ASHTON LONGWALL 101 – MID PANEL REPORT

1 INTRODUCTION

This report has been prepared by Ashton Coal Operations Pty Ltd (ACOL) and RPS Aquaterra.

The report has been prepared to satisfy the requirements of the "*Ashton Coal Project Upper Liddell Seam Extraction Plan, Longwalls 1 to 8"*, section 7.5.4. Mid-Panel Data Review.

> ***"7.5.4 Mid-Panel Data Review***
>
> *ACOL will also prepare a succinct summary review of observed data for LWs 1, 2, and 3 in the ULD Seam, within two weeks of passing XL5 (nominally located above 10ct). A copy of this review will be provided to DRE and NOW for reference.*
>
> *This review will focus on the subsidence survey monitoring and groundwater monitoring data collected to that point. The review will comment on the adequacy of the mine plan, provide a brief comparison of the observed data to the predicted subsidence and ground water effects, and whether it is considered that there have been any impacts to Glennies Creek or the Hunter River.*

The main body of the report focuses on the subsidence survey monitoring data collected for the Upper Liddell (ULD) seam LW101 to 10ct, and provides a brief comparison of the observed data to the predicted subsidence effects.

A groundwater review including a comparison of the observed data to the predicted is included in **Appendix 1**, RPS Aquaterra, 2012 *"Ashton Underground Mine LW101 Mid Panel Groundwater Report"* The groundwater report details any observed impacts to Glennies Creek or the Hunter River.

2 BACKGROUND

Longwall 101 began extraction on the 5th of August 2012. Longwall 101 is 2470m long, 205m wide. Mining to date has occurred without any unexpected impact to the surface environment or infrastructure above it.

The effects of subsidence were monitored in accordance with the document "*Ashton Coal Project Upper Liddell Seam Extraction Plan, Longwalls 1 to 8"*; this included both regular survey monitoring and visual inspection of both environmental, land and infrastructure features.

3 MINE SUBSIDENCE

The Upper Liddell Seam section is being mined along the length of Longwalls 101 at Ashton Underground Mine. Mining height is nominally in the 2.3m to 2.6m range. The seam dips to the southwest at a grade of up to 1 in 10. Overburden ranges in thickness from 155m near the start of the longwall panel to 80m at the take off end. The final extraction void is nominally 216m wide. This includes the 5.5m width of development drivage either side of the longwall block. Maingate chain pillars are at a centre to centre width and length of 30m and 150m respectively. Tailgate chain pillars are at a centre to centre width and length of 30m and 150m respectively.

Ashton's longwall mining operation commenced in February 2007. Since then 9 panels have been completed. The progress of longwall extraction is shown in **Figure 1** and **Figure 2**.

Ashton Coal has monitored the subsidence movement on the surface during the extraction of Longwall's 1-8 using longitudinal subsidence lines. These are located over the start and finish lines of each panel, a main cross line extending over all seven southern panels and a dedicated cross line extending over Longwall 7B and 8. All panels have monitoring data for each start and end lines and various cross lines relevant to the panel, surface features or strata features.

The Upper Liddell Seam (ULD) Longwall 101 utilises panel centre lines (CL1 and CL2), the Pikes Gully LW1 panel centre lines and the cross block survey monitoring lines that were used for the Pikes Gully Seam (PG) longwalls. The subsidence monitoring lines relevant to LW101 to date are CL1, XL1 to XL5 as shown in **Figure 3.**

The following table (**Table 1)** outlines the maximum subsidence parameters predicted and recorded during regular survey of subsidence lines as the longwall passed each location.

Subsidence monitoring over Longwall 101 to date consists of regular survey of centreline 1 (LW101 CL1), cross line 1 (XL1) to 5 (XL5). Cross line 2 (XL2) and 3 (XL3) do not extend over the extraction area of LW101, however monitoring was conducted to observe for subsidence impacts outside of the panel towards Glennies Creek. Cross line 4 (XL4) was extended west over the LW101 extraction panel after LW1 extraction. Previous to this XL4 extended to the panel edge of LW1. Therefore the monitoring on cross line 4 only shows cumulative results up to the edge of LW1 and does not represent the multi seam cumulative subsidence beyond this point. The results West of LW1 panel edge are only the effects of LW101. The frequency and results of the monitoring has been maintained per monitoring document "*Ashton Mine Subsidence Monitoring Programme Longwall 101 to 104".* This information is being supplied to the Principal Subsidence Engineer. A graph of the vertical subsidence of cross line 5 is shown in **Figure 4**.

Visual and survey monitoring of existing 132kV power transmission structures over Longwall 101 was undertaken regularly. The 132kV poles have been referenced as SET21, SET22 and SET23. The 132kV transmission line was surveyed prior to, during and post undermining. Survey data from the 132kV power lines was recorded and supplied to the Principal Subsidence Engineer as per the "*Ashton Mine Subsidence Monitoring Programme Longwall 101".* The effects of subsidence on the 132kV structures can be seen in **Figure 5**. Maximum subsidence measured on power poles (SET21, SET22, and SET23) during Longwall 101 mining was: 0.115m, 2.065m and 0.036m respectively.

Table 1: Subsidence of Longwall Panel 101 to 7/01/12 - Predicted vs. Actual (cumulative)

	Maximum Predicted EIS	**Maximum Predicted SMP**	**Maximum Measured as at 07/01/2013**					
Longwall 101			**CL1**	**XL1**	**XL2[1]**	**XL3[2]**	**XL4[3]**	**XL5**
Subsidence (mm)	3700	4400	2715	2494	32	200	1822	2964
Tilt (mm/m)	150	235	5.8	41.8	3.7	31.3	48.9	100.5
Tensile Strain (mm/m)	70	94	4.5	22.6	1.3	13.2	11.5	26.2

[1] **XL2 does not extend over LW101 area.**
[2] **XL3 does not extend over LW101 area.**
[3] **XL4 was extended to the west post LW1 mining and prior to LW101 mining therefore the data relates to LW101 effects only**

3.1 SUBSIDENCE IMPACTS

Surface subsidence cracks have developed along each gate edge of the Longwall panel. These generally run parallel to the gate road within the longwall block. Cracks are particularly evident on the up-hill side of the panel. Some cracks and compression lines have occurred parallel to the retreating face. Where this has occurred the features have usually started from a parallel pillar edge crack and continued around to align with the face.

The maximum subsidence movements detected over Longwall 101 are less than those predicted in the SMP. This occurred for all centreline (CL) survey monitoring lines and cross lines. Horizontal movement has occurred in the coal seam up dip direction (North East-East) above each of the Longwall panels. This movement has predominantly occurred within the longwall panels with limited displacement detected outside the panel edge.

Rehabilitation of the surface cracks has been occurring as extraction continues. The work has been completed with a small excavator smoothing over surface cracks. Effected surface roads have only required a grader to smooth compression humps and minor cracks.

4 GROUNDWATER MONITORING

Ashton has an extensive monitoring network of piezometers, ground water inflow monitoring and laboratory analysis of water quality for monitoring groundwater pressure and levels and quality. Groundwater monitoring around LW101 has been intensified for the period of extraction to identify any potential sudden changes that may occur. This information has been detailed in **Appendix 2**, RPS Aquaterra, 2012 *"Ashton Underground Mine LW101 Mid Panel Groundwater Report"*

Groundwater monitoring shows that the impact of LW101 is less than that predicted in the EIS and the LW101 extraction plan. The monitoring data does not show any indication of an affect on the Hunter River Alluvium or the Glennies Creek Alluvium from the LW101 extraction to date.

5 ADEQUACY OF THE MINE PLAN

The subsidence data and the groundwater monitoring data both show that the effects of multi seam extraction of LW101 is within the predictions of the EIS and the SMP. The offset layout of the multi seam panels has, to date, shown results that are less than those effects that were predicted. The results also show consistency across different monitoring sites indicating that the multi seam response is predictable.

Visual observation on the surface indicates that deformation from the subsidence is as expected with surface cracks occurring in similar locations as the single seam extraction with respect to the extraction panel edges. Underground observations show minimal effects from the overlying extraction in the Pikes Gully seam. These results are less than anticipated, indicating that the approach to mine design, operation and management of the multi seam extraction has been conservative.

