GROUNDWATER FIELD INVESTIGATION

A Groundwater Investigation Status Report for the Wilpinjong Coal Project

FOR

WILPINJONG COAL LIMITED

By

Groundwater Exploration Services Pty Ltd

March 2014

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

1.1 BACKGROUND

This document describes the hydrogeological investigation program conducted by Groundwater Exploration Services Pty Ltd in 2013 at Wilpinjong Coal Mine Pty Limited (Wilpinjong). The program was commissioned by Wilpinjong install groundwater monitoring bores to augment an existing groundwater monitoring network and to gather hydrogeological information within the current approved mining operations and proposed expansion areas.

The Wilpinjong Coal Mine is an existing open cut coal mine located approximately 40 kilometres (km) north-east of Mudgee near the village of Wollar in central New South Wales (NSW) (Figure 1).

The Wilpinjong Coal Mine is owned and operated by Wilpinjong Coal Pty Limited (WCPL), a wholly owned subsidiary of Peabody Energy Australia Pty Ltd (Peabody). An aerial photograph of the Wilpinjong Coal Mine is shown on Figure 2.

1.2 SCOPE OF WORK

The scope of work involved design and supervision of a hydrogeological investigation program which included the following components:

- Drilling and geological logging of shallow investigation drillholes within the Wilpinjong Creek Alluvium to the northeast of the project;
- Monitoring of groundwater levels from installed bores;
- Installation of 15 monitoring standpipes utilising exploration drill holes where available;
- Hydraulic testing of installed monitoring standpipes;
- Hydraulic testing of selected drill holes using packer testing;
- Water quality testing; and
- Undertaking a core permeability test program.

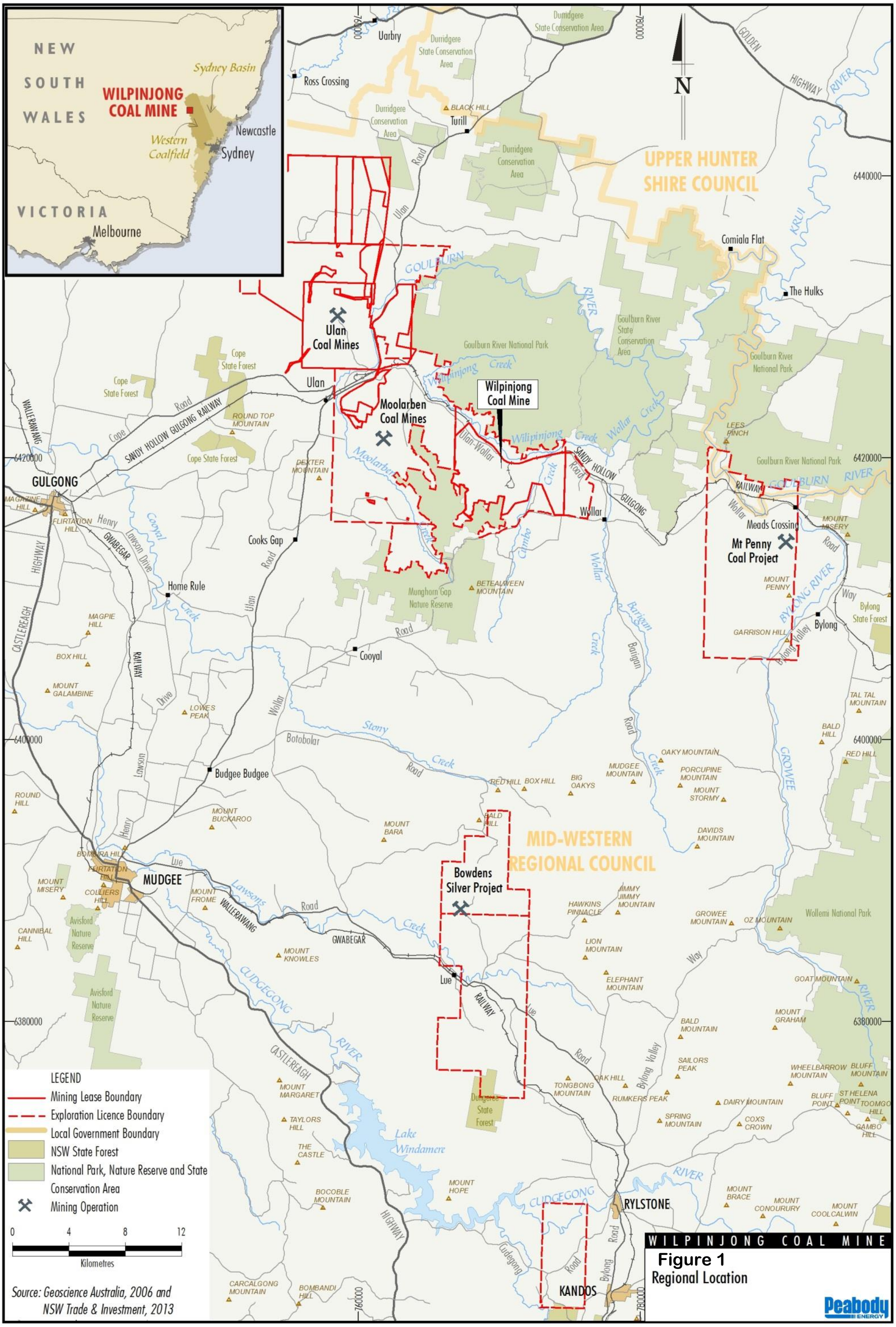


Figure 1
Regional Location

Legend

- Transect Locations
- Monitoring Locations

0 0.5 1 2
Kilometers

Project:	Date: 15/03/2014
Drawing No. 2.6	Revision : A
Drawn: AF	Datum: WGS1984

Figure 2
Location of Monitoring Bores

2 HYDROGEOLOGICAL INVESTIGATION PROGRAMME

2.1 PIEZOMETERS INSTALLATION

A total of 16 new standpipe piezometers have been installed. This includes 12 standpipes installed within existing exploration drillholes in the Illawarra Coal Measures, three standpipes installed into dedicate drillholes and 1 standpipe retrofitted into a shallow alluvial well. All installations occurred during November and December 2013. The locations of the standpipe piezometers are shown in **Figure 2**.

Table 2.1 provides a summary of the installation details for each standpipe piezometer. Further details are provided in **Appendix A**, including the geological logs for the exploration holes.

Table 2.1: Installed Standpipe Piezometers

Bore	Coordinates		Surface RL	Screened Interval*	Aquifer Screened
	Easting	Northing	(m AHD)	(m bgl)**	
GWC24	774481.1	6416005.5	426.7	21 – 24 (15 - 27)	Ulan Seam
GWc18	767945.9	6420507.9	424.6	51 – 63 (46 - 69)	Ulan Seam
GWc17	768493.5	6420994.1	397.545	35.2 –47.2 (32 – 53.2)	Ulan Seam
GWc22	772769	6419244		24.6 – 30.6 (20 – 36.6)	Ulan Seam
GWc25	767330.4	6415897	478.0	22.5 – 28.5 (17 – 34.5)	Ulan Seam
PW1126	767945.9	6420508	424.6	11.5 –17.5 (10 – 20)	Ulan Seam
GWC26	768499.1	6422995	398.429	67.9 – 79.9 (54 – 83.9)	Ulan Seam
GWc28	775364.1	6420004	375.4	66.5 –72.5 (56.5 – 78.5)	Ulan Seam
GWc29	776005.3	6419000	376.1	49.2 – 55.2 (46 – 61.2)	Ulan Seam
PW1131	770885.8	6415943	445.9	13 – 19 (11.3 – 19)	Ulan Seam
GWc23	774011.8	6417491	426.5	43 – 52 (39 – 52)	Marangaroo
GWa22	773035	6419152		1.3 – 4.3 (1– 4.3)	Cumbo Creek Alluvium
GWa16p	769658.6	6421172	378.879	34 – 40 (24 – 46)	Ulan Seam
GWa16***	769612.9	6421037	381.123		Wilpinjong Creek Alluvium
GWc32	777764.2	6417867	354.49	38 – 44 (34 – 47)	Wilpinjong Seam

*Screened interval - 21 - 24 (15 - 27) [Screen interval (Gravel Pack Interval)]

**m bgl - Metres below ground level

*** Pre-existing bore re named.

2.2 HYDRAULIC TESTING

2.2.1 FALLING HEAD TESTS

Falling head slug tests were carried out following installation on the standpipe piezometers installed within the Coal measures to obtain estimates hydraulic conductivity. The procedure involved adding a slug of water to each piezometer/bore and then recording water-level recovery back to a static level using a downhole pressure transducer.

The slug test data were analysed using the Bouwer-Rice method (Bouwer and Rice, 1976) for the tests on unconsolidated sediments (alluvium and colluvium), and the Hvorslev Method (Hvorslev, 1951) for tests on the hard rock units confined, which are suitable for providing 'near well' estimates of aquifer hydraulic conductivity (K).

A summary of the derived hydraulic conductivity values is presented in **Table 2.2**. Curve matching results of falling head tests are presented in **Appendix B**.

Table 2.2: Falling Head Slug Test Results

Bore	Aquifer Screened	Test Date	Hydraulic Conductivity K (m/day)
GWc24	Ulan Seam	20/11/2013	2.9×10^{-2}
GWc18	Ulan Seam	Not Tested	N/A
GWc17	Ulan Seam	21/11/2013	1.1×10^{-1}
GWc22	Ulan Seam	21/11/2013	6.5×10^{-2}
GWc25	Ulan Seam	23/11/2013	1.2×10^{-2}
GWc21	Ulan Seam	Not Tested	N/A
GWc26	Ulan Seam	21/11/2013	2.0×10^{-1}
GWc28	Ulan Seam	20/11/2013	3.9×10^{-1}
GWc29	Ulan Seam	20/11/2013	6.2×10^{-1}
GWc27	Ulan Seam	21/11/2013	3.3×10^{-3}
GWc23	Ulan Seam	Not Tested	N/A
GWa22	Alluvium	23/11/2013	5.1×10^{-1}
GWc16	Ulan Seam	23/11/2013	1.1×10^{-1}
GWc32	Moolarben Seam	23/11/2013	1.1×10^{-1}

* screened interval (gravel Pack interval)

Recoveries within the Ulan Seam in a number of bores (GWc28, GWa29, GWa16) recovered to values greater than 95% or initial levels within 60 seconds of test initiation. In these bore tests, a definitive analysis of an accurate calculation of hydraulic conductivity is difficult with the logging equipment that was utilised. However, the tests indicate that at these locations, the coal seam has hydraulic conductivity in excess of 0.1 m/d.

2.2.2 PACKER TESTING

Packer Testing Background

Packer tests, sometimes also call Lugeon tests, is an in-situ testing method widely used to estimate the average hydraulic conductivity of a rock mass. The packer test is a constant head permeability test carried out in an isolated part of a borehole. The results provides information about hydraulic conductivity or permeability of the rock mass including the rock matrix and any can provide some insight into structural discontinuities such as joints and fractures.

The test is conducted in a portion of a borehole isolated by pneumatic packers. The water is injected into the isolated portion of the borehole using a slotted pipe which itself is bounded by the inflated packers.

The test is carried out at five stages including increasing and decreasing pressure between zero and maximum pressure. At each stage, a constant pressure is applied for an period of 5 to 10 minutes while pumping water. Water pressure and flow rate are measured every minute. There are three loading and two unloading stages.

