Water and Environment

ASHTON COAL: END OF PANEL 2 GROUNDWATER REPORT

Prepared for	Ashton Coal Operations Limited
Date of Issue	18 May 2009
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EXECUTIVE SUMMARY

The Ashton Coal Project, located 14km west of Singleton in the Hunter Valley region, consists of both open cut and underground mining operations to access a series of coal seams within the Permian Foybrook Formation.

The underground mine is located south of the New England Highway. Development mining for the first longwall panel in the Pikes Gully Seam (LW1) commenced in July 2006. Mining of Longwall Panels 1 and 2 (LW1 and LW2) was completed on October 2007 (mining year 4) and July 2008 (mining year 5) respectively. Mining is currently proceeding in LW4 in the Pikes Gully Seam.

Prior to commencement of mining, baseline studies were initiated as part of the Environmental Impact Statement (EIS) process so that the potential impacts could be predicted and to establish pre mining conditions against which future actual impacts could be compared. A number of piezometers were installed in 2000, and additional piezometers have been installed in subsequent programs, which have been monitored to obtain base line data. Both standpipe piezometers and multi-level vibrating wire piezometers have been installed and monitored.

Throughout the mining of each longwall panel, ongoing monitoring of groundwater levels and salinity, along with subsidence surveys, groundwater flows into the mine, and seepage losses from the Glennies Creek alluvium have been carried out on a regular basis.

This end of panel review report for LW2 has been prepared after consideration of all available monitoring data. Actual impacts derived from the analysis of this data are compared to the impacts predicted in both the EIS studies and studies carried out in support of the LW1-4 SMP Application.

All groundwater related impacts from underground mining up to the completion of LW2 were at or below the levels predicted in both the EIS and the SMP groundwater assessments for this stage of mining.

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1 INTRODUCTION

The Ashton Coal Project, located 14km west of Singleton in the Hunter Valley region (**Figure 1**), consists of both open cut and underground mining operations to access a series of coal seams within the Permian Foybrook Formation.

The open cut mine, which is located north of the New England Highway, commenced operations in 2003. Coal is recovered from several seams of varying thickness, in two open cuts – the smaller Arties Pit and the larger Barrett Pit.

The underground mine is located south of New England Highway, and is accessed from the northern side of the highway via a portal in the Arties pit. The initial mine plan comprised eight longwall panels (LWs 1 to 8), four of which have been approved for mining of the Pikes Gully seam (LWs 1 to 4) under an SMP Application lodged and approved in 2006. The first four longwall panels, including LW2, were designed to mine final voids 215m wide, separated by chain pillars of 25m width rib to rib, with cut-throughs at 100m centres. The layout of LWs 1 to 4, together with the progress of mining to date, is shown on **Figure 2**.

Underground mine development commenced in July 2006, and mining of the first longwall panel (LW1) began on 12 March 2007 and was completed on 15 October 2007. An end of panel report assessing impacts from LW1 was issued in October 2008 (Aquaterra, 2008a). Mining of the second longwall panel (LW2) began on 12 November 2007 and was completed on 21 July 2008. This report presents a review of groundwater impacts at the completion of LW2.

Mining is currently proceeding in LW4 in the Pikes Gully Seam, and it is proposed to continue mining the Pikes Gully Seam across the rest of the underground mine area, and then subsequently mine the underlying Upper Liddell, Upper Lower Liddell and Lower Barrett Seams in a multi-seam longwall operation.

Prior to commencement of mining, baseline studies were initiated as part of the Environmental Impact Statement (EIS) process so that potential impacts could be predicted and actual impacts compared with pre-mining conditions. A number of piezometers were installed, and a baseline monitoring program initiated in July 2000, which included quarterly monitoring of groundwater levels in piezometers, and quarterly water quality sampling from piezometers and from the surface flows in Hunter River, Glennies Creek and Bowmans Creek. The pre-EIS investigations were reported in Appendix H of the EIS document (HLA, 2001).

Further studies were initiated as part of the SMP Application process for LWs 1 to 4. This included the installation of piezometers, hydraulic testing, and groundwater quality sampling. The new piezometers were added to the baseline monitoring network, and monitoring frequency was increased to monthly or fortnightly in some bores leading up to the commencement of underground mining.

Once mining advanced below the regional groundwater level in the underground mine, monitoring of groundwater inflows was initiated, as part of the ongoing groundwater monitoring program.

This end of panel review has been prepared after consideration of all available monitoring data, including:

- Groundwater inflows to the underground mine;
- Groundwater level records from 31 piezometers at 19 sites;
- Laboratory analysis results of water samples collected from piezometers and from underground seepages;
- Field data on water quality from underground seepages, surface water samples and selected bore water samples; and
- Survey data from seven transects across LW1 and the barrier between LW1 and Glennies Creek, and one new transect across LW2.

Access to tailgate TG1A was lost during extraction of LW1. Water inflows to TG1A are now contained and conveyed along TG1A to a collection point at 18CT, from where the water is piped through the goaf to the Longwall 1 backroad, which continues to be accessible (**Figure 2**). The discharge from this pipe is monitored separately from other underground inflows, to assess seepage losses from Glennies Creek alluvium into the mine.

All other groundwater inflows are collected at a number of sumps, the main sump being at the LW1 Backroad Sump Borehole (**Figure 2**), and another in the NW Mains. The discharge from the LW1 Backroad Pipe also flows to the LW1 Borehole Sump. Water pumped into the mine is monitored as well, to enable net groundwater inflows to be determined by water balance calculations.

Actual impacts derived from analysis of the monitoring data are compared to the impacts predicted in both the EIS studies (HLA, 2001) and the studies for the LW1-4 SMP Application (Peter Dundon and Associates, 2006).

2 SITE DESCRIPTION

2.1 LONGWALL 2

Mining of Longwall Panel 2 (LW2) was carried out between November 2007 and July 2008. Coal was recovered from the Pikes Gully Seam, which varies in thickness between 2.3m and 2.8m along LW2. The overburden thickness above the Pikes Gully Seam along LW2 ranges from 105m at the southern end to around 50m at the northern end, as a consequence of the west-south-westerly dip on the coal measures strata.

Glennies Creek is a permanent watercourse situated within an alluvial floodplain immediately east of the Ashton underground mine. It passes approximately 385 m east of LW2 goaf edge, at its closest point, about one third along the panel (**Figure 2**). Overburden depth at the goaf edge is around 90 m at the point closest to Glennies Creek. Glennies Creek is a regulated stream, and flow in the creek is largely maintained by controlled discharges from the Glennies Creek dam. The Pikes Gully Seam subcrops beneath the floodplain alluvium, and is believed to subcrop beneath or close to the stream bed itself along part of the section of Glennies Creek closest to LW1.

The surface topography above LW2 slopes gently to the west-south-west.

2.2 HYDROGEOLOGY

Two main aquifer systems occur within the Ashton underground mining area:

- A hard rock aquifer system in the Permian coal measures, in which groundwater flows predominantly along cleat fractures in the coal seams; and
- A porous-medium aquifer in unconsolidated alluvial sediments associated with Bowmans Creek, Glennies Creek or the Hunter River.

Groundwater flow in the Permian rocks is dominated by fracture flow, particularly in the coal seams. The hydraulic conductivity (permeability) of the coal seams is generally low, usually two or more orders of magnitude lower than the alluvium sediments, but higher seam permeabilities are found in some areas close to outcrop. The hydraulic conductivity of the coal seams declines gradually with greater depth of cover.

Hydraulic testing indicated that hydraulic conductivities in the order of 1 to 10 m/d may apply to parts of the Pikes Gully seam within the weathered zone close to outcrop, whereas typical values for the seam in the unweathered zone are in the order of 0.001 to 0.05 m/d. The results of hydraulic testing of bores in the zone between Glennies Creek and LW1 have confirmed that the higher permeabilities of the outcrop zone persist to less than 100m from outcrop (Aquaterra, 2008a).

The unconsolidated alluvial sediments comprise clay- and silt-bound sands and gravels, with occasional lenses or coarser horizons where sands and gravels have been concentrated. The alluvial aquifer associated with Glennies Creek has been found to be generally poorly permeable, with hydraulic conductivity values less than 1 m/d.

Baseline studies indicate that it is likely that there is some degree of hydraulic connection between the Glennies Creek alluvium and the Pikes Gully seam aquifer.

2.3 GROUNDWATER QUALITY

The groundwater in the coal measures aquifer system is saline. Typical salinities range up to more than 8,000 µS/cm EC (electrical conductivity), or more than 6,000 mg/L TDS (total dissolved solids).

Salinity of the alluvium groundwater varies, but it is generally less saline than the coal measures. Measured salinities in the alluvium range up to more than 6000 µS/cm EC, with values greater than 2000 µS/cm possibly due to upward leakage of the more saline Permian groundwater into the alluvium.

Groundwater in both the Permian and the alluvium is more saline than the typical surface flow in Glennies Creek and Bowmans Creek.

2.4 GROUNDWATER LEVELS

Groundwater levels in the Permian coal measures may have been influenced to some extent by historical mining in the area, but it is believed that prior to commencement of mining at Ashton, the groundwater levels in the Permian were higher than in both the alluvium and in the streams. The higher groundwater heads in the Permian meant that under natural conditions, groundwater discharged from the Permian to the alluvium and to the surface streams. This is reflected in relatively higher salinities in the alluvium in some places, and also in the stream flow during periods of low rainfall and runoff.

At multi-level piezometer sites, groundwater levels are commonly higher in the deeper piezometers in the Permian than in the shallow alluvium and the near-surface parts of the Permian sequence, unless affected by mining activity. In some cases, Permian groundwater heads are above the ground surface (ie artesian). Typically, there is an upward hydraulic gradient with depth below surface under natural conditions.

In places where drawdown impacts from mining have lowered groundwater levels in the Permian, the hydraulic gradients may have been reversed, such that there is potential for water to flow from the alluvium directly into the underlying Permian.

3 SURVEY MONITORING

Survey lines (XL1 to XL7) established across the LW1 tailgates and the slope between LW1 and Glennies Creek were surveyed at 2 to 4 day intervals while LW1 was advancing past the zone where Glennies Creek is closest to the mine, and monitoring then continued weekly after the longwall face passed each survey line.

During extraction of LW2, each line from XL2 to XL5 was re-surveyed shortly after LW2 had passed the location of each line in turn. The plots of horizontal movement versus time have been updated to include the LW2 results, and are shown on Figure 3. XL1, XL6 and XL7 were not re-surveyed during LW2 extraction, and prior survey results for these three lines were presented in Aquaterra (2008a).

The survey results from XL2 to XL5 show no lateral movement exceeding 30 mm during the mining of LW2 (**Figure 3**).

The small lateral displacements detected by the survey are similar to those detected during LW1 extraction, and are virtually within the error band of measurement. The displacements would be consistent with minor peg movements due to disturbance by cattle or native fauna, and are too small to indicate any horizontal shearing caused by the longwall extraction.

In the absence of any shearing, the permeability of the barrier between LW1 and Glennies Creek can not have undergone any significant change, and therefore no increase in seepage losses from Glennies Creek alluvium is expected as a result of longwall mining.

4 GROUNDWATER LEVELS

4.1 MONITORING NETWORK

An extensive network of monitoring bores was installed to monitor the effects of underground mining. Locations are shown on **Figure 2**.

The monitoring network includes bores into all the main hydrogeological units (alluvium, Permian overburden, Pikes Gully Seam and deeper seams), and geographically distributed across the underground mining area. They include:

- Standpipe piezometers between LW1 and Glennies Creek, some screened in the Pikes Gully seam (WML119, WML120A, and WML181 to WML186), others in the Glennies Creek alluvium (WML120B and WML129).
- Multi-level vibrating wire piezometer bores
    - WML106 (south of start of LW1),
    - WML107 (south of start of LW2),
    - WML108 (south of start of LW3),
    - WML109 (6m inside start of LW4),
    - WML110 to WML113 (above southern ends of LW5 to MW9),
    - WML114 (above central part of LW5),
    - WML115 (above northern end of LW9),
    - WML144 (east of Glennies Creek),
    - WML189 and WML191 (above chain pillars between LW2 and LW3), and
    - WML213 (south-west corner of UG area, near confluence of Bowmans Ck and Hunter R).
- Deep standpipe piezometers WML20 and WML21 (screened in Pikes Gully Seam).
- Shallow standpipe piezometers WML107B to WML115B (located adjacent to vibrating wire piezometers WML107 to WML115, and screened in the uppermost part of the Permian coal, measures).
- Shallow piezometers WML110C, WML111C, WML112C, WML113C and WML115C (adjacent to vibrating wire piezometers WML110 to WML115, and screened in alluvium).
- Shallow standpipe piezometers WML180, RA27 and WML180 (south of LW4, LW5 and MW9 respectively, adjacent to Hunter River, and screened in Hunter River alluvium).

The monitoring bores located along the bank of Hunter River, south of the underground mining area, are intended to monitor for any impacts on the Hunter River alluvium. There is also a number of shallow exploration bores located within the alluvial flat on the eastern side of Glennies Creek, which have been used to monitor groundwater levels in the Glennies Creek alluvium. Finally, a network of shallow standpipe piezometers above the proposed LW/MW 5-9 mining area have been used to monitor groundwater levels within the Bowmans Creek alluvium.

The above monitoring bores have been monitored regularly since the commencement of underground mining, or earlier in some cases. Most bores were monitored at 2-weekly intervals during the mining of LW1 and LW2. Automatic water level recorders were installed for a time in bores WML119, WML120A and B, WML129, and RA27, set to record water levels at 6-hourly intervals.

Two piezometers located in the barrier between LW1 and Glennies Creek were also equipped with automatic water level recorders (WML184 and WML186), set to read at 30-minute intervals, so that any impacts related to subsidence effects could be detected and related precisely to the position of the longwall or other specific site activities occurring at the time. The remaining barrier bores WML181 to 183 and WML185 were monitored manually on a weekly basis from May 2007 to January 2008, and subsequently at least once each month.

Water level hydrographs relevant to the LW1 and LW2 extraction are shown on **Figures 4**, **5**, **8**, **9**, **11** and **12**.

4.2 MINING RELATED IMPACTS

4.2.1 PIKES GULLY SEAM

As noted in the End of LW1 report (Aquaterra, 2008a), drawdown impacts were first observed within the Pikes Gully Seam as soon as the LW1 development headings advanced below the water table in July 2006. At that time, WML120A and WML119A reported maximum drawdowns of 3.0m and 1.8m respectively (**Figure 4**). The magnitude and timing of these drawdown varied according to the location of each piezometer along the length of LW1 (WML119 is located a further 700m down dip to the south of WML120A, and therefore responded later and by a smaller magnitude). In each case, the maximum drawdown was reached at approximately the time when the TG1A heading (easternmost heading in the underground workings, and closest to Glennies Creek) passed WML120A and WML119 respectively. Seepages were noted to occur from the eastern rib of TG1A through this period, and continued thereafter.

The final water level reached in the two bores (WML119, WML120) was intermediate between the elevation of the TG1A heading and the groundwater levels in the Glennies Creek alluvium to the east.

No further lowering of groundwater levels occurred, either during extraction of LW1, LW2 development headings, or extraction of the LW2 panel. Apart from the effects of rainfall recharge on 9-10 June 2007, 19-20 August 2007, 28 April 2008 and 5 June 2008 (discussed below), the head difference between TG1A and the alluvium has remained essentially the same as it was when first established between July 2006 and April 2007 (the period of LW1 heading development). Consequently, all the seepage impact occurred during LW1 development, and the actual extraction of both LW1 and LW2 did not cause any further drawdown impact.

Despite this consistent head difference, groundwater levels in WML120A have actually shown steady recovery (total of 1.5m recovery, or approximately 0.7m/y), so that almost half of the initial drawdown has now been recovered (**Figure 4**). The partial recovery in water levels, in spite of the consistent head difference, suggests a steady reduction in the hydraulic conductivity of the Pikes Gully seam, possibly due to partial clogging of the cleat fracture flow pathways. As discussed below in **Section 6**, the gradual recovery in water levels has been accompanied by a gradual reduction in the rate of seepage inflows.

Aside from rainfall recharge impacts, water levels in WML119 have not shown a similar recovery trend to that displayed by WML120A.

Figure 5 shows composite plots of all Pikes Gully Seam piezometers. It includes the following bores (see **Figure 2** for locations):

- Standpipe piezometers to the east of LW1 - WML181, WML182, WML183, WML184 and WML186;
- Multi-level vibrating wire piezometers WML106-84m, WML189-93m, WML191-100m, WML115-144m and WML213-205m; and
- Standpipe piezometers WML20 and WML21, located within the underground mining area.

None of the bores located east of LW1 shows any response attributable to the mining of LW2. The trends observed in these bores are continuations of trends established either during LW1 development or LW1 panel extraction.

