EPA SUBMISSION

Wollongong City Council

Whytes Gully Waste Disposal Facility
Annual Report

Period 01 June 2012 – 31 May 2013

Reference Z13/131625

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CONTENTS

1	*INTRODUCTION*	
1.1	*BACKGROUND*	*4*
1.2	*OBJECTIVES OF THE ANNUAL REPORT*	*4*
1.3	*SITE HISTORY*	*4*
1.4	*RELEVANT DOCUMENTS*	*5*
2	*KEY LICENCE ISSUES*	
2.1	*ENVIRONMENTAL PROTECTION LICENCE ANNUAL RETURNS*	*6*
3	*REVIEW OF LANDFILL MONITORING DATA*	
3.1	*GROUNDWATER MONITORING*	*9*
3.1.1	*TABULATED RESULTS*	*9*
3.1.2	*DATA PRESENTATION – QUARTERLY MONITORING*	*12*
3.1.3	*DATA PRESENTATION – ANNUAL MONITORING*	*19*
3.1.4	*GROUNDWATER TESTING RESULTS INTERPRETATION*	*29*
3.2	*SURFACE WATER MONITORING*	*30*
3.2.1	*TABULATED RESULTS*	*30*
3.2.2	*DATA PRESENTATION*	*31*
3.2.3	*SURFACE WATER RESULTS INTERPRETATION*	*39*
3.3	*AIR EMISSIONS MONITORING*	*40*
3.3.1	*TABULATED RESULTS*	*40*
3.3.2	*DATA PRESENTATION*	*41*
3.3.3	*AIR EMISSIONS MONITORING RESULTS INTERPRETATION*	*41*
3.4	*ENVIRONMENTAL COMPLAINTS*	*43*
3.4.1	*TABULATED RESULTS*	*43*
3.4.2	*DATA PRESENTATION*	*43*
3.4.3	*ENVIRONMENTAL COMPLAINTS RESULTS INTERPRETATION*	*44*
4	*SITE SUMMATION*	
4.1	*DEFICIENCY IDENTIFICATION & REMEDIATION*	*45*
4.1.1	*SURFACE METHANE EMISSIONS ABOVE RECOMMENDED BENCHMARK THRESHOLD LEVELS*	*45*
4.1.2	*BOREHOLES INDICATING POTENTIALLY IMPERFECT TREND STABILITY*	*45*
4.1.3	*DRY BOREHOLES*	*45*
4.2	*CONCLUSION*	*46*

ANNEXURES

ANNEXURE A	*ENVIRONMENTAL MONITORING LOCATIONS*	*47*

ABBREVIATIONS

Al	Aluminium
ANZECC	Australian and New Zealand Environment Conservation Council
Ar	Arsenic
Ba	Barium
Ca	Calcium
$CaCO_3$	Calcium Carbonate
Cd	Cadmium
CH_4	Methane
Cl	Chloride
Co	Cobalt
Cr	Chromium
Cu	Copper
DC	Development Consent
EPA	Environment Protection Authority
EPL	Environmental Protection Licence
F	Fluoride
K	Potassium
LEMP	Landfill Environmental Management Plan
Mg	Magnesium
Mn	Manganese
Na	Sodium
NH_3	Ammonia
NO_3	Nitrate
NO_2	Nitrite

ppm	Parts per Million
SO_4	Sulfate
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSS	Total Suspended Solids
WWARRP	Wollongong Waste and Resource Recovery Park
Zn	Zinc

1 INTRODUCTION

1.1 BACKGROUND

The City of Wollongong is located 80 kilometres south of Sydney and is Australia's 9th largest city. The Wollongong City Council (Council) governance area occupies a relatively narrow coastal strip bordered by the Royal National Park to the north, the Windang Bridge and Yallah to the south, the Tasman Sea to the east and the escarpment to the west.

Council owns and operates the Wollongong Waste and Resource Recovery Park (the site), which is located on Reddalls Road at Kembla Grange. The site is situated south west of Wollongong's central business district on approximately 50 hectares and is comprised of Lots 50, 52 and 53 of DP 1022266 and Lot 2 of DP 240557.

Council holds an Environmental Protection Licence (EPL) number 5862, for 'Waste Disposal – Application to Land' for the site. Council currently operates in accordance with the sites Landfill Environmental Management Plan (LEMP) in accord with the requirements of the sites EPL and Development Consent (DC).

1.2 OBJECTIVES OF THE ANNUAL REPORT

Condition R1.10 of the EPL specifies that Council must provide an Annual Report to accompany the Annual Return for the site. The objective of this report is to provide that review.

1.3 SITE HISTORY

Whytes Gully was developed in the early 1980's as the principal landfill site for Wollongong's domestic and commercial waste streams. Initially, the 'western gully' section was landfilled. The western gully is unlined by modern standards and was used from 1982 to 1993. Initially coal wash refuse was used to provide daily cover, then around 1988/89 steel furnace slag was introduced because of its stability in wet weather and Council's inability to source local clean fill in sufficient quantities. The leachate collection from the western gully is through a series of rock drains at the centre of each lift. The rock drains connect with a riser and the leachate flows from riser to riser, and then to the leachate collection well at the base of the western gully. The western gully section of the landfill has been capped with clay to varying depths between 1m and 4m.

The 'eastern gully' section development received consent in 1992/93, following extensive public consultation. The eastern gully section is lined with a single layer of HDPE smooth liner, over a subsoil drainage layer of 5mm gravel and a corrugated groundwater drainage system. The eastern gully was excavated to rock and was developed in two stages, beginning with the first stage 80 to 100m above the slope from the current toe of the landfill embankment. The leachate is drained from the first stage of the eastern gully via a 300mm corrugated drainage pipe at the base and a 300mm thick sand layer above the liner.

The second stage of the eastern gully operates in front and above the first stage, with extended leachate drains and HDPE liner. The eastern gully has intermediate cover of varying quality on the embankments.

Leachate is collected from all landfilled areas at the site and treated in a 3 stage process. The leachate is initially collected in a primary holding pond that uses a biological process and aeration primarily to strip the leachate of ammonia. The leachate is then pumped to a smaller pond with a greater surface area to increase the speed of this process. From the smaller pond the leachate is then pumped to a sequence batch reactor that in conjunction with a filtration system eliminates the residual contaminants in the leachate suitable for acceptance by sewer under the sites Trade Wastewater Agreement with Sydney Water.

1.4 RELEVANT DOCUMENTS

This annual report refers to and / or draws upon information and data from the following documents;

- Whytes Gully Waste Disposal Facility – Annual Return for Period 01 June 2011 to 31 May 2012. By Wollongong City Council July 2012
- Whytes Gully Waste Disposal Facility – Annual Return for Period 01 June 2010 to 31 May 2011. By Wollongong City Council July 2011.
- Whytes Gully Waste Disposal Facility – Annual Report for Period 01 June 2009 to 31 May 2010. By GHD July 2010.

2 *KEY LICENCE ISSUES*

2.1 *ENVIRONMENTAL PROTECTION LICENCE ANNUAL RETURNS*

The Environment Protection Authority (EPA) has issued an ***Environmental Protection Licence*** (Licence No. 5862) for the landfill and recycling operations on the Whytes Gully site. The licence, issued under the ***Protection of the Environment Operations Act 1997,*** requires an annual return to be submitted to the EPA, detailing;

a) Statement of compliance; and

b) Monitoring and complaints summary, including responses.

c) Tabulated results of all monitoring data required by the licence.

d) A graphical presentation of the data for at least three years (if available).

e) Notations made regarding any statistically significant variations or anomalies.

f) An analysis and interpretation of all monitoring data.

g) Identification of any deficiencies in environmental performance and action taken.

h) Recommendations on improving the sites environmental performance.

The EPL Annual Returns for 2008 to 2012 reporting periods were reviewed to provide a background to this report. These Annual Returns can be summarised as follows:

01 June 2008 to 31 May 2009

B1. Pollution complaints - Nine

B2. Concentration monitoring summary – Complete.

B3. Volume or mass monitoring summary - None required.

C1. Compliance with licence condition – Ten non compliances.

C2. Details of non-compliance

1. ***Stormwater pH measurement > 8.5***
2. ***Four missed stormwater conductivity measurements***
3. ***Stormwater suspended solids > 50mg/L twice***
4. ***Four missed potassium groundwater measurements***
5. ***One missed groundwater redox, coliforms and dissolved oxygen measurements***
6. ***Three missed groundwater alkalinity measurements***
7. ***One missed groundwater calcium, chloride, magnesium, sodium, sulphate and potassium tests***

8. ***One missed groundwater calcium, chloride, magnesium, sodium, sulphate and potassium test***
9. ***One missed groundwater calcium, chloride, magnesium, sodium, sulphate and potassium test***
10. ***One missed groundwater calcium, chloride, magnesium, sodium, sulphate and potassium test***

01 June 2009 to 31 May 2010

B1. Pollution complaints - Twelve

B2. Concentration monitoring summary – Complete.

B3. Volume or mass monitoring summary - None required.

C1. Compliance with licence condition – Five non compliances

C2. Details of non-compliance

1. ***Two missed stormwater temperature measurements***
2. ***Missed stormwater filterable iron measurement***
3. ***One round of groundwater monitoring missed***
4. ***One round of groundwater monitoring missed***
5. ***One round of landfill gas monitoring missed***

01 June 2010 to 31 May 2011

B1. Pollution complaints – Twelve

B2. Concentration monitoring summary – Complete.

B3. Volume or mass monitoring summary - None required.

C1. Compliance with licence condition – Zero non compliances

C2. Details of non-compliance – N/A

01 June 2011 to 31 May 2012

B1. Pollution complaints – Forty Eight

B2. Concentration monitoring summary – Complete.

B3. Volume or mass monitoring summary - None required.

C1. Compliance with licence condition – Zero non compliances

C2. Details of non-compliance – N/A

In summary, compliance issues have generally been restricted to minor exceedances of pH and suspended solids in the sediment pond, and these issues are covered by ongoing monitoring provisions.

A potential problem existed prior to June 2010 with seemingly regular missed analytical testing regimes over the previous 2 years. Subsequently, Council formally tendered for the environmental testing at the site, which now ensures regular testing routines are in place under contract performance requirements.

The EPL has had several variations applied to it in recent years. These changes include:

- Addition of pollution studies and reduction programs added on 28 November 2008.

- Scheduled Activity and Waste Classification structure changed on 17 October 2008.

- Reformatted licence including specification for cover material, litter control and other operational processes 20 November 2007.

- Clarification of water pollution prevention requirements on 11 October 2005.

- Overhauled and reformatted licence resulting from Council's request to modernise environmental testing requirements and to formally recognise the increased environmental sampling points and standards adopted by Council for the site. The request formed Annexure B of the 2010/2011 Annual Environmental Management Report and was formally approved and adopted by the EPA on 16 April 2012.

3 *REVIEW OF LANDFILL MONITORING DATA*

3.1 *GROUNDWATER MONITORING*

Recent site investigations resulting from Council's Environment Application lodged with the State Government on 01 April 2012, have confirmed a predominant approximate south-southwest groundwater flow direction. The groundwater flow direction should be used to contextualise monitoring bore locations and elevated results, please refer to the sites Environmental Monitoring Locations located in Annexure A of this document.

3.1.1 *Tabulated Results*

Analyte	23 August 2012											
	Units	1a	2a	3a	4a	5a	6a	7a	1	3	4	5	6
Alkalinity	mg/L	Dry	Dry	Dry	484	764	1000	Dry	175	1060	248	684	727
Calcium	mg/L	Dry	Dry	Dry	56	161	232	Dry	95	138	31	111	119
Chloride	mg/L	Dry	Dry	Dry	214	1830	1550	Dry	1560	968	408	1590	1100
Magnesium	mg/L	Dry	Dry	Dry	35	251	319	Dry	138	163	30	157	126
Nitrogen	mg/L	Dry	Dry	Dry	1.48	0.02	0.02	Dry	<0.12	0.06	0.08	1.3	0.06
Potassium	mg/L	Dry	Dry	Dry	5	<1	<1	Dry	<1	<1	<1	9	<1
Sodium	mg/L	Dry	Dry	Dry	249	1640	1280	Dry	1060	716	358	1130	853
Water Level	m	Dry	Dry	Dry	2.14	2.5	2.93	Dry	3.49	1.59	1.75	6.21	1.42
Sulfate	mg/L	Dry	Dry	Dry	65	592	977	Dry	414	173	174	204	317
TDS	mg/L	Dry	Dry	Dry	804	4440	5140	Dry	3440	2700	1030	3700	2750
TOC	mg/L	Dry	Dry	Dry	4	<1	<1	Dry	<1	<1	<1	30	<1
pH	pH	Dry	Dry	Dry	7.6	7.1	7	Dry	6.1	7.2	6.3	6.3	6.8

Table 3.1.1(a) Quarterly analyte testing results for August 2012

Analyte	13 November 2012											
	Units	1a	2a	3a	4a	5a	6a	7a	1	3	4	5	6
Alkalinity	mg/L	Dry	Dry	Dry	212	553	970	Dry	232	969	145	295	688
Calcium	mg/L	Dry	Dry	Dry	41	118	243	Dry	78	131	21	66	122
Chloride	mg/L	Dry	Dry	Dry	258	2290	1940	Dry	1300	1060	226	129	1260
Magnesium	mg/L	Dry	Dry	Dry	28	194	378	Dry	84	151	14	27	129
Nitrogen	mg/L	Dry	Dry	Dry	0.87	0.02	0.02	Dry	<0.01	0.11	0.03	0.5	0.1
Potassium	mg/L	Dry	Dry	Dry	4	<1	1	Dry	<1	<1	4	6	<1
Sodium	mg/L	Dry	Dry	Dry	212	1360	1410	Dry	755	684	176	164	842
Water Level	m	Dry	Dry	Dry	2.34	2.7	3.19	Dry	4.08	2.17	2.22	8	1.58
Sulfate	mg/L	Dry	Dry	Dry	152	542	1520	Dry	246	159	88	9	322
TDS	mg/L	Dry	Dry	Dry	862	5120	6990	Dry	2530	2750	626	1100	2940
TOC	mg/L	Dry	Dry	Dry	14	2	2	Dry	2	4	5	27	4
pH	pH	Dry	Dry	Dry	7.3	7.1	6.9	Dry	6.4	7.1	6.6	7.5	6.9