Using the average values of water pressure and flow rate measured at each stage, the average hydraulic conductivity of the rock mass can be determined. Following an empirical definition of the test, the hydraulic conductivity is expressed in terms of Lugeon Unit, being the conductivity required for a flow rate of 1 litre per minute per meter of the borehole interval under a constant pressure of 1 Mega Pascal (MPa). The Lugeon value for each test is therefore calculated as follows and then an average representative value is selected for the tested rock mass.

$$\text{Lugeon Value} = (q / L) \times (P0 / P)$$

Where:

- q - flow rate [lit/min]
- L - Length of the borehole test interval [m]
- P0 - reference pressure of 1 MPa
- P - Test pressure [MPa]

Pressures required to induce a flow rate are determined by the inherent hydraulic conductivity. The absolute pressures used in the stepped process therefore vary and is dependent on the conductivities being tested. However, care needs to be taken such that maximum test pressure of the test does not exceed the in-situ minimum stress, thus avoiding hydraulic fracturing. This is particularly an issue at Wilpinjong given the low hydraulic conductivities that can occur in coal measure interburden and the shallow cover depths that occur.

Wilpinjong Packer Tests

Packer tests were carried out on four open drillholes which included GWC24, GWC26, GWC29 and GWC23.

The number of downhole tests was limited due to shallow depth of holes and the relatively deep water levels found where the saturated portion of the exploration drill profiles was generally less than 50%. Of the four holes tested, GWC24 and GWC26 included three tests targeting strata below the Ulan Seam (Marangaroo Formation) the Ulan Seam and overburden immediately above the Ulan Seam. Four tests were conducted on GWC29 and GWC23 was tested at a single interval below the Ulan Seam due to the standing water table being only just above the base of the Ulan Seam.

The exploration holes generally extend 6m past the base of the Ulan Seam. Single packer tests were conducted in this basal stratum (Marangaroo) tended to have relatively low hydraulic conductivity when compared to the Ulan Seam with the exception of GWC24 which did not show such differences. The Ulan Seam itself was also tested with a single packer with the seals placed immediately above the seam roof.

Given that the conductivities in the seam were generally much higher than that encountered within the underlying Marangaroo Formation, testing of the Ulan Seam also used a single packer with the seam thickness used as the test interval (L) as it was assumed that the seam permeability would account for the bulk of the injected water.

Overburden tests included a double packer set up whereby a test interval was separated from the open hole between two inflatable packers. The intervals tested and hydraulic conductivity results are shown in **Table 2.3**.

Table 2.3 Packer Test Intervals and Results

Hole ID	Test Interval (m BGL)	Test lithology	Hydraulic Conductivity K (m/d)
GWc24	13 - 16	Ulan - Wilpinjong Interburden	2.8×10^{-2}
	16 - 27	Ulan Seam	7.8×10^{-2}
	23 - 27	Below Ulan Seam - Marangaroo	1.5×10^{-2}
GWc26	48 - 51	Ulan - Wilpinjong Interburden	8.4×10^{-4}
	62 - 72	Ulan Seam	1.3×10^{-1}
	82 - 85	Below Ulan Seam - Marangaroo	3.4×10^{-3}
GWc29	28 - 32	Ulan - Wilpinjong Interburden	2.8×10^{-1}
	33 - 37	Ulan - Wilpinjong Interburden	1.8×10^{-2}
	37-57	Ulan Seam	7.8×10^{-2}
	58 - 63.7	Below Ulan Seam - Marangaroo	1.6×10^{-3}
GWc23	47 - 51.7	Below Ulan Seam - Marangaroo	2.0×10^{-3}

*m bgl – metres below ground level

Summary of Packer Test Results

In one case (GWC24), a test was conducted in an unsaturated portion of the exploration drill hole. While this is generally not usual methodology, in this case it was done to increase the test sample size.

Testing in GWC29 indicated a stratum underlying the Ulan Seam (Marangaroo) was relatively impermeable in comparison to overlying Ulan Seam. Testing undertaken on the Ulan Seam indicated a hydraulic conductivity of 7.8×10^{-2} m/d. However overlying overburden returned test results in the order of $1 - 2 \times 10^{-1}$ m/d with tests using in excess of 1 m^3 of water during each test. This suggests that structural defects were most likely encountered.

Anecdotally, reports from the driller indicate that this hole lost considerable volumes of water during drilling. Given the head applied above standing water levels during drilling, this observation is consistent with the relatively high hydraulic conductivities found during the packer test and slug testing on this bore. Similar observations were also made during drilling of GWc28 and indicate that this area in lower Slate Gully appears to be highly fractured.

A single test was undertaken in GWC23 given that standing water levels were near the base of the Ulan Seam which would be due to the proximity to nearby coal excavation.

2.2.3 LABORATORY TESTING OF CORE PERMEABILITY

Core from three drill holes were sampled to gain representative lithologies from various interburden units where core was available. Boreholes from which core samples were taken include PW1123, GWC26 and GWC29. These were drilled as part of the recent resource delineation program and hence fresh core was available.

The locations of these holes are shown in Figure 2.1. The core samples were laboratory tested to determine vertical and horizontal hydraulic conductivity. Testing for vertical permeability was taken perpendicular to the bedding planes, while horizontal permeability was taken parallel to the bedding planes.

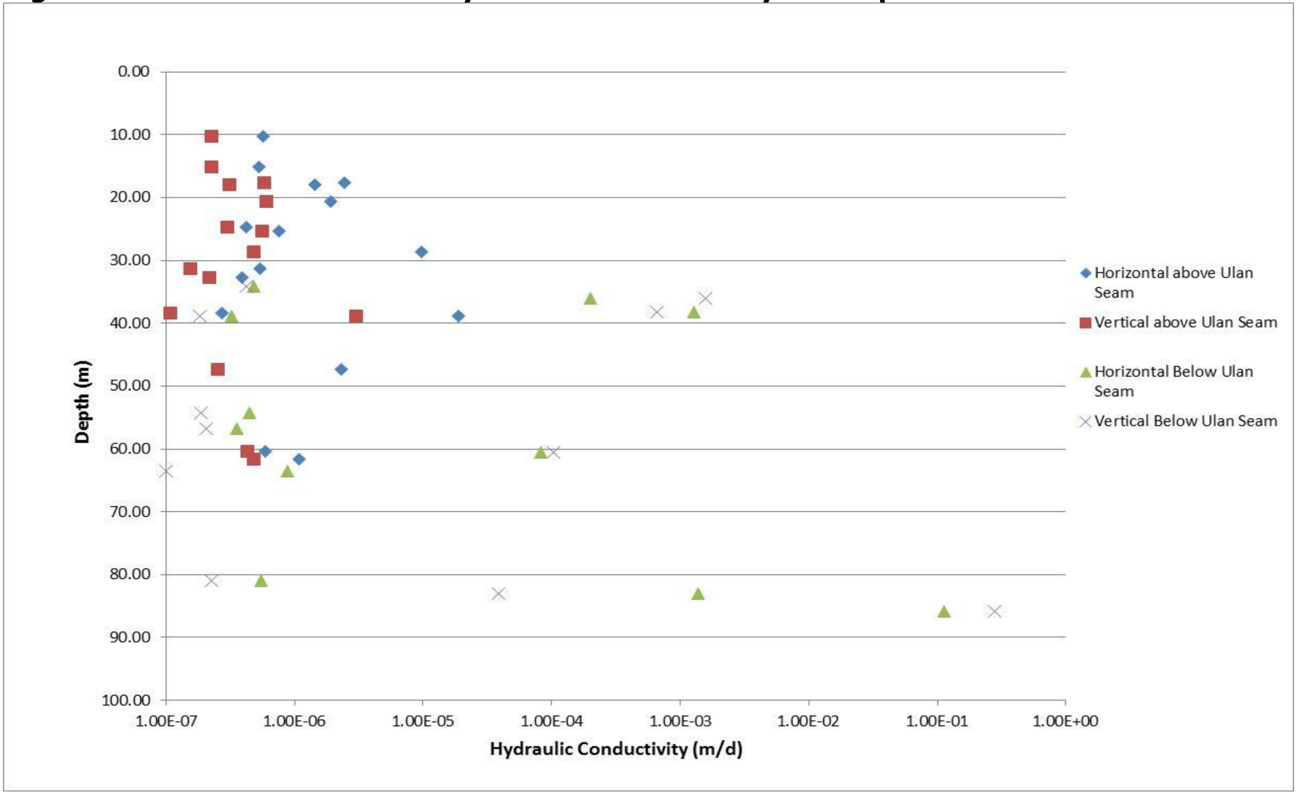
A summary of the core test results is provided in Table 2.4. The results of core permeability testing show that overall, the matrix permeability of interburden units have a range of hydraulic conductivities ranging between 1 x 10-7 and 2.8x10-01 m/d.
Two of the test results had results below detectable limits and a value of 1.0 x10-07 was assigned to these tests. There is no strong trend in the ratio between horizontal and vertical hydraulic conductivity, however the results for horizontal conductivity were on average slightly higher than the vertical results.

Figure 2.4 shows depth and hydraulic conductivity results for horizontal and vertical tests respectively. No linear relationship between increasing depth of burial and decreasing hydraulic conductivity can be seen. Higher hydraulic conductivities occurred below the Ulan Seam.

Table 2.4: Core Permeability Test Results

Horizontal Hydraulic Conductivity (m/d)					
Arithmetic Mean	Harmonic Mean	Number of Samples	Max	Min	Formation
2.8×10^{-06}	7.4×10^{-07}	15	1.9×10^{-05}	2.7×10^{-07}	Strata above Ulan Seam
1.1×10^{-02}	8.3×10^{-07}	11	1.1×10^{-01}	3.2×10^{-06}	Strata below Ulan Seam
Vertical Hydraulic Conductivity (m/d)					
Arithmetic Mean	Harmonic Mean	Number of Samples	Max	Min	
5.3×10^{-07}	3.2×10^{-07}	15	3.0×10^{-06}	1.1×10^{-07}	Strata above Ulan Seam
2.5×10^{-02}	3.8×10^{-07}	11	2.8×10^{-01}	1.0×10^{-07}	Strata below Ulan Seam

Figure 3: Core Test Results - Hydraulic Conductivity vs. Depth



2.3 GROUNDWATER MONITORING

2.3.1 GROUNDWATER LEVELS

Groundwater levels are presently recorded daily in all standpipe piezometers installed within the Permian coal measures and twice daily in bores screened within alluvium. Hydrographs for standpipes piezometers are provide in **Figures 4 to 5** which show that there is a large variation in groundwater elevations influenced by topography, particularly in the upper reaches of Slate Gully (GWc24).