Figures

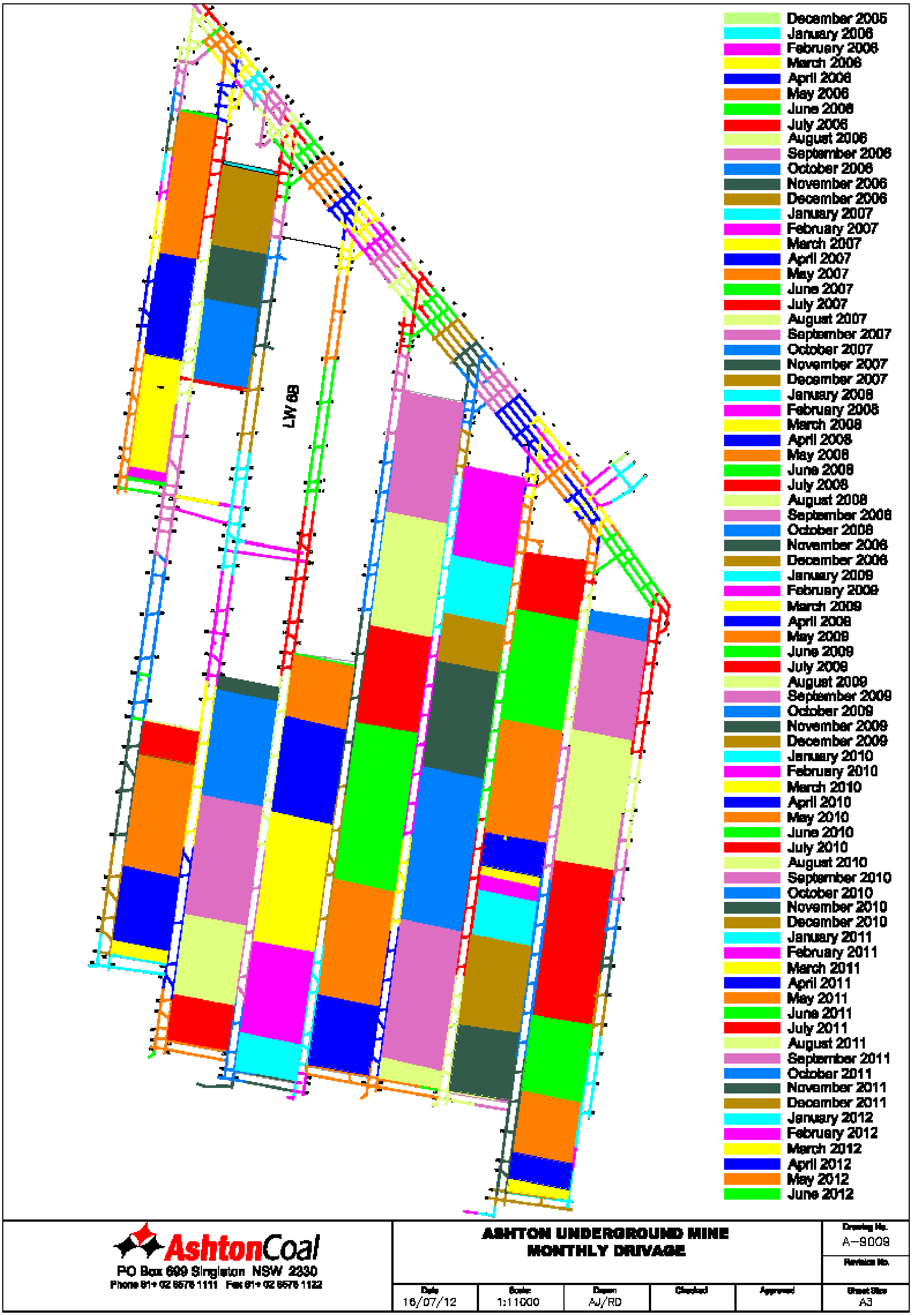

Figure 1: Progression of Longwall Extraction in the Pikes Gully Seam

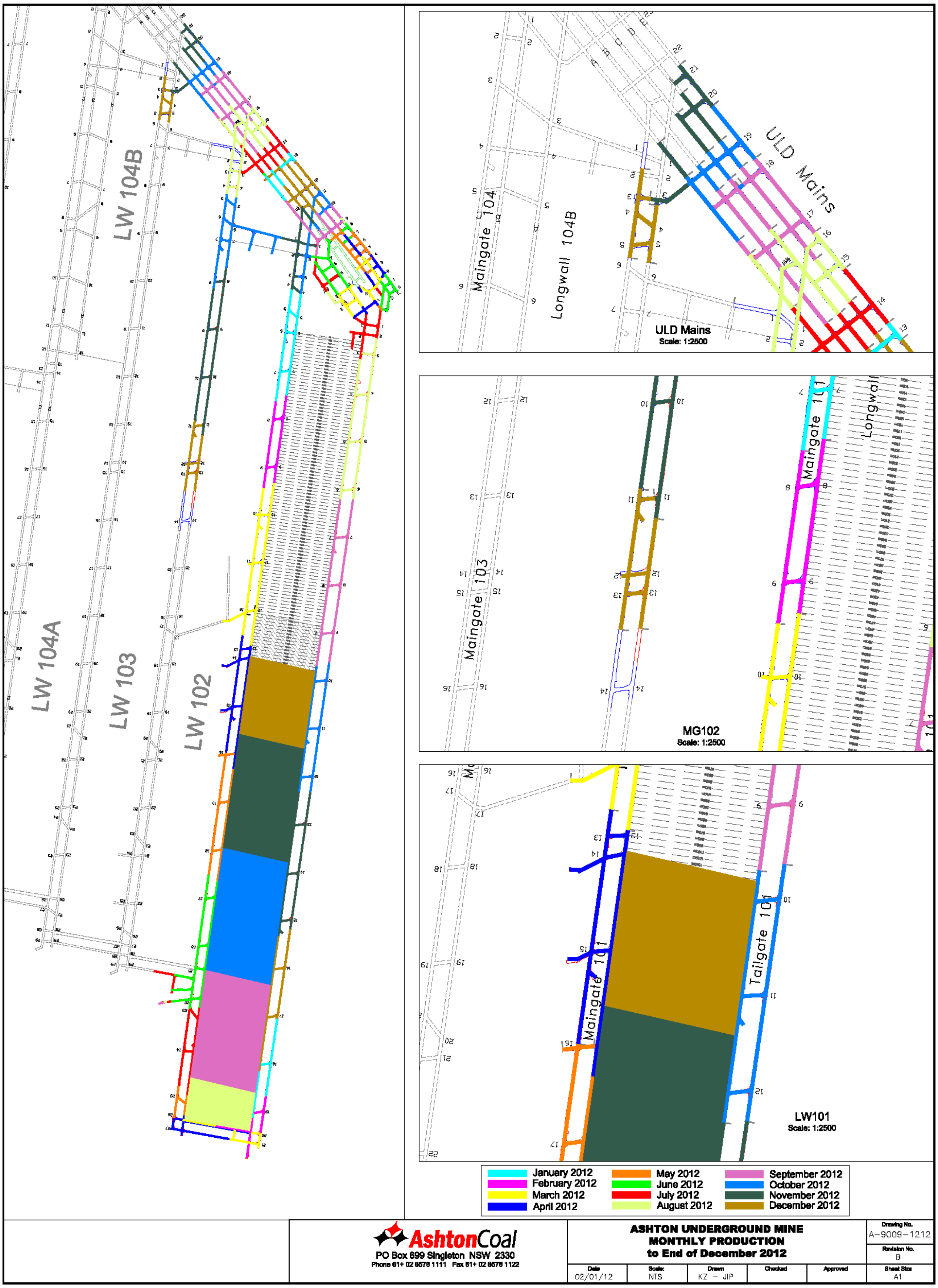

Figure 2: Progression of Longwall Extraction in the Upper Liddell Seam

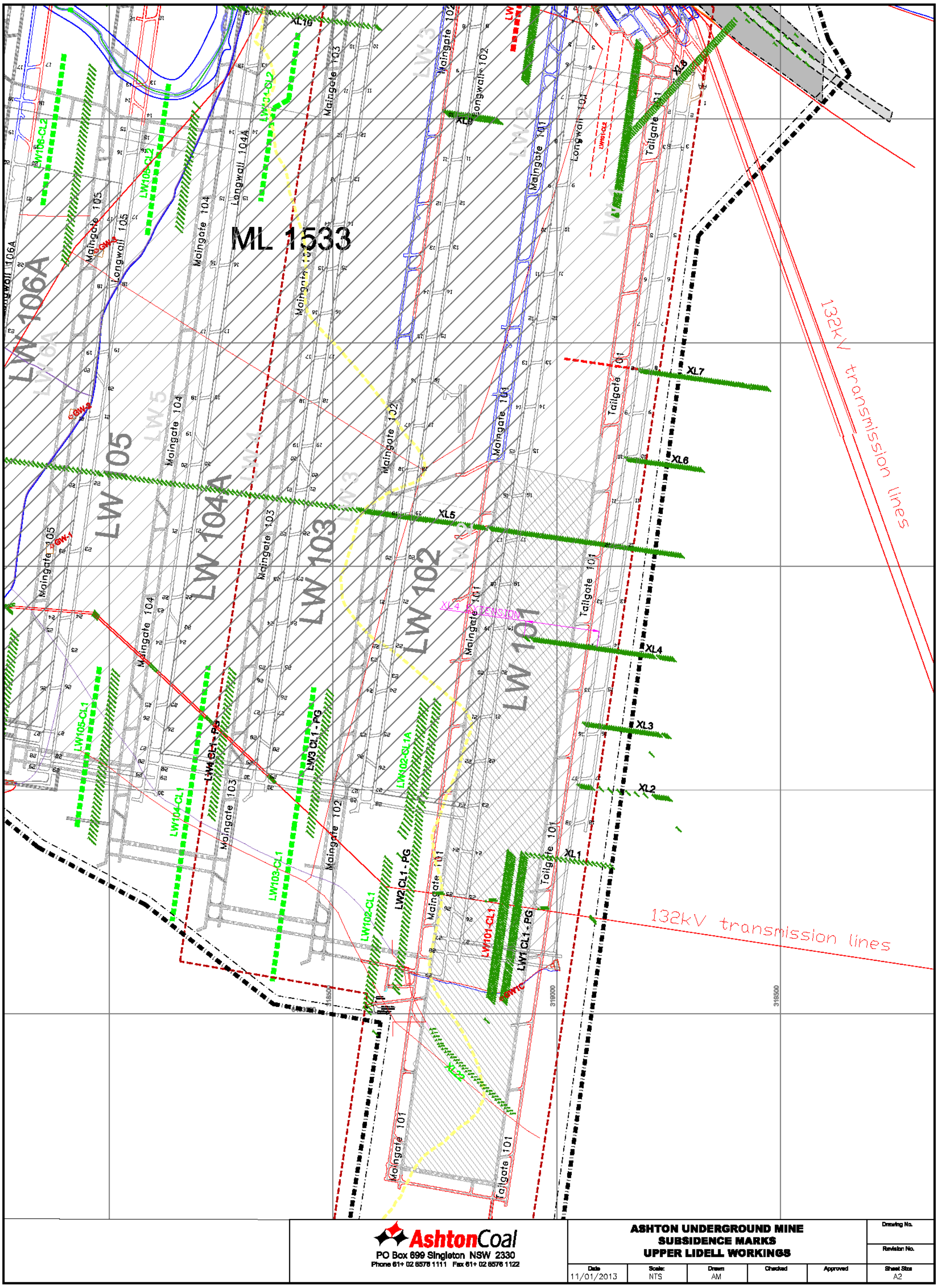

Figure 3: Plan location of Monitoring Cross Lines. Also shown is the 132kV transmission lines.

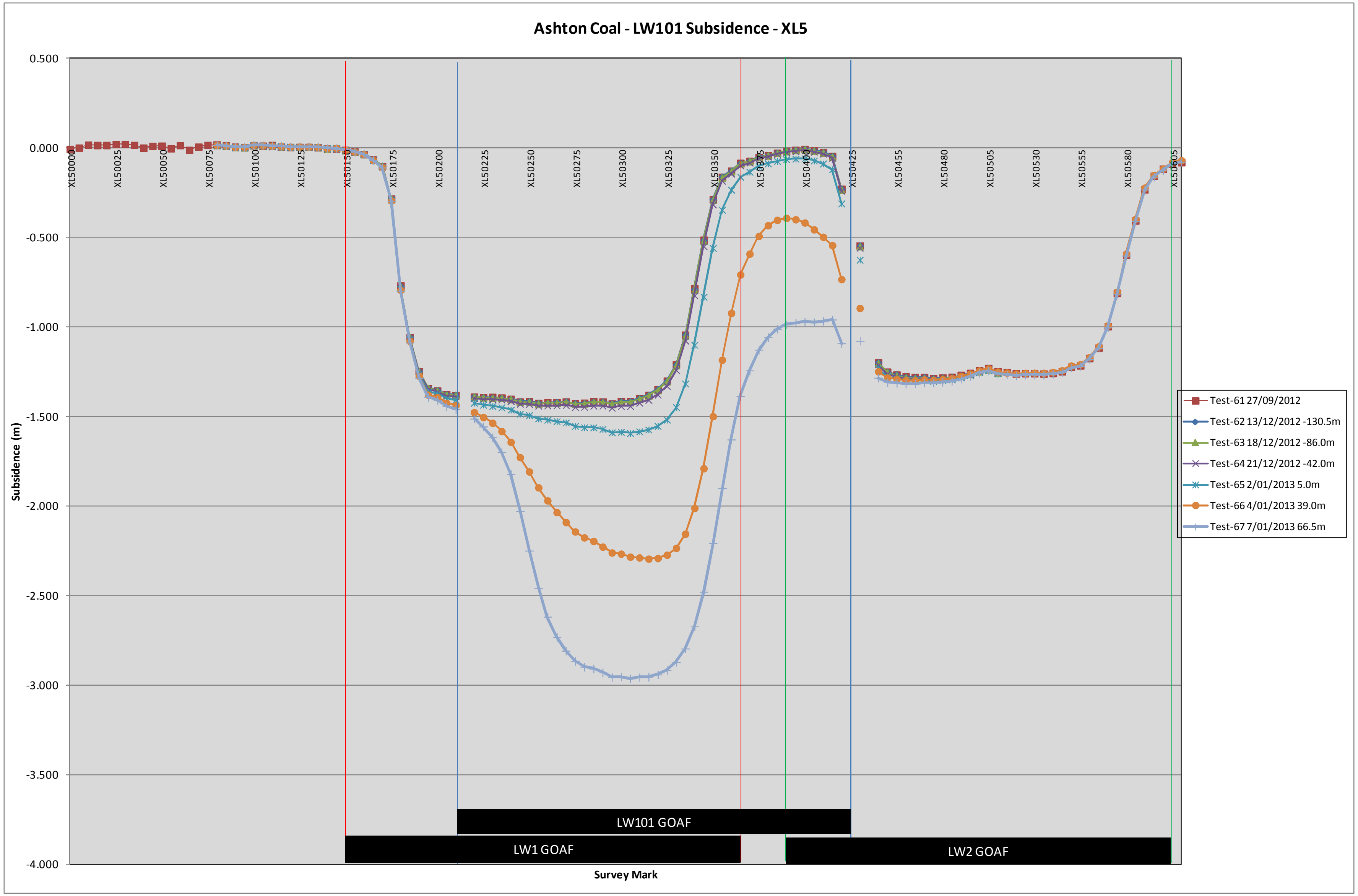

Figure 4: Vertical subsidence of XL5 – Pre and Post LW101

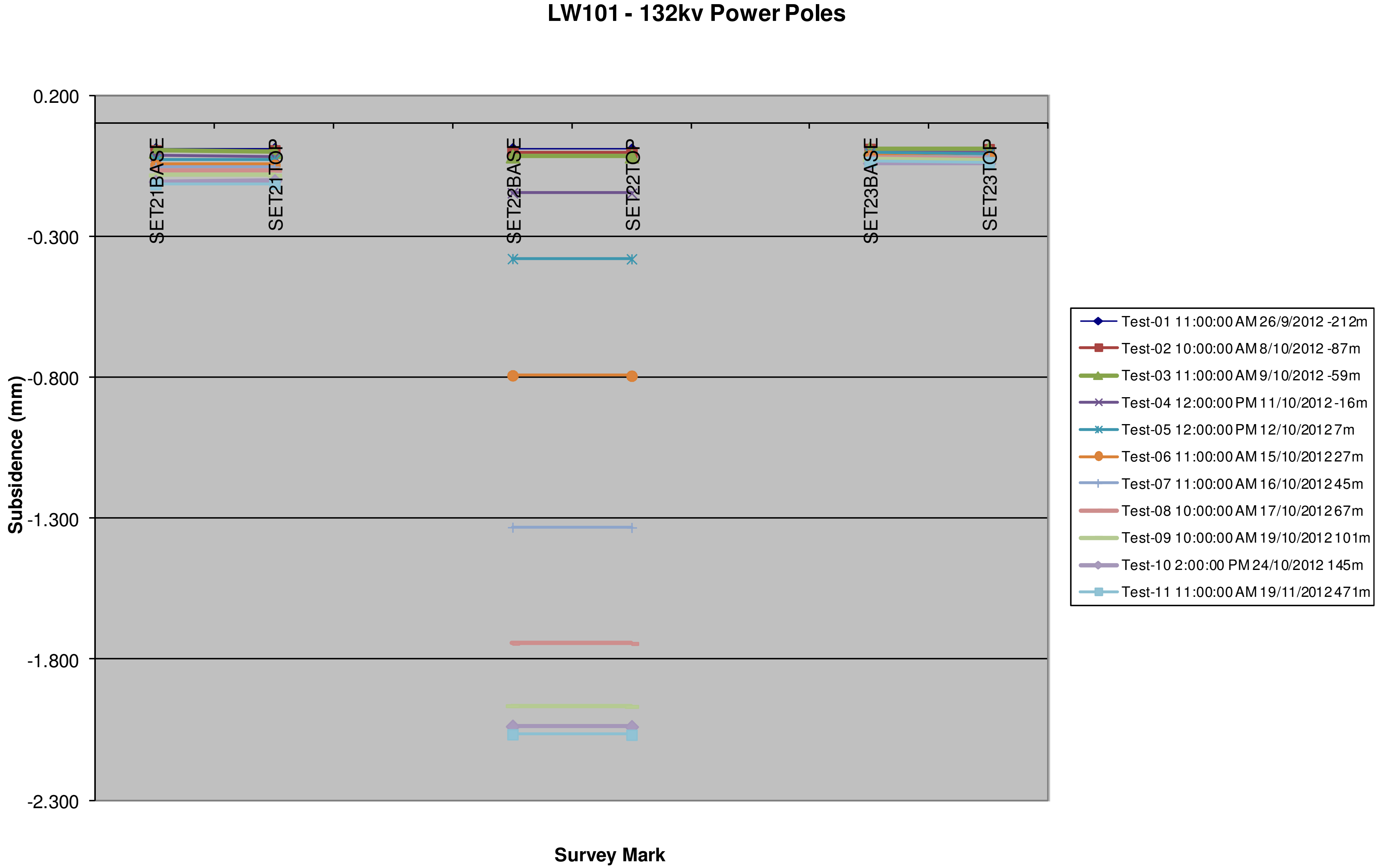

Figure 5: Subsidence Monitoring Data 132kv Power Poles

Appendix 1

Ashton Underground Mine LW101 Mid Panel Groundwater Report

RPS Aquaterra, 2012

RPS Aquaterra

ASHTON UNDERGROUND MINE
LW101 MID PANEL GROUNDWATER REVIEW





ASHTON UNDERGROUND MINE
LW101 MID PANEL GROUNDWATER REVIEW

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1. INTRODUCTION

Ashton Coal Operations Pty Limited (ACOL) operates the Ashton Coal Project (ACP), located 14 kilometres (km) west of Singleton in the Hunter Valley region of New South Wales. ACOL is a wholly owned subsidiary of Yancoal Australia Limited (Yancoal), which is the majority (90%) joint venture owner of the mine.