Bores within the mining area have all shown responses to mining, and the pattern of responses can be summarised as follows:

- Vibrating wire piezometer WML106-84m responded strongly to LW1 development, but showed no significant response during subsequent LW1 or LW2 extraction.
- Vibrating wire piezometers WML189-93m and WML191-100m, both located in chain pillars between LW2 and LW3, responded in very different ways. WML189-93m showed marked drawdown as the LW2 development headings passed, and no further response during extraction of LW2. WML191-100m showed no response to either the LW2 development headings or LW2 extraction.
- The standpipe WML20 showed initial drawdown response to the LW1 development headings and later the LW2 headings and NW Mains. In March 2008, during extraction of LW2, the bore underwent rapid drawdown and became fully dewatered. This response is

believed to be due to the LW3 maingate headings, which passed within 10m of the bore at that time, and was not the result of LW2 extraction.

- WML21 and WML115-144m, are located closer to the NW Mains than the LW1-2 area. Both bores showed a steady drawdown response through the extraction of LW1 and LW2. The responses of both bores are believed to be more due to the nearby NW Mains, than to LW1-2.

Figure 6 shows the hydrostatic head profiles for multi-level vibrating wire piezometers WML189 and WML191 (which are located above chain pillars between LW2 and LW3). The plots represent a snap shot of groundwater pressures in relation to the elevation for each piezometer, at the following times: prior to LW1 development (baseline levels), post LW1 development and post LW2 development.

Generally, under pre-mining conditions, in the Ashton area, pressures plot close to the 45° "hydrostatic line", although there is a slight shift from the line due to the upward head gradient. A marked deviation from the hydrostatic line can be seen at WML189 on **Figure 6**, due to the depressurisation effects of LW2 development and mining from LW2. The impact shown at the end of LW1 extraction was in fact due to the LW2 development headings which passed the bore prior to the completion of LW1. A small residual pressure remained in the Pikes Gully Seam within the chain pillar even after the passage of LW2 less than 20m away. A small depressurisation effect is observed to have occurred also at the Lemington 15 Seam level, approximately 45m above the Pikes Gully Seam.

By contrast, no pressure reduction was observed at WML191 up to the completion of LW2, even though like WML189, it is located above a chain pillar between LW2 and LW3

Potentiometric contours for the Pikes Gully Seam have been produced on the basis of groundwater levels measured in December 2008 (**Figure 7**). This figure shows a tight "cone" of depression around the LW1-3 longwall panels (including the influence of the LW3 development headings), with water levels controlled principally by the elevations of the completed development headings, and only limited drawdown at distance from the completed headings. A secondary depression is apparent in the north-western part of the underground mining area (**Figure 7**). The water level impacts in WML21 and WML115-VW144m are believed to be due to the nearby NW Mains.

A smaller drawdown effect is also apparent at WML213, in the SW part of the Ashton underground mining area (see both **Figure 7** and **Figure 6**), which is almost certainly caused by activity on neighbouring mines to the west and/or south, as this site is well down-dip from LW1-3.

4.2.2 PERMIAN OVERBURDEN UNITS

Varying drawdown impacts have also been observed in piezometers in the overlying Bayswater and Lemington seams, hydrographs of which are presented in **Figures 8** and **9**. The drawdown effects are also apparent on the hydrostatic head profiles (**Figures 6** and **10**).

The only Bayswater seam piezometer showing significant drawdown is WML113-40m (**Figure 9**). This is believed to be responding to activities on neighbouring mine sites, not the Ashton operation, as it has been on a consistent downward trend throughout the period of monitoring.

Two piezometers started to show drawdown responses in the shallow Lemington seams, during the LW2 extraction, viz (see **Figure 9**):

- WML110-38m (L6); and
- WML112-101m (L8).

The cyclic pattern of water levels at WML110-65m (**Figure 9**) appears to be an exaggerated rainfall recharge response, while the steady downward trend at WML112-101m is believed to be due to neighbouring mining activities, rather than Ashton.

Larger drawdowns have been observed in the deeper Lemington 10 to 19 seams (**Figure 8**). The hydrostatic head plots (**Figure 10**) show increasing partial depressurisation of the Lemington Seams with depth, with only minor impacts at the Lemington 10-12 Seams, but progressively greater impacts at the Lemington 15 and Lemington 19 Seam levels. In all cases, these seams remain partially saturated in bores near the LW1 and LW2 panels at the completion of LW2.

4.2.3 GLENNIES CREEK ALLUVIUM

As reported in the LW1 End of Panel Report (Aquaterra, 2008a), a small drawdown of 0.4m was observed in alluvium monitoring bore WML120B, between June 2006 and December 2006, coinciding with the advance of TG1A past the bore location (**Figure 11**). No further drawdown occurred in the alluvium bores during extraction of either LW1 or LW2. All drawdown impacts occurred during the development heading stage of LW1.

4.2.4 RECHARGE

A significant recharge event following rainfall in June 2007 caused water levels in the alluvium to rise by at least 1 m in all bores monitored close to Glennies Creek (**Figures 11** and **12**). A similar recharge response was observed in coal measures bores close to outcrop (eg Pikes Gully bores WML119 and WML120A – see **Figure 4**; and Bayswater Seam bores WML112B and WML113B – see **Figure 9**). However, bores distant from outcrop showed only limited or no response to this major recharge event (eg Pikes Gully Bores WML181-186 – see **Figure 5**; and the deeper Lemington Seam bores – see **Figure 9**).

Smaller recharge events during the LW2 extraction can be seen in the hydrographs for Pikes Gully Seam bores WML119 and WML120A (**Figure 4**) and the Glennies Creek alluvium bores WML120B and WML129 (**Figure 11**), although the impacts are much smaller than that caused by the June 2007 event.

4.2.5 POST EXTRACTION RECOVERY IN WATER LEVELS

Several piezometers have shown partial recovery of groundwater levels after initial drawdown impacts from mining. The best example of this is WML107-98m set at the Lemington 19 Seam (**Figure 8**), which showed drawdowns during LW1 development headings, and again at the start of LW2 extraction. Following the initial drawdown, the groundwater level has risen by several metres, although each rise represents only partial recovery.

Similar effects are seen at WML106-68m (Lemington 19 Seam – see **Figure 8**), WML189-93m (Pikes Gully Seam – see **Figure 5**), WML120A (Pikes Gully Seam – see **Figure 4**).

The WML120A response is particularly significant, as the water level in this bore is controlled by the head difference between Glennies Creek alluvium to the east and TG1A to the west, and the hydraulic conductivity of the Pikes Gully Seam between the two. As the head difference between Glennies Creek alluvium and TG1A has remained essentially unchanged during the period of recovery, the recovery can only have occurred as a result of a progressive reduction in the hydraulic conductivity of the Pikes Gully Seam between the creek alluvium and the mine. This may be due to progressive silting up of the cleat fractures by fines deposited from the through-flowing water, or a delayed benefit from the grouting measures that were implemented to reduce inflows during LW1 extraction.

The partial recovery seen in the hydrographs within the longwall area indicates that some re-sealing of subsidence fractures has probably occurred (see further discussion in **Section 6**).

5 GROUNDWATER AND SURFACE WATER QUALITY

5.1 MONITORING PROGRAMME

Monitoring of groundwater quality in the Glennies Creek alluvium and Pikes Gully coal seam was undertaken pre-mining to establish baseline conditions. Bores WML119 and WML120A monitor the Pikes Gully seam groundwater, while WML120B and WML129 monitor the alluvium groundwater. Other bores monitoring the Pikes Gully seam or the alluvium are listed in **Table 5.1** below. Further water quality sampling of the bores has taken place intermittently since underground mining commenced.

Data collected from an extensive underground water quality monitoring program was also maintained throughout the mining of LW1 and has been previously reported in Aquaterra (2008a). Initially, while access was available to the TG1A development heading, samples were collected from several locations along the eastern rib of TG1A, and from a few other underground locations. As access to TG1A was progressively lost due to the longwall advance, water quality monitoring of seepages from the eastern rib of TG1A was maintained by monitoring the discharge from the LW1 back-road pipe (**Figure 2**), as explained earlier in **Section 1**. This discharge comprises the total of all seepage into TG1A.

EC monitoring of the LW1 back-road pipe discharge from TG1A has continued through the extraction of LW2.

5.2 MONITORING RESULTS

A summary of all available EC measurements from these bores is detailed in **Table 5.1**, together with selected readings from underground seepages and surface water sampled from Glennies Creek.

Graphs of site-measured EC values from the TG1A seepages and monitoring bores are shown on **Figures 13** and **14**.

On the basis of the water quality monitoring data, the typical pre-mining salinities (ECs) of the three water sources would have been as follows:

- Pikes Gully Seam
  - 6000 to 6500 µS/cm (north of LW1 CT13)
  - 8000 to 9000 µS/cm (south of LW1 CT14)
- Glennies Creek alluvium - 500 to 2200 µS/cm
- Glennies Creek surface water - 250 to 350 µS/cm (increases to 800 to 900 µS/cm during high runoff).

It was reported in the LW1 End of Panel Report (Aquaterra, 2008a) that in the early stages of underground mining, samples from Pikes Gully bore WML120A showed a fairly rapid decrease in salinity (EC), from 6350 µS/cm in June 2006 to 810 µS/cm in August 2008. A similar but smaller magnitude decline in EC was also observed at WML119, from 6470 µS/cm in June 2006 to 1820 µS/cm in August 2008. The greatest declines in EC were mostly observed during June 2006 and June 2007, shortly after the LW1 development headings first passed beneath the water table, and are believed to be due to induced water flow from the Glennies Creek alluvium towards the mine through the Pikes Gully seam.

Groundwater salinity from WML120A, WML181 and WML184 remained reasonably steady during the extraction of LW2 (November 2007 to July 2008), although continued declines in EC were noted from WML182, WML183 and WML185 during the advance of LW2 (**Figure 14**).

After some EC decline during the development headings stage of LW1, the ECs of alluvium bores beside Glennies Creek (WML120B and WML129) have remained steady during LW1 and LW2 panel extraction.

The salinity from the LW1 back-road pipe (total TG1A seepage) showed a slight downward trend during LW2 extraction, declining from around 2000 µS/cm at the start to around 1600 µS/cm EC at the finish, but has been stable at around 1600 µS/cm since June 2008 (**Figure 13**).

Table 5.1: Groundwater and surface water EC values (µS/cm)

Source	Pre-Mining	During LW1 Extraction		During LW2 Extraction		Post LW2 Extraction	Location	
	June - Sep 2006	January 2007	May - June 2007	Nov 2007 – Feb 2008	Mar – June 2008	Aug - Dec 2008	Easting	Northing
Pikes Gully Seam								
WML 20	6240	-	6030	-	-	-	318361.8	6404331.0
WML 21	8140	-	8530	-	-	-	318245.0	6406339.9
WML 119	6470	4940	3090	2320	-	1820	319255.3	6403930.1
WML 120A	6350	1470	742	828	-	810	319292.0	6404579.6
WML 181	-	-	4920	-	-	2460	319215.0	6403958.3
WML 182	-	-	4220	8680	-	6950	319155.4	6404134.0
WML 183	-	-	8570	8180	-	5890	319188.2	6404325.2
WML 184	-	-	-	4560	-	5140	319179.2	6404530.4
WML 185	-	-	-	4430	-	2940	319200.0	6404642.7
WML 186	-	-	-	463	-	-	319218.2	6404743.9
Glennies Creek Alluvium								
WML 120B	1930	1260	1020	1220	-	992	319293.6	6404587.5
WML 129	571	522	396	577	-	571	319468.4	6403527.8
WML 148*	-	-	-	2170	-	-	319533.1	6404169
WML 155*	-	-	-	978	-	-	319380.5	6404517
WML 157*	-	-	-	842	-	-	319465.3	6404480
WML 158*	-	-	-	745	-	-	319521.1	6404460
Glennies Creek (Surface Water)								
SM7	235-518	268	319-325	347-643	402-652	442-727	-	-
SM8	235-527	267	318-328	339-699	400-644	435-754	-	-
SM11	238-542	268	320-329	335-686	410-650	439-768	-	-
Underground Seepages – TG-1A								
CT9-10	-	3770	3010	-	-	-	-	-
CT10-11	2820	1680	1390	-	-	-	-	-
CT11-12	2100	1060	1200	-	-	-	-	-
CT12-13	-	1740	1500	-	-	-	-	-
CT13-14	5600	2340	1470	-	-	-	-	-
CT14-15	-	4910	3050	-	-	-	-	-
CT15-16	-	5630	2950	-	-	-	-	-
CT16-17	-	8520	7190	-	-	-	-	-
CT17-18	-	7450	5960	-	-	-	-	-
LW1 BR Pipe	-	-	2830	1726-1950	1620-1760	1554-1739	-	-

* Exploration hole (now cemented up).

6 GROUNDWATER INFLOWS

Groundwater inflows to the mine continue to be monitored at a number of locations. In addition to inflows, water is also imported to the mine to meet operational water requirements of the longwall operation. Water is exported from the mine either via a borehole pump situated at the south-west corner of LW1 (shown on **Figure 2** as the Backroad Sump Borehole) direct to the mine water supply circuit, or via pipelines along the gate-roads to the sump in Arties Pit near the mine portal.

The main contributions to groundwater inflow are seepage into TG1A (the eastern gateroad of LW1), small inflows to the north-west mains, and broadly distributed goaf seepage into LW1 and LW2 goafs. Typically, no other persistent areas of seepage are seen.

Total groundwater inflow rate is determined by a water balance approach, using flow volumes recorded at water meters on the discharge pipelines and the imported water pipeline.

Flow rate of total seepage into TG1A (easternmost heading of LW1) is monitored separately from other inflows, to allow determination of the relative percentages of groundwater from Glennies Creek alluvium and the coal measures aquifers.

The TG1A seepage inflow rate as measured from the LW1 Backroad Pipe (**Figure 2**) reached a peak rate of 3.4 L/s in July 2007, but has since declined to an average rate of 2.9 L/s over the period of LW2 extraction (12 November 2007 to 21 July 2008). Based on EC comparisons with both the Pikes Gully seam and Glennies Creek alluvium in-situ salinities, it has been estimated that 70% of the total seepage is derived from the Glennies Creek alluvium, ie an average of 2.0 L/s (equivalent to 0.17 ML/d or 62 ML/a). Since completion of LW2, the EC of the discharge from the back-road pipe has stabilised at around 1700 µS/cm (**Figure 13**).

The seepage rate from the Glennies Creek alluvium continues to decline gradually. No increase in seepage rate was observed to occur during the extraction or LW2.

7 COMPARISON WITH EIS AND SMP PREDICTIONS

7.1 EIS PREDICTIONS

The groundwater impact predictions relating to the Ashton underground mine in the EIS are outlined in the report *"Groundwater Hydrology and Impact Report"* (HLA, 2001) which was included in full as Appendix H of the EIS. The main parameters of predicted impacts were:

- Total rates of groundwater inflow to the underground mine – Section 5.2 (page 17) and Figure 11 of Appendix H.
- Total rates of seepage losses from the Glennies Creek, Bowmans Creek and Hunter River alluvial aquifer systems – Section 5.3 (pages 17-18) and Figure 13 of Appendix H.
- Groundwater level drawdowns – Section 5.4 (pages 18) and Figures 14-16 of Appendix H.

Each of the above parameters is addressed in turn in the following sections.

The predicted impacts were derived from the use of a groundwater flow model set up by HLA for the Ashton project investigations. The model description and modelling results are presented in Appendix F to the HLA report (HLA, 2001).

The mine plan used as the basis for the groundwater simulation modelling in the EIS studies involved the commencement of underground development in Year 2, and the commencement of longwall extraction in Year 4. Underground development actually commenced in December 2005 and first intersected the water table in July 2006. Longwall extraction (LW1) commenced on 19 March 2007. In the HLA model, drain cells were enabled across the full extent of LW1 and the north-west mains (NW Mains) from the start of Mining Year 4.

Accordingly, for comparison purposes, it is considered that the year July 2007 to June 2008 equates approximately to Mining Year 5 in the EIS simulation modelling.

7.1.1 GROUNDWATER INFLOW TO UNDERGROUND MINE

The measured/calculated total groundwater inflow rates to the underground mine since the commencement of monitoring are plotted on **Figure 15**, for comparison with the inflow rates predicted in the EIS for the equivalent stage of the mining operation.

The predicted rates of total groundwater inflow to the underground mine in the EIS showed a progressively increasing inflow rate, from zero in Years 1 and 2, increasing to 0.20 ML/d (2.3 L/s) in Year 3 and 0.45 ML/d (5.2 L/s) in Year 4. Thereafter inflow rates to the underground mine were predicted to increase to a maximum of 1.7 ML/d (20 L/s) in Year 12. The predicted inflow rates for Years 1 to 5 as reported in the EIS are reproduced on **Figure 15** in this report.

The recorded actual total groundwater inflow rate to the underground mine at the completion of LW1 was 0.48 ML/d (5.5 L/s). This inflow rate is now known to have been overstated, and the actual flow rate was probably at least 20% lower than this figure.