Figure 4: Hydrograph for Recently Installed Piezometers (A)

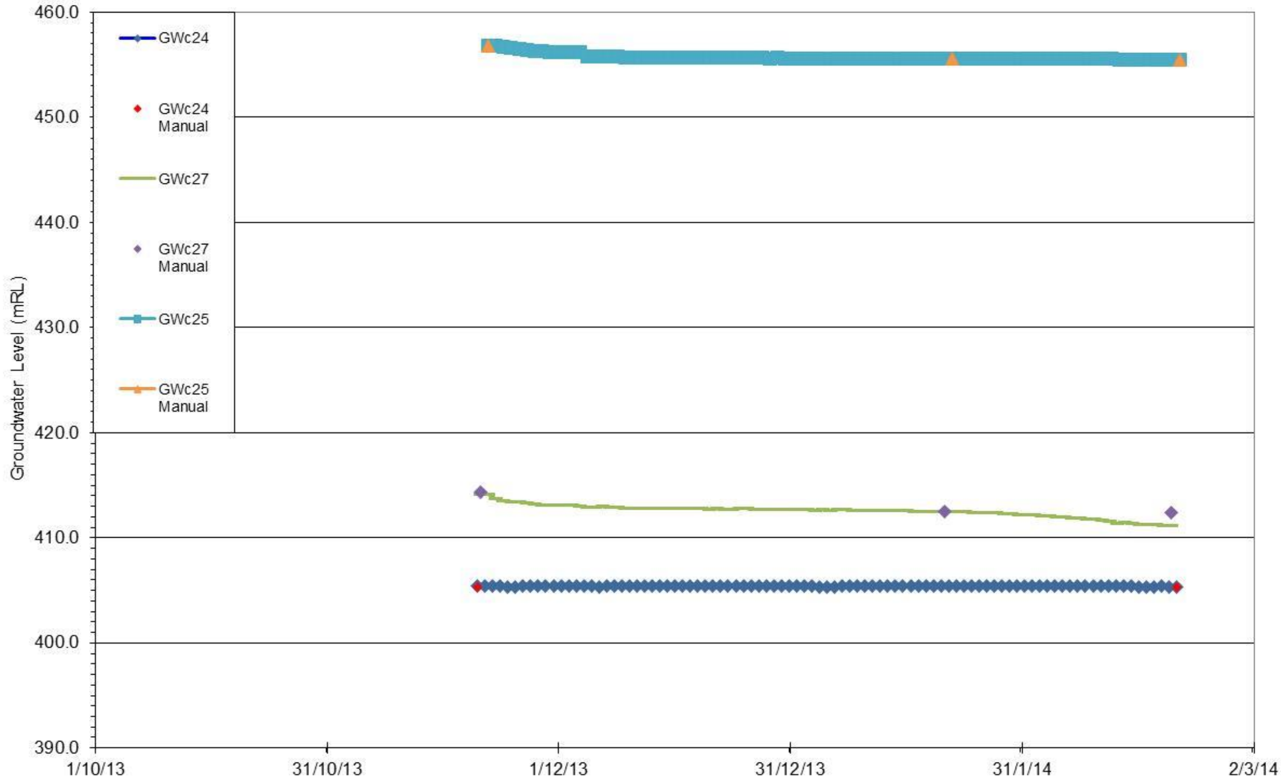
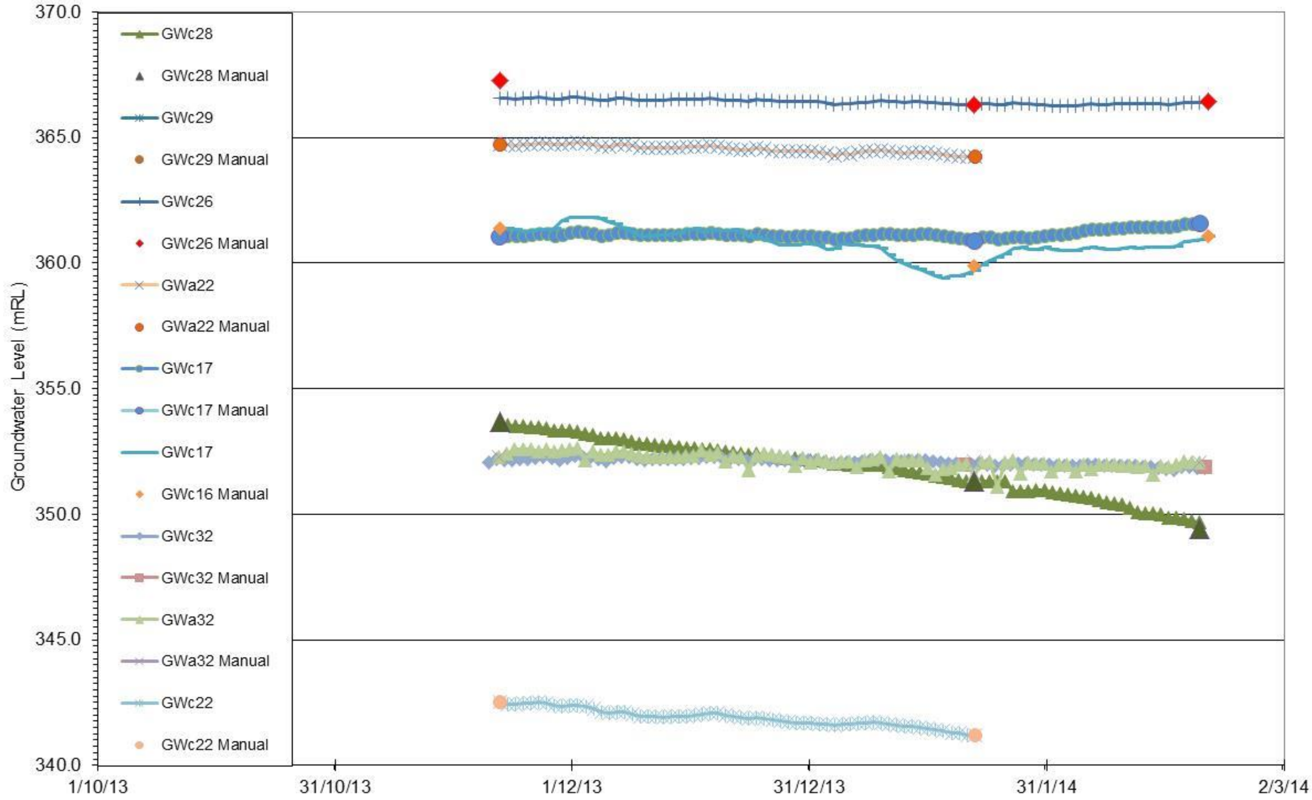


Figure 5: Hydrograph for Recently Installed Piezometers (B)



2.3.2 GROUNDWATER QUALITY

Water quality data obtained from newly installed piezometers is summarised in **Table 2.5 and 2.6.** Water samples were collected for field analysis of pH and electrical conductivity (EC), and for laboratory testing of a comprehensive suite of analytes which includes:

- pH, electrical conductivity (EC) and total dissolved solids (TDS);
- Major cations and anions; and
- Dissolved metals (As, B, Cd, Cr, Cu, Fe, Ni, Pb, Mn, Se, Zn, Hg).

The laboratory analysis was undertaken by ALS Environmental, a NATA-accredited laboratory based in Sydney.

Assessments of groundwater and surface quality can be useful in understanding conceptual hydrogeology, particularly in relation to EC and Piper diagram plots. Different strata horizons can demonstrate differing amounts of salinity, which tend to be low in areas of high recharge or connectivity with surface waters. Piper plots provide an assessment of the recharge-discharge processes, and also allow a comparison of water samples derived from different environments within the hydrological cycle. Recently-recharged water tends to plot closer to the left-hand apex of the diamond field in the Piper diagram, and waters further from the source of recharge closer to the right-hand side.

Figure 2.19 illustrates a piper diagram Piper Diagram which shows that groundwater is in the Wilpinjong area is variable. Typically in coal measure stratigraphy, a sodium chloride signature would be dominant. However, there appears to be a significant shift from a sodium chloride water type to a magnesium bicarbonate water type seen within the Permian screened bores. This is particularly noticeable in those bores located in elevated ground such as GWc26, GWc28 andGWc32.

There is a bicarbonate component seen in the Permian strata but this is noticeably absent from highly saline groundwater found within the shallow alluvium / colluvium / weathered Permian conglomerates at the southern end of CL316 suggesting that these water sample are generally not accepting recharge.

In summary, the sampling round conducted in 2012 resulted in the following findings:

- The water quality in the Permian-aged coal measures of the range from 140 to 5,260 µS/cm.
- The water quality in the two additional alluvium standpipes (GWa22 and GWc32a) are more saline than adjacent Permian standpipes with EC's of 5,620 and 3,850 µS/cm which suggests that there is some contribution from deeper Permian strata.
- Most samples are slightly alkaline, with pH values ranging from 7.2 to 8.
- No dissolved metals exceedances were observed.
- The low dissolved iron suggests the likely absence of pyrite in the coal and / or interburden strata, and in conjunction with the mostly alkaline pH, suggests that the mine waters are unlikely to have acid generating potential.

Figure 6: Piper Diagram

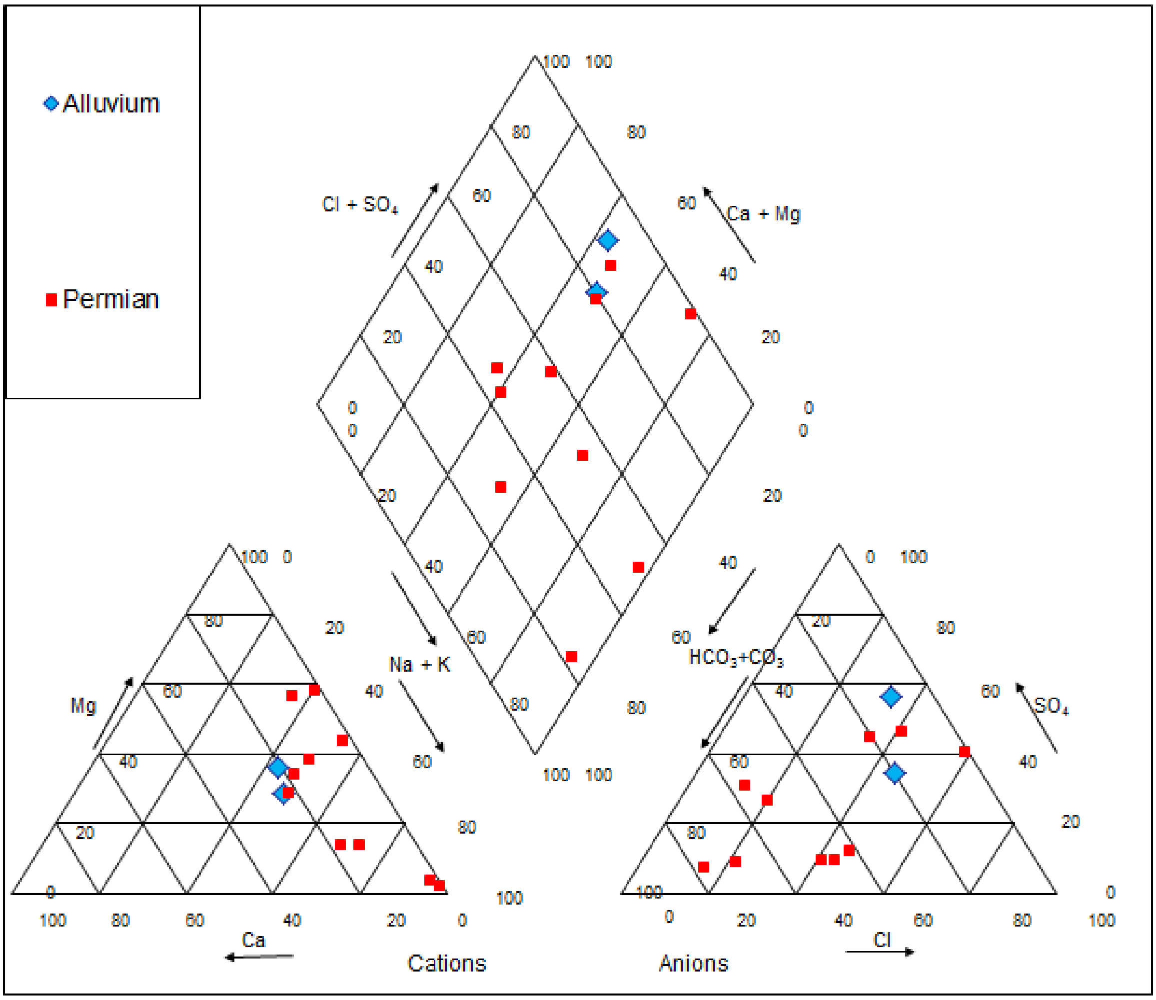


Table 2.5: Groundwater Quality Analytical Test Results

	GWA22	GWA16	GWC32P	GWC32A	GWC17	GWC22	GWc24	GWc25	GWc26	GWc28	GWC29	GWc23
Field pH	4860	8.71	7.73	7.46	1470	6.88	7.2	7.71	10.96	8.18	11.25	6.77
Field EC (Electrical Conductivity) µS/cm	7.55	174	183	3260	7.53	3640	3170	847	494	360	1133	1841
pH	7.66	7.33	7.14	7.63	7.27	6.92	7.34	7.17	11	7.62	11.1	5.31
Lab Electrical Conductivity µS/cm	5260	158	140	3850	1620	4300	3650	1150	377	323	987	1950
Total Dissolved Solids	4010	98	82	2500	841	2870	2430	594	164	180	308	1170
Hydroxide ($CaCO_3$)	<1	<1	<1	<1	<1	<1	<1	<1	51	<1	220	<1
Carbonate ($CaCO_3$)	<1	<1	<1	<1	<1	<1	<1	<1	34	<1	26	<1
Bicarbonate Alkalinity as CaCO3	353	43	35	471	363	324	464	284	<1	112	<1	10
Total $CaCO_3$	353	43	35	471	363	324	464	284	85	112	246	10
Sulfate as $SO4^{-}$	1610	19	14	635	85	951	792	46	5	11	8	342
Chloride	712	6	8	628	237	628	464	160	8	21	26	371
Calcium	260	12	9	132	73	192	128	16	<1	14	<1	26
Magnesium	247	<1	2	179	40	166	161	35	<1	1	<1	42
Sodium	585	16	11	422	179	511	416	156	27	33	56	269
Dissolved Metals												
Aluminium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.02	0.54
Arsenic	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001
Chromium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.005	<0.001
Copper	0.001	<0.001	0.002	0.002	<0.001	<0.001	0.001	<0.001	0.002	0.015	0.006	0.01
Lead	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	0.021	0.007	0.018	0.079	0.059	1.42	0.754	0.364	<0.001	0.016	<0.001	4.15
Molybdenum	0.002	0.003	0.002	0.003	<0.001	<0.001	0.025	0.004	0.004	0.002	0.008	<0.001
Nickel	0.006	0.004	0.016	0.002	0.001	0.011	0.01	0.206	<0.001	0.093	0.003	0.187
Selenium	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

