BASELINE GROUNDWATER MONITORING REPORT

PROPOSED ALLAWUNA LANDFILL

SHIRE OF YORK

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SHIRE OF YORK

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TABLE OF CONTENTS

FIGURES

TABLES

APPENDICES

STATEMENT OF LIMITATIONS

Scope of Services

This environmental site assessment report ("the report") has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and ENV.Australia Pty Ltd (ENV). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

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In preparing the report, ENV has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise stated in the report, ENV has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. ENV will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to ENV.

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On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the site at the time of preparing the report, including the presence or otherwise of contaminants or emissions. Also it should be recognised that site conditions, including the extent and concentration of contaminants, can change with time.

Within the limitations imposed by the scope of services, the monitoring, testing, sampling and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

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The report has been prepared for the benefit of the Client and no other party. ENV assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of ENV or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

1 INTRODUCTION

In August 2012, ENV Australia Pty Ltd (ENV) undertook the bore installation and an initial analysis of groundwater quality at the proposed Allawuna Landfill to be run by Sita Australia in the Shire of York. The site location is presented in Figure 1. The key factor to obtaining approval for a landfill facility is the adequate characterisation of the hydrology, hydrogeology and hydrochemistry.

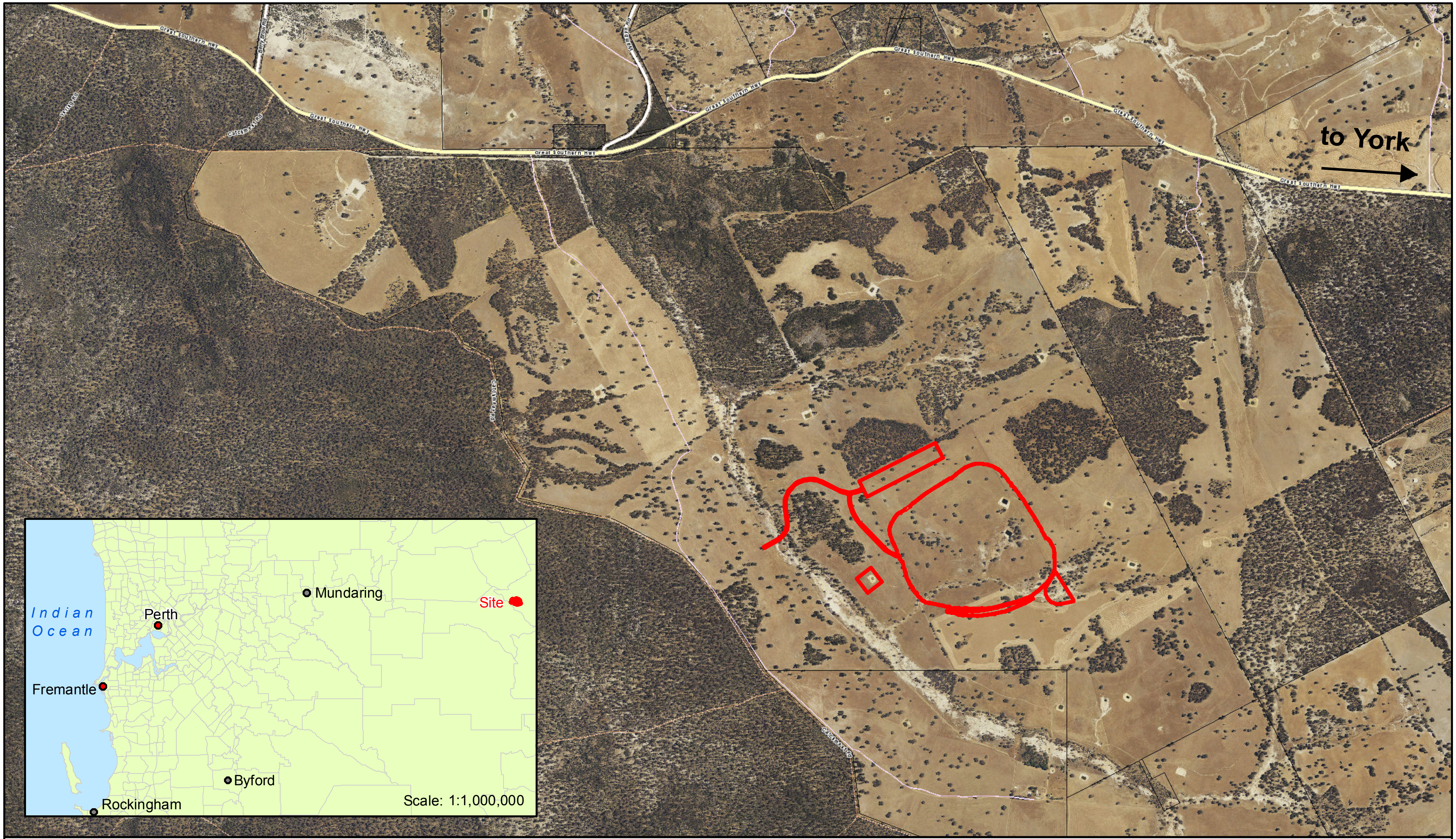
Eight groundwater monitoring bores were installed ranging in depth from 10mbgl and 18mbgl. The location of the bores was be determined by Bowman and Associates. Bore MB02 did not intersect groundwater and so no monitoring data was collected.

For each of the remaining seven bores the following field data was recorded:

- Log of borehole lithology.
- Log of bore installation, including the location, top of casing elevation, screen depth and the ground level elevation in metres AHD.
- In-situ pH, temperature, electrical conductivity, and dissolved oxygen measured with a multi parameter probe.
- Standing water levels (SWLs) in mAHD.
- Level Troll 500 probe data to record the watertable recovery from slug tests from one bore central to the site (MB06) and three bores located nearest the boundaries (MB01, MB03 and MB07).
- Level Troll 500 probe data to record the watertable recovery from a single constant rate pump undertaken at MB06 with GWL observations at two observation bores (MB05 and MB08).

1.1 GROUNDWATER MONITORING BORE LOCATIONS

The locations of the eight monitoring bores are presented in Figure 2 along with groundwater level contours. The preliminary survey data was based on GPS readings for easting and northing (GDA94) and existing mapping for elevation (mAHD). The bore locations are presented in Table 1 (Section 3 - Results).



CLIENT
Bowman & Associates

JOB NO.
J112319

AUTHOR
D. Jarvis

DRAWN
M. Mikkonen

DATE
19-09-12

SCALE
1:30,000 @ A4

PROJECTION
GDA94 MGA50

Legend

Landfill Footprint

N

0 500 1,000

Metres

Site Location

Allawuna Landfill Bore Installation & GW Monitoring

FIGURE 1

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AUTHOR	DRAWN	DATE
D. Jarvis	M. Mikkonen	20-09-12

SCALE	PROJECTION
1:10,000 @ A4	GDA94 MGA50

Legend

- Landfill Footprint
- Groundwater Contour (m AHD)
- Monitoring Bore
- Dry Bore

Groundwater Monitoring Bore Locations and Groundwater Contours (22/08/2012)

Allawuna Landfill Bore Installation & GW Monitoring

FIGURE 2

2 METHODS

2.1 MONITOR BORE INSTALLATION

The eight groundwater monitoring bores (50mm diameter) described in the groundwater monitoring bore installation logs (Appendix A) were installed using an air compressor with blade bit. Seven of the eight bores (MB01, MB03-MB08) were installed to a total depth of (at least) 1m below the depth at which the water table was intersected. For the remaining borehole (MB02), drilling continued to a total depth of 30m without intersecting the water table. As such, this borehole was not converted to a monitoring bore.

All seven completed bores were fitted with 6m of slotted screen from the base of the bore. The static water levels following the construction and development of each bore was, on average, about 5m higher than the GWLs intersected during the drilling, indicating that the water table is likely to be confined and under pressure at all bore locations.

2.2 SLUG TEST METHODOLOGY

A Level-Troll 500 probe was activated and placed in the bore. A slug of groundwater (approximately 1L) was "instantaneously" removed from the bore by hand and the response of the recovery was measured by the probe. The output from the Level-Troll is in mm of water in the column above the probe taken at one second intervals.

2.2.1 SLUG TEST DATA ANALYSIS

The time series data provides a graph that represents the groundwater recovery. Estimations of hydraulic conductivity (and other hydrogeological parameters) can be calculated from this graph by a number of methods that vary with regard to assumptions, complexity and accuracy. It is unlikely that all assumptions of the hydrogeology can ever be fully met for any investigation (Bouwer, 1978). As a result of this inherent uncertainty and the scope of the investigation, the simplest of these methods, "Hvorslev's Method" (Hvorslev, 1951) was used for the first stage of the analysis of the data.

A second method, attributed to Cooper et al (1967, in Bouwer 1978), was also used to estimate K. This method requires a more extensive understanding of the aquifer dimensions, however the use of empirically derived constants and limiting values can be employed to allow the calculation for K to be carried out with acceptable confidence in its accuracy.

