APPENDIX E: HYDRAULIC TESTING RESULTS

1. Hydraulic Testing

Hydraulic testing, involving slug tests, packer tests and constant rate pumping tests, was conducted in support of numerous previous investigations, which include the following:

- Environmental Impact Statement (EIS) (HLA Envirosciences, 2001);
- Bowmans Creek Diversion Environmental Assessment (EA) (Evans & Peck, 2009);
- Subsidence Management Plan (SMP);
- Bowmans Creek alluvium studies; and
- South East Open Cut (SEOC) EA.

Within the Ashton Coal Project (ACP) area, test pumping indicates hydraulic conductivity values for the PG coal seam in the range 0.01 to 10m/d (PDA, 2006; Aquaterra, 2008a), with the high end of the range considered to be representative of conditions near where the seam outcrops. Testing of the Pikes Gully (PG) Seam at depth in bores WML20 and WML21 indicated hydraulic conductivity values of 0.015 to 0.02m/d (PDA, 2006), which are considered to be representative of coal seam hydraulic conductivity well removed from the outcrop.

The results of packer testing and analysis for hydraulic conductivity over seventeen intervals within the Permian coal measures at WMLC213, located southwest of the Mine area, showed the following (SCT, 2008):

- Most hydraulic conductivity results were in the order of 10^{-9}m/s (10^{-4}m/d);
- Some test results in the depth range 50m to 100m, where there was very little fracturing, indicated hydraulic conductivity less than 10^{-11}m/s ($<10^{-6}$m/d); and
- Some hydraulic conductivities in the shallow, upper sections of the Permian were in the order of 10^{-8} to 10^{-7}m/s (10^{-3} to 10^{-2}m/d).

Hydraulic testing of standpipe piezometers completed in the upper parts of the Permian coal measures (generally free of coal seams) revealed hydraulic conductivities in the range 0.01 to 3.3m/d with a median value of 0.1m/d (Aquaterra, 2008b). In most cases, the tested sections were within the weathered zone, which has properties more akin to alluvium or colluvium than fractured rock.

Hydraulic testing of the Bowmans Creek alluvium (Aquaterra, 2008b) revealed a high variability in hydraulic conductivity, with values in the range 0.0002 to 15m/d, and a median value of 0.7m/d.

Alluvium associated with the Hunter River was tested at RA27 near the southern end of the ACP underground mine area, revealing a hydraulic conductivity of 50m/d (Aquaterra, 2006b). This is consistent with the results of extensive testing at the Hunter Valley No.1 Mine, where an average hydraulic conductivity of about 45m/day was established (HLA Envirosciences, 2001).

Testing was undertaken as a part of the 2009 EA for the proposed SEOC, which showed a large variation in the hydraulic properties in the alluvium and colluvium around Glennies Creek (Aquaterra, 2009a). Values ranged from less than 0.1m/d to over 100m/d. However, particularly high values were found to be very localised and unrepresentative of the alluvium as a whole and the geometric mean was found to be much lower, at only 0.6m/d. The values at the higher end of the range reflect the presence of localised lenses of cleaner coarse gravels, while the very low values are typical of the predominant clay-silt matrix which hosts the gravels over most of the Glennies Creek floodplain area.

A summary of representative aquifer properties of the hydrogeological units in the study area is provided in **Table E1**. This table lists the ranges and mean values of hydraulic conductivity obtained from analysis of the hydraulic test data collected from previous and current investigations for the principal hydrogeological units. The values of storativity and specific yield contained in the table have been estimated based on experience of the nature of the rock in this area (Aquaterra, 2009b).

