au

CHAIN OF CUSTODY TO LAB

BATCH 1 of 2

CodyHart Environmental
Monitoring & Management

CLIENT: *CodyHart Environmental*
ADDRESS / OFFICE: 3/29 Township Drive, BURLEIGH HEADS 4220 (PO Box 1073 BURLEIGH HEADS 4220)
PROJECT MANAGER (PM): Barbara Hart
PROJECT ID: Armidale Regional 2119
SITE: Armidale Regional Landfill
P.O. NO.:
RESULTS REQUIRED (Date):
QUOTE NO: **BNBQ/052/14**

SAMPLER: B. Hart
MOBILE: 042 777 5120
PHONE:
EMAIL REPORT TO: pelican@codyhart.com.au
EMAIL INVOICE TO: (above)
ANALYSES REQUIRED:

[redacted]

COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:
1. PLEASE SCAN THIS FORM ON DAY OF ARRIVAL & EMAIL.
2. PLEASE GLASS-FIBRE FILTER SEMI-VOL SAMPLES IF TURBID.

SAMPLE INFORMATION (note: S = Soil, W=Water)					CONTAINER INFORMATION																				
ALS ID	SAMPLE ID	MATRIX	DATE	Time	TYPE	No. bottles	EA025 - Water Suspended Solids	EK055A - Water Ammonia as N	NT-11 Water NOx TKN Tot P	W-30-F - ICP/MS Dissolved **PLUS Mn & B**	EP005 - Water Total Organic Carbon (TOC)	W-4 - Water TPH/TRH (C6-C36or40)BTEXN F1&F2	EP075A (SIM) - Water Phenols	EP132B - Water PAH UT	W-12 - Water OC/OP Pesticides	ED009X - Bromide	EA015H - Water TDS (by evap)	NT - 1B & 1D- Water Ca Mg Na K Hard & SAR	NT-2A - Water Cl SO4 F Alk	EG051 - Water FE II					MW06 - Water E.Coli by MF	MW023 - Water Enterococci by MF
1	GARA6	W	29/8/15	10:00	250 mL,1 mLGreen;60mLRed;60mLMaroon; 3x40m,125mLPurple; 2X100mL Orange	10	x	x	x	x	x	x	x	x	x	x	x	x	x	x						

HT Fe II & SS 7 days. So HT up by Tuesday 4 August

Environmental Division
Brisbane CP
Work Order Reference
EB1524521
Telephone : +61-7-3243 7222

RELINQUISHED BY:
Name: *Barbara Hart* Date: 29/7/15
Of: *CodyHart Environmental* Time: 17:00
Signature: *B F Hart*

RECEIVED BY:
Name: JUSTIN
Date: 30/07/15
Of: ALS Laboratory, Brisbane
Time: 15:00
Signature:

METHOD OF SHIPMENT
Transport Co: *Tamex*
Con Note No:
ALS security seal nos:

Samples were despatched in CodyHart Esky/Eskies numbered: 19 & 20 plus 4 small & 1 large CodyHart gel bricks + 2 towels

PLEASE HOLD CODYHART ESKIES & GEL BRICKS UNTIL RETURN REQUESTED.

CodyHart Consulting Pty Ltd trading as *CodyHart Environmental*

ALS Environmental

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EB1524521**

Client : **CODYHART CONSULTING PTY LTD**
Contact : MS BARBARA HART
Address : P O BOX 1073
BURLEIGH HEADS QLD, AUSTRALIA
4220

E-mail : pelican@codyhart.com.au
Telephone : +61 55205532
Facsimile : +61 07 55206531

Project : Armidale Regional 2119
Order number : ----
C-O-C number : ----

Site : Armidale Regional Landfill
Sampler : BARBARA HART

Laboratory : Environmental Division Brisbane
Contact : Customer Services EB
Address : 2 Byth Street Stafford QLD Australia
4053

E-mail : ALSEnviro.Brisbane@alsglobal.com
Telephone : +61-7-3243 7222
Facsimile : +61-7-3243 7218

Page : 1 of 3
Quote number : EB2014CODCON0251 (BNBQ/052/14)
QC Level : NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Dates

Date Samples Received : 30-Jul-2015 3:00 PM
Client Requested Due Date : 10-Aug-2015

Issue Date : 01-Aug-2015
Scheduled Reporting Date : **10-Aug-2015**

Delivery Details

Mode of Delivery : Carrier
No. of coolers/boxes : 2
Receipt Detail : MEDIUM ESKIES

Security Seal : Intact.
Temperature : <6°C - Ice present
No. of samples received / analysed : 1 / 1

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- **Ultratrace PAH analysis will be conducted by ALS Environmental, Sydney, NATA accreditation no. 825, Site No. 10911 (Micro site no. 14913).**
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of work order.
- Please direct any queries related to sample condition / numbering / breakages to John Pickering (John.Pickering@alsglobal.com).
- Analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818 (Micro site no. 18958).
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - EA065 Total Hardness as CaCO3	WATER - EG020F Dissolved Metals by ICPMS	WATER - EG051G Ferrous Iron by Discrete Analyser	WATER - EK055G Ammonia as N By Discrete Analyser	WATER - EN055 - PG Ionic Balance by ED037P, ED041G, ED045G &	WATER - NT-02A Major Anions (Chloride, Sulphate, Fluoride,	WATER - W-30 11 Metals
EB1524521-001	29-Jul-2015 10:00	GARA6	✓	✓	✓	✓	✓	✓	✓

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - EA025H Suspended Solids (High Level)	WATER - ED009-X Standard Anions (Extended method	WATER - EP075 SIM Phenols only SIM - Phenols only	WATER - EP132(PAH) Ultra Trace Polynuclear Aromatic Compounds	WATER - NT-01B Major Cations (Ca, Mg, Na, K) + SAR	WATER - NT-11 Total Nitrogen and Total Phosphorus	WATER - W-12 OC/OP Pesticides
EB1524521-001	29-Jul-2015 10:00	GARA6	✓	✓	✓	✓	✓	✓	✓

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - EA015H Total Dissolved Solids - High Level	WATER - EP005 Total Organic Carbon (TOC)	WATER - W-04 TRH/BTEXN
EB1524521-001	29-Jul-2015 10:00	GARA6	✓	✓	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

BARBARA HART

- *AU Certificate of Analysis - NATA (COA)	Email	pelican@codyhart.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	pelican@codyhart.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	pelican@codyhart.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	pelican@codyhart.com.au
- A4 - AU Tax Invoice (INV)	Email	pelican@codyhart.com.au
- Chain of Custody (CoC) (COC)	Email	pelican@codyhart.com.au
- EDI Format - ENMRG (ENMRG)	Email	pelican@codyhart.com.au
- EDI Format - XTab (XTAB)	Email	pelican@codyhart.com.au

CHAIN OF CUSTODY TO LAB

CodyHart Environmental
Monitoring & Management

HT

CLIENT: *CodyHart Environmental*	SAMPLER: B. Hart
ADDRESS / OFFICE: 3/29 Township Drive, BURLEIGH HEADS 4220 (PO Box 1073 BURLEIGH HEADS 4220)	MOBILE: 042 777 5120
PROJECT MANAGER (PM): Barbara Hart	PHONE:
PROJECT ID: Armidale Regional 2119	EMAIL REPORT TO: pelican@codyhart.com.au
SITE: Armidale Regional Landfill P.O. NO.:	EMAIL INVOICE TO: (above)
RESULTS REQUIRED (Date): QUOTE NO: **BNBQ/052/14**	**ANALYSES REQUIRED:**

FOR LABORATORY USE ONLY
COOLER SEAL (circle appropriate)
Intact: Yes No N/A
SAMPLE TEMPERATURE
°C

COMMENTS / SPECIAL HANDLING / STORAGE OR DISPOSAL:

1. PLEASE SCAN THIS FORM ON DAY OF ARRIVAL & EMAIL.

2. PLEASE GLASS-FIBRE FILTER SEMI-VOL SAMPLES IF TURBID.

SAMPLE INFORMATION (note: S = Soil, W=Water)					CONTAINER INFORMATION													
ALS ID	SAMPLE ID	MATRIX	DATE	Time	TYPE	No. bottles	ED040F - Water Sulphate	ED045P - Water Chloride (PC)	NT-1 (Ca Mg Na K)	NT-2 (Cl SO4 Alk)	EK055A - Water Ammonia as N	NT-5 Water Total Nitrogen (TKN NOx)	W-30-F - ICP/MS Dissolved **PLUS Mn & Sb**	EG051 - Water FE II	EP005 - Water Total Organic Carbon (TOC)	EP074-WF (A-H) VOC UT (71)	W-12 - Water OC/OP Pesticides	EP132B PAH UT
1	ABH9	W	30/7/15	12:00	250 mL Green; 60mLRed; 60mL Maroon; 3x40m,125mL Purple; 2x100 mL Orange	9			X	X	X	X	X	X	X	X	X	X
2	ABH11	W	"	10:00	250 mL Green; 60mLRed; 60mL Maroon; 3x40m,125mL Purple; 2x100 mL Orange	9			X	X	X	X	X	X	X	X	X	X
3	ABH12	W	"	14:00	250 mL Green; 60mLRed; 60mL Maroon; 3x40m,125mL Purple; 2x100mL Orange & 4x100mL Orange	9			X	X	X	X	X	X	X	X	X	X

↑
EXTRAS FOR LAB DUPS + MATRIX SPIKES
2 x 100mL for OC + OPs
2 x 100mL for UT PAH.

HT **Fe II 7 days. So HT up by**
Thursday 6 August

Environmental Division
Brisbane
Work Order Reference
EB1524610
Telephone : +61-7-3243 7222

RELINQUISHED BY:	RECEIVED BY:	METHOD OF SHIPMENT
Name: *Barbara Hart* Date: 30/7/15	Name: CHRIS Date: 31/7/15	Transport Co: *Tamex*
Of: *CodyHart Environmental* Time: 16:00	Of: ALS Laboratory, Brisbane Time: 10-50	Con Note No:
Signature: *B F Hart* BFHart	Signature:	ALS security seal nos:

Samples were despatched in CodyHart Esky/Eskies numbered: 7 **plus** 2 **small &** / **large CodyHart gel bricks +** / **towel**

[illegible]

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order	: **EB1524610**		
Client	: **CODYHART CONSULTING PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS BARBARA HART	Contact	: Customer Services EB
Address	: P O BOX 1073 BURLEIGH HEADS QLD, AUSTRALIA 4220	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: pelican@codyhart.com.au	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: +61 55205532	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 55206531	Facsimile	: +61-7-3243 7218
Project	: Armidale Regional 2119	Page	: 1 of 2
Order number	: ----	Quote number	: EB2014CODCON0251 (BNBQ/052/14)
C-O-C number	: ----	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Site	: Armidale Regional Landfill		
Sampler	: BARBARA HART		

Dates

Date Samples Received	: 31-Jul-2015 10:50 AM	Issue Date	: 01-Aug-2015
Client Requested Due Date	: 11-Aug-2015	Scheduled Reporting Date	: **11-Aug-2015**

Delivery Details

Mode of Delivery	: Carrier	Security Seal	: Intact.
No. of coolers/boxes	: 1	Temperature	: <6.0°C - Ice Bricks present
Receipt Detail	: MEDIUM ESKY	No. of samples received / analysed	: 3 / 3

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- Discounted Package Prices apply only when specific ALS Group Codes ('W', 'S', 'NT' suites) are referenced on COCs.
- **Ultratrace VOC analysis will be conducted by ALS Environmental, Melbourne, NATA accreditation No. 825, Site No. 13778.**
- **Ultratrace PAH analysis will be conducted by ALS Environmental, Sydney, NATA accreditation no. 825, Site No. 10911 (Micro site no. 14913).**
- Please direct any turn around / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of work order.
- Please direct any queries related to sample condition / numbering / breakages to John Pickering (John.Pickering@alsglobal.com).
- Analysis will be conducted by ALS Environmental, Brisbane, NATA accreditation no. 825, Site No. 818 (Micro site no. 18958).
- **Breaches in recommended extraction / analysis holding times (if any) are displayed overleaf in the Proactive Holding Time Report table.**

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exist.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - EG020F Dissolved Metals by ICPMS	WATER - EG051G Ferrous Iron by Discrete Analyser	WATER - EK055G Ammonia as N By Discrete Analyser	WATER - NT-01 & 02 Ca, Mg, Na, K, Cl, SO4, Alkalinity	WATER - NT-05 Total Nitrogen	WATER - W-12 OC/OP Pesticides	WATER - W-30 11 Metals
EB1524610-001	30-Jul-2015 12:00	ABH9	✓	✓	✓	✓	✓	✓	✓
EB1524610-002	30-Jul-2015 10:00	ABH11	✓	✓	✓	✓	✓	✓	✓
EB1524610-003	30-Jul-2015 14:00	ABH12	✓	✓	✓	✓	✓	✓	✓

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - EP005 Total Organic Carbon (TOC)	WATER - EP074-WF Full VOCs with WF DL incl DCM & Acetone	WATER - EP132(PAH) Ultra Trace Polynuclear Aromatic Compounds
EB1524610-001	30-Jul-2015 12:00	ABH9	✓	✓	✓
EB1524610-002	30-Jul-2015 10:00	ABH11	✓	✓	✓
EB1524610-003	30-Jul-2015 14:00	ABH12	✓	✓	✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

BARBARA HART

- *AU Certificate of Analysis - NATA (COA)	Email	pelican@codyhart.com.au
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	pelican@codyhart.com.au
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	pelican@codyhart.com.au
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	pelican@codyhart.com.au
- A4 - AU Tax Invoice (INV)	Email	pelican@codyhart.com.au
- Chain of Custody (CoC) (COC)	Email	pelican@codyhart.com.au
- EDI Format - ENMRG (ENMRG)	Email	pelican@codyhart.com.au
- EDI Format - XTab (XTAB)	Email	pelican@codyhart.com.au

APPENDIX C

Laboratory Reports

Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EB1524519**	Page	: 1 of 14
Client	: **CODYHART CONSULTING PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS BARBARA HART	Contact	: Customer Services EB
Address	: P O BOX 1073 BURLEIGH HEADS QLD, AUSTRALIA 4220	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: pelican@codyhart.com.au	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: +61 55205532	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 55206531	Facsimile	: +61-7-3243 7218
Project	: Armidale Regional 2119	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 30-Jul-2015 15:00
C-O-C number	: ----	Date Analysis Commenced	: 03-Aug-2015
Sampler	: BARBARA HART	Issue Date	: 11-Aug-2015 16:11
Site	: Armidale Regional Landfill		
		No. of samples received	: 6
Quote number	: ----	No. of samples analysed	: 6

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

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*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Organics
Ryan Story	2IC Organic Instrument Chemist	Brisbane Organics
Xing Lin	Senior Organic Chemist	Melbourne Organics

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
ø = ALS is not NATA accredited for these tests.

- Total PAH reported as the sum of Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene and Benzo(g,h,i)perylene.

Analytical Results

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

			Client sample ID	**ABH02**	**ABH02A**	**ABH4**	**ABH04**	**ABH04A**
			Client sampling date / time	29-Jul-2015 15:30	29-Jul-2015 14:00	29-Jul-2015 12:00	28-Jul-2015 16:00	29-Jul-2015 14:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524519-001**	**EB1524519-002**	**EB1524519-003**	**EB1524519-004**	**EB1524519-005**
				Result	Result	Result	Result	Result
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**544**	**525**	**584**	**566**	**541**
Total Alkalinity as CaCO3	----	1	mg/L	**544**	**525**	**584**	**566**	**541**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**174**	**160**	**163**	**340**	**335**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**419**	**231**	**163**	**369**	**36**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**181**	**168**	**148**	**294**	**87**
Magnesium	7439-95-4	1	mg/L	**80**	**67**	**56**	**67**	**46**
Sodium	7440-23-5	1	mg/L	**199**	**134**	**166**	**170**	**257**
Potassium	7440-09-7	1	mg/L	<1	<1	<1	**2**	**1**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	**0.001**	**0.001**
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.001**	**0.001**	**0.005**	<0.001	**0.001**
Nickel	7440-02-0	0.001	mg/L	**0.004**	<0.001	**0.013**	**0.001**	**0.003**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	**0.002**	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.009**	**0.009**	**0.035**	**0.026**	**0.020**
Manganese	7439-96-5	0.001	mg/L	**0.107**	**0.003**	**0.117**	**1.40**	**0.391**
Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	<0.05	**0.89**	<0.05
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EG051G: Ferrous Iron by Discrete Analyser								
Ferrous Iron	----	0.05	mg/L	<0.05	<0.05	<0.05	**1.16**	<0.05
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	**0.01**	<0.01	**0.02**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.94**	**0.62**	**0.49**	<0.01	**0.19**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**ABH02**	**ABH02A**	**ABH4**	**ABH04**	**ABH04A**
			Client sampling date / time	29-Jul-2015 15:30	29-Jul-2015 14:00	29-Jul-2015 12:00	28-Jul-2015 16:00	29-Jul-2015 14:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524519-001**	**EB1524519-002**	**EB1524519-003**	**EB1524519-004**	**EB1524519-005**
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	<0.1	<0.1	<0.1	**0.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**1.1**	**0.6**	**0.5**	<0.1	**0.4**
EN055: Ionic Balance								
^ **Total Anions**	----	0.01	meq/L	**26.3**	**20.3**	**19.7**	**28.8**	**18.8**
^ **Total Cations**	----	0.01	meq/L	**24.3**	**19.7**	**19.2**	**27.6**	**19.3**
^ **Ionic Balance**	----	0.01	%	**4.03**	**1.52**	**1.15**	**2.05**	**1.36**
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**7**	**3**	**2**	**4**	**7**
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDT	50-29-3	2	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Methoxychlor	72-43-5	2	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
^ **Total Chlordane (sum)**	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of DDD + DDE + DDT**	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
^ **Sum of Aldrin + Dieldrin**	309-00-2/60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

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

			Client sample ID	**ABH02**	**ABH02A**	**ABH4**	**ABH04**	**ABH04A**
			Client sampling date / time	29-Jul-2015 15:30	29-Jul-2015 14:00	29-Jul-2015 12:00	28-Jul-2015 16:00	29-Jul-2015 14:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524519-001**	**EB1524519-002**	**EB1524519-003**	**EB1524519-004**	**EB1524519-005**
				Result	Result	Result	Result	Result
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Monocrotophos	6923-22-4	2	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Parathion-methyl	298-00-0	2	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Parathion	56-38-2	2	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
EP074A: Monocyclic Aromatic Hydrocarbons								
Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	<1
Toluene	108-88-3	1	µg/L	<1	<1	<1	<1	<1
Ethylbenzene	100-41-4	1	µg/L	<1	<1	<1	<1	<1
meta- & para-Xylene	108-38-3 106-42-3	1	µg/L	<1	<1	<1	<1	<1
Styrene	100-42-5	1	µg/L	<1	<1	<1	<1	<1
ortho-Xylene	95-47-6	1	µg/L	<1	<1	<1	<1	<1
Isopropylbenzene	98-82-8	1	µg/L	<1	<1	<1	<1	<1
n-Propylbenzene	103-65-1	1	µg/L	<1	<1	<1	<1	<1
1.3.5-Trimethylbenzene	108-67-8	1	µg/L	<1	<1	<1	<1	<1
sec-Butylbenzene	135-98-8	1	µg/L	<1	<1	<1	<1	<1
1.2.4-Trimethylbenzene	95-63-6	1	µg/L	<1	<1	<1	<1	<1
tert-Butylbenzene	98-06-6	1	µg/L	<1	<1	<1	<1	<1
p-Isopropyltoluene	99-87-6	1	µg/L	<1	<1	<1	<1	<1
n-Butylbenzene	104-51-8	1	µg/L	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**ABH02**	**ABH02A**	**ABH4**	**ABH04**	**ABH04A**
			Client sampling date / time	29-Jul-2015 15:30	29-Jul-2015 14:00	29-Jul-2015 12:00	28-Jul-2015 16:00	29-Jul-2015 14:00
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524519-001**	**EB1524519-002**	**EB1524519-003**	**EB1524519-004**	**EB1524519-005**
				Result	Result	Result	Result	Result
EP074B: Oxygenated Compounds								
2-Propanone (Acetone)	67-64-1	10	µg/L	<10	<10	<10	<10	<10
Vinyl Acetate	108-05-4	10	µg/L	<10	<10	<10	<10	<10
2-Butanone (MEK)	78-93-3	10	µg/L	<10	<10	<10	<10	<10
4-Methyl-2-pentanone (MIBK)	108-10-1	10	µg/L	<10	<10	<10	<10	<10
2-Hexanone (MBK)	591-78-6	10	µg/L	<10	<10	<10	<10	<10
EP074C: Sulfonated Compounds								
Carbon disulfide	75-15-0	1	µg/L	<1	<1	<1	<1	<1
EP074D: Fumigants								
2.2-Dichloropropane	594-20-7	1	µg/L	<1	<1	<1	<1	<1
1.2-Dichloropropane	78-87-5	1	µg/L	<1	<1	<1	<1	<1
cis-1.3-Dichloropropylene	10061-01-5	2	µg/L	<2	<2	<2	<2	<2
trans-1.3-Dichloropropylene	10061-02-6	2	µg/L	<2	<2	<2	<2	<2
1.2-Dibromoethane (EDB)	106-93-4	1	µg/L	<1	<1	<1	<1	<1
EP074E: Halogenated Aliphatic Compounds								
Dichlorodifluoromethane	75-71-8	10	µg/L	<10	<10	<10	<10	<10
Chloromethane	74-87-3	10	µg/L	<10	<10	<10	<10	<10
Vinyl chloride	75-01-4	10	µg/L	<10.0	<10.0	<10.0	<10.0	<10.0
Bromomethane	74-83-9	10	µg/L	<10	<10	<10	<10	<10
Chloroethane	75-00-3	10	µg/L	<10	<10	<10	<10	<10
Trichlorofluoromethane	75-69-4	10	µg/L	<10	<10	<10	<10	<10
1.1-Dichloroethene	75-35-4	1	µg/L	<1	<1	<1	<1	<1
Iodomethane	74-88-4	1	µg/L	<1	<1	<1	<1	<1
Methylene chloride	75-09-2	5	µg/L	<5	<5	<5	<5	<5
trans-1.2-Dichloroethene	156-60-5	1	µg/L	<1	<1	<1	<1	<1
1.1-Dichloroethane	75-34-3	1	µg/L	<1	<1	<1	<1	<1
cis-1.2-Dichloroethene	156-59-2	1	µg/L	<1	<1	<1	<1	<1
1.1.1-Trichloroethane	71-55-6	1	µg/L	<1	<1	<1	<1	<1
1.1-Dichloropropylene	563-58-6	1	µg/L	<1	<1	<1	<1	<1
Carbon Tetrachloride	56-23-5	1	µg/L	<1	<1	<1	<1	<1
1.2-Dichloroethane	107-06-2	1	µg/L	<1	<1	<1	<1	<1
Trichloroethene	79-01-6	1	µg/L	<1	<1	<1	<1	<1
Dibromomethane	74-95-3	1	µg/L	<1	<1	<1	<1	<1
1.1.2-Trichloroethane	79-00-5	1	µg/L	<1	<1	<1	<1	<1
1.3-Dichloropropane	142-28-9	1	µg/L	<1	<1	<1	<1	<1

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	ABH02	ABH02A	ABH4	ABH04	ABH04A
			Client sampling date / time	29-Jul-2015 15:30	29-Jul-2015 14:00	29-Jul-2015 12:00	28-Jul-2015 16:00	29-Jul-2015 14:00
Compound	CAS Number	LOR	Unit	EB1524519-001	EB1524519-002	EB1524519-003	EB1524519-004	EB1524519-005
				Result	Result	Result	Result	Result
EP074E: Halogenated Aliphatic Compounds - Continued								
Tetrachloroethene	127-18-4	1	µg/L	<1	<1	<1	<1	<1
1.1.1.2-Tetrachloroethane	630-20-6	1	µg/L	<1	<1	<1	<1	<1
trans-1.4-Dichloro-2-butene	110-57-6	1	µg/L	<1	<1	<1	<1	<1
cis-1.4-Dichloro-2-butene	1476-11-5	1	µg/L	<1	<1	<1	<1	<1
1.1.2.2-Tetrachloroethane	79-34-5	1	µg/L	<1	<1	<1	<1	<1
1.2.3-Trichloropropane	96-18-4	1	µg/L	<1	<1	<1	<1	<1
Pentachloroethane	76-01-7	1	µg/L	<1	<1	<1	<1	<1
1.2-Dibromo-3-chloropropane	96-12-8	1	µg/L	<1	<1	<1	<1	<1
Hexachlorobutadiene	87-68-3	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
EP074F: Halogenated Aromatic Compounds								
Chlorobenzene	108-90-7	1	µg/L	<1	<1	<1	<1	<1
Bromobenzene	108-86-1	1	µg/L	<1	<1	<1	<1	<1
2-Chlorotoluene	95-49-8	1	µg/L	<1	<1	<1	<1	<1
4-Chlorotoluene	106-43-4	1	µg/L	<1	<1	<1	<1	<1
1.3-Dichlorobenzene	541-73-1	1	µg/L	<1	<1	<1	<1	<1
1.4-Dichlorobenzene	106-46-7	1	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
1.2-Dichlorobenzene	95-50-1	1	µg/L	<1	<1	<1	<1	<1
1.2.4-Trichlorobenzene	120-82-1	1	µg/L	<1	<1	<1	<1	<1
1.2.3-Trichlorobenzene	87-61-6	1	µg/L	<1	<1	<1	<1	<1
EP074G: Trihalomethanes								
Chloroform	67-66-3	1	µg/L	<1	<1	<1	<1	<1
Bromodichloromethane	75-27-4	1	µg/L	<1	<1	<1	<1	<1
Dibromochloromethane	124-48-1	1	µg/L	<1	<1	<1	<1	<1
Bromoform	75-25-2	1	µg/L	<1	<1	<1	<1	<1
EP074H: Naphthalene								
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	<5
EP132B: Polynuclear Aromatic Hydrocarbons								
3-Methylcholanthrene	56-49-5	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
2-Methylnaphthalene	91-57-6	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
7.12-Dimethylbenz(a)anthracene	57-97-6	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthene	83-32-9	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Acenaphthylene	208-96-8	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Anthracene	120-12-7	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Benz(a)anthracene	56-55-3	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1

Analytical Results

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

			Client sample ID	ABH02	ABH02A	ABH4	ABH04	ABH04A
			Client sampling date / time	29-Jul-2015 15:30	29-Jul-2015 14:00	29-Jul-2015 12:00	28-Jul-2015 16:00	29-Jul-2015 14:00
Compound	CAS Number	LOR	Unit	EB1524519-001	EB1524519-002	EB1524519-003	EB1524519-004	EB1524519-005
				Result	Result	Result	Result	Result
EP132B: Polynuclear Aromatic Hydrocarbons - Continued								
Benzo(a)pyrene	50-32-8	0.05	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(e)pyrene	192-97-2	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(g.h.i)perylene	191-24-2	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Benzo(k)fluoranthene	207-08-9	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Chrysene	218-01-9	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Coronene	191-07-1	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Dibenz(a.h)anthracene	53-70-3	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Fluoranthene	206-44-0	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Fluorene	86-73-7	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Indeno(1.2.3.cd)pyrene	193-39-5	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
N-2-Fluorenyl Acetamide	53-96-3	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Naphthalene	91-20-3	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Perylene	198-55-0	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Phenanthrene	85-01-8	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Pyrene	129-00-0	0.1	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Sum of PAHs	----	0.05	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
Benzo(a)pyrene TEQ (zero)	----	0.05	µg/L	<0.05	<0.05	<0.05	<0.05	<0.05
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.5	%	**62.0**	**66.5**	**64.9**	**49.1**	**70.2**
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.5	%	**70.6**	**81.6**	**76.3**	**73.1**	**83.1**
EP074S: VOC Surrogates								
1.2-Dichloroethane-D4	17060-07-0	1	%	**104**	**93.8**	**95.2**	**102**	**98.2**
Toluene-D8	2037-26-5	1	%	**99.4**	**76.6**	**86.5**	**93.3**	**98.4**
4-Bromofluorobenzene	460-00-4	1	%	**87.2**	**79.6**	**83.6**	**85.8**	**87.4**
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	**74.9**	**97.7**	**66.7**	**75.9**	**90.5**
Anthracene-d10	1719-06-8	0.1	%	**94.2**	**101**	**103**	**94.9**	**106**
4-Terphenyl-d14	1718-51-0	0.1	%	**98.6**	**103**	**123**	**99.7**	**122**

Analytical Results

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

			Client sample ID	**ABHD**	----	----	----	----
			Client sampling date / time	[28-Jul-2015]	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524519-006**	--------	--------	--------	--------
				Result	Result	Result	Result	Result
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**533**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**533**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**161**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**227**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**169**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**66**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**135**	----	----	----	----
Potassium	7440-09-7	1	mg/L	<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.001**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.007**	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.004**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EG051G: Ferrous Iron by Discrete Analyser								
Ferrous Iron	----	0.05	mg/L	<0.05	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.61**	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Client sample ID	**ABHD**	----	----	----	----
			Client sampling date / time	[28-Jul-2015]	----	----	----	----
Compound	CAS Number	LOR	Unit	**EB1524519-006**	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.1**	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.7**	----	----	----	----
EN055: Ionic Balance								
^ **Total Anions**	----	0.01	meq/L	**20.4**	----	----	----	----
^ **Total Cations**	----	0.01	meq/L	**19.7**	----	----	----	----
^ **Ionic Balance**	----	0.01	%	**1.66**	----	----	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**2**	----	----	----	----
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	----	----	----	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	----	----	----	----
beta-BHC	319-85-7	0.5	µg/L	<0.5	----	----	----	----
gamma-BHC	58-89-9	0.5	µg/L	<0.5	----	----	----	----
delta-BHC	319-86-8	0.5	µg/L	<0.5	----	----	----	----
Heptachlor	76-44-8	0.5	µg/L	<0.5	----	----	----	----
Aldrin	309-00-2	0.5	µg/L	<0.5	----	----	----	----
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	----	----	----	----
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	----	----	----	----
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	----	----	----	----
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	----	----	----	----
Dieldrin	60-57-1	0.5	µg/L	<0.5	----	----	----	----
4.4`-DDE	72-55-9	0.5	µg/L	<0.5	----	----	----	----
Endrin	72-20-8	0.5	µg/L	<0.5	----	----	----	----
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	----	----	----	----
4.4`-DDD	72-54-8	0.5	µg/L	<0.5	----	----	----	----
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	----	----	----	----
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	----	----	----	----
4.4`-DDT	50-29-3	2	µg/L	<2.0	----	----	----	----
Endrin ketone	53494-70-5	0.5	µg/L	<0.5	----	----	----	----
Methoxychlor	72-43-5	2	µg/L	<2.0	----	----	----	----
^ **Total Chlordane (sum)**	----	0.5	µg/L	<0.5	----	----	----	----
^ **Sum of DDD + DDE + DDT**	----	0.5	µg/L	<0.5	----	----	----	----
^ **Sum of Aldrin + Dieldrin**	309-00-2/60-57-1	0.5	µg/L	<0.5	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**ABHD**	**----**	**----**	**----**	**----**
			Client sampling date / time	[28-Jul-2015]	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524519-006**	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.5	µg/L	<0.5	----	----	----	----
Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	----	----	----	----
Monocrotophos	6923-22-4	2	µg/L	<2.0	----	----	----	----
Dimethoate	60-51-5	0.5	µg/L	<0.5	----	----	----	----
Diazinon	333-41-5	0.5	µg/L	<0.5	----	----	----	----
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	----	----	----	----
Parathion-methyl	298-00-0	2	µg/L	<2.0	----	----	----	----
Malathion	121-75-5	0.5	µg/L	<0.5	----	----	----	----
Fenthion	55-38-9	0.5	µg/L	<0.5	----	----	----	----
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	----	----	----	----
Parathion	56-38-2	2	µg/L	<2.0	----	----	----	----
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	----	----	----	----
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	----	----	----	----
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	----	----	----	----
Fenamiphos	22224-92-6	0.5	µg/L	<0.5	----	----	----	----
Prothiofos	34643-46-4	0.5	µg/L	<0.5	----	----	----	----
Ethion	563-12-2	0.5	µg/L	<0.5	----	----	----	----
Carbophenothion	786-19-6	0.5	µg/L	<0.5	----	----	----	----
Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	----	----	----	----
EP074A: Monocyclic Aromatic Hydrocarbons								
Benzene	71-43-2	1	µg/L	<1	----	----	----	----
Toluene	108-88-3	1	µg/L	<1	----	----	----	----
Ethylbenzene	100-41-4	1	µg/L	<1	----	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	1	µg/L	<1	----	----	----	----
Styrene	100-42-5	1	µg/L	<1	----	----	----	----
ortho-Xylene	95-47-6	1	µg/L	<1	----	----	----	----
Isopropylbenzene	98-82-8	1	µg/L	<1	----	----	----	----
n-Propylbenzene	103-65-1	1	µg/L	<1	----	----	----	----
1.3.5-Trimethylbenzene	108-67-8	1	µg/L	<1	----	----	----	----
sec-Butylbenzene	135-98-8	1	µg/L	<1	----	----	----	----
1.2.4-Trimethylbenzene	95-63-6	1	µg/L	<1	----	----	----	----
tert-Butylbenzene	98-06-6	1	µg/L	<1	----	----	----	----
p-Isopropyltoluene	99-87-6	1	µg/L	<1	----	----	----	----
n-Butylbenzene	104-51-8	1	µg/L	<1	----	----	----	----