The ACP comprises an open cut mine, an underground mine, a coal handling and preparation plant, rail loading facilities, run-of-mine and product coals stockpiles, and various surface support infrastructure and facilities. Development Consent (DA 309-11-2001) for the ACP was granted by the Minister for Planning in October 2002. The ACP is approved to produce up to 5.45Mtpa of ROM coal until February 2024.

The underground mine is located south of the New England Highway and is situated between the highway and the Hunter River. The underground is accessed from the highwall of the open cut pit, on the north side of the highway.

Coal is extracted via longwall mining with approval to mine the Pikes Gully (PG), Upper Liddell (ULD), Upper Lower Liddell (ULLD) and Lower Barrett (LB) coal seams. The approved plan includes a diversion of Bowmans Creek via two diversion channels, which have re-routed the creek to areas not undermined by longwall panels (Figure 1).

Development of the underground mine commenced in the PG seam in 2005 with longwall coal extraction commencing in 2007. With the exception of longwall panel LW6B mining of the PG seam has now been completed. To date nine groundwater impact assessment reports assessing the impacts from each longwall have been completed, details of these are presented in Table 1.1.

Table 1.1: Longwall Mining Completed at Ashton

Seam / Panel	Start date	End date	Report reference
PG / LW1	12/03/2007	15/10/2007	Aquaterra, 2008
PG / LW2	10/11/2007	21/07/2008	Aquaterra, 2009a
PG / LW3	20/08/2008	03/03/2009	Aquaterra, 2009b
PG / LW4	02/04/2009	15/10/2009	Aquaterra, 2010a
PG / LW5	04/01/2010	07/06/2010	Aquaterra, 2011
PG / LW6A	09/07/2010	22/11/2010	RPS Aquaterra, 2011
PG / LW7A	23/03/2011	05/08/2011	RPS Aquaterra, 2012a (included in 2011 AEMR)
PG / LW7B	03/10/2011	17/01/2012	RPS Aquaterra, 2012b
PG / LW8	27/02/2012	05/06/2012	RPS Aquaterra, 2012a
PG / LW101	03/08/2012	31/01/2012[1]	Current report

Note: [1] LW101 has only been mined to the midpoint by the 31/01/2012

1.1 Report Scope

The primary aim of this report is to demonstrate that mining has been undertaken in accordance with the approved plans that all the identified potential impacts are within those predicted.

The report demonstrates that subsidence and induced fracturing resulting from LW101 coal extraction has not caused long-term degradation of the groundwater storage and quality in the alluvial aquifer system associated with Glennies Creek and the Hunter River.

The report provides a data review at the midpoint of mining of longwall panel LW101. The review has been prepared after consideration of all the available monitoring data, including:

- Groundwater inflows to the mine;
- Groundwater level records from 53 piezometers across 24 sites;
- Laboratory analysis of groundwater samples collected from piezometers and underground

water sampling points; and

- Field data on water quality from underground water sampling points, surface water samples and selected bore water samples.

Prior to the commencement of mining in the ULD seam, baseline studies a groundwater extraction plan and impact assessment was conducted (RPS Aquaterra 2012f). These studies were carried out to revise predictions from the EIS based on additional hydrogeological information acquired since the original Development Consent was granted. Data collected during LW101 extraction have been compared to the baseline data to assess actual impacts against predicted.

2. SITE DESCRIPTION

2.1 Longwall 101

Longwall 101 (LW101) is the first longwall panel to extract coal from the ULD seam. LW101 underlies the previously mined PG seam with the ULD mine plan offset by 60m to the west to minimize impacts (Figure 2).

Extraction of LW101 commenced on 3 August 2012. This report covers extraction up to cut-through 14 along the maingate (LW101 MG 14 C/T) which occurred on 31 December 2012.

The ULD seam varies in thickness between 1.75m and 3m along the LW101 panel. The overburden thickness above the ULD seam along LW101 ranges from 140m at the north-east corner to around 155m between cut-through 23-24 along MG101 23-24.

Deposits of saturated alluvium of the Glennies Creek floodplain are located adjacent to the southern quarter LW101, on its eastern side (Figure 2). Saturated Hunter River Alluvium (HRA) is located south of LW101and on the south-western side (Figure 2).

2.2 Rainfall

Table 2.1 presents the monthly rainfall data collected by the Ashton onsite weather station. This data is compared with the long-term median (LTM) rainfall for rainfall at the Jerry’s Plains weather station, situated approximately 14km to the southwest of the ACP.

During LW101 extraction to-date (3 August 2012 to 31 December 2012) the Ashton area received 95.4mm of rainfall, well below than the LTM for the period of 220.9mm.

Table 2.1: Ashton Coal 2012 Monthly Rainfall

	Jan 12	Feb 12	Mar 12	Apr 12	May 12	Jun 12	Jul 12	Aug 12	Sep 12	Oct 12	Nov 12	Dec 12
Rainfall (mm)	45.8	142.6	76.6	28.8	12.2	55.8	35.2	10.6	4.8	3.2	27.6	81.0
LTM (mm)	64.3	49.6	47.0	32.3	29.9	31.2	35.4	30.6	34	49.2	50.1	57.0

Source: Bureau of Meteorology (BOM January 2012).

Shading denotes period of LW101 extraction

Monthly rainfall and the cumulative deviation from the long-term median are plotted on the hydrographs to assist with interpretations of observed groundwater responses.

2.3 Hydrogeological Environment

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

- A hard rock aquifer system in the Permian coal measures, in which the predominant groundwater flow occurs along cleat fractures within the coal seams; and
- An aquifer of medium porosity consisting of unconsolidated alluvial sediments associated with Bowmans Creek, Glennies Creek or the Hunter River.

Groundwater flow in the Permian is dominated by fracture flow, particularly within the coal seams. The hydraulic conductivity (permeability) of the coal seams is low, generally two or more orders of magnitude lower than the alluvial sediments. Higher permeabilities are found within the coal seams in areas with less overburden (close to the seam outcrop). The hydraulic conductivity of the coal seams declines gradually with increasing depth of cover. As groundwater flow and storage are dominated by relatively tight, sparse fracturing, storage capacity and storativity within the Permian rocks is very low.

2.3.1 Pre-mining groundwater conditions

The pre-mining hydrogeological environment is described in detail in the ULD Seam Extraction Plan Groundwater Impact Assessment (RPS Aquaterra 2012).

The key features are:

- The general groundwater flow direction within the Permian was to the south and the west. Groundwater flow is controlled by elevation with elevated areas of the subcrop on the eastern side of the underground mine, through to the deeper Permian associated with the Bayswater syncline to the west;
- Potentiometric head in the Permian was generally higher than the BCA groundwater levels in the lower valley areas, particularly in the south near the Hunter River confluence. A similar situation occurs to the east within the Glennies Creek Alluvium (GCA), where a potential for upwards flow from the Permian to the alluvium occurs in the baseline condition; and
- Bowmans Creek, Glennies Creek and the Hunter River were all generally gaining watercourses in the pre-mining hydrogeological environment (i.e. alluvial groundwater contributed baseflow into the creeks and River).

2.3.2 Upper Liddell Seam hydraulic conductivity

Hydraulic testing of the ULD seam indicated that the horizontal hydraulic conductivities (kh) are in the order of 0.002 to 0.03m/d. Higher conductivities typically apply to parts of the ULD seam within the weathered zone that are close to outcrop, the higher hydraulic conductivity of 0.03m/d was measured in WML261 (Figure 2).

The results of hydraulic testing of bores in the zone between Glennies Creek and LW101 have confirmed that the higher permeabilities of the outcrop zone are limited to a depth of less than 100m from outcrop (Aquaterra, 2008a).

2.3.3 Alluvium hydraulic conductivity

The alluvial sediments associated with Glennies Creek and Hunter River comprise of clay and silt-bound sands and gravel, with occasional coarser lenses or horizons where sands and gravel have been concentrated.

There is limited alluvium associated with Glennies Creek to the east of ULD LW101. The GCA is moderately to poorly permeable, with hydraulic conductivity values generally less than 1m/d. The occasional coarser horizons are found within the GCA with conductivities of around 10m/d.

The hydraulic connection between alluvial deposits and shallow weathered Permian sediments is limited to small localised variations, which is of particular relevance to water management. The limited hydraulic connection is evidenced by differences in groundwater levels, differences in groundwater quality and differing responses to recharge or mining activity.

Groundwater monitoring undertaken during PG extraction detailed the limited hydraulic connection between the alluvium and the underlying Permian coal measures (RPS Aquaterra 2012b). This demonstrated that an effective aquiclude at the base of the alluvium protects the alluvium from drainage into subsidence affected strata beneath. This has been found to be consistent across the ACOL site.

2.3.4 Groundwater quality

Coal seams

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

Groundwater electrical conductivity (EC) values for the ULD seam east of LW101 vary from 2,510µS/cm (1,390 mg/L TDS) in WML261, and 6,270µS/cm (3,500 mg/L TDS) in WML262. The lower EC level encountered in WML261 is likely a reflection of increased connectivity with groundwater in the overlying alluvium.

Alluvium

The approved LW101 panel does not directly overlie any saturated alluvium however some saturated GCA is present to the east of the southern half of LW101 (Figure 2). The GCA is 200m east of the LW101 panel at its closest point.

Salinity levels within the GCA are moderate to low, particularly in the more permeable alluvium that contains a higher rate of through flow from surface recharge. In these areas, the EC is generally below 1,000μS/cm. Higher salinity levels exist within the GCA in areas away from the creek where the groundwater is within poorly connected alluvial materials that mix with colluvium and fine sediments.

Over the LW101 extraction period the EC of the HRA ranged from 1,007 to 2,820μS/cm, with an average of 1,765μS/cm. Groundwater in the colluvium that exists above LW5 and parts of LW6A is more saline (4,500 to 13,800μS/cm), indicating that it is not strongly connected hydraulically.

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

2.3.5 Groundwater levels

It is considered likely that prior to commencement of mining at the ACP, the groundwater levels in the Permian were higher than in the overlying alluvium and in the rivers. Higher groundwater heads in the Permian suggest that under natural conditions, groundwater is discharged from the Permian to the alluvium and to the surface river systems. This is reflected in relatively higher salinities in areas of the alluvium and in the constant stream flow during periods of low rainfall and runoff.

At multi-level piezometer sites, groundwater heads 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 locations, Permian groundwater heads have been historically recorded at above the ground surface (i.e. artesian and flowing). Typically, there is an upward hydraulic gradient with depth below surface under natural conditions.

In areas where drawdown impacts from mining have lowered groundwater levels in the Permian, the hydraulic gradients may have been reversed, so that there is potential for water to flow from the alluvium directly into the underlying Permian. However, groundwater studies and the ongoing monitoring have indicated that there is generally very poor hydraulic connection between the alluvium and the underlying Permian coal measures, and therefore flow between them is limited.

3. SUBSIDENCE MONITORING

As underground mining progresses subsidence survey monitoring is undertaken in accordance with the approved Subsidence Monitoring Program.

Subsidence is presented in Figures 3 to 7. The latest subsidence monitoring survey of the ULD seam Longwall 101 centre line indicates that 2.12m of subsidence occurred over the LW101 extraction period.

Four lateral subsidence monitoring cross lines were established to monitor subsidence adjacent to the GCA during LW101 extraction (Figure 2). These cross lines start at the eastern base of the steep slopes associated with Glennies Creek and extend west to TG1 of PG seam LW1:

- XL1 runs perpendicular from the north of the LW101 center line1 towards Glennies Creek;
- XL2 runs across ridge between LW101 tail gate cut through (TG C/T) 17 and Glennies Creek;
- XL3 runs across ridge between LW101 TG C/T 16 and Glennies Creek;
- XL4 runs across ridge between LW101 TG C/T 14 and Glennies Creek; and
- XL5 runs across LW101 ridge between LW101 MG C/T 17 and Glennies Creek.

The latest subsidence survey monitoring data (11/12/2012) shows subsidence related to LW101 extraction has occurred across XL1 (1.3m),XL4 (1.8m), and XL5 (1.5m).

There has been no significant subsidence effects measured across XL2 or XL3 to date. It is noted that these sections end at the edge of the LW1 extraction panel and do not cover LW101 itself however have continued to be monitored for LW101 as an indicator for any potential reactivation of Pikes Gully Seam LW1 subsidence. .

During the current reporting period subsidence levels at the ACP remained within current predictions, as approved for the underground mining area. Resulting subsidence impacts continue to be adequately managed under ACOL’s Environmental Management System, the Extraction Plan and associated sub plans.

4. GROUNDWATER LEVELS

4.1 Groundwater Monitoring Network

An extensive network of groundwater monitoring bores has been installed across the entire ACOL underground area (Figure 1).

The network is spatially distributed across the underground mining area to provide detailed coverage (Figure 1). More intensive monitoring coverage is focussed in areas of saturated alluvium and environmentally sensitive locations.

The monitoring network targets all identified geological units in the area. These units include saturated alluviums, Permian overburden and interburden units and the coal seams. Targeted monitoring of individual units is achieved through the use of standpipe piezometers with sealed off screened intervals and multi-level vibrating wire piezometers (VWPs).

The key monitoring sites for LW101 include 53 piezometers across 24 sites (Figure 2, Table 4.1 and 4.2 and Appendix A).

4.2 Monitoring Frequency

Ongoing routine monitoring of the ACOL groundwater monitoring network began prior to the commencement of underground mining. Groundwater levels are monitored on a fortnightly basis and groundwater quality is monitored on bi-annual basis. Monitoring is otherwise conducted according to frequencies detailed the Water Management Plan (Aquaterra 2012e).

During LW101 extraction the monitoring frequency at key monitoring piezometers close LW101 extraction was increased to fortnightly (Figure 2, Appendix A). In addition key standpipe and vibrating wire piezometers were equipped with data loggers to automatically monitor piezometric pressures on a 6 hourly interval.

To capture the most applicable data, loggers were relocated to piezometers of higher importance, generally closest to the position of the advancing longwall face as follows:

- WML106 had a RST multi-channel data logger (VWP logger) installed over the period 14 August 2012 to 8 October 2012;
- WMLC334 had a VWP logger installed over the period 14 August 2012 to 7 November 2012;
- WML119, WML129, WML301 and WML262 had Level Toll 500 pressure transducers installed over the period 14 August 2012 to 7 November 2012;
- WML106 to WML107A had VWP loggers installed over the period 8 October 2012 to 7 November 2012;
- WMLC248 and WML189 currently have VWP loggers that were installed on 7 November 2012; and
- WML189, WML261, WML120A and WML120B currently have pressure transducers that were installed on 7 November 2012.