The governing equation for calculating K using Hvorslev's Method:

Hvorslev's Method $K=r^2*\ln(L/R) / 2*L*To$

where:

r	radius of the well casing (cm)
R	R radius of the well screen (cm)
L	length of the well screen (cm)
To	time required for water level to reach 37% of the initial change (second)
K	hydraulic conductivity (m/d)

The governing equation for calculating K using the Cooper et al Method (1967 in Bouwer, 1978):

Cooper & Jacob Method $K=(r^2*\ln(Re/Rw) / 2*L)*(1/t)*(\ln(y0/y1))$

where:

r	radius of the well casing (m)
Rw	radius of the well (casing and screen) (m)
Re	effective radius over which head difference is dissipated (m)
Le	length of the well screen (m)
y0	head difference at initial time To
y1	head difference at T1
t	T1-T0
K	hydraulic conductivity (m/s)

2.3 PUMP TEST METHODOLOGY

A pump was place in MB06 and was run continuously for approximately 5.5 hours. A Level Troll 500 probe was placed in the well to record the in-situ drawdown. Two other probes were placed in two surrounding observation bores (MB05 and MB08) to record any drawdown/recovery of the water table resulting from the pumping of MB06.

After about 5.5 hours of pumping, the pump was switched off. The in-situ Level Troll 500 probe remained in the bore for an additional 1 hour to measure the recovery response of the water table.

2.4 GROUNDWATER SAMPLING METHOD

Groundwater was sampled to provide an understanding of its background physical and chemical properties.

- A water bailer suitable for environmental investigations was used to purge the groundwater bores until stability in measured field physico-chemical parameters was achieved.

- Water samples were collected once field parameters have stabilised (including pH and electrical conductivity) and sent to a laboratory with NATA accreditation for the parameters to be measured, and will be analysed in accordance with Standard Methods for Examination of Water and Wastewater 22nd Edition (APHA et. al. 2012).

- Analysis included the following parameters; pH, total dissolved solids, total organic carbon, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, zinc, potassium, chloride, sulphate, ammonia-N, nitrate-N, nitrite-N, total nitrogen, total phosphorous, total petroleum hydrocarbons, total recoverable hydrocarbons, BTEX, polycyclic aromatic hydrocarbons (PAH), polychlorinated biphenyls, trichloroethylene (TCE), tetrachloroethylene (PCE), organochloride pesticides and organophosphorous pesticides.

- Collection of quality control field duplicate and triplicate samples was undertaken at a rate of one sample per 20 primary samples.

3 RESULTS

3.1 FIELD MEASURED PARAMETERS

Groundwater monitoring bore locations, depth to water and field measured water quality parameters: pH, Temperature, Dissolved Oxygen (DO), Electrical Conductivity (EC) and Total Dissolved Solids (TDS, derived from the value for EC i.e. TDS = EC x 680) are presented in Table 1.

Table 1. Groundwater Monitor Bore Locations and Gauging Results.

Monitoring Well ID	Coordinates (MGA 94 Zone 50)		Date	ToC (m AHD)	Well Stickup (m)	Ground Level (m AHD)	Total Well Depth (m bTOC)	Depth to SWL (m bToC)	SWL (m AHD)	SWL (m bgl)	Water Quality					Comments (odours, sheen etc)
	Easting	Northing									pH	Temp (°C)	DO (mg/L)	EC (mS/cm)	TDS (mg/L)	
MB01	461241.00	6469802.00	22/08/2012	270.12	0.64	269.48	11.90	2.405	267.72	1.765	5.34	18.9	2.81	30.6	20808	White, cloudy
MB02	461064.00	6469095.00	22/08/2012	287.62		287.62	-	-	-	-	-	-	-	-	-	-
MB03	462012.00	6468382.00	22/08/2012	280.73	0.53	280.20	13.42	5.600	275.127	5.075	4.92	19.64	4.60	2.13	1448	Slightly cloudy, no odour
MB04	462314.00	6468385.00	22/08/2012	275.35	0.43	274.92	10.91	1.115	274.233	0.685	3.84	19.19	1.71	16.20	11016	Clear, no odour
MB05	462063.00	6468857.00	22/08/2012	274.65	0.77	273.88	9.70	1.804	272.848	1.036	5.14	19.23	1.25	6.38	4338	Cloudy, brown/red, no odour
MB06	462704.00	6468877.00	22/08/2012	283.88	0.53	283.35	10.64	0.543	283.332	0.013	5.06	19.31	1.53	19.70	13396	Clear, small amount of sediment
MB07	463610.00	6469135.00	22/08/2012	304.46	0.53	303.93	10.55	1.055	303.404	0.525	5.70	19.9	4.34	1.3	884	Cloudy, orange, no odour
MB08	463173.00	6469493.00	22/08/2012	308.19	0.53	307.67	11.25	6.530	301.663	6.005	3.93	18.2	4.88	26.1	17748	Cloudy, light brown

NOTES:

SWL	Static Water Level (the water table)	bToC	below Top of Casing (50 mm PVC)
SPH	Separated Phase Hydrocarbon	bgl	below ground level
EC	Electrical Conductivity	AHD	Australian Height Datum
TDS	Total Dissolved Solids (=EC*680; EPA 1993)	mS	milli Siemens

Environmental Protection Agency, 1993. Western Australian Water Quality Guidelines for Fresh and Marine Waters. Bulletin 711, October 1993.

3.2 SLUG TEST RESULTS

Table 2 presents the results for the successful slug tests performed at 4 bores (MB01, MB03, MB06 and MB07). The estimations of Hydraulic Conductivity (K in m/day) were calculated based on the methods described in Hvorslev (1951) and Cooper et al (1967).

Table 2. Hydraulic Conductivity (K in m/day) based on slug test results.

Monitor Bore	Hvorslev (1951)	Cooper et al. (1967)
MB01	0.03	0.5
MB03	-	0.1
MB06	0.02	0.6
MB07	0.02	0.6

The results for K range from 0.02 to 0.6 m/day. These values are in accordance with K values for clay soils (Bouwer, 1978), which estimate a range of 0.01-0.2 m/day for clay soils (surface)

The recovery curves are presented in Figure 3. The vertical scale on the graphs (mm) is arbitrary.

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3.3 PUMP TEST RESULTS

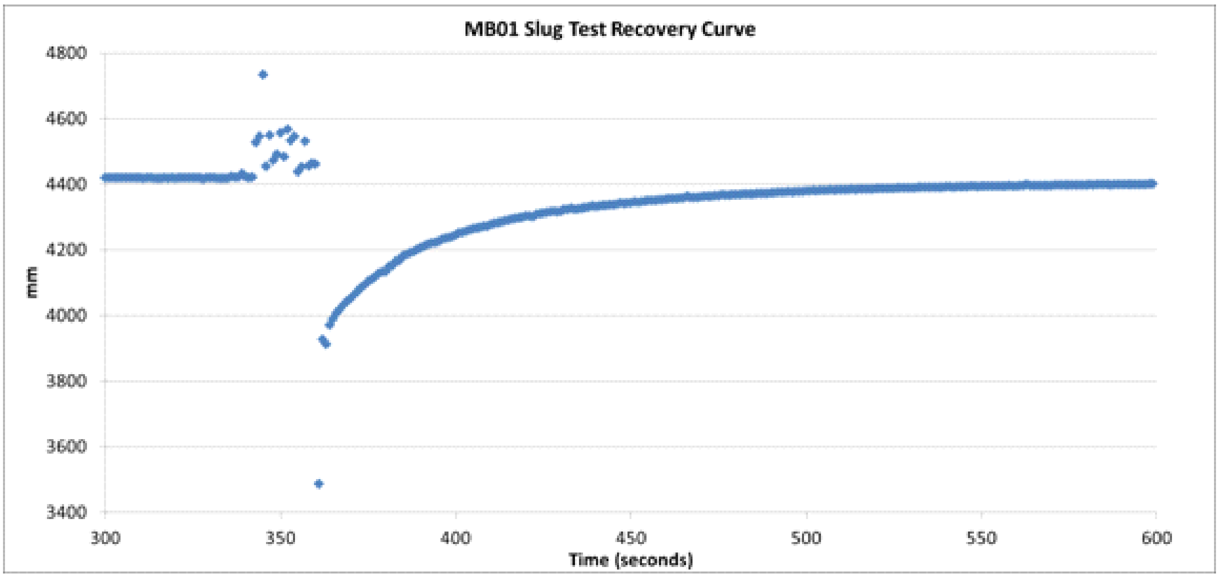
Monitor Bore MB06 underwent pumping for approximately 5.5hrs at a rate sufficient to reduce the water table by about 2cm. The recovery of the well was monitored for one hour after the cessation of pumping. The water table recovered by about 1cm (Figure 4). The pump test at monitor bore MB06 did not provide any significant data to assist in the assessment of the regional hydrogeology. This was due to small magnitude of the measured drawdown in MB06, and the observations bores MB05 and MB08 (both several hundred metres away from MB06). The small magnitude of the measurements results in unacceptable margins of error in the estimation of a value for K (the hydraulic conductivity of aquifer material surrounding the bore being tested). An accurate estimation of K was also limited by the lack of reliable data of the dimensions of the aquifer, in particular the depth to the confining layer at the base of the aquifer, as well as the highly variable lithology of the soils at MB06 (and at the site in general).