Analytical Results

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

			Client sample ID	**ABHD**	----	----	----	----
			Client sampling date / time	[28-Jul-2015]	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524519-006**	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EP074B: Oxygenated Compounds								
2-Propanone (Acetone)	67-64-1	10	µg/L	<10	----	----	----	----
Vinyl Acetate	108-05-4	10	µg/L	<10	----	----	----	----
2-Butanone (MEK)	78-93-3	10	µg/L	<10	----	----	----	----
4-Methyl-2-pentanone (MIBK)	108-10-1	10	µg/L	<10	----	----	----	----
2-Hexanone (MBK)	591-78-6	10	µg/L	<10	----	----	----	----
EP074C: Sulfonated Compounds								
Carbon disulfide	75-15-0	1	µg/L	<1	----	----	----	----
EP074D: Fumigants								
2.2-Dichloropropane	594-20-7	1	µg/L	<1	----	----	----	----
1.2-Dichloropropane	78-87-5	1	µg/L	<1	----	----	----	----
cis-1.3-Dichloropropylene	10061-01-5	2	µg/L	<2	----	----	----	----
trans-1.3-Dichloropropylene	10061-02-6	2	µg/L	<2	----	----	----	----
1.2-Dibromoethane (EDB)	106-93-4	1	µg/L	<1	----	----	----	----
EP074E: Halogenated Aliphatic Compounds								
Dichlorodifluoromethane	75-71-8	10	µg/L	<10	----	----	----	----
Chloromethane	74-87-3	10	µg/L	<10	----	----	----	----
Vinyl chloride	75-01-4	10	µg/L	<10.0	----	----	----	----
Bromomethane	74-83-9	10	µg/L	<10	----	----	----	----
Chloroethane	75-00-3	10	µg/L	<10	----	----	----	----
Trichlorofluoromethane	75-69-4	10	µg/L	<10	----	----	----	----
1.1-Dichloroethene	75-35-4	1	µg/L	<1	----	----	----	----
Iodomethane	74-88-4	1	µg/L	<1	----	----	----	----
Methylene chloride	75-09-2	5	µg/L	<5	----	----	----	----
trans-1.2-Dichloroethene	156-60-5	1	µg/L	<1	----	----	----	----
1.1-Dichloroethane	75-34-3	1	µg/L	<1	----	----	----	----
cis-1.2-Dichloroethene	156-59-2	1	µg/L	<1	----	----	----	----
1.1.1-Trichloroethane	71-55-6	1	µg/L	<1	----	----	----	----
1.1-Dichloropropylene	563-58-6	1	µg/L	<1	----	----	----	----
Carbon Tetrachloride	56-23-5	1	µg/L	<1	----	----	----	----
1.2-Dichloroethane	107-06-2	1	µg/L	<1	----	----	----	----
Trichloroethene	79-01-6	1	µg/L	<1	----	----	----	----
Dibromomethane	74-95-3	1	µg/L	<1	----	----	----	----
1.1.2-Trichloroethane	79-00-5	1	µg/L	<1	----	----	----	----
1.3-Dichloropropane	142-28-9	1	µg/L	<1	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Client sample ID	**ABHD**	----	----	----	----
			Client sampling date / time	[28-Jul-2015]	----	----	----	----
Compound	CAS Number	LOR	Unit	**EB1524519-006**	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EP074E: Halogenated Aliphatic Compounds - Continued								
Tetrachloroethene	127-18-4	1	µg/L	<1	----	----	----	----
1.1.1.2-Tetrachloroethane	630-20-6	1	µg/L	<1	----	----	----	----
trans-1.4-Dichloro-2-butene	110-57-6	1	µg/L	<1	----	----	----	----
cis-1.4-Dichloro-2-butene	1476-11-5	1	µg/L	<1	----	----	----	----
1.1.2.2-Tetrachloroethane	79-34-5	1	µg/L	<1	----	----	----	----
1.2.3-Trichloropropane	96-18-4	1	µg/L	<1	----	----	----	----
Pentachloroethane	76-01-7	1	µg/L	<1	----	----	----	----
1.2-Dibromo-3-chloropropane	96-12-8	1	µg/L	<1	----	----	----	----
Hexachlorobutadiene	87-68-3	1	µg/L	<1.0	----	----	----	----
EP074F: Halogenated Aromatic Compounds								
Chlorobenzene	108-90-7	1	µg/L	<1	----	----	----	----
Bromobenzene	108-86-1	1	µg/L	<1	----	----	----	----
2-Chlorotoluene	95-49-8	1	µg/L	<1	----	----	----	----
4-Chlorotoluene	106-43-4	1	µg/L	<1	----	----	----	----
1.3-Dichlorobenzene	541-73-1	1	µg/L	<1	----	----	----	----
1.4-Dichlorobenzene	106-46-7	1	µg/L	<1.0	----	----	----	----
1.2-Dichlorobenzene	95-50-1	1	µg/L	<1	----	----	----	----
1.2.4-Trichlorobenzene	120-82-1	1	µg/L	<1	----	----	----	----
1.2.3-Trichlorobenzene	87-61-6	1	µg/L	<1	----	----	----	----
EP074G: Trihalomethanes								
Chloroform	67-66-3	1	µg/L	<1	----	----	----	----
Bromodichloromethane	75-27-4	1	µg/L	<1	----	----	----	----
Dibromochloromethane	124-48-1	1	µg/L	<1	----	----	----	----
Bromoform	75-25-2	1	µg/L	<1	----	----	----	----
EP074H: Naphthalene								
Naphthalene	91-20-3	5	µg/L	<5	----	----	----	----
EP132B: Polynuclear Aromatic Hydrocarbons								
3-Methylcholanthrene	56-49-5	0.1	µg/L	<0.1	----	----	----	----
2-Methylnaphthalene	91-57-6	0.1	µg/L	<0.1	----	----	----	----
7.12-Dimethylbenz(a)anthracene	57-97-6	0.1	µg/L	<0.1	----	----	----	----
Acenaphthene	83-32-9	0.1	µg/L	<0.1	----	----	----	----
Acenaphthylene	208-96-8	0.1	µg/L	<0.1	----	----	----	----
Anthracene	120-12-7	0.1	µg/L	<0.1	----	----	----	----
Benz(a)anthracene	56-55-3	0.1	µg/L	<0.1	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**ABHD**	----	----	----	----
			Client sampling date / time	[28-Jul-2015]	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524519-006**	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EP132B: Polynuclear Aromatic Hydrocarbons - Continued								
Benzo(a)pyrene	50-32-8	0.05	µg/L	<0.05	----	----	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.1	µg/L	<0.1	----	----	----	----
Benzo(e)pyrene	192-97-2	0.1	µg/L	<0.1	----	----	----	----
Benzo(g.h.i)perylene	191-24-2	0.1	µg/L	<0.1	----	----	----	----
Benzo(k)fluoranthene	207-08-9	0.1	µg/L	<0.1	----	----	----	----
Chrysene	218-01-9	0.1	µg/L	<0.1	----	----	----	----
Coronene	191-07-1	0.1	µg/L	<0.1	----	----	----	----
Dibenz(a.h)anthracene	53-70-3	0.1	µg/L	<0.1	----	----	----	----
Fluoranthene	206-44-0	0.1	µg/L	<0.1	----	----	----	----
Fluorene	86-73-7	0.1	µg/L	<0.1	----	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	0.1	µg/L	<0.1	----	----	----	----
N-2-Fluorenyl Acetamide	53-96-3	0.1	µg/L	<0.1	----	----	----	----
Naphthalene	91-20-3	0.1	µg/L	<0.1	----	----	----	----
Perylene	198-55-0	0.1	µg/L	<0.1	----	----	----	----
Phenanthrene	85-01-8	0.1	µg/L	<0.1	----	----	----	----
Pyrene	129-00-0	0.1	µg/L	<0.1	----	----	----	----
Sum of PAHs	----	0.05	µg/L	<0.05	----	----	----	----
Benzo(a)pyrene TEQ (zero)	----	0.05	µg/L	<0.05	----	----	----	----
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.5	%	**50.6**	----	----	----	----
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.5	%	**76.8**	----	----	----	----
EP074S: VOC Surrogates								
1.2-Dichloroethane-D4	17060-07-0	1	%	**95.3**	----	----	----	----
Toluene-D8	2037-26-5	1	%	**103**	----	----	----	----
4-Bromofluorobenzene	460-00-4	1	%	**88.6**	----	----	----	----
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	**78.1**	----	----	----	----
Anthracene-d10	1719-06-8	0.1	%	**98.0**	----	----	----	----
4-Terphenyl-d14	1718-51-0	0.1	%	**114**	----	----	----	----

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EB1524519**	Page	: 1 of 20
Client	: **CODYHART CONSULTING PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS BARBARA HART	Contact	: Customer Services EB
Address	: P O BOX 1073 BURLEIGH HEADS QLD, AUSTRALIA 4220	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: pelican@codyhart.com.au	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: +61 55205532	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 55206531	Facsimile	: +61-7-3243 7218
Project	: Armidale Regional 2119	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 30-Jul-2015
C-O-C number	: ----	Date Analysis Commenced	: 03-Aug-2015
Sampler	: BARBARA HART	Issue Date	: 11-Aug-2015
Site	: Armidale Regional Landfill	No. of samples received	: 6
Quote number	: ----	No. of samples analysed	: 6

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA WORLD RECOGNISED ACCREDITATION

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 ir compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Organics
Ryan Story	2IC Organic Instrument Chemist	Brisbane Organics
Xing Lin	Senior Organic Chemist	Melbourne Organics

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 hig

Key :
Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
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
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:0% - 20%.

Sub-Matrix**: WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED037P: Alkalinity by PC Titrator (QC Lot: 171194)									
EB1524519-001	ABH02	ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	544	543	0.353	0% - 20%
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	544	543	0.353	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 173826)									
EB1524711-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	60	62	3.01	0% - 20%
EB1524519-001	ABH02	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	174	164	5.93	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 173827)									
EB1524519-001	ABH02	ED045G: Chloride	16887-00-6	1	mg/L	419	418	0.00	0% - 20%
EB1524789-008	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	2900	2890	0.196	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 171214)									
EB1524544-004	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	36	35	2.81	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	22	22	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	6	6	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	83	82	1.25	0% - 20%
EB1524519-001	ABH02	ED093F: Calcium	7440-70-2	1	mg/L	181	182	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	80	80	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	<1	<1	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	199	199	0.00	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 171215)									
EB1524544-004	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.030	0.028	4.28	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EB1524519-001	ABH02	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG020F: Dissolved Metals by ICP-MS (QC Lot: 171215) - continued									
EB1524519-001	ABH02	EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.107	0.106	0.00	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.009	0.010	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 171213)									
EB1524544-005	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EB1524519-001	ABH02	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG051G: Ferrous Iron by Discrete Analyser (QC Lot: 172524)									
EB1524394-001	Anonymous	EG051G: Ferrous Iron	----	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EB1524610-002	Anonymous	EG051G: Ferrous Iron	----	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 172037)									
EB1524516-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	3.47	3.28	5.57	0% - 20%
EB1524519-006	ABHD	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 172038)									
EB1524516-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.07	0.07	0.00	No Limit
EB1524519-006	ABHD	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.61	0.62	0.00	0% - 20%
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 176688)									
EB1524519-001	ABH02	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.2	0.1	0.00	No Limit
EB1524721-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EP005: Total Organic Carbon (TOC) (QC Lot: 171057)									
EB1524519-001	ABH02	EP005: Total Organic Carbon	----	1	mg/L	7	5	30.6	No Limit
EB1524610-003	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	1	4	102	No Limit
EP068A: Organochlorine Pesticides (OC) (QC Lot: 171807)									
EB1524526-003	Anonymous	EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP068A: Organochlorine Pesticides (OC) (QC Lot: 171807) - continued									
EB1524526-003	Anonymous	EP068: Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	<2.0	0.00	No Limit
EP068A: Organochlorine Pesticides (OC) (QC Lot: 172751)									
EB1524610-003	Anonymous	EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	<2.0	0.00	No Limit
EP068A: Organochlorine Pesticides (OC) (QC Lot: 173448)									
EB1524633-002	Anonymous	EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP068A: Organochlorine Pesticides (OC) (QC Lot: 173448) - continued									
EB1524633-002	Anonymous	EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	<2.0	0.00	No Limit
EB1524674-001	Anonymous	EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	<2.0	0.00	No Limit
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 171807)									
EB1524526-003	Anonymous	EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 171807) - continued									
EB1524526-003	Anonymous	EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP068: Parathion	56-38-2	2	µg/L	<2.0	<2.0	0.00	No Limit
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 172751)									
EB1524610-003	Anonymous	EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP068: Parathion	56-38-2	2	µg/L	<2.0	<2.0	0.00	No Limit
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 173448)									
EB1524633-002	Anonymous	EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 173448) - continued									
EB1524633-002	Anonymous	EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP068: Parathion	56-38-2	2	µg/L	<2.0	<2.0	0.00	No Limit
EB1524674-001	Anonymous	EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP068: Parathion	56-38-2	2	µg/L	<2.0	<2.0	0.00	No Limit
EP074A: Monocyclic Aromatic Hydrocarbons (QC Lot: 173675)									
EB1524519-001	ABH02	EP074-WF: 1.2.4-Trimethylbenzene	95-63-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.3.5-Trimethylbenzene	108-67-8	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Ethylbenzene	100-41-4	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Isopropylbenzene	98-82-8	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: meta- & para-Xylene	108-38-3 106-42-3	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: n-Butylbenzene	104-51-8	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: n-Propylbenzene	103-65-1	1	µg/L	<1	<1	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP074A: Monocyclic Aromatic Hydrocarbons (QC Lot: 173675) - continued									
EB1524519-001	ABH02	EP074-WF: ortho-Xylene	95-47-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: p-Isopropyltoluene	99-87-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: sec-Butylbenzene	135-98-8	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Styrene	100-42-5	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: tert-Butylbenzene	98-06-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Toluene	108-88-3	1	µg/L	<1	<1	0.00	No Limit
EP074B: Oxygenated Compounds (QC Lot: 173675)									
EB1524519-001	ABH02	EP074-WF: 2-Butanone (MEK)	78-93-3	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: 2-Hexanone (MBK)	591-78-6	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: 2-Propanone (Acetone)	67-64-1	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: 4-Methyl-2-pentanone (MIBK)	108-10-1	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: Vinyl Acetate	108-05-4	10	µg/L	<10	<10	0.00	No Limit
EP074C: Sulfonated Compounds (QC Lot: 173675)									
EB1524519-001	ABH02	EP074-WF: Carbon disulfide	75-15-0	1	µg/L	<1	<1	0.00	No Limit
EP074D: Fumigants (QC Lot: 173675)									
EB1524519-001	ABH02	EP074-WF: 1.2-Dibromoethane (EDB)	106-93-4	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.2-Dichloropropane	78-87-5	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 2.2-Dichloropropane	594-20-7	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: cis-1.3-Dichloropropylene	10061-01-5	2	µg/L	<2	<2	0.00	No Limit
		EP074-WF: trans-1.3-Dichloropropylene	10061-02-6	2	µg/L	<2	<2	0.00	No Limit
EP074E: Halogenated Aliphatic Compounds (QC Lot: 173675)									
EB1524519-001	ABH02	EP074-WF: Vinyl chloride	75-01-4	0.2	µg/L	<10.0	<10.0	0.00	No Limit
		EP074-WF: Hexachlorobutadiene	87-68-3	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP074-WF: 1.1.1.2-Tetrachloroethane	630-20-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.1.1-Trichloroethane	71-55-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.1.2.2-Tetrachloroethane	79-34-5	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.1.2-Trichloroethane	79-00-5	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.1-Dichloroethane	75-34-3	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.1-Dichloroethene	75-35-4	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.1-Dichloropropylene	563-58-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.2.3-Trichloropropane	96-18-4	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.2-Dibromo-3-chloropropane	96-12-8	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.2-Dichloroethane	107-06-2	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.3-Dichloropropane	142-28-9	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Carbon Tetrachloride	56-23-5	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: cis-1.2-Dichloroethene	156-59-2	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: cis-1.4-Dichloro-2-butene	1476-11-5	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Dibromomethane	74-95-3	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Iodomethane	74-88-4	1	µg/L	<1	<1	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP074E: Halogenated Aliphatic Compounds (QC Lot: 173675) - continued									
EB1524519-001	ABH02	EP074-WF: Pentachloroethane	76-01-7	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Tetrachloroethene	127-18-4	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: trans-1.2-Dichloroethene	156-60-5	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: trans-1.4-Dichloro-2-butene	110-57-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Trichloroethene	79-01-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Bromomethane	74-83-9	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: Chloroethane	75-00-3	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: Chloromethane	74-87-3	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: Dichlorodifluoromethane	75-71-8	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: Trichlorofluoromethane	75-69-4	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: Methylene chloride	75-09-2	2	µg/L	<5	<5	0.00	No Limit
EP074F: Halogenated Aromatic Compounds (QC Lot: 173675)									
EB1524519-001	ABH02	EP074-WF: 1.4-Dichlorobenzene	106-46-7	0.1	µg/L	<1.0	<1.0	0.00	No Limit
		EP074-WF: 1.2.3-Trichlorobenzene	87-61-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.2.4-Trichlorobenzene	120-82-1	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.2-Dichlorobenzene	95-50-1	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.3-Dichlorobenzene	541-73-1	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 2-Chlorotoluene	95-49-8	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 4-Chlorotoluene	106-43-4	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Bromobenzene	108-86-1	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Chlorobenzene	108-90-7	1	µg/L	<1	<1	0.00	No Limit
EP074G: Trihalomethanes (QC Lot: 173675)									
EB1524519-001	ABH02	EP074-WF: Bromodichloromethane	75-27-4	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Bromoform	75-25-2	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Chloroform	67-66-3	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Dibromochloromethane	124-48-1	1	µg/L	<1	<1	0.00	No Limit
EP074H: Naphthalene (QC Lot: 173675)									
EB1524519-001	ABH02	EP074-WF: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
ED037P: Alkalinity by PC Titrator (QCLot: 171194)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	104	87	112
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 173826)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	113	85	118
				<1	100 mg/L	101	85	118
ED045G: Chloride by Discrete Analyser (QCLot: 173827)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	111	90	115
				<1	1000 mg/L	102	90	115
ED093F: Dissolved Major Cations (QCLot: 171214)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS (QCLot: 171215)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	85.5	79	118
EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	0.1 mg/L	112	87	113
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	90.2	88	116
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	89.4	88	108
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	92.2	87	113
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	92.2	88	114
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	86.6	82	114
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	92.7	89	110
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	89.3	89	120
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	91.7	89	113
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	84.0	83	112
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	88.5	87	113
EG035F: Dissolved Mercury by FIMS (QCLot: 171213)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	85.7	84	118
EG051G: Ferrous Iron by Discrete Analyser (QCLot: 172524)								
EG051G: Ferrous Iron	----	0.05	mg/L	<0.05	2 mg/L	110	85	120
EK055G: Ammonia as N by Discrete Analyser (QCLot: 172037)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	102	86	112
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 172038)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	108	89	115

Sub-Matrix: **WATER**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 176688)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	103	70	111
EP005: Total Organic Carbon (TOC) (QCLot: 171057)								
EP005: Total Organic Carbon	----	1	mg/L	<1 <1	10 mg/L 100 mg/L	85.8 92.7	79 79	113 113
EP068A: Organochlorine Pesticides (OC) (QCLot: 171807)								
EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	5 µg/L	99.8	52	124
EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	5 µg/L	102	56	122
EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	5 µg/L	101	35	131
EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	5 µg/L	101	52	123
EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	5 µg/L	116	45	125
EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	5 µg/L	106	54	128
EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	5 µg/L	114	39	122
EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	5 µg/L	108	50	126
EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	5 µg/L	99.4	51	125
EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	5 µg/L	112	53	112
EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	5 µg/L	104	50	124
EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	5 µg/L	109	37	124
EP068: Endrin	72-20-8	0.5	µg/L	<0.5	5 µg/L	111	47	129
EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	5 µg/L	111	49	131
EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	5 µg/L	117	45	129
EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	5 µg/L	91.2	42	119
EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	5 µg/L	112	45	118
EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	5 µg/L	101	52	124
EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	5 µg/L	108	41	121
EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	5 µg/L	94.9	32	135
EP068: Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L	<0.5	----	----	----	----
EP068: Sum of DDD + DDE + DDT	----	0.5	µg/L	<0.5	----	----	----	----
EP068: Total Chlordane (sum)	----	0.5	µg/L	<0.5	----	----	----	----
EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	5 µg/L	99.7	48	125
EP068A: Organochlorine Pesticides (OC) (QCLot: 172751)								
EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	5 µg/L	97.6	52	124
EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	5 µg/L	96.1	56	122
EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	5 µg/L	88.8	35	131
EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	5 µg/L	94.7	52	123
EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	5 µg/L	72.8	45	125
EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	5 µg/L	98.3	54	128
EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	5 µg/L	69.4	39	122

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP068A: Organochlorine Pesticides (OC) (QCLot: 172751) - continued								
EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	5 µg/L	106	50	126
EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	5 µg/L	93.1	51	125
EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	5 µg/L	91.2	53	112
EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	5 µg/L	95.3	50	124
EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	5 µg/L	89.6	37	124
EP068: Endrin	72-20-8	0.5	µg/L	<0.5	5 µg/L	93.4	47	129
EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	5 µg/L	95.9	49	131
EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	5 µg/L	107	45	129
EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	5 µg/L	61.8	42	119
EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	5 µg/L	97.3	45	118
EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	5 µg/L	99.8	52	124
EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	5 µg/L	66.8	41	121
EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	5 µg/L	80.1	32	135
EP068: Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L	<0.5	----	----	----	----
EP068: Sum of DDD + DDE + DDT	----	0.5	µg/L	<0.5	----	----	----	----
EP068: Total Chlordane (sum)	----	0.5	µg/L	<0.5	----	----	----	----
EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	5 µg/L	93.4	48	125
EP068A: Organochlorine Pesticides (OC) (QCLot: 173448)								
EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	5 µg/L	123	52	124
EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	5 µg/L	119	56	122
EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	5 µg/L	116	35	131
EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	5 µg/L	122	52	123
EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	5 µg/L	77.0	45	125
EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	5 µg/L	123	54	128
EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	5 µg/L	97.6	39	122
EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	5 µg/L	106	50	126
EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	5 µg/L	107	51	125
EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	5 µg/L	98.0	53	112
EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	5 µg/L	115	50	124
EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	5 µg/L	114	37	124
EP068: Endrin	72-20-8	0.5	µg/L	<0.5	5 µg/L	92.1	47	129
EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	5 µg/L	94.2	49	131
EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	5 µg/L	118	45	129
EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	5 µg/L	95.5	42	119
EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	5 µg/L	93.4	45	118
EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	5 µg/L	110	52	124
EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	5 µg/L	92.1	41	121
EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	5 µg/L	91.4	32	135

Sub-Matrix: **WATER**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EP068A: Organochlorine Pesticides (OC) (QCLot: 173448) - continued								
EP068: Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L	<0.5	----	----	----	----
EP068: Sum of DDD + DDE + DDT	----	0.5	µg/L	<0.5	----	----	----	----
EP068: Total Chlordane (sum)	----	0.5	µg/L	<0.5	----	----	----	----
EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	5 µg/L	109	48	125
EP068B: Organophosphorus Pesticides (OP) (QCLot: 171807)								
EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	5 µg/L	82.3	44	130
EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	5 µg/L	104	52	124
EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	5 µg/L	108	48	128
EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	5 µg/L	119	50	127
EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	5 µg/L	106	54	119
EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	5 µg/L	114	50	118
EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	5 µg/L	109	44	118
EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	5 µg/L	123	44	129
EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	5 µg/L	102	49	115
EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	5 µg/L	96.3	41	111
EP068: Ethion	563-12-2	0.5	µg/L	<0.5	5 µg/L	106	50	127
EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	5 µg/L	89.8	43	121
EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	5 µg/L	116	49	121
EP068: Malathion	121-75-5	0.5	µg/L	<0.5	5 µg/L	121	51	122
EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	5 µg/L	# 5.68	16	49
EP068: Parathion	56-38-2	2	µg/L	<2.0	5 µg/L	118	43	123
EP068: Parathion-methyl	298-00-0	----	µg/L	----	5 µg/L	102	50	118
EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	5 µg/L	106	52	126
EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	5 µg/L	104	53	126
EP068B: Organophosphorus Pesticides (OP) (QCLot: 172751)								
EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	5 µg/L	49.2	44	130
EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	5 µg/L	92.3	52	124
EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	5 µg/L	88.3	48	128
EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	5 µg/L	106	50	127
EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	5 µg/L	92.5	54	119
EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	5 µg/L	97.4	50	118
EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	5 µg/L	71.4	44	118
EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	5 µg/L	66.2	44	129
EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	5 µg/L	96.5	49	115
EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	5 µg/L	69.6	41	111
EP068: Ethion	563-12-2	0.5	µg/L	<0.5	5 µg/L	90.8	50	127
EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	5 µg/L	79.7	43	121
EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	5 µg/L	90.8	49	121

Sub-Matrix: **WATER**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EP068B: Organophosphorus Pesticides (OP) (QCLot: 172751) - continued								
EP068: Malathion	121-75-5	0.5	µg/L	<0.5	5 µg/L	96.1	51	122
EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	5 µg/L	# 1.56	16	49
EP068: Parathion	56-38-2	2	µg/L	<2.0	5 µg/L	90.4	43	123
EP068: Parathion-methyl	298-00-0	----	µg/L	----	5 µg/L	88.9	50	118
EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	5 µg/L	89.5	52	126
EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	5 µg/L	88.9	53	126
EP068B: Organophosphorus Pesticides (OP) (QCLot: 173448)								
EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	5 µg/L	78.0	44	130
EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	5 µg/L	89.2	52	124
EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	5 µg/L	86.1	48	128
EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	5 µg/L	114	50	127
EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	5 µg/L	112	54	119
EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	5 µg/L	117	50	118
EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	5 µg/L	70.0	44	118
EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	5 µg/L	96.6	44	129
EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	5 µg/L	72.8	49	115
EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	5 µg/L	53.3	41	111
EP068: Ethion	563-12-2	0.5	µg/L	<0.5	5 µg/L	96.1	50	127
EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	5 µg/L	71.8	43	121
EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	5 µg/L	107	49	121
EP068: Malathion	121-75-5	0.5	µg/L	<0.5	5 µg/L	92.7	51	122
EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	5 µg/L	# 2.00	16	49
EP068: Parathion	56-38-2	2	µg/L	<2.0	5 µg/L	87.0	43	123
EP068: Parathion-methyl	298-00-0	----	µg/L	----	5 µg/L	84.2	50	118
EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	5 µg/L	113	52	126
EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	5 µg/L	85.0	53	126
EP074A: Monocyclic Aromatic Hydrocarbons (QCLot: 173675)								
EP074-WF: 1.2.4-Trimethylbenzene	95-63-6	1	µg/L	<1	20 µg/L	90.9	77	109
EP074-WF: 1.3.5-Trimethylbenzene	108-67-8	1	µg/L	<1	20 µg/L	91.0	77	109
EP074-WF: Benzene	71-43-2	1	µg/L	<1	20 µg/L	102	81	119
EP074-WF: Ethylbenzene	100-41-4	1	µg/L	<1	20 µg/L	96.4	78	118
EP074-WF: Isopropylbenzene	98-82-8	1	µg/L	<1	20 µg/L	91.0	77	117
EP074-WF: meta- & para-Xylene	108-38-3 106-42-3	1	µg/L	<1	40 µg/L	92.0	78	118
EP074-WF: n-Butylbenzene	104-51-8	1	µg/L	<1	20 µg/L	81.8	65	111
EP074-WF: n-Propylbenzene	103-65-1	1	µg/L	<1	20 µg/L	90.5	74	110
EP074-WF: ortho-Xylene	95-47-6	1	µg/L	<1	20 µg/L	96.5	82	118
EP074-WF: p-Isopropyltoluene	99-87-6	1	µg/L	<1	20 µg/L	88.2	73	113
EP074-WF: sec-Butylbenzene	135-98-8	1	µg/L	<1	20 µg/L	92.3	76	110

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EP074A: Monocyclic Aromatic Hydrocarbons (QCLot: 173675) - continued								
EP074-WF: Styrene	100-42-5	1	µg/L	<1	20 µg/L	90.7	78	118
EP074-WF: tert-Butylbenzene	98-06-6	1	µg/L	<1	20 µg/L	96.3	78	110
EP074-WF: Toluene	108-88-3	1	µg/L	<1	20 µg/L	99.6	81	121
EP074B: Oxygenated Compounds (QCLot: 173675)								
EP074-WF: 2-Butanone (MEK)	78-93-3	10	µg/L	<10	200 µg/L	99.2	71	131
EP074-WF: 2-Hexanone (MBK)	591-78-6	10	µg/L	<10	200 µg/L	101	75	129
EP074-WF: 2-Propanone (Acetone)	67-64-1	10	µg/L	<10	200 µg/L	102	69	151
EP074-WF: 4-Methyl-2-pentanone (MIBK)	108-10-1	10	µg/L	<10	200 µg/L	98.6	72	132
EP074-WF: Vinyl Acetate	108-05-4	10	µg/L	<10	200 µg/L	98.7	65	129
EP074C: Sulfonated Compounds (QCLot: 173675)								
EP074-WF: Carbon disulfide	75-15-0	1	µg/L	<1	20 µg/L	89.6	53	123
EP074D: Fumigants (QCLot: 173675)								
EP074-WF: 1.2-Dibromoethane (EDB)	106-93-4	1	µg/L	<1	20 µg/L	101	81	115
EP074-WF: 1.2-Dichloropropane	78-87-5	1	µg/L	<1	20 µg/L	96.2	80	118
EP074-WF: 2.2-Dichloropropane	594-20-7	1	µg/L	<1	20 µg/L	96.9	69	115
EP074-WF: cis-1.3-Dichloropropylene	10061-01-5	2	µg/L	<2	20 µg/L	92.2	72	110
EP074-WF: trans-1.3-Dichloropropylene	10061-02-6	2	µg/L	<2	20 µg/L	88.6	70	108
EP074E: Halogenated Aliphatic Compounds (QCLot: 173675)								
EP074-WF: 1.1.1.2-Tetrachloroethane	630-20-6	1	µg/L	<1	20 µg/L	96.7	75	107
EP074-WF: 1.1.1-Trichloroethane	71-55-6	1	µg/L	<1	20 µg/L	98.6	75	113
EP074-WF: 1.1.2.2-Tetrachloroethane	79-34-5	1	µg/L	<1	20 µg/L	99.8	85	121
EP074-WF: 1.1.2-Trichloroethane	79-00-5	1	µg/L	<1	20 µg/L	100	85	117
EP074-WF: 1.1-Dichloroethane	75-34-3	1	µg/L	<1	20 µg/L	99.5	76	120
EP074-WF: 1.1-Dichloroethene	75-35-4	1	µg/L	<1	20 µg/L	99.4	68	122
EP074-WF: 1.1-Dichloropropylene	563-58-6	1	µg/L	<1	20 µg/L	102	73	117
EP074-WF: 1.2.3-Trichloropropane	96-18-4	1	µg/L	<1	20 µg/L	101	84	118
EP074-WF: 1.2-Dibromo-3-chloropropane	96-12-8	1	µg/L	<1	20 µg/L	92.5	64	114
EP074-WF: 1.2-Dichloroethane	107-06-2	1	µg/L	<1	20 µg/L	101	81	119
EP074-WF: 1.3-Dichloropropane	142-28-9	1	µg/L	<1	20 µg/L	102	85	117
EP074-WF: Bromomethane	74-83-9	10	µg/L	<10	200 µg/L	85.8	52	128
EP074-WF: Carbon Tetrachloride	56-23-5	1	µg/L	<1	20 µg/L	98.1	66	110
EP074-WF: Chloroethane	75-00-3	10	µg/L	<10	200 µg/L	103	67	127
EP074-WF: Chloromethane	74-87-3	10	µg/L	<10	200 µg/L	102	66	138
EP074-WF: cis-1.2-Dichloroethene	156-59-2	1	µg/L	<1	20 µg/L	102	82	118
EP074-WF: cis-1.4-Dichloro-2-butene	1476-11-5	1	µg/L	<1	20 µg/L	82.8	51	109
EP074-WF: Dibromomethane	74-95-3	1	µg/L	<1	20 µg/L	109	80	116
EP074-WF: Dichlorodifluoromethane	75-71-8	10	µg/L	<10	200 µg/L	106	61	137
EP074-WF: Hexachlorobutadiene	87-68-3	0.5	µg/L	<0.5	20 µg/L	94.0	64	118

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP074E: Halogenated Aliphatic Compounds (QCLot: 173675) - continued								
EP074-WF: Iodomethane	74-88-4	1	µg/L	<1	20 µg/L	80.1	26	119
EP074-WF: Methylene chloride	75-09-2	2	µg/L	<2	20 µg/L	109	52	184
EP074-WF: Pentachloroethane	76-01-7	1	µg/L	<1	20 µg/L	93.2	52	126
EP074-WF: Tetrachloroethene	127-18-4	1	µg/L	<1	20 µg/L	92.6	74	116
EP074-WF: trans-1.2-Dichloroethene	156-60-5	1	µg/L	<1	20 µg/L	96.9	69	123
EP074-WF: trans-1.4-Dichloro-2-butene	110-57-6	1	µg/L	<1	20 µg/L	90.8	64	118
EP074-WF: Trichloroethene	79-01-6	1	µg/L	<1	20 µg/L	94.7	76	118
EP074-WF: Trichlorofluoromethane	75-69-4	10	µg/L	<10	200 µg/L	100	70	124
EP074-WF: Vinyl chloride	75-01-4	0.2	µg/L	<0.2	200 µg/L	102	60	138
EP074F: Halogenated Aromatic Compounds (QCLot: 173675)								
EP074-WF: 1.2.3-Trichlorobenzene	87-61-6	1	µg/L	<1	20 µg/L	93.4	78	116
EP074-WF: 1.2.4-Trichlorobenzene	120-82-1	1	µg/L	<1	20 µg/L	84.0	68	112
EP074-WF: 1.2-Dichlorobenzene	95-50-1	1	µg/L	<1	20 µg/L	96.9	83	113
EP074-WF: 1.3-Dichlorobenzene	541-73-1	1	µg/L	<1	20 µg/L	87.9	78	112
EP074-WF: 1.4-Dichlorobenzene	106-46-7	0.1	µg/L	<0.1	20 µg/L	89.6	78	116
EP074-WF: 2-Chlorotoluene	95-49-8	1	µg/L	<1	20 µg/L	91.6	79	111
EP074-WF: 4-Chlorotoluene	106-43-4	1	µg/L	<1	20 µg/L	91.1	77	111
EP074-WF: Bromobenzene	108-86-1	1	µg/L	<1	20 µg/L	105	71	117
EP074-WF: Chlorobenzene	108-90-7	1	µg/L	<1	20 µg/L	95.5	82	116
EP074G: Trihalomethanes (QCLot: 173675)								
EP074-WF: Bromodichloromethane	75-27-4	1	µg/L	<1	20 µg/L	94.4	75	112
EP074-WF: Bromoform	75-25-2	1	µg/L	<1	20 µg/L	89.5	62	106
EP074-WF: Chloroform	67-66-3	1	µg/L	<1	20 µg/L	102	83	115
EP074-WF: Dibromochloromethane	124-48-1	1	µg/L	<1	20 µg/L	92.4	68	108
EP074H: Naphthalene (QCLot: 173675)								
EP074-WF: Naphthalene	91-20-3	5	µg/L	<5	20 µg/L	98.3	82	116
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 174001)								
EP132: 2-Methylnaphthalene	91-57-6	0.1	µg/L	<0.1	2 µg/L	76.8	59	123
EP132: 3-Methylcholanthrene	56-49-5	0.1	µg/L	<0.1	2 µg/L	76.0	60	120
EP132: 7.12-Dimethylbenz(a)anthracene	57-97-6	0.1	µg/L	<0.1	2 µg/L	76.2	12	156
EP132: Acenaphthene	83-32-9	0.1	µg/L	<0.1	2 µg/L	80.2	64	122
EP132: Acenaphthylene	208-96-8	0.1	µg/L	<0.1	2 µg/L	87.5	62	124
EP132: Anthracene	120-12-7	0.1	µg/L	<0.1	2 µg/L	86.1	66	124
EP132: Benz(a)anthracene	56-55-3	0.1	µg/L	<0.1	2 µg/L	86.9	64	130
EP132: Benzo(a)pyrene	50-32-8	0.05	µg/L	<0.05	2 µg/L	86.2	64	126
EP132: Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.1	µg/L	<0.1	2 µg/L	86.0	62	126
EP132: Benzo(e)pyrene	192-97-2	0.1	µg/L	<0.1	2 µg/L	86.2	62	126