Table E1 Representative Aquifer Parameters for Main Hydrogeological Units

Aquifer Units	Horizontal Hydraulic Conductivity (m/d)		Confined Storativity	Unconfined Storativity (Specific Yield)
	Tested Range	Median		
Bowmans Creek alluvium	0.0002 - 15	0.7	0.0001	0.05
Glennies Creek alluvium	0.07 to 180	0.6*	0.0001	0.05
Floodplain alluvium of the Hunter River	50	50	0.0001	0.1
PG Coal Seam	0.01 - 10**	0.04	0.0001	0.005
ULD Coal Seam	0.002 - 0.03	0.016	0.0005	0.001
Other coal seams	0.002 - 0.03	n/a	0.0001	0.005
Interburden/overburden above PG Seam	<0.000001 - 0.008	0.0003	0.00001	0.005

Notes:

* This value is the calculated geometric mean. High values for Glennies Creek alluvium relate to specific areas under specific depositional environments. This variability has been appropriately allowed for in the groundwater modelling and assessment.

**The value of 10m/d (1×10^{-4} m/s) determined at WML120A is much higher than all other test results for the PG Seam, and is atypical for coal seams in the Hunter Valley. Bore WML120A is located close to the outcrop, up-dip from the underground mine, and the result is believed to be more indicative of weathered PG close to the outcrop, rather than the coal seam at depth below the base of weathering.

The aquifer parameters in **Table E1** have been used in the groundwater modelling described in **Appendix C**. The following inferences have been made regarding the hydraulic nature of the hydrogeological units based on the hydraulic testing, field observations and experience of the coal measures in this area:

- The PG Seam appears to have a higher hydraulic conductivity (at least near the outcrop/subcrop) than the deeper coal seams, probably resultant from greater cleating of the coal and more open fractures due to the lower overburden pressures. The range of hydraulic conductivity for the ULD Seam is typically an order of magnitude lower than the range recorded for the PG Seam.
- The overburden above the PG Seam contains multiple coal seams (the Bayswater and Lemington Seams) and lower overburden compression. Hence it has a higher bulk rock-mass hydraulic conductivity than the interburden beneath the PG Seam, particularly in terms of horizontal hydraulic conductivity.
- The coal measures are highly laminar sedimentary rocks. The majority of the hydraulic conductivity is therefore parallel to bedding (caused by fracturing and shear along the bedding planes). It is therefore considered that vertical hydraulic conductivity in the undisturbed rock mass is at least two orders of magnitude less than the measured, mainly

horizontal, hydraulic conductivity.

- There is only limited hydraulic connection between alluvial deposits and shallow weathered Permian sediments. This is evidenced by distinctly different groundwater levels, differences in groundwater quality, and differing responses to recharge or mining activity. It is considered that this is due to the low vertical hydraulic conductivity of the upper Permian layers and the presence of low hydraulic conductivity clays at the bottom of the alluvium that tend to block any vertical fractures that may be present within the Permian strata.

References

Aquaterra, 2008a. ‘Ashton Coal: End of Panel 1 Groundwater Report’ Monitoring Report submitted to ACOL.

Aquaterra, 2008b. ‘Ashton Underground Mine Pikes Gully Seam Groundwater Modelling Report’ Report submitted to ACOL in support of the Longwall/Miniwall 5-9 SMP Application.

Aquaterra, 2009a. ‘Ashton South East Open Cut Project: Hydrogeological Impact Assessment’ Report submitted to ACOL in support of the SEOC EA.

Aquaterra, 2009b. ‘Bowmans Creek Diversion: Groundwater Impact Assessment Report’. Report submitted to ACOL in support of the Bowmans Creek Diversion EA.

Evans & Peck Pty Ltd, 2009. ‘Bowmans Creek Diversion Environmental Assessment’.

HLA Envirosciences, 2001. ‘Ashton Coal Project: Groundwater Hydrology and Impact Assessment’. Appendix H Report Submitted in Support of the 2002 Ashton Coal Project EIS.

Peter Dundon and Associates Pty Ltd (PDA), 2006. ‘Ashton Coal Mine Longwall Panels 1-4 Subsidence Management Plan; Groundwater Assessment’ Report provided to ACOL.

SCT Operations Pty Ltd (SCT), 2008. ‘ACARP Project C13013: Aquifer Inflow Prediction above Longwall Panels’. Report to the Australian Coal Association Program September 2008.