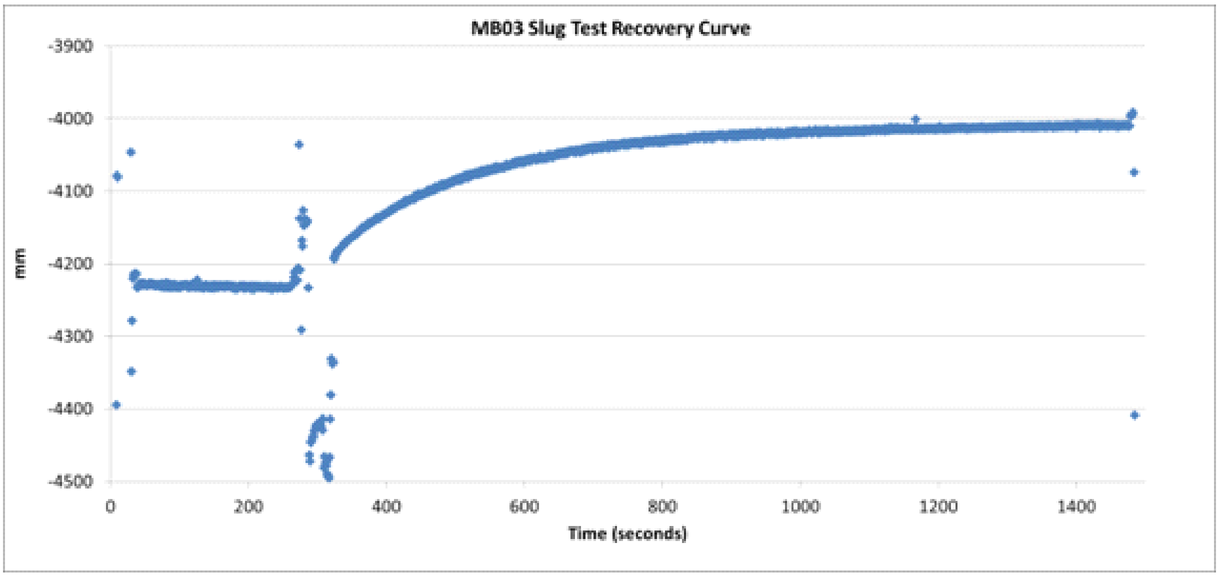
The locations of the monitoring bores were determined primarily for assessing groundwater levels and quality and, as such, were not ideally positioned for the pump test. The regional hydrogeology is, therefore, best assessed by considering the consistent results for K obtained from the slug testing of the four bores that are evenly distributed across the site.

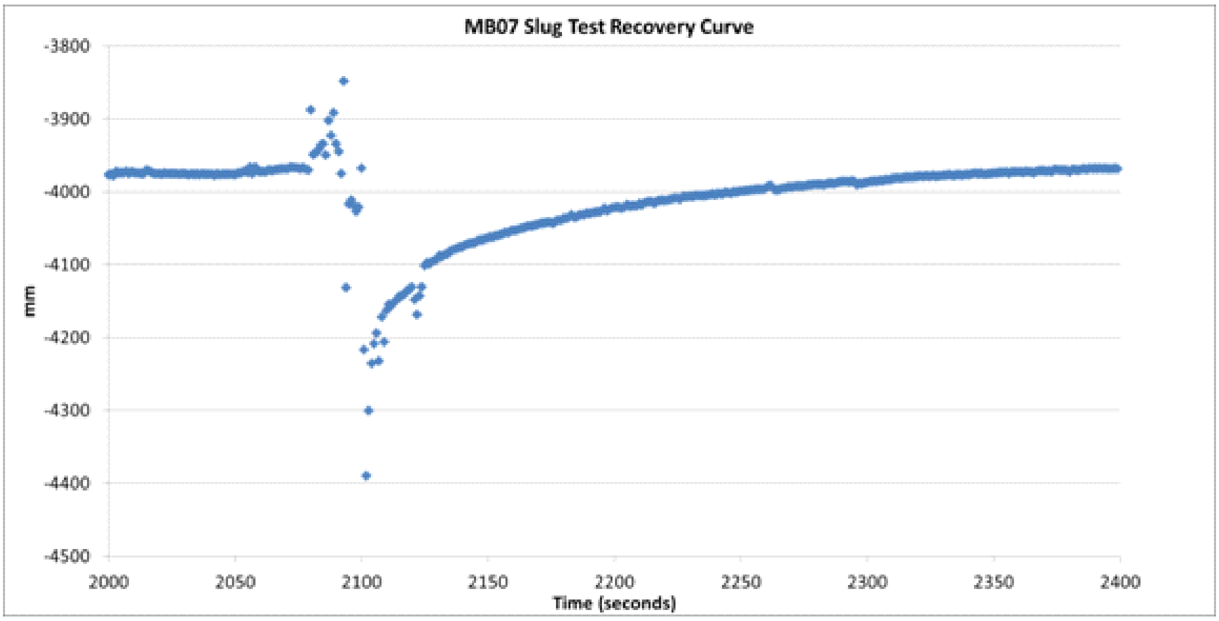
3.4 WATER QUALITY RESULTS

Table 3 presents the laboratory analysis results for the seven bores that were sampled (MB01, MB03, MB04, MB05, MB06, MB07 & MB08) as well as for the duplicate (DUP1, MB06 as the primary) and triplicate (TRIP 1, MB06 as the primary). All samples (including DUP1 and TRIP1) were analysed for a total of 105 parameters from eight parameter groups, including:

Metals:	12
TPH 1999 NEPM Fractions:	5
TRH Draft 2010 NEPM Fractions:	4
MAHs:	4
PAHs:	17
VOCs:	2
PCBs:	8
OCPs:	21
OPPs:	20
Nutrients:	5
Other:	7







Vertical scale in mm is arbitrary

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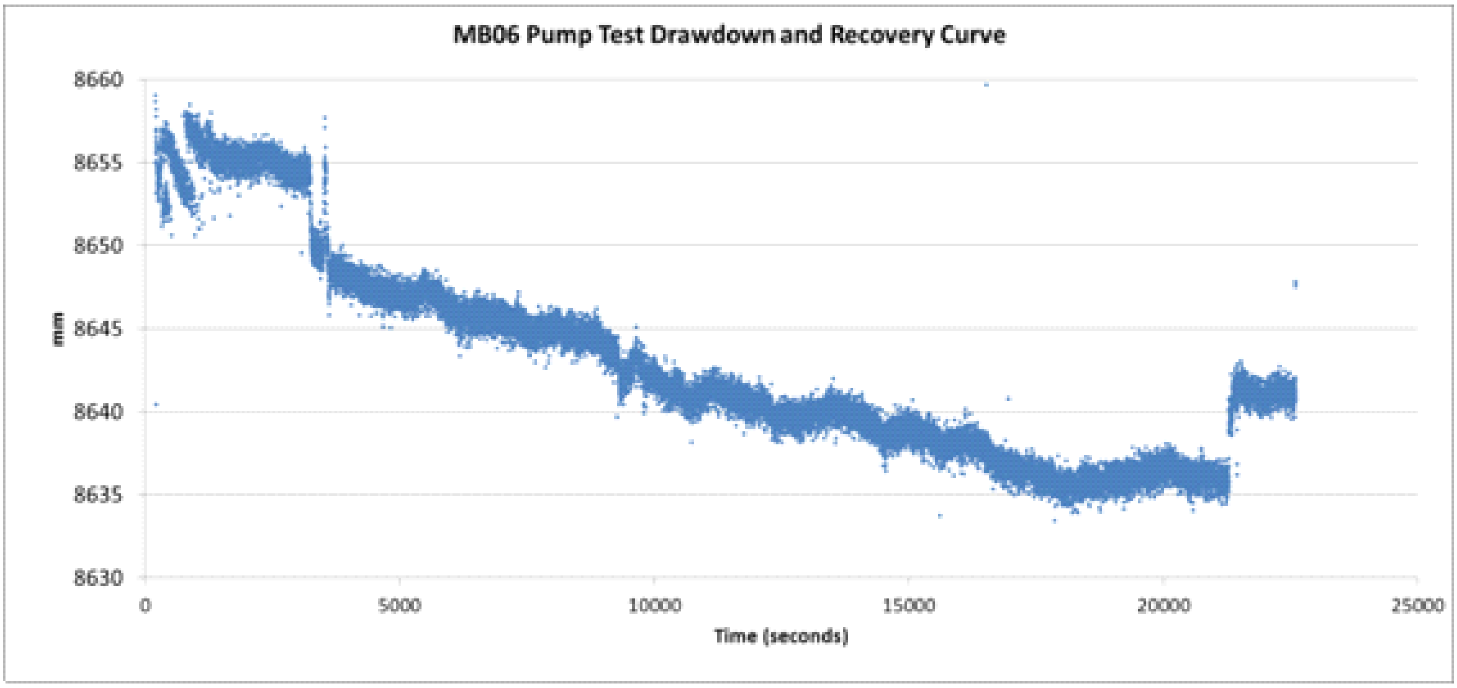
D Jarvis	T Ellis	3-10-2012
SCALE	PROJECTION	
Not applicable	Not applicable	

Slug Test Recovery Curves for MB01, MB03 and MB07

Allawuna Landfill Bore Installation & GW Monitoring

FIGURE 3



Vertical scale in mm is arbitrary

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AUTHOR D Jarvis	DRAWN T Ellis	DATE 3-10-2012
SCALE Not applicable	PROJECTION Not applicable	

Pump Test Drawdown and Recovery Curve for MB06

Allawuna Landfill Bore Installation & GW Monitoring

FIGURE **4**

Table 3. Groundwater Laboratory Analysis Results.