The determined cause of the overestimate was that there are two flow meters separated by approximately 4 km on the main discharge pipeline from the underground dewatering bore back to the process water dam. The two meters consistently returned different flow rates, and the higher flow rate was adopted in the total inflow calculations to provide a conservative outcome. It has since been discovered that the meter returning the higher rate was affected by an air leak in the pipeline. Following repair of the air leak, the two meters now agree, and the consistent (lower) meter reading has now been adopted as being more accurate, and incorporated into the water balance calculation. This shows up as an apparent sharp drop in the total inflow rate, mid-way through the LW2 extraction. The drop is artificial, but the flow rate shown for the later stages of LW2 is a more reliable indication of the true inflow rate applying throughout the period.

Actual total groundwater inflow rate to the underground mine at the completion of LW2 is now believed to have been 0.26 ML/d (3.1 L/s). An average inflow rate of approximately 0.35 ML/d (4 L/s) is considered appropriate as a representative value for the period of LW2 extraction. The EIS predicted inflow rate for this stage of mining was around 1.1 ML/d (13 L/s), so the actual inflow rate is well below the EIS prediction (**Figure 15**).

The total inflow rate includes all the groundwater seepages into TG1-A, all goaf inflows from LW1 and LW2, seepages into maingate roads of LW3, all inflows to the NW Mains, and other miscellaneous seepages. These figures are conservative, as they may also include a component of recycled water, derived from seepage losses back into the NW Mains from the sump in Arties Pit beside the mine portal.

7.1.2 SEEPAGE LOSSES FROM GLENNIES CREEK ALLUVIUM

The total seepage inflows to the eastern gate road of LW1 have been closely monitored separately from other mine inflows since the first appearance of seepage during the installation of the LW1 development headings, and monitoring has continued to the present time through the installation of the collection system and LW1 Backroad Pipeline described in **Section 1**. In addition to flow rates, the EC and pH are monitored.

The seepage into TG1-A includes groundwater from storage within the Pikes Gully coal seam, as well as water seeping through the barrier from the Glennies Creek alluvium. Through an assessment of the water quality of TG1-A seepages in comparison to the in-situ groundwater qualities of the Pikes Gully seam and the Glennies Creek alluvium respectively, it was calculated that approximately 70% of the total TG1-A seepage is derived from Glennies Creek alluvium, and the balance from storage in the Pikes Gully seam and other Permian strata. The derivation of this proportion was described in detail in Peter Dundon and Associates (2007).

The actual seepage from Glennies Creek alluvium into the underground workings, calculated using the above analysis, is plotted on **Figure 15** together with the alluvium seepage inflow rates predicted in the EIS studies. It can be seen that the actual seepage inflow rates during LW2 extraction (approximately 2.2 – 1.8 L/s) are below the EIS predictions (2.7 – 2.9 L/s) for this stage of the mining operation.

No increase in measured seepage rate was observed during the extraction of LW2. Instead, the plot of seepage inflows is showing a downward trend with time, which is consistent with the gradual recovery in water levels at WML120A in particular described in **Section 4.2.1**.

7.1.3 GROUNDWATER LEVEL DRAWDOWNS

Predicted drawdown impacts in the Permian coal measures were only presented in the EIS for the completion of mining, not for intermediate stages of the mine life, and it is therefore not possible to compare actual impacts with the predicted impacts for the present stage of mining.

However, hydrographs of predicted drawdown in the Glennies Creek alluvium were presented as Figure 16 in HLA (2001). Two prediction hydrographs are shown, one denoted "North Bore" coinciding with registered bore GW064515 in Camberwell village (**Figure 2**), and another denoted "South Bore" at a location *"… within the alluvium overlying the sub-crop of the Upper Liddell Seam adjacent to the underground mine"*.

Ashton monitoring bores are located in the general vicinity of these two notional sites:

- ▼ G3B in Camberwell village (ie near "North Bore");
- ▼ WML120B and WML129 (alluvium bores on western side of Glennies Creek) and exploration bores WML148, WML155, WML157 and WML158 (on the eastern side of Glennies Creek) adjacent to the underground mine (ie near "South Bore"). The location of the "South Bore" shown on Figure E1 of the HLA Groundwater Assessment Report (HLA, 2001) places it very close to bores WML120B, WML155 and WML157 (see Figure 2).

Bore G3B has been dry through most of the period of underground mining, and has not been able to identify any impact. However, bore WML120B has been monitored since before the start of underground seepage, and initially showed a drawdown of approximately 0.6m, much smaller than the 1.3m drawdown predicted in the EIS for the "South Bore" at this stage of mining. By the completion of LW2 extraction, the groundwater level at WML120B has recovered slightly, and the total impact has always been well below the EIS prediction.

7.2 SMP PREDICTIONS

The groundwater assessment report prepared in support of the SMP application for LW1-4 (Dundon and Associates, 2006) stated that inflow rates and seepage rates would be consistent with those predicted in the EIS studies, as described above in **Section 7.1**.

7.2.1 TOTAL GROUNDWATER INFLOWS COMPARED WITH SMP PREDICTIONS

As indicated above in **Section 7.1.1**, actual inflows during the extraction of LW2 have been well below the EIS prediction, which were adopted as predicted inflows in the SMP.

The LW1-4 SMP report (Peter Dundon and Associates, 2006) also calculated possible increased inflows to the underground workings due to increased recharge from rainfall following surface cracking over the longwall goaf areas. It was stated that the recharge rate might increase from 0.5-1.0% of rainfall to possibly as much as 20% of rainfall, and that this would apply particularly to areas of limited cover depth, including most of LW1.

Several small rainfall events occurred during the extraction of LW2, but none was accompanied by a measurable increase in goaf inflow rates.

7.2.2 ACTUAL SEEPAGE FROM GLENNIES CREEK ALLUVIUM COMPARED WITH SMP PREDICTIONS

Actual seepage inflow rates from the Glennies Creek alluvium during LW2 extraction were in the range 2.2 to 1.8 L/s, ie an average of approximately 2.0 L/s. No specific seepage rate was predicted for LW2 in the LW1-4 SMP report, but it was anticipated seepage inflows would arise with the development of LW1, and would not increase during mining of subsequent panels. The predicted seepage rate was calculated by Darcy's law to be around 2.0 L/s during LW1 extraction, with no increase during extraction of LW2 or subsequent longwall panels.

Thus the actual seepage rates have been consistent with the SMP predictions.

The End of Longwall 1 report (Aquaterra, 2008a) reported that there was no evidence of any increase in permeability in the barrier between LW1 and Glennies Creek as a result of subsidence impacts.

This situation has not changed with the extraction of LW2. Subsidence impacts have been limited to areas immediately above the extraction panels, within the 20mm subsidence line defined by the 26.5° angle of draw from the goaf edge (SCT, 2006). As no change in barrier hydraulic conductivities has occurred, seepage rates from the Glennies Creek alluvium through the Pikes Gully seam into the alluvium are related to the natural prevailing hydraulic conductivities in the barrier.

As indicated in **Section 7.1.2** above, the seepage inflow rate has been declining, suggesting a possible reduction in the permeability of the barrier, possibly due to clogging by suspended fines, or due to a delayed benefit from the grout injection program implemented during 2007.

8 CONCLUSIONS

Mining of Longwall Panel 2 (LW2) was carried out between November 2008 and July 2008, with coal being recovered from the Pikes Gully Seam.

The groundwater in the coal measures aquifer system is saline, with salinities ranging up to more than 8,000 µS/cm EC, or more than 6,000 mg/L TDS. Salinity of the groundwater in the Glennies Creek alluvium varies, but it is generally less saline than the coal measures. Alluvium salinity is typically less than 1000 µS/cm EC, or less than 800 mg/L TDS, but can be as high as 2500 µS/cm (2000mg/L TDS).

Prior to commencement of mining at Ashton, groundwater levels in the Permian coal measures were believed to have been higher than in both the alluvium and in the streams. Under natural conditions, groundwater discharged from the Permian to the alluvium and to the surface streams. This is still occurring, and mixing of saline coal measures water with lower salinity water derived from local rainfall recharge is responsible for the salinity variability seen in both the alluvium groundwater and from time to time in the stream flow.

Survey lines established across the LW1 tailgates and the slope between LW1 and Glennies Creek were re-surveyed following the adjacent passage of LW2, and showed no lateral movement exceeding 30 mm, and in most locations less than 12 mm. This indicates that there has been no lateral movement within the barrier during the extraction or LW2. In the absence of any shearing, the permeability of the barrier between LW1 and Glennies Creek will not have undergone any significant change, and therefore no increase in seepage losses from Glennies Creek alluvium was expected to occur during the LW2 extraction, and no increase was seen.

There has been no significant increase in total mine inflows following goafing of LW2. Measured (reported) total inflow rates have recently been revised downwards following repair of an air leak that had affected the readings at one of the flow meters, resulting in an inflation of the true flow rate. The actual total groundwater inflow rate at the completion of LW2 was only around 4 L/s (0.35 ML/d). The majority of mine water inflow is apparently coming from (or through) the Pikes Gully seam.

A comparison of observed impacts with the EIS and SMP predictions has led to the following conclusions:

- ***Actual groundwater inflows have been below the EIS and SMP predictions for this stage of mining.*** Total groundwater inflows into the underground mine averaged approximately 0.35 ML/d (4 L/s) during the extraction of LW2, compared with the EIS and LW1-4 SMP predicted inflow rate for this stage of mining of around 1.1 ML/d (13 L/s).
- ***Actual seepage rates from the Glennies Creek alluvium have been at or below the EIS and SMP predictions***. Calculated rates of actual Glennies Creek alluvium seepage into the underground mine during the LW2 extraction were approximately 2.2 – 1.8 L/s, below the EIS predictions (2.7 – 2.9 L/s) and consistent with the LW1-4 SMP prediction (2.0 L/s).
- ***Groundwater level drawdown in the Glennies Creek alluvium has been significantly less than predicted in the EIS.*** Groundwater levels in bore WML120B were drawn down a total of 0.6m since underground mining advanced below the water table, compared with the EIS prediction of 1.3m for this locality.
- ***Monitoring suggests that the possibility of increased mine inflow from higher rates of rainfall recharge due to the subsidence fracturing is likely to be less than that considered in the LW1-4 SMP groundwater report.*** No measurable increase in mine inflows occurred following significant rainfall recharge events during mining of LW1, and smaller rainfalls during subsequent mining of LW2.

In summary, all groundwater-related impacts from underground mining up to the completion of LW2 (July 2008) were at or below the levels predicted in the EIS (2001), and in the SMP groundwater assessments carried out in 2006.

Most of the impacts had stabilised prior to the end of LW1, and no significant incremental impact or influence from mining LW2 has been observed.

9 REFERENCES

Aquaterra Consulting Pty Ltd, 2008a. *Ashton Coal: End of Panel 1 Groundwater Report*

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Peter Dundon and Associates Pty Ltd, 2006. *Ashton Coal Mine Longwall Panels 1-4, Subsidence Management Plan – Groundwater Assessment.*

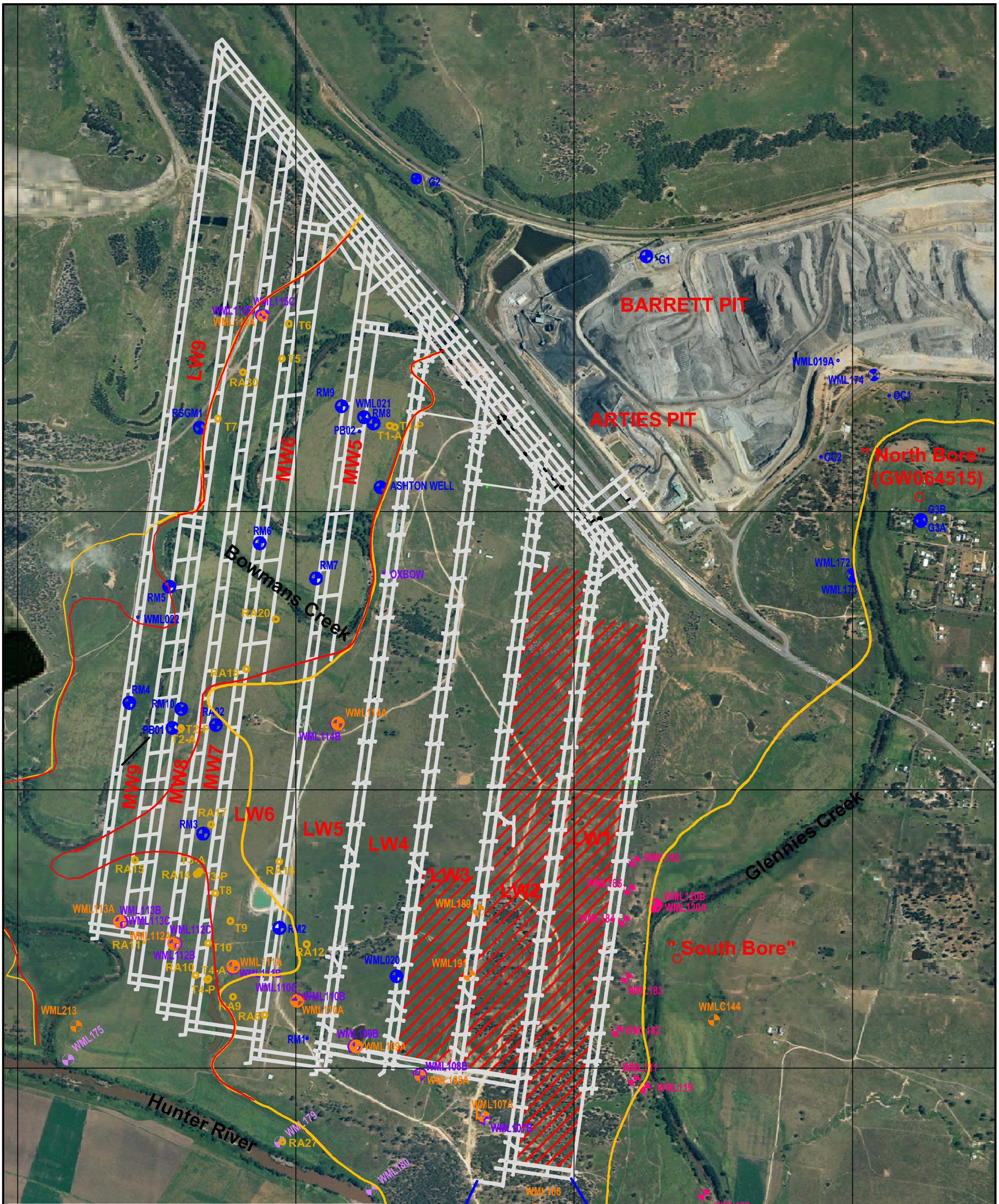
Peter Dundon and Associates Pty Ltd, 2007. *Ashton Underground Mine, Groundwater Impacts of Longwall 1, Comparison with EIS and SMP Predictions.*

Strata Control Technology (SCT), 2006. *Subsidence Assessment for Ashton Coal Mine Longwalls 1-4.*

FIGURES

Basemap sourced from NSW National Parks and Wildlife Service

Ashton Project Location
Figure 1



Legend

- EIS Investigation Bores
- Subsidence Monitoring - Vibrating Wire Piezo
- Subsidence Monitoring - Standpipe Piezo
- Bowmans Creek Alluvium Investigation Bores
- Hunter River Alluvium Piezometer
- LW1 - Glennies Ck Barrier Piezometers
- Dry / Abandoned / Lost Bore
- Extent Of Alluvium
- Extent Of Saturated Bowmans Creek Alluvium
- Longwall Extraction Completed
- Groundwater Model Targets (Glennies Ck Alluvium)