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 174001) - continued								
EP132: Benzo(g.h.i)perylene	191-24-2	0.1	µg/L	<0.1	2 µg/L	76.6	56	126
EP132: Benzo(k)fluoranthene	207-08-9	0.1	µg/L	<0.1	2 µg/L	90.2	63	127
EP132: Chrysene	218-01-9	0.1	µg/L	<0.1	2 µg/L	80.2	64	128
EP132: Coronene	191-07-1	0.1	µg/L	<0.1	2 µg/L	52.3	35	133
EP132: Dibenz(a.h)anthracene	53-70-3	0.1	µg/L	<0.1	2 µg/L	78.0	58	128
EP132: Fluoranthene	206-44-0	0.1	µg/L	<0.1	2 µg/L	93.7	65	127
EP132: Fluorene	86-73-7	0.1	µg/L	<0.1	2 µg/L	88.1	64	124
EP132: Indeno(1.2.3.cd)pyrene	193-39-5	0.1	µg/L	<0.1	2 µg/L	76.9	57	127
EP132: N-2-Fluorenyl Acetamide	53-96-3	0.1	µg/L	<0.1	2 µg/L	80.3	54	131
EP132: Naphthalene	91-20-3	0.1	µg/L	<0.1	2 µg/L	79.0	60	124
EP132: Perylene	198-55-0	0.1	µg/L	<0.1	2 µg/L	85.0	64	124
EP132: Phenanthrene	85-01-8	0.1	µg/L	<0.1	2 µg/L	86.5	65	125
EP132: Pyrene	129-00-0	0.1	µg/L	<0.1	2 µg/L	94.3	66	128

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 173826)							
EB1524519-002	ABH02A	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	# Not Determined	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 173827)							
EB1524519-002	ABH02A	ED045G: Chloride	16887-00-6	400 mg/L	99.1	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 171215)							
EB1524519-003	ABH4	EG020A-F: Aluminium	7429-90-5	0.5 mg/L	89.2	70	130
		EG020A-F: Antimony	7440-36-0	0.1 mg/L	70.3	70	130
		EG020A-F: Arsenic	7440-38-2	0.1 mg/L	90.5	70	130
		EG020A-F: Cadmium	7440-43-9	0.1 mg/L	92.9	70	130
		EG020A-F: Chromium	7440-47-3	0.1 mg/L	92.3	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	89.9	70	130
		EG020A-F: Lead	7439-92-1	0.1 mg/L	92.7	70	130
		EG020A-F: Manganese	7439-96-5	0.1 mg/L	86.2	70	130
		EG020A-F: Nickel	7440-02-0	0.1 mg/L	89.6	70	130
		EG020A-F: Selenium	7782-49-2	0.1 mg/L	79.0	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	87.4	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	*SpikeRecovery(%)*	*Recovery Limits (%)*	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EG035F: Dissolved Mercury by FIMS (QCLot: 171213)							
EB1524519-002	ABH02A	EG035F: Mercury	7439-97-6	0.01 mg/L	83.0	70	130
EG051G: Ferrous Iron by Discrete Analyser (QCLot: 172524)							
EB1524394-004	Anonymous	EG051G: Ferrous Iron	----	2 mg/L	110	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 172037)							
EB1524516-002	Anonymous	EK055G: Ammonia as N	7664-41-7	0.4 mg/L	91.8	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 172038)							
EB1524516-002	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.4 mg/L	# Not Determined	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 176688)							
EB1524721-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	125	70	130
EP005: Total Organic Carbon (TOC) (QCLot: 171057)							
EB1524519-002	ABH02A	EP005: Total Organic Carbon	----	100 mg/L	95.6	70	130
EP068A: Organochlorine Pesticides (OC) (QCLot: 171807)							
EB1524519-004	ABH04	EP068: 4.4`-DDT	50-29-3	4 µg/L	120	70	130
		EP068: Aldrin	309-00-2	1 µg/L	92.8	70	130
		EP068: Dieldrin	60-57-1	1 µg/L	119	70	130
		EP068: Endrin	72-20-8	4 µg/L	130	70	130
		EP068: gamma-BHC	58-89-9	1 µg/L	94.8	70	130
		EP068: Heptachlor	76-44-8	1 µg/L	126	70	130
EP068A: Organochlorine Pesticides (OC) (QCLot: 172751)							
EB1524610-003	Anonymous	EP068: 4.4`-DDT	50-29-3	4 µg/L	74.9	70	130
		EP068: Aldrin	309-00-2	1 µg/L	100	70	130
		EP068: Dieldrin	60-57-1	1 µg/L	93.1	70	130
		EP068: Endrin	72-20-8	4 µg/L	73.1	70	130
		EP068: gamma-BHC	58-89-9	1 µg/L	77.0	70	130
		EP068: Heptachlor	76-44-8	1 µg/L	81.4	70	130
EP068A: Organochlorine Pesticides (OC) (QCLot: 173448)							
EB1524633-001	Anonymous	EP068: 4.4`-DDT	50-29-3	4 µg/L	84.9	70	130
		EP068: Aldrin	309-00-2	1 µg/L	112	70	130
		EP068: Dieldrin	60-57-1	1 µg/L	127	70	130
		EP068: Endrin	72-20-8	4 µg/L	108	70	130
		EP068: gamma-BHC	58-89-9	1 µg/L	118	70	130
		EP068: Heptachlor	76-44-8	1 µg/L	107	70	130
EP068B: Organophosphorus Pesticides (OP) (QCLot: 171807)							
EB1524519-004	ABH04	EP068: Bromophos-ethyl	4824-78-6	1 µg/L	115	70	130
		EP068: Chlorpyrifos-methyl	5598-13-0	1 µg/L	121	70	130

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
				Concentration	MS	Low	High
EP068B: Organophosphorus Pesticides (OP) (QCLot: 171807) - continued							
EB1524519-004	ABH04	EP068: Diazinon	333-41-5	1 µg/L	124	70	130
		EP068: Pirimphos-ethyl	23505-41-1	1 µg/L	124	70	130
		EP068: Prothiofos	34643-46-4	1 µg/L	122	70	130
EP068B: Organophosphorus Pesticides (OP) (QCLot: 172751)							
EB1524610-003	Anonymous	EP068: Bromophos-ethyl	4824-78-6	1 µg/L	73.8	70	130
		EP068: Chlorpyrifos-methyl	5598-13-0	1 µg/L	96.6	70	130
		EP068: Diazinon	333-41-5	1 µg/L	75.1	70	130
		EP068: Pirimphos-ethyl	23505-41-1	1 µg/L	91.5	70	130
		EP068: Prothiofos	34643-46-4	1 µg/L	76.1	70	130
EP068B: Organophosphorus Pesticides (OP) (QCLot: 173448)							
EB1524633-001	Anonymous	EP068: Bromophos-ethyl	4824-78-6	1 µg/L	99.4	70	130
		EP068: Chlorpyrifos-methyl	5598-13-0	1 µg/L	115	70	130
		EP068: Diazinon	333-41-5	1 µg/L	114	70	130
		EP068: Pirimphos-ethyl	23505-41-1	1 µg/L	130	70	130
		EP068: Prothiofos	34643-46-4	1 µg/L	105	70	130
EP074A: Monocyclic Aromatic Hydrocarbons (QCLot: 173675)							
EB1524519-002	ABH02A	EP074-WF: Benzene	71-43-2	20 µg/L	94.2	76	128
		EP074-WF: Toluene	108-88-3	20 µg/L	93.4	72	132
EP074E: Halogenated Aliphatic Compounds (QCLot: 173675)							
EB1524519-002	ABH02A	EP074-WF: 1.1-Dichloroethene	75-35-4	20 µg/L	82.2	63	129
		EP074-WF: Trichloroethene	79-01-6	20 µg/L	82.8	64	126
EP074F: Halogenated Aromatic Compounds (QCLot: 173675)							
EB1524519-002	ABH02A	EP074-WF: Chlorobenzene	108-90-7	20 µg/L	91.1	81	119

QA/QC Compliance Assessment for DQO Reporting

Work Order	: **EB1524519**	Page	: 1 of 8
Client	: **CODYHART CONSULTING PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS BARBARA HART	Telephone	: +61-7-3243 7222
Project	: Armidale Regional 2119	Date Samples Received	: 30-Jul-2015
Site	: Armidale Regional Landfill	Issue Date	: 11-Aug-2015
Sampler	: BARBARA HART	No. of samples received	: 6
Order number	: ----	No. of samples analysed	: 6

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **Laboratory Control outliers exist - please see following pages for full details.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	**Analyte**	CAS Number	Data	Limits	**Comment**
Laboratory Control Spike (LCS) Recoveries							
EP068B: Organophosphorus Pesticides (OP)	QC-171807-002	----	**Monocrotophos**	6923-22-4	5.68 %	16-49%	**Recovery less than lower control limit**
EP068B: Organophosphorus Pesticides (OP)	QC-172751-002	----	**Monocrotophos**	6923-22-4	1.56 %	16-49%	**Recovery less than lower control limit**
EP068B: Organophosphorus Pesticides (OP)	QC-173448-002	----	**Monocrotophos**	6923-22-4	2.00 %	16-49%	**Recovery less than lower control limit**
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	EB1524519--002	ABH02A	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Ar	EB1524516--002	Anonymous	**Nitrite + Nitrate as N**	----	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***
EP132B: Polynuclear Aromatic Hydrocarbons						
Amber Glass Bottle - Unpreserved						
ABH04, ABHD	05-Aug-2015	04-Aug-2015	**1**	----	----	----

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	0	10	0.00	10.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)					
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	0	10	0.00	5.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	*Sample Date*	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)		*Date extracted*	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P) ABH04, ABHD	**28-Jul-2015**	----	----	----	**03-Aug-2015**	11-Aug-2015	✓
Clear Plastic Bottle - Natural (ED037-P) ABH02, ABH02A, ABH4, ABH04A	**29-Jul-2015**	----	----	----	**03-Aug-2015**	12-Aug-2015	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G) ABH04, ABHD	**28-Jul-2015**	----	----	----	**06-Aug-2015**	25-Aug-2015	✓
Clear Plastic Bottle - Natural (ED041G) ABH02, ABH02A, ABH4, ABH04A	**29-Jul-2015**	----	----	----	**06-Aug-2015**	26-Aug-2015	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) ABH04, ABHD	**28-Jul-2015**	----	----	----	**06-Aug-2015**	25-Aug-2015	✓
Clear Plastic Bottle - Natural (ED045G) ABH02, ABH02A, ABH4, ABH04A	**29-Jul-2015**	----	----	----	**06-Aug-2015**	26-Aug-2015	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) ABH04, ABHD	**28-Jul-2015**	----	----	----	**04-Aug-2015**	25-Aug-2015	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) ABH02, ABH02A, ABH4, ABH04A	**29-Jul-2015**	----	----	----	**04-Aug-2015**	26-Aug-2015	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) ABH04, ABHD	**28-Jul-2015**	----	----	----	**04-Aug-2015**	24-Jan-2016	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) ABH02, ABH02A, ABH4, ABH04A	**29-Jul-2015**	----	----	----	**04-Aug-2015**	25-Jan-2016	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) ABH04, ABHD	**28-Jul-2015**	----	----	----	**05-Aug-2015**	25-Aug-2015	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) ABH02, ABH02A, ABH4, ABH04A	**29-Jul-2015**	----	----	----	**05-Aug-2015**	26-Aug-2015	✓
EG051G: Ferrous Iron by Discrete Analyser							
Clear Plastic Bottle - HCl - Filtered (EG051G) ABH04, ABHD	**28-Jul-2015**	----	----	----	**04-Aug-2015**	04-Aug-2015	✓
Clear Plastic Bottle - HCl - Filtered (EG051G) ABH02, ABH02A, ABH4, ABH04A	**29-Jul-2015**	----	----	----	**04-Aug-2015**	05-Aug-2015	✓

Matrix: **WATER**

Evaluation: ✗ = Holding time breach ; ✓ = Within holding time.

Method		*Sample Date*	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)			*Date extracted*	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EK055G: Ammonia as N by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK055G)								
ABH04,	ABHD	**28-Jul-2015**	**----**	----	----	**04-Aug-2015**	25-Aug-2015	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)								
ABH02, ABH4,	ABH02A, ABH04A	**29-Jul-2015**	**----**	----	----	**04-Aug-2015**	26-Aug-2015	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK059G)								
ABH04,	ABHD	**28-Jul-2015**	**----**	----	----	**04-Aug-2015**	25-Aug-2015	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)								
ABH02, ABH4,	ABH02A, ABH04A	**29-Jul-2015**	**----**	----	----	**04-Aug-2015**	26-Aug-2015	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK061G)								
ABH04,	ABHD	**28-Jul-2015**	**10-Aug-2015**	25-Aug-2015	✓	**10-Aug-2015**	25-Aug-2015	✓
Clear Plastic Bottle - Sulfuric Acid (EK061G)								
ABH02, ABH4,	ABH02A, ABH04A	**29-Jul-2015**	**10-Aug-2015**	26-Aug-2015	✓	**10-Aug-2015**	26-Aug-2015	✓
EP005: Total Organic Carbon (TOC)								
Amber TOC Vial - Sulfuric Acid (EP005)								
ABH04,	ABHD	**28-Jul-2015**	**----**	----	----	**03-Aug-2015**	25-Aug-2015	✓
Amber TOC Vial - Sulfuric Acid (EP005)								
ABH02, ABH4,	ABH02A, ABH04A	**29-Jul-2015**	**----**	----	----	**03-Aug-2015**	26-Aug-2015	✓
EP068A: Organochlorine Pesticides (OC)								
Amber Glass Bottle - Unpreserved (EP068)								
ABH04,	ABHD	**28-Jul-2015**	**03-Aug-2015**	04-Aug-2015	✓	**04-Aug-2015**	12-Sep-2015	✓
Amber Glass Bottle - Unpreserved (EP068)								
ABH02, ABH4,	ABH02A, ABH04A	**29-Jul-2015**	**04-Aug-2015**	05-Aug-2015	✓	**05-Aug-2015**	13-Sep-2015	✓
EP074A: Monocyclic Aromatic Hydrocarbons								
Amber VOC Vial - Sulfuric Acid (EP074-WF)								
ABH04,	ABHD	**28-Jul-2015**	**05-Aug-2015**	11-Aug-2015	✓	**07-Aug-2015**	11-Aug-2015	✓
Amber VOC Vial - Sulfuric Acid (EP074-WF)								
ABH02, ABH4,	ABH02A, ABH04A	**29-Jul-2015**	**05-Aug-2015**	12-Aug-2015	✓	**07-Aug-2015**	12-Aug-2015	✓
EP132B: Polynuclear Aromatic Hydrocarbons								
Amber Glass Bottle - Unpreserved (EP132)								
ABH04,	ABHD	**28-Jul-2015**	**05-Aug-2015**	04-Aug-2015	✗	**11-Aug-2015**	14-Sep-2015	✓
Amber Glass Bottle - Unpreserved (EP132)								
ABH02, ABH4,	ABH02A, ABH04A	**29-Jul-2015**	**05-Aug-2015**	05-Aug-2015	✓	**11-Aug-2015**	14-Sep-2015	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	1	10	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ammonia as N by Discrete analyser	EK055G	2	19	**10.53**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ferrous Iron by Discrete Analyser	EG051G	2	12	**16.67**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	18	**11.11**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	10	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	0	10	**0.00**	**10.00**	✗	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Organic Carbon	EP005	2	19	**10.53**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Volatile Organic Compounds WF Detection Limits	EP074-WF	1	6	**16.67**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	10	**10.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ferrous Iron by Discrete Analyser	EG051G	1	12	**8.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	10	**10.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	1	10	**10.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Organic Carbon	EP005	2	19	**10.53**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Volatile Organic Compounds WF Detection Limits	EP074-WF	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ferrous Iron by Discrete Analyser	EG051G	1	12	**8.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		*Count*		*Rate (%)*			*Quality Control Specification*
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Pesticides by GCMS	EP068	1	10	**10.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	1	10	**10.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Organic Carbon	EP005	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Volatile Organic Compounds WF Detection Limits	EP074-WF	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ferrous Iron by Discrete Analyser	EG051G	1	12	**8.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	10	**10.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	0	10	**0.00**	**5.00**	×	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Organic Carbon	EP005	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Volatile Organic Compounds WF Detection Limits	EP074-WF	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45 um filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ferrous Iron by Discrete Analyser	EG051G	WATER	In house: Referenced to APHA 3500 Fe-B. A colorimetric determination based on the reaction between phenanthroline and ferrous iron at pH 3.2-3.3 to form an orange-red complex that is measured against a five-point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM (2013) Schedule B(3)
Pesticides by GCMS	EP068	WATER	USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Volatile Organic Compounds WF Detection Limits	EP074-WF	WATER	USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	WATER	USEPA 3640 (GPC Cleanup), 8270 GCMS Capiliary column, SIM mode. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
TKN/TP Digestion	EK061/EK067	WATER	APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order : **EB1524521**
Client : **CODYHART CONSULTING PTY LTD**
Contact : MS BARBARA HART
Address : P O BOX 1073
BURLEIGH HEADS QLD, AUSTRALIA 4220
E-mail : pelican@codyhart.com.au
Telephone : +61 55205532
Facsimile : +61 07 55206531
Project : Armidale Regional 2119
Order number : ----
C-O-C number : ----
Sampler : BARBARA HART
Site : Armidale Regional Landfill
Quote number : ----

Page : 1 of 9
Laboratory : Environmental Division Brisbane
Contact : Customer Services EB
Address : 2 Byth Street Stafford QLD Australia 4053
E-mail : ALSEnviro.Brisbane@alsglobal.com
Telephone : +61-7-3243 7222
Facsimile : +61-7-3243 7218
QC Level : NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Date Samples Received : 30-Jul-2015 15:00
Date Analysis Commenced : 03-Aug-2015
Issue Date : 11-Aug-2015 16:18
No. of samples received : 1
No. of samples analysed : 1

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

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*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics Brisbane Organics WB Water Lab Brisbane
Pabi Subba	Senior Organic Chemist	Sydney Organics
Ryan Story	2IC Organic Instrument Chemist	Brisbane Organics

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
ø = ALS is not NATA accredited for these tests.

- EP068: Sample shows poor matrix spike recovey for DDT due to matrix interferences.
- Total PAH reported as the sum of Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene and Benzo(g,h,i)perylene.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.

Analytical Results

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

			Client sample ID	**GARA6**	----	----	----	----
			Client sampling date / time	29-Jul-2015 10:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524521-001**	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EA006: Sodium Adsorption Ratio (SAR)								
^ **Sodium Adsorption Ratio**	----	0.01	-	**0.77**	----	----	----	----
EA015: Total Dissolved Solids								
^ **Total Dissolved Solids @180°C**	----	10	mg/L	**212**	----	----	----	----
EA025: Suspended Solids								
^ **Suspended Solids (SS)**	----	5	mg/L	<5	----	----	----	----
EA065: Total Hardness as CaCO3								
^ **Total Hardness as CaCO3**	----	1	mg/L	**154**	----	----	----	----
ED009: Anions								
Bromide	24959-67-9	0.01	mg/L	**0.029**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**154**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**154**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**36**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**22**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**27**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**21**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**22**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**3**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.002**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.001**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.002**	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**GARA6**	----	----	----	----
			Client sampling date / time	29-Jul-2015 10:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524521-001**	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Boron	7440-42-8	0.05	mg/L	<0.05	----	----	----	----
Iron	7439-89-6	0.05	mg/L	<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EG051G: Ferrous Iron by Discrete Analyser								
Ferrous Iron	----	0.05	mg/L	<0.05	----	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.01**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	----	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**1.2**	----	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**1.2**	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.02**	----	----	----	----
EN055: Ionic Balance								
^ **Total Anions**	----	0.01	meq/L	**4.45**	----	----	----	----
^ **Total Cations**	----	0.01	meq/L	**4.11**	----	----	----	----
^ **Ionic Balance**	----	0.01	%	**3.96**	----	----	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**8**	----	----	----	----
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	----	----	----	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	----	----	----	----
beta-BHC	319-85-7	0.5	µg/L	<0.5	----	----	----	----
gamma-BHC	58-89-9	0.5	µg/L	<0.5	----	----	----	----
delta-BHC	319-86-8	0.5	µg/L	<0.5	----	----	----	----
Heptachlor	76-44-8	0.5	µg/L	<0.5	----	----	----	----
Aldrin	309-00-2	0.5	µg/L	<0.5	----	----	----	----
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Client sample ID	**GARA6**	----	----	----	----
			Client sampling date / time	29-Jul-2015 10:00	----	----	----	----
Compound	CAS Number	LOR	Unit	**EB1524521-001**	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EP068A: Organochlorine Pesticides (OC) - Continued								
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	----	----	----	----
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	----	----	----	----
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	----	----	----	----
Dieldrin	60-57-1	0.5	µg/L	<0.5	----	----	----	----
4.4`-DDE	72-55-9	0.5	µg/L	<0.5	----	----	----	----
Endrin	72-20-8	0.5	µg/L	<0.5	----	----	----	----
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	----	----	----	----
4.4`-DDD	72-54-8	0.5	µg/L	<0.5	----	----	----	----
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	----	----	----	----
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	----	----	----	----
4.4`-DDT	50-29-3	2	µg/L	<2.0	----	----	----	----
Endrin ketone	53494-70-5	0.5	µg/L	<0.5	----	----	----	----
Methoxychlor	72-43-5	2	µg/L	<2.0	----	----	----	----
^ **Total Chlordane (sum)**	----	0.5	µg/L	<0.5	----	----	----	----
^ **Sum of DDD + DDE + DDT**	----	0.5	µg/L	<0.5	----	----	----	----
^ **Sum of Aldrin + Dieldrin**	309-00-2/60-57-1	0.5	µg/L	<0.5	----	----	----	----
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.5	µg/L	<0.5	----	----	----	----
Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	----	----	----	----
Monocrotophos	6923-22-4	2	µg/L	<2.0	----	----	----	----
Dimethoate	60-51-5	0.5	µg/L	<0.5	----	----	----	----
Diazinon	333-41-5	0.5	µg/L	<0.5	----	----	----	----
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	----	----	----	----
Parathion-methyl	298-00-0	2	µg/L	<2.0	----	----	----	----
Malathion	121-75-5	0.5	µg/L	<0.5	----	----	----	----
Fenthion	55-38-9	0.5	µg/L	<0.5	----	----	----	----
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	----	----	----	----
Parathion	56-38-2	2	µg/L	<2.0	----	----	----	----
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	----	----	----	----
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	----	----	----	----
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	----	----	----	----
Fenamiphos	22224-92-6	0.5	µg/L	<0.5	----	----	----	----
Prothiofos	34643-46-4	0.5	µg/L	<0.5	----	----	----	----
Ethion	563-12-2	0.5	µg/L	<0.5	----	----	----	----
Carbophenothion	786-19-6	0.5	µg/L	<0.5	----	----	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**GARA6**	----	----	----	----
			Client sampling date / time	29-Jul-2015 10:00	----	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524521-001**	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EP068B: Organophosphorus Pesticides (OP) - Continued								
Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	----	----	----	----
EP075(SIM)A: Phenolic Compounds								
Phenol	108-95-2	1	µg/L	<1.0	----	----	----	----
2-Chlorophenol	95-57-8	1	µg/L	<1.0	----	----	----	----
2-Methylphenol	95-48-7	1	µg/L	<1.0	----	----	----	----
3- & 4-Methylphenol	1319-77-3	2	µg/L	<2.0	----	----	----	----
2-Nitrophenol	88-75-5	1	µg/L	<1.0	----	----	----	----
2.4-Dimethylphenol	105-67-9	1	µg/L	<1.0	----	----	----	----
2.4-Dichlorophenol	120-83-2	1	µg/L	<1.0	----	----	----	----
2.6-Dichlorophenol	87-65-0	1	µg/L	<1.0	----	----	----	----
4-Chloro-3-methylphenol	59-50-7	1	µg/L	<1.0	----	----	----	----
2.4.6-Trichlorophenol	88-06-2	1	µg/L	<1.0	----	----	----	----
2.4.5-Trichlorophenol	95-95-4	1	µg/L	<1.0	----	----	----	----
Pentachlorophenol	87-86-5	2	µg/L	<2.0	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	----	----	----	----
C10 - C14 Fraction	----	50	µg/L	<50	----	----	----	----
C15 - C28 Fraction	----	100	µg/L	<100	----	----	----	----
C29 - C36 Fraction	----	50	µg/L	<50	----	----	----	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L	<50	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	----	----	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L	<20	----	----	----	----
>C10 - C16 Fraction	>C10_C16	100	µg/L	<100	----	----	----	----
>C16 - C34 Fraction	----	100	µg/L	<100	----	----	----	----
>C34 - C40 Fraction	----	100	µg/L	<100	----	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L	<100	----	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L	<100	----	----	----	----
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	----	----	----	----
Toluene	108-88-3	2	µg/L	<2	----	----	----	----
Ethylbenzene	100-41-4	2	µg/L	<2	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GARA6	----	----	----	----
			Client sampling date / time	29-Jul-2015 10:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EB1524521-001	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EP080: BTEXN - Continued								
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	----	----	----	----
ortho-Xylene	95-47-6	2	µg/L	<2	----	----	----	----
^ Total Xylenes	1330-20-7	2	µg/L	<2	----	----	----	----
^ Sum of BTEX	----	1	µg/L	<1	----	----	----	----
Naphthalene	91-20-3	5	µg/L	<5	----	----	----	----
EP132B: Polynuclear Aromatic Hydrocarbons								
3-Methylcholanthrene	56-49-5	0.1	µg/L	<0.1	----	----	----	----
2-Methylnaphthalene	91-57-6	0.1	µg/L	<0.1	----	----	----	----
7.12-Dimethylbenz(a)anthracene	57-97-6	0.1	µg/L	<0.1	----	----	----	----
Acenaphthene	83-32-9	0.1	µg/L	<0.1	----	----	----	----
Acenaphthylene	208-96-8	0.1	µg/L	<0.1	----	----	----	----
Anthracene	120-12-7	0.1	µg/L	<0.1	----	----	----	----
Benz(a)anthracene	56-55-3	0.1	µg/L	<0.1	----	----	----	----
Benzo(a)pyrene	50-32-8	0.05	µg/L	<0.05	----	----	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.1	µg/L	<0.1	----	----	----	----
Benzo(e)pyrene	192-97-2	0.1	µg/L	<0.1	----	----	----	----
Benzo(g.h.i)perylene	191-24-2	0.1	µg/L	<0.1	----	----	----	----
Benzo(k)fluoranthene	207-08-9	0.1	µg/L	<0.1	----	----	----	----
Chrysene	218-01-9	0.1	µg/L	<0.1	----	----	----	----
Coronene	191-07-1	0.1	µg/L	<0.1	----	----	----	----
Dibenz(a.h)anthracene	53-70-3	0.1	µg/L	<0.1	----	----	----	----
Fluoranthene	206-44-0	0.1	µg/L	<0.1	----	----	----	----
Fluorene	86-73-7	0.1	µg/L	<0.1	----	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	0.1	µg/L	<0.1	----	----	----	----
N-2-Fluorenyl Acetamide	53-96-3	0.1	µg/L	<0.1	----	----	----	----
Naphthalene	91-20-3	0.1	µg/L	<0.1	----	----	----	----
Perylene	198-55-0	0.1	µg/L	<0.1	----	----	----	----
Phenanthrene	85-01-8	0.1	µg/L	<0.1	----	----	----	----
Pyrene	129-00-0	0.1	µg/L	<0.1	----	----	----	----
Sum of PAHs	----	0.05	µg/L	<0.05	----	----	----	----
Benzo(a)pyrene TEQ (zero)	----	0.05	µg/L	<0.05	----	----	----	----
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.5	%	**58.1**	----	----	----	----
EP068T: Organophosphorus Pesticide Surrogate								

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Client sample ID	**GARA6**	----	----	----	----
			Client sampling date / time	29-Jul-2015 10:00	----	----	----	----
Compound	CAS Number	LOR	Unit	**EB1524521-001**	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EP068T: Organophosphorus Pesticide Surrogate - Continued								
DEF	78-48-8	0.5	%	**73.5**	----	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	1	%	**32.3**	----	----	----	----
2-Chlorophenol-D4	93951-73-6	1	%	**79.7**	----	----	----	----
2.4.6-Tribromophenol	118-79-6	1	%	**74.3**	----	----	----	----
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	1	%	**70.6**	----	----	----	----
Anthracene-d10	1719-06-8	1	%	**79.8**	----	----	----	----
4-Terphenyl-d14	1718-51-0	1	%	**83.6**	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	2	%	**105**	----	----	----	----
Toluene-D8	2037-26-5	2	%	**100**	----	----	----	----
4-Bromofluorobenzene	460-00-4	2	%	**101**	----	----	----	----
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	**106**	----	----	----	----
Anthracene-d10	1719-06-8	0.1	%	**108**	----	----	----	----
4-Terphenyl-d14	1718-51-0	0.1	%	**112**	----	----	----	----

QUALITY CONTROL REPORT

Work Order	: **EB1524521**	Page	: 1 of 13
Client	: **CODYHART CONSULTING PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS BARBARA HART	Contact	: Customer Services EB
Address	: P O BOX 1073 BURLEIGH HEADS QLD, AUSTRALIA 4220	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: pelican@codyhart.com.au	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: +61 55205532	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 55206531	Facsimile	: +61-7-3243 7218
Project	: Armidale Regional 2119	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 30-Jul-2015
C-O-C number	: ----	Date Analysis Commenced	: 03-Aug-2015
Sampler	: BARBARA HART	Issue Date	: 11-Aug-2015
Site	: Armidale Regional Landfill	No. of samples received	: 1
Quote number	: ----	No. of samples analysed	: 1

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

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

Key :
Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
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
RPD = Relative Percentage Difference
# = Indicates failed QC

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*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics Brisbane Organics WB Water Lab Brisbane
Pabi Subba	Senior Organic Chemist	Sydney Organics
Ryan Story	2IC Organic Instrument Chemist	Brisbane Organics

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA015: Total Dissolved Solids (QC Lot: 171054)									
EB1524407-002	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	2050	2040	0.391	0% - 20%
EB1524544-005	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	453	444	2.00	0% - 20%
EA025: Suspended Solids (QC Lot: 171053)									
EB1524480-007	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	11	8	30.8	No Limit
EB1524407-002	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	14	13	0.00	No Limit
ED009: Anions (QC Lot: 171019)									
EB1524503-020	Anonymous	ED009-X: Bromide	24959-67-9	0.01	mg/L	0.128	0.124	3.17	0% - 20%
ED037P: Alkalinity by PC Titrator (QC Lot: 171194)									
EB1524519-001	Anonymous	ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	544	543	0.353	0% - 20%
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	544	543	0.353	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 173819)									
EB1524306-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	773	766	0.932	0% - 20%
EB1524696-002	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	0.00	No Limit
ED045G: Chloride by Discrete Analyser (QC Lot: 173818)									
EB1524306-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	18100	18400	1.53	0% - 20%
EB1524696-002	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	85	84	1.25	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 171226)									
EB1524518-003	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	18	18	0.00	0% - 50%
		ED093F: Magnesium	7439-95-4	1	mg/L	28	27	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	2	2	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	168	167	0.00	0% - 20%
EB1524209-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	9	9	0.00	No Limit
		ED093F: Magnesium	7439-95-4	1	mg/L	48	48	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	7	7	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	89	90	0.00	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 171223)									
EB1524518-003	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	2.00	1.99	0.328	0% - 20%

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG020F: Dissolved Metals by ICP-MS (QC Lot: 171223) - continued									
EB1524518-003	Anonymous	EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.016	0.016	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	18.5	18.5	0.127	0% - 20%
EB1524209-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.224	0.226	0.893	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.116	0.114	1.34	0% - 20%
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	0.01	0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.34	0.34	0.00	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 171225)									
EB1524209-001	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG051G: Ferrous Iron by Discrete Analyser (QC Lot: 172524)									
EB1524394-001	Anonymous	EG051G: Ferrous Iron	----	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EB1524610-002	Anonymous	EG051G: Ferrous Iron	----	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EK040P: Fluoride by PC Titrator (QC Lot: 171195)									
EB1524521-001	GARA6	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.2	0.2	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 172037)									
EB1524516-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	3.47	3.28	5.57	0% - 20%
EB1524519-006	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 172038)									
EB1524516-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.07	0.07	0.00	No Limit
EB1524519-006	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.61	0.62	0.00	0% - 20%
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 175418)									
EB1524464-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	59.1	62.3	5.29	0% - 20%
EB1524631-004	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.7	1.7	0.00	0% - 50%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 175417)									
EB1524464-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	6.44	6.61	2.67	0% - 20%
EB1524631-004	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP005: Total Organic Carbon (TOC) (QC Lot: 171057)									
EB1524519-001	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	7	5	30.6	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP005: Total Organic Carbon (TOC) (QC Lot: 171057) - continued									
EB1524610-003	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	1	4	102	No Limit
EP068A: Organochlorine Pesticides (OC) (QC Lot: 172109)									
EB1524375-001	Anonymous	EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Aldrin	309-00-2	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: alpha-BHC	319-84-6	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: beta-BHC	319-85-7	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: delta-BHC	319-86-8	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Dieldrin	60-57-1	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Endrin	72-20-8	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Endrin ketone	53494-70-5	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: gamma-BHC	58-89-9	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Heptachlor	76-44-8	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: 4.4`-DDT	50-29-3	2	µg/L	<1.0	<1.0	66.7	No Limit
		EP068: Methoxychlor	72-43-5	2	µg/L	<1.0	<1.0	66.7	No Limit
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 172109)									
EB1524375-001	Anonymous	EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Carbophenothion	786-19-6	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Diazinon	333-41-5	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Dichlorvos	62-73-7	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Dimethoate	60-51-5	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Ethion	563-12-2	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Fenamiphos	22224-92-6	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Fenthion	55-38-9	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Malathion	121-75-5	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP068: Prothiofos	34643-46-4	0.5	µg/L	<1.0	<1.0	0.00	No Limit

Sub-Matrix: **WATER**				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 172109) - continued									
EB1524375-001	Anonymous	EP068: Monocrotophos	6923-22-4	2	µg/L	<1.0	<1.0	66.7	No Limit
		EP068: Parathion	56-38-2	2	µg/L	<1.0	<1.0	66.7	No Limit
EP075(SIM)A: Phenolic Compounds (QC Lot: 172110)									
EB1524375-001	Anonymous	EP075(SIM): 2.4.5-Trichlorophenol	95-95-4	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): 2.4.6-Trichlorophenol	88-06-2	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): 2.4-Dichlorophenol	120-83-2	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): 2.4-Dimethylphenol	105-67-9	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): 2.6-Dichlorophenol	87-65-0	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): 2-Chlorophenol	95-57-8	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): 2-Methylphenol	95-48-7	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): 2-Nitrophenol	88-75-5	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): 4-Chloro-3-methylphenol	59-50-7	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): Phenol	108-95-2	1	µg/L	<1.0	<1.0	0.00	No Limit
		EP075(SIM): 3- & 4-Methylphenol	1319-77-3	2	µg/L	<1.0	<1.0	63.9	No Limit
		EP075(SIM): Pentachlorophenol	87-86-5	2	µg/L	<1.0	<1.0	63.9	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 175170)									
EB1524306-003	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.00	No Limit
EB1524932-001	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	48900	51900	6.02	0% - 20%
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 175170)									
EB1524306-003	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EB1524932-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	57000	60300	5.67	0% - 20%
EP080: BTEXN (QC Lot: 175170)									
EB1524306-003	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit
EB1524932-001	Anonymous	EP080: Benzene	71-43-2	1	µg/L	933	872	6.72	0% - 50%
		EP080: Ethylbenzene	100-41-4	2	µg/L	2670	2640	1.07	0% - 20%
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	15600	15600	0.223	0% - 20%
		EP080: ortho-Xylene	95-47-6	2	µg/L	4820	4850	0.672	0% - 20%
		EP080: Toluene	108-88-3	2	µg/L	7680	7380	4.10	0% - 20%
		EP080: Naphthalene	91-20-3	5	µg/L	549	680	21.4	0% - 50%