	GWA22	GWA16	GWC32P	GWC32A	GWC17	GWC22	GWc24	GWc25	GWc26	GWc28	GWC29	GWc23
Zinc	<0.005	2.25	5.98	0.143	0.007	0.025	0.2	0.686	0.066	3.98	<0.005	1.3
Boron	0.14	<0.05	<0.05	0.08	<0.05	0.07	<0.05	<0.05	<0.05	<0.05	<0.05	0.11
Iron	<0.05	<0.05	<0.05	<0.05	<0.05	0.38	<0.05	0.34	<0.05	<0.05	<0.05	0.47
Total Metals												
Aluminium	0.63	0.13	0.35	0.06	10	0.2	4.1	0.72	0.71	0.79	0.68	1.34
Arsenic	<0.001	<0.001	<0.001	<0.001	0.05	0.003	0.008	0.004	<0.001	<0.001	<0.001	0.002
Chromium	<0.001	<0.001	0.004	<0.001	0.05	0.001	0.018	0.004	0.009	0.008	0.012	0.002
Copper	0.002	0.002	0.007	0.008	0.039	0.003	0.024	0.124	0.01	0.066	0.015	0.02
Lead	<0.001	<0.001	0.001	<0.001	0.085	0.001	0.028	0.004	0.009	0.006	0.005	0.004
Manganese	0.025	0.009	0.026	0.296	0.684	1.52	0.938	0.417	0.057	0.068	0.094	4.19
Molybdenum	0.004	0.003	0.002	0.003	0.003	<0.001	0.029	0.003	0.004	0.002	0.008	<0.001
Nickel	0.008	0.005	0.02	0.003	0.03	0.011	0.024	0.221	0.008	0.126	0.016	0.208
Selenium	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Silver	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zinc	<0.005	2.13	5.97	0.152	0.364	0.029	0.644	1.02	0.742	4.64	0.314	1.26
Boron	0.08	<0.05	<0.05	0.06	0.08	0.1	0.06	0.05	<0.05	<0.05	<0.05	0.12
Iron	0.33	0.13	0.5	0.08	375	15.2	23.3	6.21	1.02	1.26	1.29	2.54

2.4 WILLPINJONG CREEK ALLUVIUM DELINEATION

Investigative drilling was undertaken within alluvium associated with the Wilpinjong Creek in order to gain an understanding of the geometry of the alluvium and the contact with the underlying Permian Strata. Drilling using rotary auger method was undertaken by Macquarie Drilling. A single transect in which six shallow holes were drilled. Figure 3 shows a photograph taken during drilling providing some scale.

The topography along the investigative transect is that of a narrow floodplain associated with Wilpinjong Creek. There is sharp topographical transition to the north into remnant Triassic sandstone typical along the course of the creek in this area (Figure7). To the south of Wilpinjong Creek there is a relatively rapid transition from alluvium to weathered Permian and colluvium slopes on gently rising ground.

The locations of the investigative holes are shown in **Figure 2**. Drillhole logs are provided in **Appendix A**.

Table 2.6: Alluvium Transect Drillhole Locations

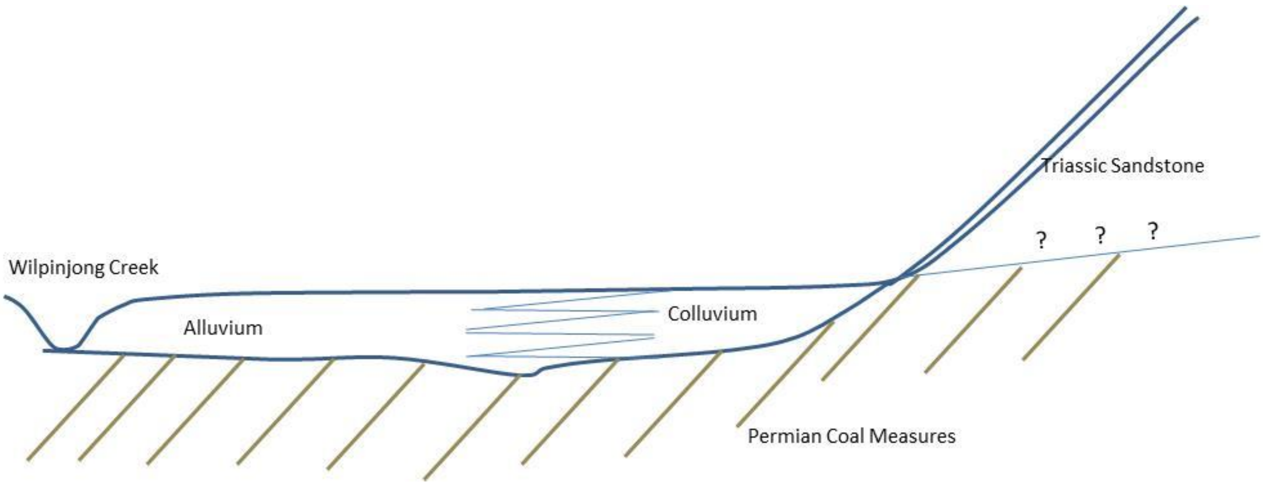
Transect Drillhole	Easting	Northing	Surface RL (m AHD)
WTr1	774345.5	6420760	350.8
WTr2	774322.9	6420787	351.4
WTr3	774294.6	6420804	350.2
WTr4	774282.4	6420815	352.8
WTr5	774438.6	6420671	351.4
WTr6	774466.8	6420639	353.4

Figure 8 shows interpreted schematic cross sections along the investigative transect based on the six investigation holes. Generally, alluvium depths were limited to 4 – 5m thickness overlying a weathered Permian surface.

The soil structure within the alluvium varied across the transect showing no definitive trend. Grain size varied from clays and silts to gravels with the variability consistent with a variable fluvial depositional environment and the inter-fingering of unconsolidated soils of alluvial and colluvial origins. The Permian coal measures are exposed within the base of Wilpinjong Creek providing a hard traversable base.

Figure 7: Photo showing Alluvial Transect Drilling

Figure 8: Schematic Alluvial Transect Cross Section



FIGURES

APPENDIX A
STANDPIPE PIEZOMETER AND ALLUVIAL TRANSECT BORE LOGS

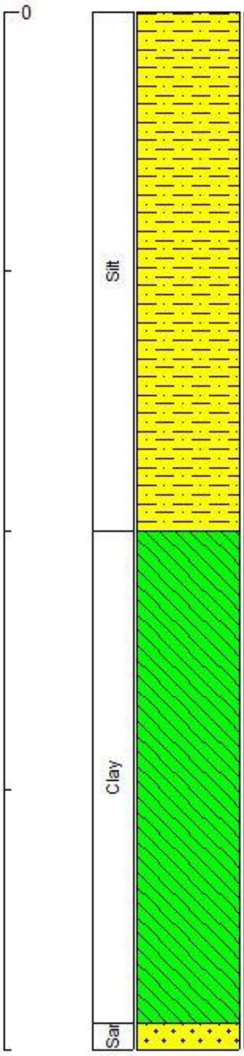
COMPOSITE WELL LOG

Well No: WTr1

Groundwater Exploration Services
1/156 Arden Street Coogee
NSW 2034
Australia

Client:	Wipinjong Coal			**Project:**	Alluvium Transect
Commenced:	21/11/2013	**Method:**	Auger	**Area:**	Wilpinjong Creek
Completed:	21/11/2013	**Fluid:**	N/A	**East:**	774345.5
Drilled:	Macquarie Drilling	**Bit Record:**	100mm	**North:**	6420759.9
Logged By:	A Fulton		100mm	**Collar (RL):**	350.6
Static Water Level:	N/A			**Date:**	N/A

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0	Silt		Silt: Light Brown Silty Clay. Minor fine sand.			
	Clay		Clay: Clay with minor fine sand			
	Sar		Sandstone: Weathered Sandstone			



Groundwater Exploration Services 1/156 Arden Street Coogee NSW 2034 Australia	**COMPOSITE WELL LOG**	**Well No:** WTr2

Client: Wipinjong Coal		**Project:** Alluvium Transect	
Commenced: 21/11/2013	**Method:** Auger		**Area:** Wilpinjong Creek
Completed: 21/11/2013	**Fluid:** N/A		**East:** 7743229.9
Drilled: Macquarie Drilling	**Bit Record:** 100mm		**North:** 6420786.6
Logged By: A Fulton	100mm		**Collar (RL):** 351.4
Static Water Level: N/A			**Date:** N/A

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0	Silty Clay		Silt: Light Brown Silty Clay. Minor fine sand.			
	Clay		Clay: Light brown clay with minor fine sand			
	Dark Brown Clay		Clay: Dark Brown Clay. Minor silt			
	Weathered sandstone		Sandstone: Light Grey Weathered sandstone	Dry		

COMPOSITE WELL LOG

Well No: WTr3

Groundwater Exploration Services
1/156 Arden Street Coogee
NSW 2034
Australia

Client: Wipinjong Coal		**Project:** Alluvium Transect	
Commenced: 21/11/2013	**Method:** Auger		**Area:** Wilpinjong Creek
Completed: 21/11/2013	**Fluid:** N/A		**East:** 774294.6
Drilled: Macquarie Drilling	**Bit Record:** 100mm		**North:** 6420803.5
Logged By: A Fulton	100mm		**Collar (RL):** 350.2
Static Water Level: N/A			**Date:** N/A

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0	Silty Clay		Silt: Light Brown Silty Clay. Minor fine sand.			
	Clay		Clay: Light brown clay with minor fine sand			
	Dark Brown Clay		Clay: Dark Brown Clay. Minor silt			
	Sandstone		Sandstone: Light Grey Weathered sandstone	Dry		

COMPOSITE WELL LOG

Well No: WTr4

Groundwater Exploration Services
1/156 Arden Street Coogee
NSW 2034
Australia

Client: Wipinjong Coal		**Project:** Alluvium Transect	
Commenced: 21/11/2013	**Method:** Auger	**Area:** Wilpinjong Creek	
Completed: 21/11/2013	**Fluid:** N/A	**East:** 774282.4	
Drilled: Macquarie Drilling	**Bit Record:** 100mm	**North:** 6420815.2	
Logged By: A Fulton	100mm	**Collar (RL):** 352.8	
Static Water Level: N/A		**Date:** N/A	