Sample ID		MB01	MB03	MB04	MB05	MB06	MB07	MB08	DUP1	TRIP1	RPD (%)	RPD (%)
Date		22/8/12	22/8/12	22/8/12	22/8/12	22/8/12	22/8/12	22/8/12	22/8/12	22/8/12	DUP1	TRIP1
Report Number		349496	349496	349496	349496	349496	349496	349496	349496	349496	MB06	MB06
Metals	Arsenic	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.006	*0*	*143*
	Cadmium	0.0051	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< LOR	*0*	*0*
	Chromium	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Copper	0.01	0.002	< 0.001	0.005	< 0.001	< 0.001	0.02	< 0.001	< LOR	*0*	*0*
	Iron	< 0.05	4.1	11	2.9	< 0.05	< 0.05	69	< 0.05	0.08	*0*	*46*
	Lead	< 0.001	< 0.001	0.002	< 0.001	0.002	< 0.001	0.003	0.002	0.01	*0*	*0*
	Manganese	1.4	0.041	0.05	0.11	0.13	0.022	0.13	0.13	0.1	*0*	*26*
	Mercury	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Molybdenum	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< LOR	*0*	*0*
	Nickel	0.039	0.006	0.004	0.012	0.002	0.002	0.032	0.002	0.002	*0*	*0*
	Selenium	0.001	< 0.001	0.002	< 0.001	0.005	< 0.001	0.004	0.005	0.005	*0*	*0*
	Zinc	2.9	0.023	0.035	0.34	0.003	0.014	0.14	0.003	0.01	*0*	*108*
TPH 1999 NEPM Fractions	C6-C9	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< LOR	*0*	*0*
	C10-C14	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< LOR	*0*	*0*
	C15-C28	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< LOR	*0*	*0*
	C29-C36	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< LOR	*0*	*0*
	C10-36	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< LOR	*0*	*0*
TRH Draft 2010 NEPM Fractions	C6-C10	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< LOR	*0*	*0*
	>C10-C16	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< LOR	*0*	*0*
	>C16-C34	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< LOR	*0*	*0*
	>C34-C40	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< LOR	*0*	*0*
MAHs	Benzene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Ethylbenzene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Toluene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Xylenes(o,m & p)	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< LOR	*0*	*0*
PAHs	Acenaphthene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Acenaphthylene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Anthracene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Benz(a)anthracene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Benzo(a)pyrene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Benzo(b)fluoranthene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Benzo(g.h.i)perylene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Benzo(k)fluoranthene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Chrysene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Dibenz(a.h)anthracene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Fluoranthene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Fluorene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Indeno(1.2.3-cd)pyrene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Naphthalene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Phenanthrene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Pyrene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Total PAH	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
VOCs	Tetrachloroethene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Trichloroethene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
PCBs	Aroclor-1016	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Aroclor-1221	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Aroclor-1232	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Aroclor-1242	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Aroclor-1248	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Aroclor-1254	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Aroclor-1260	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Total PCB	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*

Notes

Results are in mg/L unless otherwise stated

Table 3. Groundwater Laboratory Analysis Results (continued)

	4.4'-DDD	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	4.4'-DDE	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	4.4'-DDT	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	a-BHC	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Aldrin	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	b-BHC	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Chlordane	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	d-BHC	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Dieldrin	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Endosulfan I	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
OCPs	Endosulfan II	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Endosulfan sulphate	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Endrin	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Endrin aldehyde	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Endrin ketone	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	g-BHC (Lindane)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Heptachlor	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Heptachlor epoxide	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Hexachlorobenzene	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Methoxychlor	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Toxaphene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Bolstar	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Chlorpyrifos	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Demeton-O	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Diazinon	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Dichlorvos	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Disulfoton	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Ethion	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Ethoprop	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Fenitrothion	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Fensulfothion	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
OPPs	Fenthion	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Merphos	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Methyl azinphos	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Methyl parathion	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Mevinphos	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Naled	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Phorate	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Ronnel	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Tokuthion	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Trichloronate	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Ammonia (as N)	0.11	0.21	0.47	0.37	0.1	0.03	1.2	0.15	1.4	*40*	*173*
	Nitrate (as N)	0.06	0.57	< 0.02	0.33	< 0.02	1.1	< 0.02	< 0.02	< LOR	*0*	*0*
Nutrients	Nitrate & Nitrite (as N)	0.07	0.58	< 0.05	0.35	< 0.05	1.1	< 0.05	< 0.05	< LOR	*0*	*0*
	Total Kjeldahl Nitrogen (as N)	< 0.2	0.3	0.47	0.7	<0.2	6.8	1.2	< 0.2	1.4	*0*	*150*
	Total Nitrogen (as N)	<0.2	0.88	0.47	1.1	<0.2	7.9	1.2	<0.2	1.4	*0*	*150*
	Potassium	49	6.6	14	59	49	6.7	95	54	36	*10*	*31*
	Chloride	12000	650	5500	1900	6800	470	9300	6500	6400	*5*	*6*
	Sulphate (as S)	300	33	130	88	170	27	270	170	460	*0*	*92*
Other	Suspended Solids	680	1400	53	1400	95	2800	3500	110	NT	*15*	*0*
	Total Dissolved Solids	19000	1300	8700	3200	11000	970	15000	12000	13000	*9*	*17*
	Total Organic Carbon	13	5.7	12	15	16	11	15	15	2	*6*	*156*
	pH	6.4	5.9	3.6	5.8	6	6.1	3.8	6	5.4	*0*	*11*
Notes												
Results are in mg/L unless otherwise stated												
NT: Not Tested				Potassiur	Chloride	Sulphate (	Suspende	Total Diss	Total Orga	pH		

The analysis of primary samples reported a total of 85 parameters with values below the LOR (Limit of Reporting). This included all of the hydrocarbon, VOCs, PCBs, and pesticide parameter groups.

3.4.1 Metals

The following metals were detected in the laboratory analysis:

Cadmium:	MB01
Copper:	MB01, MB03, MB05, MB08
Iron:	MB03, MB04,MB05, MB08
Lead:	MB06, MB08
Manganese:	All Bores
Nickel:	All Bores
Selenium:	MB01, MB04,MB06, MB08
Zinc:	All Bores

Arsenic, Chromium, Mercury and Molybdenum were not detected in any of the primary samples. Arsenic was detected in the triplicate sample TRIP1 (0.006 mg/L)

For the primary bore samples, monitor bore MB08 had the highest recorded values for Iron (69 mg/L). MB01 had the highest levels of Zinc (2.9 mg/L), Manganese (1.4 mg/L) and the only recorded levels of Cadmium (0.0051 mg/L).

3.4.2 Nutrients

The following nutrients were detected in the laboratory analysis:

Ammonia (as N):	All Bores
Nitrate (as N):	MB01, MB03, MB05, MB07
Nitrate & Nitrite (as N):	MB01, MB03, MB05, MB07
Total Kjeldahl Nitrogen (as N):	MB03, MB04,MB05, MB07, MB08
Total Nitrogen (as N):	MB03, MB04,MB05, MB07, MB08

For the primary bore samples, monitor bore MB07 had the highest recorded values for Total N (7.9 mg/L). This was due mainly to Total Kjeldahl Nitrogen (as N) (6.8 mg/L) and corresponds with the lowest recorded levels of Ammonia (as N) (0.03 mg/L). Use of broad-acre fertilisers and manure from grazing animals are the likely source of the nitrogen.

3.4.3 Other Parameters

Other parameters include Potassium, Chloride, Sulphate (as S), Suspended Solids, Total Dissolved Solids, Total Organic Carbon and pH. All bore samples had typical values reported for these parameters (except for TRIP1 that was not tested for Total Suspended Solids).