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EA015: Total Dissolved Solids (QCLot: 171054)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	293 mg/L	103	80	120
				<10	2000 mg/L	95.4	80	120
EA025: Suspended Solids (QCLot: 171053)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	93.1	83	120
				<5	1000 mg/L	99.7	83	120
ED009: Anions (QCLot: 171019)								
ED009-X: Bromide	24959-67-9	0.01	mg/L	<0.010	0.2 mg/L	88.0	80	115
ED037P: Alkalinity by PC Titrator (QCLot: 171194)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	104	87	112
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 173819)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	112	85	118
				<1	100 mg/L	105	85	118
ED045G: Chloride by Discrete Analyser (QCLot: 173818)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	110	90	115
				<1	1000 mg/L	114	90	115
ED093F: Dissolved Major Cations (QCLot: 171226)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS (QCLot: 171223)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	98.8	79	118
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	92.5	88	116
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.5 mg/L	101	81	125
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	93.5	88	108
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	102	87	113
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	100	88	114
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	86.6	82	114
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	102	89	110
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	93.5	89	120
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	100	89	113
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	102	83	112
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	102	87	113

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EG035F: Dissolved Mercury by FIMS (QCLot: 171225)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	92.8	84	118
EG051G: Ferrous Iron by Discrete Analyser (QCLot: 172524)								
EG051G: Ferrous Iron	----	0.05	mg/L	<0.05	2 mg/L	110	85	120
EK040P: Fluoride by PC Titrator (QCLot: 171195)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	10 mg/L	96.0	80	117
EK055G: Ammonia as N by Discrete Analyser (QCLot: 172037)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	102	86	112
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 172038)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	108	89	115
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 175418)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	89.7	70	111
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 175417)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	88.3	77	109
EP005: Total Organic Carbon (TOC) (QCLot: 171057)								
EP005: Total Organic Carbon	----	1	mg/L	<1	10 mg/L	85.8	79	113
				<1	100 mg/L	92.7	79	113
EP068A: Organochlorine Pesticides (OC) (QCLot: 172109)								
EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	5 µg/L	124	52	124
EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	5 µg/L	119	56	122
EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	5 µg/L	112	35	131
EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	5 µg/L	117	52	123
EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	5 µg/L	82.0	45	125
EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	5 µg/L	119	54	128
EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	5 µg/L	109	39	122
EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	5 µg/L	122	50	126
EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	5 µg/L	109	51	125
EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	5 µg/L	112	53	112
EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	5 µg/L	114	50	124
EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	5 µg/L	106	37	124
EP068: Endrin	72-20-8	0.5	µg/L	<0.5	5 µg/L	95.4	47	129
EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	5 µg/L	88.8	49	131
EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	5 µg/L	105	45	129
EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	5 µg/L	94.0	42	119
EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	5 µg/L	90.6	45	118
EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	5 µg/L	108	52	124
EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	5 µg/L	101	41	121
EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	5 µg/L	91.6	32	135

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP068A: Organochlorine Pesticides (OC) (QCLot: 172109) - continued								
EP068: Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L	<0.5	----	----	----	----
EP068: Sum of DDD + DDE + DDT	----	0.5	µg/L	<0.5	----	----	----	----
EP068: Total Chlordane (sum)	----	0.5	µg/L	<0.5	----	----	----	----
EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	5 µg/L	110	48	125
EP068B: Organophosphorus Pesticides (OP) (QCLot: 172109)								
EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	5 µg/L	80.0	44	130
EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	5 µg/L	94.7	52	124
EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	5 µg/L	87.4	48	128
EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	5 µg/L	96.0	50	127
EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	5 µg/L	116	54	119
EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	5 µg/L	118	50	118
EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	5 µg/L	70.6	44	118
EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	5 µg/L	111	44	129
EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	5 µg/L	72.1	49	115
EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	5 µg/L	70.8	41	111
EP068: Ethion	563-12-2	0.5	µg/L	<0.5	5 µg/L	97.2	50	127
EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	5 µg/L	88.3	43	121
EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	5 µg/L	105	49	121
EP068: Malathion	121-75-5	0.5	µg/L	<0.5	5 µg/L	91.8	51	122
EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	5 µg/L	# 2.88	16	49
EP068: Parathion	56-38-2	2	µg/L	<2.0	5 µg/L	94.4	43	123
EP068: Parathion-methyl	298-00-0	----	µg/L	----	5 µg/L	89.4	50	118
EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	5 µg/L	113	52	126
EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	5 µg/L	87.6	53	126
EP075(SIM)A: Phenolic Compounds (QCLot: 172110)								
EP075(SIM): 2.4.5-Trichlorophenol	95-95-4	1	µg/L	<1.0	10 µg/L	106	54	108
EP075(SIM): 2.4.6-Trichlorophenol	88-06-2	1	µg/L	<1.0	10 µg/L	88.9	54	106
EP075(SIM): 2.4-Dichlorophenol	120-83-2	1	µg/L	<1.0	10 µg/L	86.8	55	115
EP075(SIM): 2.4-Dimethylphenol	105-67-9	1	µg/L	<1.0	10 µg/L	84.8	39	109
EP075(SIM): 2.6-Dichlorophenol	87-65-0	1	µg/L	<1.0	10 µg/L	84.9	53	106
EP075(SIM): 2-Chlorophenol	95-57-8	1	µg/L	<1.0	10 µg/L	100.0	52	102
EP075(SIM): 2-Methylphenol	95-48-7	1	µg/L	<1.0	10 µg/L	73.2	46	102
EP075(SIM): 2-Nitrophenol	88-75-5	1	µg/L	<1.0	10 µg/L	84.6	43	119
EP075(SIM): 3- & 4-Methylphenol	1319-77-3	2	µg/L	<2.0	20 µg/L	58.2	40	101
EP075(SIM): 4-Chloro-3-methylphenol	59-50-7	1	µg/L	<1.0	10 µg/L	83.0	40	102
EP075(SIM): Pentachlorophenol	87-86-5	2	µg/L	<2.0	20 µg/L	118	21	135
EP075(SIM): Phenol	108-95-2	1	µg/L	<1.0	10 µg/L	47.1	19	54

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP080/071: Total Petroleum Hydrocarbons (QCLot: 172108)								
EP071: C10 - C14 Fraction	----	50	µg/L	<50	1211 µg/L	88.2	38	114
EP071: C15 - C28 Fraction	----	100	µg/L	<100	2103 µg/L	84.4	50	132
EP071: C29 - C36 Fraction	----	50	µg/L	<50	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons (QCLot: 175170)								
EP080: C6 - C9 Fraction	----	20	µg/L	<20	160 µg/L	97.0	76	122
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 172108)								
EP071: >C10 - C16 Fraction	>C10_C16	100	µg/L	<100	1696 µg/L	87.0	43	119
EP071: >C16 - C34 Fraction	----	100	µg/L	<100	1496 µg/L	84.4	49	134
EP071: >C34 - C40 Fraction	----	100	µg/L	<100	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 175170)								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	185 µg/L	95.3	75	123
EP080: C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	----	----	----	----
EP080: BTEXN (QCLot: 175170)								
EP080: Benzene	71-43-2	1	µg/L	<1	10 µg/L	103	77	119
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	98.9	78	119
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	20 µg/L	99.6	77	121
EP080: Naphthalene	91-20-3	5	µg/L	<5	10 µg/L	82.6	75	120
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	95.7	76	121
EP080: Sum of BTEX	----	1	µg/L	<1	----	----	----	----
EP080: Toluene	108-88-3	2	µg/L	<2	10 µg/L	104	78	122
EP080: Total Xylenes	1330-20-7	2	µg/L	<2	----	----	----	----
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 174001)								
EP132: 2-Methylnaphthalene	91-57-6	0.1	µg/L	<0.1	2 µg/L	76.8	59	123
EP132: 3-Methylcholanthrene	56-49-5	0.1	µg/L	<0.1	2 µg/L	76.0	60	120
EP132: 7.12-Dimethylbenz(a)anthracene	57-97-6	0.1	µg/L	<0.1	2 µg/L	76.2	12	156
EP132: Acenaphthene	83-32-9	0.1	µg/L	<0.1	2 µg/L	80.2	64	122
EP132: Acenaphthylene	208-96-8	0.1	µg/L	<0.1	2 µg/L	87.5	62	124
EP132: Anthracene	120-12-7	0.1	µg/L	<0.1	2 µg/L	86.1	66	124
EP132: Benz(a)anthracene	56-55-3	0.1	µg/L	<0.1	2 µg/L	86.9	64	130
EP132: Benzo(a)pyrene	50-32-8	0.05	µg/L	<0.05	2 µg/L	86.2	64	126
EP132: Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.1	µg/L	<0.1	2 µg/L	86.0	62	126
EP132: Benzo(e)pyrene	192-97-2	0.1	µg/L	<0.1	2 µg/L	86.2	62	126
EP132: Benzo(g.h.i)perylene	191-24-2	0.1	µg/L	<0.1	2 µg/L	76.6	56	126
EP132: Benzo(k)fluoranthene	207-08-9	0.1	µg/L	<0.1	2 µg/L	90.2	63	127
EP132: Chrysene	218-01-9	0.1	µg/L	<0.1	2 µg/L	80.2	64	128

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 174001) - continued								
EP132: Coronene	191-07-1	0.1	µg/L	<0.1	2 µg/L	52.3	35	133
EP132: Dibenz(a.h)anthracene	53-70-3	0.1	µg/L	<0.1	2 µg/L	78.0	58	128
EP132: Fluoranthene	206-44-0	0.1	µg/L	<0.1	2 µg/L	93.7	65	127
EP132: Fluorene	86-73-7	0.1	µg/L	<0.1	2 µg/L	88.1	64	124
EP132: Indeno(1.2.3.cd)pyrene	193-39-5	0.1	µg/L	<0.1	2 µg/L	76.9	57	127
EP132: N-2-Fluorenyl Acetamide	53-96-3	0.1	µg/L	<0.1	2 µg/L	80.3	54	131
EP132: Naphthalene	91-20-3	0.1	µg/L	<0.1	2 µg/L	79.0	60	124
EP132: Perylene	198-55-0	0.1	µg/L	<0.1	2 µg/L	85.0	64	124
EP132: Phenanthrene	85-01-8	0.1	µg/L	<0.1	2 µg/L	86.5	65	125
EP132: Pyrene	129-00-0	0.1	µg/L	<0.1	2 µg/L	94.3	66	128

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED009: Anions (QCLot: 171019)							
EB1524503-021	Anonymous	ED009-X: Bromide	24959-67-9	0.5 mg/L	95.4	70	130
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 173819)							
EB1524306-002	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	# Not Determined	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 173818)							
EB1524306-002	Anonymous	ED045G: Chloride	16887-00-6	400 mg/L	# Not Determined	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 171223)							
EB1524383-001	Anonymous	EG020A-F: Aluminium	7429-90-5	0.5 mg/L	74.3	70	130
		EG020A-F: Arsenic	7440-38-2	0.1 mg/L	74.2	70	130
		EG020A-F: Boron	7440-42-8	0.5 mg/L	# Not Determined	70	130
		EG020A-F: Cadmium	7440-43-9	0.1 mg/L	74.0	70	130
		EG020A-F: Chromium	7440-47-3	0.1 mg/L	73.1	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	70.8	70	130
		EG020A-F: Lead	7439-92-1	0.1 mg/L	70.1	70	130
		EG020A-F: Manganese	7439-96-5	0.1 mg/L	74.2	70	130
		EG020A-F: Nickel	7440-02-0	0.1 mg/L	75.0	70	130
		EG020A-F: Selenium	7782-49-2	0.1 mg/L	107	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 171223) - continued							
EB1524383-001	Anonymous	EG020A-F: Zinc	7440-66-6	0.2 mg/L	72.7	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 171225)							
EB1524383-001	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	81.9	70	130
EG051G: Ferrous Iron by Discrete Analyser (QCLot: 172524)							
EB1524394-004	Anonymous	EG051G: Ferrous Iron	----	2 mg/L	110	70	130
EK040P: Fluoride by PC Titrator (QCLot: 171195)							
EB1524541-001	Anonymous	EK040P: Fluoride	16984-48-8	6.1 mg/L	83.1	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 172037)							
EB1524516-002	Anonymous	EK055G: Ammonia as N	7664-41-7	0.4 mg/L	91.8	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 172038)							
EB1524516-002	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.4 mg/L	# Not Determined	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 175418)							
EB1524464-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	# Not Determined	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 175417)							
EB1524464-002	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	# Not Determined	70	130
EP005: Total Organic Carbon (TOC) (QCLot: 171057)							
EB1524519-002	Anonymous	EP005: Total Organic Carbon	----	100 mg/L	95.6	70	130
EP068A: Organochlorine Pesticides (OC) (QCLot: 172109)							
EB1524521-001	GARA6	EP068: 4.4`-DDT	50-29-3	4 µg/L	# 55.5	70	130
		EP068: Aldrin	309-00-2	1 µg/L	85.2	70	130
		EP068: Dieldrin	60-57-1	1 µg/L	82.3	70	130
		EP068: Endrin	72-20-8	4 µg/L	81.5	70	130
		EP068: gamma-BHC	58-89-9	1 µg/L	114	70	130
		EP068: Heptachlor	76-44-8	1 µg/L	101	70	130
EP068B: Organophosphorus Pesticides (OP) (QCLot: 172109)							
EB1524521-001	GARA6	EP068: Bromophos-ethyl	4824-78-6	1 µg/L	91.8	70	130
		EP068: Chlorpyrifos-methyl	5598-13-0	1 µg/L	85.1	70	130
		EP068: Diazinon	333-41-5	1 µg/L	126	70	130
		EP068: Pirimphos-ethyl	23505-41-1	1 µg/L	84.0	70	130
		EP068: Prothiofos	34643-46-4	1 µg/L	94.0	70	130
EP075(SIM)A: Phenolic Compounds (QCLot: 172110)							
EB1524521-001	GARA6	EP075(SIM): 2-Chlorophenol	95-57-8	10 µg/L	87.6	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EP075(SIM)A: Phenolic Compounds (QCLot: 172110) - continued							
EB1524521-001	GARA6	EP075(SIM): 2-Nitrophenol	88-75-5	10 µg/L	84.8	70	130
		EP075(SIM): 4-Chloro-3-methylphenol	59-50-7	10 µg/L	84.3	70	130
		EP075(SIM): Pentachlorophenol	87-86-5	10 µg/L	118	70	130
		EP075(SIM): Phenol	108-95-2	10 µg/L	39.4	20	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 175170)							
EB1524521-001	GARA6	EP080: C6 - C9 Fraction	----	40 µg/L	121	70	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 175170)							
EB1524521-001	GARA6	EP080: C6 - C10 Fraction	C6_C10	40 µg/L	110	70	130
EP080: BTEXN (QCLot: 175170)							
EB1524521-001	GARA6	EP080: Benzene	71-43-2	10 µg/L	105	70	130
		EP080: Toluene	108-88-3	10 µg/L	91.9	70	130

QA/QC Compliance Assessment for DQO Reporting

Work Order	: **EB1524521**	Page	: 1 of 10
Client	: **CODYHART CONSULTING PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS BARBARA HART	Telephone	: +61-7-3243 7222
Project	: Armidale Regional 2119	Date Samples Received	: 30-Jul-2015
Site	: Armidale Regional Landfill	Issue Date	: 11-Aug-2015
Sampler	: BARBARA HART	No. of samples received	: 1
Order number	: ----	No. of samples analysed	: 1

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **Laboratory Control outliers exist - please see following pages for full details.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	**Analyte**	CAS Number	Data	Limits	**Comment**
Laboratory Control Spike (LCS) Recoveries							
EP068B: Organophosphorus Pesticides (OP)	QC-172109-002	----	**Monocrotophos**	6923-22-4	2.88 %	16-49%	**Recovery less than lower control limit**
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	EB1524306--002	Anonymous	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
ED045G: Chloride by Discrete Analyser	EB1524306--002	Anonymous	**Chloride**	16887-00-6	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG020F: Dissolved Metals by ICP-MS	EB1524383--001	Anonymous	**Boron**	7440-42-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Ar	EB1524516--002	Anonymous	**Nitrite + Nitrate as N**	----	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser	EB1524464--002	Anonymous	**Total Kjeldahl Nitrogen as N**	----	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK067G: Total Phosphorus as P by Discrete Analyser	EB1524464--002	Anonymous	**Total Phosphorus as P**	----	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EP068A: Organochlorine Pesticides (OC)	EB1524521--001	GARA6	**4.4`-DDT**	50-29-3	55.5 %	70-130%	**Recovery less than lower data quality objective**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
PAH/Phenols (GC/MS - SIM)	1	13	7.69	10.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	0	10	0.00	10.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	0	9	0.00	10.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)					
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	0	10	0.00	5.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	0	9	0.00	5.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	*Sample Date*	*Extraction / Preparation*			*Analysis*		
Container */ Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA015: Total Dissolved Solids							
Clear Plastic Bottle - Natural (EA015H)							
GARA6	**29-Jul-2015**	**----**	----	----	**03-Aug-2015**	05-Aug-2015	✓
EA025: Suspended Solids							
Clear Plastic Bottle - Natural (EA025H)							
GARA6	**29-Jul-2015**	**----**	----	----	**03-Aug-2015**	05-Aug-2015	✓
ED009: Anions							
Clear Plastic Bottle - Natural (ED009-X)							
GARA6	**29-Jul-2015**	**----**	----	----	**03-Aug-2015**	26-Aug-2015	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
GARA6	**29-Jul-2015**	**----**	----	----	**03-Aug-2015**	12-Aug-2015	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
GARA6	**29-Jul-2015**	**----**	----	----	**05-Aug-2015**	26-Aug-2015	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
GARA6	**29-Jul-2015**	**----**	----	----	**05-Aug-2015**	26-Aug-2015	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
GARA6	**29-Jul-2015**	**----**	----	----	**03-Aug-2015**	26-Aug-2015	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
GARA6	**29-Jul-2015**	**----**	----	----	**03-Aug-2015**	25-Jan-2016	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
GARA6	**29-Jul-2015**	**----**	----	----	**04-Aug-2015**	26-Aug-2015	✓
EG051G: Ferrous Iron by Discrete Analyser							
Clear Plastic Bottle - HCl - Filtered (EG051G)							
GARA6	**29-Jul-2015**	**----**	----	----	**04-Aug-2015**	05-Aug-2015	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P)							
GARA6	**29-Jul-2015**	**----**	----	----	**03-Aug-2015**	26-Aug-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
GARA6	**29-Jul-2015**	**----**	----	----	**04-Aug-2015**	26-Aug-2015	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
GARA6	**29-Jul-2015**	**----**	----	----	**04-Aug-2015**	26-Aug-2015	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G)							
GARA6	**29-Jul-2015**	**06-Aug-2015**	26-Aug-2015	✓	**06-Aug-2015**	26-Aug-2015	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G)							
GARA6	**29-Jul-2015**	**06-Aug-2015**	26-Aug-2015	✓	**06-Aug-2015**	26-Aug-2015	✓
EP005: Total Organic Carbon (TOC)							
Amber TOC Vial - Sulfuric Acid (EP005)							
GARA6	**29-Jul-2015**	**----**	----	----	**03-Aug-2015**	26-Aug-2015	✓
EP068A: Organochlorine Pesticides (OC)							
Amber Glass Bottle - Unpreserved (EP068)							
GARA6	**29-Jul-2015**	**03-Aug-2015**	05-Aug-2015	✓	**04-Aug-2015**	12-Sep-2015	✓
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071)							
GARA6	**29-Jul-2015**	**03-Aug-2015**	05-Aug-2015	✓	**04-Aug-2015**	12-Sep-2015	✓
EP075(SIM)T: PAH Surrogates							
Amber Glass Bottle - Unpreserved (EP075(SIM))							
GARA6	**29-Jul-2015**	**03-Aug-2015**	05-Aug-2015	✓	**04-Aug-2015**	12-Sep-2015	✓
EP080S: TPH(V)/BTEX Surrogates							
Amber VOC Vial - Sulfuric Acid (EP080)							
GARA6	**29-Jul-2015**	**07-Aug-2015**	12-Aug-2015	✓	**07-Aug-2015**	12-Aug-2015	✓
EP132B: Polynuclear Aromatic Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP132)							
GARA6	**29-Jul-2015**	**05-Aug-2015**	05-Aug-2015	✓	**11-Aug-2015**	14-Sep-2015	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		*Count*		*Rate (%)*			*Quality Control Specification*
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	1	10	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ammonia as N by Discrete analyser	EK055G	2	19	**10.53**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	4	**25.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	14	**14.29**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ferrous Iron by Discrete Analyser	EG051G	2	12	**16.67**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Fluoride by PC Titrator	EK040P	1	9	**11.11**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Major Cations - Dissolved	ED093F	2	9	**22.22**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	18	**11.11**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	13	**7.69**	**10.00**	✗	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	2	**50.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	0	10	**0.00**	**10.00**	✗	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Standard Anions -by IC (Extended Method)	ED009-X	1	6	**16.67**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Suspended Solids (High Level)	EA025H	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids (High Level)	EA015H	2	10	**20.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Organic Carbon	EP005	2	19	**10.53**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	0	9	**0.00**	**10.00**	✗	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH Volatiles/BTEX	EP080	2	18	**11.11**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	10	**10.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	4	**25.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	14	**7.14**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ferrous Iron by Discrete Analyser	EG051G	1	12	**8.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Fluoride by PC Titrator	EK040P	1	9	**11.11**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	13	**7.69**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	1	10	**10.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Standard Anions -by IC (Extended Method)	ED009-X	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Suspended Solids (High Level)	EA025H	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Control Samples (LCS) - Continued							
Total Dissolved Solids (High Level)	EA015H	2	10	**20.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Organic Carbon	EP005	2	19	**10.53**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	1	9	**11.11**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH Volatiles/BTEX	EP080	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	4	**25.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	14	**7.14**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ferrous Iron by Discrete Analyser	EG051G	1	12	**8.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Fluoride by PC Titrator	EK040P	1	9	**11.11**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Major Cations - Dissolved	ED093F	1	9	**11.11**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	13	**7.69**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	1	10	**10.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Standard Anions -by IC (Extended Method)	ED009-X	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Suspended Solids (High Level)	EA025H	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Dissolved Solids (High Level)	EA015H	1	10	**10.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Organic Carbon	EP005	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	1	9	**11.11**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH Volatiles/BTEX	EP080	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	4	**25.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	14	**7.14**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ferrous Iron by Discrete Analyser	EG051G	1	12	**8.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Fluoride by PC Titrator	EK040P	1	9	**11.11**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	13	**7.69**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	2	**50.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	0	10	**0.00**	**5.00**	×	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Standard Anions -by IC (Extended Method)	ED009-X	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type *Analytical Methods*	*Method*	*Count* *QC*	 *Regular*	*Rate (%)* ***Actual***	 ***Expected***	 *Evaluation*	*Quality Control Specification*
Matrix Spikes (MS) - Continued							
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Organic Carbon	EP005	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH - Semivolatile Fraction	EP071	0	9	**0.00**	**5.00**	✗	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
TRH Volatiles/BTEX	EP080	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Hardness as CaCO3	EA065	WATER	In house: Referenced to APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Standard Anions -by IC (Extended Method)	ED009-X	WATER	In house: Referenced to APHA 4110. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocyanate forms highly-coloured ferric thiocyanate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45 um filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ferrous Iron by Discrete Analyser	EG051G	WATER	In house: Referenced to APHA 3500 Fe-B. A colorimetric determination based on the reaction between phenanthroline and ferrous iron at pH 3.2-3.3 to form an orange-red complex that is measured against a five-point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500 F--C CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM (2013) Schedule B(3)
Pesticides by GCMS	EP068	WATER	USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	WATER	USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
TRH Volatiles/BTEX	EP080	WATER	USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	WATER	USEPA 3640 (GPC Cleanup), 8270 GCMS Capiliary column, SIM mode. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
TKN/TP Digestion	EK061/EK067	WATER	APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

CERTIFICATE OF ANALYSIS

Work Order	: **EB1524610**	Page	: 1 of 8
Client	: **CODYHART CONSULTING PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS BARBARA HART	Contact	: Customer Services EB
Address	: P O BOX 1073 BURLEIGH HEADS QLD, AUSTRALIA 4220	Address	: 2 Byth Street Stafford QLD Australia 4053
E-mail	: pelican@codyhart.com.au	E-mail	: ALSEnviro.Brisbane@alsglobal.com
Telephone	: +61 55205532	Telephone	: +61-7-3243 7222
Facsimile	: +61 07 55206531	Facsimile	: +61-7-3243 7218
Project	: Armidale Regional 2119	QC Level	: NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Order number	: ----	Date Samples Received	: 31-Jul-2015 10:50
C-O-C number	: ----	Date Analysis Commenced	: 03-Aug-2015
Sampler	: BARBARA HART	Issue Date	: 11-Aug-2015 16:12
Site	: Armidale Regional Landfill		
		No. of samples received	: 3
Quote number	: ----	No. of samples analysed	: 3

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

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*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Organics
Ryan Story	2IC Organic Instrument Chemist	Brisbane Organics
Xing Lin	Senior Organic Chemist	Melbourne Organics

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
ø = ALS is not NATA accredited for these tests.

- EP074-WF: Particular samples (EB-1524610-001,002,003) show minor hit of Chloroform. Confirmed by re-analysis.
- Total PAH reported as the sum of Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene and Benzo(g,h,i)perylene.

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Client sample ID	**ABH9**	**ABH11**	**ABH12**	**----**	**----**
			Client sampling date / time	30-Jul-2015 12:00	30-Jul-2015 10:00	30-Jul-2015 14:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524610-001**	**EB1524610-002**	**EB1524610-003**	**--------**	**--------**
				Result	Result	Result	Result	Result
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	**108**	**338**	**555**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**108**	**338**	**555**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**127**	**100**	**111**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**388**	**164**	**82**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**64**	**91**	**121**	----	----
Magnesium	7439-95-4	1	mg/L	**82**	**50**	**46**	----	----
Sodium	7440-23-5	1	mg/L	**89**	**100**	**127**	----	----
Potassium	7440-09-7	1	mg/L	**5**	<1	**1**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Copper	7440-50-8	0.001	mg/L	**0.001**	**0.001**	**0.002**	----	----
Nickel	7440-02-0	0.001	mg/L	**0.007**	<0.001	**0.001**	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	**0.001**	**0.001**	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Zinc	7440-66-6	0.005	mg/L	**0.034**	**0.013**	**0.035**	----	----
Manganese	7439-96-5	0.001	mg/L	**0.882**	<0.001	**0.027**	----	----
Iron	7439-89-6	0.05	mg/L	**0.05**	<0.05	<0.05	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
EG051G: Ferrous Iron by Discrete Analyser								
Ferrous Iron	----	0.05	mg/L	<0.05	<0.05	<0.05	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.01**	<0.01	<0.01	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.39**	**0.44**	**0.13**	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**ABH9**	**ABH11**	**ABH12**	----	----
			Client sampling date / time	30-Jul-2015 12:00	30-Jul-2015 10:00	30-Jul-2015 14:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524610-001**	**EB1524610-002**	**EB1524610-003**	--------	--------
				Result	Result	Result	Result	Result
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**0.2**	**0.2**	**0.2**	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**0.6**	**0.6**	**0.3**	----	----
EN055: Ionic Balance								
^ **Total Anions**	----	0.01	meq/L	**15.7**	**13.5**	**15.7**	----	----
^ **Total Cations**	----	0.01	meq/L	**13.9**	**13.0**	**15.4**	----	----
^ **Ionic Balance**	----	0.01	%	**6.07**	**1.72**	**1.10**	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**1**	**1**	**1**	----	----
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	<0.5	----	----
beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	<0.5	----	----
gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	<0.5	----	----
delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	<0.5	----	----
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	<0.5	----	----
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	----	----
4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	<0.5	----	----
4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
4.4`-DDT	50-29-3	2	µg/L	<2.0	<2.0	<2.0	----	----
Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Methoxychlor	72-43-5	2	µg/L	<2.0	<2.0	<2.0	----	----
^ **Total Chlordane (sum)**	----	0.5	µg/L	<0.5	<0.5	<0.5	----	----
^ **Sum of DDD + DDE + DDT**	----	0.5	µg/L	<0.5	<0.5	<0.5	----	----
^ **Sum of Aldrin + Dieldrin**	309-00-2/60-57-1	0.5	µg/L	<0.5	<0.5	<0.5	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**ABH9**	**ABH11**	**ABH12**	**----**	**----**
			Client sampling date / time	30-Jul-2015 12:00	30-Jul-2015 10:00	30-Jul-2015 14:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524610-001**	**EB1524610-002**	**EB1524610-003**	**--------**	**--------**
				Result	Result	Result	Result	Result
EP068B: Organophosphorus Pesticides (OP)								
Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Monocrotophos	6923-22-4	2	µg/L	<2.0	<2.0	<2.0	----	----
Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Parathion-methyl	298-00-0	2	µg/L	<2.0	<2.0	<2.0	----	----
Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Parathion	56-38-2	2	µg/L	<2.0	<2.0	<2.0	----	----
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	<0.5	----	----
Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	<0.5	----	----
EP074A: Monocyclic Aromatic Hydrocarbons								
Benzene	71-43-2	1	µg/L	<1	<1	<1	----	----
Toluene	108-88-3	1	µg/L	<1	<1	<1	----	----
Ethylbenzene	100-41-4	1	µg/L	<1	<1	<1	----	----
meta- & para-Xylene	108-38-3 106-42-3	1	µg/L	<1	<1	<1	----	----
Styrene	100-42-5	1	µg/L	<1	<1	<1	----	----
ortho-Xylene	95-47-6	1	µg/L	<1	<1	<1	----	----
Isopropylbenzene	98-82-8	1	µg/L	<1	<1	<1	----	----
n-Propylbenzene	103-65-1	1	µg/L	<1	<1	<1	----	----
1.3.5-Trimethylbenzene	108-67-8	1	µg/L	<1	<1	<1	----	----
sec-Butylbenzene	135-98-8	1	µg/L	<1	<1	<1	----	----
1.2.4-Trimethylbenzene	95-63-6	1	µg/L	<1	<1	<1	----	----
tert-Butylbenzene	98-06-6	1	µg/L	<1	<1	<1	----	----
p-Isopropyltoluene	99-87-6	1	µg/L	<1	<1	<1	----	----
n-Butylbenzene	104-51-8	1	µg/L	<1	<1	<1	----	----

Analytical Results

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

			Client sample ID	**ABH9**	**ABH11**	**ABH12**	**----**	**----**
			Client sampling date / time	30-Jul-2015 12:00	30-Jul-2015 10:00	30-Jul-2015 14:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524610-001**	**EB1524610-002**	**EB1524610-003**	**--------**	**--------**
				Result	Result	Result	Result	Result
EP074B: Oxygenated Compounds								
2-Propanone (Acetone)	67-64-1	10	µg/L	<10	<10	<10	----	----
Vinyl Acetate	108-05-4	10	µg/L	<10	<10	<10	----	----
2-Butanone (MEK)	78-93-3	10	µg/L	<10	<10	<10	----	----
4-Methyl-2-pentanone (MIBK)	108-10-1	10	µg/L	<10	<10	<10	----	----
2-Hexanone (MBK)	591-78-6	10	µg/L	<10	<10	<10	----	----
EP074C: Sulfonated Compounds								
Carbon disulfide	75-15-0	1	µg/L	<1	<1	<1	----	----
EP074D: Fumigants								
2.2-Dichloropropane	594-20-7	1	µg/L	<1	<1	<1	----	----
1.2-Dichloropropane	78-87-5	1	µg/L	<1	<1	<1	----	----
cis-1.3-Dichloropropylene	10061-01-5	2	µg/L	<2	<2	<2	----	----
trans-1.3-Dichloropropylene	10061-02-6	2	µg/L	<2	<2	<2	----	----
1.2-Dibromoethane (EDB)	106-93-4	1	µg/L	<1	<1	<1	----	----
EP074E: Halogenated Aliphatic Compounds								
Dichlorodifluoromethane	75-71-8	10	µg/L	<10	<10	<10	----	----
Chloromethane	74-87-3	10	µg/L	<10	<10	<10	----	----
Vinyl chloride	75-01-4	10	µg/L	<10.0	<10.0	<10.0	----	----
Bromomethane	74-83-9	10	µg/L	<10	<10	<10	----	----
Chloroethane	75-00-3	10	µg/L	<10	<10	<10	----	----
Trichlorofluoromethane	75-69-4	10	µg/L	<10	<10	<10	----	----
1.1-Dichloroethene	75-35-4	1	µg/L	<1	<1	<1	----	----
Iodomethane	74-88-4	1	µg/L	<1	<1	<1	----	----
Methylene chloride	75-09-2	5	µg/L	<5	<5	<5	----	----
trans-1.2-Dichloroethene	156-60-5	1	µg/L	<1	<1	<1	----	----
1.1-Dichloroethane	75-34-3	1	µg/L	<1	<1	<1	----	----
cis-1.2-Dichloroethene	156-59-2	1	µg/L	<1	<1	<1	----	----
1.1.1-Trichloroethane	71-55-6	1	µg/L	<1	<1	<1	----	----
1.1-Dichloropropylene	563-58-6	1	µg/L	<1	<1	<1	----	----
Carbon Tetrachloride	56-23-5	1	µg/L	<1	<1	<1	----	----
1.2-Dichloroethane	107-06-2	1	µg/L	<1	<1	<1	----	----
Trichloroethene	79-01-6	1	µg/L	<1	<1	<1	----	----
Dibromomethane	74-95-3	1	µg/L	<1	<1	<1	----	----
1.1.2-Trichloroethane	79-00-5	1	µg/L	<1	<1	<1	----	----
1.3-Dichloropropane	142-28-9	1	µg/L	<1	<1	<1	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Client sample ID	**ABH9**	**ABH11**	**ABH12**	**----**	**----**
			Client sampling date / time	30-Jul-2015 12:00	30-Jul-2015 10:00	30-Jul-2015 14:00	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EB1524610-001**	**EB1524610-002**	**EB1524610-003**	**--------**	**--------**
				Result	Result	Result	Result	Result
EP074E: Halogenated Aliphatic Compounds - Continued								
Tetrachloroethene	127-18-4	1	µg/L	<1	<1	<1	----	----
1.1.1.2-Tetrachloroethane	630-20-6	1	µg/L	<1	<1	<1	----	----
trans-1.4-Dichloro-2-butene	110-57-6	1	µg/L	<1	<1	<1	----	----
cis-1.4-Dichloro-2-butene	1476-11-5	1	µg/L	<1	<1	<1	----	----
1.1.2.2-Tetrachloroethane	79-34-5	1	µg/L	<1	<1	<1	----	----
1.2.3-Trichloropropane	96-18-4	1	µg/L	<1	<1	<1	----	----
Pentachloroethane	76-01-7	1	µg/L	<1	<1	<1	----	----
1.2-Dibromo-3-chloropropane	96-12-8	1	µg/L	<1	<1	<1	----	----
Hexachlorobutadiene	87-68-3	1	µg/L	<1.0	<1.0	<1.0	----	----
EP074F: Halogenated Aromatic Compounds								
Chlorobenzene	108-90-7	1	µg/L	<1	<1	<1	----	----
Bromobenzene	108-86-1	1	µg/L	<1	<1	<1	----	----
2-Chlorotoluene	95-49-8	1	µg/L	<1	<1	<1	----	----
4-Chlorotoluene	106-43-4	1	µg/L	<1	<1	<1	----	----
1.3-Dichlorobenzene	541-73-1	1	µg/L	<1	<1	<1	----	----
1.4-Dichlorobenzene	106-46-7	1	µg/L	<1.0	<1.0	<1.0	----	----
1.2-Dichlorobenzene	95-50-1	1	µg/L	<1	<1	<1	----	----
1.2.4-Trichlorobenzene	120-82-1	1	µg/L	<1	<1	<1	----	----
1.2.3-Trichlorobenzene	87-61-6	1	µg/L	<1	<1	<1	----	----
EP074G: Trihalomethanes								
Chloroform	67-66-3	1	µg/L	**5**	**6**	**1**	----	----
Bromodichloromethane	75-27-4	1	µg/L	<1	<1	<1	----	----
Dibromochloromethane	124-48-1	1	µg/L	<1	<1	<1	----	----
Bromoform	75-25-2	1	µg/L	<1	<1	<1	----	----
EP074H: Naphthalene								
Naphthalene	91-20-3	5	µg/L	<5	<5	<5	----	----
EP132B: Polynuclear Aromatic Hydrocarbons								
3-Methylcholanthrene	56-49-5	0.1	µg/L	<0.1	<0.1	<0.1	----	----
2-Methylnaphthalene	91-57-6	0.1	µg/L	<0.1	<0.1	<0.1	----	----
7.12-Dimethylbenz(a)anthracene	57-97-6	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Acenaphthene	83-32-9	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Acenaphthylene	208-96-8	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Anthracene	120-12-7	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Benz(a)anthracene	56-55-3	0.1	µg/L	<0.1	<0.1	<0.1	----	----