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0	Clayey Silt		Clayey Silt: Light Brown Silt Minor clay Minor fine sand.			
	Clay		Clay: Medium brown clay. Minor silt. Minor fine sand.			
	Sand		Sand: Fine to coarse sand. Minor gravel.			
	Clay		Clay: Light to medium brown clay. Common fine sand.			
	Clay		Clay: Medum to dark brown clay. Common sand.	Dry		
	Sandstone		Sandstone: Medium grey weathered sandstone			

COMPOSITE WELL LOG

Well No: WTr6

Groundwater Exploration Services
1/156 Arden Street Coogee
NSW 2034
Australia

Client: Wipinjong Coal | **Project:** Alluvium Transect

Commenced:	21/11/2013	**Method:**	Auger	**Area:**	Wilpinjong Creek
Completed:	21/11/2013	**Fluid:**	N/A	**East:**	774438.6
Drilled:	Macquarie Drilling	**Bit Record:**	100mm	**North:**	6420671.1
Logged By:	A Fulton		100mm	**Collar (RL):**	351.4

Static Water Level: N/A **Date:** N/A

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0	Clayey Silt		Clayey Silt: Light Brown Silt Minor clay Minor fine sand.			
	Sandstone		Sandstone: Medium grey weathered sandstone			

COMPOSITE WELL LOG

Well No: WTr6

Groundwater Exploration Services
1/156 Arden Street Coogee
NSW 2034
Australia

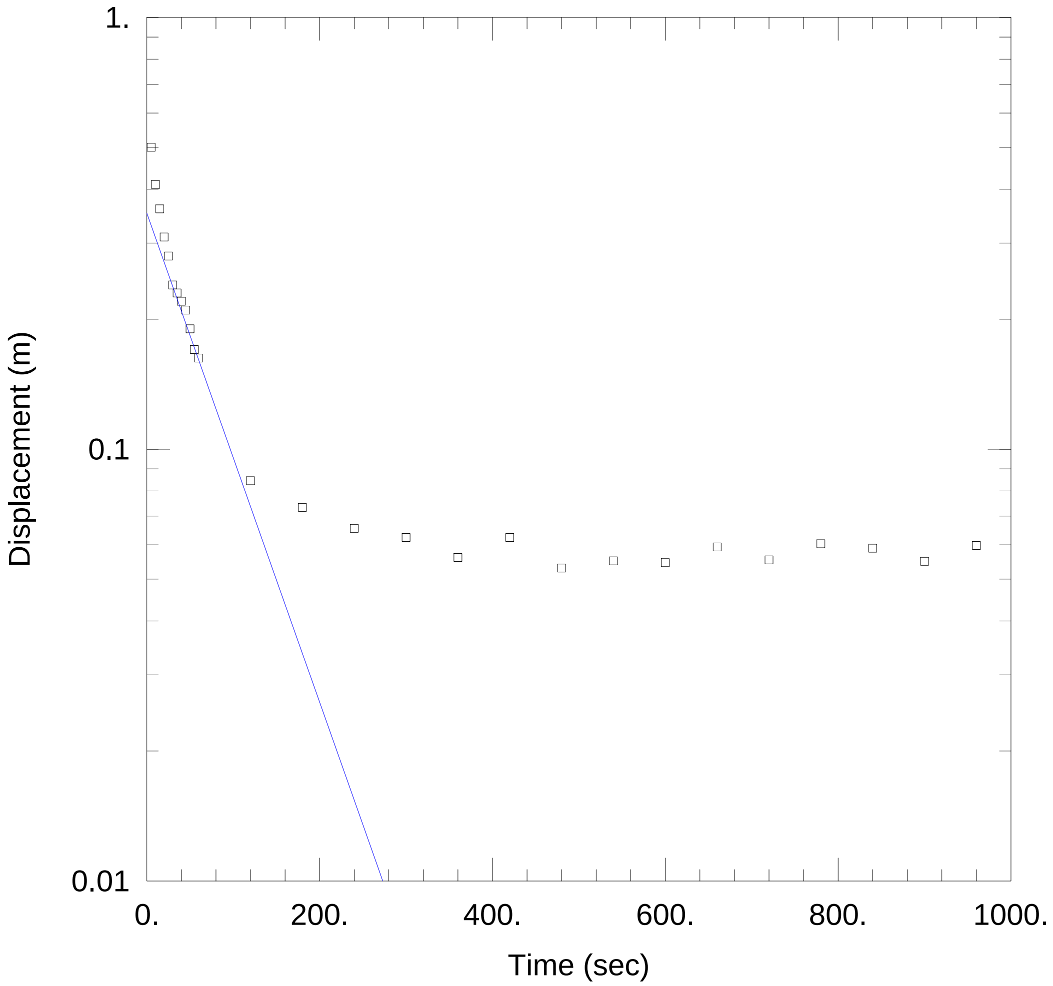
Client: Wipinjong Coal | **Project:** Alluvium Transect

Commenced:	21/11/2013	**Method:**	Auger	**Area:**	Wilpinjong Creek
Completed:	21/11/2013	**Fluid:**	N/A	**East:**	774466.8
Drilled:	Macquarie Drilling	**Bit Record:**	100mm	**North:**	6420638.8
Logged By:	A Fulton		100mm	**Collar (RL):**	353.4

Static Water Level: N/A **Date:** N/A

Depth (mbgl)	Geology	Graphic Log	Lithological Description	Field Notes	Well Completion Diagram	Well Completion Notes
0	Clayey Silt		Clayey Silt: Light Brown Silt Minor clay Minor fine sand.			
	Sandstone		Sandstone: Medium grey weathered sandstone			

APPENDIX B
SLUG TEST RESULTS



WELL TEST ANALYSIS

Data Set: C:\Andy\Jobs\Wilpinjong\Hydraulic Tseting\GWa22.aqt
Date: 03/24/14 Time: 12:03:48

PROJECT INFORMATION

Company: Wilpinjong Coal
Client: Wilpinjong Coal
Location: Wilpinjong
Test Well: GWa22
Test Date: 20/11/2013

AQUIFER DATA

Saturated Thickness: 20. m Anisotropy Ratio (Kz/Kr): 1.

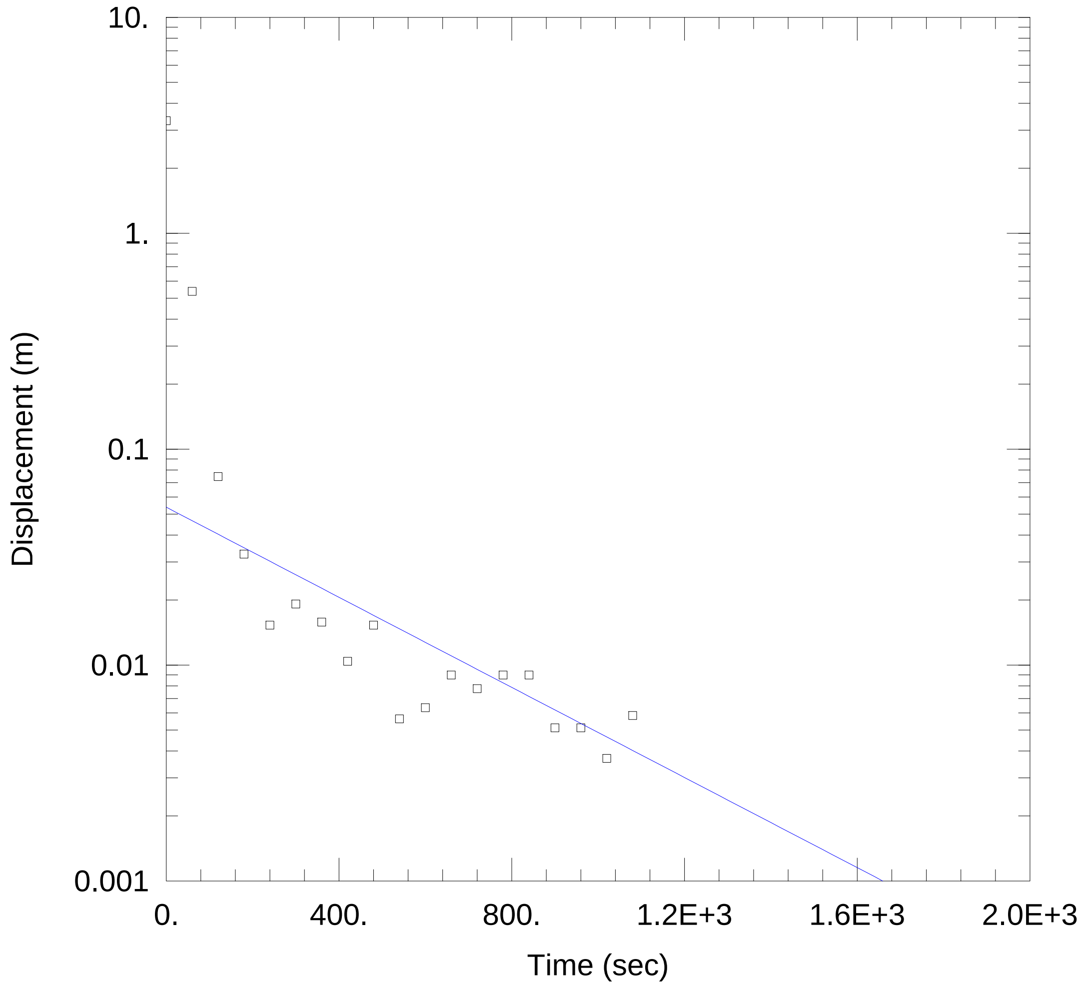
WELL DATA (New Well)

Initial Displacement: 21.7 m Static Water Column Height: 20. m
Total Well Penetration Depth: 24. m Screen Length: 3. m
Casing Radius: 0.025 m Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.5139 m/day y0 = 0.3518 m



WELL TEST ANALYSIS

Data Set: C:\Andy\Jobs\Wilpinjong\Hydraulic Tseting\GWc17.aqt
Date: 03/24/14 Time: 10:46:51

PROJECT INFORMATION

Company: Wilpinjong Coal
Client: Wilpinjong Coal
Location: Wilpinjong
Test Well: GWc17
Test Date: 20/11/2013

AQUIFER DATA

Saturated Thickness: 10. m Anisotropy Ratio (Kz/Kr): 1.