Table 3.1.1(b) Quarterly analyte testing results for November 2012

Analyte	14 February 2013												
	Units	1a	2a	3a	4a	5a	6a	7a	1	3	4	5	6
Alkalinity	mg/L	Dry	Dry	Dry	200	472	932	Dry	225	965	159	Dry	685
Calcium	mg/L	Dry	Dry	Dry	53	102	225	Dry	78	140	35	Dry	127
Chloride	mg/L	Dry	Dry	Dry	120	2110	1600	Dry	975	967	24	Dry	1080
Magnesium	mg/L	Dry	Dry	Dry	26	205	353	Dry	75	180	10	Dry	143
Nitrogen	mg/L	Dry	Dry	Dry	0.18	<0.01	0.01	Dry	0.01	0.08	0.06	Dry	0.09
Potassium	mg/L	Dry	Dry	Dry	4	<1	<1	Dry	<1	<1	19	Dry	<1
Sodium	mg/L	Dry	Dry	Dry	112	1420	1340	Dry	669	762	29	Dry	855
Water Level	m	Dry	Dry	Dry	2.37	2.72	3.23	Dry	4.51	2.49	2.44	Dry	1.52
Sulfate	mg/L	Dry	Dry	Dry	96	542	1280	Dry	213	152	14	Dry	303
TDS	mg/L	Dry	Dry	Dry	564	4760	5400	Dry	2090	2690	268	Dry	2860
TOC	mg/L	Dry	Dry	Dry	21	<1	1	Dry	4	74	11	Dry	2
pH	pH	Dry	Dry	Dry	7.5	6.8	6.8	Dry	6.2	6.8	6.9	Dry	6.7

Table 3.1.1(c) Quarterly analyte testing results for February 2013

Analyte	15 May 2013												
	Units	1a	2a	3a	4a	5a	6a	7a	1	3	4	5	6
Alkalinity	mg/L	Dry	Dry	Dry	450	674	900	Dry	242	960	99	273	702
Calcium	mg/L	Dry	Dry	Dry	66	115	183	Dry	80	131	24	19	108
Chloride	mg/L	Dry	Dry	Dry	132	1590	1310	Dry	978	871	9	170	960
Magnesium	mg/L	Dry	Dry	Dry	30	186	284	Dry	76	153	6	13	122
Nitrogen	mg/L	Dry	Dry	Dry	8.74	<0.01	0.02	Dry	<0.01	0.13	0.04	0.52	0.04
Potassium	mg/L	Dry	Dry	Dry	5	<1	1	Dry	<1	<1	19	2	<1
Sodium	mg/L	Dry	Dry	Dry	142	1320	1250	Dry	685	663	9	216	838
Water Level	m	Dry	Dry	Dry	2.28	2.64	3.21	Dry	4.1	2.11	2.19	7.9	1.48
Sulfate	mg/L	Dry	Dry	Dry	42	482	1200	Dry	325	179	<10	32	323
TDS	mg/L	Dry	Dry	Dry	698	4670	5050	Dry	2450	2740	167	670	2990
TOC	mg/L	Dry	Dry	Dry	20	1	3	Dry	4	15	10	17	<4
pH	pH	Dry	Dry	Dry	7.4	6.8	6.8	Dry	6.2	6.8	7.2	6.9	7.2

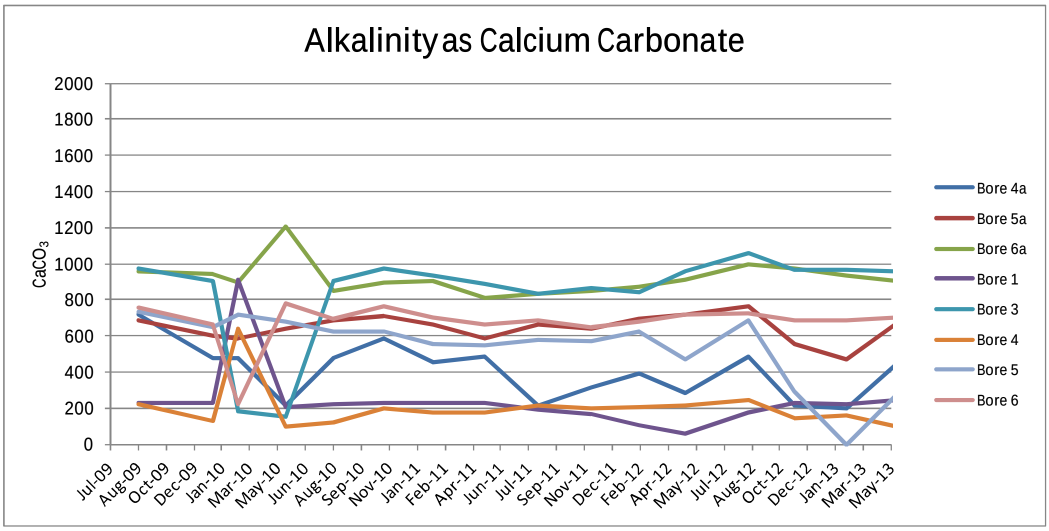
Table 3.1.1(d) Quarterly analyte testing results for May 2013

Analyte	Units	23 August 2012											
		1a	2a	3a	4a	5a	6a	7a	1	3	4	5	6
Aluminium	mg/L	Dry	Dry	Dry	0.03	0.09	0.27	Dry	0.16	0.16	0.52	3.26	0.07
Arsenic	mg/L	Dry	Dry	Dry	<0.001	<0.001	<0.001	Dry	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	Dry	Dry	Dry	0.039	0.021	0.006	Dry	0.087	0.09	0.076	0.308	0.051
Benzene	µg/	Dry	Dry	Dry	<1	<1	<1	Dry	<1	<1	<1	<1	<1
Cadmium	mg/L	Dry	Dry	Dry	<0.0001	<0.0001	<0.0001	Dry	<0.0001	<0.0001	<0.0001	0.0002	0.0002
Chromium (hex.)	mg/L	Dry	Dry	Dry	<0.01	<0.01	<0.01	Dry	<0.01	<0.01	<0.01	<0.01	<0.01
Chromium (total)	mg/L	Dry	Dry	Dry	<0.001	<0.001	0.002	Dry	<0.001	<0.001	<0.001	0.007	0.001
Cobalt	mg/L	Dry	Dry	Dry	<0.001	<0.001	<0.001	Dry	0.012	0.008	<0.001	0.019	0.011
Copper	mg/L	Dry	Dry	Dry	0.002	0.002	0.004	Dry	0.004	0.003	0.003	0.014	0.005
Ethyl Benzene	µg/L	Dry	Dry	Dry	<2	<2	<2	Dry	<2	<2	<2	<2	<2
Fluoride	mg/L	Dry	Dry	Dry	0.4	0.9	0.9	Dry	0.2	0.6	0.2	0.8	0.8
Lead	mg/L	Dry	Dry	Dry	0.002	0.002	0.003	Dry	0.004	0.002	0.003	0.022	0.004
Manganese	mg/L	Dry	Dry	Dry	0.239	0.023	0.034	Dry	1.02	0.407	0.057	2.46	1.46
Mercury	mg/L	Dry	Dry	Dry	<0.0001	<0.0001	<0.0001	Dry	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Nitrate	mg/L	Dry	Dry	Dry	0.01	0.06	0.02	Dry	0.01	0.03	0.04	0.07	0.02
Nitrite	mg/L	Dry	Dry	Dry	0.02	<0.01	<0.01	Dry	<0.01	<0.01	<0.01	<0.01	<0.01
Organochlorine Pesticides	µg/	Dry	Dry	Dry	<0.5	<0.5	<0.5	Dry	<0.5	<0.5	<0.5	<0.5	<0.5
Organophosphate Pesticides	µg/	Dry	Dry	Dry	<0.5	<0.5	<0.5	Dry	<0.5	<0.5	<0.5	<0.5	<0.5
Polycyclic Aromatic Hydrocarbons	µg/	Dry	Dry	Dry	<0.5	<0.5	<0.5	Dry	<0.5	<0.5	<0.5	<0.5	<0.5
Toluene	µg/	Dry	Dry	Dry	<2	<2	<2	Dry	<2	<2	<2	<2	<2
Total Petroleum Hydrocarbons	µg/	Dry	Dry	Dry	<50	<50	<50	Dry	<50	<50	<50	1620	<50
Total Phenolics	mg/L	Dry	Dry	Dry	<0.05	<0.05	<0.05	Dry	<0.05	<0.05	<0.05	<0.05	<0.05
Xylene	µg/	Dry	Dry	Dry	<2	<2	<2	Dry	<2	<2	<2	<2	<2
Zinc	mg/L	Dry	Dry	Dry	0.134	0.007	0.012	Dry	0.012	0.039	0.011	0.057	0.019

Table 3.1.1(e) Annual analyte testing August 2012 results

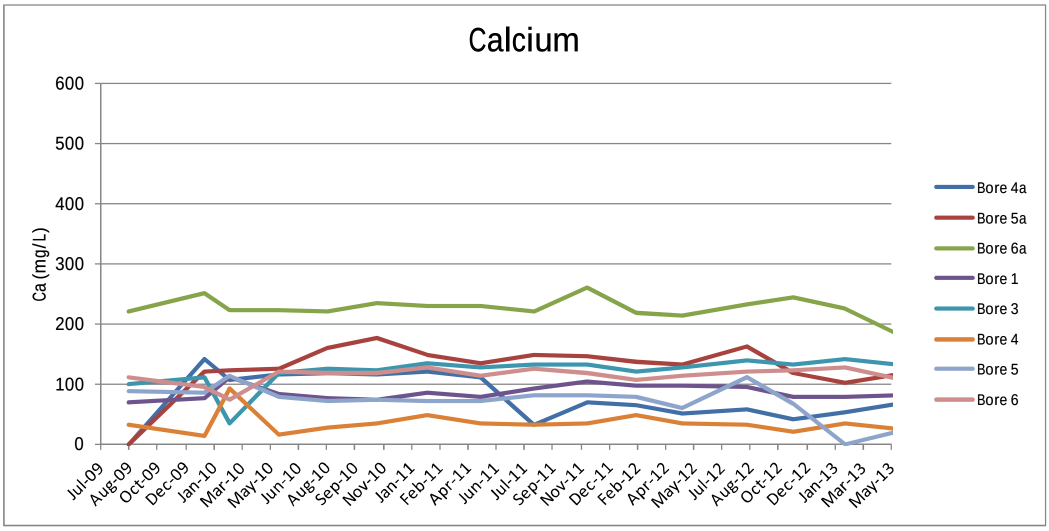
3.1.2 Data Presentation – Quarterly Monitoring

Alkalinity results presentation.



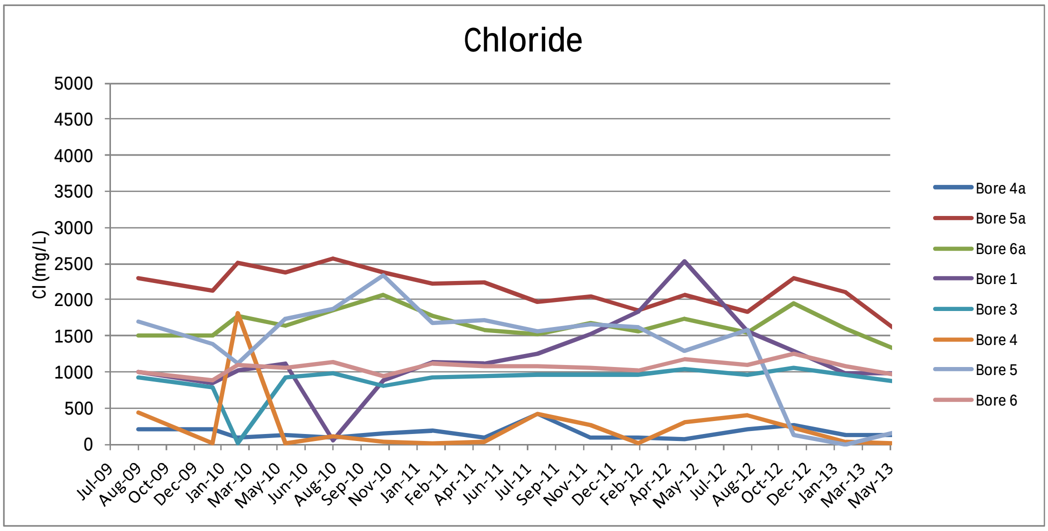
Increased alkalinity levels can be caused by many chemical processes including the denitrification process common in landfill leachate. Denitrification is the anaerobic biological reduction of nitrate (NO_3) to nitrogen (N_2) in its gaseous form. Under anoxic conditions microorganisms consume the oxygen in the nitrate and liberate the nitrogen. This process produces calcium carbonate as a by-product. The stability of the calcium carbonate in the groundwater monitoring wells over the five year sample period shows that it is unlikely that the denitrification process caused by leachate ingress is taking place in the groundwater around the site. Nonetheless, the calcium carbonate levels are relatively high and quite “hard” in plumbing terms and continued monitoring is necessary to scrutinise for any increased value trends. It should be noted that many natural groundwater sources often contain much higher alkalinity levels than this site.

Calcium results presentation.



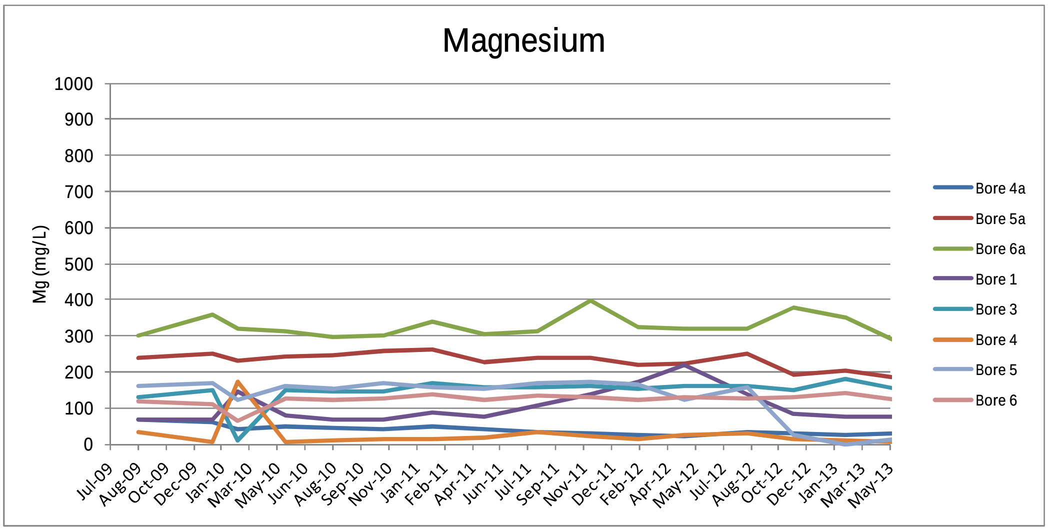
The groundwater monitoring wells show a consistent stable trend for calcium levels. The calcium levels sampled would be considered "hard" water in the region of 120-180mg/L. This is consistent with the presented results for alkalinity.

Chloride results presentation.