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			Client sample ID	**ABH9**	**ABH11**	**ABH12**	**----**	**----**
			Client sampling date / time	30-Jul-2015 12:00	30-Jul-2015 10:00	30-Jul-2015 14:00	----	----
Compound	CAS Number	LOR	Unit	**EB1524610-001**	**EB1524610-002**	**EB1524610-003**	**--------**	**--------**
				Result	Result	Result	Result	Result
EP132B: Polynuclear Aromatic Hydrocarbons - Continued								
Benzo(a)pyrene	50-32-8	0.05	µg/L	<0.05	<0.05	<0.05	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Benzo(e)pyrene	192-97-2	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Benzo(g.h.i)perylene	191-24-2	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Benzo(k)fluoranthene	207-08-9	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Chrysene	218-01-9	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Coronene	191-07-1	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Dibenz(a.h)anthracene	53-70-3	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Fluoranthene	206-44-0	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Fluorene	86-73-7	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	0.1	µg/L	<0.1	<0.1	<0.1	----	----
N-2-Fluorenyl Acetamide	53-96-3	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Naphthalene	91-20-3	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Perylene	198-55-0	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Phenanthrene	85-01-8	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Pyrene	129-00-0	0.1	µg/L	<0.1	<0.1	<0.1	----	----
Sum of PAHs	----	0.05	µg/L	<0.05	<0.05	<0.05	----	----
Benzo(a)pyrene TEQ (zero)	----	0.05	µg/L	<0.05	<0.05	<0.05	----	----
EP068S: Organochlorine Pesticide Surrogate								
Dibromo-DDE	21655-73-2	0.5	%	**56.9**	**55.0**	**61.7**	----	----
EP068T: Organophosphorus Pesticide Surrogate								
DEF	78-48-8	0.5	%	**69.6**	**66.6**	**75.1**	----	----
EP074S: VOC Surrogates								
1.2-Dichloroethane-D4	17060-07-0	1	%	**88.2**	**98.2**	**97.4**	----	----
Toluene-D8	2037-26-5	1	%	**100**	**109**	**104**	----	----
4-Bromofluorobenzene	460-00-4	1	%	**89.0**	**102**	**96.7**	----	----
EP132T: Base/Neutral Extractable Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	**85.2**	**64.7**	**80.5**	----	----
Anthracene-d10	1719-06-8	0.1	%	**110**	**79.2**	**103**	----	----
4-Terphenyl-d14	1718-51-0	0.1	%	**113**	**89.9**	**108**	----	----

QUALITY CONTROL REPORT

Work Order : **EB1524610**

Client : **CODYHART CONSULTING PTY LTD**
Contact : MS BARBARA HART
Address : P O BOX 1073
BURLEIGH HEADS QLD, AUSTRALIA 4220
E-mail : pelican@codyhart.com.au
Telephone : +61 55205532
Facsimile : +61 07 55206531
Project : Armidale Regional 2119
Order number : ----
C-O-C number : ----
Sampler : BARBARA HART
Site : Armidale Regional Landfill
Quote number : ----

Page : 1 of 14

Laboratory : Environmental Division Brisbane
Contact : Customer Services EB
Address : 2 Byth Street Stafford QLD Australia 4053
E-mail : ALSEnviro.Brisbane@alsglobal.com
Telephone : +61-7-3243 7222
Facsimile : +61-7-3243 7218
QC Level : NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Date Samples Received : 31-Jul-2015
Date Analysis Commenced : 03-Aug-2015
Issue Date : 11-Aug-2015
No. of samples received : 3
No. of samples analysed : 3

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

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Laboratory 825

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compliance with
ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Andrew Epps	Senior Inorganic Chemist	Brisbane Inorganics
Kim McCabe	Senior Inorganic Chemist	Brisbane Inorganics
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General Comments

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

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

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

Key :
Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
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
RPD = Relative Percentage Difference
# = Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
ED037P: Alkalinity by PC Titrator (QC Lot: 171194)									
EB1524519-001	Anonymous	ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	544	543	0.353	0% - 20%
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	544	543	0.353	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 173826)									
EB1524711-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	60	62	3.01	0% - 20%
EB1524519-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	174	164	5.93	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 173827)									
EB1524519-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	419	418	0.00	0% - 20%
EB1524789-008	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	2900	2890	0.196	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 171217)									
EB1524607-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	103	103	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	38	39	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	9	9	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	400	405	1.28	0% - 20%
EB1524590-005	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	314	311	0.843	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	393	392	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	17	17	0.00	0% - 50%
		ED093F: Sodium	7440-23-5	1	mg/L	2780	2800	0.890	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 171219)									
EB1524607-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	0.003	0.002	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.044	0.045	0.00	0% - 20%
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.014	0.015	7.14	0% - 50%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.003	0.002	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.006	0.006	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EB1524590-005	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EG020F: Dissolved Metals by ICP-MS (QC Lot: 171219) - continued									
EB1524590-005	Anonymous	EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.167	0.168	0.00	0% - 20%
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	0.33	0.34	0.00	No Limit
EG035F: Dissolved Mercury by FIMS (QC Lot: 171218)									
EB1524607-002	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EB1524590-005	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG051G: Ferrous Iron by Discrete Analyser (QC Lot: 172524)									
EB1524394-001	Anonymous	EG051G: Ferrous Iron	----	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EB1524610-002	ABH11	EG051G: Ferrous Iron	----	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 172037)									
EB1524516-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	3.47	3.28	5.57	0% - 20%
EB1524519-006	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 172038)									
EB1524516-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.07	0.07	0.00	No Limit
EB1524519-006	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.61	0.62	0.00	0% - 20%
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 176688)									
EB1524519-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.2	0.1	0.00	No Limit
EB1524721-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EP005: Total Organic Carbon (TOC) (QC Lot: 171057)									
EB1524519-001	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	7	5	30.6	No Limit
EB1524610-003	ABH12	EP005: Total Organic Carbon	----	1	mg/L	1	4	102	No Limit
EP068A: Organochlorine Pesticides (OC) (QC Lot: 172751)									
EB1524610-003	ABH12	EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP068A: Organochlorine Pesticides (OC) (QC Lot: 172751) - continued									
EB1524610-003	ABH12	EP068: Endrin	72-20-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	<2.0	0.00	No Limit
EP068B: Organophosphorus Pesticides (OP) (QC Lot: 172751)									
EB1524610-003	ABH12	EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Ethion	563-12-2	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Malathion	121-75-5	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP068: Parathion	56-38-2	2	µg/L	<2.0	<2.0	0.00	No Limit
EP074A: Monocyclic Aromatic Hydrocarbons (QC Lot: 175012)									
EB1524610-001	ABH9	EP074-WF: 1.2.4-Trimethylbenzene	95-63-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.3.5-Trimethylbenzene	108-67-8	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Ethylbenzene	100-41-4	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Isopropylbenzene	98-82-8	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: meta- & para-Xylene	108-38-3 106-42-3	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: n-Butylbenzene	104-51-8	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: n-Propylbenzene	103-65-1	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: ortho-Xylene	95-47-6	1	µg/L	<1	<1	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP074A: Monocyclic Aromatic Hydrocarbons (QC Lot: 175012) - continued									
EB1524610-001	ABH9	EP074-WF: p-Isopropyltoluene	99-87-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: sec-Butylbenzene	135-98-8	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Styrene	100-42-5	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: tert-Butylbenzene	98-06-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Toluene	108-88-3	1	µg/L	<1	<1	0.00	No Limit
EP074B: Oxygenated Compounds (QC Lot: 175012)									
EB1524610-001	ABH9	EP074-WF: 2-Butanone (MEK)	78-93-3	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: 2-Hexanone (MBK)	591-78-6	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: 2-Propanone (Acetone)	67-64-1	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: 4-Methyl-2-pentanone (MIBK)	108-10-1	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: Vinyl Acetate	108-05-4	10	µg/L	<10	<10	0.00	No Limit
EP074C: Sulfonated Compounds (QC Lot: 175012)									
EB1524610-001	ABH9	EP074-WF: Carbon disulfide	75-15-0	1	µg/L	<1	<1	0.00	No Limit
EP074D: Fumigants (QC Lot: 175012)									
EB1524610-001	ABH9	EP074-WF: 1.2-Dibromoethane (EDB)	106-93-4	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.2-Dichloropropane	78-87-5	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 2.2-Dichloropropane	594-20-7	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: cis-1.3-Dichloropropylene	10061-01-5	2	µg/L	<2	<2	0.00	No Limit
		EP074-WF: trans-1.3-Dichloropropylene	10061-02-6	2	µg/L	<2	<2	0.00	No Limit
EP074E: Halogenated Aliphatic Compounds (QC Lot: 175012)									
EB1524610-001	ABH9	EP074-WF: Vinyl chloride	75-01-4	0.2	µg/L	<10.0	<10.0	0.00	No Limit
		EP074-WF: Hexachlorobutadiene	87-68-3	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EP074-WF: 1.1.1.2-Tetrachloroethane	630-20-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.1.1-Trichloroethane	71-55-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.1.2.2-Tetrachloroethane	79-34-5	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.1.2-Trichloroethane	79-00-5	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.1-Dichloroethane	75-34-3	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.1-Dichloroethene	75-35-4	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.1-Dichloropropylene	563-58-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.2.3-Trichloropropane	96-18-4	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.2-Dibromo-3-chloropropane	96-12-8	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.2-Dichloroethane	107-06-2	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.3-Dichloropropane	142-28-9	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Carbon Tetrachloride	56-23-5	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: cis-1.2-Dichloroethene	156-59-2	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: cis-1.4-Dichloro-2-butene	1476-11-5	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Dibromomethane	74-95-3	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Iodomethane	74-88-4	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Pentachloroethane	76-01-7	1	µg/L	<1	<1	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP074E: Halogenated Aliphatic Compounds (QC Lot: 175012) - continued									
EB1524610-001	ABH9	EP074-WF: Tetrachloroethene	127-18-4	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: trans-1.2-Dichloroethene	156-60-5	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: trans-1.4-Dichloro-2-butene	110-57-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Trichloroethene	79-01-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Bromomethane	74-83-9	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: Chloroethane	75-00-3	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: Chloromethane	74-87-3	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: Dichlorodifluoromethane	75-71-8	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: Trichlorofluoromethane	75-69-4	10	µg/L	<10	<10	0.00	No Limit
		EP074-WF: Methylene chloride	75-09-2	2	µg/L	<5	<5	0.00	No Limit
EP074F: Halogenated Aromatic Compounds (QC Lot: 175012)									
EB1524610-001	ABH9	EP074-WF: 1.4-Dichlorobenzene	106-46-7	0.1	µg/L	<1.0	<1.0	0.00	No Limit
		EP074-WF: 1.2.3-Trichlorobenzene	87-61-6	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.2.4-Trichlorobenzene	120-82-1	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.2-Dichlorobenzene	95-50-1	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 1.3-Dichlorobenzene	541-73-1	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 2-Chlorotoluene	95-49-8	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: 4-Chlorotoluene	106-43-4	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Bromobenzene	108-86-1	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Chlorobenzene	108-90-7	1	µg/L	<1	<1	0.00	No Limit
EP074G: Trihalomethanes (QC Lot: 175012)									
EB1524610-001	ABH9	EP074-WF: Bromodichloromethane	75-27-4	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Bromoform	75-25-2	1	µg/L	<1	<1	0.00	No Limit
		EP074-WF: Chloroform	67-66-3	1	µg/L	5	5	0.00	No Limit
		EP074-WF: Dibromochloromethane	124-48-1	1	µg/L	<1	<1	0.00	No Limit
EP074H: Naphthalene (QC Lot: 175012)									
EB1524610-001	ABH9	EP074-WF: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
ED037P: Alkalinity by PC Titrator (QCLot: 171194)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	104	87	112
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 173826)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	113	85	118
				<1	100 mg/L	101	85	118
ED045G: Chloride by Discrete Analyser (QCLot: 173827)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	111	90	115
				<1	1000 mg/L	102	90	115
ED093F: Dissolved Major Cations (QCLot: 171217)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	----	----	----	----
ED093F: Magnesium	7439-95-4	1	mg/L	<1	----	----	----	----
ED093F: Potassium	7440-09-7	1	mg/L	<1	----	----	----	----
ED093F: Sodium	7440-23-5	1	mg/L	<1	----	----	----	----
EG020F: Dissolved Metals by ICP-MS (QCLot: 171219)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	85.2	79	118
EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	0.1 mg/L	110	87	113
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	90.1	88	116
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	89.6	88	108
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	92.0	87	113
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.2 mg/L	91.1	88	114
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	87.4	82	114
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	94.0	89	110
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	89.5	89	120
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	93.4	89	113
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	86.4	83	112
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.2 mg/L	89.3	87	113
EG035F: Dissolved Mercury by FIMS (QCLot: 171218)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	87.7	84	118
EG051G: Ferrous Iron by Discrete Analyser (QCLot: 172524)								
EG051G: Ferrous Iron	----	0.05	mg/L	<0.05	2 mg/L	110	85	120
EK055G: Ammonia as N by Discrete Analyser (QCLot: 172037)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	102	86	112
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 172038)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	108	89	115

Sub-Matrix: **WATER**

				Method Blank (MB) Report	*Laboratory Control Spike (LCS) Report*			
					Spike	*Spike Recovery (%)*	*Recovery Limits (%)*	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 176688)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	103	70	111
EP005: Total Organic Carbon (TOC) (QCLot: 171057)								
EP005: Total Organic Carbon	----	1	mg/L	<1	10 mg/L	85.8	79	113
				<1	100 mg/L	92.7	79	113
EP068A: Organochlorine Pesticides (OC) (QCLot: 172751)								
EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	5 µg/L	97.6	52	124
EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	5 µg/L	96.1	56	122
EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	5 µg/L	88.8	35	131
EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	5 µg/L	94.7	52	123
EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	5 µg/L	72.8	45	125
EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	5 µg/L	98.3	54	128
EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	5 µg/L	69.4	39	122
EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	5 µg/L	106	50	126
EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	5 µg/L	93.1	51	125
EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	5 µg/L	91.2	53	112
EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	5 µg/L	95.3	50	124
EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	5 µg/L	89.6	37	124
EP068: Endrin	72-20-8	0.5	µg/L	<0.5	5 µg/L	93.4	47	129
EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	5 µg/L	95.9	49	131
EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	5 µg/L	107	45	129
EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	5 µg/L	61.8	42	119
EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	5 µg/L	97.3	45	118
EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	5 µg/L	99.8	52	124
EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	5 µg/L	66.8	41	121
EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	5 µg/L	80.1	32	135
EP068: Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L	<0.5	----	----	----	----
EP068: Sum of DDD + DDE + DDT	----	0.5	µg/L	<0.5	----	----	----	----
EP068: Total Chlordane (sum)	----	0.5	µg/L	<0.5	----	----	----	----
EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	5 µg/L	93.4	48	125
EP068B: Organophosphorus Pesticides (OP) (QCLot: 172751)								
EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	5 µg/L	49.2	44	130
EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	5 µg/L	92.3	52	124
EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	5 µg/L	88.3	48	128
EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	5 µg/L	106	50	127
EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	5 µg/L	92.5	54	119
EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	5 µg/L	97.4	50	118
EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	5 µg/L	71.4	44	118

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EP068B: Organophosphorus Pesticides (OP) (QCLot: 172751) - continued								
EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	5 µg/L	66.2	44	129
EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	5 µg/L	96.5	49	115
EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	5 µg/L	69.6	41	111
EP068: Ethion	563-12-2	0.5	µg/L	<0.5	5 µg/L	90.8	50	127
EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	5 µg/L	79.7	43	121
EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	5 µg/L	90.8	49	121
EP068: Malathion	121-75-5	0.5	µg/L	<0.5	5 µg/L	96.1	51	122
EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	5 µg/L	# 1.56	16	49
EP068: Parathion	56-38-2	2	µg/L	<2.0	5 µg/L	90.4	43	123
EP068: Parathion-methyl	298-00-0	----	µg/L	----	5 µg/L	88.9	50	118
EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	5 µg/L	89.5	52	126
EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	5 µg/L	88.9	53	126
EP074A: Monocyclic Aromatic Hydrocarbons (QCLot: 175012)								
EP074-WF: 1.2.4-Trimethylbenzene	95-63-6	1	µg/L	<1	20 µg/L	93.7	77	109
EP074-WF: 1.3.5-Trimethylbenzene	108-67-8	1	µg/L	<1	20 µg/L	91.9	77	109
EP074-WF: Benzene	71-43-2	1	µg/L	<1	20 µg/L	102	81	119
EP074-WF: Ethylbenzene	100-41-4	1	µg/L	<1	20 µg/L	95.1	78	118
EP074-WF: Isopropylbenzene	98-82-8	1	µg/L	<1	20 µg/L	90.9	77	117
EP074-WF: meta- & para-Xylene	108-38-3 106-42-3	1	µg/L	<1	40 µg/L	92.8	78	118
EP074-WF: n-Butylbenzene	104-51-8	1	µg/L	<1	20 µg/L	87.4	65	111
EP074-WF: n-Propylbenzene	103-65-1	1	µg/L	<1	20 µg/L	93.6	74	110
EP074-WF: ortho-Xylene	95-47-6	1	µg/L	<1	20 µg/L	98.1	82	118
EP074-WF: p-Isopropyltoluene	99-87-6	1	µg/L	<1	20 µg/L	93.0	73	113
EP074-WF: sec-Butylbenzene	135-98-8	1	µg/L	<1	20 µg/L	92.5	76	110
EP074-WF: Styrene	100-42-5	1	µg/L	<1	20 µg/L	90.6	78	118
EP074-WF: tert-Butylbenzene	98-06-6	1	µg/L	<1	20 µg/L	95.0	78	110
EP074-WF: Toluene	108-88-3	1	µg/L	<1	20 µg/L	97.8	81	121
EP074B: Oxygenated Compounds (QCLot: 175012)								
EP074-WF: 2-Butanone (MEK)	78-93-3	10	µg/L	<10	200 µg/L	109	71	131
EP074-WF: 2-Hexanone (MBK)	591-78-6	10	µg/L	<10	200 µg/L	103	75	129
EP074-WF: 2-Propanone (Acetone)	67-64-1	10	µg/L	<10	200 µg/L	106	69	151
EP074-WF: 4-Methyl-2-pentanone (MIBK)	108-10-1	10	µg/L	<10	200 µg/L	105	72	132
EP074-WF: Vinyl Acetate	108-05-4	10	µg/L	<10	200 µg/L	107	65	129
EP074C: Sulfonated Compounds (QCLot: 175012)								
EP074-WF: Carbon disulfide	75-15-0	1	µg/L	<1	20 µg/L	89.7	53	123
EP074D: Fumigants (QCLot: 175012)								
EP074-WF: 1.2-Dibromoethane (EDB)	106-93-4	1	µg/L	<1	20 µg/L	99.2	81	115

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP074D: Fumigants (QCLot: 175012) - continued								
EP074-WF: 1.2-Dichloropropane	78-87-5	1	µg/L	<1	20 µg/L	100	80	118
EP074-WF: 2.2-Dichloropropane	594-20-7	1	µg/L	<1	20 µg/L	95.9	69	115
EP074-WF: cis-1.3-Dichloropropylene	10061-01-5	2	µg/L	<2	20 µg/L	96.1	72	110
EP074-WF: trans-1.3-Dichloropropylene	10061-02-6	2	µg/L	<2	20 µg/L	94.9	70	108
EP074E: Halogenated Aliphatic Compounds (QCLot: 175012)								
EP074-WF: 1.1.1.2-Tetrachloroethane	630-20-6	1	µg/L	<1	20 µg/L	96.5	75	107
EP074-WF: 1.1.1-Trichloroethane	71-55-6	1	µg/L	<1	20 µg/L	96.5	75	113
EP074-WF: 1.1.2.2-Tetrachloroethane	79-34-5	1	µg/L	<1	20 µg/L	102	85	121
EP074-WF: 1.1.2-Trichloroethane	79-00-5	1	µg/L	<1	20 µg/L	101	85	117
EP074-WF: 1.1-Dichloroethane	75-34-3	1	µg/L	<1	20 µg/L	104	76	120
EP074-WF: 1.1-Dichloroethene	75-35-4	1	µg/L	<1	20 µg/L	95.9	68	122
EP074-WF: 1.1-Dichloropropylene	563-58-6	1	µg/L	<1	20 µg/L	97.7	73	117
EP074-WF: 1.2.3-Trichloropropane	96-18-4	1	µg/L	<1	20 µg/L	101	84	118
EP074-WF: 1.2-Dibromo-3-chloropropane	96-12-8	1	µg/L	<1	20 µg/L	94.8	64	114
EP074-WF: 1.2-Dichloroethane	107-06-2	1	µg/L	<1	20 µg/L	106	81	119
EP074-WF: 1.3-Dichloropropane	142-28-9	1	µg/L	<1	20 µg/L	99.8	85	117
EP074-WF: Bromomethane	74-83-9	10	µg/L	<10	200 µg/L	84.4	52	128
EP074-WF: Carbon Tetrachloride	56-23-5	1	µg/L	<1	20 µg/L	97.8	66	110
EP074-WF: Chloroethane	75-00-3	10	µg/L	<10	200 µg/L	96.0	67	127
EP074-WF: Chloromethane	74-87-3	10	µg/L	<10	200 µg/L	99.4	66	138
EP074-WF: cis-1.2-Dichloroethene	156-59-2	1	µg/L	<1	20 µg/L	103	82	118
EP074-WF: cis-1.4-Dichloro-2-butene	1476-11-5	1	µg/L	<1	20 µg/L	85.8	51	109
EP074-WF: Dibromomethane	74-95-3	1	µg/L	<1	20 µg/L	107	80	116
EP074-WF: Dichlorodifluoromethane	75-71-8	10	µg/L	<10	200 µg/L	96.1	61	137
EP074-WF: Hexachlorobutadiene	87-68-3	0.5	µg/L	<0.5	20 µg/L	95.0	64	118
EP074-WF: Iodomethane	74-88-4	1	µg/L	<1	20 µg/L	71.6	26	119
EP074-WF: Methylene chloride	75-09-2	2	µg/L	<2	20 µg/L	111	52	184
EP074-WF: Pentachloroethane	76-01-7	1	µg/L	<1	20 µg/L	94.3	52	126
EP074-WF: Tetrachloroethene	127-18-4	1	µg/L	<1	20 µg/L	95.5	74	116
EP074-WF: trans-1.2-Dichloroethene	156-60-5	1	µg/L	<1	20 µg/L	102	69	123
EP074-WF: trans-1.4-Dichloro-2-butene	110-57-6	1	µg/L	<1	20 µg/L	94.8	64	118
EP074-WF: Trichloroethene	79-01-6	1	µg/L	<1	20 µg/L	94.4	76	118
EP074-WF: Trichlorofluoromethane	75-69-4	10	µg/L	<10	200 µg/L	96.4	70	124
EP074-WF: Vinyl chloride	75-01-4	0.2	µg/L	<0.2	200 µg/L	93.4	60	138
EP074F: Halogenated Aromatic Compounds (QCLot: 175012)								
EP074-WF: 1.2.3-Trichlorobenzene	87-61-6	1	µg/L	<1	20 µg/L	96.9	78	116
EP074-WF: 1.2.4-Trichlorobenzene	120-82-1	1	µg/L	<1	20 µg/L	89.3	68	112
EP074-WF: 1.2-Dichlorobenzene	95-50-1	1	µg/L	<1	20 µg/L	97.2	83	113
EP074-WF: 1.3-Dichlorobenzene	541-73-1	1	µg/L	<1	20 µg/L	97.4	78	112

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP074F: Halogenated Aromatic Compounds (QCLot: 175012) - continued								
EP074-WF: 1.4-Dichlorobenzene	106-46-7	0.1	µg/L	<0.1	20 µg/L	96.2	78	116
EP074-WF: 2-Chlorotoluene	95-49-8	1	µg/L	<1	20 µg/L	97.8	79	111
EP074-WF: 4-Chlorotoluene	106-43-4	1	µg/L	<1	20 µg/L	93.0	77	111
EP074-WF: Bromobenzene	108-86-1	1	µg/L	<1	20 µg/L	105	71	117
EP074-WF: Chlorobenzene	108-90-7	1	µg/L	<1	20 µg/L	94.4	82	116
EP074G: Trihalomethanes (QCLot: 175012)								
EP074-WF: Bromodichloromethane	75-27-4	1	µg/L	<1	20 µg/L	98.4	75	112
EP074-WF: Bromoform	75-25-2	1	µg/L	<1	20 µg/L	90.8	62	106
EP074-WF: Chloroform	67-66-3	1	µg/L	<1	20 µg/L	105	83	115
EP074-WF: Dibromochloromethane	124-48-1	1	µg/L	<1	20 µg/L	92.8	68	108
EP074H: Naphthalene (QCLot: 175012)								
EP074-WF: Naphthalene	91-20-3	5	µg/L	<5	20 µg/L	99.8	82	116
EP132B: Polynuclear Aromatic Hydrocarbons (QCLot: 174001)								
EP132: 2-Methylnaphthalene	91-57-6	0.1	µg/L	<0.1	2 µg/L	76.8	59	123
EP132: 3-Methylcholanthrene	56-49-5	0.1	µg/L	<0.1	2 µg/L	76.0	60	120
EP132: 7.12-Dimethylbenz(a)anthracene	57-97-6	0.1	µg/L	<0.1	2 µg/L	76.2	12	156
EP132: Acenaphthene	83-32-9	0.1	µg/L	<0.1	2 µg/L	80.2	64	122
EP132: Acenaphthylene	208-96-8	0.1	µg/L	<0.1	2 µg/L	87.5	62	124
EP132: Anthracene	120-12-7	0.1	µg/L	<0.1	2 µg/L	86.1	66	124
EP132: Benz(a)anthracene	56-55-3	0.1	µg/L	<0.1	2 µg/L	86.9	64	130
EP132: Benzo(a)pyrene	50-32-8	0.05	µg/L	<0.05	2 µg/L	86.2	64	126
EP132: Benzo(b+j)fluoranthene	205-99-2 205-82-3	0.1	µg/L	<0.1	2 µg/L	86.0	62	126
EP132: Benzo(e)pyrene	192-97-2	0.1	µg/L	<0.1	2 µg/L	86.2	62	126
EP132: Benzo(g.h.i)perylene	191-24-2	0.1	µg/L	<0.1	2 µg/L	76.6	56	126
EP132: Benzo(k)fluoranthene	207-08-9	0.1	µg/L	<0.1	2 µg/L	90.2	63	127
EP132: Chrysene	218-01-9	0.1	µg/L	<0.1	2 µg/L	80.2	64	128
EP132: Coronene	191-07-1	0.1	µg/L	<0.1	2 µg/L	52.3	35	133
EP132: Dibenz(a.h)anthracene	53-70-3	0.1	µg/L	<0.1	2 µg/L	78.0	58	128
EP132: Fluoranthene	206-44-0	0.1	µg/L	<0.1	2 µg/L	93.7	65	127
EP132: Fluorene	86-73-7	0.1	µg/L	<0.1	2 µg/L	88.1	64	124
EP132: Indeno(1.2.3.cd)pyrene	193-39-5	0.1	µg/L	<0.1	2 µg/L	76.9	57	127
EP132: N-2-Fluorenyl Acetamide	53-96-3	0.1	µg/L	<0.1	2 µg/L	80.3	54	131
EP132: Naphthalene	91-20-3	0.1	µg/L	<0.1	2 µg/L	79.0	60	124
EP132: Perylene	198-55-0	0.1	µg/L	<0.1	2 µg/L	85.0	64	124
EP132: Phenanthrene	85-01-8	0.1	µg/L	<0.1	2 µg/L	86.5	65	125
EP132: Pyrene	129-00-0	0.1	µg/L	<0.1	2 µg/L	94.3	66	128

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Spike Concentration*	*SpikeRecovery(%) MS*	*Recovery Limits (%) Low*	*High*
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 173826)							
EB1524519-002	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	20 mg/L	# Not Determined	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 173827)							
EB1524519-002	Anonymous	ED045G: Chloride	16887-00-6	400 mg/L	99.1	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 171219)							
EB1524590-007	Anonymous	EG020A-F: Aluminium	7429-90-5	0.5 mg/L	93.6	70	130
		EG020A-F: Antimony	7440-36-0	0.1 mg/L	75.9	70	130
		EG020A-F: Arsenic	7440-38-2	0.1 mg/L	97.7	70	130
		EG020A-F: Cadmium	7440-43-9	0.1 mg/L	99.4	70	130
		EG020A-F: Chromium	7440-47-3	0.1 mg/L	98.0	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	95.4	70	130
		EG020A-F: Lead	7439-92-1	0.1 mg/L	97.8	70	130
		EG020A-F: Manganese	7439-96-5	0.1 mg/L	95.4	70	130
		EG020A-F: Nickel	7440-02-0	0.1 mg/L	95.5	70	130
		EG020A-F: Selenium	7782-49-2	0.1 mg/L	83.0	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	92.2	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 171218)							
EB1524590-006	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	79.6	70	130
EG051G: Ferrous Iron by Discrete Analyser (QCLot: 172524)							
EB1524394-004	Anonymous	EG051G: Ferrous Iron	----	2 mg/L	110	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 172037)							
EB1524516-002	Anonymous	EK055G: Ammonia as N	7664-41-7	0.4 mg/L	91.8	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 172038)							
EB1524516-002	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.4 mg/L	# Not Determined	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 176688)							
EB1524721-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	125	70	130
EP005: Total Organic Carbon (TOC) (QCLot: 171057)							
EB1524519-002	Anonymous	EP005: Total Organic Carbon	----	100 mg/L	95.6	70	130
EP068A: Organochlorine Pesticides (OC) (QCLot: 172751)							
EB1524610-003	ABH12	EP068: 4.4`-DDT	50-29-3	4 µg/L	74.9	70	130
		EP068: Aldrin	309-00-2	1 µg/L	100	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*Concentration*	*MS*	*Low*	*High*
EP068A: Organochlorine Pesticides (OC) (QCLot: 172751) - continued							
EB1524610-003	ABH12	EP068: Dieldrin	60-57-1	1 µg/L	93.1	70	130
		EP068: Endrin	72-20-8	4 µg/L	73.1	70	130
		EP068: gamma-BHC	58-89-9	1 µg/L	77.0	70	130
		EP068: Heptachlor	76-44-8	1 µg/L	81.4	70	130
EP068B: Organophosphorus Pesticides (OP) (QCLot: 172751)							
EB1524610-003	ABH12	EP068: Bromophos-ethyl	4824-78-6	1 µg/L	73.8	70	130
		EP068: Chlorpyrifos-methyl	5598-13-0	1 µg/L	96.6	70	130
		EP068: Diazinon	333-41-5	1 µg/L	75.1	70	130
		EP068: Pirimphos-ethyl	23505-41-1	1 µg/L	91.5	70	130
		EP068: Prothiofos	34643-46-4	1 µg/L	76.1	70	130
EP074A: Monocyclic Aromatic Hydrocarbons (QCLot: 175012)							
EB1524610-002	ABH11	EP074-WF: Benzene	71-43-2	20 µg/L	95.9	76	128
		EP074-WF: Toluene	108-88-3	20 µg/L	111	72	132
EP074E: Halogenated Aliphatic Compounds (QCLot: 175012)							
EB1524610-002	ABH11	EP074-WF: 1.1-Dichloroethene	75-35-4	20 µg/L	84.2	63	129
		EP074-WF: Trichloroethene	79-01-6	20 µg/L	82.4	64	126
EP074F: Halogenated Aromatic Compounds (QCLot: 175012)							
EB1524610-002	ABH11	EP074-WF: Chlorobenzene	108-90-7	20 µg/L	106	81	119

QA/QC Compliance Assessment for DQO Reporting

Work Order	: **EB1524610**	Page	: 1 of 8
Client	: **CODYHART CONSULTING PTY LTD**	Laboratory	: Environmental Division Brisbane
Contact	: MS BARBARA HART	Telephone	: +61-7-3243 7222
Project	: Armidale Regional 2119	Date Samples Received	: 31-Jul-2015
Site	: Armidale Regional Landfill	Issue Date	: 11-Aug-2015
Sampler	: BARBARA HART	No. of samples received	: 3
Order number	: ----	No. of samples analysed	: 3