Date: 11 May 2009	Scale: as shown	**Ashton Coal Operations Ltd**
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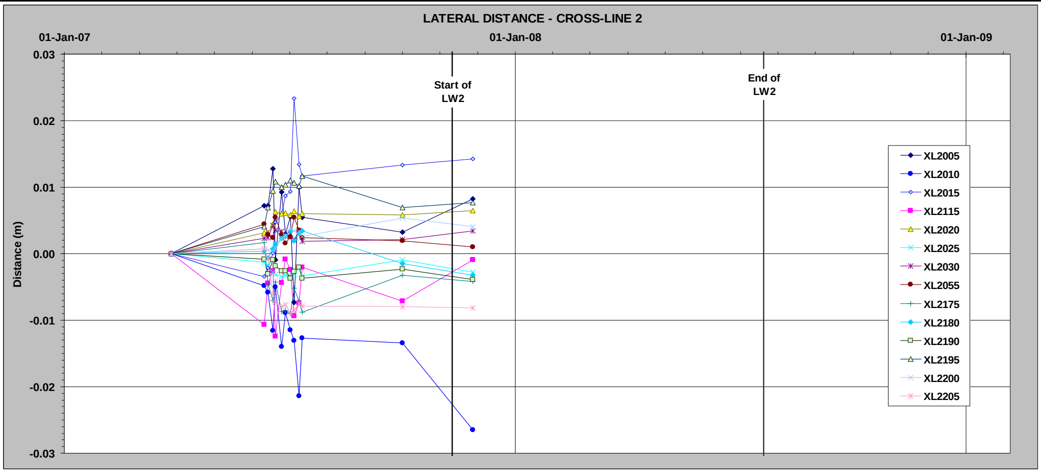
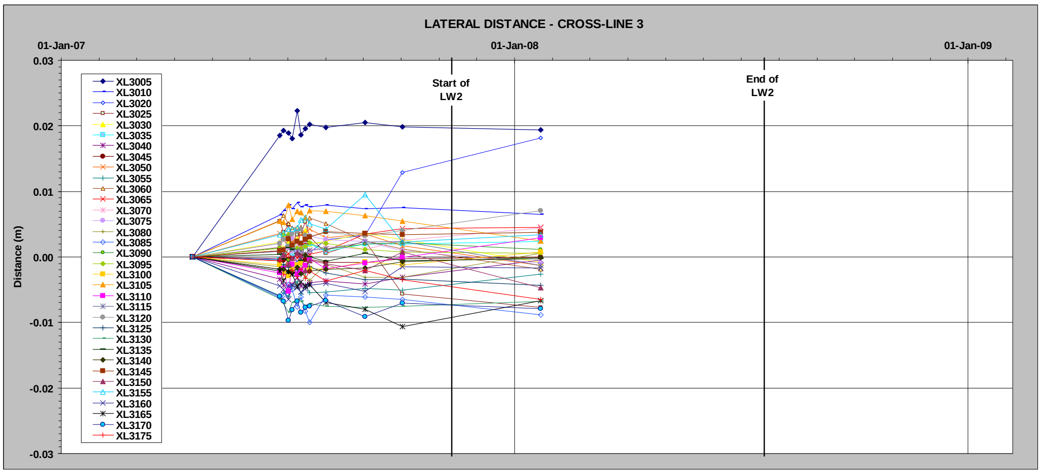
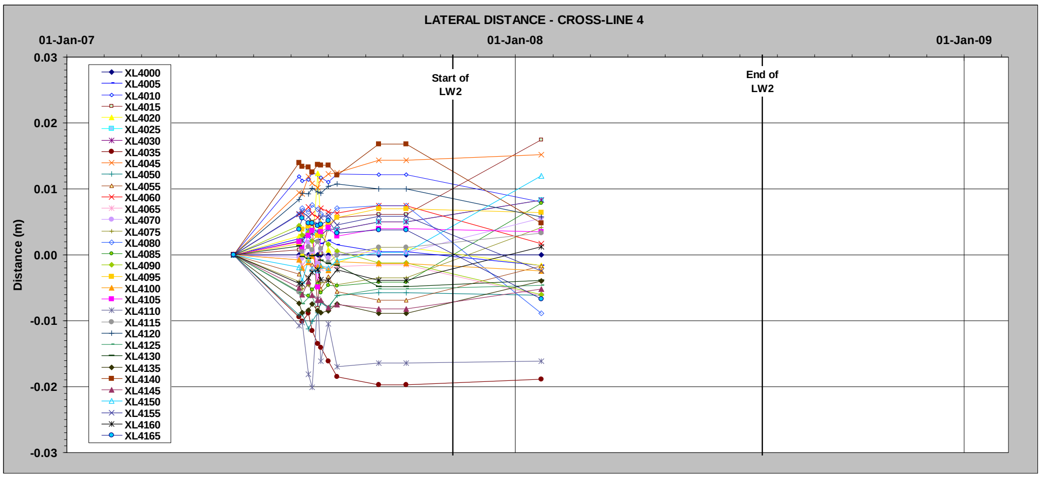
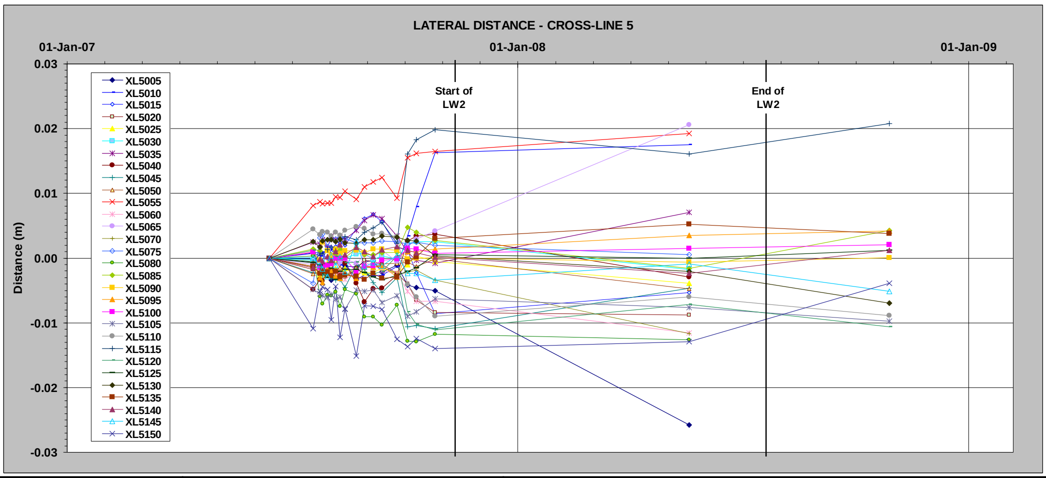
Drawing No: S03 -228c	Revision: C	
aquaterra		Figure 2









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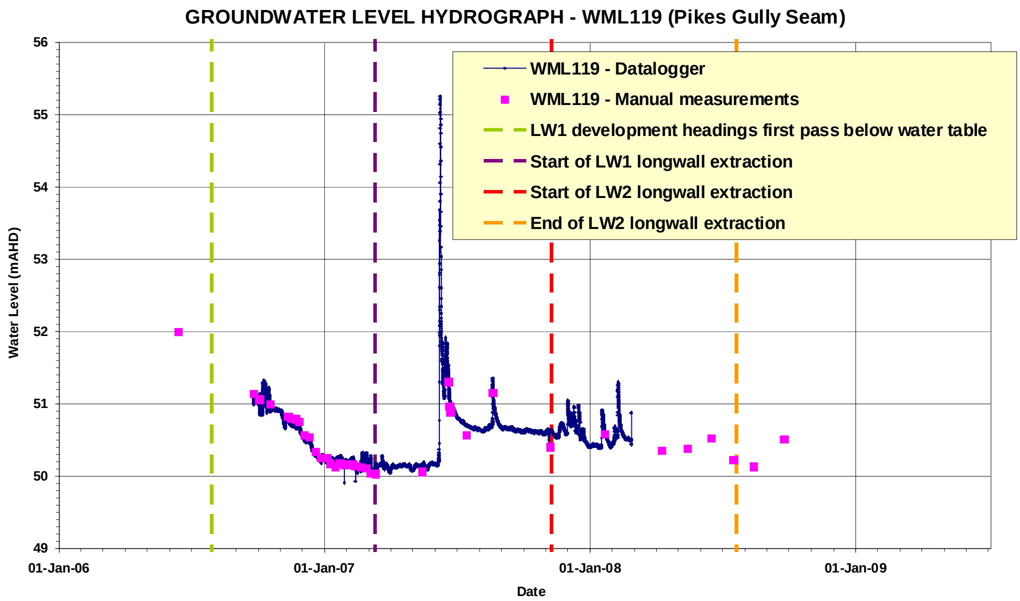
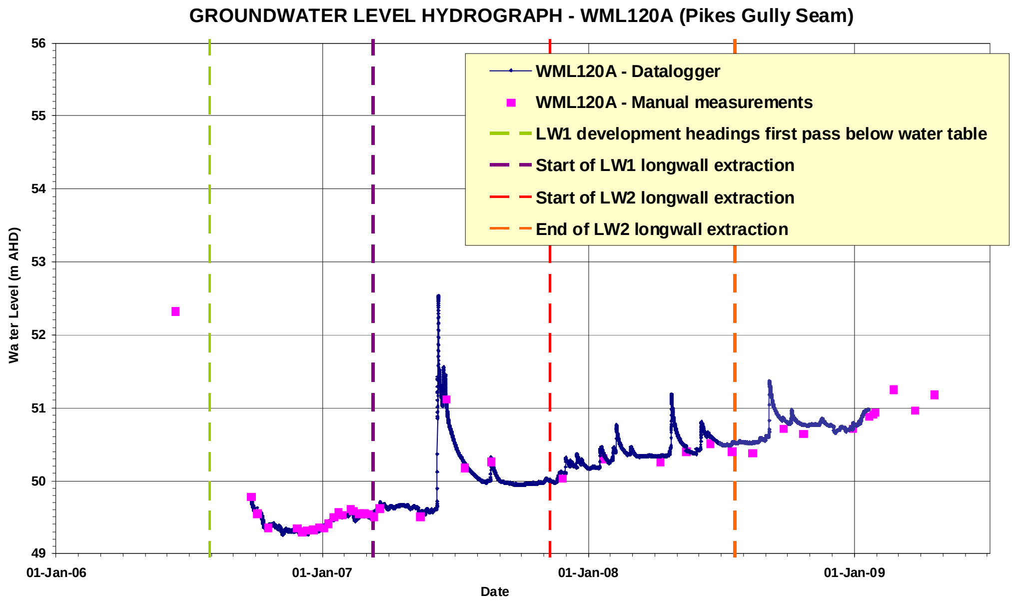
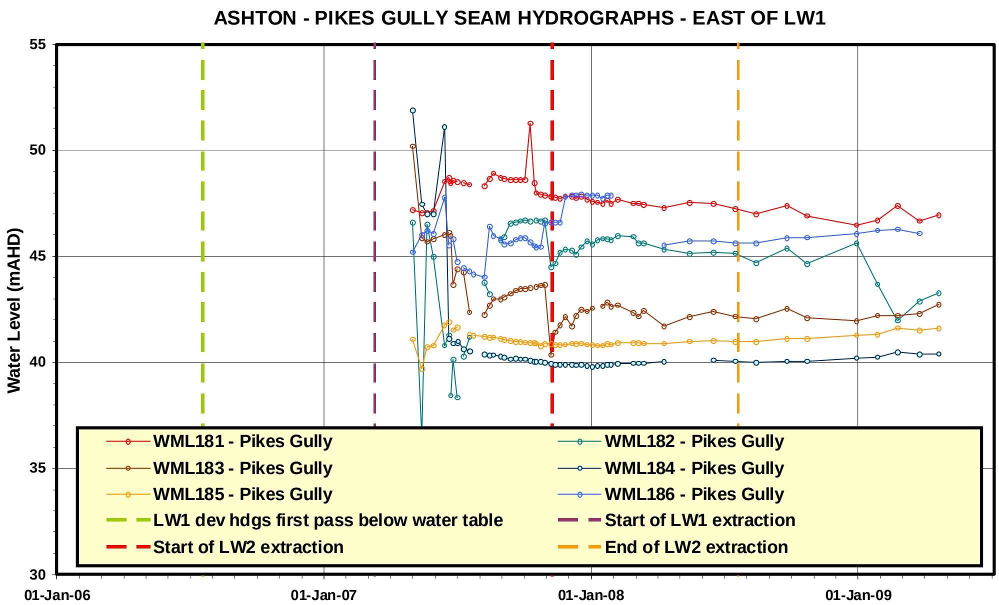
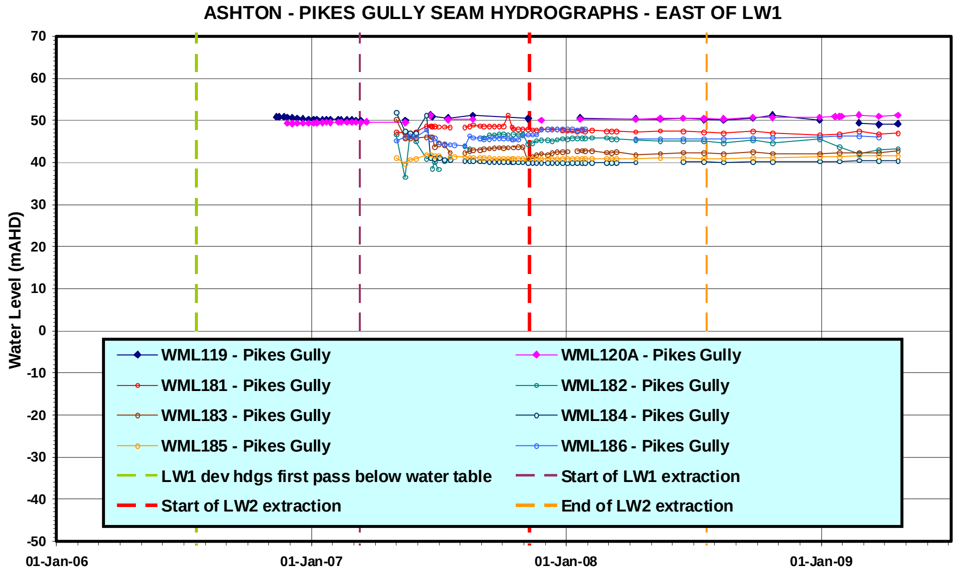
Drawing No: S03-127c	Rev: C	
aquaterra		**Figure 3**

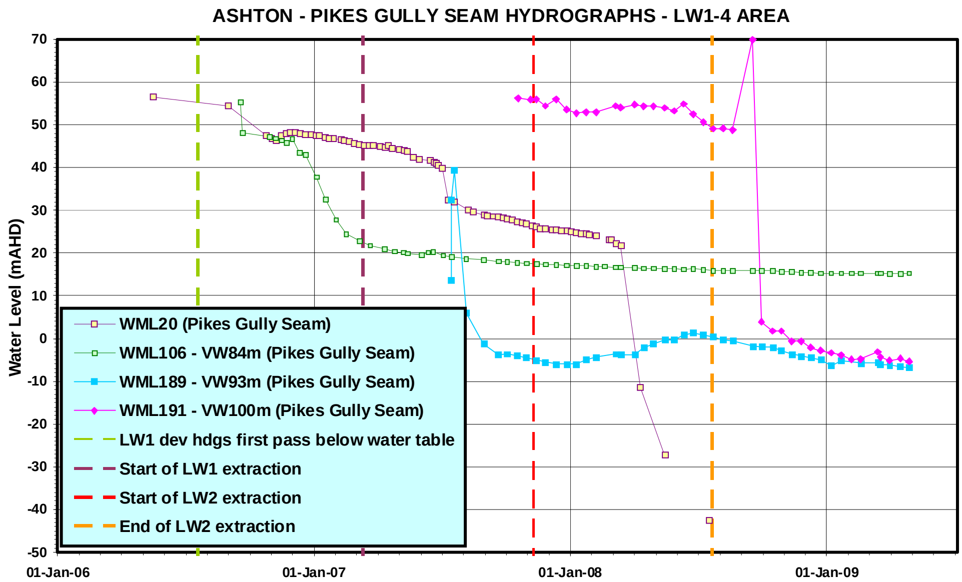


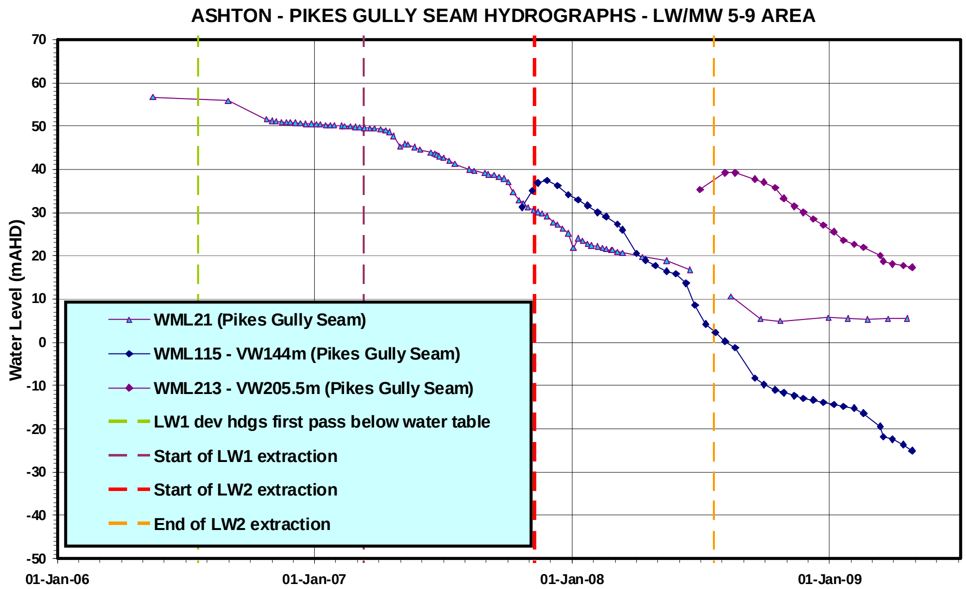




Date: 9 May 2009	Scale: as indicated	**Ashton Coal Operations Ltd**
Initials: PJD	Job No: S03	**GROUNDWATER LEVEL HYDROGRAPHS**
Drawing No: S03-R11-004a	Rev: A	**Pikes Gully Seam WML119, WML120A and WML181-186**
aquaterra		**Figure 4**