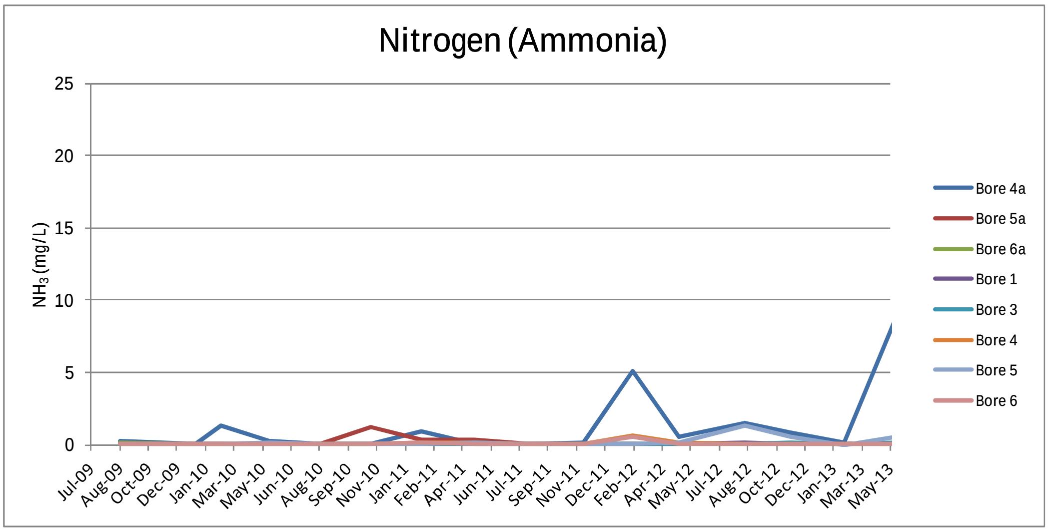
The trends realised through chloride monitoring have been in line with the historical levels over the data range available. Large quantities of inorganic ions such as chloride can be an indicator of leachate contamination of groundwater. A sudden increase in these ions can act as early warning system. The sampling history for chloride suggests that no significant spikes have occurred that has not returned to normal or historical levels and therefore leachate is not indicated in the groundwater network.

Magnesium results presentation.



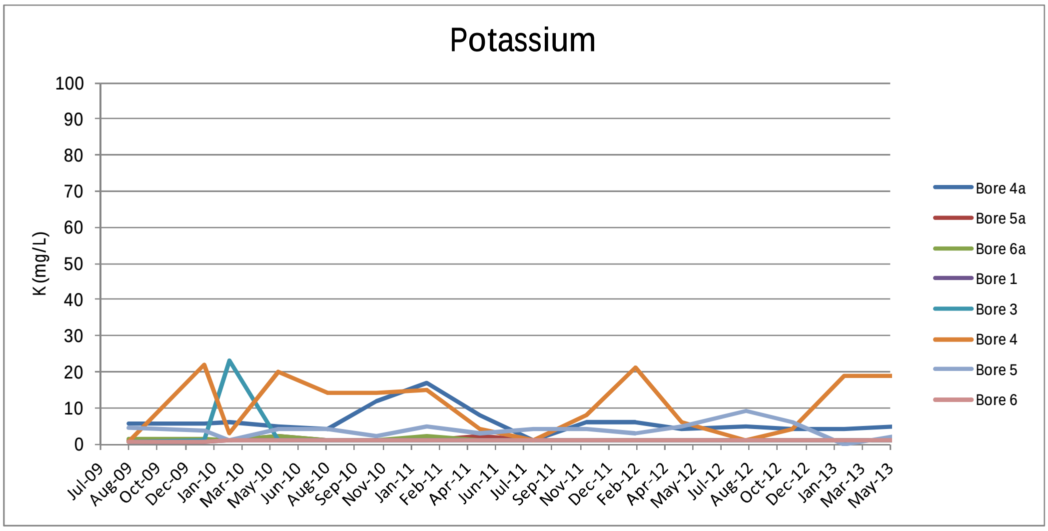
Groundwater monitoring well results are in line with historical levels and have maintained consistent levels. The magnesium levels sampled would be considered quite "hard" and consistent with other typical water hardness measures such as alkalinity and calcium.

Nitrogen as ammonia results presentation.



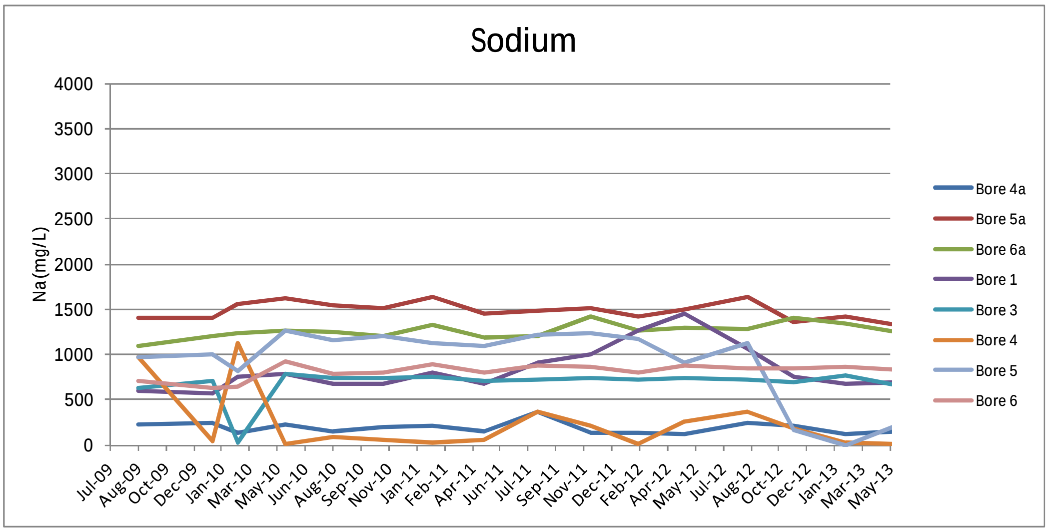
The groundwater monitoring wells indicate that ammonia levels in the groundwater are extremely low and often beneath the testing limits. Any perceived spikes have consistently tended back down towards low levels with regularity. However, even the perceived spikes are at low measurement levels close to undetectable limits. Ammonia is perhaps the clearest indicator of leachate contamination and the results from monitoring well 4a, should be carefully monitored in future sampling events to be sure that the relative spike of 8.74 mg/L from May 2013 returns back to normal low levels.

Potassium results presentation.



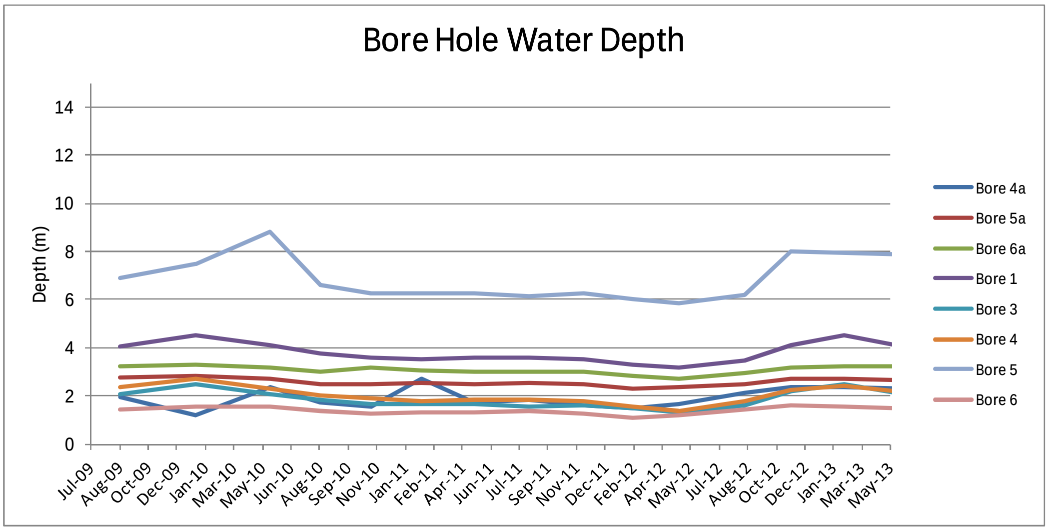
Potassium is present in groundwater systems outside coastal areas generally through weathering of clays and as a result of agriculture (leaching of fertiliser). Potassium may also be present in the breakdown of glass and especially cathode ray tubes. Groundwater monitoring wells indicate that potassium levels in the ground water have not increased relative to historic levels over the available results period. Groundwater monitoring well 4 is historically reading higher than all other bores. The area surrounding bore 4 is rich in imported clay with 2 clay stormwater ponds in close proximity. Natural surface breakdown of these clay materials due to storm events may be the reason for the elevation of potassium in Bore 4.

Sodium results presentation.



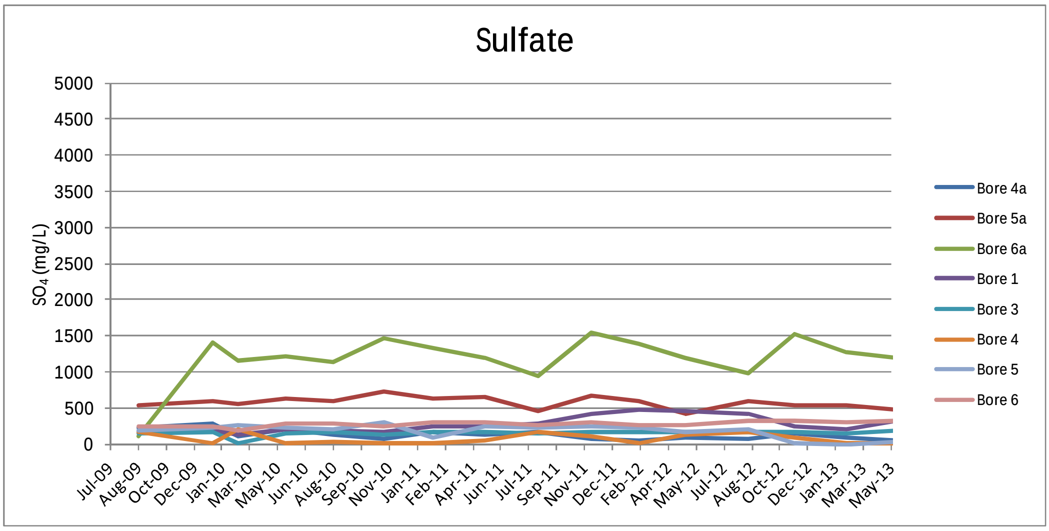
High sodium levels are indicative of leachate contamination infiltrating the groundwater. As presented, results for sodium have been stable over the history of data available.

Standing water level presentation.



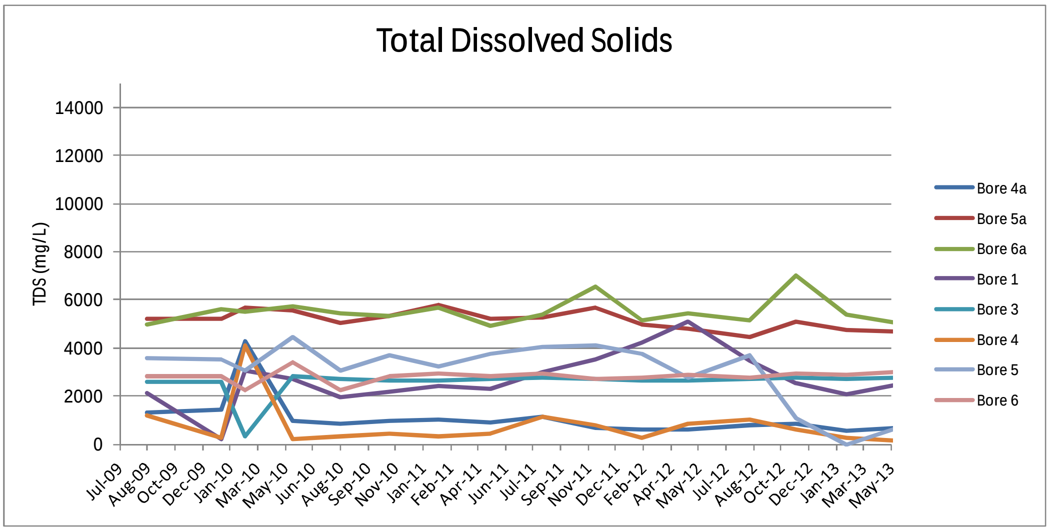
Groundwater level trends have been fairly stable, with the fluctuation over the 3 year testing period being a maximum of about 3m in Bore 5. The relatively large depth to water level in Bore 5 would indicate that it has an increased propensity to become dry.

Sulfate results presentation.



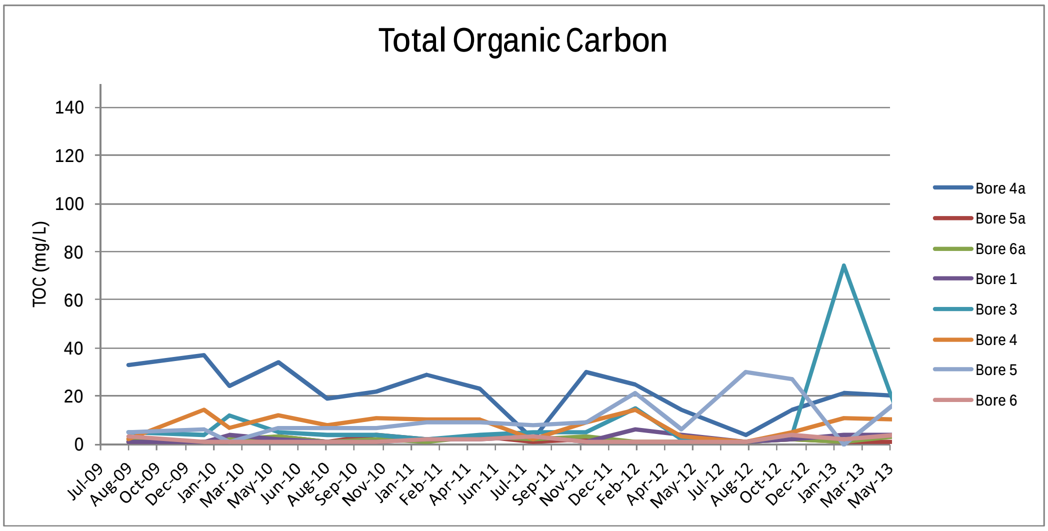
The ***2011 Australian Drinking Water Guidelines 6*** sets maximum sulfate levels in drinking water as 500mg/L. The sulfate levels in the groundwater monitoring wells are in line with the historical levels and are generally below the drinkable water standard. Inorganic ions such as sulfate provide a good indication of groundwater contamination by landfill leachate. A sudden increase in these ions can act as early warning system. Bores 5a and 6a show sulfate levels potentially higher than other bores. These bores along with Bore 4a are located on the underside of the sites primary leachate storage pond. Regular close monitoring of these 3 bores in particular should be maintained to watch for any spikes that could indicate leachate ingress.

Total dissolved solids results presentation.