All samples had pH (field) values of less than 6. The bore with the lowest pH (field and laboratory) was MB04 (pH (field) = 3.84). This reflects the weathering of the acidic granitic rock underlying geology.

For the primary bore samples, monitor bore MB01 had the highest recorded values for Total Dissolved Salts (19000 mg/L), Chloride (12000 mg/L) and Sulfate (300mg/L). High chloride and dissolved salts indicates secondary salinisation of the landscape as a result of the clearing of native vegetation.

For the primary bore samples, monitor bore MB07 had the lowest recorded values for Total Dissolved Solids (970 mg/L), Chloride (470 mg/L) and Sulfate (327mg/L).

Monitor bore MB08 (the bore with elevated levels of Iron) recorded a corresponding pH(field) of 3.93 (the second lowest pH). MB08 had the second highest recorded values for Total Dissolved Solids (15000 mg/L), Chloride (93000 mg/L) and Sulfate (270mg/L).

4 CONCLUSIONS

4.1 HYDRAULIC CONDUCTIVITY

The hydraulic conductivity of the clay soils at the site are estimated to be in the range 0.02-0.6 m/day. These values are consistent with K values for clay soils from Southwest Australia derived from Granite (Davidson, 1995). These values agree with K values found in Bouwer (1978), which estimates a range of 0.01-0.2 m/day for clay soils (surface).

Clay soils at the base of the aquifer are likely to be of lower hydraulic conductivity and within the range provided in Bouwer (1978) of 10^{-8}-10^{-2} m/day. Clay, sand and gravel mixes (identified in the borehole lithology logs, Appendix A) have a K value in the range 0.001-0.1 m/day (Bouwer, 1978).

4.2 GROUNDWATER LEVELS AND FLOW

Groundwater levels at the site range from about 303 mAHD (MB07, to the east) to 268 mAHD (MB01, to the west) indicating a flow from east to west (Figure 2). The groundwater levels provide suitable baseline assessment for the purposes of ongoing monitoring that will be required as part of the proposed landfill.

4.3 GROUNDWATER QUALITY

The groundwater quality at the site ranges from fresh (MB07, TDS=970mg/L) to saline (MB01, TDS=19000 mg/L). For the seven primary samples, MB03 and MB07 would be classified as "fresh", with the remaining bores classified as "saline" (AWRC, 1988).

The groundwater pH (field) ranged from 3.84 to 5.70, indicating that the groundwater is moderately acidic. The bores with pH<4 (MB08 and MB04) have correspondingly higher concentrations of iron (exceeding the 10mg/L)

The analysis of the groundwater indicated all levels of pesticides and hydrocarbons are below the detection limits of the laboratory analysis. This is expected in a site that should not have been affected by pesticide treatments.

The extensive analysis of the groundwater quality provides a suitable baseline assessment for the purposes of ongoing monitoring that will be required as part of the proposed landfill.

5 REFERENCES

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TABLES

Table 1. Groundwater Monitor Bore Locations and Gauging Results.

Monitoring Well ID	Coordinates (MGA 94 Zone 50)		Date	ToC (m AHD)	Well Stickup (m)	Ground Level (m AHD)	Total Well Depth (m bTOC)	Depth to SWL (m bToC)	SWL (m AHD)	SWL (m bgl)	Water Quality					Comments (odours, sheen etc)
	Easting	Northing									pH	Temp (°C)	DO (mg/L)	EC (mS/cm)	TDS (mg/L)	
MB01	461241.00	6469802.00	22/08/2012	270.12	0.64	269.48	11.90	2.405	267.72	1.765	5.34	18.9	2.81	30.6	20808	White, cloudy
MB02	461064.00	6469095.00	22/08/2012	287.62		287.62	-	-	-	-	-	-	-	-	-	-
MB03	462012.00	6468382.00	22/08/2012	280.73	0.53	280.20	13.42	5.600	275.127	5.075	4.92	19.64	4.60	2.13	1448	Slightly cloudy, no odour
MB04	462314.00	6468385.00	22/08/2012	275.35	0.43	274.92	10.91	1.115	274.233	0.685	3.84	19.19	1.71	16.20	11016	Clear, no odour
MB05	462063.00	6468857.00	22/08/2012	274.65	0.77	273.88	9.70	1.804	272.848	1.036	5.14	19.23	1.25	6.38	4338	Cloudy, brown/red, no odour
MB06	462704.00	6468877.00	22/08/2012	283.88	0.53	283.35	10.64	0.543	283.332	0.013	5.06	19.31	1.53	19.70	13396	Clear, small amount of sediment
MB07	463610.00	6469135.00	22/08/2012	304.46	0.53	303.93	10.55	1.055	303.404	0.525	5.70	19.9	4.34	1.3	884	Cloudy, orange, no odour
MB08	463173.00	6469493.00	22/08/2012	308.19	0.53	307.67	11.25	6.530	301.663	6.005	3.93	18.2	4.88	26.1	17748	Cloudy, light brown

NOTES:

SWL	Static Water Level (the water table)	bToC	below Top of Casing (50 mm PVC)
SPH	Separated Phase Hydrocarbon	bgl	below ground level
EC	Electrical Conductivity	AHD	Australian Height Datum
TDS	Total Dissolved Solids (=EC*680; EPA 1993)	mS	milli Siemens

Environmental Protection Agency, 1993. Western Australian Water Quality Guidelines for Fresh and Marine Waters. Bulletin 711, October 1993.

Table 2. Hydraulic Conductivity (K in m/day) based on slug test results.

Monitor Bore	Hvorslev (1951)	Cooper et al (1967)
MB01	0.03	0.5
MB03	-	0.1
MB06	0.02	0.6
MB07	0.02	0.6

Table 3. Groundwater Laboratory Analysis Results.

Sample ID		MB01	MB03	MB04	MB05	MB06	MB07	MB08	DUP1	TRIP1	RPD (%)	RPD (%)
Date		22/8/12	22/8/12	22/8/12	22/8/12	22/8/12	22/8/12	22/8/12	22/8/12	22/8/12	DUP1	TRIP1
Report Number		349496	349496	349496	349496	349496	349496	349496	349496	349496	MB06	MB06
Metals	Arsenic	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.001	0.006	*0*	*143*
	Cadmium	0.0051	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< 0.0002	< LOR	*0*	*0*
	Chromium	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Copper	0.01	0.002	< 0.001	0.005	< 0.001	< 0.001	0.02	< 0.001	< LOR	*0*	*0*
	Iron	< 0.05	4.1	11	2.9	< 0.05	< 0.05	69	< 0.05	0.08	*0*	*46*
	Lead	< 0.001	< 0.001	0.002	< 0.001	0.002	< 0.001	0.003	0.002	0.01	*0*	*0*
	Manganese	1.4	0.041	0.05	0.11	0.13	0.022	0.13	0.13	0.1	*0*	*26*
	Mercury	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Molybdenum	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< LOR	*0*	*0*
	Nickel	0.039	0.006	0.004	0.012	0.002	0.002	0.032	0.002	0.002	*0*	*0*
	Selenium	0.001	< 0.001	0.002	< 0.001	0.005	< 0.001	0.004	0.005	0.005	*0*	*0*
	Zinc	2.9	0.023	0.035	0.34	0.003	0.014	0.14	0.003	0.01	*0*	*108*
TPH 1999 NEPM Fractions	C6-C9	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< LOR	*0*	*0*
	C10-C14	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< LOR	*0*	*0*
	C15-C28	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< LOR	*0*	*0*
	C29-C36	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< LOR	*0*	*0*
	C10-36	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< LOR	*0*	*0*
TRH Draft 2010 NEPM Fractions	C6-C10	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< LOR	*0*	*0*
	>C10-C16	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< LOR	*0*	*0*
	>C16-C34	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< LOR	*0*	*0*
	>C34-C40	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< LOR	*0*	*0*
MAHs	Benzene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Ethylbenzene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Toluene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Xylenes(o,m & p)	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< 0.003	< LOR	*0*	*0*
PAHs	Acenaphthene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Acenaphthylene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Anthracene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Benz(a)anthracene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Benzo(a)pyrene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Benzo(b)fluoranthene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Benzo(g.h.i)perylene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Benzo(k)fluoranthene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Chrysene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Dibenz(a.h)anthracene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Fluoranthene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Fluorene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Indeno(1.2.3-cd)pyrene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Naphthalene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Phenanthrene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Pyrene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Total PAH	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
VOCs	Tetrachloroethene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Trichloroethene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
PCBs	Aroclor-1016	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Aroclor-1221	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Aroclor-1232	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Aroclor-1242	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Aroclor-1248	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Aroclor-1254	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Aroclor-1260	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Total PCB	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*

Notes

Results are in mg/L unless otherwise stated

Table 3. Groundwater Laboratory Analysis Results (continued)