Water level hydrographs relevant to the LW101 extraction are shown on Figures 8 to 19. Hydrostatic head profiles for VWPs WML107A, WML189, WML191 and WMLC248 are presented in Figures 20 to 23 to demonstrate the vertical difference in depressurisation across the various formations.

4.3 Monitoring Results

No water level decline attributable to LW101 extraction has been observed in the alluvial aquifers. Partial depressurisation observed in the shallow Lemington coal measures (above the PG seam) has been attributed to LW101 extraction (Tables 4.1 and 4.2).

These pressure responses show partial to full recovery after the longwall face progresses past the piezometer locations. This provides an indication that any connective cracking created by the subsidence does not extend past the Lemington 19 seam. It can therefore be concluded that no hydraulic connection has been created from the longwall goaf to the GCA or HRA.

Observed pressure responses to LW101 extraction are indentified in Table 4.2 and discussed in section 4.3.1 to 4.3.7.

4.3.1 Glennies Creek Alluvium

Minor decreases in the water levels of the GCA piezometers were observed in mid August and early September 2012 (Figure 8). Complete recovery has been shown in all the piezometers following increased rainfall in November and December 2012.

Responses to longwall mining in alluvium typically exhibit a rapid water level reduction that has not been observed in the monitoring results to date (Figure 8). The timing of the observed gradual decline and recovery in water levels suggests climatic influences.

4.3.2 Hunter River Alluvium

A steady declining trend in water levels is observed in the HRA bores and is consistent with the below average rainfall for the period (Figure 9). There are no impacts to the HCA attributed to LW101 extraction.

Initially, in the months following the recent drilling and installation of the HCA monitoring bores a slight decreasing trend of the water levels is observed. The decreasing trend is likely a result of slow recovery from installation and/or the low rainfall recharge experienced over the LW101 extraction period.

The data from these bores does not however, show a response that could be attributed to LW101 extraction. Instead the monitoring results indicate the HCA remains saturated following LW101 extraction in the area.

4.3.3 Lemington seams

Lemington 10

Depressurisation is observed in August at WMLC334-29m in a staged, rapid manner responding to longwall extraction (Figure 10). A similar slightly muted response is also observed in WML107A-38m in October 2012. Both piezometers responded as the longwall face approached and passed the piezometer location.

These rapid non-dewatering responses are typical of bed separation and fissure dilation effects (pressure-storage responses) caused by a stretching of the coal seam due to subsidence (Booth. 2007). Pressure-storage responses temporarily increase the groundwater storage capacity of the coal measures which simultaneously decreases the piezometric pressure.

Partial recovery is observed in both piezometers after the longwall face has passed the piezometer locations. The response does not therefore represent a dewatering the Lemington 10 seam. This indicates that the seam has remained intact and is not directly connected (by subsidence cracking) to the goaf created below.

Lemington 15

Pressure responses to LW101 extraction are observed in WML106-38m, WML107A-69m and WMLC334-63m (Figure 11).

WML106-38m exhibits a fluctuating pressure response as the longwall face approaches the piezometer. This response is believed to be the result of abutment pressures ahead of the advancing face resulting in the restriction of existing fractures. As the longwall passes the piezometer location WML106 was destroyed and no further measurements were possible.

The responses seen in Lemington 15 seam (WML107-69m and WMLC334-63m) are similar to the response observed in the overlying Lemington 10 seam. The notable exception to this statement is that no recovery has yet been observed in the Lemington 15 seam.

The Lemington 15 seam responses are also attributed to pressure-storage responses from subsidence. The noted delayed recovery can be attributed to a greater storage increase in the underlying seam. Coal seams closer to the goaf can stretch to a greater extent increasing pressure-storage responses and therefore groundwater storage capacity (Booth. 2007).

The Lemington 15 seam is shown to remain saturated after LW101 extraction has progressed past key piezometers. The seam is therefore assumed to have remained intact with no direct hydraulic connection to the longwall goaf.

Lemington 19

Depressurisation responses to LW101 extraction are observed in WML106 and WMLC334-91m (Figure 12).

WML106 is responding to the abutment pressures of the approaching longwall face as described in the Lemington 15 section.

The gradual pressure decline observed at WMLC334 is shown to stabilize as longwall mining has continued. This pressure reduction is thought to represent pressure-storage responses in the seams where it directly overlies the ULD as described above in Lemington 10 and 15. WMLC334 does not directly overlie LW101 extraction zone muting observed responses.

4.3.4 Pikes Gully Seam

Minor responses to LW101 extraction are observed within the previously mined PG seam (Figures 13 and 14).

The PG seam was partially depressurised prior to the mining of LW101 due to longwall extraction in the PG seam. The PG seam was observed to remain partially saturated in the barrier, further gradual depressurisation was observed in these areas during LW101 extraction. This indicates some hydraulic connection with the LW101 goaf.

In summary, small pressure reductions were observed in areas of the PG seam that were partially depressurised prior to LW101 extraction.

4.3.5 Arties coal Seam

Significant pressure responses to LW101 extraction are observed in the Arties seam in (Figure 15). These responses are likely due to connective cracking with the ULD seam caused by subsidence.

The Arties seam is observed to remain partially pressurised (saturated) at piezometers WMLC334 and WMLC335 with other piezometers showing stable trends (Figure 15). This indicates possible connective cracking creating hydraulic connection with the LW101 goaf is localized to certain areas.

4.3.6 Upper Liddell Seam

Decreasing pressure responses to LW101 extraction are observed in the ULD seam at WMLC334 and WMLC335 (Figures 16 and 17).

The most significant response was observed at WMLC334-157m showing change in piezometric pressure of 9.79m since commencement of LW101 extraction (Table 4.2).

As ULD mining progresses the piezometric pressures in the ULD seam are predicted to continue to gradually decrease. Responses to date show the seam remains saturated in areas outside of the immediate LW101 extraction area.

4.3.7 Upper and Lower Barrett Seams

The Upper and Lower Barrett seams underlying the ULD seam generally show no response to LW101 extraction (Figure 19).

Depressurisation responses are observed in the Upper and Lower Barrett in VWP WMLC335. These responses are attributed to a hydraulic connection with the LW101 goaf. The connection was possibly formed by the drilling/construction of the piezometer, which is supported by a lack of response in other Upper and Lower Barrett piezometers. This being the case the responses observed in the underlying Barrett seams are unlikely to be widespread and/or significant.

Table 4.1: Piezometric Pressure Heads – Saturated Alluvium

Piezometer ID	Baseline Data 10 May 2012 - 13 July 2012 (m)	Current Data 28 December 2012 and 8 January 2013 (m)	Drawdown (m) [3]	Approved Drawdown (m) [3]	Reporting Period Summary
			Negative values represent drawdown		
Glennies Creek Alluvium – Figure 8					
WML129*	4.84	5.03	0.19	-0.18m	Slight decrease in water level at WML240 within approved drawdown (east of LW101). Minor water level increases at WML129, WML239 and WML120B.
WML239	5.97	6.10	0.13		
WML240	4.82	4.76	-0.06		
WML120B*	7.18	7.24	0.06		
Hunter River Alluvium – Figure 9					
WMLP336	2.68[1]	2.46	-0.22	0m	Slight decreases in HRA water level over the LW101 extraction period associated with seasonal conditions.
WMLP337	2.26[2]	1.84	-0.42		
WMLP338	2.81[2]	1.82	-0.99		

Note: [1] Baseline data from September 2012

[2] Baseline data from August 2012

[3] Negative values represent a water level decrease and positive values an increase in water level.

Table 4.2: Piezometric Pressure Heads – Coal Measures

Piezometer	Baseline Data 10 May - 13 July (m)	Current Data 8 January 2013 (m)	Drawdown (m)	Predicted Drawdown (m)	Reporting Period Summary
			Negative values represent drawdown		
Lemington 10 Coal Measure – Figure 10					
WMLC334-29.5m*	2.88	2.08	-0.80	Not predicted	Water level recovery observed following decline observed over August to September 2012.
Lemington 11 Coal Measure – Figure 10					
WML107A-38m*	-3.85	-4.20	-0.35	Not predicted	Water level recovery observed following a decline observed in October 2012.
Lemington 15 Coal Measure – Figure 11					
WML106-38m*	0.25	NA	NA	Not predicted	WML 106 was destroyed by LW101 extraction. WML107-69m shows 2.65m depressurisation pressure responses to LW101 extraction. WMLC334-63m shows 10.3m depressurisation pressure responses to LW101 extraction. Other bores have stable pressures in the Lemington 15 Seam over the reporting period.
WML107A-69m*	8.6	5.95	-2.65		
WML189-49m*	-0.33	-0.36	-0.03		
WML191-52m	-0.5	-0.57	-0.07		
WMLC334-63m*	33.69	23.39	-10.3		
WMLC335-23m	4.28	3.54	-0.74		
Lemington 17 and 19 Coal Measures – Figure 12					
WMLC335-29.5m	12.08	12.64	0.56	Not predicted	Gradual depressurisation observed at WMLC335-91m has been shown recent stabilization. WML107-98m exhibits a recovery to a sharp decline in October 2012.
WMLC334-91m*	56.2	48.43	-7.77		
WML106-68m*	20.95	NA	NA		
WML107A-98m*	28.83	25.40	-3.43		

Note: * Piezometers were equipped with a data logger over reporting period.

Negative values represent a water level drawdown impact and positive values an increase

Piezometer	Baseline Data 10 May - 13 July (m)	Current Data 8 January 2013 (m)	Drawdown (m)	Predicted Drawdown (m)	Reporting Period Summary
			Negative values represent drawdown		
Pikes Gully Coal Measure – Figures 13 and 14					
WML191-100m	8.03	5.91	-2.12	Seam predicted to be completely dewatered by 2016	Stable water level observed at WML119, WML120A and WML181. Gradual decline in water levels observed at WML191-132m and WMLC335-67m, WML182 shows partial recovery from a recent water level decline. WML189-107m shows partial recovery from a recent water level decline
WML191-132m	86.27	64.51	-21.76		
WML119*	12.47	10.59	0.12		
WML120A	7.10	7.00	-0.10		
WML181	14.61	14.78	0.17		
WML182	21.52	17.91	-3.61		
WML183	17.86	17.83	-0.03		
WML184	11.29	11.37	0.08		
WML185	10.88	10.78	-0.10		
WMLC335-67m	48.22	44.25	-3.97		
WML189-107m*	52.38	51.42	-0.96		
Arties Coal Measure – Figure 15					
WMLC334-126m*	95.06	85.95	-9.11	Not applicable	Significant depressurisation responses to LW101 extraction are observed at WMLC334-126m and WMLC335-86m. A recent gradual reduction in piezometric pressure is observed in WML301.
WMLC335-86m	68.28	64.56	-3.72		
WML301*	29.65	25.12	-4.53		
WML302	15.09	15.03	-0.06		
WML189-93m*	3.6	3.32	-0.28		

Note: * Piezometers were equipped with a data logger over reporting period.

Negative values represent a water level drawdown impact and positive values an increase

Piezometer	Baseline Data 10 May - 13 July (m)	Current Data 8 January 2013 (m)	Drawdown (m)	Predicted Drawdown (m)	Reporting Period Summary
			Negative values represent drawdown		
Upper Liddell Coal Measure – Figure 16 and 17					
WMLC334-157m*	129.15	119.36	-9.79	-10m	Gradual long term decline continues in WML262. Gradual pressure responses observed in WMLC334-157m, WMLC334-175m and WMLC335-141.5m throughout LW101 extraction period.
WMLC144-26m	17.25	16.53	-0.72		
WML191-155m	105.88	102.98	-2.9		
WML261*	30.06	31.16	1.1		
WML262*	42.95	40.26	-2.69		
WMLC335-121.5m	104.01	101.27	-2.74		
WMLC334-175m	147.08	141.26	-5.82		
WMLC335-141.5m	128.49	125.09	-3.40		
Middle Liddell Coal Measure – Figure 18					
WMLC144-32m	21.65	21.18	-0.47	-10m	Stable water levels observed in the Middle Liddell seam. Observed water level decline within seasonal variability.
WMLC144-45m	33.87	33.65	-0.22		
Lower Liddell Measure – Figure 18					
WMLC144-50m	36.98	36.57	-0.41	Not predicted	Stable water levels observed in the Lower Liddell seam. Observed water level decline within seasonal variability.
WMLC144-58m	45.88	45.73	-0.15		
Upper Barrett Coal Measure – Figure 19					
WMLC334-198m	174.86	174.45	-0.41	Not predicted	Drawdown of 2m observed in WMLC335 indicating some depressurisation likely associated with a hydraulic connection to the LW101 goaf (see section 4.3.7). Stable water levels observed in other Upper Barrett piezometers.
WMLC335-159m	146.35	144.33	-2.02		
WMLC144-81m	70.89	70.54	-0.35		

Note: * Piezometers were equipped with a data logger over reporting period.

Negative values represent a water level drawdown impact and positive values an increase

Piezometer	Baseline Data 10 May - 13 July (m)	Current Data 8 January 2013 (m)	Drawdown (m)	Predicted Drawdown (m)	Reporting Period Summary
			Negative values represent drawdown		
Lower Barrett Coal Measure – Figure 19					
WMLC335-173m	161.4	159.55	-1.85	Not predicted	Drawdown of 1.85m observed in WMLC335 indicating some depressurisation from LW101 extraction (see section 4.3.7). Stable water levels observed in other Lower Barrett seam piezometers.
WMLC334-209m	185.03	184.49	-0.54		
WML191-200m	170.33	170.73	0.4		
WMLC144-98m	90.34	89.74	-0.6		

Note: * Piezometers were equipped with a data logger over reporting period.

Negative values represent a water level drawdown impact and positive values an increase

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5. GROUNDWATER AND SURFACE WATER QUALITY

5.1 Monitoring Program

Monitoring of water quality in the alluvium and Permian groundwater was undertaken prior to the commencement of mining to establish baseline conditions.