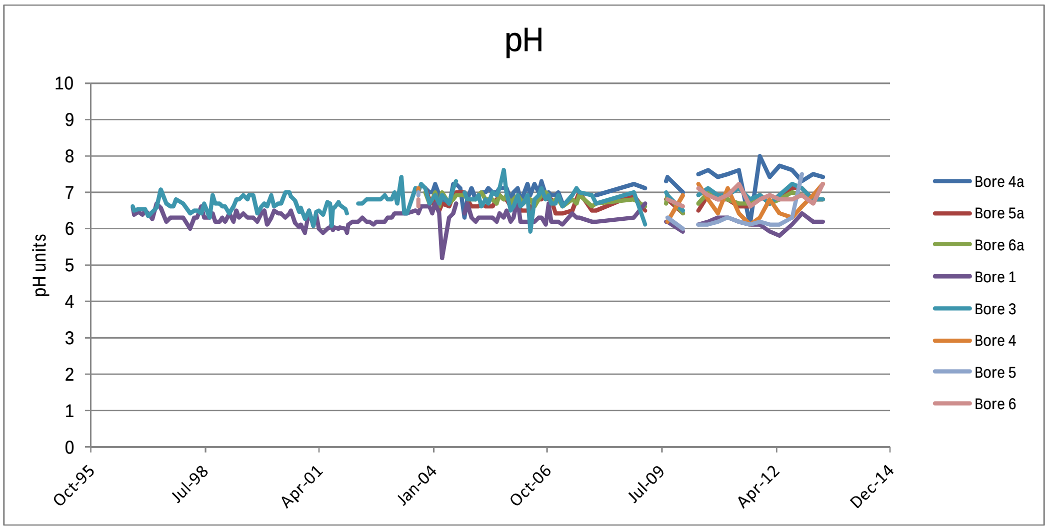
The trend for the quantity of dissolved solids has been fairly stable for the ground water monitoring wells over the reporting period, in line with historical trends. High levels of dissolved solids can be sourced from salts derived from leachate infiltration

Total organic carbon results presentation.



Microbial degradation of organic matter can increase the total organic carbon content in water and may provide evidence of groundwater contamination by organic compounds derived from the landfilling of organic matter. The amount of total organic carbon has remained consistently stable over the five year results period indicating no organic leachate accumulation in the groundwater. However, a solitary spike of 74 mg/L in Bore 3 in February 2013 subsequently returned to normal low levels. Close monitoring of this bore should take place for the next sampling periods.

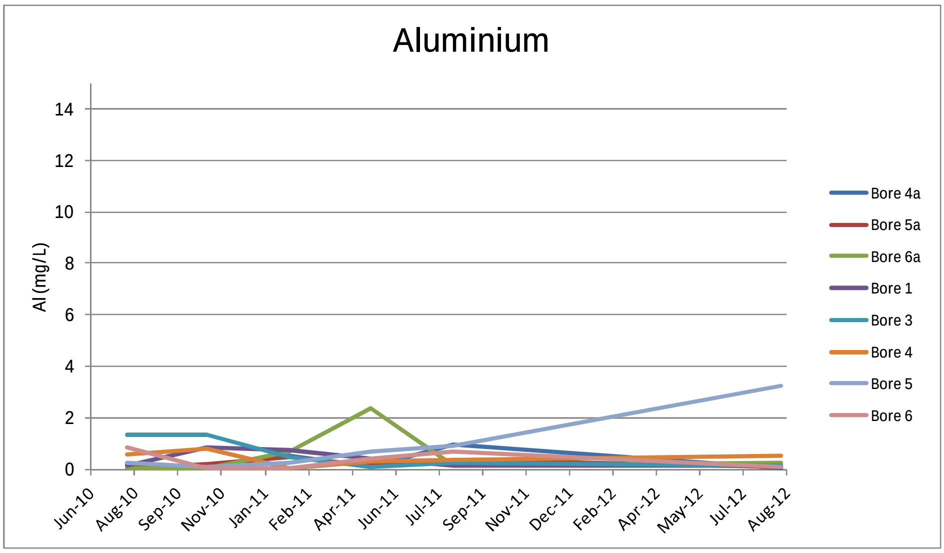
pH results presentation.



The pH levels indicated in the groundwater monitoring wells have been extremely stable over the sixteen year sample period. The fluctuations have been very small except with minor anomalies that invariably return to a stable trend. The groundwater monitoring wells indicate that the historical pH of the groundwater has been maintained over the large sample period.

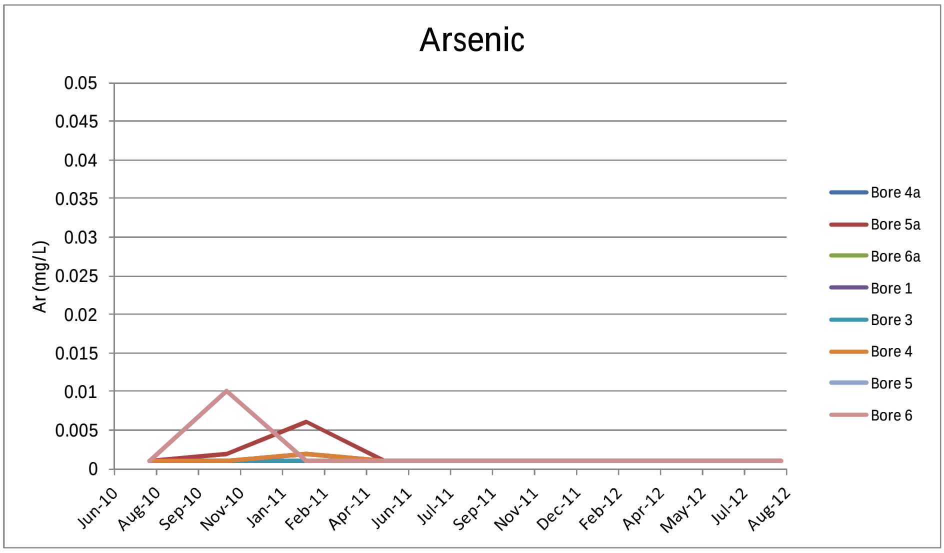
3.1.3 Data Presentation – Annual Monitoring

Aluminium results presentation



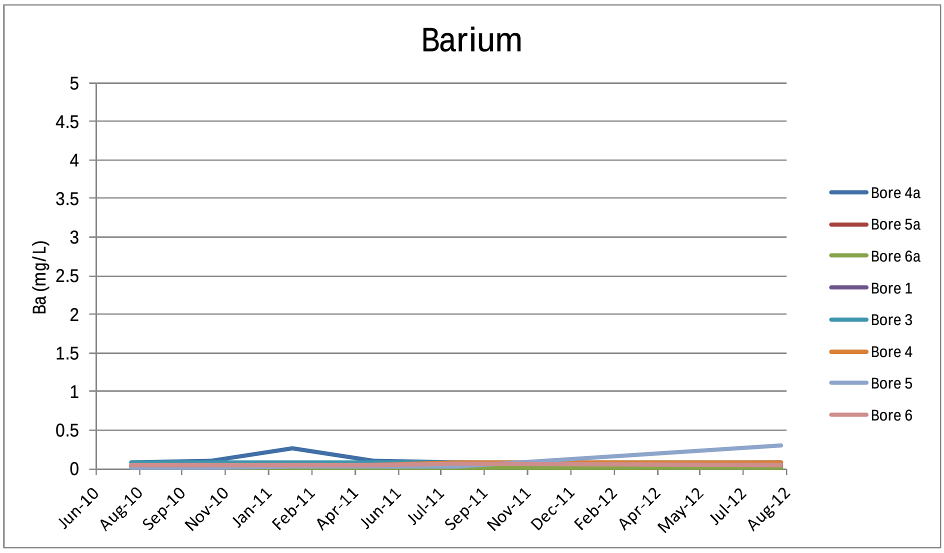
Aluminium levels in the sampled groundwater monitoring wells have been maintained at a consistent low level throughout the reporting period. Anthropogenic sources of aluminium in groundwater are generally related to low pH runoff and colliery based leachate. Bore 5 located at the base of the western gully, which ceased taking waste materials over 30 years ago, has shown a slight increasing trend over the twelve months. Whilst still at low levels, this potential trend should be closely monitored.

Arsenic results presentation



The US EPA sets the maximum contaminant level of arsenic in groundwater at 0.05mg/L. Therefore amount of arsenic found in the groundwater monitoring bores over the reporting period is extremely low. In fact arsenic levels are below detectable limits in 75% of the test results, and in 100% of results over the reporting period.

Barium results presentation

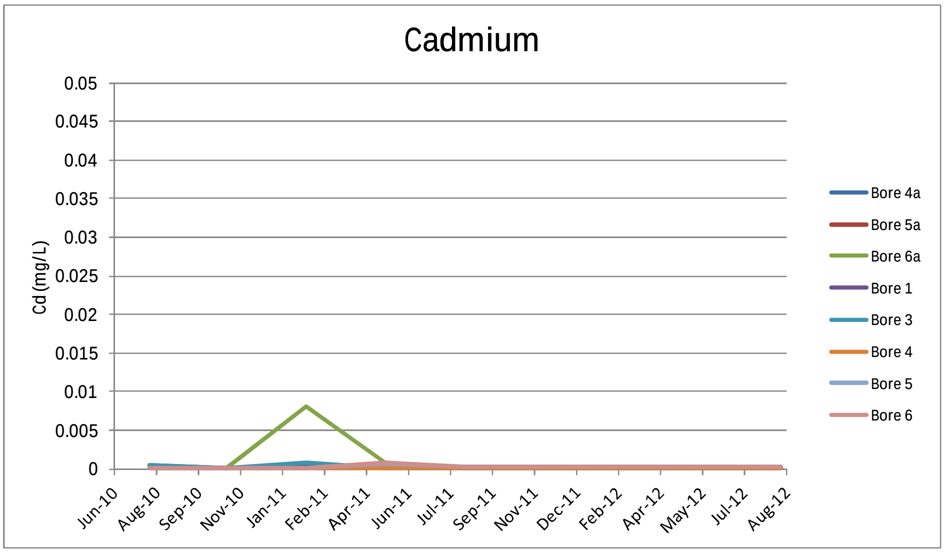


The ***2011 Australian Drinking Water Guidelines 6*** states that a maximum of 2 mg/L of barium is safe for consumption. Anthropogenic sources of barium in groundwater include bleaches, dyes and drillers mud. Barium levels are therefore extremely low and stable in the sites groundwater.

Benzene results presentation

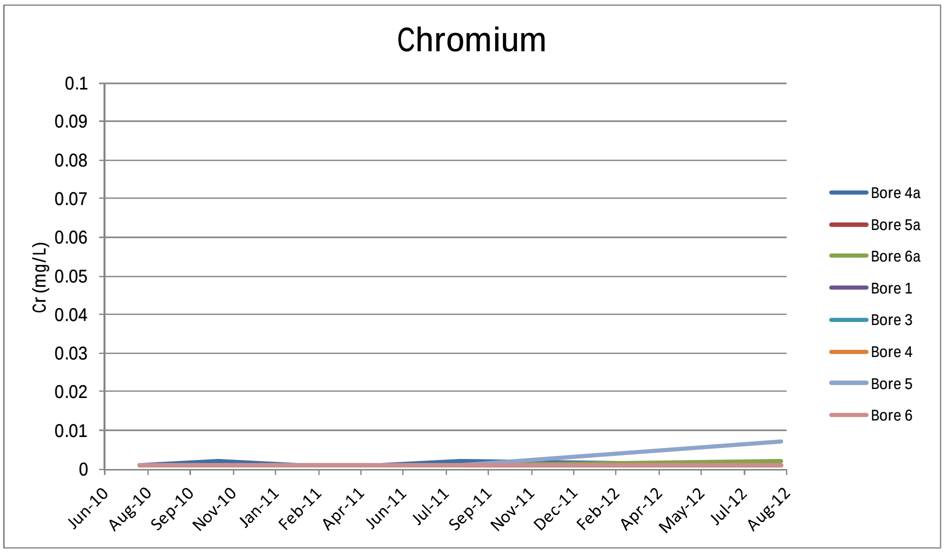
Benzene has not been modelled as every instance of sampling has not provided a result due to the concentration of benzene being below laboratory testing thresholds.

Cadmium results presentation



The US EPA sets the maximum contaminant level of cadmium in groundwater at 0.01mg/L. Cadmium levels present in the ground water monitoring bores is extremely small. Cadmium levels are always below 0.01 mg/L and below detectable limits in 75% of readings taken during the reporting period.

Chromium results presentation

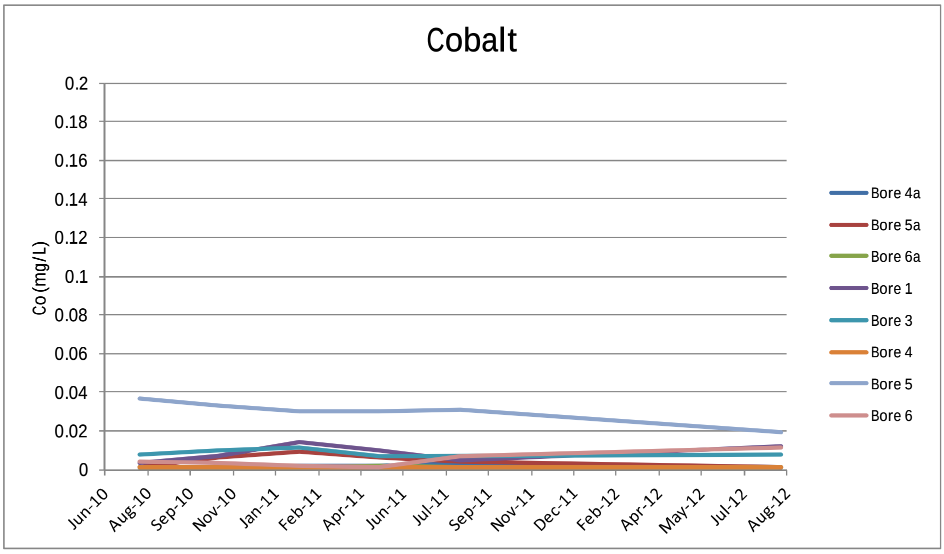


The US EPA sets the maximum contaminant level of chromium in groundwater at 0.05mg/L The levels of chromium detected in the ground water monitoring wells over the reporting period have been extremely low. Chromium levels are below detectable limits on 63% of the tested occasions.