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **Laboratory Control outliers exist - please see following pages for full details.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	**Analyte**	CAS Number	Data	Limits	**Comment**
Laboratory Control Spike (LCS) Recoveries							
EP068B: Organophosphorus Pesticides (OP)	QC-172751-002	----	**Monocrotophos**	6923-22-4	1.56 %	16-49%	**Recovery less than lower control limit**
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	EB1524519--002	Anonymous	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Ar	EB1524516--002	Anonymous	**Nitrite + Nitrate as N**	----	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type Method	Count QC	Count Regular	Rate (%) Actual	Rate (%) Expected	Quality Control Specification
Laboratory Duplicates (DUP)					
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	0	10	0.00	10.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)					
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	0	10	0.00	5.00	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method ***Container*** */ Client Sample ID(s)*		***Sample Date***	*Extraction / Preparation* ***Date extracted***	*Due for extraction*	*Evaluation*	*Analysis* ***Date analysed***	*Due for analysis*	*Evaluation*
ED037P: Alkalinity by PC Titrator								
Clear Plastic Bottle - Natural (ED037-P)								
ABH9, ABH12	ABH11,	**30-Jul-2015**	**----**	----	----	**03-Aug-2015**	13-Aug-2015	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Clear Plastic Bottle - Natural (ED041G)								
ABH9, ABH12	ABH11,	**30-Jul-2015**	**----**	----	----	**06-Aug-2015**	27-Aug-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	***Sample Date***	*Extraction / Preparation*			*Analysis*		
***Container** / Client Sample ID(s)*		***Date extracted***	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) ABH9, ABH11, ABH12	**30-Jul-2015**	**----**	----	----	**06-Aug-2015**	27-Aug-2015	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) ABH9, ABH11, ABH12	**30-Jul-2015**	**----**	----	----	**04-Aug-2015**	27-Aug-2015	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) ABH9, ABH11, ABH12	**30-Jul-2015**	**----**	----	----	**04-Aug-2015**	26-Jan-2016	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F) ABH9, ABH11, ABH12	**30-Jul-2015**	**----**	----	----	**05-Aug-2015**	27-Aug-2015	✓
EG051G: Ferrous Iron by Discrete Analyser							
Clear Plastic Bottle - HCl - Filtered (EG051G) ABH9, ABH11, ABH12	**30-Jul-2015**	**----**	----	----	**04-Aug-2015**	06-Aug-2015	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) ABH9, ABH11, ABH12	**30-Jul-2015**	**----**	----	----	**04-Aug-2015**	27-Aug-2015	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) ABH9, ABH11, ABH12	**30-Jul-2015**	**----**	----	----	**04-Aug-2015**	27-Aug-2015	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) ABH9, ABH11, ABH12	**30-Jul-2015**	**10-Aug-2015**	27-Aug-2015	✓	**10-Aug-2015**	27-Aug-2015	✓
EP005: Total Organic Carbon (TOC)							
Amber TOC Vial - Sulfuric Acid (EP005) ABH9, ABH11, ABH12	**30-Jul-2015**	**----**	----	----	**03-Aug-2015**	27-Aug-2015	✓
EP068A: Organochlorine Pesticides (OC)							
Amber Glass Bottle - Unpreserved (EP068) ABH9, ABH11, ABH12	**30-Jul-2015**	**04-Aug-2015**	06-Aug-2015	✓	**05-Aug-2015**	13-Sep-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method *Container / Client Sample ID(s)*	*Sample Date*	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EP074A: Monocyclic Aromatic Hydrocarbons							
Amber VOC Vial - Sulfuric Acid (EP074-WF) ABH9, ABH11, ABH12	**30-Jul-2015**	**06-Aug-2015**	13-Aug-2015	✓	**07-Aug-2015**	13-Aug-2015	✓
EP132B: Polynuclear Aromatic Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP132) ABH9, ABH11, ABH12	**30-Jul-2015**	**05-Aug-2015**	06-Aug-2015	✓	**11-Aug-2015**	14-Sep-2015	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	1	10	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ammonia as N by Discrete analyser	EK055G	2	19	**10.53**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	2	14	**14.29**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	14	**14.29**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ferrous Iron by Discrete Analyser	EG051G	2	12	**16.67**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Major Cations - Dissolved	ED093F	2	14	**14.29**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	18	**11.11**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	6	**16.67**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	0	10	**0.00**	**10.00**	✗	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Organic Carbon	EP005	2	19	**10.53**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Volatile Organic Compounds WF Detection Limits	EP074-WF	1	3	**33.33**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	10	**10.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	14	**7.14**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	14	**7.14**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ferrous Iron by Discrete Analyser	EG051G	1	12	**8.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	1	10	**10.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Organic Carbon	EP005	2	19	**10.53**	**10.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Volatile Organic Compounds WF Detection Limits	EP074-WF	1	3	**33.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	14	**7.14**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	14	**7.14**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ferrous Iron by Discrete Analyser	EG051G	1	12	**8.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Major Cations - Dissolved	ED093F	1	14	**7.14**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type *Analytical Methods*	*Method*	*Count* *QC*	 *Regular*	*Rate (%)* ***Actual***	 ***Expected***	 *Evaluation*	*Quality Control Specification*
Method Blanks (MB) - Continued							
Pesticides by GCMS	EP068	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	1	10	**10.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Organic Carbon	EP005	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Volatile Organic Compounds WF Detection Limits	EP074-WF	1	3	**33.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Mercury by FIMS	EG035F	1	14	**7.14**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	14	**7.14**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Ferrous Iron by Discrete Analyser	EG051G	1	12	**8.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Pesticides by GCMS	EP068	1	6	**16.67**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	0	10	**0.00**	**5.00**	✗	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Total Organic Carbon	EP005	1	19	**5.26**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement
Volatile Organic Compounds WF Detection Limits	EP074-WF	1	3	**33.33**	**5.00**	✓	NEPM 2013 Schedule B(3) and ALS QCS3 requirement

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45 um filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ferrous Iron by Discrete Analyser	EG051G	WATER	In house: Referenced to APHA 3500 Fe-B. A colorimetric determination based on the reaction between phenanthroline and ferrous iron at pH 3.2-3.3 to form an orange-red complex that is measured against a five-point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM (2013) Schedule B(3)
Pesticides by GCMS	EP068	WATER	USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Volatile Organic Compounds WF Detection Limits	EP074-WF	WATER	USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	WATER	USEPA 3640 (GPC Cleanup), 8270 GCMS Capiliary column, SIM mode. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
TKN/TP Digestion	EK061/EK067	WATER	APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

CodyHart Environmental Analyses

Due to holding time problems if sent to a NATA registered laboratory, CodyHart conducts laboratory analyses for alkalinity and free CO_2 on-site or on the evening of the sampling day. The analyses are more accurate when conducted on fresh samples. Alkalinity has always been regarded as a 'field analyte' in the literature.

- For alkalinity, CodyHart uses titration and/or colour change, on site or on the evening of sampling, to endpoint pH 4.5 as detailed in APHA (1998) section 2320, which is the NSW EPA approved method. The colour change method adopted uses a mixed indicator alkalinity (Bromocresol Green – Methyl Red) indicator solution (APHA 1992, 2-25, 2-27) which in combination with titration changes the sample colour from blue to wild moss green at approximately pH 4.5.
- High concentrations of free CO_2 indicate that landfill gas may be permeating groundwater. The APHA 4500-CO_2 C titration method is used as detailed in *Standard Methods for the Examination of Water and Wastewater,* 18th edition 1992:4-17, and/or a phenolphthalein indicator colour method which in combination with titration changes the sample colour from clear to mid-pink (APHA 1992, 2-25, 2-27) at pH 8.3.

Results 28-30/07/15

Groundwater baseline

	ABH02	ABH02A	ABH4	ABH4A	ABH04	ABH04A	ABH9	ABH11	ABH12
Alkalinity (mg/L) (titration & colour change)	540	576	587	DRY	567	548	93	323	577
Free CO_2 (mg/L) (titration & colour change)	176	182	176	DRY	235	102	85	97	176

Surface water baseline

	GARA6
Alkalinity (mg/L) (titration & colour change)	143
Free CO_2 (mg/L) (titration & colour change)	9

APPENDIX D

Well Development Forms

WELL DEVELOPMENT

Well ABH02

Site: Armidale Regional Landfill   Date: 30/4/15

Well development

Well development cleans out the fines in between the sand pack around the screen. It is an essential task if reliable and consistent water quality results are to be obtained over time from a well. A weighted bailer to stir up and collect fines is paramount and may be used in combination with a pump if there is sufficient water in the well.

Well development groundwater volume calculation

(a) Pack section water volume (from bore log)

Depth of sand pack section = depth of well on bore log – depth to top of pack section on bore log
= 11.0 m — 3.5 m = 7.5 m

Pack cross-sectional area = 0.004 m^2

Pack section water volume = area x depth of sand pack section on bore log x 1000
= 0.004 m^2 x 7.5 m x 1000 = 30 L

(b) Casing water volume (from well measurements using dip meter)   (6m screen)

Depth of well from top of casing = 11.84 m measured

Water level from top of casing = 7.78 m

Water column height = 4.06 m

Casing water depth = Water column height – depth of pack section = 4.06m — 7.5 m = -3.44m

Upper casing cross-sectional area = ΠR^2 ID casing = ~0.002 m^2 Negative ∴ ↙

Casing water volume = area x casing water depth x 1000
= 0.002 m^2 x m x 1000
= L

If casing water volume is negative, this is because the water column height is less than the depth of the sand pack section. There is no casing water volume to calculate. If negative, recalculate the pack section water volume:

Pack section water volume if not fully immersed = area x water column height x 1000
= 0.004 m^2 x 4.06 m x 1000 = 16.24 L

(c) One well volume = pack section water volume + casing water volume
= 16.24 L + 0 L = 16.24 L

(d) Six well volumes = 98.4 L

Extraction record: Bailed. Weighted bailer. Twenty up + down movements through full water column. Then extracted.
30/4/15 Extracted 10L → became dry.
1/5/15 " 8.5L → " ", then 4L.

Recovery: 4L over 3 hours   TOTAL EXTRACTED = 22.5L

Colour and turbidity of groundwater

	Initial	½ well development	Final
Colour	brown	brown	clear → cloudy white
Turbidity	heavy	heavy	trace

For future monitoring:
Suspend pump at 9.0 m from top of PVC casing.

Top of PVC = 770 mm above ground level
Top of closed standpipe to ground level = 960 mm

WELL DEVELOPMENT

Well ABH02A

Site: Armidale Regional Landfill   Date: 30/4/15

Well development

Well development cleans out the fines in between the sand pack around the screen. It is an essential task if reliable and consistent water quality results are to be obtained over time from a well. A weighted bailer to stir up and collect fines is paramount and may be used in combination with a pump if there is sufficient water in the well.

Well development groundwater volume calculation

(a) Pack section water volume (from bore log)

Depth of sand pack section = depth of well on bore log – depth to top of pack section on bore log
= ~29.6 m — 23.2 m = 6.4 m

Pack cross-sectional area = 0.004 m^2

Pack section water volume = area x depth of sand pack section on bore log x 1000
= 0.004 m^2 x 6.4 m x 1000 = 25.6 L

(b) Casing water volume (from well measurements using dip meter)

Depth of well from top of casing = 30.15 m measured

Water level from top of casing = 7.62 m

Water column height = 22.43 m

Casing water depth = Water column height – depth of pack section = 22.43m — 6.4 m = 16.03m

Upper casing cross-sectional area = ΠR^2 ID casing = ~0.002 m^2

Casing water volume = area x casing water depth x 1000
= 0.002 m^2 x 16.03 m x 1000
= 32.06 L

If casing water volume is negative, this is because the water column height is less than the depth of the sand pack section. There is no casing water volume to calculate. If negative, recalculate the pack section water volume:

Pack section water volume if not fully immersed = area x water column height x 1000
= 0.004 m^2 x m x 1000 = NA L

(c) One well volume = pack section water volume + casing water volume
= 25.6 L + 32.06 L = 57.66 L

(d) Six well volumes = 345.96L

30/4/15

Extraction record: Solinst Double Valve pump. 10 quick movements of pump up + down 6m screen before each level pump out.

Refill / Discharge 20secs / 20secs

PSI 70

5/8" tubing 400mL+

~29.5m bg 10L (30m from top of PVC); ~27.5m bg 10L (28m from top of PVC); ~26.5m bg 10L (27m from top of PVC); ~25.5m bg 10L (26m from top of PVC); ~29.5m bg 30L (30m from top of PVC)

TOTAL EXTRACTED = 60L = 1 well volume

Recovery: WL after 50L = 7.80 m

Colour and turbidity of groundwater

	Initial	½ well development	Final
Colour	dark grey	lt grey	cloudy v lt grey
Turbidity	heavy	moderate	trace

For future monitoring:
Suspend pump at 27m from top of PVC casing.
Has cap.

Top of PVC = 450mm above ground level
Top of closed standpipe to ground level = 480 mm

WELL DEVELOPMENT

Well ABH4

Site: Armidale Regional Landfill 1/5/15

Well development

Well development cleans out the fines in between the sand pack around the screen. It is an essential task if reliable and consistent water quality results are to be obtained over time from a well. A weighted bailer to stir up and collect fines is paramount and may be used in combination with a pump if there is sufficient water in the well.

Well development groundwater volume calculation

(a) Pack section water volume (from bore log)

Depth of sand pack section = depth of well on bore log – depth to top of pack section on bore log

= 18·0 m — 6·0 m = 12·0 m

Pack cross-sectional area = 0.004 m^2

Pack section water volume = area x depth of sand pack section on bore log x 1000

= 0.004 m^2 x 12·0 m x 1000 = 48 L

(b) Casing water volume (from well measurements using dip meter)

Depth of well from top of casing = 18·83 m measured

Water level from top of casing = 5·13 m

Water column height = 13·70 m

Casing water depth = Water column height – depth of pack section = 13·7 m — 11·5 m = 2·2 m

Upper casing cross-sectional area = ΠR^2 ID casing = ~0.002 m^2

Casing water volume = area x casing water depth x 1000

= 0.002 m^2 x 2·2 m x 1000

= 4·4 L

If casing water volume is negative, this is because the water column height is less than the depth of the sand pack section. There is no casing water volume to calculate. If negative, recalculate the pack section water volume:

Pack section water volume if not fully immersed = area x water column height x 1000

= 0.004 m^2 x m x 1000 = NA L

(c) One well volume = pack section water volume + casing water volume

= 48 L + 4·4 L = 52·4 L

(d) Six well volumes = 52·4 L

1/5/14

Extraction record: Twister pump. 10 quick movements of pump up & down 12m screen between each level pump out.

Battery operated.

~17·9m bg 10L ; ~15·9m bg 10L ; ~14·9m bg 10L ; ~13·9m bg 10L

(18·7m from top of PVC) (16·7m from top of PVC) (15·7m from top of PVC) (14·7m PVC)

~17·9m bg 30L

(18·7m from top of PVC)

TOTAL EXTRACTED = 70L

Recovery: WL 5·19m after

Colour and turbidity of groundwater

	Initial	½ well development	Final
Colour	cloudy dark grey	light grey	cloudy white
Turbidity	heavy	moderate	trace

For future monitoring:

Suspend pump at 16m from top of PVC casing.

Top of PVC to ground level = 500mm

″ ″ standpipe to ″ ″ = 600mm

ABH4 A - dry. Top of PVC to grd. level = 630mm

is 3·16m deep. from top PVC. Top of standpipe to grd. level = 730mm

WELL DEVELOPMENT

Well ABH04

Site: Armidale Regional Landfill

1/5/15

Well development

Well development cleans out the fines in between the sand pack around the screen. It is an essential task if reliable and consistent water quality results are to be obtained over time from a well. A weighted bailer to stir up and collect fines is paramount and may be used in combination with a pump if there is sufficient water in the well.

Well development groundwater volume calculation

(a) Pack section water volume (from bore log)

Depth of sand pack section = depth of well on bore log – depth to top of pack section on bore log
= 28·3m m — 19·5 m = 8·8 m

Pack cross-sectional area = 0.004 m^2

Pack section water volume = area x depth of sand pack section on bore log x 1000
= 0.004 m^2 x 8·8 m x 1000 = 35·2 L

(b) Casing water volume (from well measurements using dip meter)

Depth of well from top of casing = 29·32 m measured

Water level from top of casing = 4·83 m

Water column height = 24·49 m

Casing water depth = Water column height – depth of pack section = 24·49 m — 8·8 m = 15·69 m

Upper casing cross-sectional area = ΠR^2 ID casing = ~0.002 m^2

Casing water volume = area x casing water depth x 1000
= 0.002 m^2 x 15·69 m x 1000
= 31·38 L

If casing water volume is negative, this is because the water column height is less than the depth of the sand pack section. There is no casing water volume to calculate. If negative, recalculate the pack section water volume:

Pack section water volume if not fully immersed = area x water column height x 1000
= 0.004 m^2 x m x 1000 = NA L

(c) One well volume = pack section water volume + casing water volume
= 35·2 L + 31·38 L = 66·58 L

(d) Six well volumes = 399·48 L

Extraction record:

Refill / Discharge
20secs / 20secs
PSI 60
→ ~500mL / 5/8" tubing

Solinst Double Valve pump. 10 quick movements of pump up + down 6m screen between each level pump out.
~28·2m bg 10L; (29·2m from top of PVC) ~26·2m bg 10L; (27·2m from top of PVC) ~25·2m bg 10L; (26·2m from top of PVC)
~24·2m bg 10L; (25·2m from top of PVC) ~28·2m bg 20L. (29·2m from top of PVC)
Total extracted = 60 L

Recovery:

WL 5·24m after 40L

Colour and turbidity of groundwater

	Initial	½ well development	Final
Colour	cloudy grey	cloudy light grey	very light grey
Turbidity	heavy	moderate	trace

For future monitoring:
Suspend pump at 26·0m from top of PVC casing.

Top of PVC to ground level = 740 mm
Top of Standpipe to " " = 780 mm

WELL DEVELOPMENT

Well ABH04A

Site: Armidale Regional Landfill   Date: 1/5/15

Well development

Well development cleans out the fines in between the sand pack around the screen. It is an essential task if reliable and consistent water quality results are to be obtained over time from a well. A weighted bailer to stir up and collect fines is paramount and may be used in combination with a pump if there is sufficient water in the well.

Well development groundwater volume calculation

(a) Pack section water volume (from bore log)

Depth of sand pack section = depth of well on bore log – depth to top of pack section on bore log

= m — m = m

Pack cross-sectional area = 0.004 m^2

Pack section water volume = area x depth of sand pack section on bore log x 1000

= 0.004 m^2 x m x 1000 = L

Pack section

(b) ~~Casing~~ water volume (from well measurements using dip meter)

Depth of well from top of casing = 8.80 m   Screen 3.5 m high

Water level from top of casing = 4.96 m

Water column height = 3.84 m x 0.004 m^2 x 1000 = 15.36 L

Casing water depth = Water column height – depth of pack section = m — m = m

Upper casing cross-sectional area = ΠR^2 ID casing = ~0.002 m^2

Casing water volume = area x casing water depth x 1000

= 0.002 m^2 x m x 1000

= L

If casing water volume is negative, this is because the water column height is less than the depth of the sand pack section. There is no casing water volume to calculate. If negative, recalculate the pack section water volume:

Pack section water volume if not fully immersed = area x water column height x 1000

= 0.004 m^2 x m x 1000 = L

(c) One well volume = pack section water volume + casing water volume

= L + L = 15.36 L

(d) Six well volumes = 92.16 L

Extraction record: Bailed with weighted bailer. Twenty up + down movements through full water column then extracted.

30/4/15 Extracted 14 L → dry.

1/5/15 " 13 L → dry. Later during day 2L + 2L + 1L

TOTAL EXTRACTED = 32 L

Recovery: 2L over 1 hour

Colour and turbidity of groundwater

	Initial	½ well development	Final
Colour	dark grey	cloudy brown	cloudy light brown
Turbidity	heavy	heavy	moderate

For future monitoring:
Suspend pump at 7.0 m from top of PVC casing.

Top of PVC to GL = 610 mm
Top of Standpipe to GL = 730 mm

WELL DEVELOPMENT

Well ABH 9

Site: Armidale Regional Landfill Date: 29/4/15

Well development

Well development cleans out the fines in between the sand pack around the screen. It is an essential task if reliable and consistent water quality results are to be obtained over time from a well. A weighted bailer to stir up and collect fines is paramount and may be used in combination with a pump if there is sufficient water in the well.

Well development groundwater volume calculation

(a) Pack section water volume (from bore log)

Depth of sand pack section = depth of well on bore log – depth to top of pack section on bore log
= ~60.5 m — 52.0 m = 8.5 m

Pack cross-sectional area = 0.004 m^2

Pack section water volume = area x depth of sand pack section on bore log x 1000
= 0.004 m^2 x 8.5 m x 1000 = 34 L

(b) Casing water volume (from well measurements using dip meter)

Depth of well from top of casing = ~60.50 m

Water level from top of casing = 45.15 m

Water column height = 16.35 m

Casing water depth = Water column height – depth of pack section = 15.35m — 8.5 m = 6.85 m

Upper casing cross-sectional area = ΠR^2 ID casing = ~0.002 m^2

Casing water volume = area x casing water depth x 1000
= 0.002 m^2 x 6.85 m x 1000
= 13.7 L

If casing water volume is negative, this is because the water column height is less than the depth of the sand pack section. There is no casing water volume to calculate. If negative, recalculate the pack section water volume:

Pack section water volume if not fully immersed = area x water column height x 1000
= 0.004 m^2 x m x 1000 = NA L

(c) One well volume = pack section water volume + casing water volume
= 34 L + 13.7L L = 47.7 L

(d) Six well volumes = 286.2L

29/4/15

Extraction record: Solinst Double Valve pump. Refill 15 Discharge 30 for 200mL. 10 quick movements of pump up + down 6m screen before each level pump out.
~58m BG 15L; ~56.5m BG 15L
Total extracted = 30L = ~ $\frac{2}{3}$ of 1 well volume

Refill / Discharge
15 secs / 30 secs
PSI 90
$\frac{1}{4}$" tubing

Recovery: WL 45.14 m after extracting 30L

Colour and turbidity of groundwater

	Initial	½ well development	Final
Colour	orange	lt orange	Very light orange
Turbidity	moderate	moderate	trace

For future monitoring:
Suspend pump at 57.5m from top of PVC casing. This is midway in screen.

Put on new PVC cap

Top of PVC = 0.940 m above ground level

Top of PVC is 1cm above top of opened stand pipe

Top of open stand pipe to top of closed stand pipe = 90 mm

WELL DEVELOPMENT

Well ABH11

Site: Armidale Regional Landfill Date: 30/4/15

Well development

Well development cleans out the fines in between the sand pack around the screen. It is an essential task if reliable and consistent water quality results are to be obtained over time from a well. A weighted bailer to stir up and collect fines is paramount and may be used in combination with a pump if there is sufficient water in the well.

Well development groundwater volume calculation

(a) Pack section water volume (from bore log)
Depth of sand pack section = depth of well on bore log – depth to top of pack section on bore log
= ~ 36.0 m — ~29m m = 7.0 m
Pack cross-sectional area = 0.004 m^2
Pack section water volume = area x depth of sand pack section on bore log x 1000
= 0.004 m^2 x 7.0 m x 1000 = 28 L

(b) Casing water volume (from well measurements using dip meter)
Depth of well from top of casing = ~ 37.00 m
Water level from top of casing = 25.67 m
Water column height = 11.33 m

Casing water depth = Water column height – depth of pack section = 11.33m — 7.0 m = 4.33 m
Upper casing cross-sectional area = ΠR^2 ID casing = ~0.002 m^2
Casing water volume = area x casing water depth x 1000
= 0.002 m^2 x 4.33 m x 1000
= 8.66 L

If casing water volume is negative, this is because the water column height is less than the depth of the sand pack section. There is no casing water volume to calculate. If negative, recalculate the pack section water volume:
Pack section water volume if not fully immersed = area x water column height x 1000
= 0.004 m^2 x m x 1000 = NA L

(c) One well volume = pack section water volume + casing water volume
= 28 L+ 8.66 L= 36.66 L

(d) Six well volumes = 219.96 L

30/4/15
Extraction record: Solinst Double Valve pump. 10 quick movements of pump up & down 6m screen before each level pump out.
~35.5 m bg 10L; ~34.0mbg 10L ; ~33m bg 10L
(36.5 m from top PVC) (~35.0m from top of PVC) (~34m from top of PVC)
~32m bg 10L ; ~35.9m bg 20L
(~33m from top of PVC) (36.4m from top of PVC)
Total extracted = 60L = ~2 well volumes

Refill/Discharge
20 secs/20 secs
PSI 60
5/8" tubing 400mL+

Recovery: WL 25.67m after 20L
WL 25.67m after 50L

Colour and turbidity of groundwater

	Initial	½ well development	Final
Colour	brown	light brown	almost clear
Turbidity	high	moderate	trace

For future monitoring:
Suspend pump at 34 m from top of PVC.

Put on new PVC cap
Top of PVC = 700mm above ground level. Sawed off 2cm top of PVC 30/7/15.
Top of PVC = 0.0mm above top of opened standpipe
Top of open standpipe to top of closed standpipe = 100mm.
Top of standpipe to ground level = 800mm.

WELL DEVELOPMENT

Well ABH12

Site: Armidale Regional Landfill Date: 30/4/15

Well development

Well development cleans out the fines in between the sand pack around the screen. It is an essential task if reliable and consistent water quality results are to be obtained over time from a well. A weighted bailer to stir up and collect fines is paramount and may be used in combination with a pump if there is sufficient water in the well.

Well development groundwater volume calculation

(a) Pack section water volume (from bore log)

Depth of sand pack section = depth of well on bore log – depth to top of pack section on bore log

= 40.0 m — 33.0 m = 7.0 m

Pack cross-sectional area = 0.004 m^2

Pack section water volume = area x depth of sand pack section on bore log x 1000

= 0.004 m^2 x 7.0 m x 1000 = 28 L

(b) Casing water volume (from well measurements using dip meter)

Depth of well from top of casing = ~40.60 m

Water level from top of casing = 19.75 m

Water column height = 20.85 m

Casing water depth = Water column height – depth of pack section = 20.85 m — 7.0 m = 12.15 m

Upper casing cross-sectional area = ΠR^2 ID casing = ~0.002 m^2

Casing water volume = area x casing water depth x 1000

= 0.002 m^2 x 12.15 m x 1000

= 24.3 L

If casing water volume is negative, this is because the water column height is less than the depth of the sand pack section. There is no casing water volume to calculate. If negative, recalculate the pack section water volume:

Pack section water volume if not fully immersed = area x water column height x 1000

= 0.004 m^2 x m x 1000 = NA L

(c) One well volume = pack section water volume + casing water volume

= 28 L + 24.3 L = 52.3 L

(d) Six well volumes = 313.8 L

30/4/15

Extraction record: Solinst Double Value Pump. 10 quick movements of pump up + down 6m screen before each level pump out.

Refill / Discharge 20 secs / 20 secs

PSI 70

5/8" tubing 380mL

~39.9m bg 10L (40.9m from top of PVC) ; ~37.9m bg 10L (38.9m from top PVC) ; ~36.9m bg 10L (37.9m from top PVC) ; ~35.9m bg 10L (36.9m from top PVC) ; ~39.9m bg 20L (40.9m from top of PVC).

Total extracted = 60L = ~1 well volume

Recovery:

not measured.

Colour and turbidity of groundwater

	Initial	½ well development	Final
Colour	dark grey	lt grey	clear
Turbidity	heavy	moderate	trace

For future monitoring:

Suspend pump at 38 m from top of PVC.

Has a butterfly cap.

Top of PVC = 580mm above ground level

" " " = 10 mm lower than top of opened standpipe

Top of open standpipe to top of closed standpipe = 100mm.

APPENDIX E

Slug Tests

SLUG-IN / FALLING HEAD TEST RESULTS – ABH02

DATA from *Super Slug* program

ABH02 - SLUG-IN / FALLING HEAD TEST

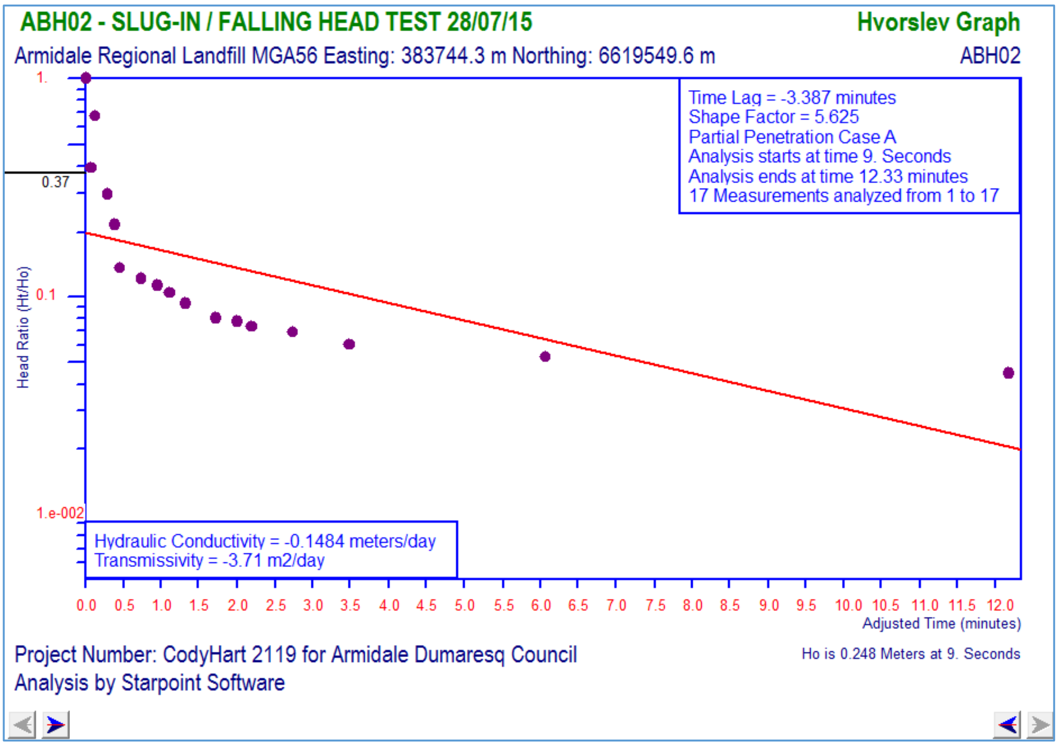
Site Name:	Armidale Regional Landfill
Location:	MGA56 Easting: 383744.3 m Northing: 6619549.6 m
Test Date:	28/07/15
Client:	Armidale Dumaresq Council
Project Number:	CodyHart 2119

Well Label:	ABH02
Aquifer Thickness:	25. Meters
Screen Length:	7.4 Meters
Casing Radius:	2.5e-002 Meters
Effective Radius:	0.11 Meters
Static Water Level:	7.878 Meters
Water Table to Screen Bottom:	3.727 Meters
Anisotropy Ratio:	0.9
Time Adjustment:	141. Seconds

Test starts with trial 0
There are 17 time and drawdown measurements
Maximum head is 0.248 Meters
Minimum head is 0. Meters

Trial	Time (Seconds)	Adjusted Time (Seconds)	Drawdown (Meters)	Head (Meters)	Head Ratio
1	9.	-132.	7.63	0.248	1.
2	14.	-127.	7.78	9.8e-002	0.3952
3	17.	-124.	7.71	0.168	0.6774
4	27.	-114.	7.805	7.3e-002	0.2944
5	32.	-109.	7.825	5.3e-002	0.2137
6	37.	-104.	7.844	3.4e-002	0.1371
7	53.	-88.	7.848	3.e-002	0.121
8	66.	-75.	7.85	2.8e-002	0.1129
9	76.	-65.	7.852	2.6e-002	0.1048
10	89.	-52.	7.855	2.3e-002	9.274e-002
11	112.	-29.	7.858	2.e-002	8.065e-002
12	129.	-12.	7.859	1.9e-002	7.661e-002
13	141.	0.	7.86	1.8e-002	7.258e-002
14	173.	32.	7.861	1.7e-002	6.855e-002
15	218.	77.	7.863	1.5e-002	6.048e-002
16	373.	232.	7.865	1.3e-002	5.242e-002
17	740.	599.	7.867	1.1e-002	4.435e-002

GRAPHS from *Super Slug* program

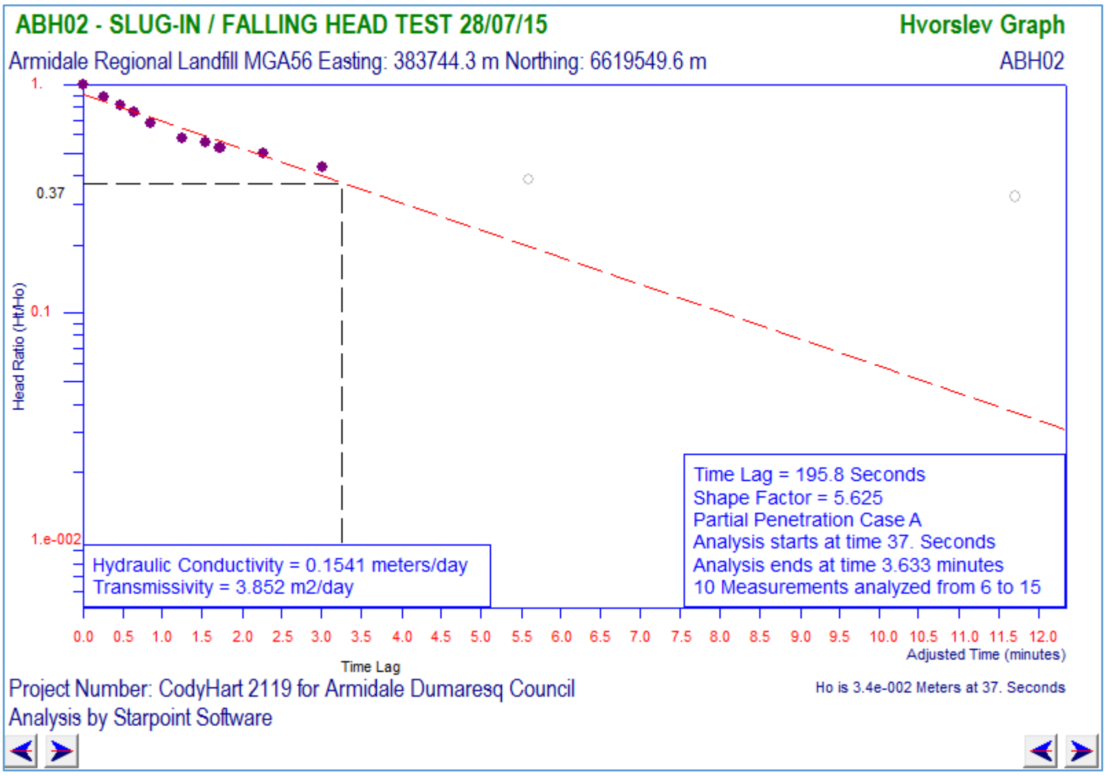

ABH02 - SLUG-IN / FALLING HEAD TEST 28/07/15 Hvorslev Graph
Armidale Regional Landfill MGA56 Easting: 383744.3 m Northing: 6619549.6 m ABH02

Time Lag = -3.387 minutes
Shape Factor = 5.625
Partial Penetration Case A
Analysis starts at time 9. Seconds
Analysis ends at time 12.33 minutes
17 Measurements analyzed from 1 to 17

Hydraulic Conductivity = -0.1484 meters/day
Transmissivity = -3.71 m2/day

Project Number: CodyHart 2119 for Armidale Dumaresq Council
Analysis by Starpoint Software
Ho is 0.248 Meters at 9. Seconds

Review of the graph above shows that there would be a '*double straight line*'. Duffield (2015) cautions that this can occur when a well is '*screened across the water table*' - which is the case for well ABH02. The second straight line is '*more indicative of flow into the well from the aquifer*' when the first straight line is indicative of '*drainage into the well from a permeable gravel pack*'. As well, the negative K value makes no sense. The 'best fit' line also would exclude the last two data points. Hence the deletion of the first five and the last two data points to obtain the best fit, single line as shown in the next graph.