A primary aim of the monitoring program is to assess if alluvium groundwater or surface water flows to the underground mine. The program is setup to identify any potential adverse impacts the underground extraction may have on the quality of the alluvium or surface water. To do this identified variation from baseline values are compared with the ACOL predicted and approved groundwater and surface water impacts.

EC is used as the key screening parameter as it provides an easily measurable representation of salinity. Each water body (surface, alluvium or the Permian) has a distinct salinity signature and has been assigned a trigger level value. This allows the identification of impacts to a water source and an estimation of inflow contributions.

Groundwater EC measurements were recorded at the key monitoring bores during LW101 extraction (Table 5.1).

Surface water EC is measured at a number of stations (Figure 24). A summary of EC measurements from these locations is presented in Table 5.1 and graphically in Figure 25.

5.2 Baseline Data

Data from the underground water quality monitoring program has been collected throughout the mining of the PG seam LW1-LW8 and previously reported in the End of Panel reports. Inflow quality comprises the total of all seepage into the underground.

Sampling for quality analysis of groundwater in the GCA, BCA, PG seam and ULD seam was undertaken prior to the commencement of mining. This has enabled the establishment of baseline water quality data.

On the basis of the water quality monitoring data, the typical pre-mining EC of the water sources was as follows:

- PG seam (east of LW101) – 3,000 to 7,000µS/cm;
- ULD seam – 1,000 to 7,000µS/cm;
- GCA – 500 to 2,000µS/cm;
- HRA – 1000 to 2,500+ µS/cm (piezometers located west of LW101);
- Glennies Creek – 200 to 550µS/cm; and
- Hunter River – 400 to 550µS/cm.

5.3 Monitoring Results

5.3.1 Groundwater

A summary of available groundwater EC measurements is presented in Table 5.1. The data sets are plotted on Figures 26, 27 and 28 (grouped by aquifer) and discussed in the following sections.

Glennies Creek Alluvium

A long-term trend of reducing EC levels is observed within the GCA throughout longwall mining. This is attributed (in part) to the reduced effects of upward leakage from the Permian coal measures resulting from ACOL underground mining.

Over the LW101 extraction period, the EC trends have been stable in all Glennies Creek piezometers (Table 5.1, Figure 26). Small fluctuations are considered to be seasonal and responding to recharge and surface runoff events.

The maximum EC level measured in the GCA over the LW101 extraction period was 1010µS/cm at WML240. This level is significantly lower that the baseline EC values recorded at WML120B prior to underground mining (Figure 26). High baseline EC levels indicate that in this area the alluvium maybe have been connected to the nearby outcropping PG seam.

The EC trend observed in piezometer WML129 has remained relatively stable (269 to 430µS/cm) across the LW101 extraction period to date showing no response to the passing longwall face (Table 5.1, Figure 26).

Hunter River Alluvium

No historical baseline data exist for the key HRA key piezometers WMLP336, WMLP337 and WMLP338. Baseline data that exists for alternate HRA piezometers gives an approximate range of 1000 to 2,500µS/cm.

Over the LW101 extraction period the EC in key HCA bores ranged from 1007 to 2820µS/cm with a stable trend in WMLP336 and WMLP338 and an upward trend in WMLP337 (Table 5.1, Figure 27).

Coal Measures

All coal measure piezometers continue to follow the established water quality trends showing no response to LW101 extraction (Table 5.1, Figure 28).

WML119 (PG seam) is the exception to this showing low EC levels prior to LW101 extraction. The influence of induced water flow from Glennies Creek (Aquaterra 2012) is the dominant driver behind these initial low levels.

Underground Water Sampling

Over the LW101 extraction period the water quality of underground water samples were collected at sampling points NWM 14C/T FT, MG09 C/T, NWM 24C/T, MG101 FT. EC levels indicated saline quality (2880 to 9,200µS/cm) providing evidence that the majority of underground water is coming from (or through) the coal seams, predominantly the ULD seam.

During LW101 extraction the majority of bores show a slight decrease in salinity levels (Figure 29).

5.3.2 Surface water

Surface water EC data has been plotted on Figure 25 with the data for each water course and presented in Table 5.2. Of relevance to LW101 extraction are Glennies Creek and the Hunter River.

Over the LW101 extraction period the surface water salinity levels are shown to gradually increase in the dry periods and then rapidly decrease following rainfall events in November and December 2012.

The salinity levels in Glennies Creek and the Hunter River are shown to be within the established long-term trends with no impacts from LW101 extraction (Figure 25).

Glennies Creek

Water quality in Glennies Creek is monitored at surface monitoring stations; SM7, SM8 and SM11. The established baseline seasonal trends are shown to continue across the LW101 extraction period.

Glennies Creek shows the lowest overall EC of the three monitored water courses with salinity levels that range from 234µS/cm to 554µS/cm. No impacts are observed from LW101 extraction activities.

Hunter River

Water quality in the Hunter River is monitored at surface monitoring stations; SM9, SM10, SM12, SM13 and SM14. The established baseline seasonal trends are shown to continue across the

LW101 extraction period with no significant variation with salinity levels ranging from 378µS/cm to 1230µS/cm.

Table 5.1: Groundwater Quality: Electrical Conductivity

Aquifer/Seam	Bore ID	Baseline Range (4/01/2006-12/07/2012)		LW101 extraction period (31/08/2012 – 31/12/2012)	
		Range (µS/cm)	**Average** (µS/cm)	**Range** (µS/cm)	**Average** (µS/cm)
Glennies Creek Alluvium	WML120B	438 – 1,930	1,113	624 – 800	736
	WML129	378 – 789	476	269 – 430	344
	WML239	No data	NA	686 – 874	809
	WML240	564	564	529 – 1,010	757
Hunter River Alluvium	WMLP336[1]	No data	NA	1,007 – 1,669	1,221
	WMLP337[1]	No data	NA	1,940 – 2,820	2,445
	WMLP338[1]	No data	NA	1,343 – 1,730	1,591
Pikes Gully	WML119[2]	86 – 5,410	2844	147 – 1,913	797
	WML120A	476 – 1,290	973	500 – 632	565
	WML181	3,570 – 3,870	3,720	2,600 – 3,540	3,209
	WML182	3,840 – 8,820	5,630	3,450 – 4,900	4,356
	WML183	5,100 – 8,350	7,196	3,830 – 5,140	4,666
	WML184	3180	3,180	1,353 – 4,910	3,686
	WML185	1,220 – 1,850	1,536	1,392 – 2,244	1,933
Arties	WMLP301	No data	NA	4,560 – 6,040	5,543
	WMLP302	No data	NA	688 – 891	814
Upper Liddell	WML261	932	932	132 – 238	183
	WML262	6,410 – 7390	6,900	5,520 – 7,370	6,762

Note: [1] Piezometers WMLP336, WMLP337 and WMLP338 were installed following the baseline monitoring period.

[2] Fresh measurements from WML119 not considered representative of PG seam.

NA – Not applicable.

Table 5.2: Surface Water Quality: Monthly Electrical Conductivity

Date	SM7 (µS/cm)	SM8 (µS/cm)	SM11 (µS/cm)	SM9 (µS/cm)	SM10 (µS/cm)	SM12 (µS/cm)	SM13 (µS/cm)	SM14 (µS/cm)
	Glennies Creek			Hunter River				
Jan-12	403	416	441	840	845	783	846	847
Feb-12	312	315	322	-	396	378	421	448
Mar-12	306	310	320	561	586	-	572	580
Apr-12	452	458	472	893	902	794	897	881
May-12	414	413	432	978	977	848	973	977
Jun-12	293	297	298	691	705	556	701	701
Jul-12	278	282	279	576	691	444	614	616
Aug-12	496	522	554	663	676	656	663	669
Sep-12	450	463	476	1030	1040	965	1040	1040
Oct-12	277	281	279	1160	1150	782	1150	1150
Nov-12	245	246	246	1210	1210	557	1230	1230
Dec-12	235	234	244	958	960	468	955	960
Min	**235**	**234**	**244**	**561**	**396**	**378**	**421**	**448**
Max	**496**	**522**	**554**	**1210**	**1210**	**965**	**1230**	**1230**
Average	**347**	**353**	**364**	**869**	**845**	**657**	**839**	**842**

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

LW101 coal extraction in the ULD occurred beneath Permian overburden. Saturated GCA exists 200m to the east of the panel and HRA to the south (Figure 2).

To facilitate the identification of any potential impacts to the alluvium extensive monitoring of the groundwater level and quality was conducted along with subsidence surveying. The results demonstrate that mining did not cause any adverse impacts to groundwater within the GCA or HRA.

Subsidence effects are expected to have substantial depressurisation effects on the Permian strata above each panel area within the zone of subsidence across the LW101 footprint. Monitoring results to date indicate that, whilst partial depressurisation is evident in areas immediately outside the LW101 goaf, the overlying Permian strata has remained saturated.

Historical impacts to GCA stabilized prior to the end of PG LW1 with no significant incremental impact or influence from mining of PG LW2 to LW8 or LW101 observed to date. No significant inflows or groundwater levels impacts have been observed in alluvium associated with Glennies Creek at the midpoint of LW101 extraction.

The network of piezometers installed across the Hunter River floodplain has shown no observed impacts to date in relation to the Hunter River or its alluvium in terms of drawdown or seepage. There has been no mining-related drawdown observed in the HRA from the extraction of LW101 or earlier longwalls.

6.2 Comparison against EIS, EA and SMP

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

- There is no observed drawdown in the alluvium east of Glennies Creek attributable to LW101 mining. Groundwater drawdown in the GCA has been significantly less than that predicted in the EIS (2.2m drawdown) for the current stage of mining. As of 8 January 2013 groundwater level elevations in the GCA are consistent with pre PG LW1 conditions ;
- Actual seepage rates from the GCA have been at, or below, the EIS, EA and SMP predictions at all stages of mining to date; and
- Mining of LW101 has not resulted in a reduction in HRA storage and consequently, no losses from the HRA to underground workings are likely to have occurred.

In summary, groundwater-related impacts from underground mining up to the midpoint of LW101 were at, or below the levels predicted in the EIS (HLA Envirosciences, 2001), and in the SMP and EA Groundwater Assessments (Aquaterra, 2010b and Aquaterra, 2009c).

7. REFERENCES

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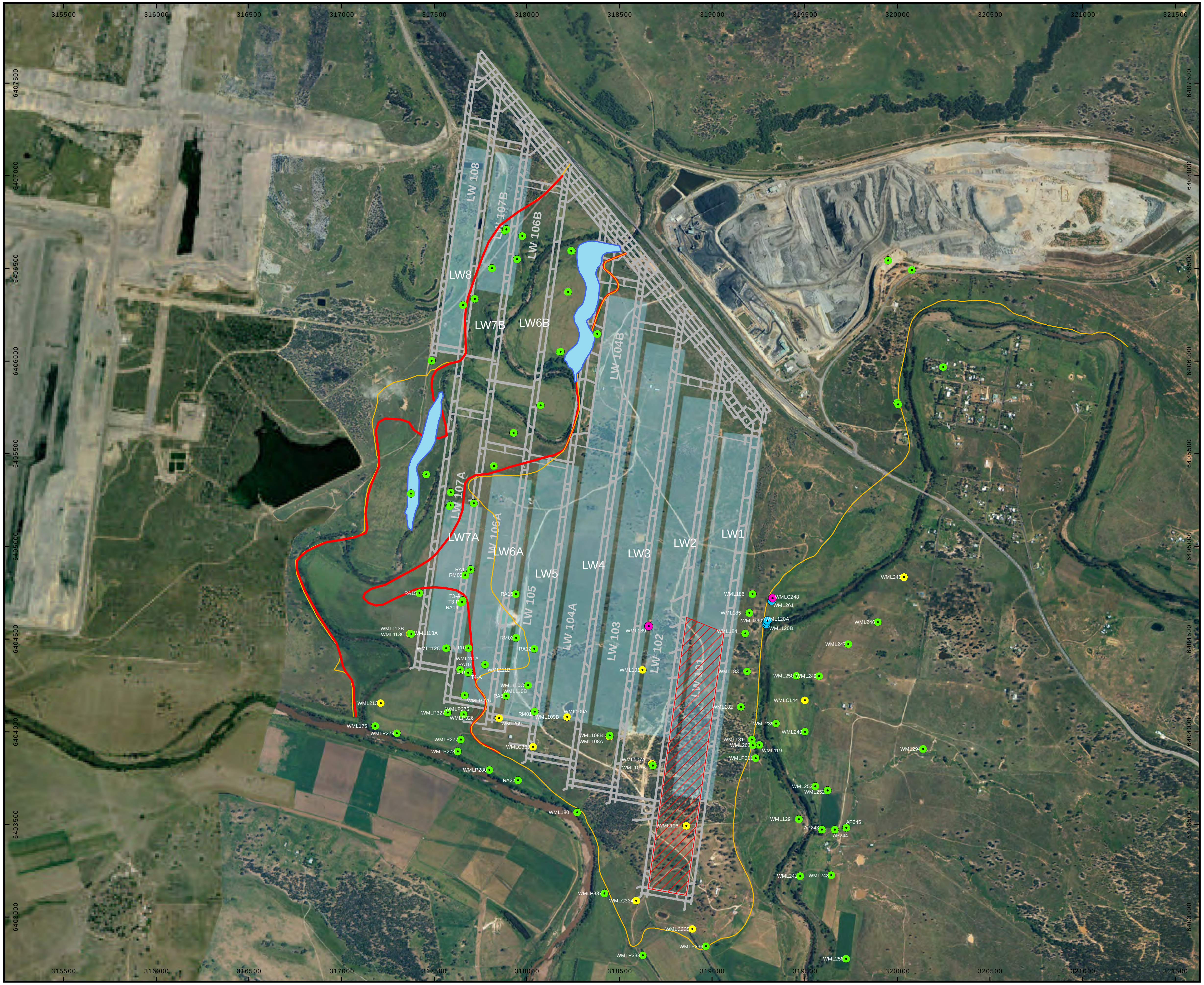
FIGURES



LEGEND

Monitoring Bores

Type

- Stand Pipe Piezometer
- Stand Pipe Piezometer with Data Logger
- Vibrating Wire Piezometer
- Vibrating Wire Piezometer with Data Logger
- Bowmans Creek Diversion Footprint
- Upper Liddell Seam Extraction
- Pikes Gully Seam Extraction
- Alluvium boundary
- Saturated alluvium boundary
- Upper Liddell Seam Underground Mine Plan

N

200 0 200 400

Metres

APPROX SCALE 1:20,000 @ A3

GDA 1994 MGA Zone 56

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no guarantee is given that the information portrayed is free from error or omission. Please verify the accuracy of all information prior to use.