Chromium (hexavalent) results presentation

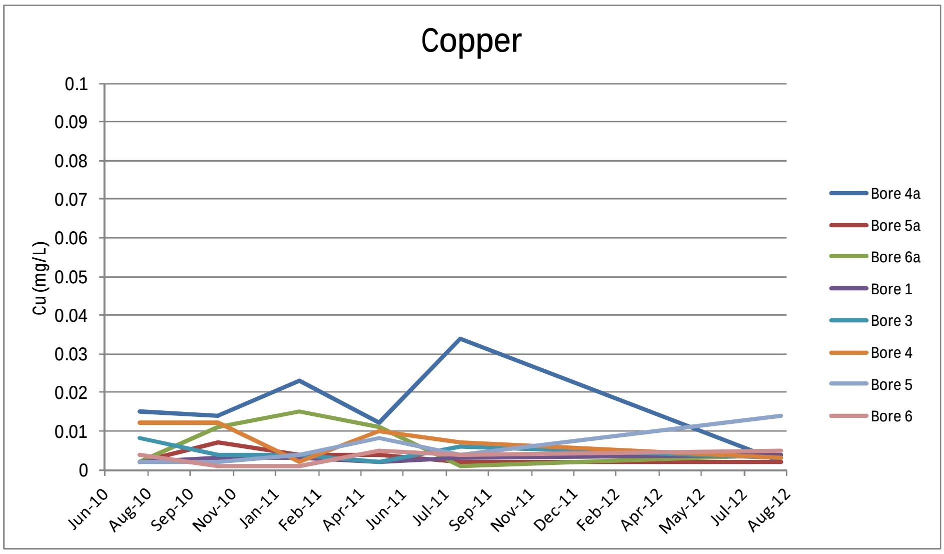
Hexavalent chromium has not been modelled as every instance of sampling has not provided a result due to the concentration of hexavalent chromium being below laboratory testing thresholds.

Cobalt results presentation



Anthropogenic sources of cobalt in the environment include agricultural runoff and sewage effluent. The amount of cobalt detected the ground water monitoring wells over the reporting period is at low levels with a consistently low trend.

Copper results presentation

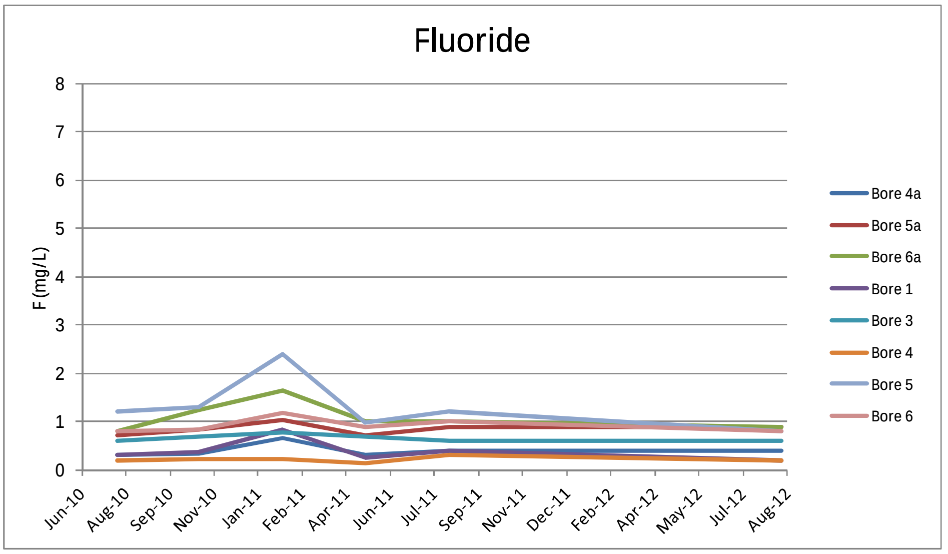


Tested results from the ground water monitoring wells show an extremely small amount of copper. The ***2011 Australian Drinking Water Guidelines 6*** prescribes an aesthetic limit of 1 mg/L of copper in drinking water. Clearly, the results therefore indicate that copper contamination is not evident.

Ethyl Benzene results presentation

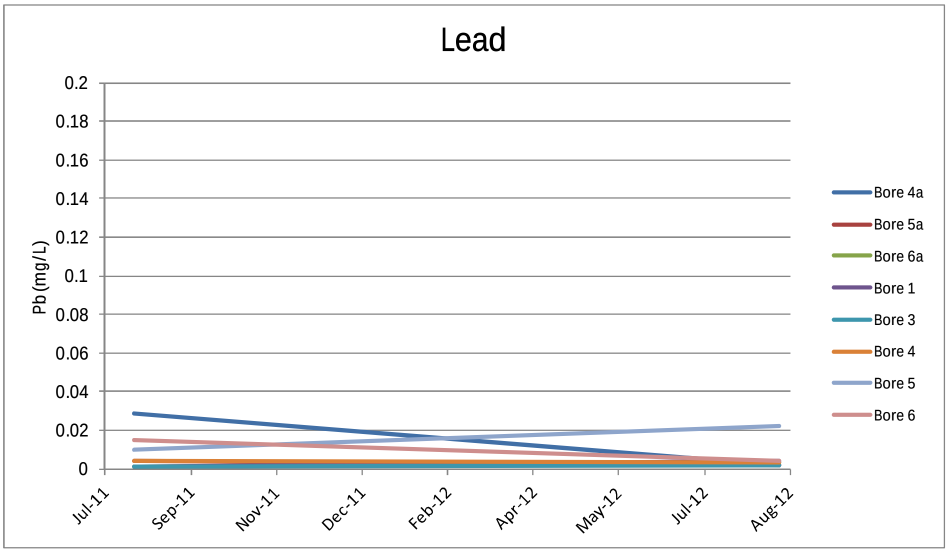
Ethyl benzene was not detected at any level in the ground water monitoring wells during the reporting period and has never been detected at any quantity. Therefore historical comparison is futile.

Fluoride results presentation



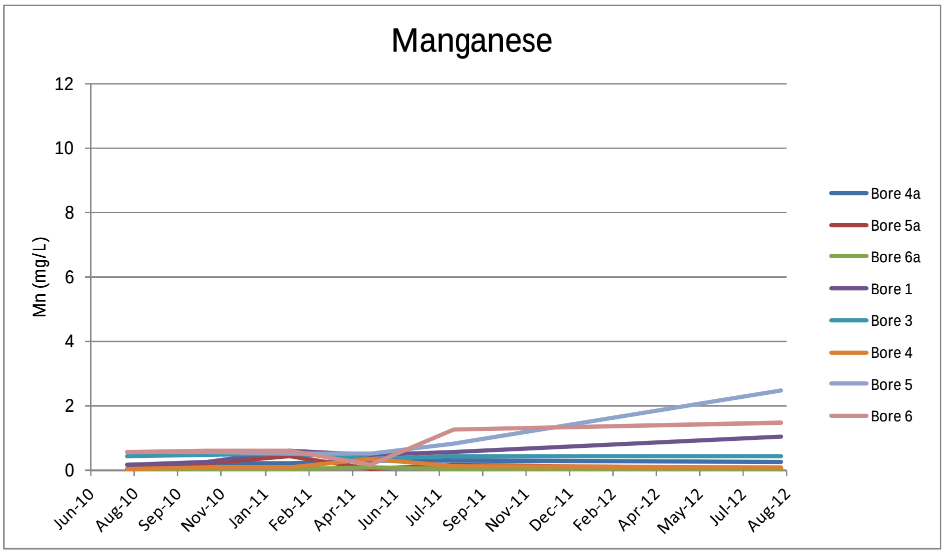
Industrial emissions are understood to be the primary anthropogenic pathway for fluoride to enter the environment. The US EPA sets the maximum contaminant level of fluoride in groundwater at 4 mg/L. Fluoride occurs in Australian drinking water at levels up to 1.5 mg/L. The level of fluoride found in the ground water monitoring wells is therefore relatively low and displays a consistent trend over the reporting period.

Lead results presentation



Heavy metal contamination in the groundwater in the form of lead has been at very low levels over the two year sample period.

Manganese results presentation

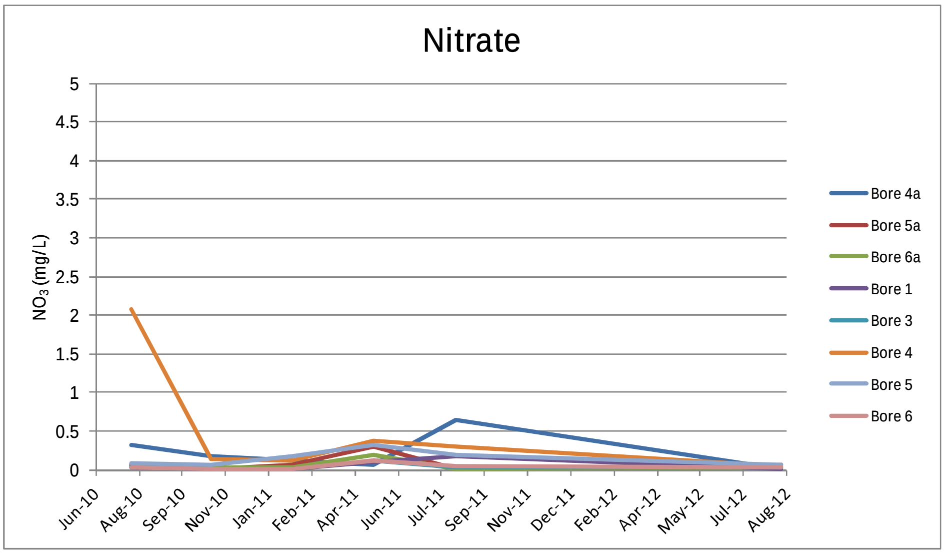


The ***2011 Australian Drinking Water Guidelines 6*** states that a maximum of 0.5 mg/L of manganese is safe for consumption. Manganese can be a strong indicator of landfill leachate in groundwater leached from hazardous waste sites and often derived from battery disposal. The levels of manganese found in August 2012 have shown a slight increase of Manganese in the groundwater. Further, sampling is due in August 2013 and should be reviewed to identify if an elevating trend is emerging.

Mercury results presentation

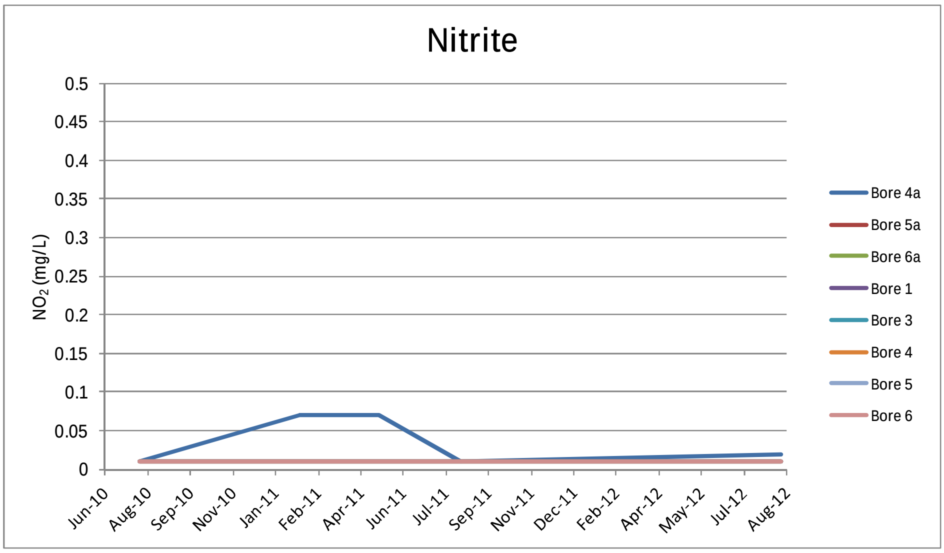
Mercury was not detected at any level in the ground water monitoring wells during the reporting period and has never been detected at any quantity. Therefore historical comparison is futile.

Nitrate results presentation



The ***2011 Australian Drinking Water Guidelines 6*** states that a maximum of 50 mg/L of nitrate is safe for consumption. Denitrification is a process common in leachate treatment where the anaerobic biological reduction of nitrate (NO_3) to nitrogen (N_2) in its gaseous form occurs. Under anoxic conditions microorganisms consume the oxygen in the nitrate and liberate the nitrogen. The relatively low levels of nitrate sampled, indicate that the denitrification process is not evident and landfill leachate is not present in the groundwater.

Nitrite results presentation



Nitrification is a twostep aerobic biological process where bacteria known as nitrosomonas convert ammonia and ammonium to nitrite. Next, bacteria called nitrobacter finish the conversion of nitrite to nitrate. The conversion of nitrite to nitrate is generally very fast and nitrite levels are therefore invariably quite low. More toxic than nitrate, nitrite is an indicator of ammonia (major constituent of landfill leachate) that has not been biologically processed (into nitrate). Nitrite levels above 3 mg/L are considered potentially harmful by the ***2011 Australian Drinking Water Guidelines 6***. As demonstrated by the above data presentation, nitrite levels found in the ground water monitoring wells are extremely small and below detectable limits in 90% of the samples taken.

Organochlorine Pesticides results presentation

Organochlorine pesticides were not detected at any level in the ground water monitoring wells during the reporting period and have never been detected at any quantity. Therefore historical comparison is futile.

Organophosphate Pesticides results presentation

Organophosphate pesticides were not detected at any level in the ground water monitoring wells during the reporting period and have never been detected at any quantity. Therefore historical comparison is futile.

Polycyclic Aromatic Hydrocarbons results presenatation

Polycyclic aromatic hydrocarbons were not detected at any level in the ground water monitoring wells during the reporting period and have never been detected at any quantity. Therefore historical comparison is futile.

Toluene results presentation

Toluene was not detected at any level in the ground water monitoring wells during the reporting period and has never been detected at any quantity. Therefore historical comparison is futile.

Total Petroleum Hydrocarbons results presentation

Total petroleum hydrocarbons were not detected at any level in the ground water monitoring wells during the reporting period and have never been detected at any quantity. Therefore historical comparison is futile

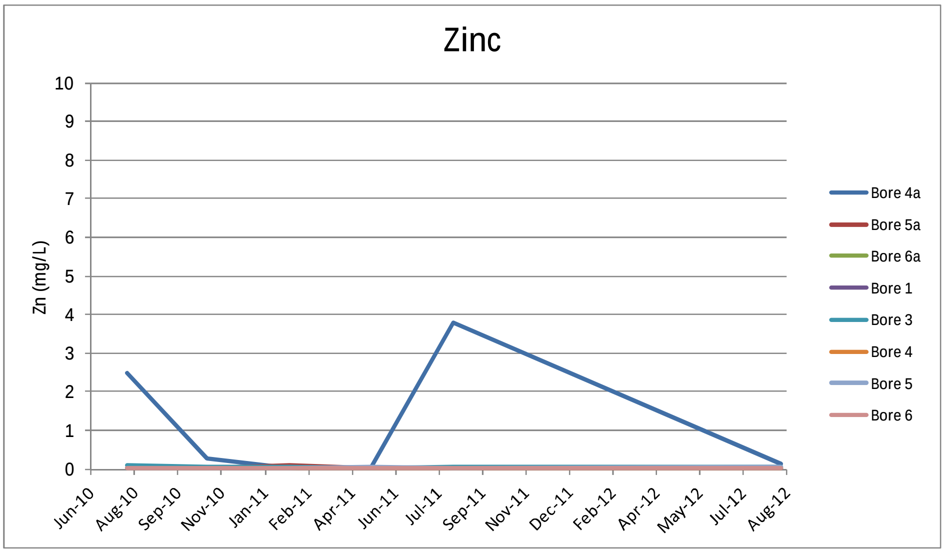
Total Phenolics results presentation

Total phenolics were not detected at any level in the ground water monitoring wells during the reporting period and have never been detected at any quantity. Therefore historical comparison is futile.