Date: 9 May 2009	Scale: as indicated	**Ashton Coal Operations Ltd**
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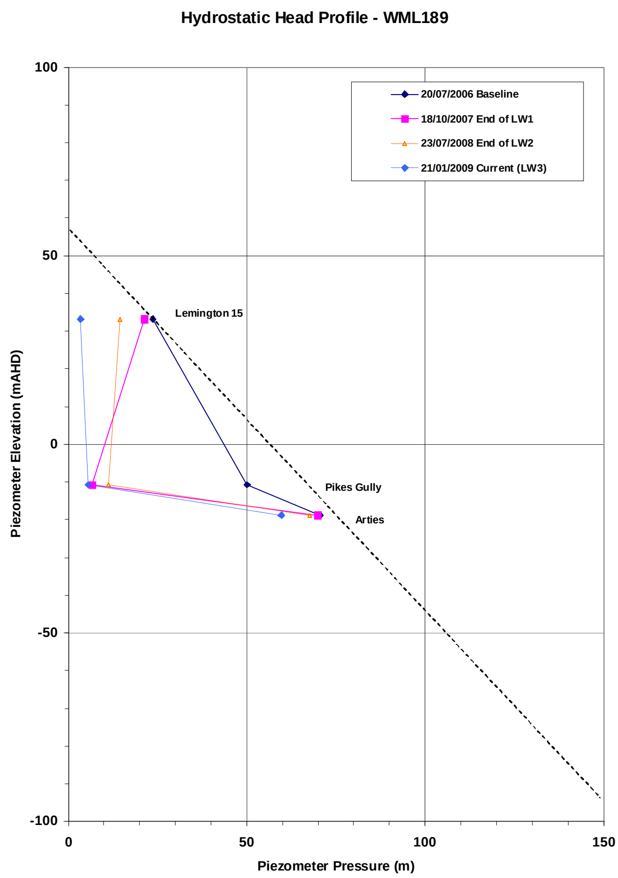
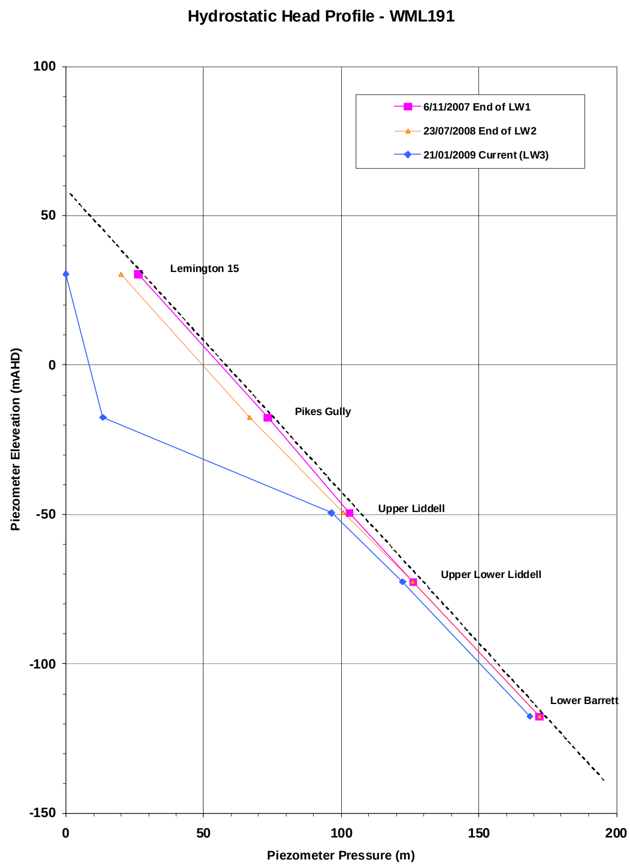
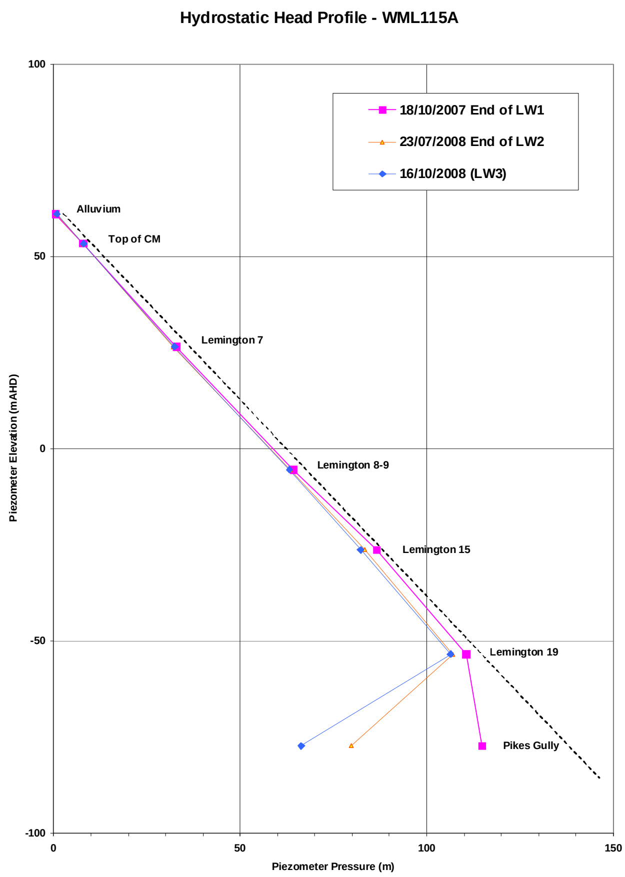
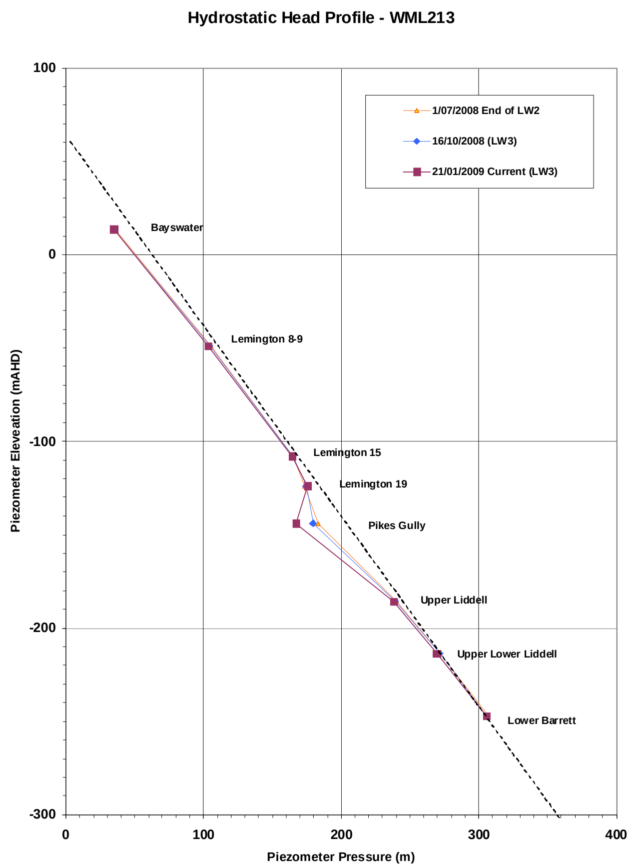
Drawing No: S03-144b	Rev: B	**Pikes Gully Seam**
aquaterra		**Figure 5**









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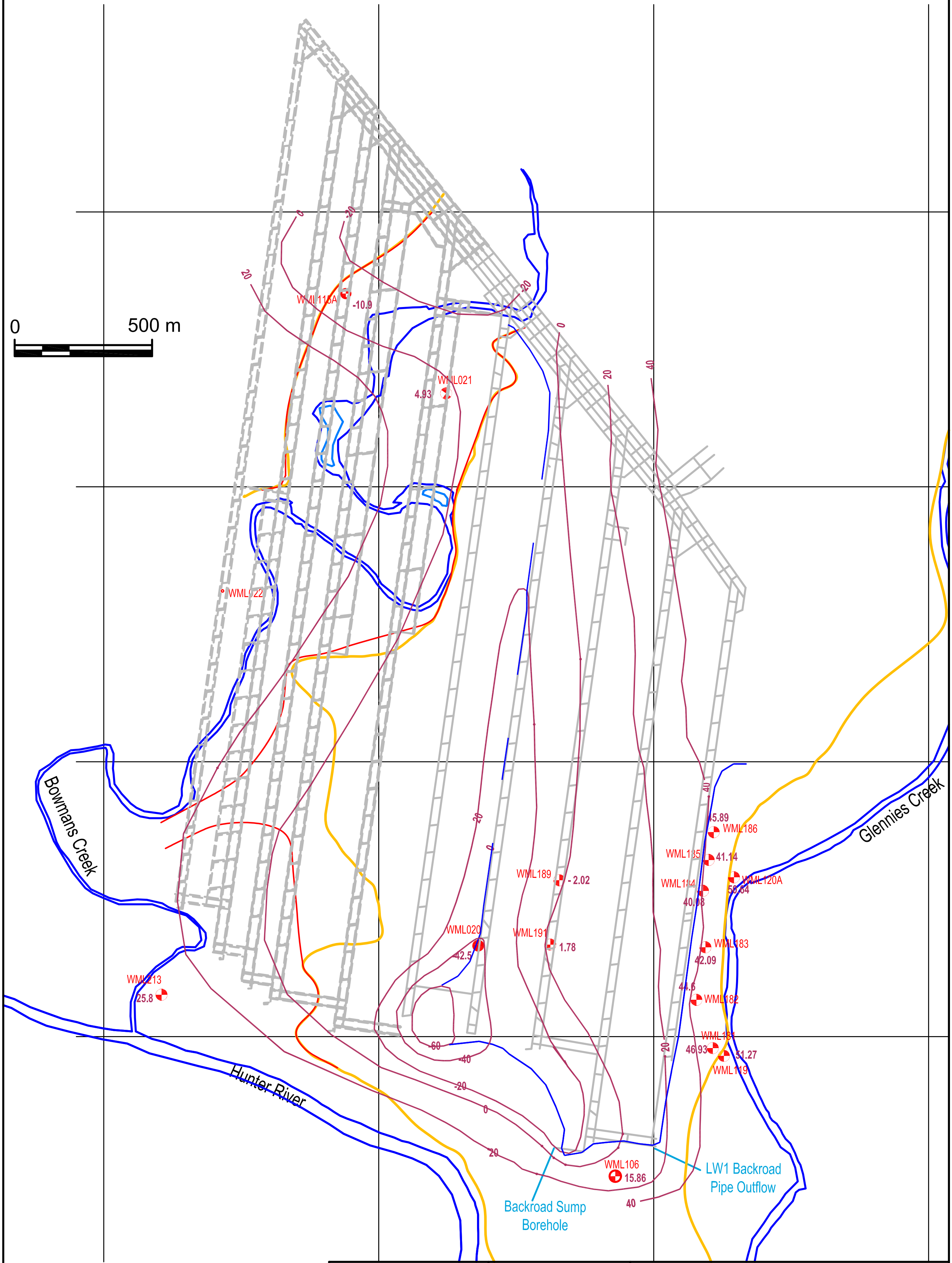
Drawing No: S03-228a	Rev: A	
aquaterra		**Figure 6**



Pikes Gully Piezometer

-26.3 GW Level (mAHD)

Extent of dewatered Pikes Gully Seam

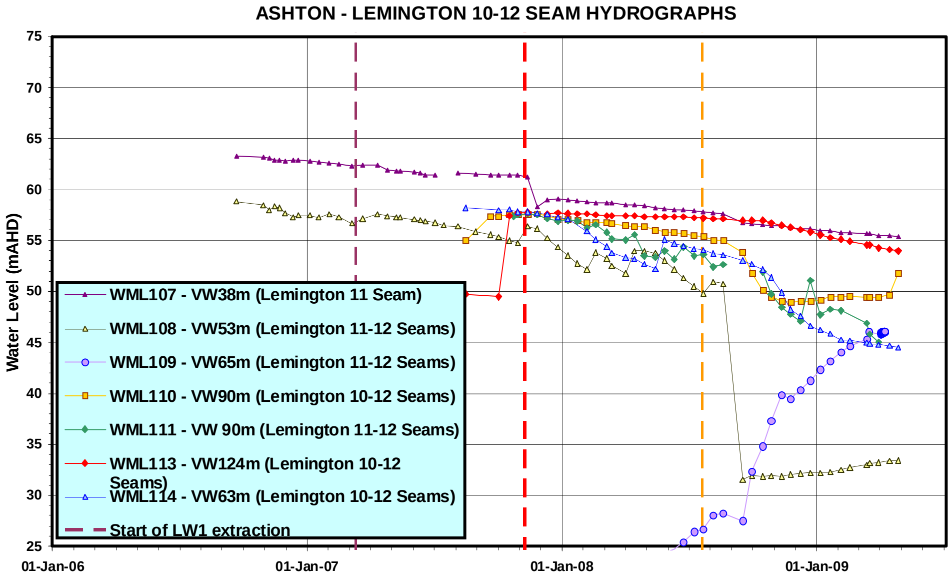
Date:	28 January 2009	Scale:	as shown
Initials:	PJD	Job No:	S03
Drawing No:	S03-171f	Revision:	F

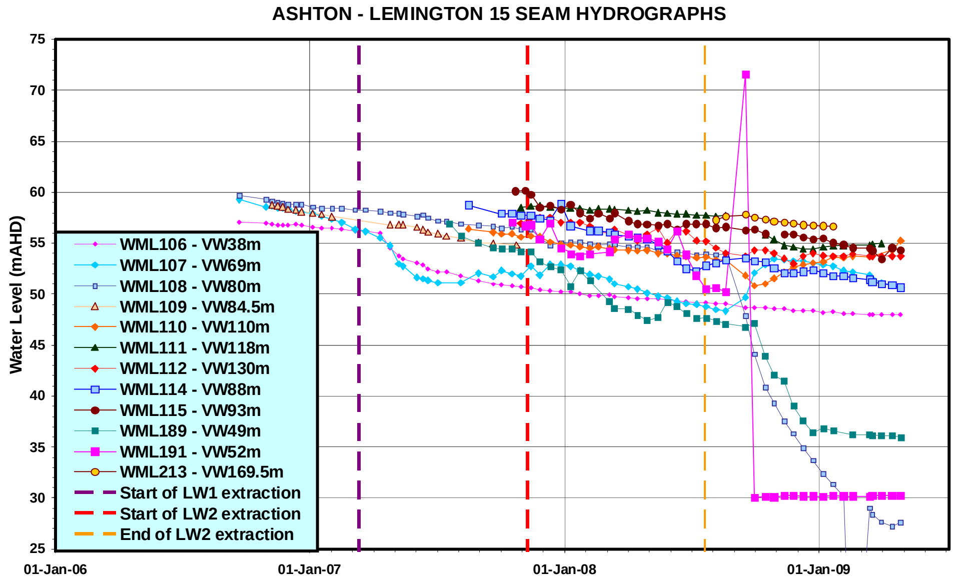
aquaterra

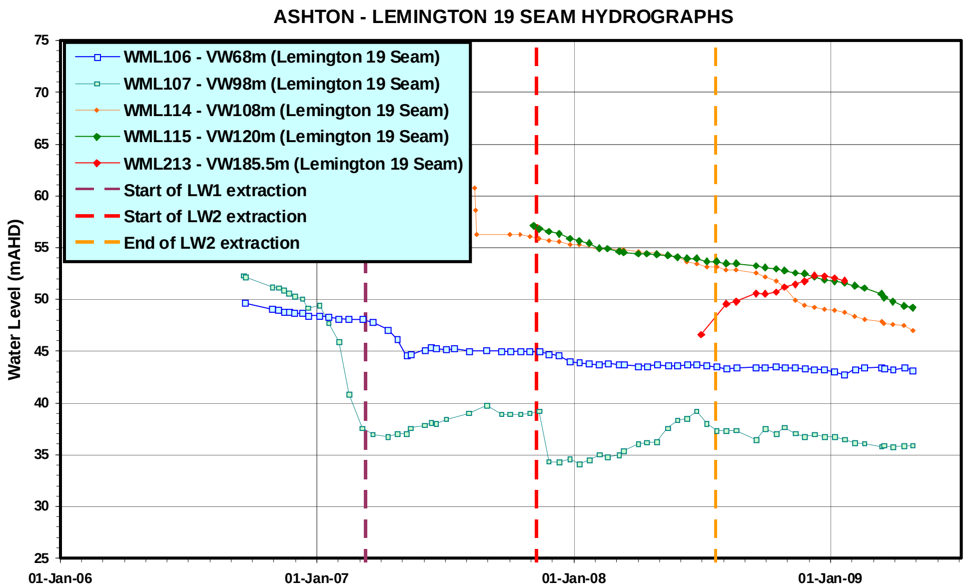
Ashton Coal Operations Ltd

GROUNDWATER LEVELS - PIKES GULLY DECEMBER 2008 (mAHD)