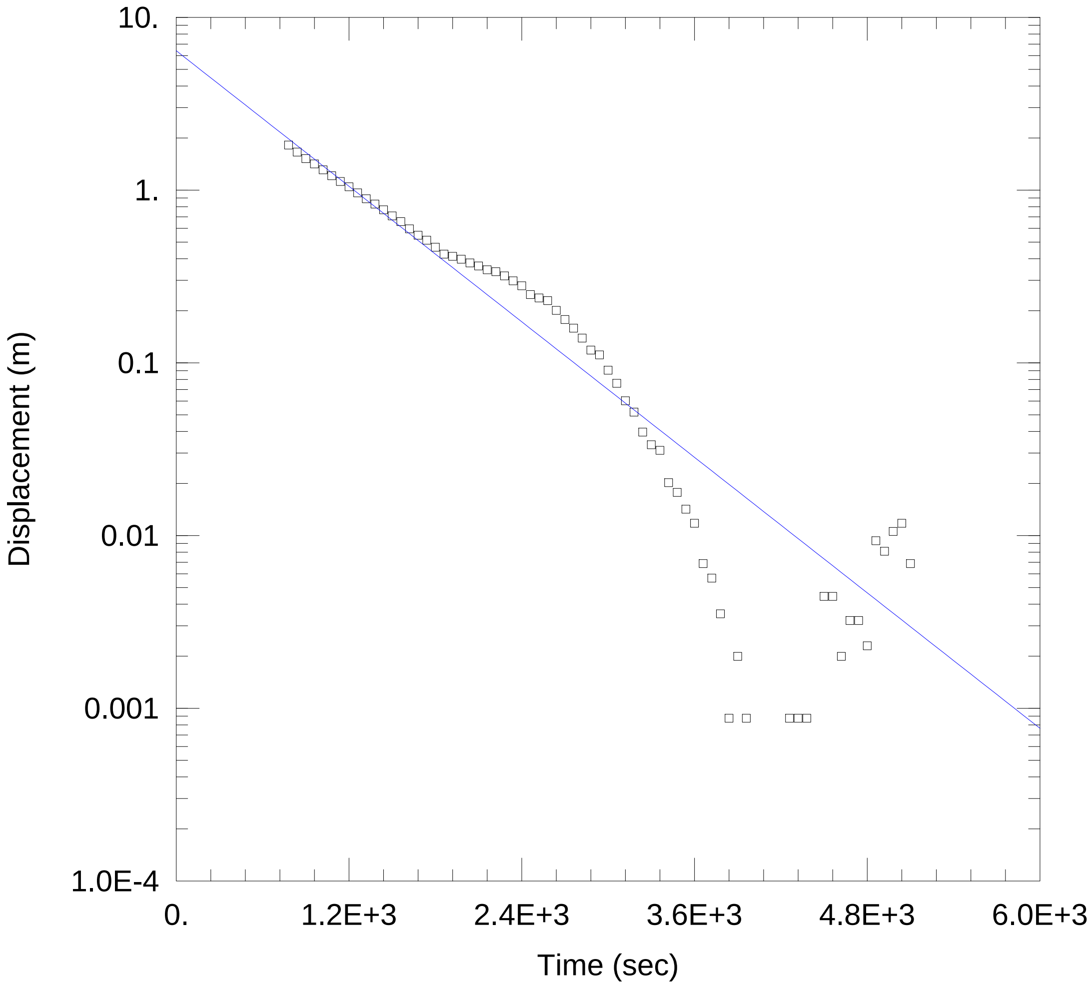
WELL DATA (GWc17)

Initial Displacement: 21.7 m
Total Well Penetration Depth: 24. m
Casing Radius: 0.025 m
Static Water Column Height: 20. m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.1034 m/day
y0 = 0.05385 m



WELL TEST ANALYSIS

Data Set: C:\Andy\Jobs\Wilpinjong\Hydraulic Tseting\GWc22.aqt
Date: 03/24/14 Time: 11:53:35

PROJECT INFORMATION

Company: Wilpinjong Coal
Client: Wilpinjong Coal
Location: Wilpinjong
Test Well: GWc22
Test Date: 20/11/2013

AQUIFER DATA

Saturated Thickness: 20. m Anisotropy Ratio (Kz/Kr): 1.

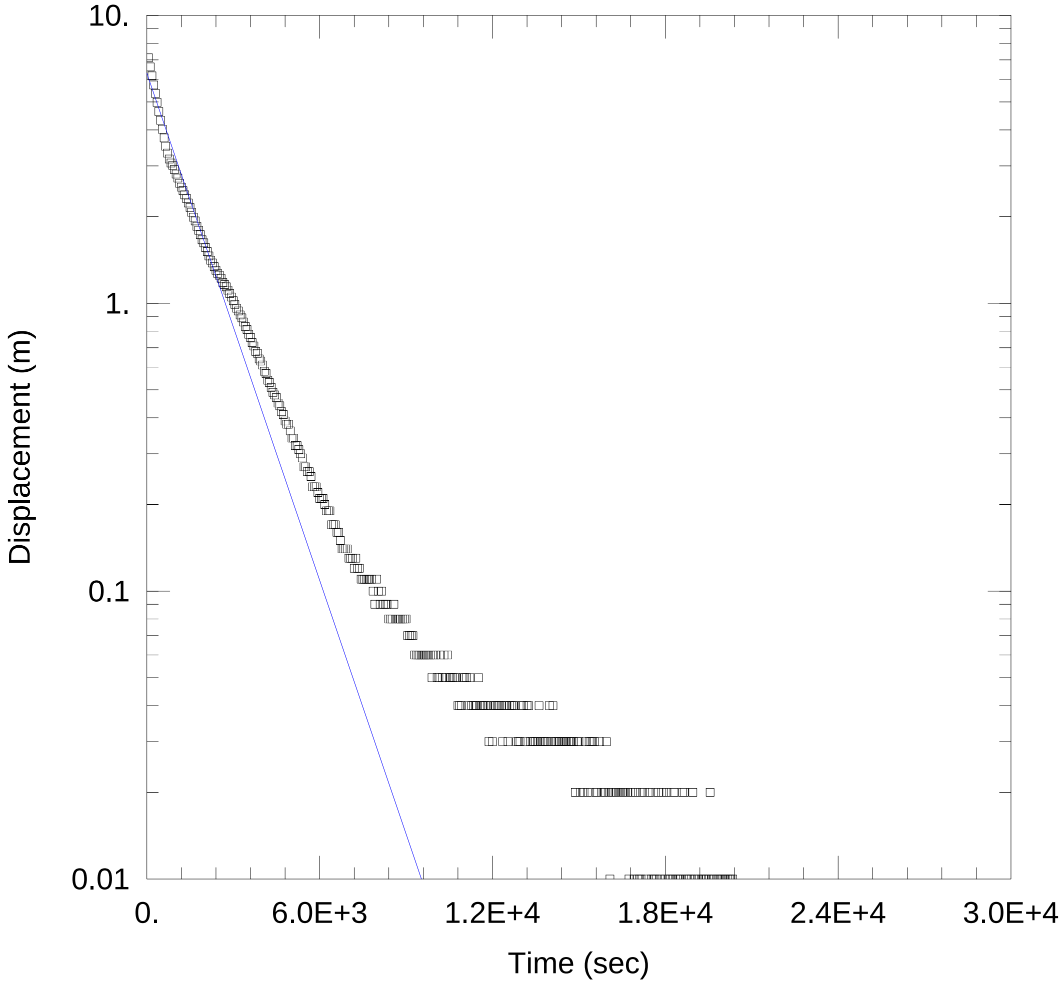
WELL DATA (New Well)

Initial Displacement: 21.7 m Static Water Column Height: 20. m
Total Well Penetration Depth: 24. m Screen Length: 3. m
Casing Radius: 0.025 m Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.06477 m/day y0 = 6.405 m



WELL TEST ANALYSIS

Data Set: C:\Andy\Jobs\Wilpinjong\Hydraulic Tseting\GWc24.aqt
Date: 03/24/14 Time: 11:48:26

PROJECT INFORMATION

Company: Wilpinjong Coal
Client: Wilpinjong Coal
Location: Wilpinjong
Test Well: GWc24
Test Date: 20/11/2013

AQUIFER DATA

Saturated Thickness: 20. m Anisotropy Ratio (Kz/Kr): 1.

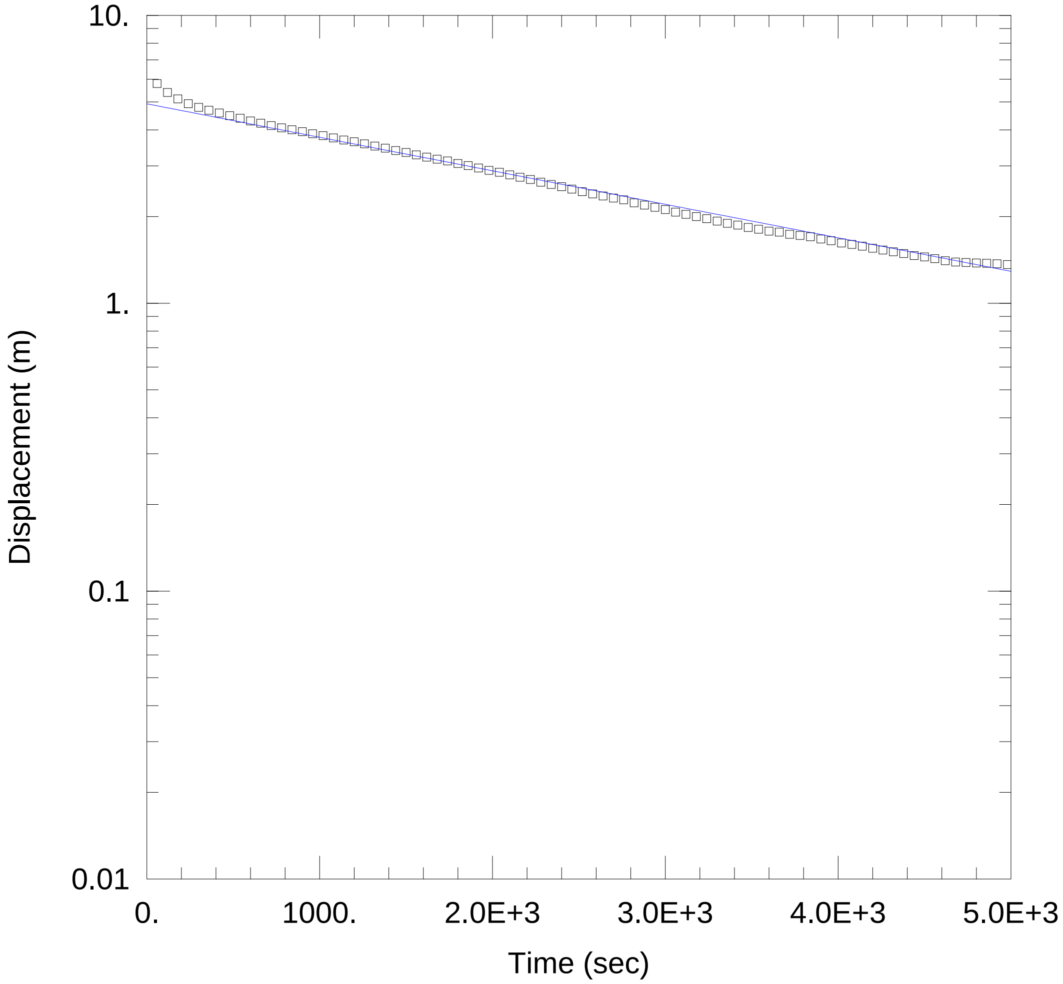
WELL DATA (New Well)

Initial Displacement: 21.7 m Static Water Column Height: 20. m
Total Well Penetration Depth: 24. m Screen Length: 3. m
Casing Radius: 0.025 m Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.02908 m/day y0 = 6.294 m



WELL TEST ANALYSIS

Data Set: C:\Andy\Jobs\Wilpinjong\Hydraulic Tseting\GWc25.aqt
Date: 03/24/14 Time: 11:57:21

PROJECT INFORMATION

Company: Wilpinjong Coal
Client: Wilpinjong Coal
Location: Wilpinjong
Test Well: GWc25
Test Date: 20/11/2013

AQUIFER DATA

Saturated Thickness: 20. m Anisotropy Ratio (Kz/Kr): 1.