Xylene results presentation

Xylene was not detected at any level in the ground water monitoring wells during the reporting period and has never been detected at any quantity. Therefore historical comparison is futile.

Zinc results presentation



The ***2011 Australian Drinking Water Guidelines 6*** states that for aesthetic reasons a maximum of 3 mg/L of zinc is desirable for consumption. Landfill sites can be an anthropogenic source of zinc in groundwater, however the extremely low levels of zinc detected indicate that landfill leachate is not intercepting the groundwater system around the site. The relatively high result indicated in Bore 4a in August 2011 subsequently returned to below detectable limits in August 2012.

3.1.4 Groundwater Testing Results Interpretation

Results indicate that there has been no definitive increase in concentration levels for any of the analytes detailed when compared to the historical results and trends. The following table indicates the analytes that should be closely monitored for developing trends over the next twelve months:

Analyte	Bore Number	Regime	Next Sample
Nitrogen (Ammonia)	4a	Quarterly	August 2013
Potassium	4	Quarterly	August 2013
Total Organic Carbon	3	Quarterly	August 2013
Aluminium	5	Annual	August 2013
Manganese	1, 5, 6	Annual	August 2013

On reflection, key indicators of landfill leachate's potential ingress into ground water including ammonia, nitrate, nitrite levels and other less poignant indicators as tested do not conclude that that landfill leachate is entering the surrounding ground water system.

3.2 SURFACE WATER MONITORING

3.2.1 *Tabulated Results*

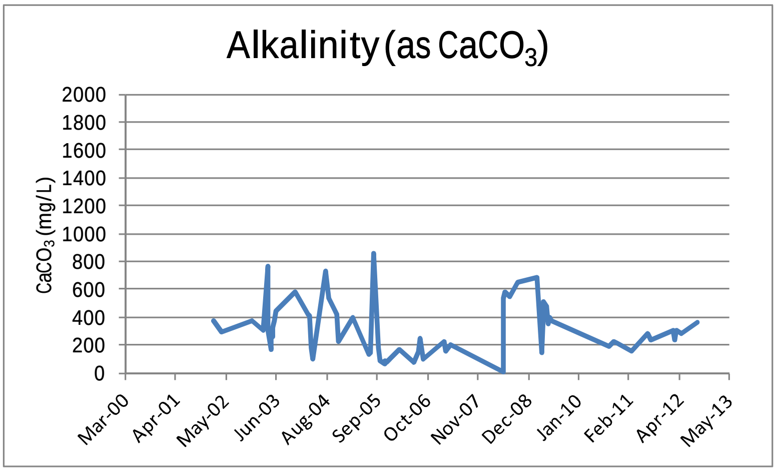
As per the sites EPL, annual sampling and sampling each stormwater overflow event were undertaken with the following results:

Analyte	Sample Date	
	Units	23/08/2012
Alkalinity	mg/L	360
Ammonia	mg/L	1.7
Calcium	mg/L	89
Chloride	mg/L	428
Conductivity	µS/cm	1960
Dissolved O_2	mg/L	5.11
Iron	mg/L	0.18
Fluoride	mg/L	0.7
Magnesium	mg/L	63
Nitrate	mg/L	0.13
Potassium	mg/L	14
Sodium	mg/L	256
Sulfate	mg/L	94
Temperature	^{o}C	16
TP	mg/L	<0.05
TOC	mg/L	5
TSS	mg/L	56
pH	pH	7.3

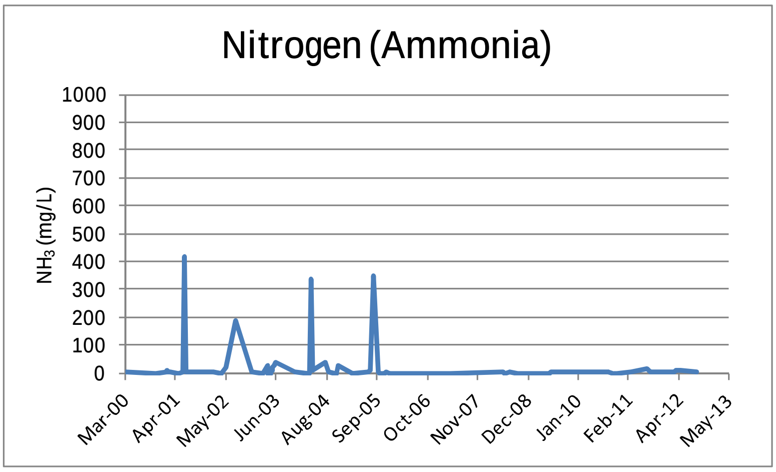
Table 3.2.1 Stormwater overflow monitoring results for the reporting period

3.2.2 Data Presentation

Alkalinity results presentation.

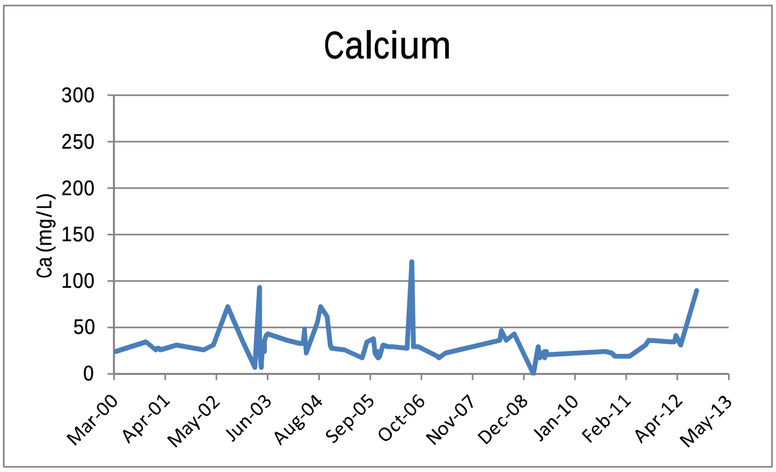


Ammonia results presentation

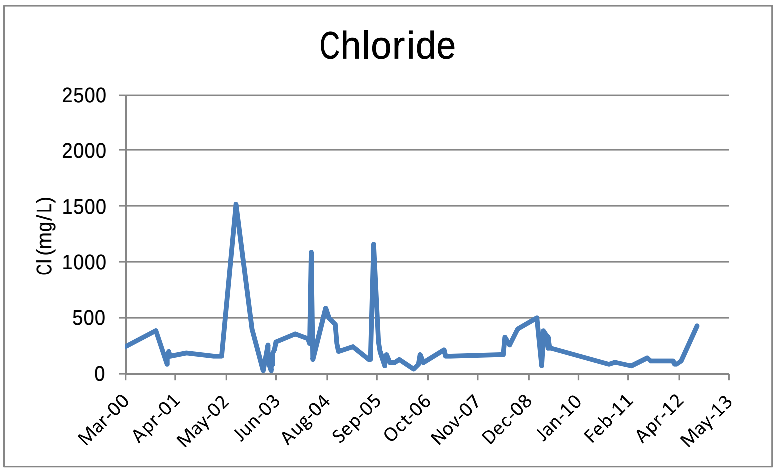


Increased alkalinity and ammonia levels can be caused by biological reactions in landfill leachate. The stability of results, particularly in regard to the reporting period indicates that leachate does not appear to be affecting the stormwater pond. The relatively high alkalinity levels coincide with natural groundwater levels in the area.

Calcium results presentation

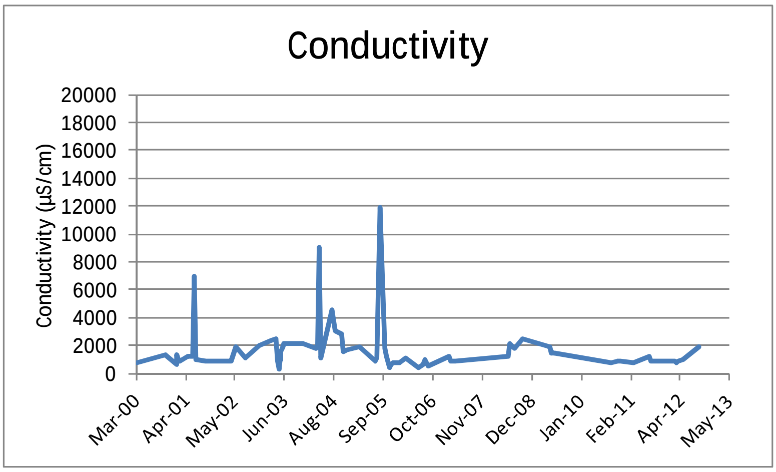


Chloride results presentation

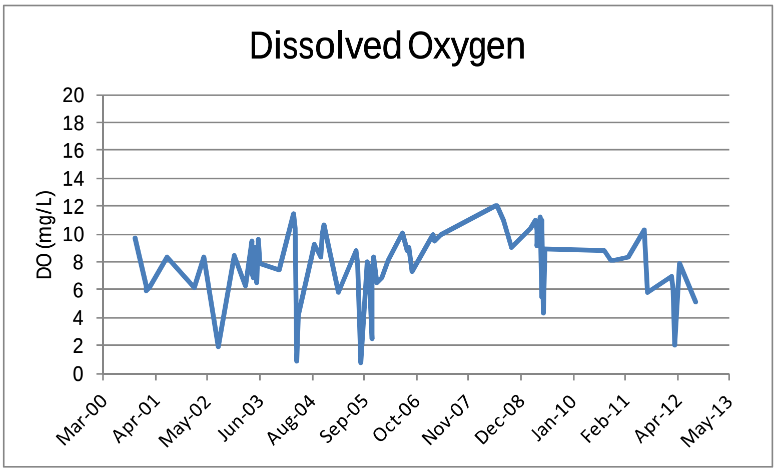


The calcium and chloride levels in the stormwater pond are invariably better than historical results. The levels sampled are also in line with the results sampled throughout the surrounding groundwater system.

Conductivity results presentation

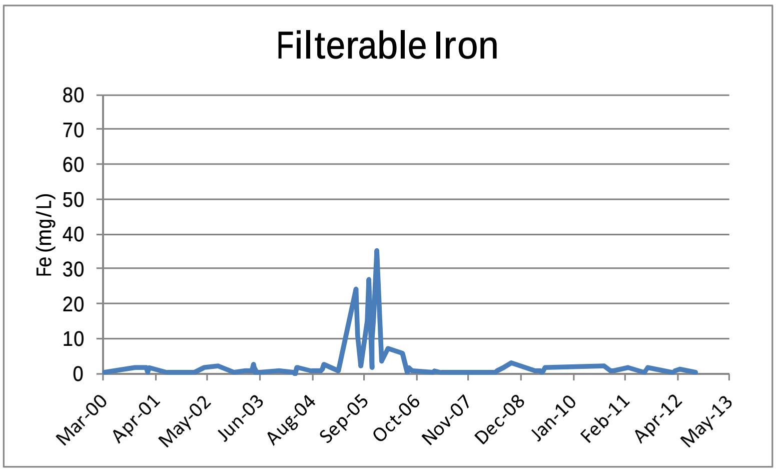


Dissolved oxygen results presentation

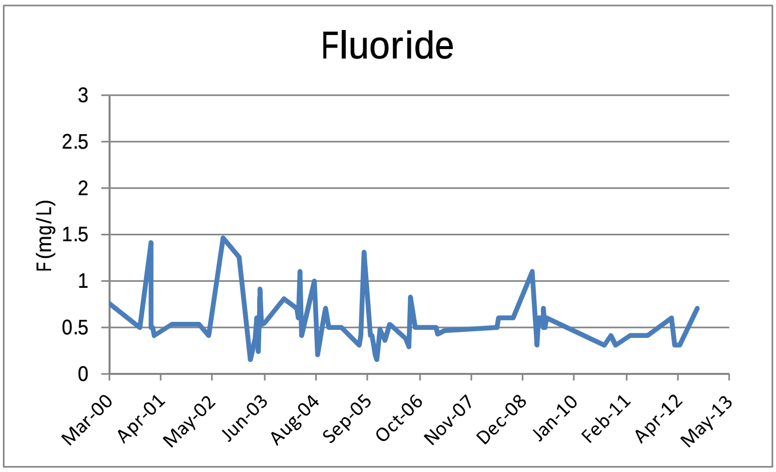


Conductivity is a measure of the waters ability to pass electrical current, usually though positively or negatively charged inorganic dissolved solids (e.g. sodium, magnesium, calcium, iron). The conductivity results for the stormwater detention pond have been stable and trending downwards. Dissolved oxygen levels can be depleted by biological activity associated with the nitrification process. The dissolved oxygen levels have been stable over the history of available results with around 8mg/L of variation over the twelve year sampling period.

Filterable iron results presentation



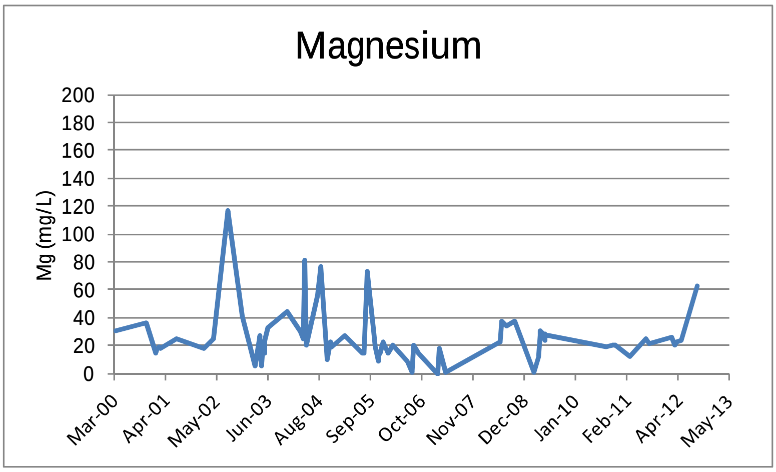
Fluoride results presentation



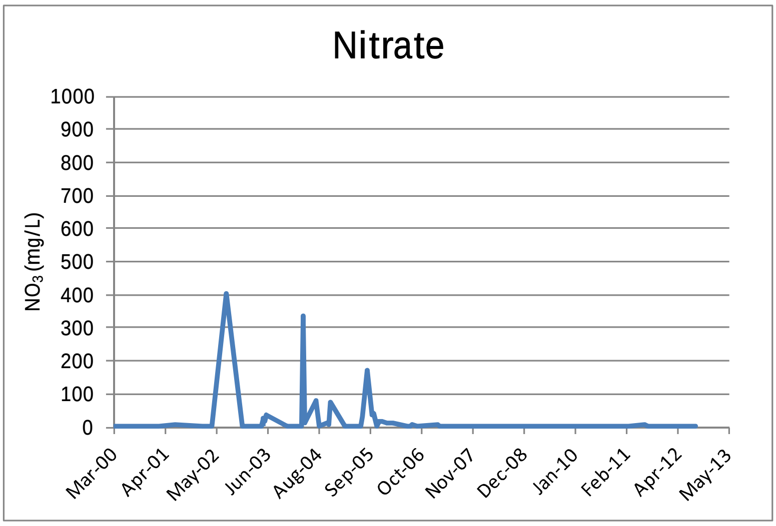
Filterable iron and fluoride have continued to trend at very low levels, especially with regard to the reporting period.