	4.4'-DDD	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	4.4'-DDE	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	4.4'-DDT	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	a-BHC	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Aldrin	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	b-BHC	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Chlordane	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	d-BHC	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Dieldrin	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Endosulfan I	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
OCPs	Endosulfan II	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Endosulfan sulphate	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Endrin	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Endrin aldehyde	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Endrin ketone	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	g-BHC (Lindane)	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Heptachlor	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Heptachlor epoxide	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Hexachlorobenzene	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Methoxychlor	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< LOR	*0*	*0*
	Toxaphene	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< LOR	*0*	*0*
	Bolstar	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Chlorpyrifos	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Demeton-O	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Diazinon	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Dichlorvos	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Disulfoton	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Ethion	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Ethoprop	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Fenitrothion	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Fensulfothion	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
OPPs	Fenthion	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Merphos	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Methyl azinphos	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Methyl parathion	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Mevinphos	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Naled	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Phorate	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Ronnel	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Tokuthion	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Trichloronate	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< LOR	*0*	*0*
	Ammonia (as N)	0.11	0.21	0.47	0.37	0.1	0.03	1.2	0.15	1.4	*40*	*173*
	Nitrate (as N)	0.06	0.57	< 0.02	0.33	< 0.02	1.1	< 0.02	< 0.02	< LOR	*0*	*0*
Nutrients	Nitrate & Nitrite (as N)	0.07	0.58	< 0.05	0.35	< 0.05	1.1	< 0.05	< 0.05	< LOR	*0*	*0*
	Total Kjeldahl Nitrogen (as N)	< 0.2	0.3	0.47	0.7	<0.2	6.8	1.2	< 0.2	1.4	*0*	*150*
	Total Nitrogen (as N)	<0.2	0.88	0.47	1.1	<0.2	7.9	1.2	<0.2	1.4	*0*	*150*
	Potassium	49	6.6	14	59	49	6.7	95	54	36	*10*	*31*
	Chloride	12000	650	5500	1900	6800	470	9300	6500	6400	*5*	*6*
	Sulphate (as S)	300	33	130	88	170	27	270	170	460	*0*	*92*
Other	Suspended Solids	680	1400	53	1400	95	2800	3500	110	NT	*15*	*0*
	Total Dissolved Solids	19000	1300	8700	3200	11000	970	15000	12000	13000	*9*	*17*
	Total Organic Carbon	13	5.7	12	15	16	11	15	15	2	*6*	*156*
	pH	6.4	5.9	3.6	5.8	6	6.1	3.8	6	5.4	*0*	*11*

Notes

Results are in mg/L unless otherwise stated

NT: Not Tested

Potassium Chloride Sulphate (Suspende Total Diss Total Orga pH

APPENDIX A

GROUNDWATER MONITORING BORE LITHOLOGY AND INSTALLATION LOGS

Project No: J112319

Project: Groundwater Assessment

Client: Bowman and Associates

Location: Allawuna Farm, Shire of York

Easting: 461246

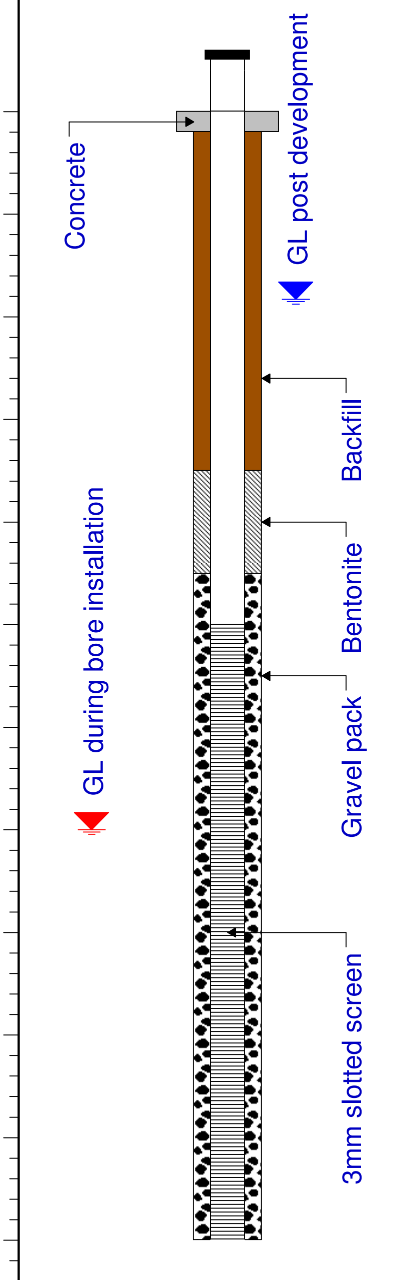
Northing: 6469801

Datum: GDA94 (UTM 50)

Scientist: Kristy Ferguson

Well ID: MB01

SUBSURFACE PROFILE				SAMPLE			WELL	
Depth (mbgl)	Elevation (mAHD)	Symbol	Lithology	Number	Type	Lab Analysed	Depth (m)	Well Construction
0	267.7		Ground Surface				0	
0–1	266.7		***Clayey SAND*** Orange/brown, medium grain, poorly sorted, damp.					
1–2	265.7		***Clayey SAND*** Orange/yellow, medium grain, poorly sorted, damp.					
2–3	264.7		***Gravelly, clayey SAND*** Yellow, medium grain, poorly sorted, damp.					
3–5	262.7		***Gravelly SAND*** Red/grey, medium grain, poorly sorted, damp.					
5–11	256.7		***Gravelly CLAY*** White, damp.					
11			End of Borehole				11	



Installation Contractor: Strataprobe

Installation Method: Air compressor with blade bit

Bore Diameter: 50mm

Date: 01/08/2012

COMMENTS:

Project No: J112319
Project: Groundwater Assessment
Client: Bowman and Associates
Location: Allawuna, Shire of York

Easting: 461064
Northing: 6469095
Datum: GDA94 (UTM50)
Scientist: Kristy Ferguson

Well ID: MB02

SUBSURFACE PROFILE				SAMPLE			WELL	
Depth (mbgl)	Elevation (mAHD)	Symbol	Lithology	Number	Type	Lab Analysed	Depth (m)	Well Construction

Elevation (mAHD) labels: 322.0, 320.0, 317.5, 316.5, 309.0, 307.0, 304.0, 302.0, 294.0, 292.0

Ground Surface

Sandy, clayey GRAVEL
Orange/brown, coarse grain, poorly sorted, dry.

Gravelly, clayey, SAND
Yellow, coarse grain, poorly sorted, dry.

Sandy, clayey SILT
Orange/cream, fine grain, poorly sorted, dry

SILT
Orange/pink, fine grain, moderately sorted, dry.

Clayey, SILT
Orange/cream, fine grain, well sorted, dry.

SILT
White, fine grain, well sorted, dry.

SILT
Pink, fine grain, well sorted, dry.

SILT
White, fine grain, well sorted, dry.

SILT
White/grey, fine grain, well sorted, damp.

Sandy, silty, CLAY
White, fine grain, well sorted, damp.

Sandy, clayey, SILT
Orange, yellow, white, mdeium grain, poorly sorted, damp.

End of Borehole

Installation Contractor: Strataprobe
Installation Method: Air compressor with blade bit
Bore Diameter: 50 mm
Date: 2/08/2012

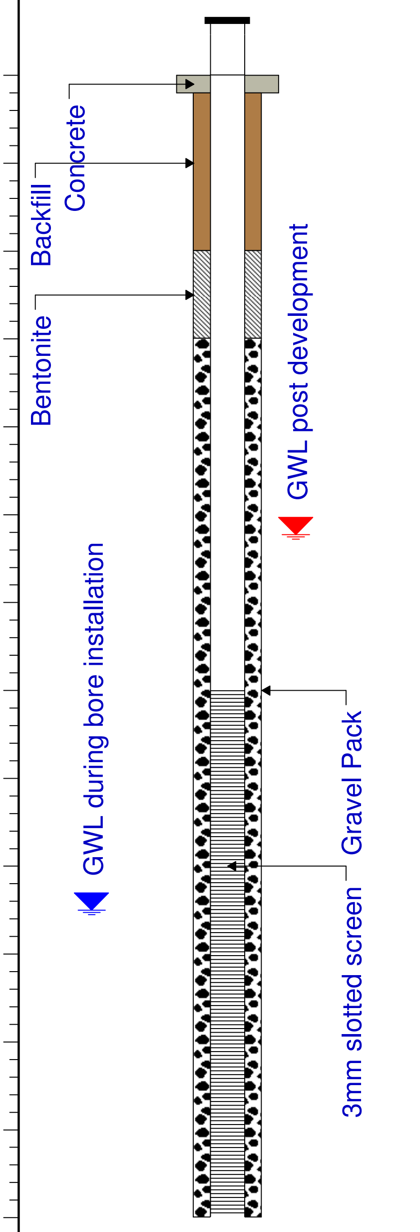
COMMENTS:
Well was not constructed as groundwater was not intercepted