ABH02 - SLUG-IN / FALLING HEAD TEST 28/07/15 Hvorslev Graph
Armidale Regional Landfill MGA56 Easting: 383744.3 m Northing: 6619549.6 m ABH02

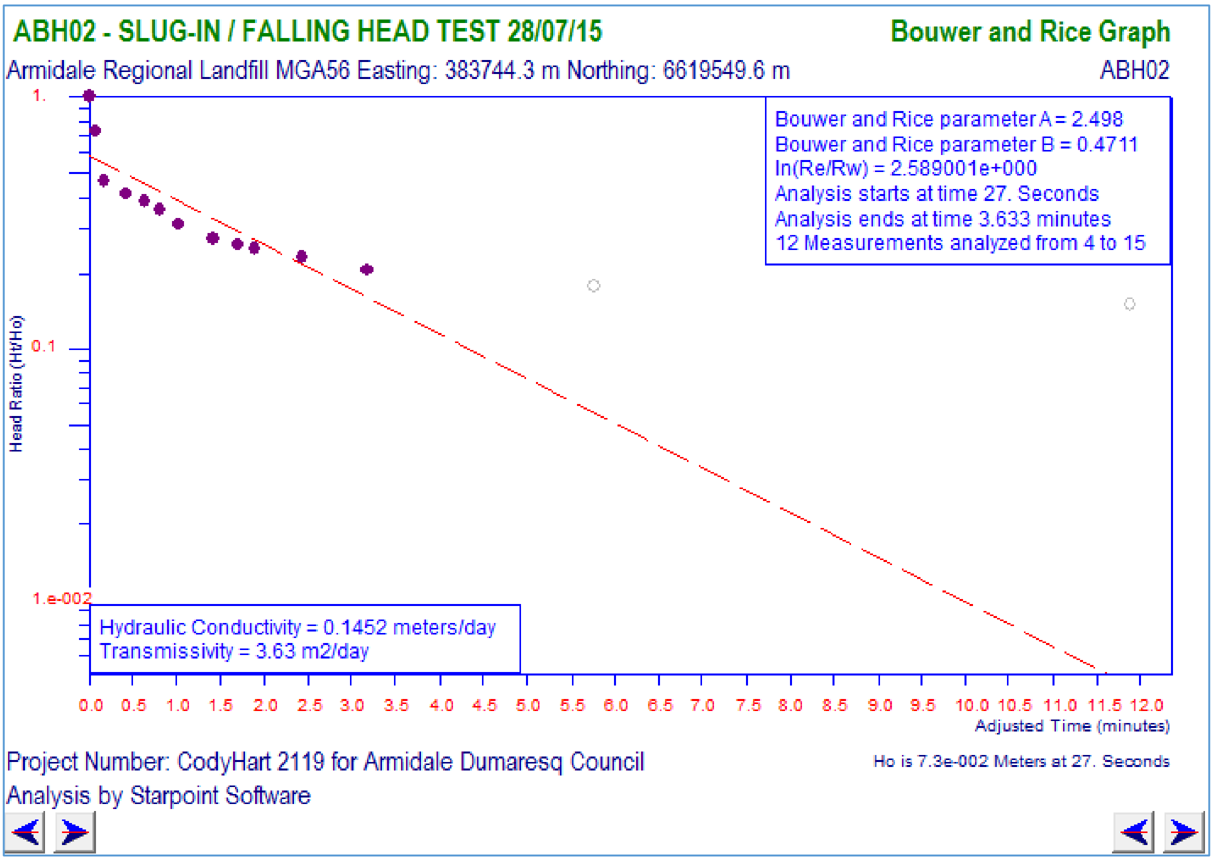
Time Lag = 195.8 Seconds
Shape Factor = 5.625
Partial Penetration Case A
Analysis starts at time 37. Seconds
Analysis ends at time 3.633 minutes
10 Measurements analyzed from 6 to 15

Hydraulic Conductivity = 0.1541 meters/day
Transmissivity = 3.852 m2/day

Project Number: CodyHart 2119 for Armidale Dumaresq Council
Analysis by Starpoint Software
Ho is 3.4e-002 Meters at 37. Seconds

K = 0.1541 m/day = 1.8 x 10^{-6} m/s

Excluding just the first three data points as well as the end two data points resulted in a very similar hydraulic conductivity result using the Bower and Rice graphical method as with the Hvorslev graphical method.



ABH02 - SLUG-IN / FALLING HEAD TEST 28/07/15 **Bouwer and Rice Graph**

Armidale Regional Landfill MGA56 Easting: 383744.3 m Northing: 6619549.6 m ABH02

Bouwer and Rice parameter A = 2.498
Bouwer and Rice parameter B = 0.4711
ln(Re/Rw) = 2.589001e+000
Analysis starts at time 27. Seconds
Analysis ends at time 3.633 minutes
12 Measurements analyzed from 4 to 15

Hydraulic Conductivity = 0.1452 meters/day
Transmissivity = 3.63 m2/day

Project Number: CodyHart 2119 for Armidale Dumaresq Council
Analysis by Starpoint Software

Ho is 7.3e-002 Meters at 27. Seconds

K = 0.1452 m/day = 1.7 x 1 x 10^{-6} m/s

SLUG-OUT / RISING HEAD TEST RESULTS – ABH02

DATA from *Super Slug* program

ABH02 - SLUG-OUT / RISING HEAD TEST

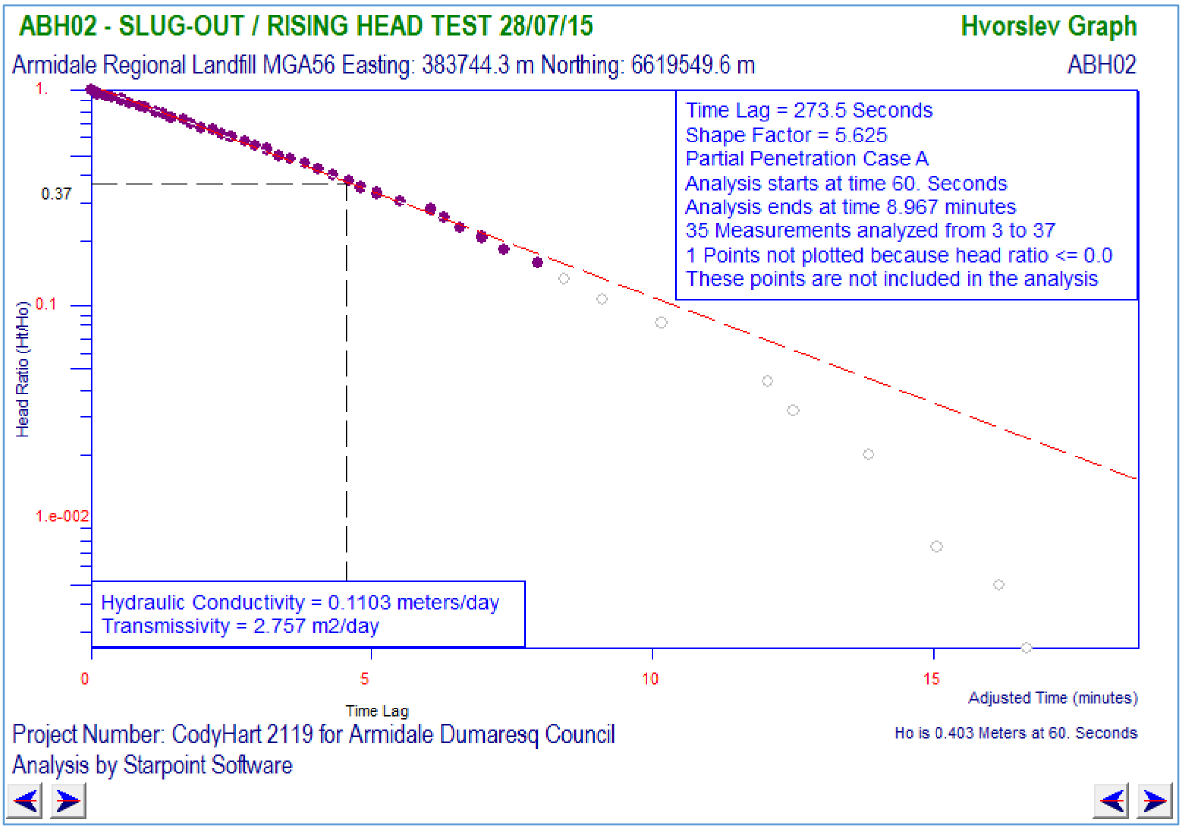
Site Name:	Armidale Regional Landfill
Location:	MGA56 Easting: 383744.3 m Northing: 6619549.6 m
Test Date:	28/07/15
Client:	Armidale Dumaresq Council
Project Number:	CodyHart 2119

Well Label:	ABH02
Aquifer Thickness:	25. Meters
Screen Length:	7.4 Meters
Casing Radius:	2.5e-002 Meters
Effective Radius:	0.11 Meters
Static Water Level:	7.867 Meters
Water Table to Screen Bottom:	3.727 Meters
Anisotropy Ratio:	0.9
Time Adjustment:	41. Seconds

Test starts with trial 0
There are 47 time and drawdown measurements
Maximum head is 0.423 Meters
Minimum head is 0. Meters

Trial	Time (Seconds)	Adjusted Time (Seconds)	Drawdown (Meters)	Head (Meters)	Head Ratio
1	41.	0.	8.29	0.423	1.
2	53.	12.	8.25	0.383	0.9054
3	60.	19.	8.27	0.403	0.9527
4	67.	26.	8.26	0.393	0.9291
5	75.	34.	8.25	0.383	0.9054
6	83.	42.	8.24	0.373	0.8818
7	93.	52.	8.23	0.363	0.8582
8	101.	60.	8.22	0.353	0.8345
9	113.	72.	8.21	0.343	0.8109
10	119.	78.	8.2	0.333	0.7872
11	130.	89.	8.19	0.323	0.7636
12	138.	97.	8.18	0.313	0.74
13	147.	106.	8.17	0.303	0.7163
14	158.	117.	8.16	0.293	0.6927
15	167.	126.	8.15	0.283	0.669
16	178.	137.	8.14	0.273	0.6454
17	190.	149.	8.13	0.263	0.6217
18	200.	159.	8.12	0.253	0.5981
19	211.	170.	8.11	0.243	0.5745
20	224.	183.	8.1	0.233	0.5508
21	236.	195.	8.09	0.223	0.5272
22	249.	208.	8.08	0.213	0.5035
23	262.	221.	8.07	0.203	0.4799
24	274.	233.	8.06	0.193	0.4563
25	288.	247.	8.05	0.183	0.4326
26	303.	262.	8.04	0.173	0.409
27	319.	278.	8.03	0.163	0.3853
28	335.	294.	8.02	0.153	0.3617
29	349.	308.	8.01	0.143	0.3381
30	366.	325.	8.	0.133	0.3144
31	391.	350.	7.99	0.123	0.2908
32	423.	382.	7.98	0.113	0.2671
33	437.	396.	7.97	0.103	0.2435
34	455.	414.	7.96	9.3e-002	0.2199

GRAPHS from *Super Slug* program



ABH02 - SLUG-OUT / RISING HEAD TEST 28/07/15

Hvorslev Graph

Armidale Regional Landfill MGA56 Easting: 383744.3 m Northing: 6619549.6 m

ABH02

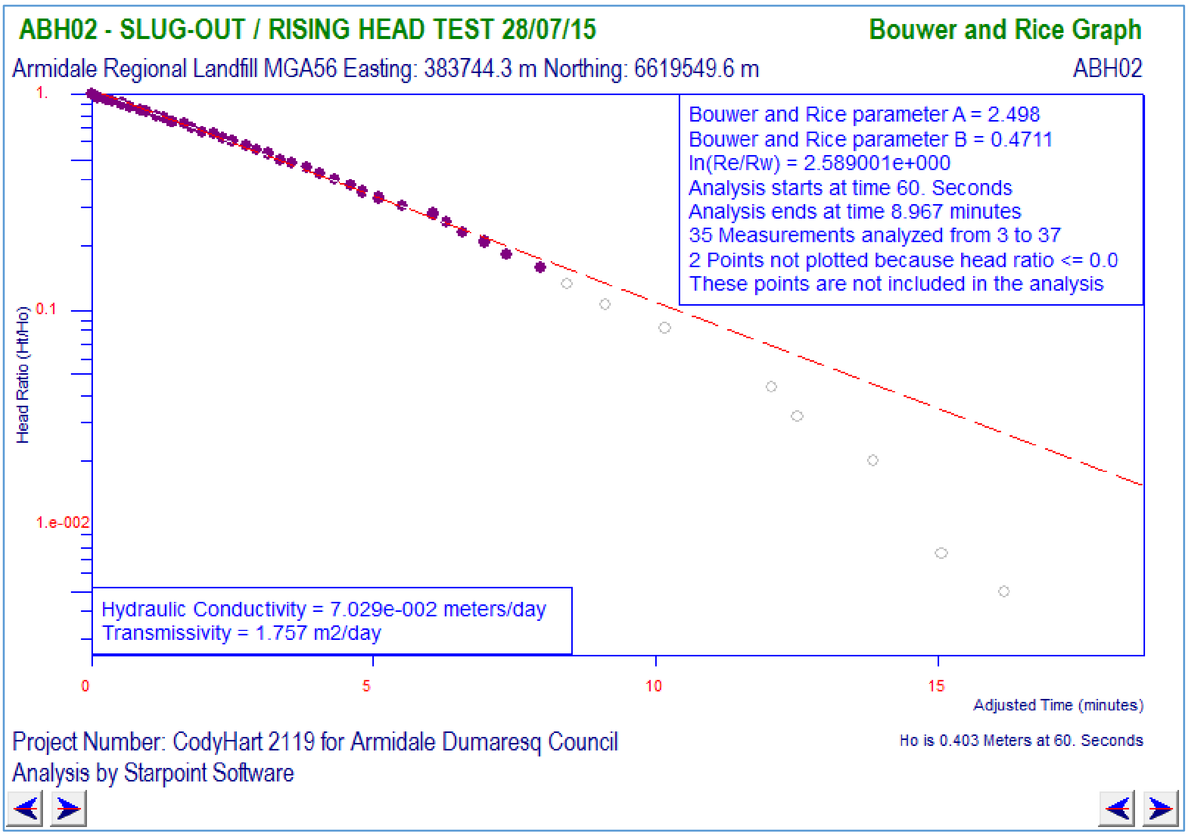
Time Lag = 273.5 Seconds
Shape Factor = 5.625
Partial Penetration Case A
Analysis starts at time 60. Seconds
Analysis ends at time 8.967 minutes
35 Measurements analyzed from 3 to 37
1 Points not plotted because head ratio <= 0.0
These points are not included in the analysis

Hydraulic Conductivity = 0.1103 meters/day
Transmissivity = 2.757 m2/day

Project Number: CodyHart 2119 for Armidale Dumaresq Council
Analysis by Starpoint Software

Ho is 0.403 Meters at 60. Seconds

K in the 'best fit' graph above is 0.11 m/day = 1.3 x 10^{-6} m/s and *K* in the graph below is 0.07 m/day = 8.1 x 10^{-7} m/s. To be precautionary, the Bouwer and Rice result will be excluded so that it will not slow the overall *K* for well ABH02.



ABH02 - SLUG-OUT / RISING HEAD TEST 28/07/15

Bouwer and Rice Graph

Armidale Regional Landfill MGA56 Easting: 383744.3 m Northing: 6619549.6 m

ABH02

Bouwer and Rice parameter A = 2.498
Bouwer and Rice parameter B = 0.4711
ln(Re/Rw) = 2.589001e+000
Analysis starts at time 60. Seconds
Analysis ends at time 8.967 minutes
35 Measurements analyzed from 3 to 37
2 Points not plotted because head ratio <= 0.0
These points are not included in the analysis

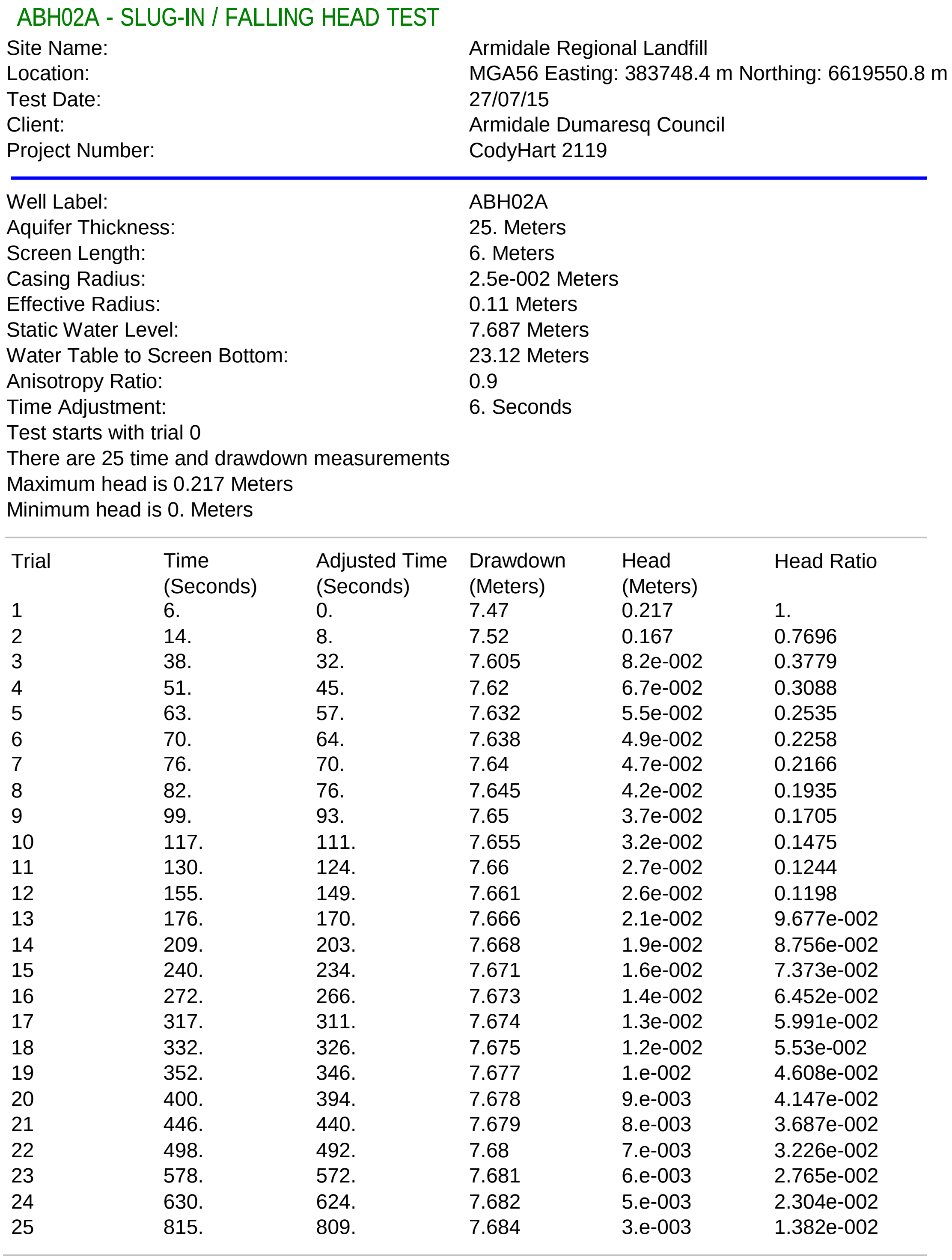
Hydraulic Conductivity = 7.029e-002 meters/day
Transmissivity = 1.757 m2/day

Project Number: CodyHart 2119 for Armidale Dumaresq Council
Analysis by Starpoint Software

Ho is 0.403 Meters at 60. Seconds

SLUG-IN / FALLING HEAD TEST RESULTS – ABH02A

DATA from *Super Slug* program



ABH02A - SLUG-IN / FALLING HEAD TEST

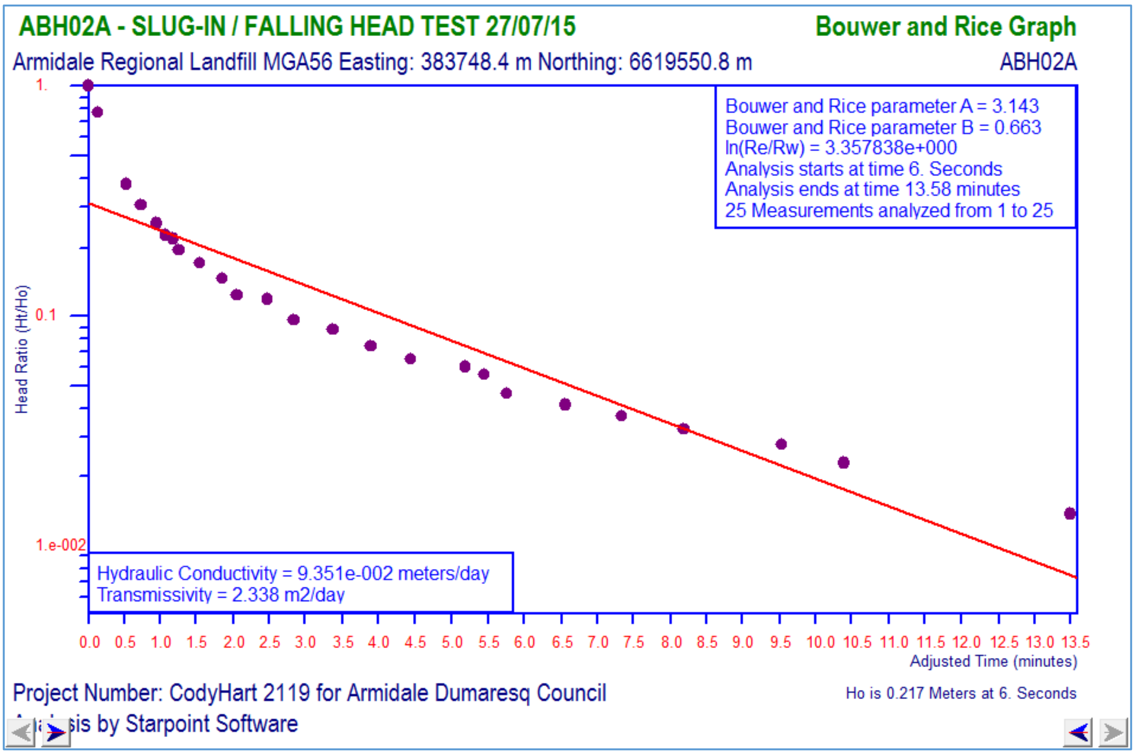
Site Name:	Armidale Regional Landfill
Location:	MGA56 Easting: 383748.4 m Northing: 6619550.8 m
Test Date:	27/07/15
Client:	Armidale Dumaresq Council
Project Number:	CodyHart 2119

Well Label:	ABH02A
Aquifer Thickness:	25. Meters
Screen Length:	6. Meters
Casing Radius:	2.5e-002 Meters
Effective Radius:	0.11 Meters
Static Water Level:	7.687 Meters
Water Table to Screen Bottom:	23.12 Meters
Anisotropy Ratio:	0.9
Time Adjustment:	6. Seconds

Test starts with trial 0
There are 25 time and drawdown measurements
Maximum head is 0.217 Meters
Minimum head is 0. Meters

Trial	Time (Seconds)	Adjusted Time (Seconds)	Drawdown (Meters)	Head (Meters)	Head Ratio
1	6.	0.	7.47	0.217	1.
2	14.	8.	7.52	0.167	0.7696
3	38.	32.	7.605	8.2e-002	0.3779
4	51.	45.	7.62	6.7e-002	0.3088
5	63.	57.	7.632	5.5e-002	0.2535
6	70.	64.	7.638	4.9e-002	0.2258
7	76.	70.	7.64	4.7e-002	0.2166
8	82.	76.	7.645	4.2e-002	0.1935
9	99.	93.	7.65	3.7e-002	0.1705
10	117.	111.	7.655	3.2e-002	0.1475
11	130.	124.	7.66	2.7e-002	0.1244
12	155.	149.	7.661	2.6e-002	0.1198
13	176.	170.	7.666	2.1e-002	9.677e-002
14	209.	203.	7.668	1.9e-002	8.756e-002
15	240.	234.	7.671	1.6e-002	7.373e-002
16	272.	266.	7.673	1.4e-002	6.452e-002
17	317.	311.	7.674	1.3e-002	5.991e-002
18	332.	326.	7.675	1.2e-002	5.53e-002
19	352.	346.	7.677	1.e-002	4.608e-002
20	400.	394.	7.678	9.e-003	4.147e-002
21	446.	440.	7.679	8.e-003	3.687e-002
22	498.	492.	7.68	7.e-003	3.226e-002
23	578.	572.	7.681	6.e-003	2.765e-002
24	630.	624.	7.682	5.e-003	2.304e-002
25	815.	809.	7.684	3.e-003	1.382e-002

GRAPHS from *Super Slug* program



ABH02A - SLUG-IN / FALLING HEAD TEST 27/07/15

Bouwer and Rice Graph

Armidale Regional Landfill MGA56 Easting: 383748.4 m Northing: 6619550.8 m

ABH02A

Bouwer and Rice parameter A = 3.143
Bouwer and Rice parameter B = 0.663
ln(Re/Rw) = 3.357838e+000
Analysis starts at time 6. Seconds
Analysis ends at time 13.58 minutes
25 Measurements analyzed from 1 to 25

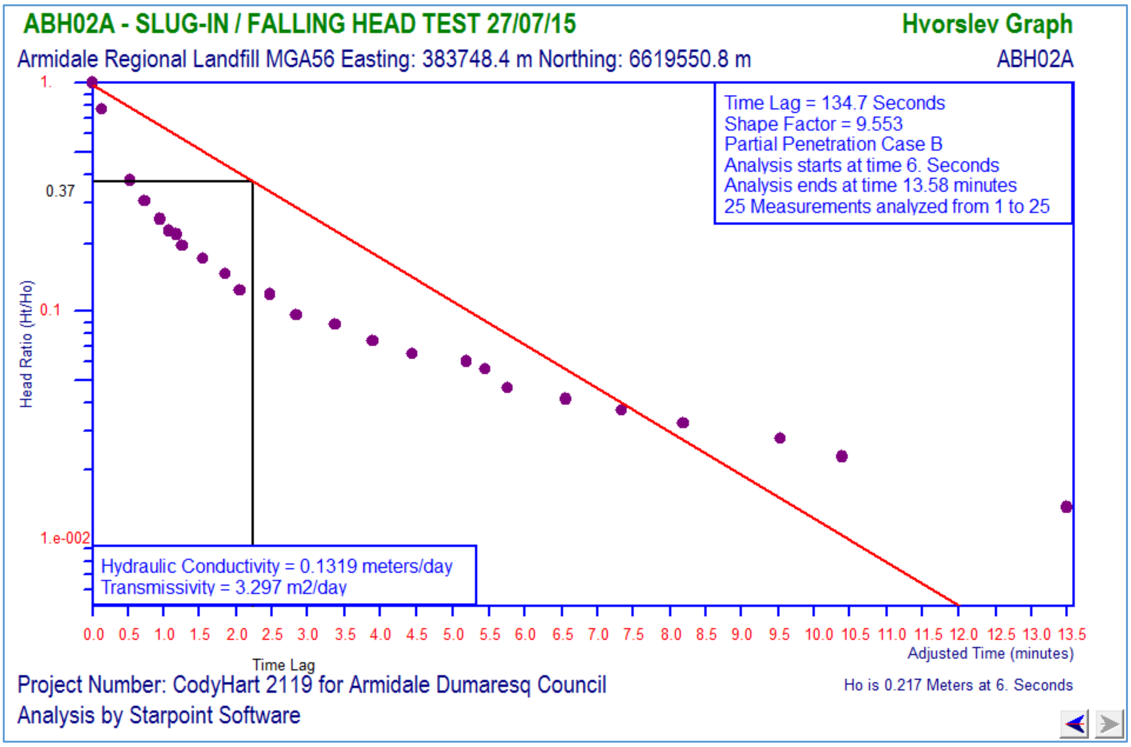
Hydraulic Conductivity = 9.351e-002 meters/day
Transmissivity = 2.338 m2/day

Project Number: CodyHart 2119 for Armidale Dumaresq Council

Analysis by Starpoint Software

Ho is 0.217 Meters at 6. Seconds

All data were included for both the Bouwer and Rice test above and for the Hvorslev test below. These results provided the greatest hydraulic conductivity results, which is precautionary because accepting the fastest *K* means that a more frequent sampling frequency will be favoured. The Hvorslev graph was implemented with the assumption that the line is always drawn through Ho = 1.0, and is best fit to the remaining points. In the Hvorslev graph below, the line does not pass exactly through the first point. It is statistically weighted in the analysis, and not precisely fixed.



ABH02A - SLUG-IN / FALLING HEAD TEST 27/07/15

Hvorslev Graph

Armidale Regional Landfill MGA56 Easting: 383748.4 m Northing: 6619550.8 m

ABH02A

Time Lag = 134.7 Seconds
Shape Factor = 9.553
Partial Penetration Case B
Analysis starts at time 6. Seconds
Analysis ends at time 13.58 minutes
25 Measurements analyzed from 1 to 25

Hydraulic Conductivity = 0.1319 meters/day
Transmissivity = 3.297 m2/day

Project Number: CodyHart 2119 for Armidale Dumaresq Council

Analysis by Starpoint Software

Ho is 0.217 Meters at 6. Seconds

Bouwer & Rice *K* = 0.0935 m/day = 1.1 x 10^{-6} m/s; Hvorslev *K* = 0.1319 m/day = 1.5 x 10^{-6} m/s

SLUG-OUT / RISING HEAD TEST RESULTS – ABH02A

DATA from *Super Slug* program

ABH02A - SLUG-OUT / RISING HEAD TEST

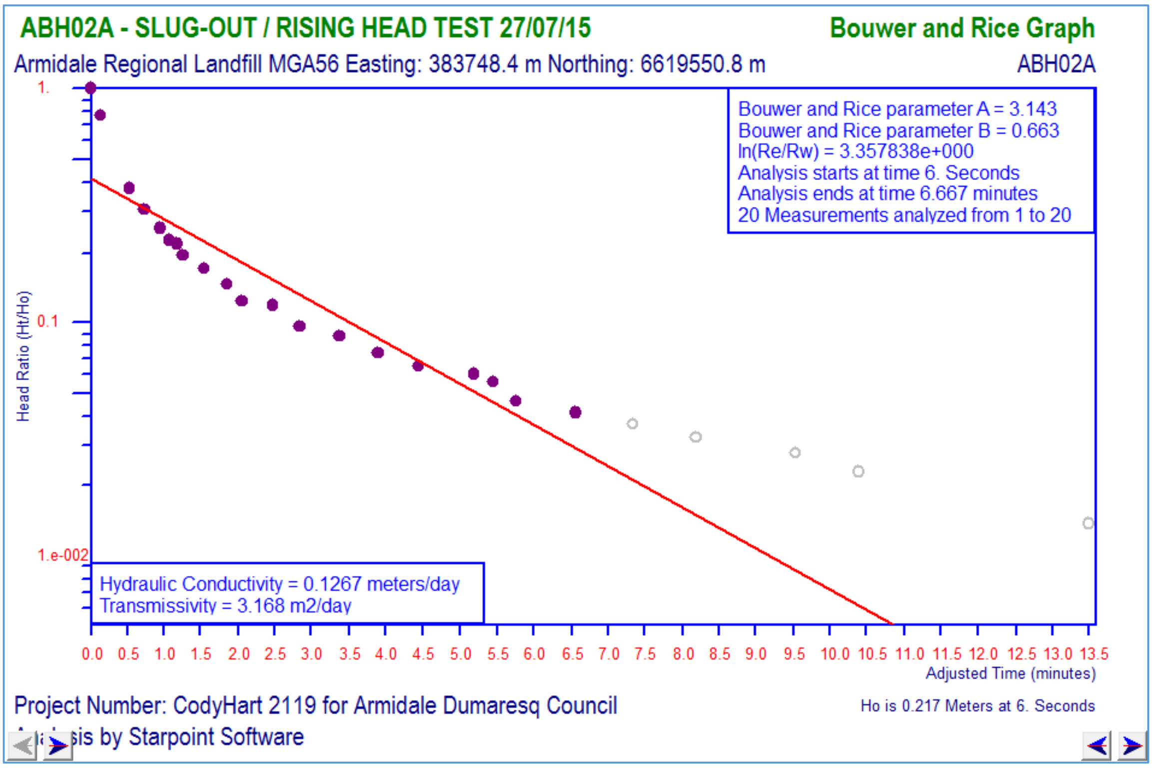
Site Name:	Armidale Regional Landfill
Location:	MGA56 Easting: 383748.4 m Northing: 6619550.8 m
Test Date:	27/07/15
Client:	Armidale Dumaresq Council
Project Number:	CodyHart 2119

Well Label:	ABH02A
Aquifer Thickness:	25. Meters
Screen Length:	6. Meters
Casing Radius:	2.5e-002 Meters
Effective Radius:	0.11 Meters
Static Water Level:	7.687 Meters
Water Table to Screen Bottom:	23.12 Meters
Anisotropy Ratio:	1.
Time Adjustment:	6. Seconds

Test starts with trial 0
There are 25 time and drawdown measurements
Maximum head is 0.217 Meters
Minimum head is 0. Meters

Trial	Time (Seconds)	Adjusted Time (Seconds)	Drawdown (Meters)	Head (Meters)	Head Ratio
1	6.	0.	7.47	0.217	1.
2	14.	8.	7.52	0.167	0.7696
3	38.	32.	7.605	8.2e-002	0.3779
4	51.	45.	7.62	6.7e-002	0.3088
5	63.	57.	7.632	5.5e-002	0.2535
6	70.	64.	7.638	4.9e-002	0.2258
7	76.	70.	7.64	4.7e-002	0.2166
8	82.	76.	7.645	4.2e-002	0.1935
9	99.	93.	7.65	3.7e-002	0.1705
10	117.	111.	7.655	3.2e-002	0.1475
11	130.	124.	7.66	2.7e-002	0.1244
12	155.	149.	7.661	2.6e-002	0.1198
13	176.	170.	7.666	2.1e-002	9.677e-002
14	209.	203.	7.668	1.9e-002	8.756e-002
15	240.	234.	7.671	1.6e-002	7.373e-002
16	272.	266.	7.673	1.4e-002	6.452e-002
17	317.	311.	7.674	1.3e-002	5.991e-002
18	332.	326.	7.675	1.2e-002	5.53e-002
19	352.	346.	7.677	1.e-002	4.608e-002
20	400.	394.	7.678	9.e-003	4.147e-002
21	446.	440.	7.679	8.e-003	3.687e-002
22	498.	492.	7.68	7.e-003	3.226e-002
23	578.	572.	7.681	6.e-003	2.765e-002
24	630.	624.	7.682	5.e-003	2.304e-002
25	815.	809.	7.684	3.e-003	1.382e-002

GRAPHS from *Super Slug* program



ABH02A - SLUG-OUT / RISING HEAD TEST 27/07/15

Bouwer and Rice Graph

Armidale Regional Landfill MGA56 Easting: 383748.4 m Northing: 6619550.8 m

ABH02A

Bouwer and Rice parameter A = 3.143
Bouwer and Rice parameter B = 0.663
ln(Re/Rw) = 3.357838e+000
Analysis starts at time 6. Seconds
Analysis ends at time 6.667 minutes
20 Measurements analyzed from 1 to 20

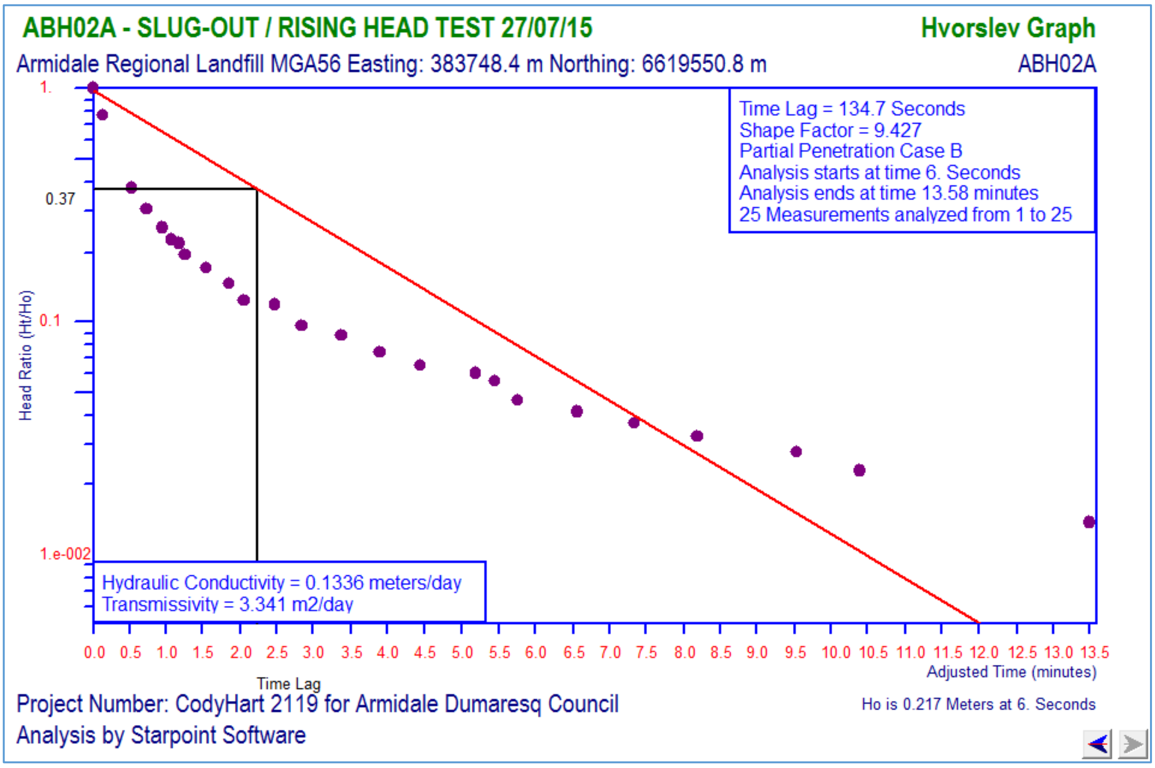
Hydraulic Conductivity = 0.1267 meters/day
Transmissivity = 3.168 m2/day

Project Number: CodyHart 2119 for Armidale Dumaresq Council

sis by Starpoint Software

Ho is 0.217 Meters at 6. Seconds

K in the 'best fit' Bouwer & Rice graph above is 0.1276 m/day = 1.5 x 10^{-6} m/s and Hvorslev *K* in the graph below is 0.1336 m/day = 1.6 x 10^{-6} m/s. Again the Hvorslev graph was implemented with the assumption that the line is always drawn through Ho = 1.0, and is best fit to the remaining points.