Fluoride occurs in Australian drinking water at levels up to 1.5 mg/L. The level of fluoride found in the stormwater detention pond is therefore relatively low and displays a consistent trend over the twelve year sampling period.

Magnesium results presentation

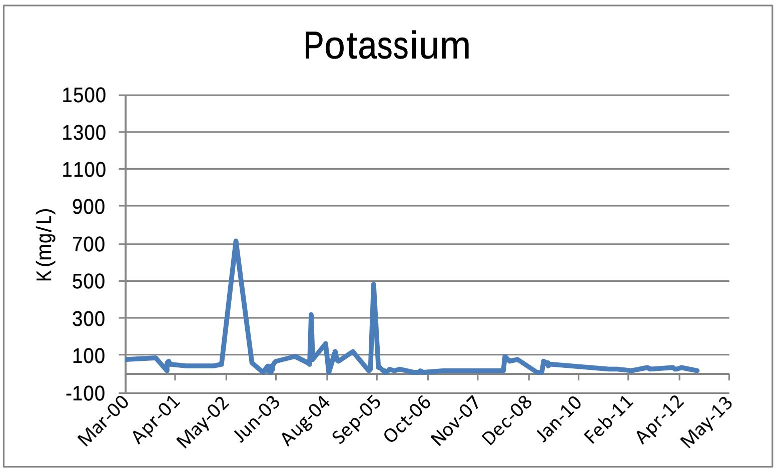


Nitrate results presentation

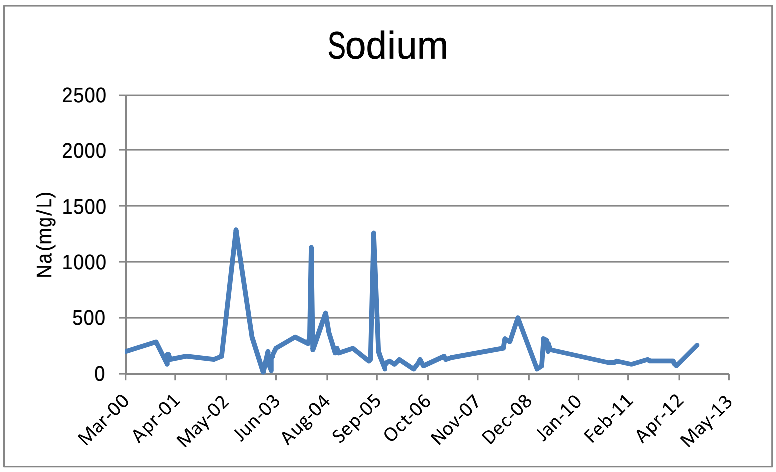


The ***2011 Australian Drinking Water Guidelines 6*** states that a maximum of 50 mg/L of nitrate is safe for consumption, whilst magnesium is considered as “soft” in the range of 0-60 mg/L. The relatively low levels of nitrate and magnesium sampled indicate that landfill leachate is probably not present in the stormwater detention pond.

Potassium results presentation

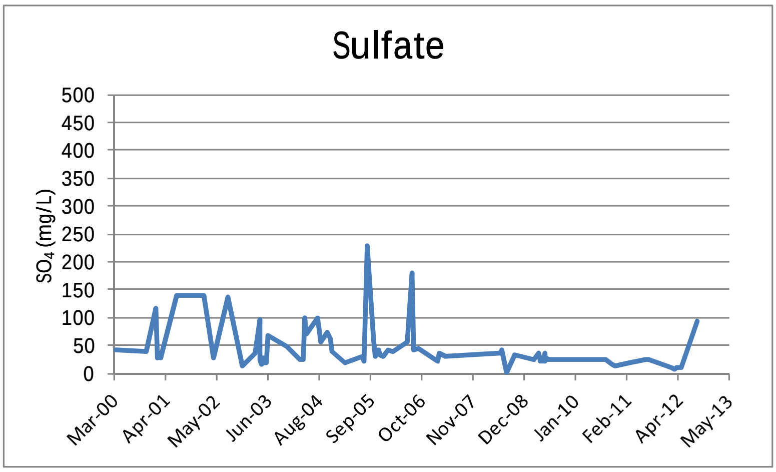


Sodium results presentation



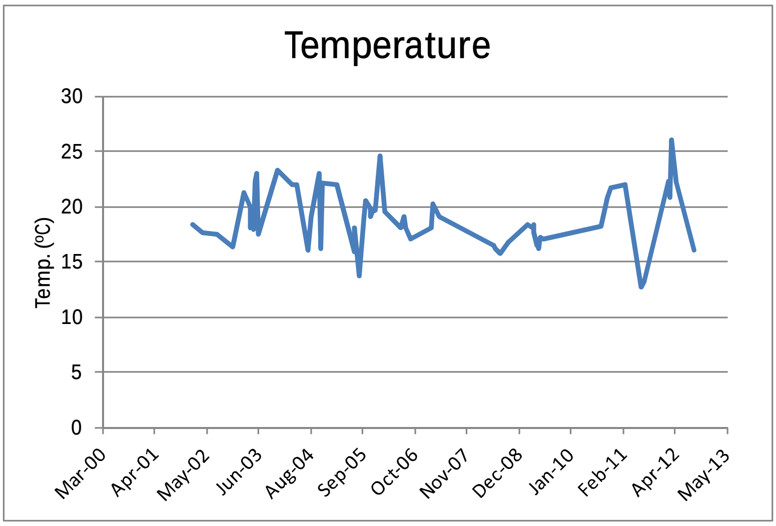
Potassium and sodium concentrations have been in line with recent trends and with the naturally occurring groundwater levels of these analytes around the site. Both analytes have trended downwards in recent years.

Sulfate results presentation



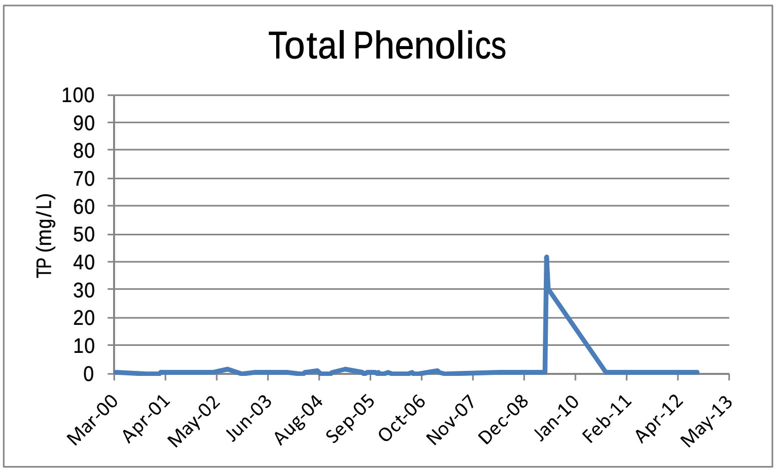
The ***2011 Australian Drinking Water Guidelines 6*** sets maximum sulfate levels in drinking water as 500 mg/L. The sulfate levels in the stormwater detention pond are in line with the historical levels and are better than the drinkable water standard. Inorganic ions such as sulfate provide a potential indicator of groundwater contamination by landfill leachate. A sudden increase in these ions can act as early warning system.

Temperature results presentation



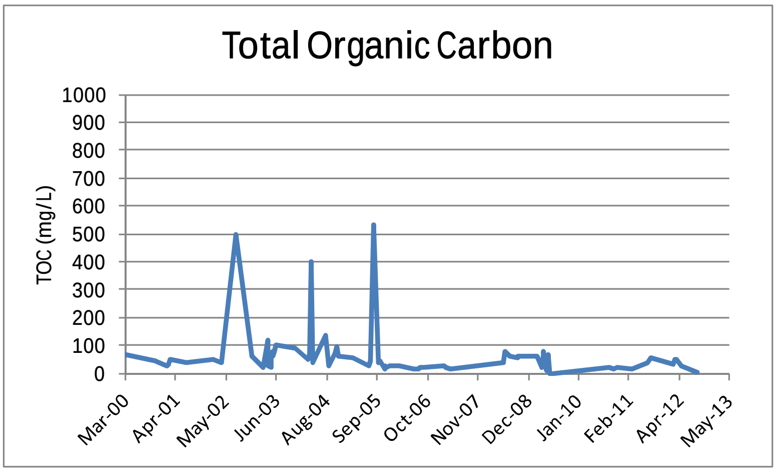
Temperature, as expected has generally been indicative of the season in which the stormwater detention pond has been sampled.

Total phenolics results presentation



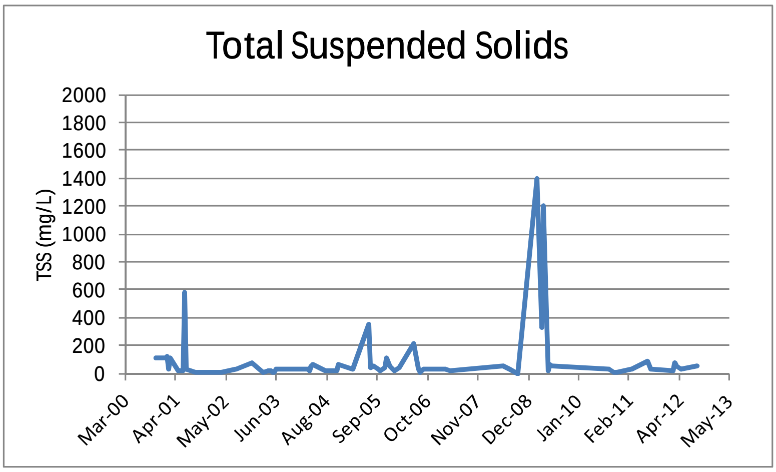
Total phenols are widely used in the manufacture of resins, plastics, insecticides, explosives, dyes, and detergents. It is also used as a raw material for the production of medicinal drugs such as aspirin. Historical results for total phenols have been extremely low and more often than not, below detectable limits in the stormwater detention pond. In fact, all samples taken during the reporting period were below detectable limits.

Total organic carbon results presentation

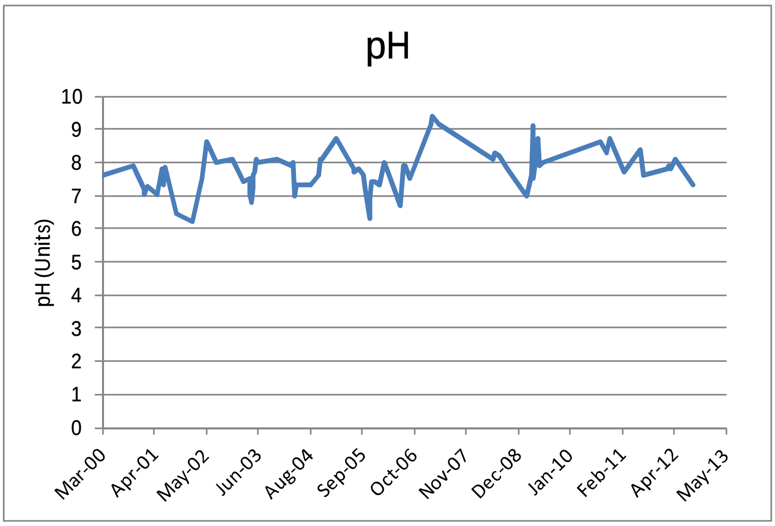


Microbial degradation of organic matter can increase the total organic carbon content in water and may provide evidence of water contamination by natural compounds derived from the landfilling of organic matter. The amount of total organic carbon has remained consistently stable over the last 8 years.

Total suspended solids results presentation



pH results presentation



The detention pond analytes measured at the site show relatively low levels of suspended solids and consistent pH levels in the surface water. The suspended solids levels were somewhat inconsistent in the 2008-2010 period, with the amount of solids suspended in the stormwater fluctuating. More modern results indicate that the stormwater pond is functioning effectively.

3.2.3 Surface Water Results Interpretation

From the analytical results it can be demonstrated that the sites sediment and stormwater pond infrastructure are performing adequately and as desired.

3.3 *AIR EMISSIONS MONITORING*

3.3.1 Tabulated Results

Date	Results Above Recommended Threshold 500ppm	Accumulation Above Recommended Threshold 1250ppm
Jun-12	2	0
Jul-12	2	0
Aug-12	0	0
Sep-12	0	0
Oct-12	0	0
Nov-12	0	0
Dec-12	0	0
Jan-13	0	0
Feb-13	1	0
Mar-13	0	0
Apr-13	0	0
May-13	0	0

Table 3.3.1 Methane monitoring results for the reporting period

Presented results are the number of individual sample results derived from monthly testing that are above the EPA Benchmark Technique recommended threshold levels for further action regarding surface emissions (500 ppm) and accumulation levels (1,250 ppm).

3.3.2 *Data Presentation*

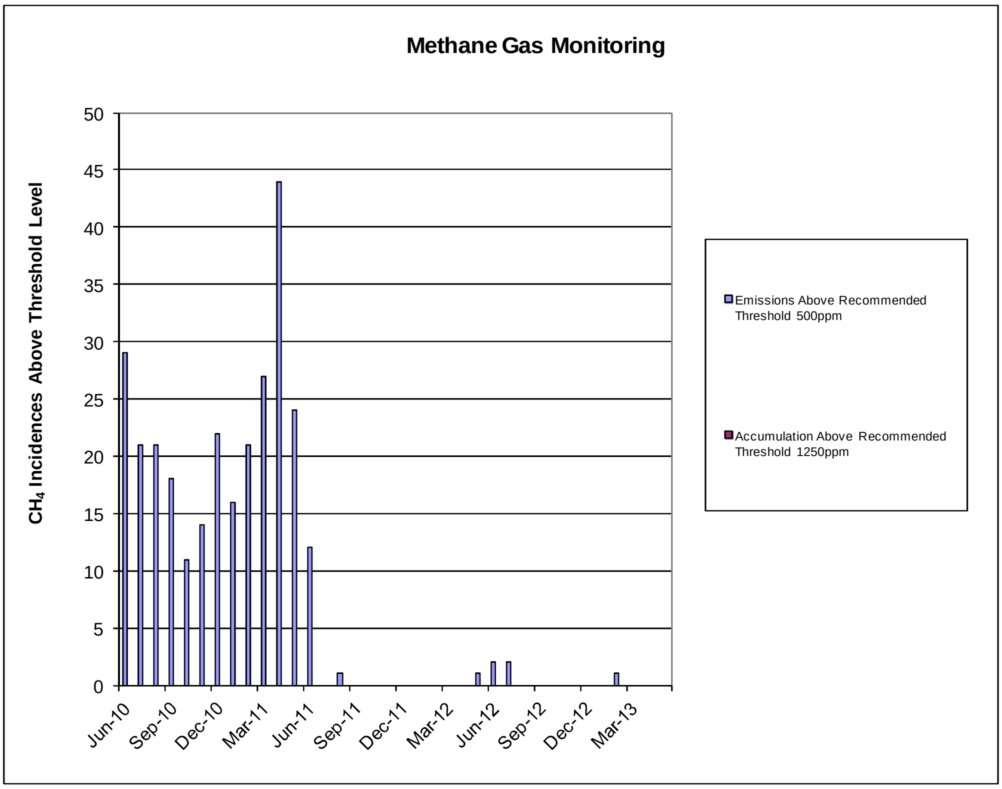


Figure 3.3.2 Air emissions test results above benchmark recommended threshold levels presentation

There is no evident trend for methane gas emissions from the landfill surface. No accumulation levels above the recommended benchmark threshold were found.