RPS Aquaterra

FIGURE 1

Ashton Coal

ULD LW101 Mornitoring Network

LEGEND

Monitoring Bores

Type

- Stand Pipe Piezometer
- Stand Pipe Piezometer with Data Logger
- Vibrating Wire Piezometer
- Vibrating Wire Piezometer with Data Logger
- Subsidence Lines
- Upper Liddell Seam Extraction
- Pikes Gully Seam Extraction
- Alluvium boundary
- Saturated alluvium boundary
- Upper Liddell Seam Underground Mine Plan
- Bores to Monitor for ULD LW101

N

200 0 200 400

Metres

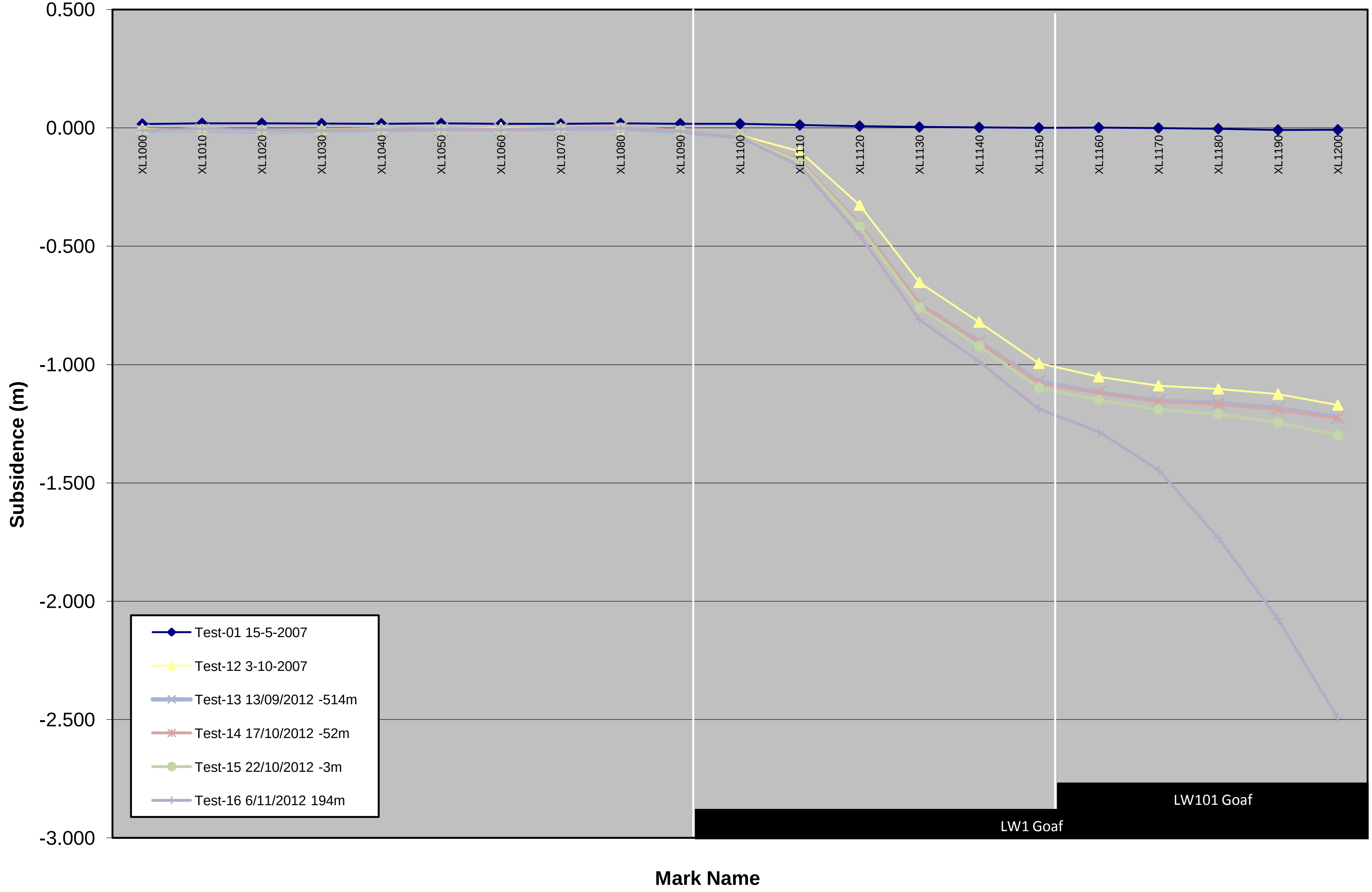
APPROX SCALE 1:9,998 @ A3

GDA 1994 MGA Zone 56

RPS Aquaterra

FIGURE 2
Ashton Coal
ULD LW101 Mornitoring Network
and Subsidence Lines

S56_065b Rev: b Produced: HZ Reviewed: SC Date: 08/01/2013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XL1020
XL1030
XL1040
XL1050
XL1060
XL1070
XL1080
XL1090
XL1100
XL1110
XL1120
XL1130
XL1140
XL1150
XL1160
XL1170
XL1180
XL1190
XL1200
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Test-12 3-10-2007
Test-13 13/09/2012 -514m
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Test-16 6/11/2012 194m
LW101 Goaf
LW1 Goaf
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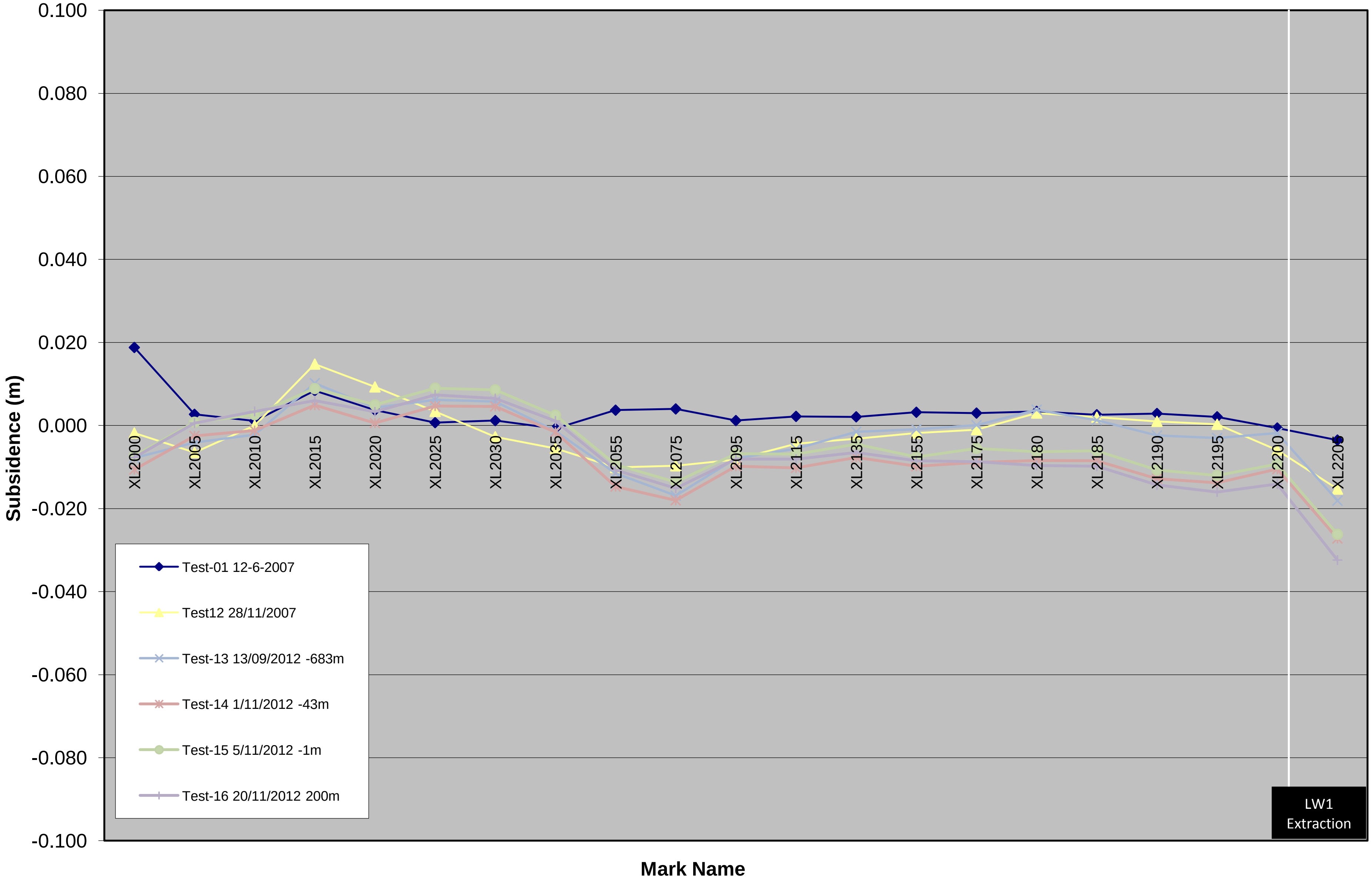