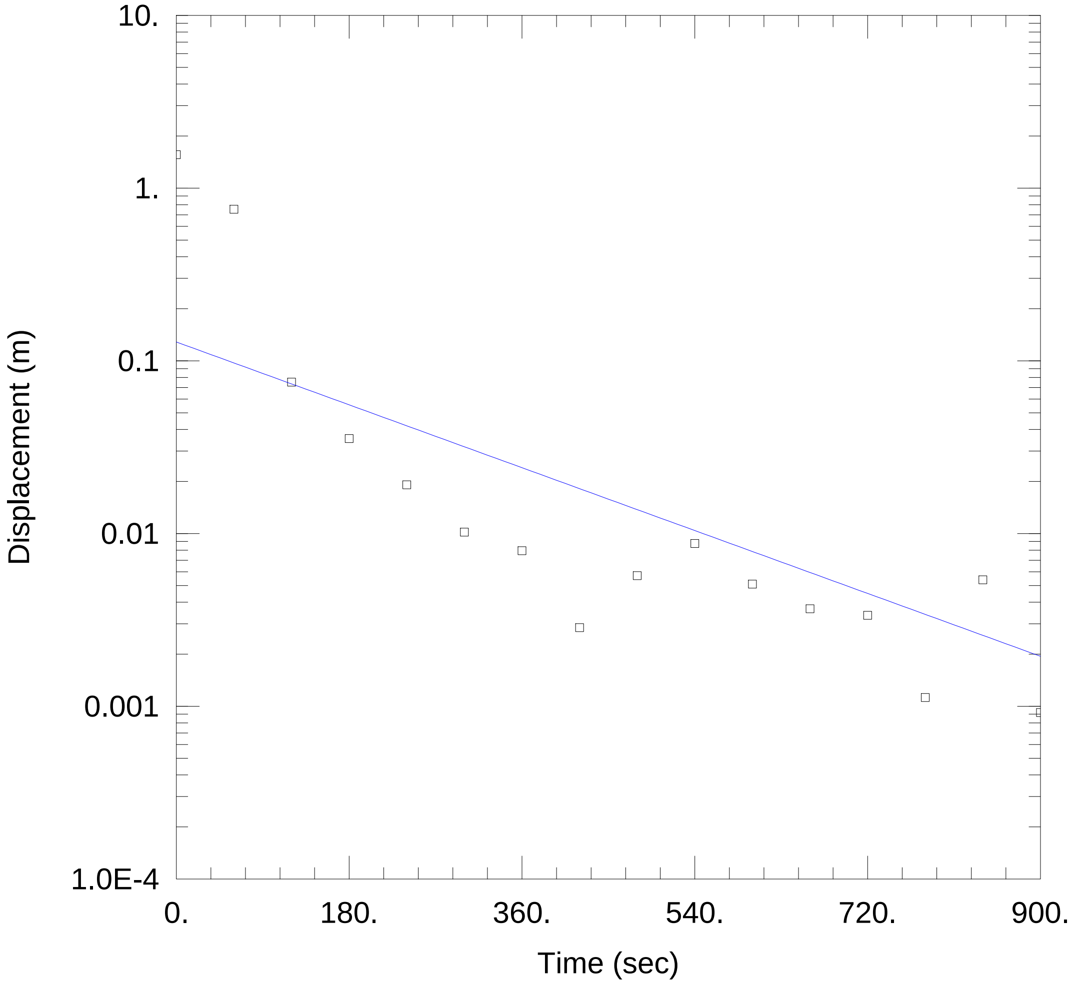
WELL DATA (New Well)

Initial Displacement: 21.7 m
Total Well Penetration Depth: 24. m
Casing Radius: 0.025 m
Static Water Column Height: 20. m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.01152 m/day
y0 = 4.927 m



WELL TEST ANALYSIS

Data Set: C:\Andy\Jobs\Wilpinjong\Hydraulic Tseting\GWc26.aqt
Date: 03/24/14 Time: 10:50:05

PROJECT INFORMATION

Company: Wilpinjong Coal
Client: Wilpinjong Coal
Location: Wilpinjong
Test Well: GWc26
Test Date: 20/11/2013

AQUIFER DATA

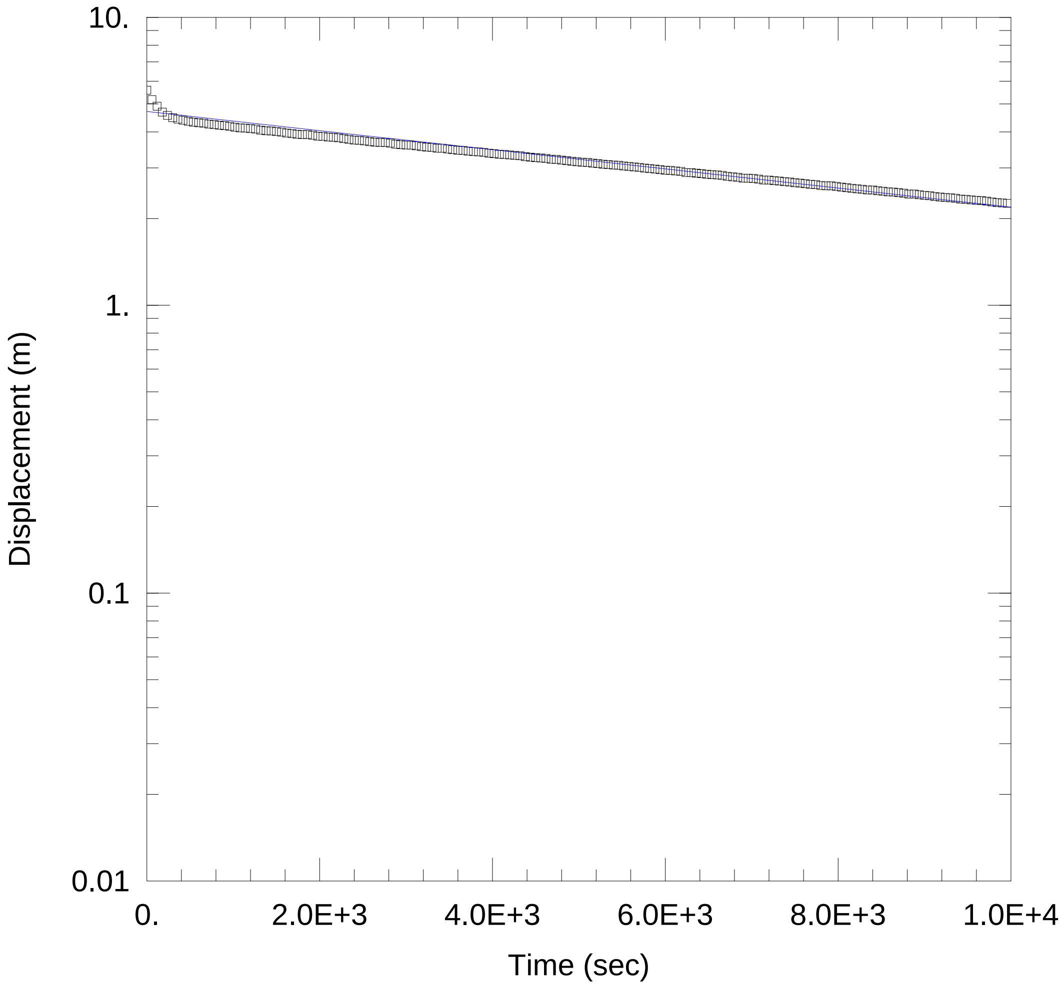
Saturated Thickness: 10. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

Initial Displacement: 21.7 m
Total Well Penetration Depth: 24. m
Casing Radius: 0.025 m
Static Water Column Height: 20. m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev
K = 0.2003 m/day y0 = 0.1284 m



WELL TEST ANALYSIS

Data Set: C:\Andy\Jobs\Wilpinjong\Hydraulic Tseting\GWc27.aqt
Date: 03/24/14 Time: 12:27:13

PROJECT INFORMATION

Company: Wilpinjong Coal
Client: Wilpinjong Coal
Location: Wilpinjong
Test Well: GWc27
Test Date: 20/11/2013

AQUIFER DATA

Saturated Thickness: 20. m Anisotropy Ratio (Kz/Kr): 1.

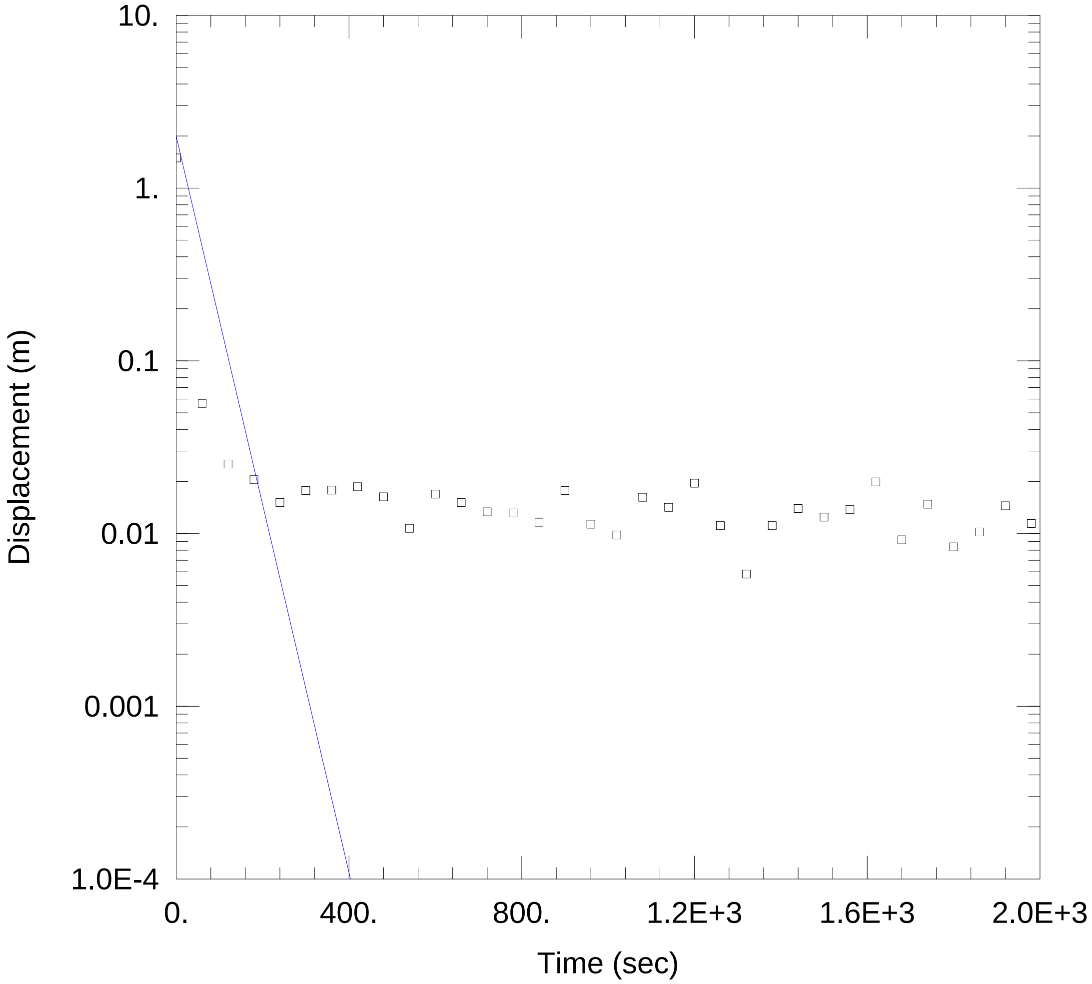
WELL DATA (New Well)

Initial Displacement: 21.7 m Static Water Column Height: 20. m
Total Well Penetration Depth: 24. m Screen Length: 3. m
Casing Radius: 0.025 m Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined Solution Method: Hvorslev

K = 0.003294 m/day y0 = 4.711 m



WELL TEST ANALYSIS

Data Set: C:\Andy\Jobs\Wilpinjong\Hydraulic Tseting\GWc28.aqt
Date: 03/24/14 Time: 11:41:50

PROJECT INFORMATION

Company: Wilpinjong Coal
Client: Wilpinjong Coal
Location: Wilpinjong
Test Well: GWc28
Test Date: 20/11/2013

AQUIFER DATA

Saturated Thickness: 20. m
Anisotropy Ratio (Kz/Kr): 1.