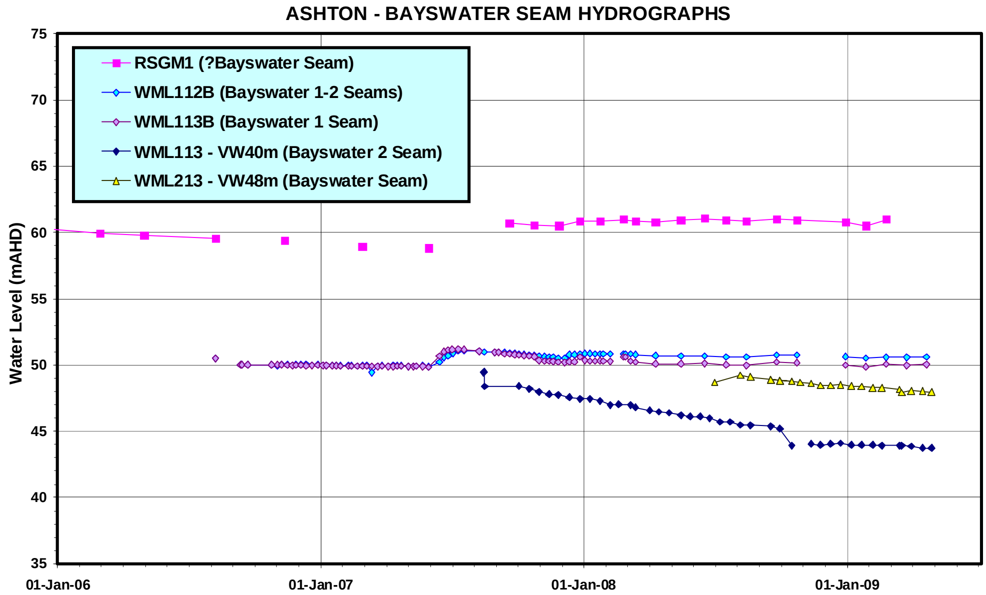
Figure 7

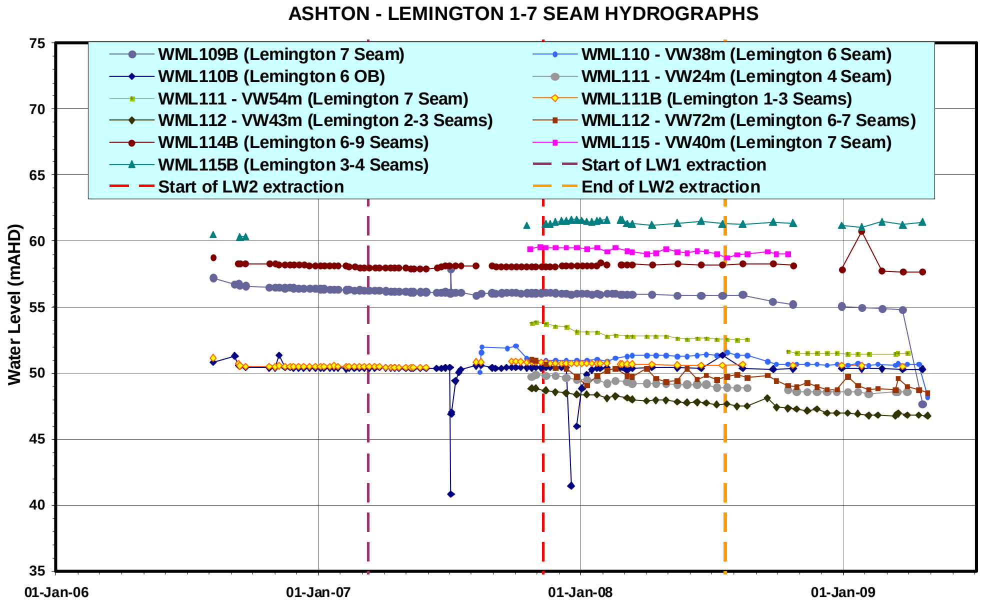


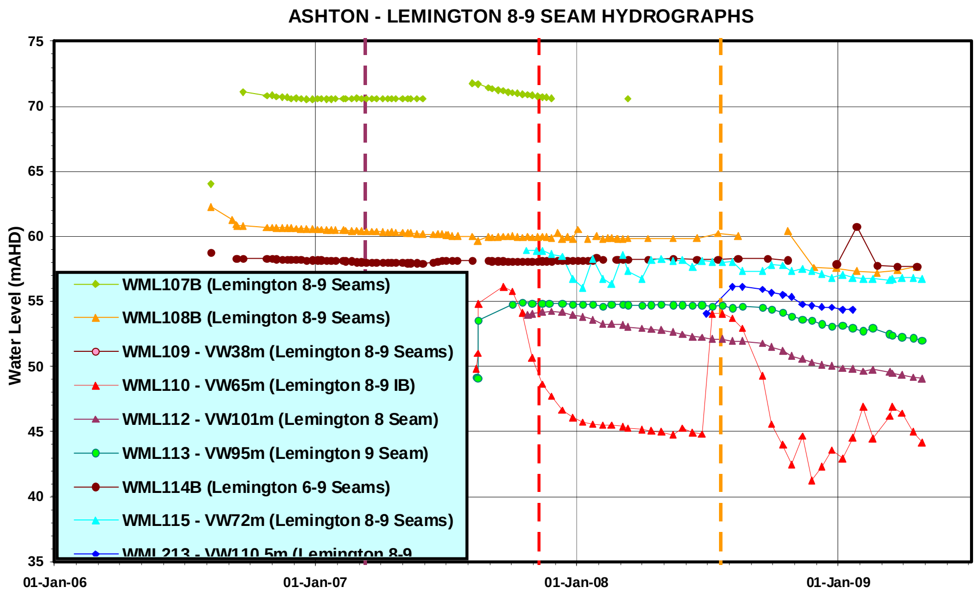




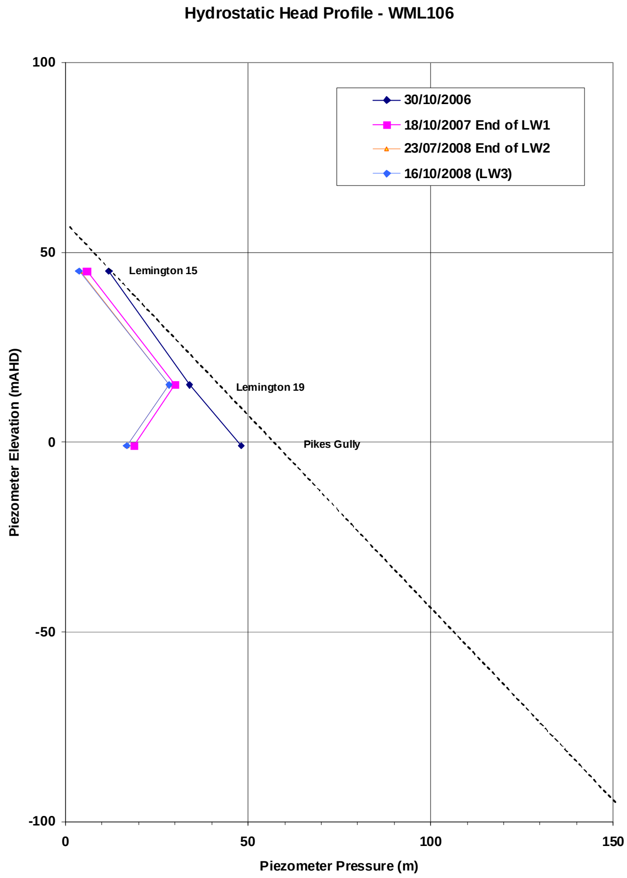
Date: 9 May 2009	Scale: as indicated	**Ashton Coal Operations Ltd**
Initials: PJD	Job No: S03	**GROUNDWATER LEVEL HYDROGRAPHS**
Drawing No: S03-143d	Rev: D	**Lemington 10-12 Seams Lemington 15 Seam Lemington 19 Seam**
aquaterra		**Figure 8**

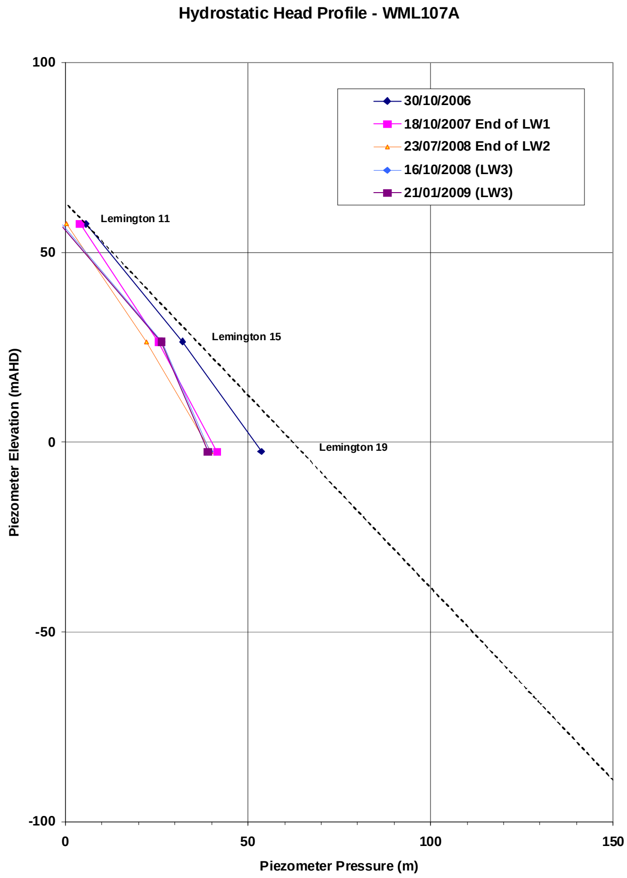


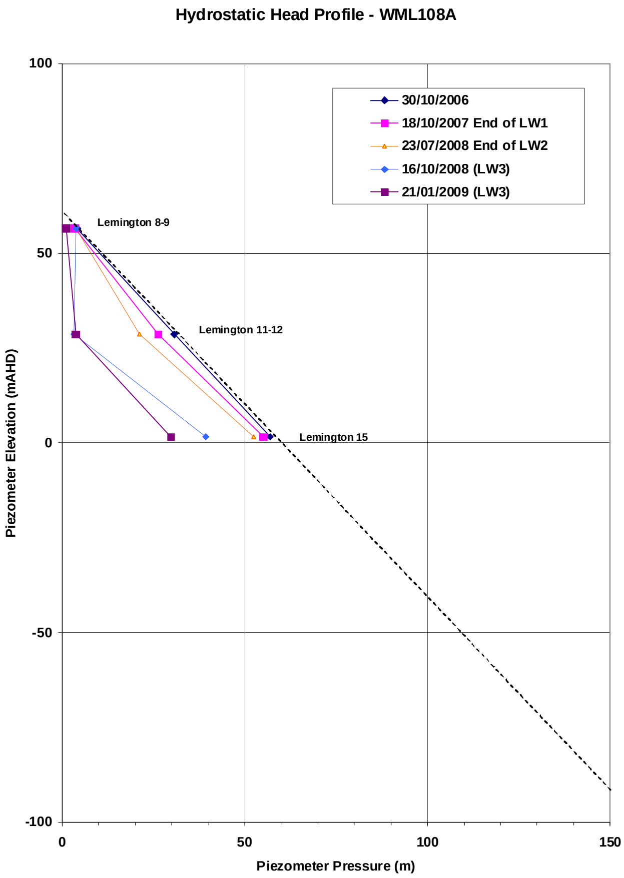


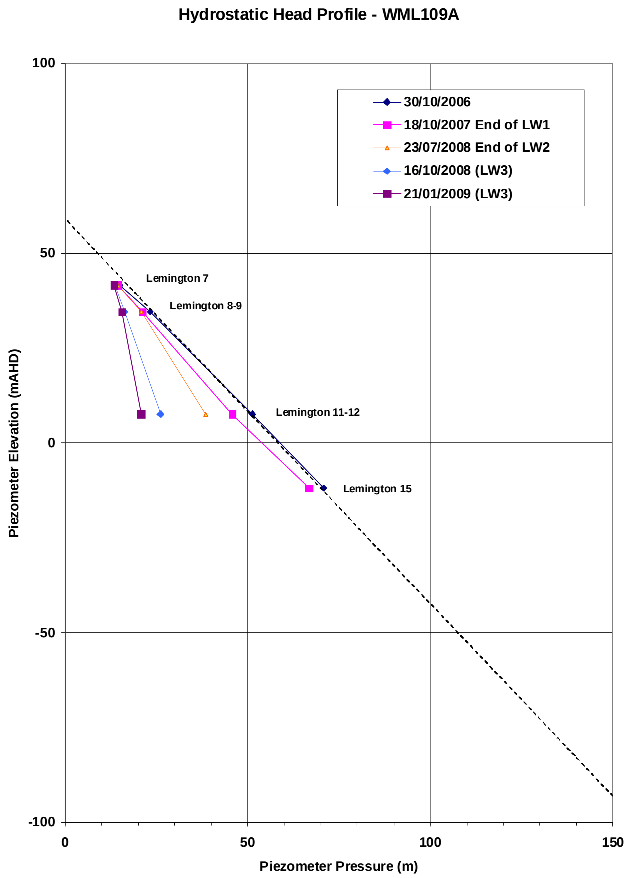


Date: 9 May 2009	Scale: as indicated	**Ashton Coal Operations Ltd**
Initials: PJD	Job No: S03	**GROUNDWATER LEVEL HYDROGRAPHS**
Drawing No: S03-142d	Rev: D	**Bayswater Seam** **Lemington 1-7 Seams** **Lemington 8-9 Seams**
aquaterra		**Figure 9**