Project No: J112319
Project: Groundwater Assessment
Client: Bowman and Associates
Location: Allawuna, Shire of York

Easting: 462012
Northing: 6468392
Datum: GDA94 (UTM50)
Scientist: Kristy Ferguson

Well ID: MB03

SUBSURFACE PROFILE				SAMPLE			WELL	
Depth (mbgl)	Elevation (mAHD)	Symbol	Lithology	Number	Type	Lab Analysed	Depth (m)	Well Construction
0	275.1		Ground Surface				0	
0	275.1		***Gravelly, sandy, CLAY*** Orange/brown, fine and coarse grain, poorly sorted, damp.					
0.5	274.6		***Gravelly, clayey, SAND*** Orange/yellow, fine and coarse grain, poorly sorted, dry.					
2	273.1		***Gravelly, SAND*** Orange/brown, medium grain, moderately sorted, dry					
3	272.1		***Sandy, SILT*** Grey/white, fine grain, well sorted, dry.					
6	269.1		***Sandy, silty, CLAY*** Borwn/grey, fine grain, moderately sorted, dry.					
8	267.1		***Sandy, silty, CLAY*** Brown/grey, fine and coarse grain, moderately sorted, saturated.					
13	262.1		End of Borehole				13	



Installation Contractor: Edrill
Installation Method: Air compressor with blade bit
Bore Diameter: 50 mm
Date: 14/08/2012

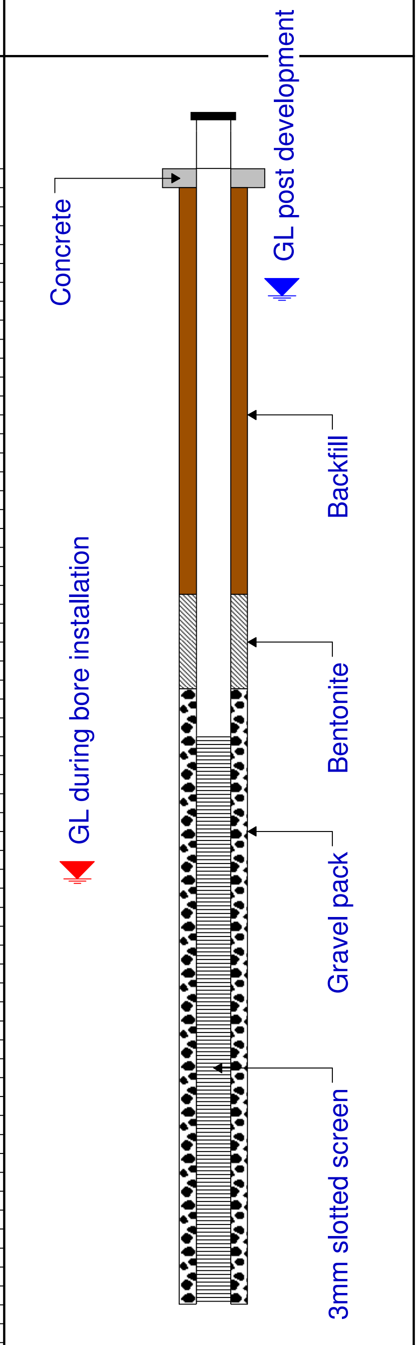
COMMENTS:

Project No: J112319
Project: Groundwater Assessment
Client: Bowman and Associates
Location: Allawuna Farm, Shire of York

Easting: 462316
Northing: 6468390
Datum: GDA94 (UTM 50)
Scientist: Kristy Ferguson

Well ID: MB04

SUBSURFACE PROFILE				SAMPLE			WELL	
Depth (mbgl)	Elevation (mAHD)	Symbol	Lithology	Number	Type	Lab Analysed	Depth (m)	Well Construction
0	274.2		Ground Surface				0	
0–0.5	273.7		***Gravelly SAND*** Brown, medium grain, moderately sorted, damp.					
0.5–2	272.2		***Gravelly, clayey SAND*** Orange and brown coloured, medium grain, poorly sorted, and dry					
2–4	270.2		***Gravelly, sandy CLAY*** Orange/yellow/brown, medium grain, poorly sorted, damp.					
4–7	267.2		***Sandy, silty, CLAY*** Brown/grey, fine to medium grain, moderately sorted, damp.					
7–12	262.2		***CLAY*** White, fine grain, well sorted, damp.					
12			End of Borehole				12	



Installation Contractor: Strataprobe
Installation Method: Air compressor with blade bit
Bore Diameter: 50 mm
Date: 01/08/2012

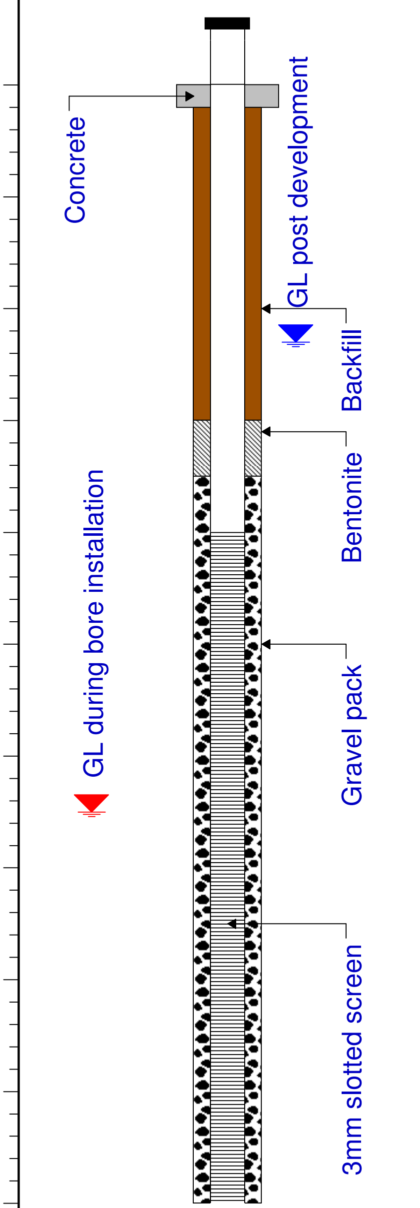
COMMENTS:

Project No: J112319
Project: Groundwater Assessment
Client: Bowman and Associates
Location: Allawuna Farm, Shire of York

Easting: 462065
Northing: 6468851
Datum: GDA94 (UTM 50)
Scientist: Kristy Ferguson

Well ID: MB05

SUBSURFACE PROFILE				SAMPLE			WELL	
Depth (mbgl)	Elevation (mAHD)	Symbol	Lithology	Number	Type	Lab Analysed	Depth (m)	Well Construction
0	272.8		Ground Surface				0	
0–0.5	272.3		***SAND*** Brown, coarse grain, poorly sorted, damp.					
0.5–2	270.8		***Sandy CLAY*** Yellow/brown colour, coarse grain, poorly sorted, damp.					
2–3	269.8		***Sandy SILT*** Orange and brown coloured, coarse grain, poorly sorted and dry.					
3–4.5	268.3		***Sandy, silty, CLAY.*** Brown and grey coloured,fine and medium grain, moderately sorted, and damp.					
4.5–6	266.8		***Sandy CLAY*** Brown and grey coloured, coarse grain, moderately sorted and damp.					
6–7	265.8		***Gravelly CLAY*** Orange and grey coloured, coarse grain, poorly sorted and saturated.					
7–8	264.8		***Gravelly CLAY*** Orange coloured, coarse grain, poorly sorted and saturated.					
8–10	262.8		***Sandy, clayey GRAVEL*** Orange and brown coloured. coarse grain, poorly sorted and saturated.					
10			End of Borehole				10	



Installation Contractor: Strataprobe
Installation Method: Air compressor with blade bit
Bore Diameter: 50 mm
Date: 01/08/2012

COMMENTS:

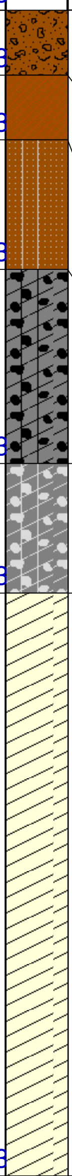
Project No: J112319
Project: Groundwater Assessment
Client: Bowman and Associates
Location: Allawuna Farm, Shire of York

Easting: 462699
Northing: 6468873
Datum: GDA94 (UTM 50)
Scientist: Kristy Ferguson