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Subsidence (m)
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XL2005
XL2010
XL2015
XL2020
XL2025
XL2030
XL2035
XL2055
XL2075
XL2095
XL2115
XL2135
XL2155
XL2175
XL2180
XL2185
XL2190
XL2195
XL2200
XL2205
Test-01 12-6-2007
Test12 28/11/2007
Test-13 13/09/2012 -683m
Test-14 1/11/2012 -43m
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Test-16 20/11/2012 200m
LW1
Extraction
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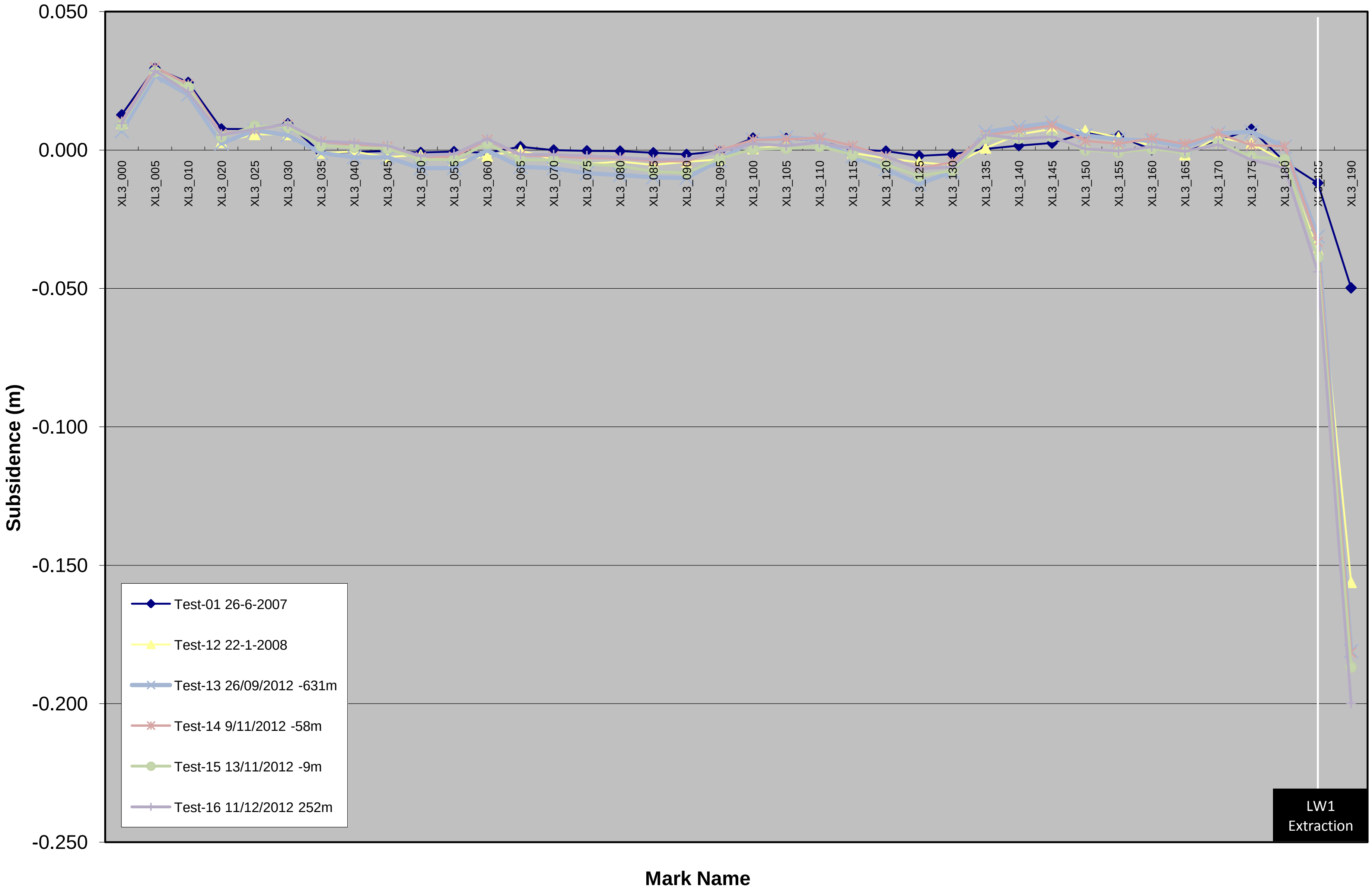
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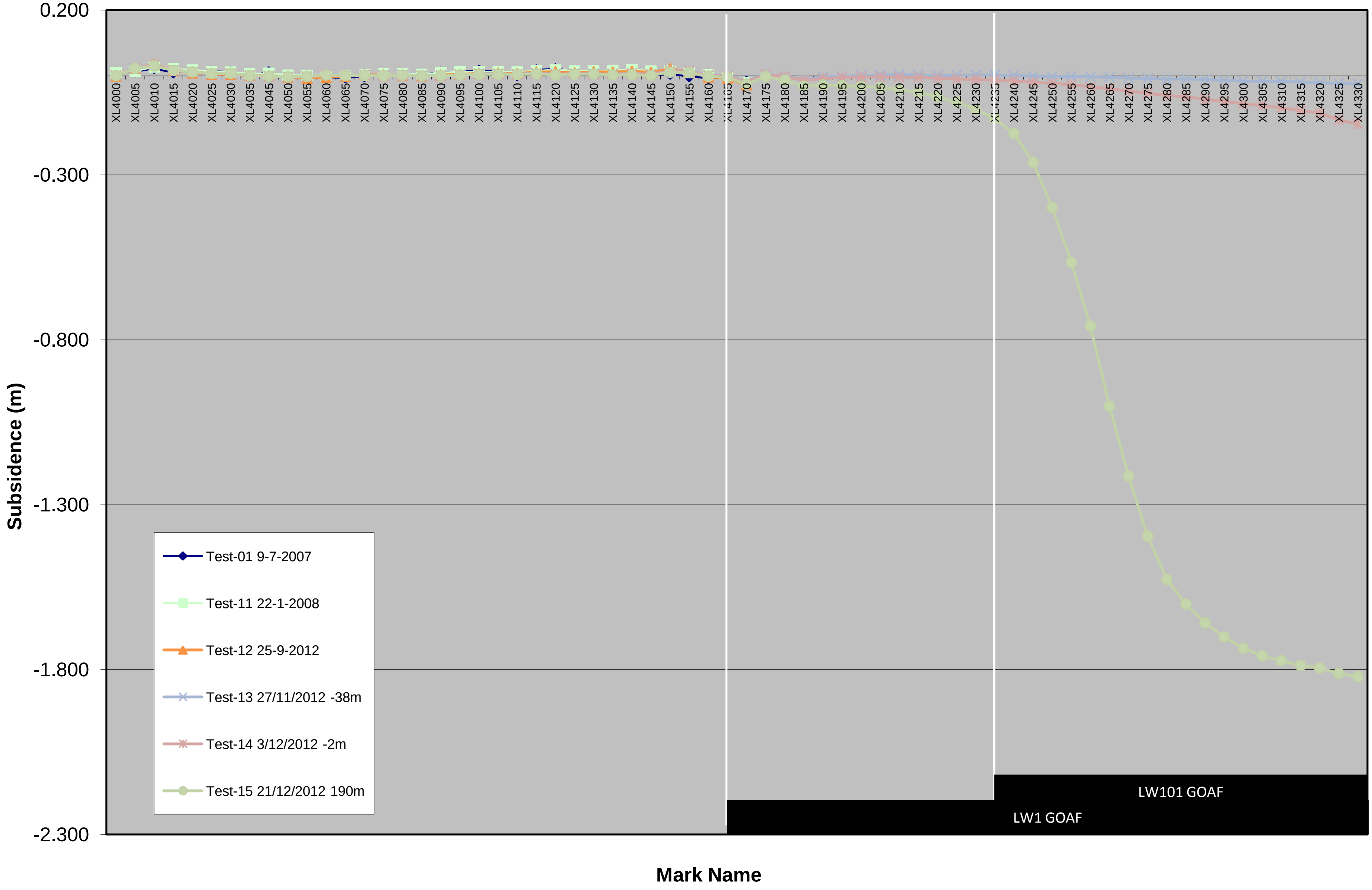
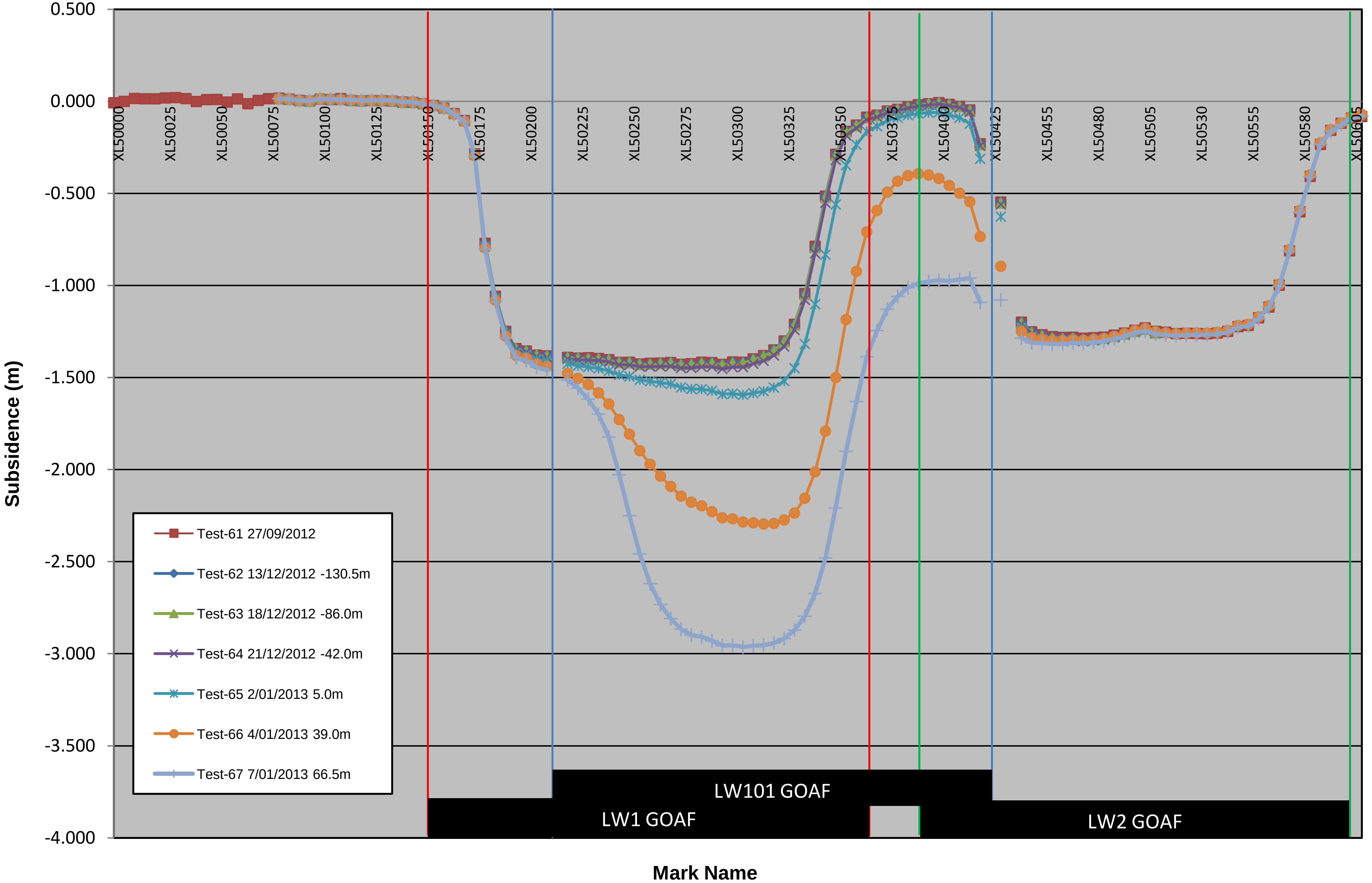
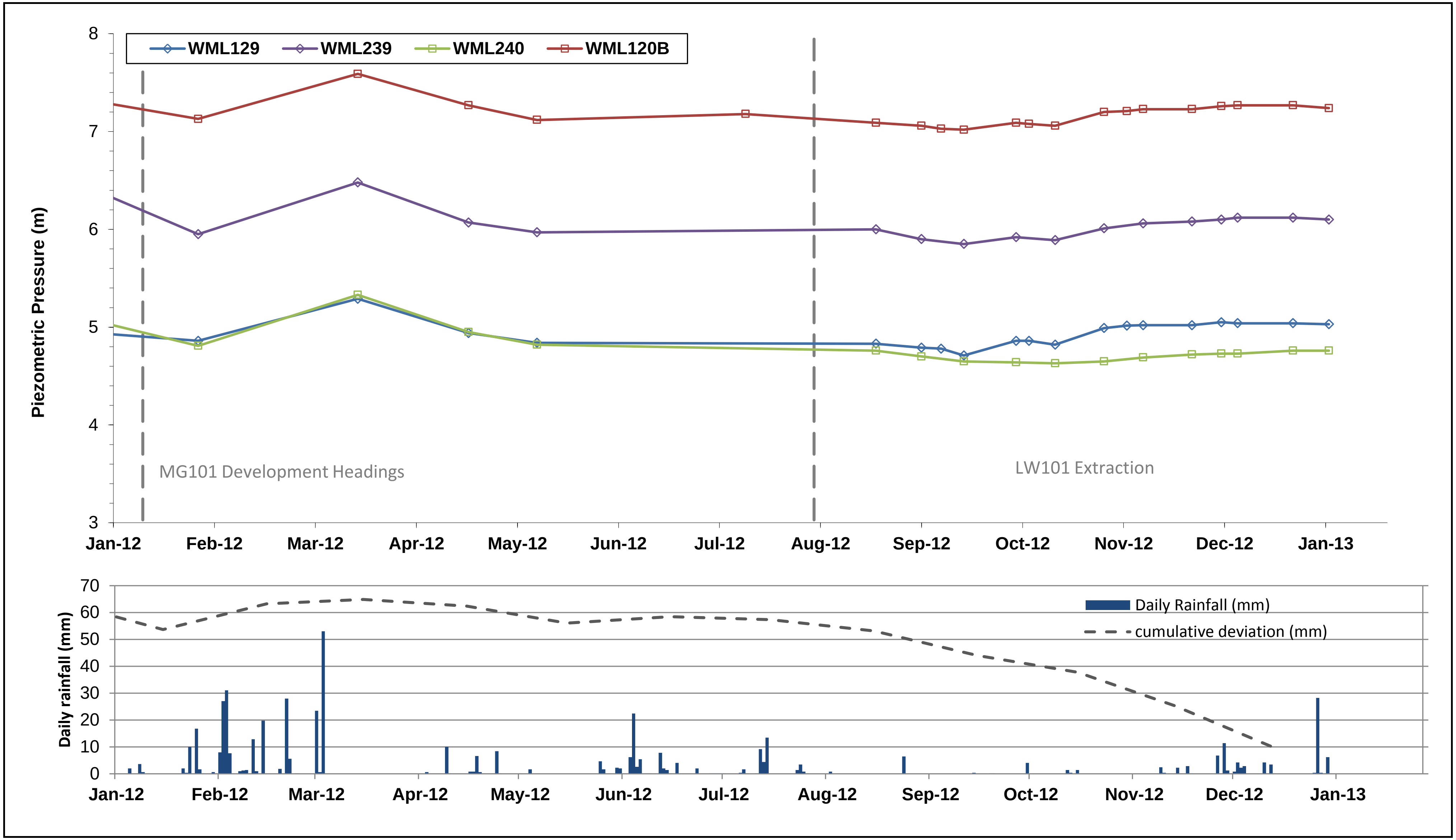
XL3_020
XL3_025
XL3_030
XL3_035
XL3_040
XL3_045
XL3_050
XL3_055
XL3_060
XL3_065
XL3_070
XL3_075
XL3_080
XL3_085
XL3_090
XL3_095
XL3_100
XL3_105
XL3_110
XL3_115
XL3_120
XL3_125
XL3_130
XL3_135
XL3_140
XL3_145
XL3_150
XL3_155
XL3_160
XL3_165
XL3_170
XL3_175
XL3_180
XL3_190
Test-01 26-6-2007
Test-12 22-1-2008
Test-13 26/09/2012 -631m
Test-14 9/11/2012 -58m
Test-15 13/11/2012 -9m
Test-16 11/12/2012 252m
LW1
Extraction
Mark Name


0.200
-0.300
-0.800
-1.300
-1.800
-2.300
Subsidence (m)
Mark Name
Test-01 9-7-2007
Test-11 22-1-2008
Test-12 25-9-2012
Test-13 27/11/2012 -38m
Test-14 3/12/2012 -2m
Test-15 21/12/2012 190m
LW101 GOAF
LW1 GOAF



0.500
0.000
-0.500
-1.000
-1.500
-2.000
-2.500
-3.000
-3.500
-4.000
Subsidence (m)
XL50000
XL50025
XL50050
XL50075
XL50100
XL50125
XL50150
XL50175
XL50200
XL50225
XL50250
XL50275
XL50300
XL50325
XL50350
XL50375
XL50400
XL50425
XL50455
XL50480
XL50505
XL50530
XL50555
XL50580
XL50605
Test-61 27/09/2012
Test-62 13/12/2012 -130.5m
Test-63 18/12/2012 -86.0m
Test-64 21/12/2012 -42.0m
Test-65 2/01/2013 5.0m
Test-66 4/01/2013 39.0m
Test-67 7/01/2013 66.5m
LW101 GOAF
LW1 GOAF
LW2 GOAF
Mark Name