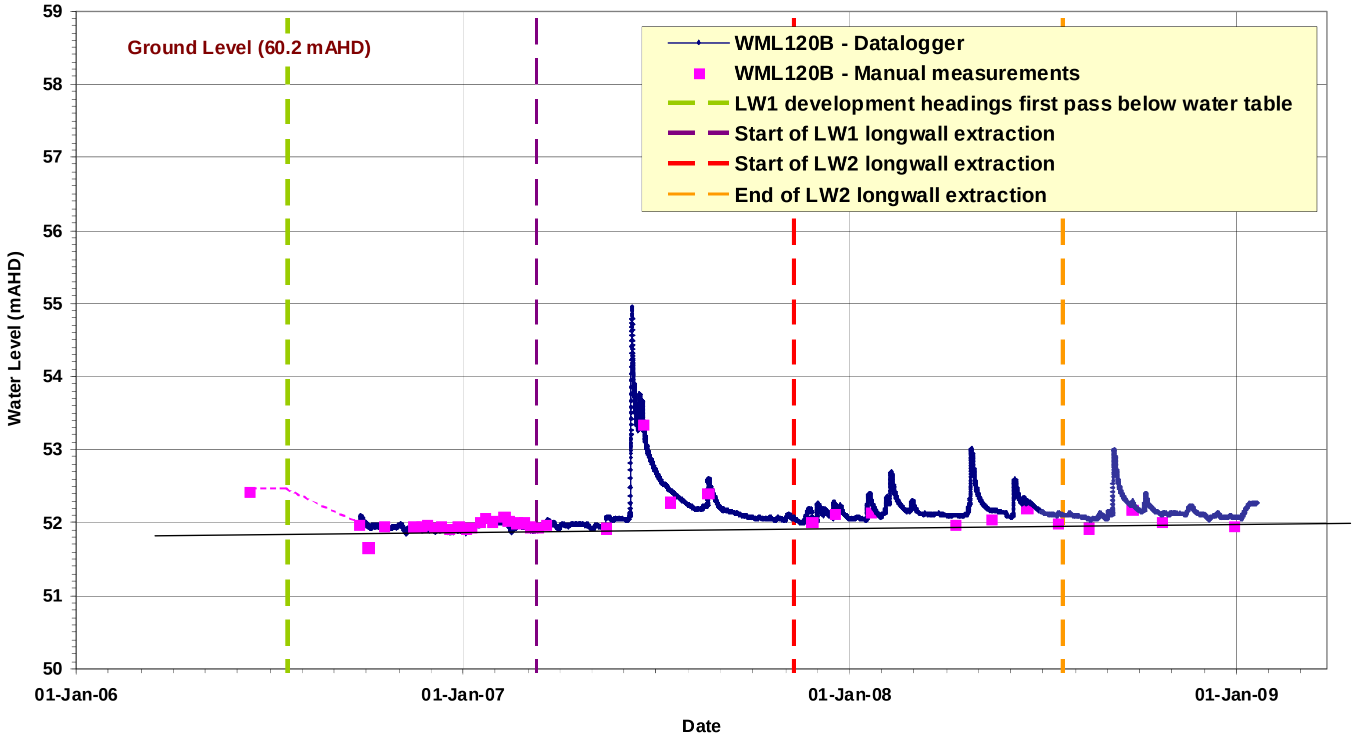




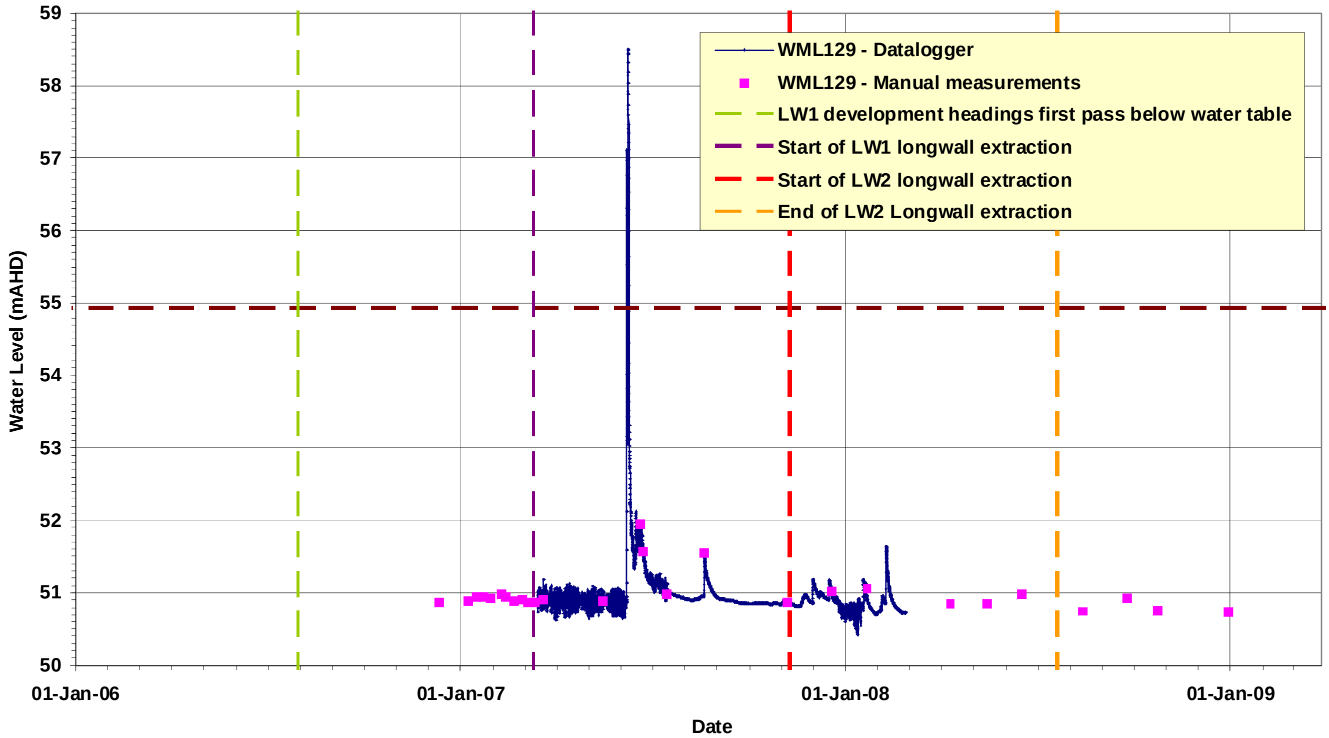


Date: 28 January 2009	Scale: as indicated	**Ashton Coal Operations Ltd**
Initials: JVDA	Job No: S03	**HYDROSTATIC HEAD PROFILES WML106 to WML109**
Drawing No: S03-230a	Rev: A	
aquaterra		**Figure 10**

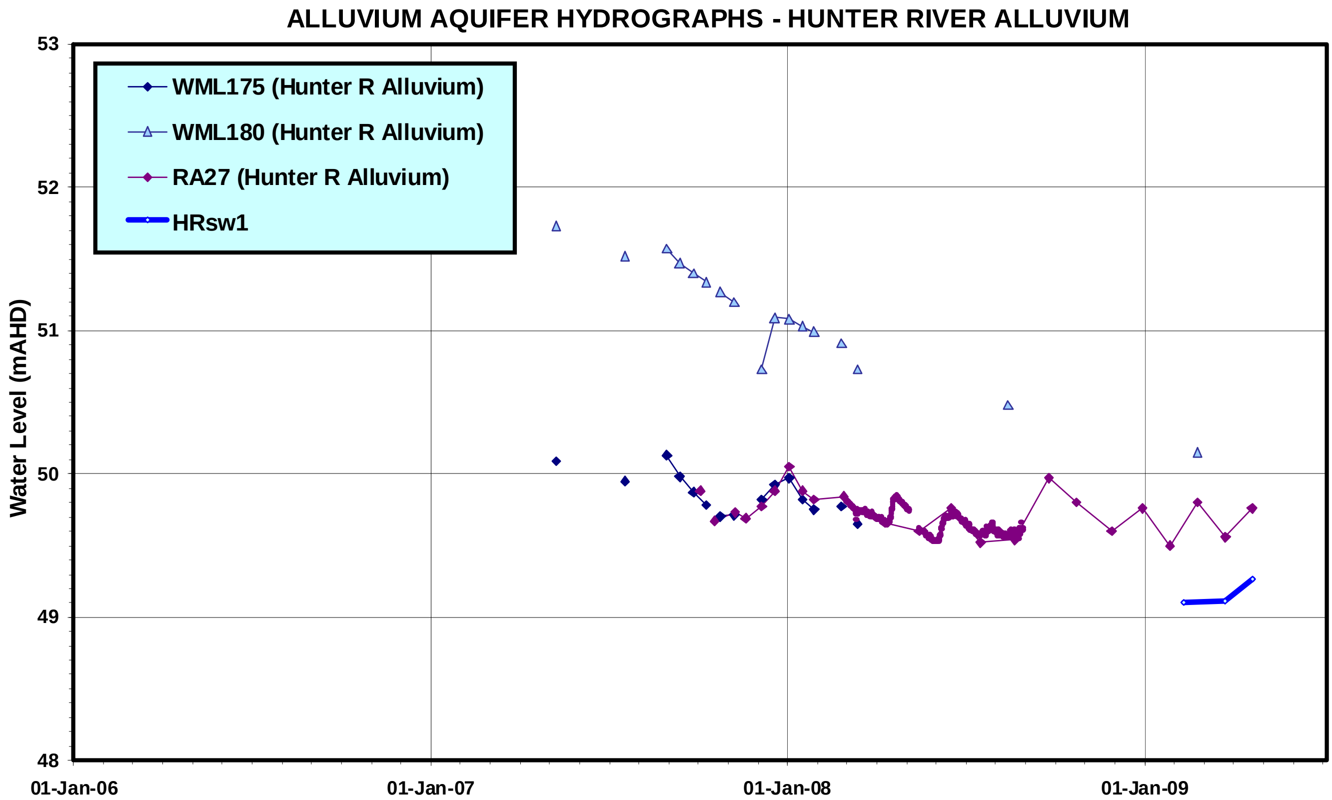
HYDROGRAPH - WML120B (Glennies Creek Alluvium)

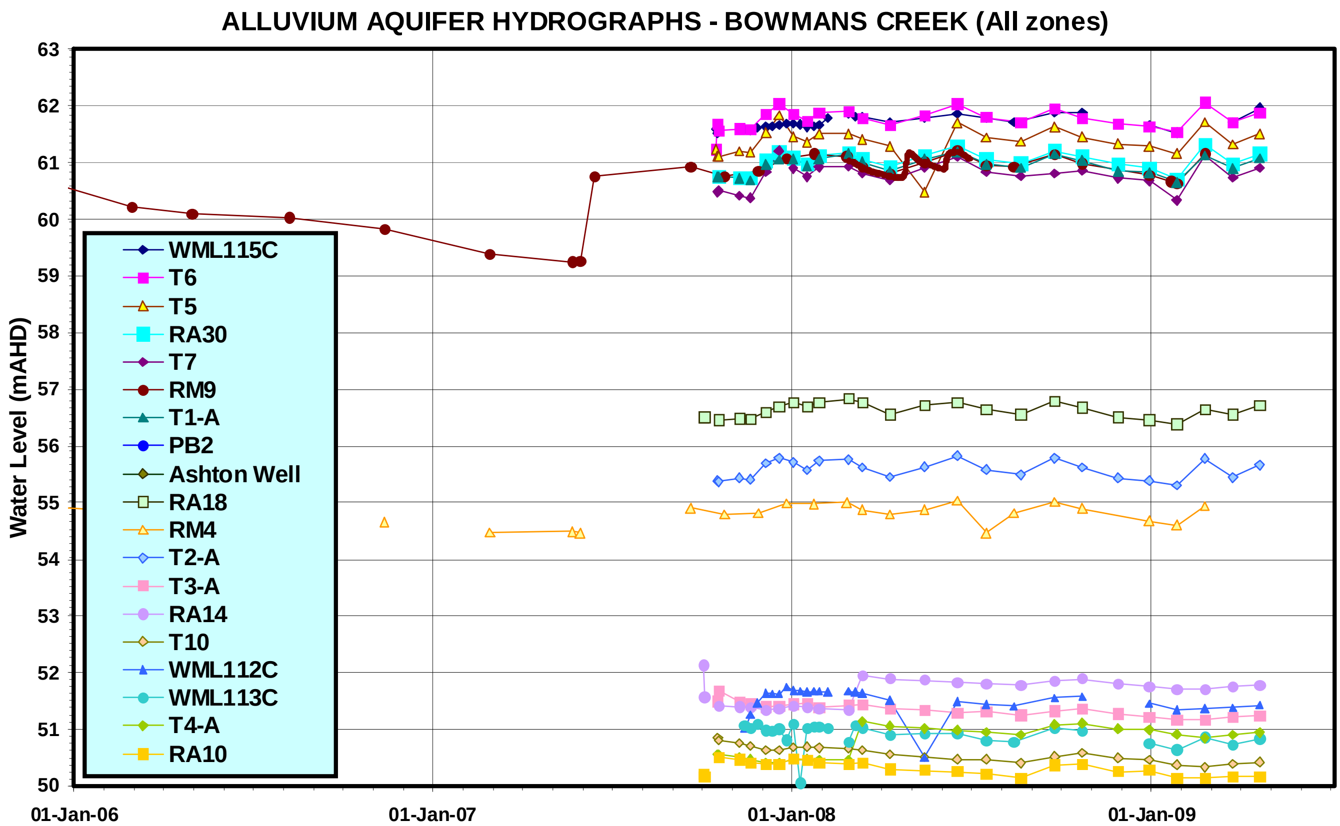


GROUNDWATER LEVEL HYDROGRAPH - WML129 (Glennies Creek Alluvium)

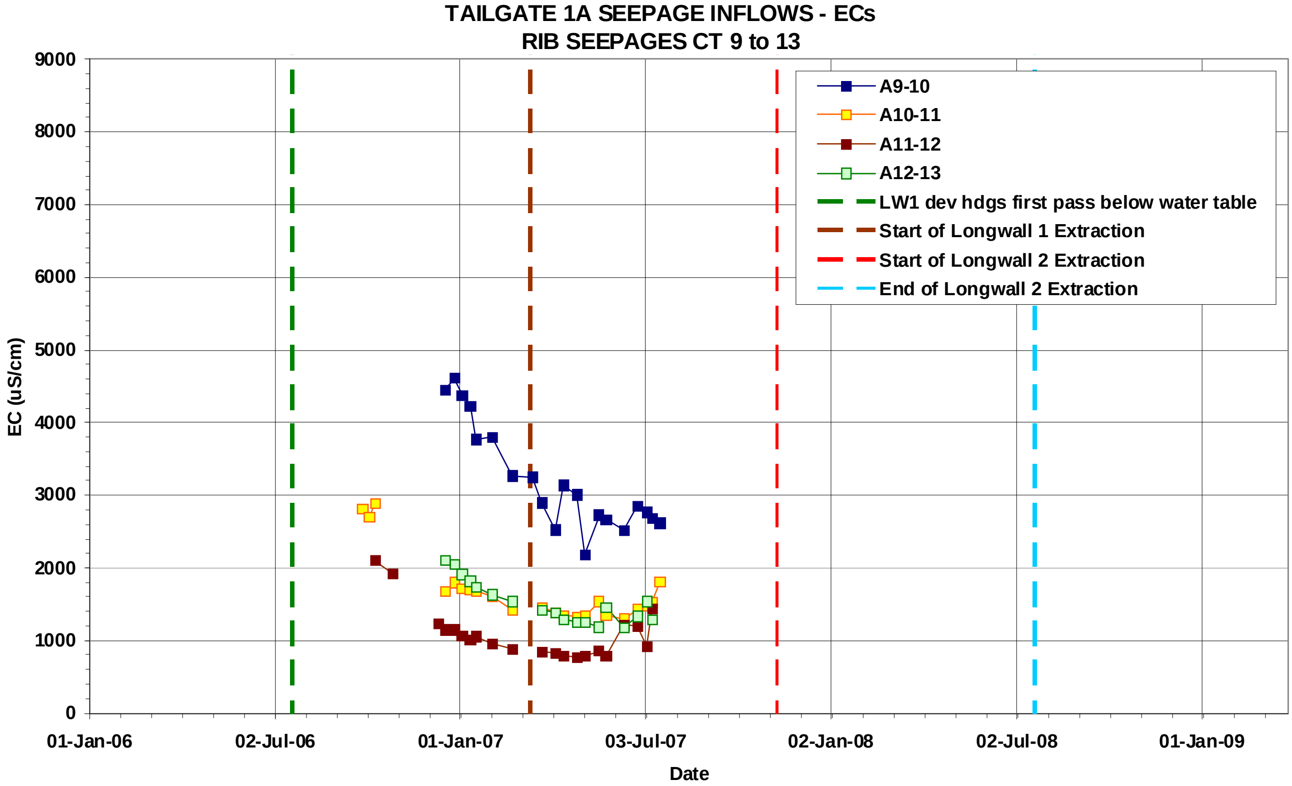


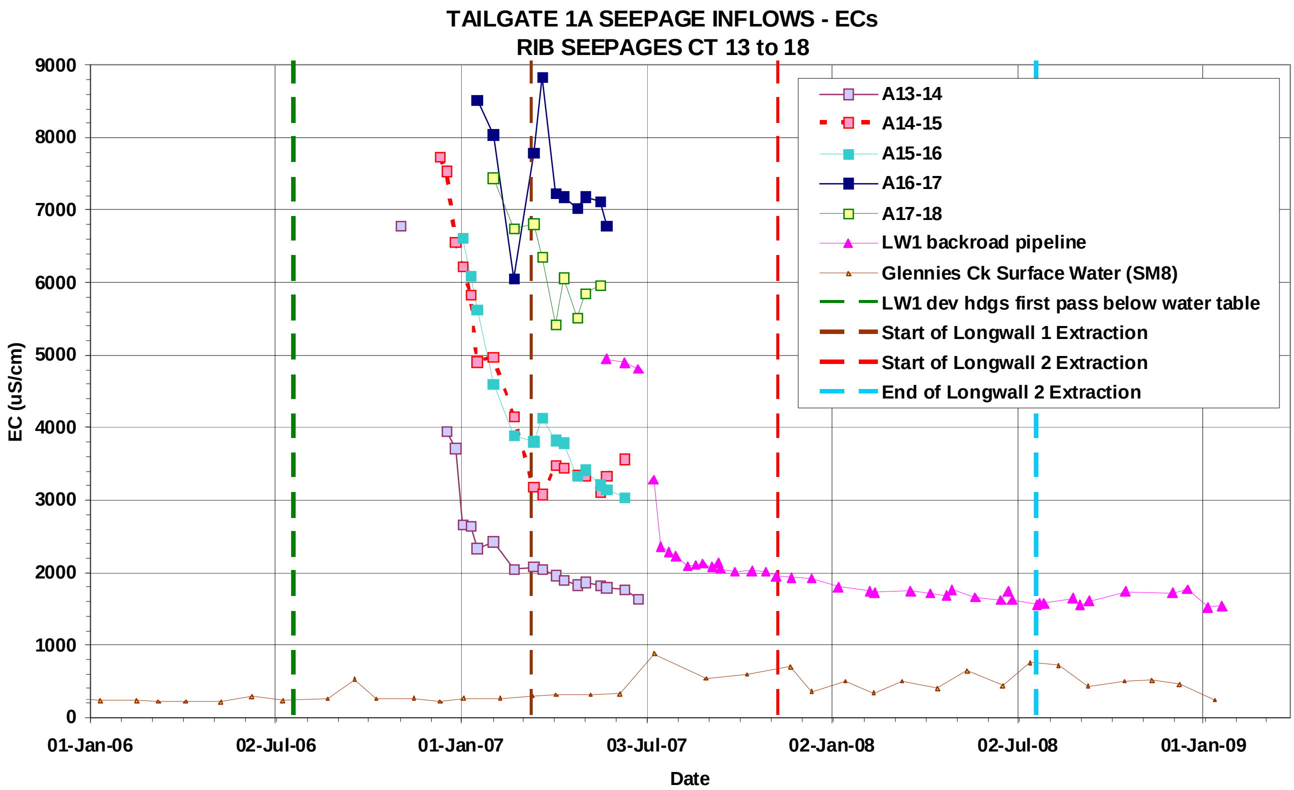
Date: 29 January 2009	Scale: as indicated	**Ashton Coal Operations Ltd**
Initials: PJD	Job No: S03	**GROUNDWATER LEVEL HYDROGRAPHS GLENNIES CREEK ALLUVIUM WML120B and WML129**
Drawing No: S03-152c	Rev: C	
aquaterra		**Figure 11**