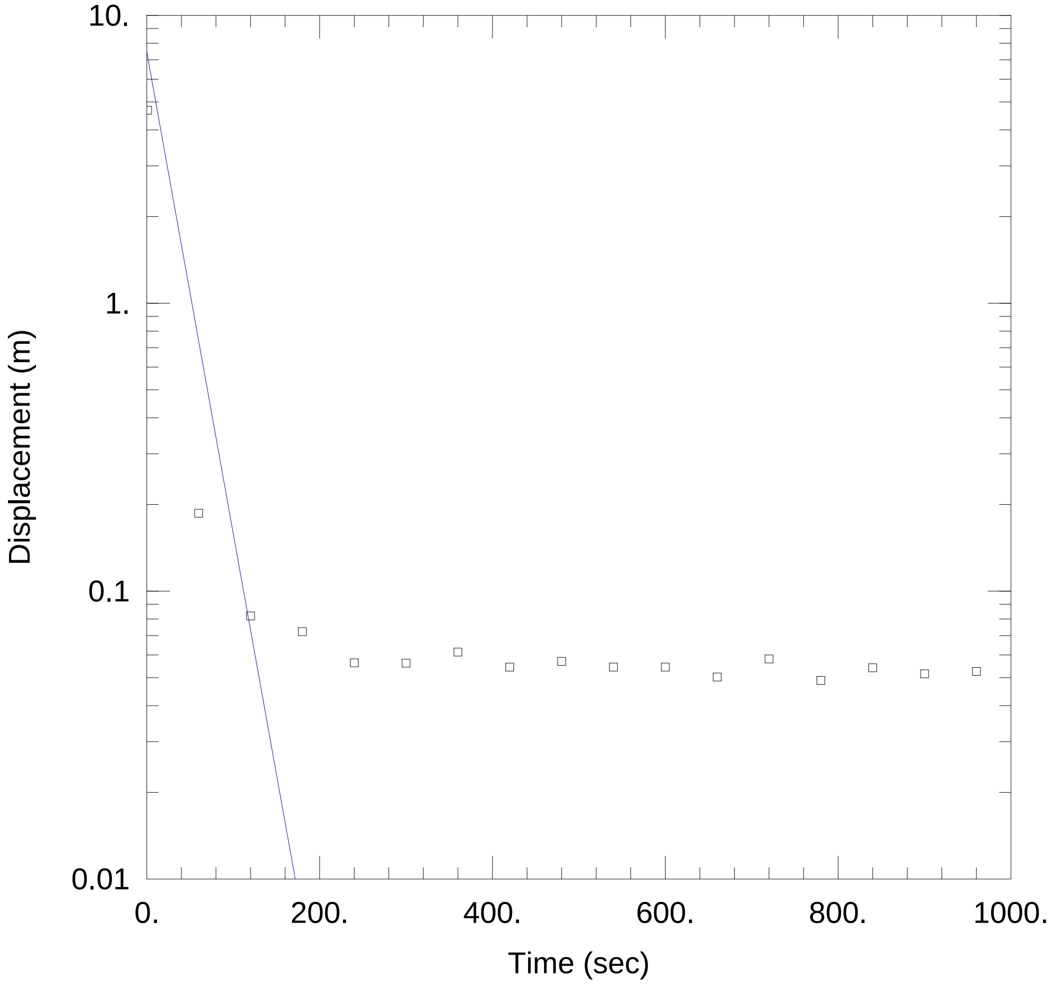
WELL DATA (New Well)

Initial Displacement: 21.7 m
Static Water Column Height: 20. m
Total Well Penetration Depth: 31. m
Screen Length: 10. m
Casing Radius: 0.025 m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Hvorslev

K = 0.3962 m/day
y0 = 1.991 m



WELL TEST ANALYSIS

Data Set: C:\Andy\Jobs\Wilpinjong\Hydraulic Tseting\GWc29.aqt
Date: 03/24/14 Time: 11:01:04

PROJECT INFORMATION

Company: Wilpinjong Coal
Client: Wilpinjong Coal
Location: Wilpinjong
Test Well: GWc29
Test Date: 20/11/2013

AQUIFER DATA

Saturated Thickness: 20. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (New Well)

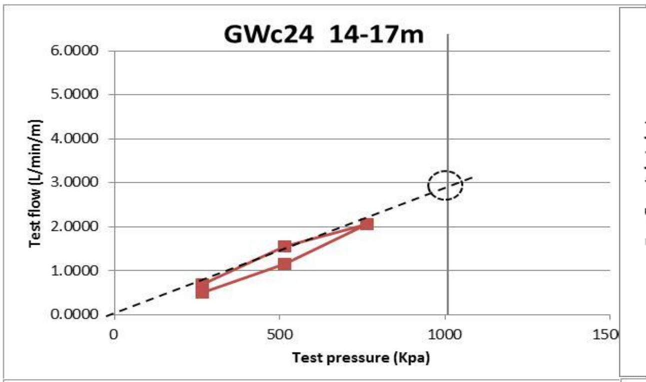
Initial Displacement: 21.7 m Static Water Column Height: 20. m
Total Well Penetration Depth: 31. m Screen Length: 10. m
Casing Radius: 0.025 m Well Radius: 0.05 m

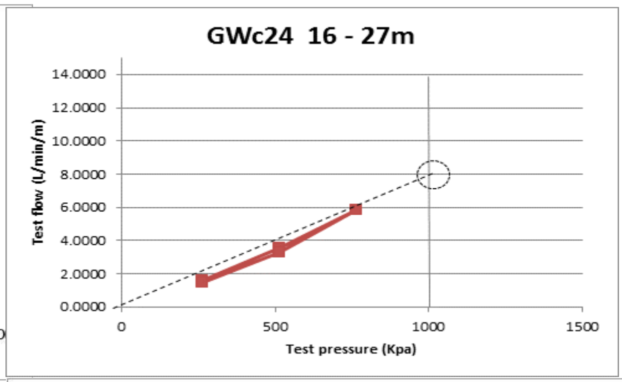
SOLUTION

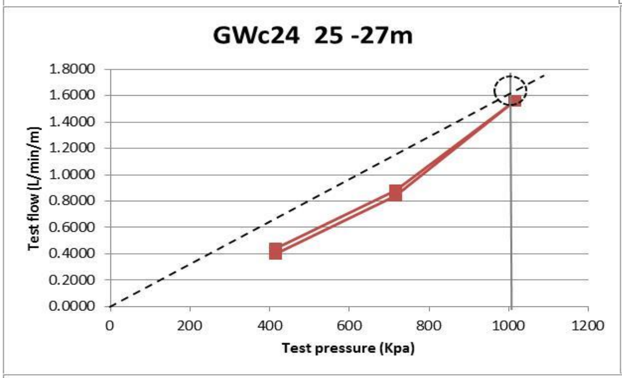
Aquifer Model: Confined Solution Method: Hvorslev

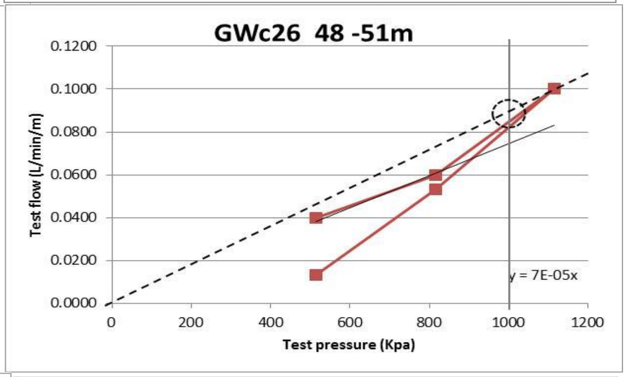
K = 0.6217 m/day y0 = 7.438 m

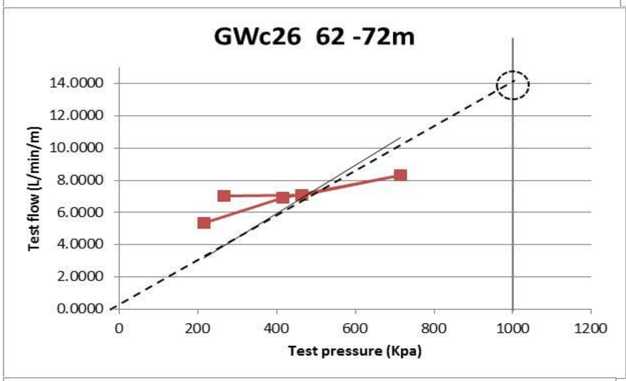
APPENDIX C
PACKER HYDRAULIC TEST RESULTS

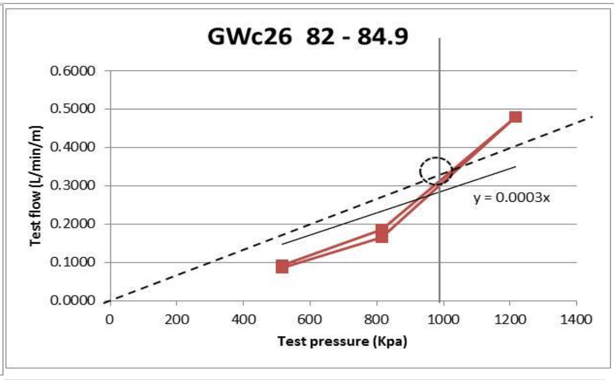

GWc24 14-17m
Test flow (L/min/m)
Test pressure (Kpa)

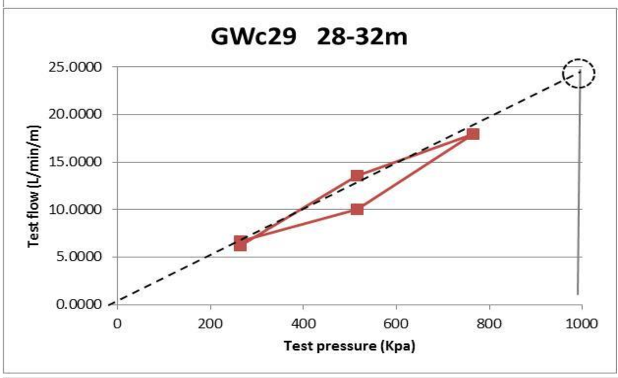

GWc24 16 - 27m
Test flow (L/min/m)
Test pressure (Kpa)

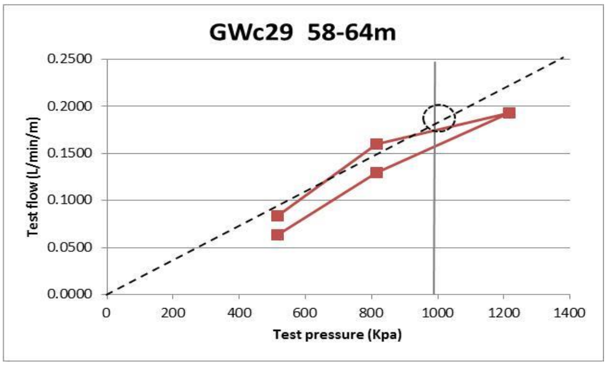

GWc24 25 -27m
Test flow (L/min/m)
Test pressure (Kpa)

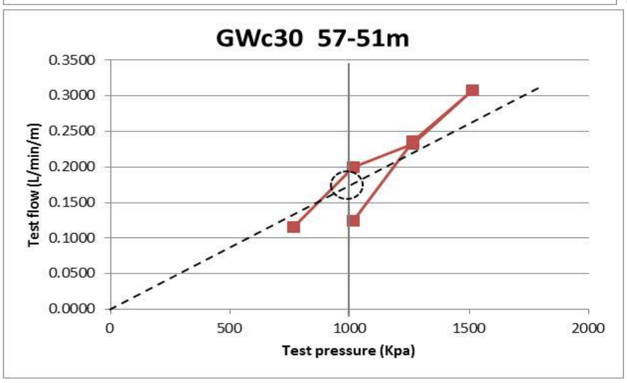

GWc26 48 -51m
Test flow (L/min/m)
y = 7E-05x
Test pressure (Kpa)


GWc26 62 -72m
Test flow (L/min/m)
Test pressure (Kpa)


GWc26 82 - 84.9
Test flow (L/min/m)
y = 0.0003x
Test pressure (Kpa)


GWc29 28-32m
Test flow (L/min/m)
Test pressure (Kpa)


GWc29 58-64m
Test flow (L/min/m)
Test pressure (Kpa)


GWc30 57-51m
Test flow (L/min/m)
Test pressure (Kpa)