3.3.3 *Air Emissions Monitoring Results Interpretation*

Prior to the preceding reporting period (2011-2012) results sampled by GHD showed continued occurrences of surface methane emissions above the EPA recommended threshold levels. A more recent contract awarded to a NATA approved laboratory (ALS Environmental) has shown that the GHD recorded levels were potentially overstated. Both companies state that the accumulation monitoring clearly shows that the methane is not migrating offsite.

Despite the differences in sample results, the site clearly generates relatively high amounts of landfill gas, namely methane that must be dealt with. Accordingly, Council commenced installation of methane gas extraction infrastructure. In fact, Phase 1 of the landfill gas management is in place and connected to a flaring unit. Phase 2 is currently progressing to tender and will more than double the landfill area captured by the gas extraction system and will lead to power generation (as well as flaring of the methane gas). The Phase 3 gas collection system will coincide with waste filling of the new landfill cell at the WWARRP.

It should be noted that Council has not attempted to rehabilitate the areas prone to surface gas emissions as it would increase the possibility of those some what controlled emissions finding a new path of least resistance and becoming uncontrolled.

3.4 ENVIRONMENTAL COMPLAINTS

3.4.1 Tabulated Results

Year	Environmental Complaints
2000/2001	0
2001/2002	99
2002/2003	66
2003/2004	19
2004/2005	36
2005/2006	19
2006/2007	22
2007/2008	21
2008/2009	9
2009/2010	12
2010/2011	12
2011/2012	48
2012/2013	59

Table 3.4.1 Tabulated complaints for the reporting period and historically

3.4.2 Data Presentation

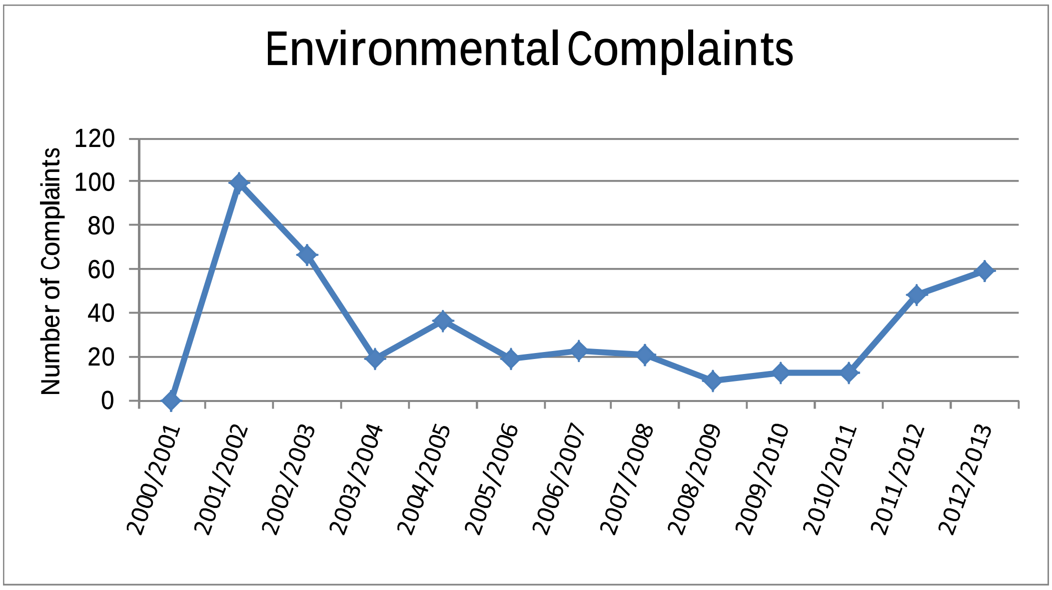
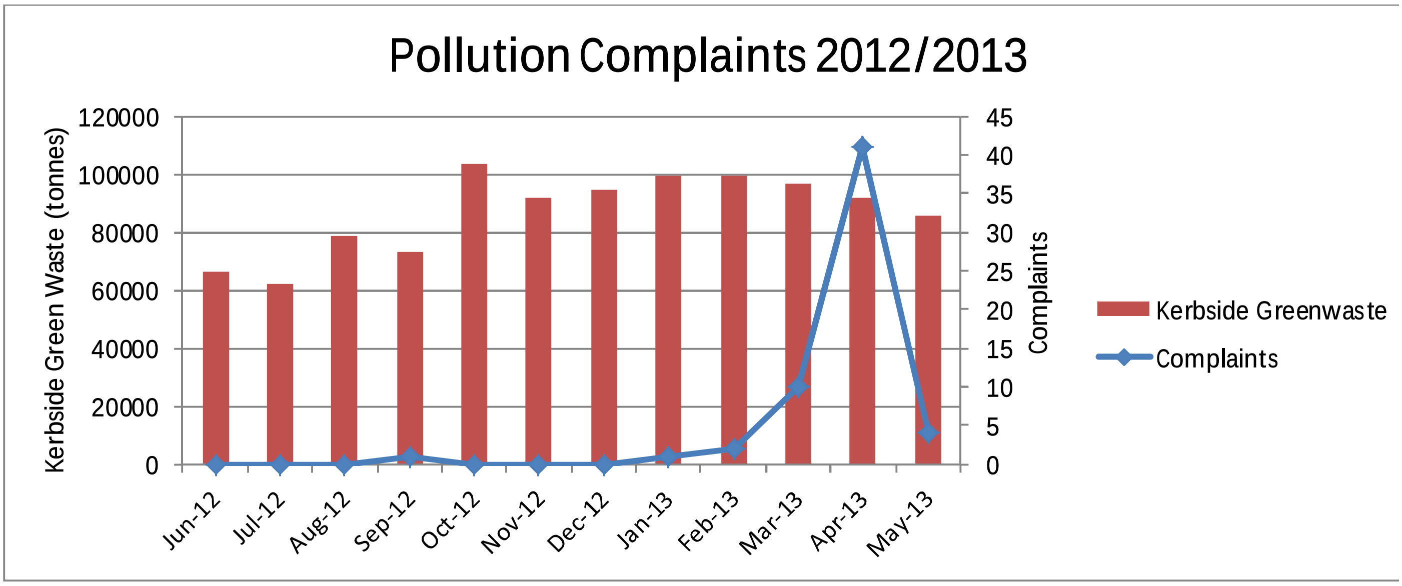


Figure 3.4.2 Environmental complaints results.

Environmental complaints have generally trended downwards until the subsequent two reporting periods where a significant spike has occurred.

3.4.3 Environmental Complaints Results Interpretation

The overlying trend for environmental complaints had been downward after closure of the solid waste energy recovery facility in 2004. However, the previous two reporting periods have given rise to a spike of over 100 complaints, invariably regarding perceived odour from the WWARRP.



Period of processing site shutdowns

As detailed in the above chart, the complaints were received generally during the autumn season after 6 months of high kerbside green waste received tonnages. The green waste was not received at the WWARRP during the reporting period and was instead received at a nearby site also located on Reddalls Road at Kembla Grange. It should be duly noted that the green waste processing site recorded shut downs in February and March 2013 and as a result created a lag in green waste processing and excessive stockpiles of decomposing material was stored on the site.

Complaints received during autumn 2013 were directed to Council and only upon follow up with each individual resident was Council able to conclude that the vast majority did not know about other processing facilities on Reddalls Road at Kembla Grange. It should be noted that the majority of residents opined that as a whole Council is still responsible for ensuring odour in its governance area is minimised.

Therefore, it is the conclusion of this report that the preponderance of odour complaints received during the reporting period were not necessarily aimed at the performance of the WWARRP, but rather aimed at Council from a governance of the Environmental Planning and Assessment Act compliance perspective.

4 SITE SUMMATION

4.1 DEFICIENCY IDENTIFICATION & REMEDIATION

4.1.1 Surface Methane Emissions above Recommended Benchmark Threshold Levels

As discussed in Section 3.3.3, the site has historically possessed some previously landfilled areas that emit methane gas above the EPA's recommended benchmark level for further investigation into surface gas emissions. Council has not attempted to cap these areas so that the peak emissions locations are identified and so that the possibility of offsite migration is nullified. Council has trialled a biofiltration type system to attempt to reduce the methane emissions from identified peak areas. However, in February 2013 Council commenced installation of a gas extraction system. The gas management system and its future developments are expected to address the gas emission issues that have arisen from time to time at the WWARRP.

4.1.2 Boreholes Indicating Potentially Imperfect Trend Stability

As discussed in Section 3.1.4, seven borehole locations have provided individual and incidental analytical results that require an increased level of scrutiny upon future measurements to ensure negative trends are not establishing. Whilst it is common for individual analytical results to vary from time to time, the prudent course of action is to provide an increased level of vigilance for these analyte and borehole combinations until such time the results return to historic levels or further action is required.

4.1.3 Dry Boreholes

During the current and previous sampling periods, several boreholes (namely, MW1A, MW2A, MW3A and MW7A) have developed into dry boreholes. To rectify this, Council in association with Golder Associates and the EPA have developed a new groundwater monitoring regime with many new boreholes that collectively replaces the regime detailed in this report. It is anticipated that the next reporting period will have a far more modern and suitable groundwater monitoring regime that will rectify the dry boreholes issue and provide far more relevant results for site investigations and future actions.

4.2 *CONCLUSION*

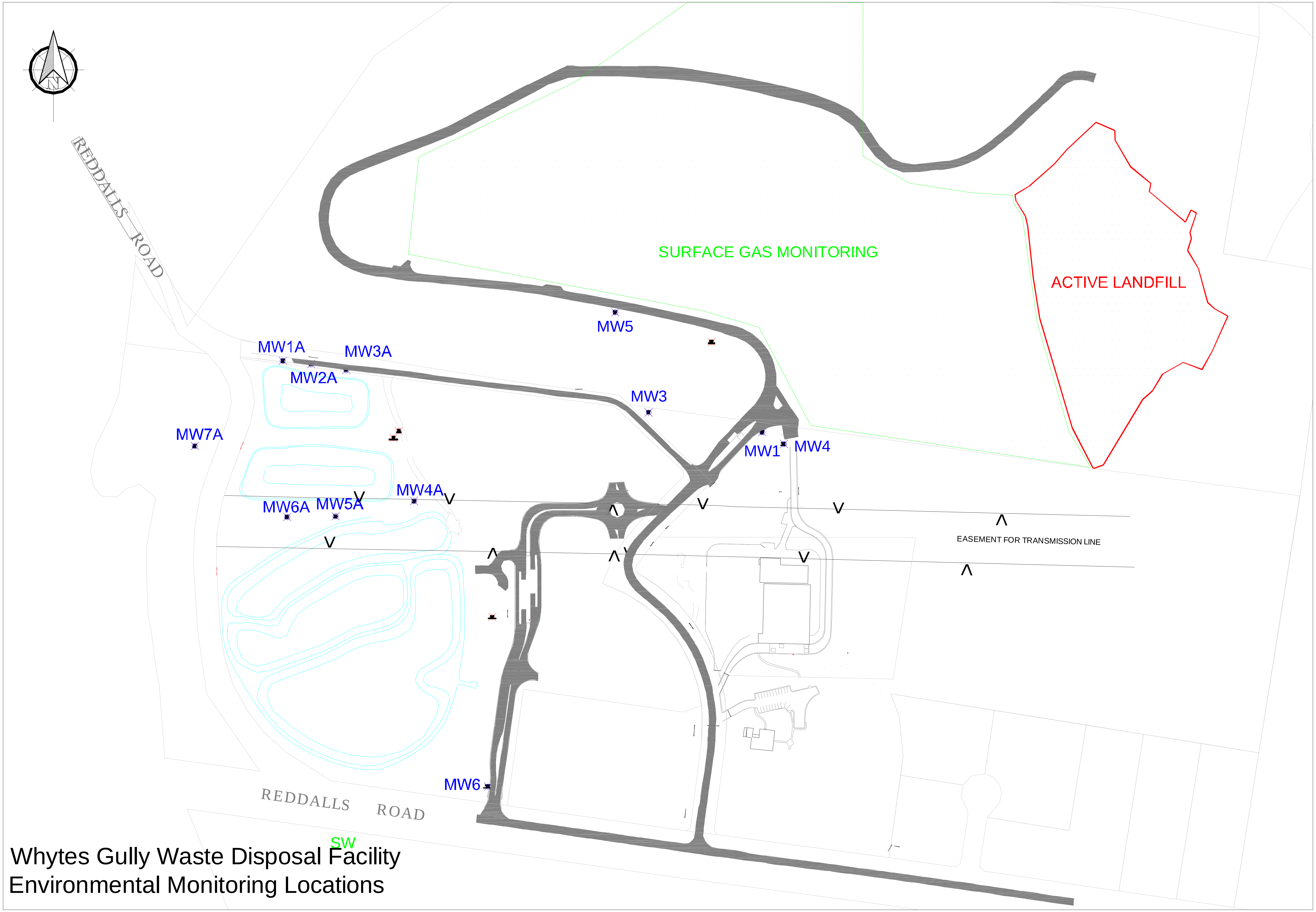
The site is performing well within the individual criteria and limits assigned to it in regard to environmental performance. The low number of deficiencies and nil non compliances in conjunction with the continued downward trend of environmental complaints shows that Council has maintained satisfactory environmental performance. Actions have already commenced to improve the sites performance in regard to the identified deficiency in Section 4.1.1, which will ensure Council's goal of continuous environmental improvement at Whytes Gully is achieved.

Further, modernised test regimes to be implemented in the next reporting period alongside the planned new cell development will provide a far better reflection of the state of the environment affected by the site. Consequently, environmental performance trend analysis and analytical results with be more pertinent as the new cell develops.

Annexure A

A Environmental Monitoring Locations

Environmental Monitoring Locations



Whytes Gully Waste Disposal Facility
Environmental Monitoring Locations