Well ID: MB06

SUBSURFACE PROFILE

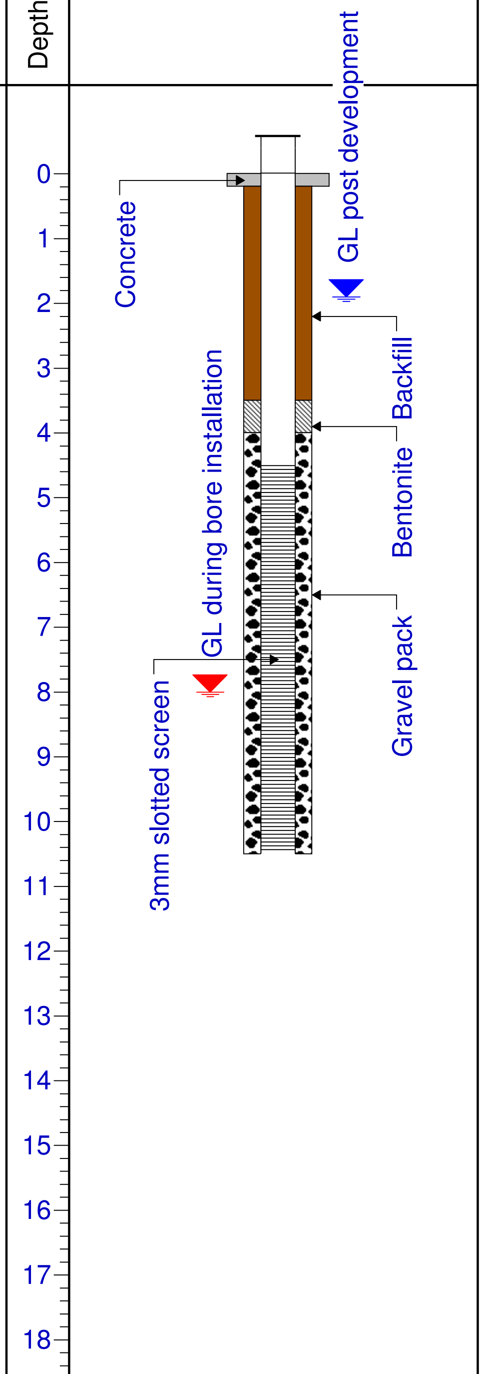
Depth (mbgl)	Elevation (mAHD)	Lithology
0	283.3	Ground Surface
0–1	283.3–282.3	***Gravelly, clayey SAND*** Brown, medium grain, poorly sorted, damp.
1–2	282.3–281.3	***Gravelly, sandy CLAY*** Orange/brown, medium grain, moderately sorted, dry.
2–4	281.3–279.3	***Sandy, silty CLAY*** Grey/brown, fine to medium grain, moderately sorted, damp.
4–7	279.3–276.3	***Sandy, gravelly CLAY*** Grey, fine grain, moderately sorted and wet.
7–9	276.3–274.3	***Gravelly CLAY*** White and grey, fine grain, moderately sorted, wet.
9–18	274.3–265.3	***Gravelly, sandy CLAY*** Cream coloured, fine to coarse grain, poorly sorted, saturated.
18	265.3	End of Borehole



SAMPLE

Number	Type	Lab Analysed

WELL



Installation Contractor: Strataprobe
Installation Method: Air compressor with blade bit
Bore Diameter: 50 mm
Date: 01/08/2012

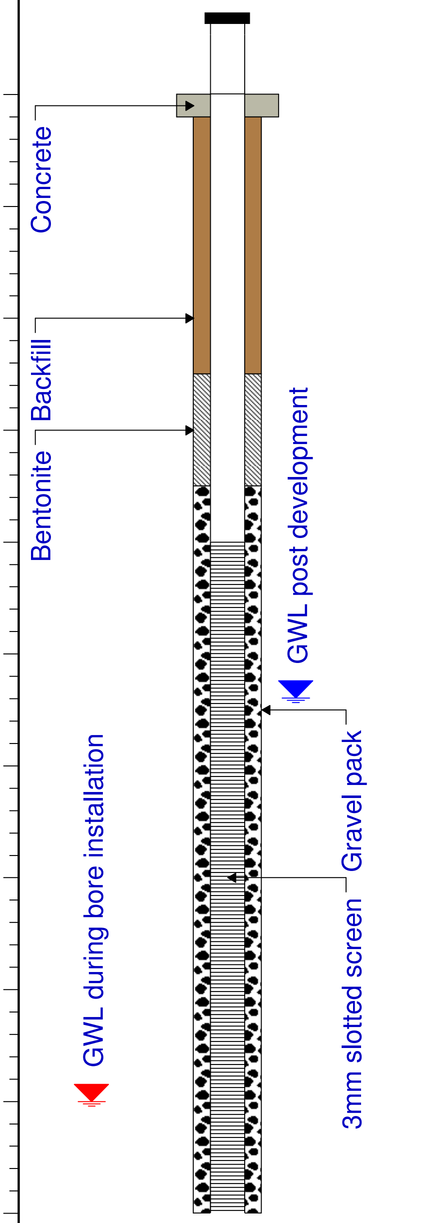
COMMENTS:

Project No: J112319
Project: Groundwater Assessment
Client: Bowman and Associates
Location: Allawuna Farm, Shire of York

Easting: 463607
Northing: 6469137
Datum: GDA94 (UTM50)
Scientist: Kristy Ferguson

Well ID: MB07

SUBSURFACE PROFILE				SAMPLE			WELL	
Depth (mbgl)	Elevation (mAHD)	Symbol	Lithology	Number	Type	Lab Analysed	Depth (m)	Well Construction
0	303.4		Ground Surface				0	
0–1	303.4–302.4		***Gravelly, clayey, SAND*** Orange/brown, medium grain, poorly sorted, dry,					
1–4	302.4–299.4		***Gravelly, SAND*** Grey/brown,coarse grain, poorly sorted, dry.					
4–6	299.4–297.4		***Sandy, CLAY*** Yellow/orange, medium grain, moderately sorted, damp.					
6–8	297.4–295.4		***Sandy, CLAY*** Brown/grey, moderately sorted, damp.					
8–10	295.4–293.4		***Gravelly, sandy, CLAY*** Brown/grey, poorly sorted, saturated.					
10	293.4		End of Borehole				10	



Installation Contractor: Edrill
Installation Method: Air compressor with blade bit
Bore Diameter: 50 mm
Date: 14/08/2012

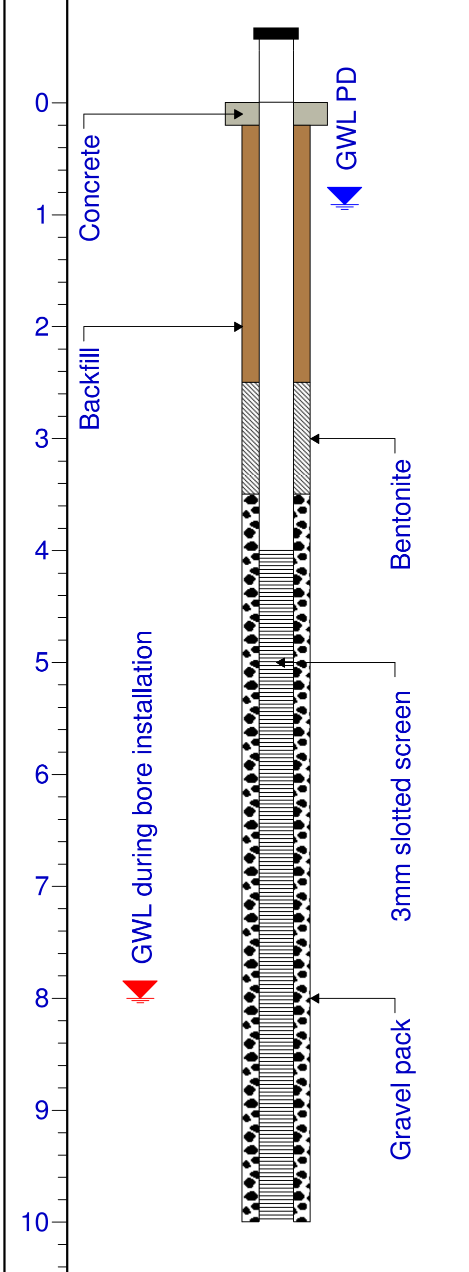
COMMENTS:

Project No: J112319
Project: Groundwater Assessment
Client: Bowman and Associates
Location: Allawuna Farm, Shire of York

Easting: 463172
Northing: 6469459
Datum: GDA94 (UTM50)
Scientist: Kristy Ferguson

Well ID: MB08

SUBSURFACE PROFILE				SAMPLE			WELL
Depth (mbgl)	Elevation (mAHD)	Symbol	Lithology	Number	Type	Lab Analysed	Well Construction
0	301.7		Ground Surface				
0 – 2			***Gravelly, SAND*** Brown, coarse grain, poorly sorted, dry.				
2 – 3	299.7		***Gravelly, silty, SAND*** Grey/brown, fine and coarse grain, poorly sorted, dry.				
3 – 7	298.7		***Sandy, silty, CLAY*** Grey, fine grain, well sorted, dry.				
7 – 10	294.7		***Silty, CLAY*** Brown/grey, fined grain, well sorted, damp.				
10	291.7		End of Borehole				



Installation Contractor: Edrill
Installation Method: Air compressor with blade bit
Bore Diameter: 50 mm
Date: 14/05/2012

COMMENTS: PD = post development