ABH02A - SLUG-OUT / RISING HEAD TEST 27/07/15

Hvorslev Graph

Armidale Regional Landfill MGA56 Easting: 383748.4 m Northing: 6619550.8 m

ABH02A

Time Lag = 134.7 Seconds
Shape Factor = 9.427
Partial Penetration Case B
Analysis starts at time 6. Seconds
Analysis ends at time 13.58 minutes
25 Measurements analyzed from 1 to 25

Hydraulic Conductivity = 0.1336 meters/day
Transmissivity = 3.341 m2/day

Project Number: CodyHart 2119 for Armidale Dumaresq Council

Analysis by Starpoint Software

Ho is 0.217 Meters at 6. Seconds

SLUG-IN / FALLING HEAD TEST RESULTS – ABH04A

DATA from *Super Slug* program

ABH04A - SLUG-IN / FALLING HEAD TEST

Site Name:	Armidale Regional Landfill
Location:	MGA56 Easting: 383636.5 m Northing: 6619659.2 m
Test Date:	27/07/15
Client:	Armidale Dumaresq Council
Project Number:	CodyHart 2119

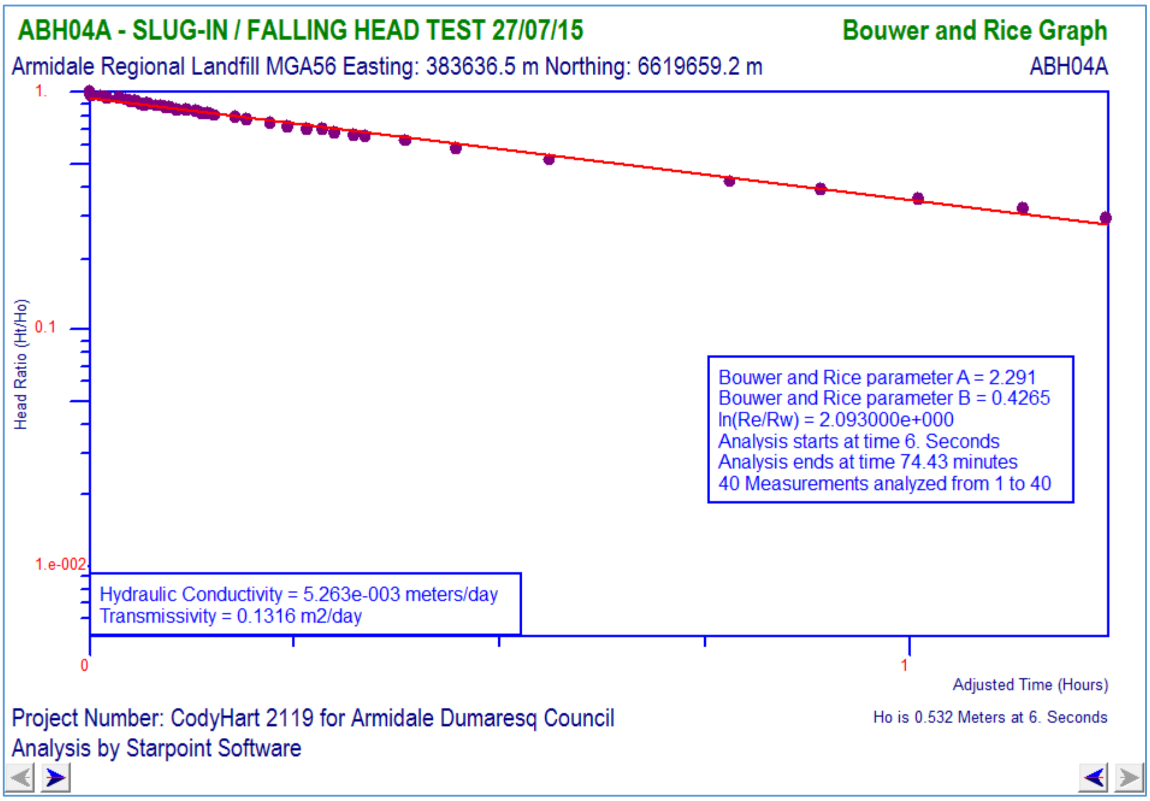
Well Label:	ABH04A
Aquifer Thickness:	25. Meters
Screen Length:	3. Meters
Casing Radius:	2.5e-002 Meters
Effective Radius:	0.11 Meters
Static Water Level:	5.01 Meters
Water Table to Screen Bottom:	3.76 Meters
Anisotropy Ratio:	0.9
Time Adjustment:	6. Seconds

Test starts with trial 0
There are 40 time and drawdown measurements
Maximum head is 0.532 Meters
Minimum head is 0. Meters

Trial	Time (Seconds)	Adjusted Time (Seconds)	Drawdown (Meters)	Head (Meters)	Head Ratio
1	6.	0.	4.478	0.532	1.
2	15.	9.	4.49	0.52	0.9774
3	64.	58.	4.495	0.515	0.968
4	86.	80.	4.5	0.51	0.9586
5	141.	135.	4.505	0.505	0.9492
6	169.	163.	4.51	0.5	0.9398
7	192.	186.	4.517	0.493	0.9267
8	204.	198.	4.52	0.49	0.9211
9	215.	209.	4.524	0.486	0.9135
10	232.	226.	4.527	0.483	0.9079
11	248.	242.	4.536	0.474	0.891
12	259.	253.	4.533	0.477	0.8966
13	267.	261.	4.535	0.475	0.8929
14	298.	292.	4.54	0.47	0.8835
15	329.	323.	4.542	0.468	0.8797
16	338.	332.	4.546	0.464	0.8722
17	361.	355.	4.55	0.46	0.8647
18	395.	389.	4.555	0.455	0.8553
19	439.	433.	4.56	0.45	0.8459
20	481.	475.	4.565	0.445	0.8365
21	501.	495.	4.572	0.438	0.8233
22	532.	526.	4.576	0.434	0.8158
23	558.	552.	4.58	0.43	0.8083
24	645.	639.	4.59	0.42	0.7895
25	702.	696.	4.6	0.41	0.7707
26	798.	792.	4.612	0.398	0.7481
27	881.	875.	4.625	0.385	0.7237
28	959.	953.	4.632	0.378	0.7105
29	1032	1026	4.637	0.373	0.7011
30	1082	1076	4.647	0.363	0.6823
31	1165	1159	4.655	0.355	0.6673
32	1222	1216	4.66	0.35	0.6579
33	1395	1389	4.678	0.332	0.6241

34	1621	1615	4.699	0.311	0.5846
35	2026	2020	4.732	0.278	0.5226
36	2820	2814	4.783	0.227	0.4267
37	3221	3215	4.802	0.208	0.391
38	3645	3639	4.822	0.188	0.3534
39	4099	4093	4.839	0.171	0.3214
40	4466	4460	4.853	0.157	0.2951

GRAPHS from *Super Slug* program



ABH04A - SLUG-IN / FALLING HEAD TEST 27/07/15

Bouwer and Rice Graph

Armidale Regional Landfill MGA56 Easting: 383636.5 m Northing: 6619659.2 m

ABH04A

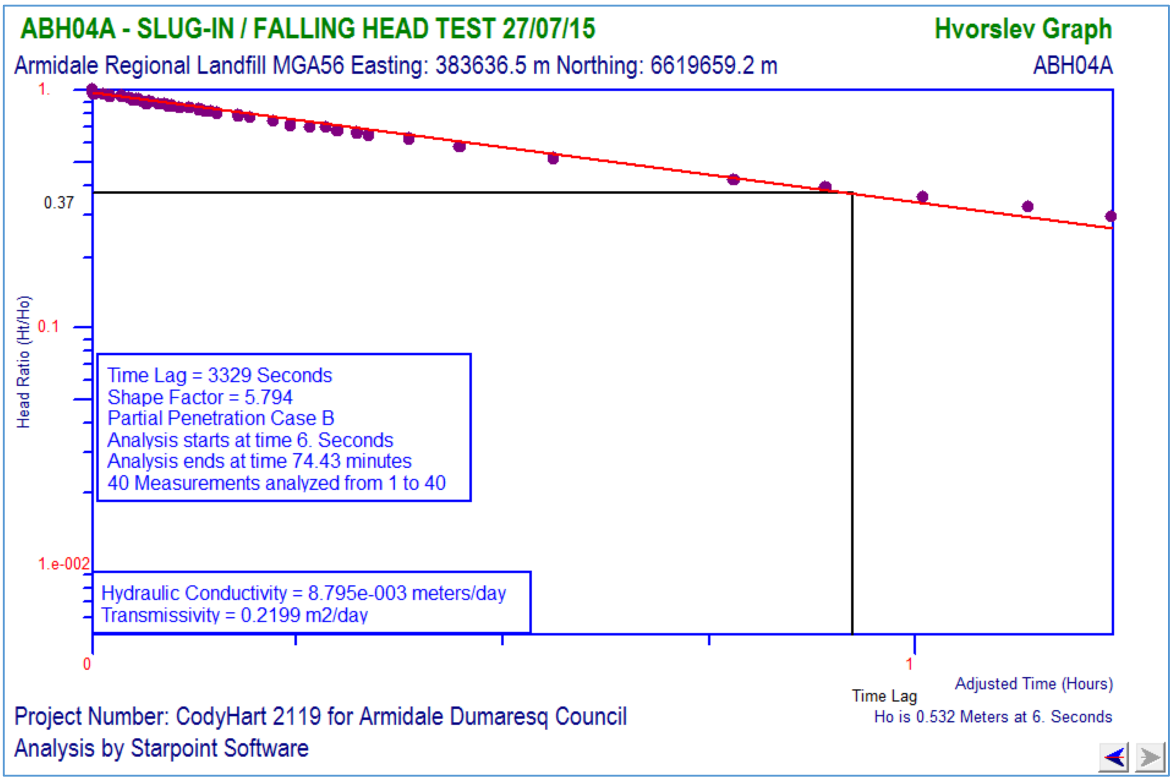
Bouwer and Rice parameter A = 2.291
Bouwer and Rice parameter B = 0.4265
ln(Re/Rw) = 2.093000e+000
Analysis starts at time 6. Seconds
Analysis ends at time 74.43 minutes
40 Measurements analyzed from 1 to 40

Hydraulic Conductivity = 5.263e-003 meters/day
Transmissivity = 0.1316 m2/day

Project Number: CodyHart 2119 for Armidale Dumaresq Council
Analysis by Starpoint Software

Ho is 0.532 Meters at 6. Seconds

The recovery was very slow and was not complete even after one hour. Hence the slow *K*. All data were included for both the Bouwer & Rice test above and for the Hvorslev test below. The Hvorslev graph was implemented with the assumption that the line is always drawn through Ho = 1.0, and is best fit to the remaining points.



ABH04A - SLUG-IN / FALLING HEAD TEST 27/07/15

Hvorslev Graph

Armidale Regional Landfill MGA56 Easting: 383636.5 m Northing: 6619659.2 m

ABH04A

Time Lag = 3329 Seconds
Shape Factor = 5.794
Partial Penetration Case B
Analysis starts at time 6. Seconds
Analysis ends at time 74.43 minutes
40 Measurements analyzed from 1 to 40

Hydraulic Conductivity = 8.795e-003 meters/day
Transmissivity = 0.2199 m2/day

Project Number: CodyHart 2119 for Armidale Dumaresq Council
Analysis by Starpoint Software

Ho is 0.532 Meters at 6. Seconds

Bouwer & Rice *K* = 0.0053 m/day = 6.1 x 10^{-8} m/s; Hvorslev *K* = 0.0088 m/day = 1.0 x 10^{-7} m/s

SLUG-OUT / RISING HEAD TEST RESULTS – ABH04A

DATA from *Super Slug* program

ABH04A - SLUG-OUT / RISING HEAD TEST

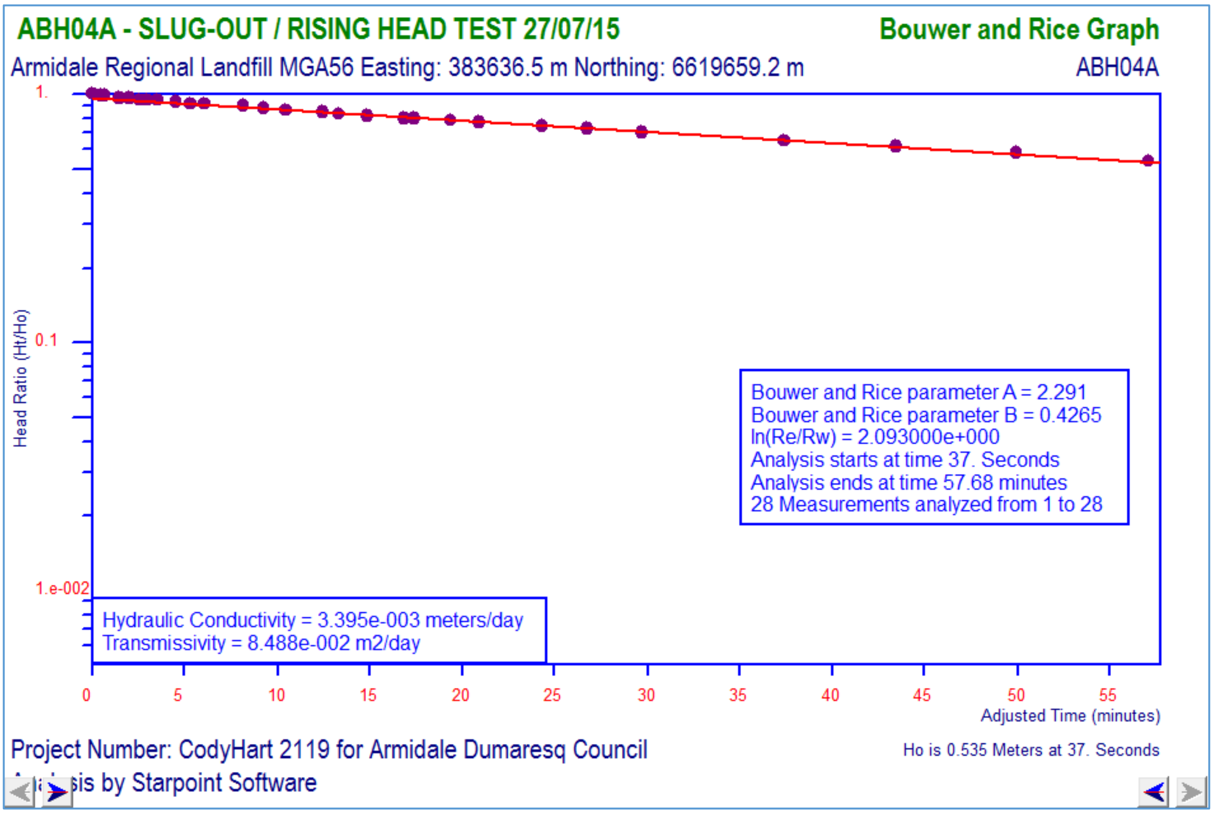
Site Name:	Armidale Regional Landfill
Location:	MGA56 Easting: 383636.5 m Northing: 6619659.2 m
Test Date:	27/07/15
Client:	Armidale Dumaresq Council
Project Number:	CodyHart 2119

Well Label:	ABH04A
Aquifer Thickness:	25. Meters
Screen Length:	3. Meters
Casing Radius:	2.5e-002 Meters
Effective Radius:	0.11 Meters
Static Water Level:	4.94 Meters
Water Table to Screen Bottom:	3.76 Meters
Anisotropy Ratio:	0.9
Time Adjustment:	37. Seconds

Test starts with trial 0
There are 28 time and drawdown measurements
Maximum head is 0.535 Meters
Minimum head is 0. Meters

Trial	Time (Seconds)	Adjusted Time (Seconds)	Drawdown (Meters)	Head (Meters)	Head Ratio
1	37.	0.	5.475	0.535	1.
2	64.	27.	5.47	0.53	0.9907
3	81.	44.	5.466	0.526	0.9832
4	127.	90.	5.462	0.522	0.9757
5	161.	124.	5.457	0.517	0.9664
6	192.	155.	5.453	0.513	0.9589
7	215.	178.	5.45	0.51	0.9533
8	254.	217.	5.447	0.507	0.9477
9	310.	273.	5.44	0.5	0.9346
10	359.	322.	5.436	0.496	0.9271
11	403.	366.	5.431	0.491	0.9178
12	527.	490.	5.419	0.479	0.8953
13	597.	560.	5.413	0.473	0.8841
14	664.	627.	5.407	0.467	0.8729
15	786.	749.	5.395	0.455	0.8505
16	836.	799.	5.391	0.451	0.843
17	931.	894.	5.382	0.442	0.8262
18	1047	1010	5.372	0.432	0.8075
19	1081	1044	5.37	0.43	0.8037
20	1202	1165	5.361	0.421	0.7869
21	1292	1255	5.355	0.415	0.7757
22	1500	1463	5.34	0.4	0.7477
23	1640	1603	5.33	0.39	0.729
24	1820	1783	5.32	0.38	0.7103
25	2281	2244	5.29	0.35	0.6542
26	2642	2605	5.27	0.33	0.6168
27	3033	2996	5.25	0.31	0.5794
28	3461	3424	5.23	0.29	0.5421

GRAPHS from *Super Slug* program



ABH04A - SLUG-OUT / RISING HEAD TEST 27/07/15

Bouwer and Rice Graph

Armidale Regional Landfill MGA56 Easting: 383636.5 m Northing: 6619659.2 m

ABH04A

Bouwer and Rice parameter A = 2.291
Bouwer and Rice parameter B = 0.4265
ln(Re/Rw) = 2.093000e+000
Analysis starts at time 37. Seconds
Analysis ends at time 57.68 minutes
28 Measurements analyzed from 1 to 28

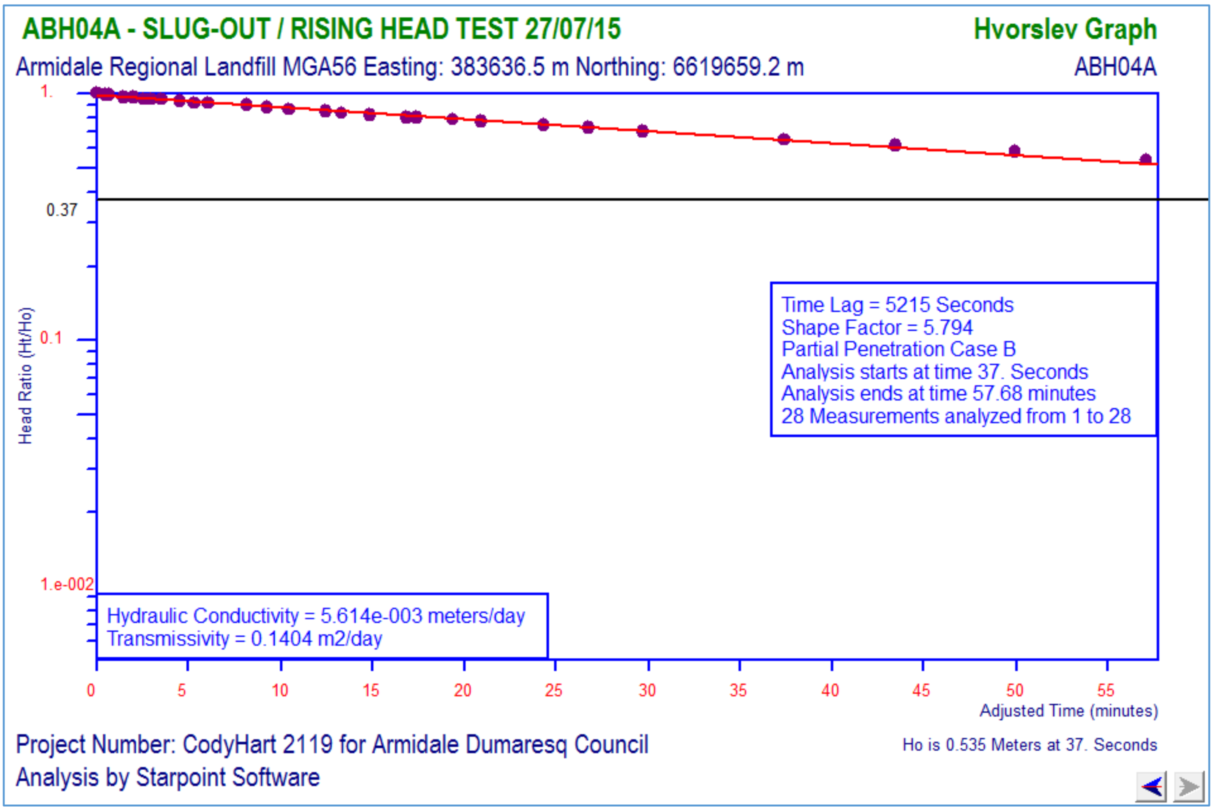
Hydraulic Conductivity = 3.395e-003 meters/day
Transmissivity = 8.488e-002 m2/day

Project Number: CodyHart 2119 for Armidale Dumaresq Council

sis by Starpoint Software

Ho is 0.535 Meters at 37. Seconds

The 'Slug out' test results reiterate the slow *K* as indicated by the slow water recovery. Bouwer & Rice graph above is 0.0034 m/day = 3.9 x 10^{-8} m/s and Hvorslev *K* in the graph below is 0.0056 m/day = 6.5 x 10^{-8} m/s. Again the Hvorslev graph was implemented with the assumption that the line is always drawn through Ho = 1.0, and is best fit to the remaining points.



ABH04A - SLUG-OUT / RISING HEAD TEST 27/07/15

Hvorslev Graph

Armidale Regional Landfill MGA56 Easting: 383636.5 m Northing: 6619659.2 m

ABH04A

Time Lag = 5215 Seconds
Shape Factor = 5.794
Partial Penetration Case B
Analysis starts at time 37. Seconds
Analysis ends at time 57.68 minutes
28 Measurements analyzed from 1 to 28

Hydraulic Conductivity = 5.614e-003 meters/day
Transmissivity = 0.1404 m2/day

Project Number: CodyHart 2119 for Armidale Dumaresq Council

Analysis by Starpoint Software

Ho is 0.535 Meters at 37. Seconds

SLUG-IN / FALLING HEAD TEST RESULTS – ABH12

DATA from *Super Slug* program

ABH12 - SLUG-IN / FALLING HEAD TEST

Site Name:	Armidale Regional Landfill
Location:	MGA56 Easting:383558.08m Northing: 6619122.94m
Test Date:	28/07/15
Client:	Armidale Dumaresq Council
Project Number:	CodyHart 2119

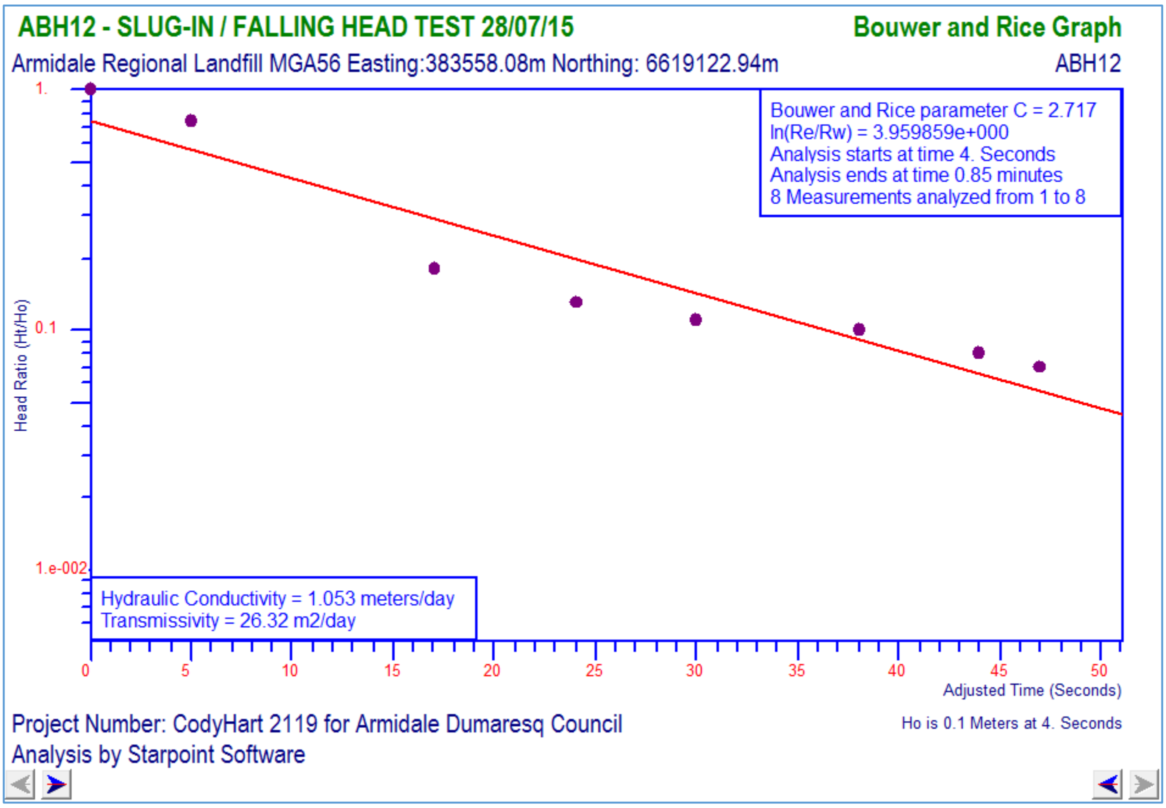
Well Label:	ABH12
Aquifer Thickness:	25. Meters
Screen Length:	6. Meters
Casing Radius:	2.5e-002 Meters
Effective Radius:	0.11 Meters
Static Water Level:	19.845 Meters
Water Table to Screen Bottom:	29.77 Meters
Anisotropy Ratio:	0.9
Time Adjustment:	4. Seconds

Test starts with trial 0
There are 8 time and drawdown measurements
Maximum head is 0.1 Meters
Minimum head is 0. Meters

Trial	Time (Seconds)	Adjusted Time (Seconds)	Drawdown (Meters)	Head (Meters)	Head Ratio
1	4.	0.	19.750	0.1	1.
2	9.	5.	19.775	7.5e-002	0.75
3	21.	17.	19.832	1.8e-002	0.18
4	28.	24.	19.837	1.3e-002	0.13
5	34.	30.	19.839	1.1e-002	0.11
6	42.	38.	19.840	1.e-002	0.1
7	48.	44.	19.842	8.e-003	8.e-002
8	51.	47.	19.843	7.e-003	7.e-002

No ‘slug out / rising head’ test was conducted because measurements for fast recovery wells are impossible to read without a data logger. The slug cannot be removed from the well and a dip meter inserted for measurements before the well has recovered.

GRAPHS from *Super Slug* program



ABH12 - SLUG-IN / FALLING HEAD TEST 28/07/15

Bouwer and Rice Graph

Armidale Regional Landfill MGA56 Easting:383558.08m Northing: 6619122.94m

ABH12

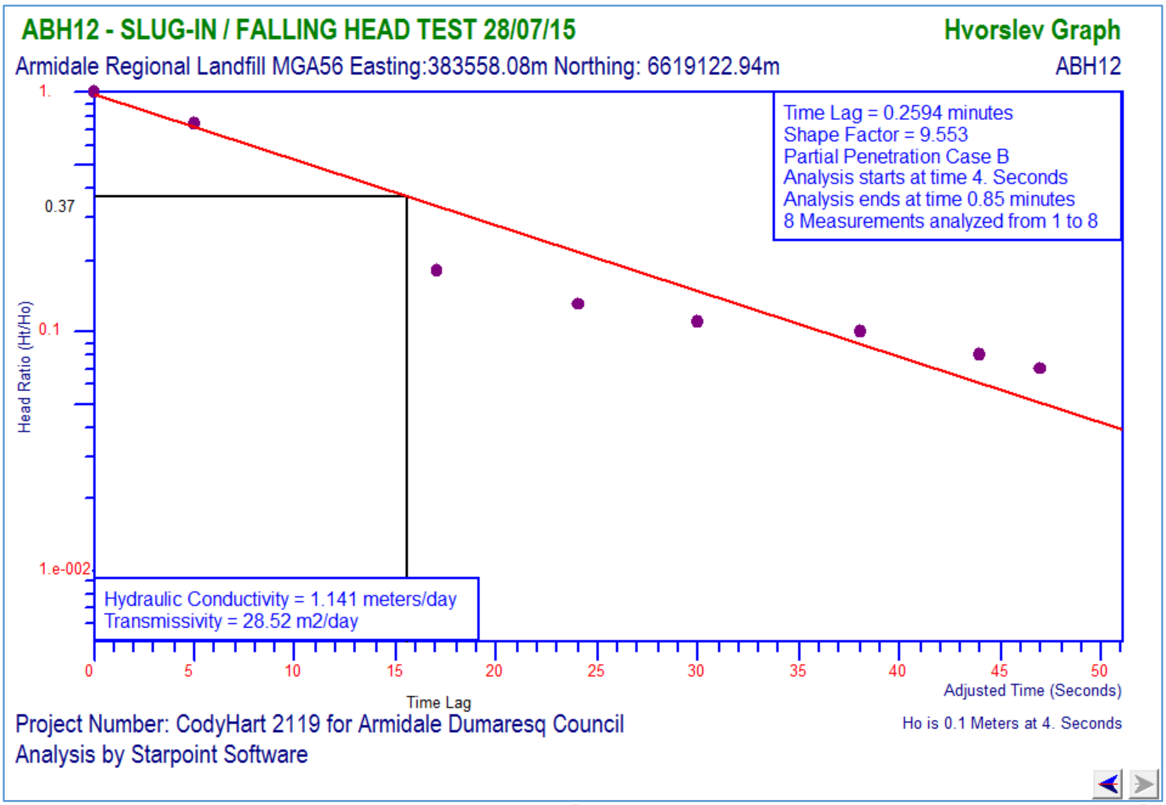
Bouwer and Rice parameter C = 2.717
ln(Re/Rw) = 3.959859e+000
Analysis starts at time 4. Seconds
Analysis ends at time 0.85 minutes
8 Measurements analyzed from 1 to 8

Hydraulic Conductivity = 1.053 meters/day
Transmissivity = 26.32 m2/day

Project Number: CodyHart 2119 for Armidale Dumaresq Council
Analysis by Starpoint Software

Ho is 0.1 Meters at 4. Seconds

The recovery was very fast completing by 51 seconds. Hence the faster *K*. All data were included for both the Bouwer & Rice test above and for the Hvorslev test below. The Hvorslev graph was implemented with the assumption that the line is always drawn through Ho = 1.0, and is best fit to the remaining points.



ABH12 - SLUG-IN / FALLING HEAD TEST 28/07/15

Hvorslev Graph

Armidale Regional Landfill MGA56 Easting:383558.08m Northing: 6619122.94m

ABH12

Time Lag = 0.2594 minutes
Shape Factor = 9.553
Partial Penetration Case B
Analysis starts at time 4. Seconds
Analysis ends at time 0.85 minutes
8 Measurements analyzed from 1 to 8

Hydraulic Conductivity = 1.141 meters/day
Transmissivity = 28.52 m2/day

Project Number: CodyHart 2119 for Armidale Dumaresq Council
Analysis by Starpoint Software

Ho is 0.1 Meters at 4. Seconds

Bouwer & Rice *K* = 1.053 m/day = 1.2 x 10^{-5} m/s; Hvorslev *K* = 1.141 m/day = 1.3 x 10^{-5} m/s