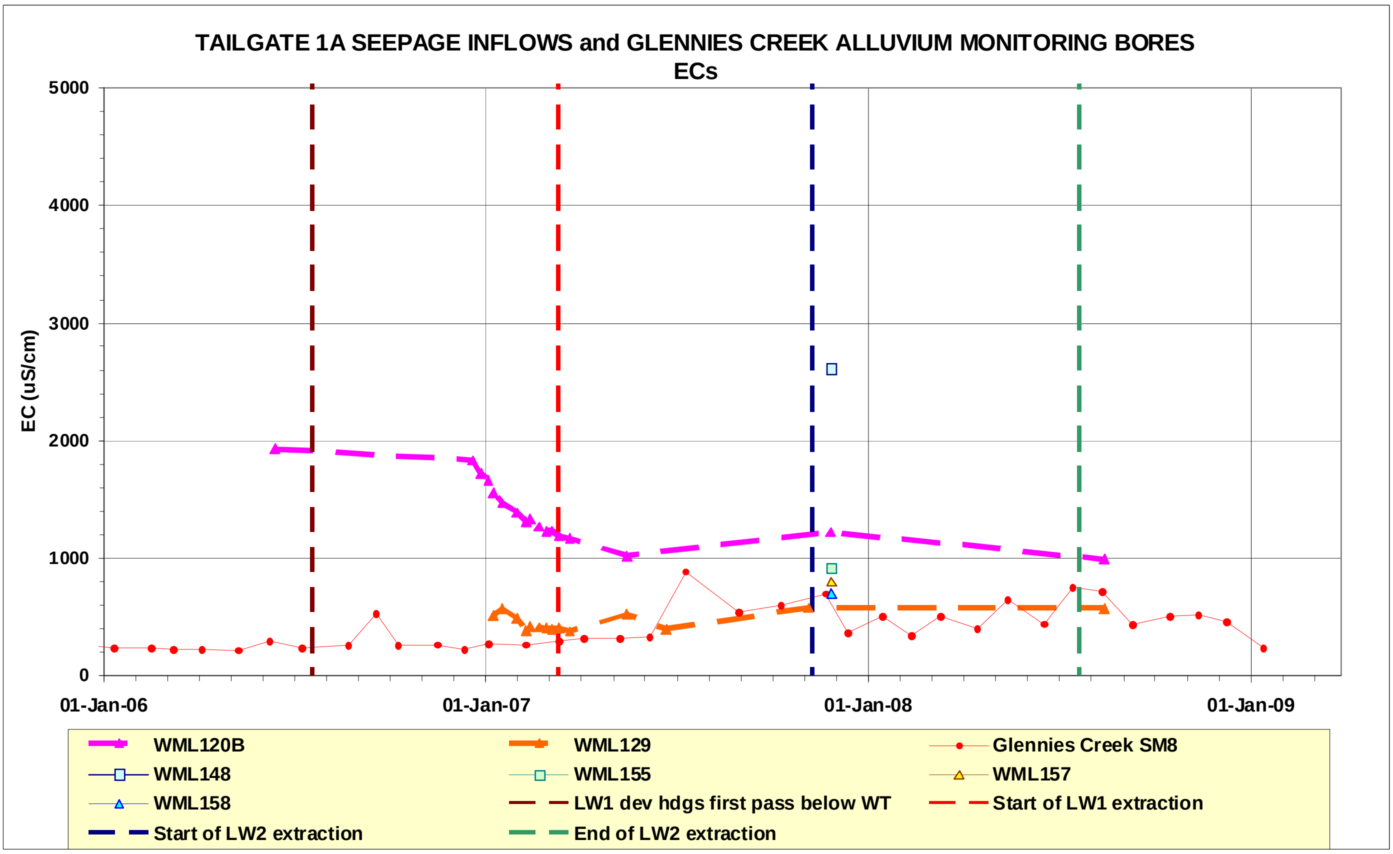


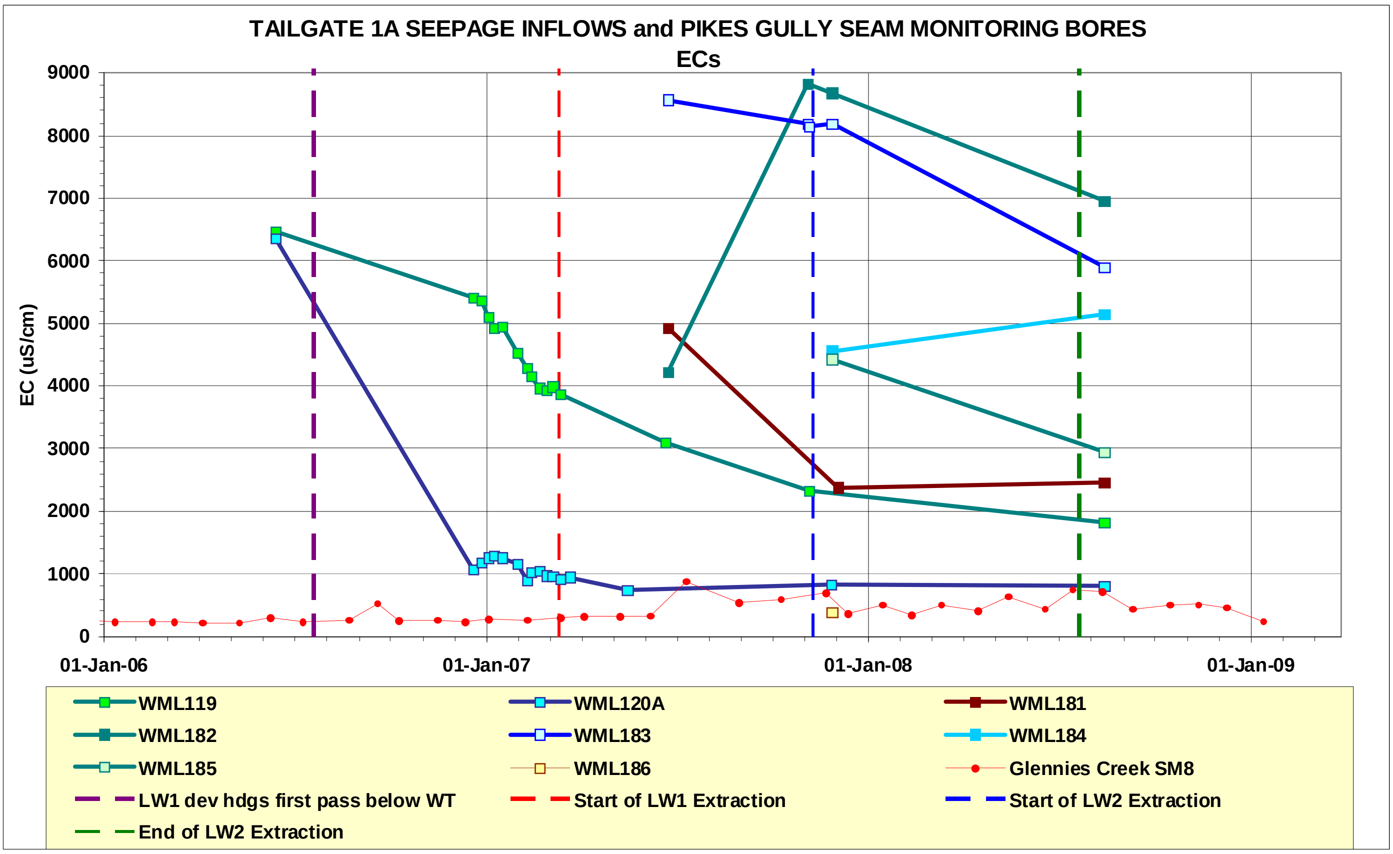
Date: 9 May 2009	Scale: as indicated	**Ashton Coal Operations Ltd**
Initials: PJD	Job No: S03	**GROUNDWATER LEVEL HYDROGRAPHS**
Drawing No: S03-146d	Rev: D	**Bowmans Creek Alluvium**
aquaterra		**Hunter River Alluvium**
		Figure 12



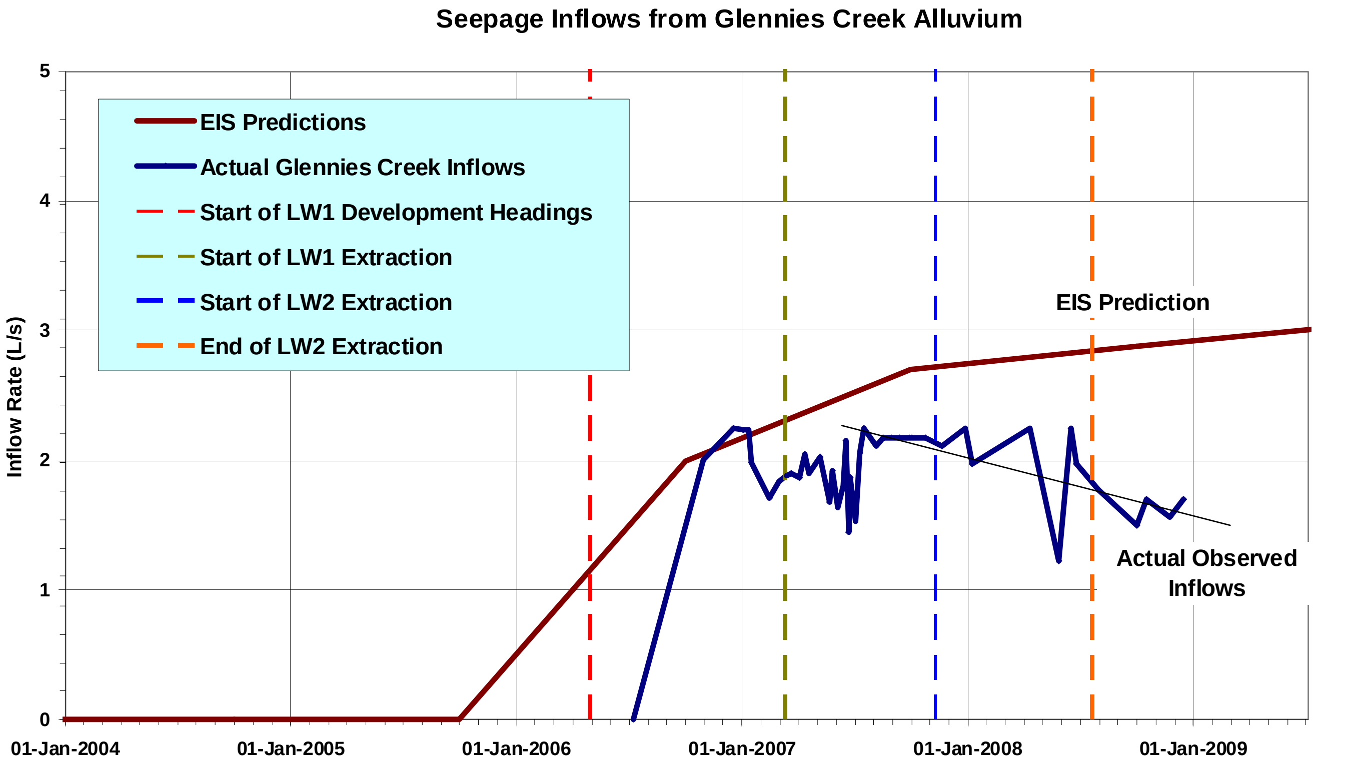


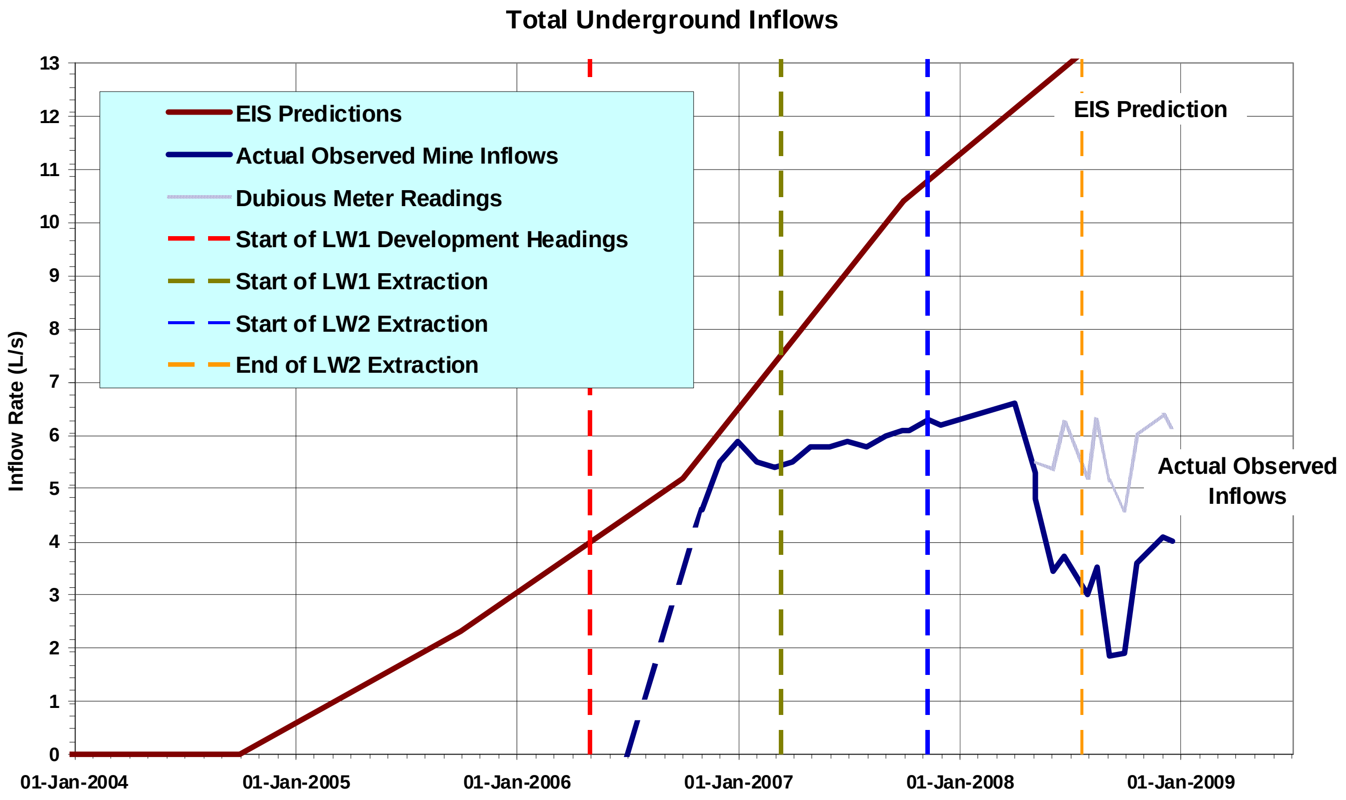
Date: 28 January 2009	Scale: as indicated	**Ashton Coal Operations Ltd**
Initials: JVDA	Job No: S03	**ASHTON UNDERGROUND MINE LONGWALL 1 TG1-A SEEPAGES ECs**
Drawing No: S03-137c	Rev: C	
aquaterra		**Figure 13**





Date: 30 January 2009	Scale: as indicated	**Ashton Coal Operations Ltd**
Initials: JVDA	Job No: S03	**ASHTON UNDERGROUND MINE GLENNIES CREEK MONITORING BORE ECs**
Drawing No: S03-138c	Rev: C	
aquaterra		**Figure 14**





Date: 9 May 2009	Scale: as indicated	**Ashton Coal Operations Ltd**
Initials: PJD	Job No: S03	**ASHTON UNDERGROUND MINE GROUNDWATER INFLOWS vs EIS PREDICTIONS**
Drawing No: S03-135d	Rev: D	
aquaterra		**Figure 15**

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