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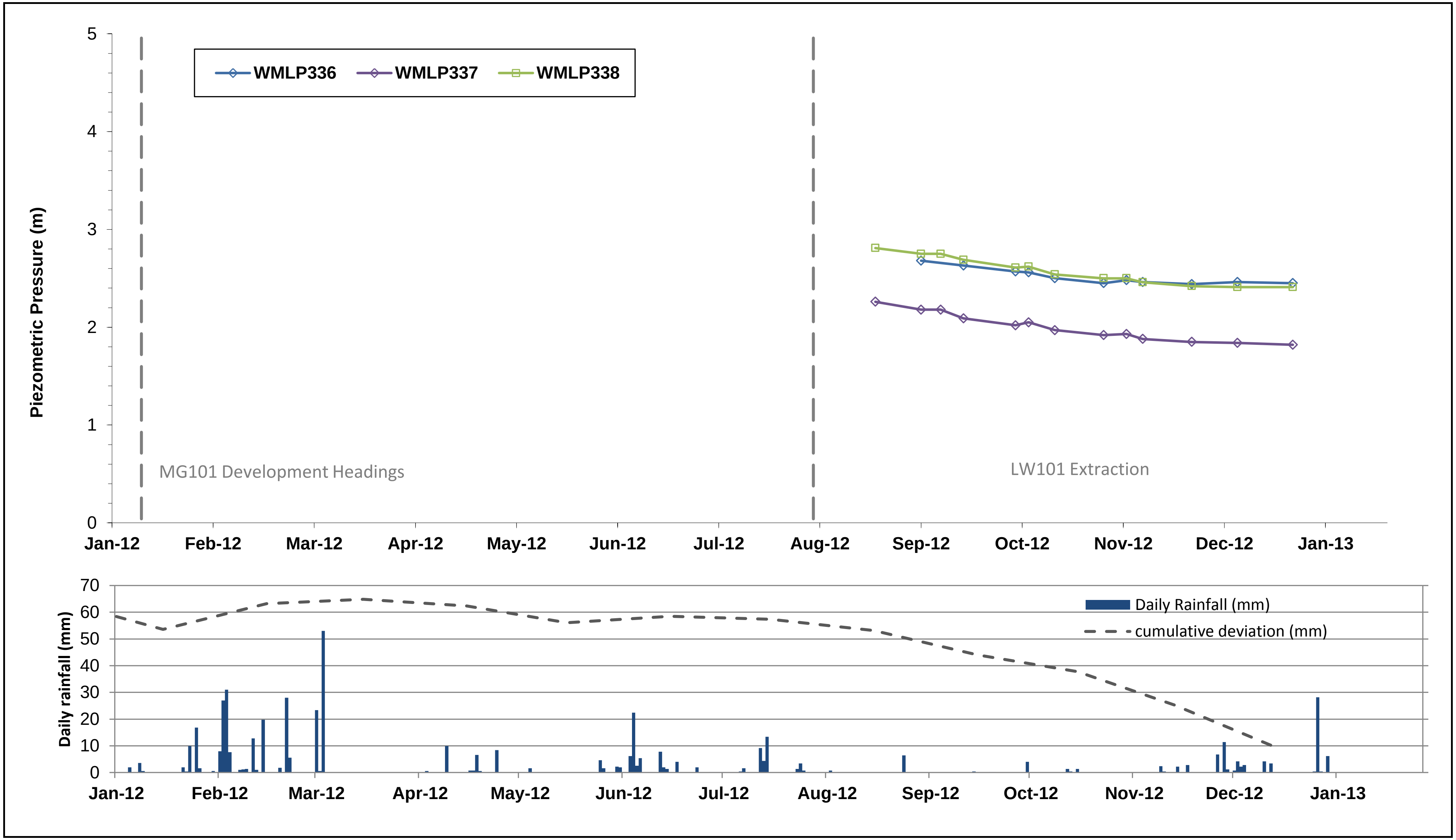
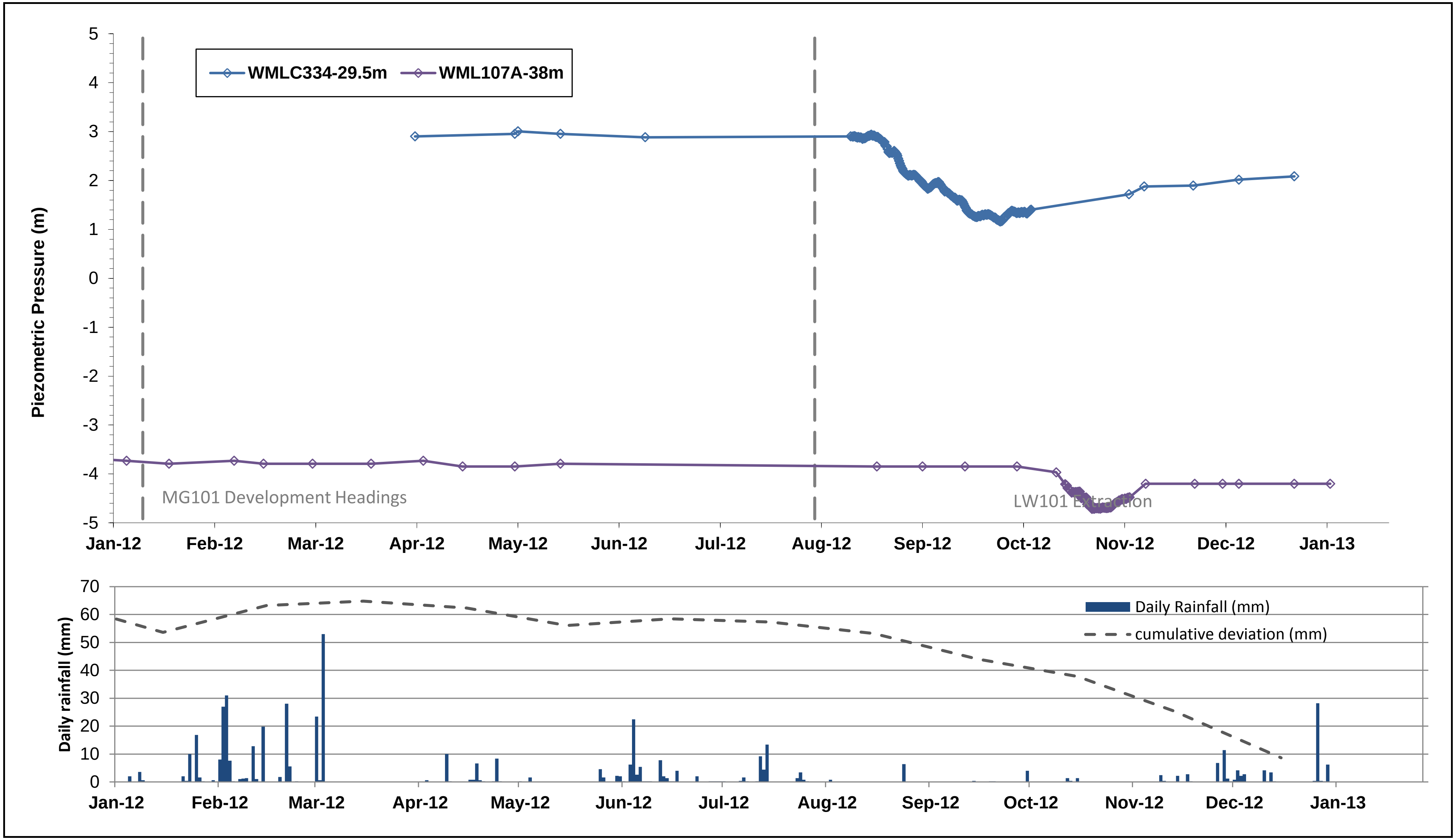
HYDROGRAPHS: GLENNIES CREEK ALLUVIUM FIGURE 8



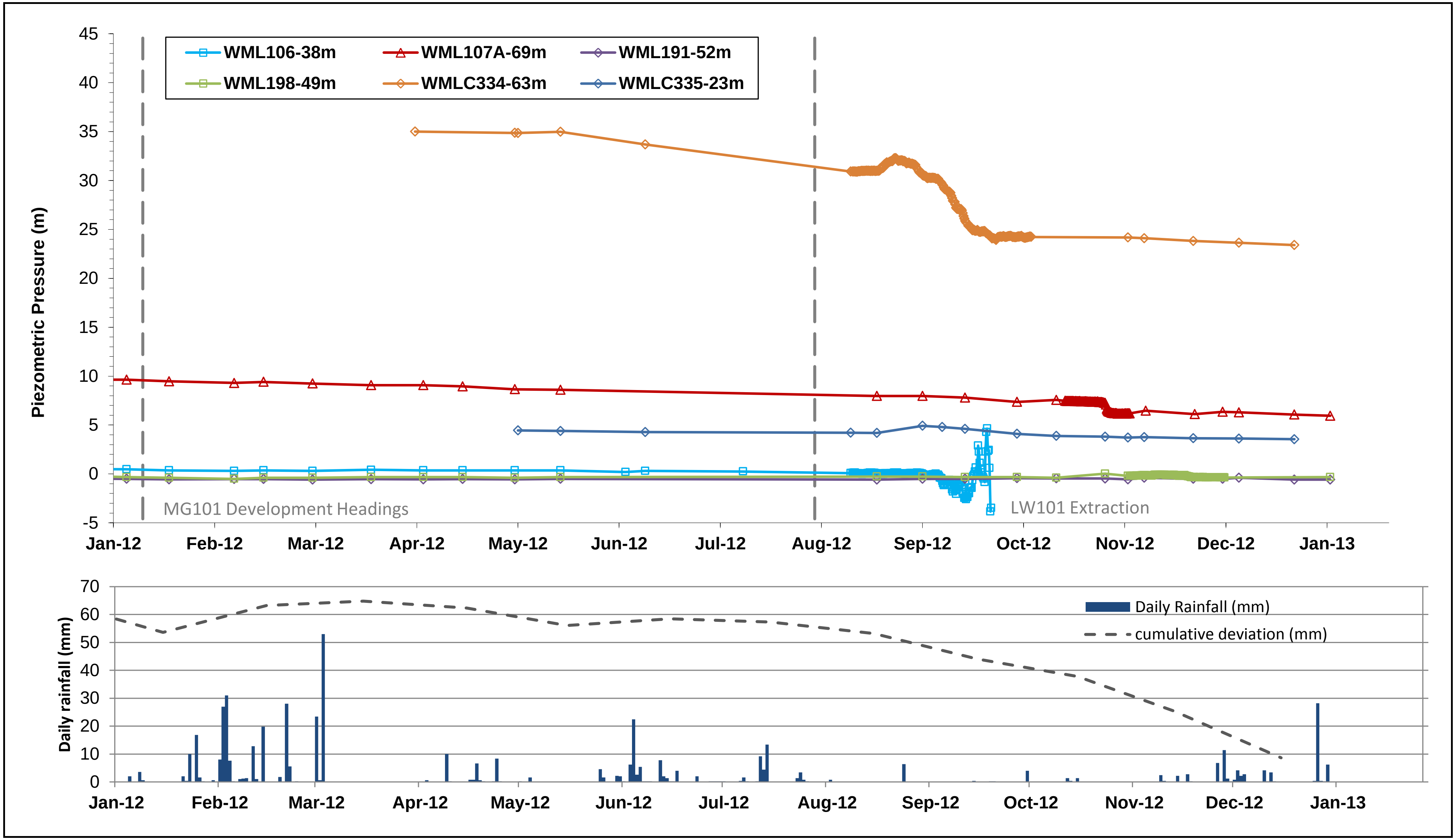
RPS Aquaterra

HYDROGRAPHS: HUNTER RIVER ALLUVIUM FIGURE 9



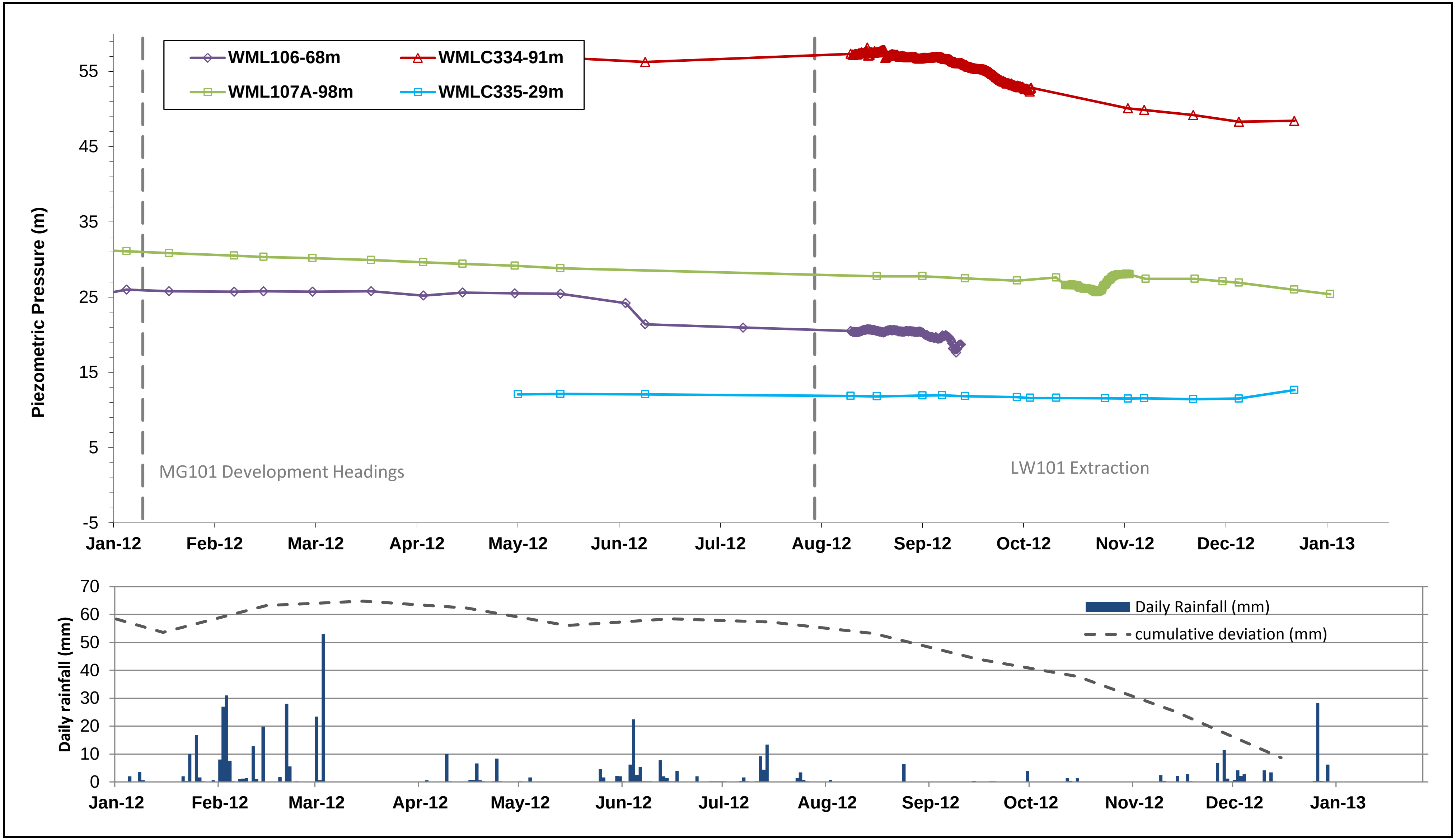
RPS Aquaterra

HYDROGRAPHS: LEMINGTON SEAMS 10 AND 11 FIGURE 10

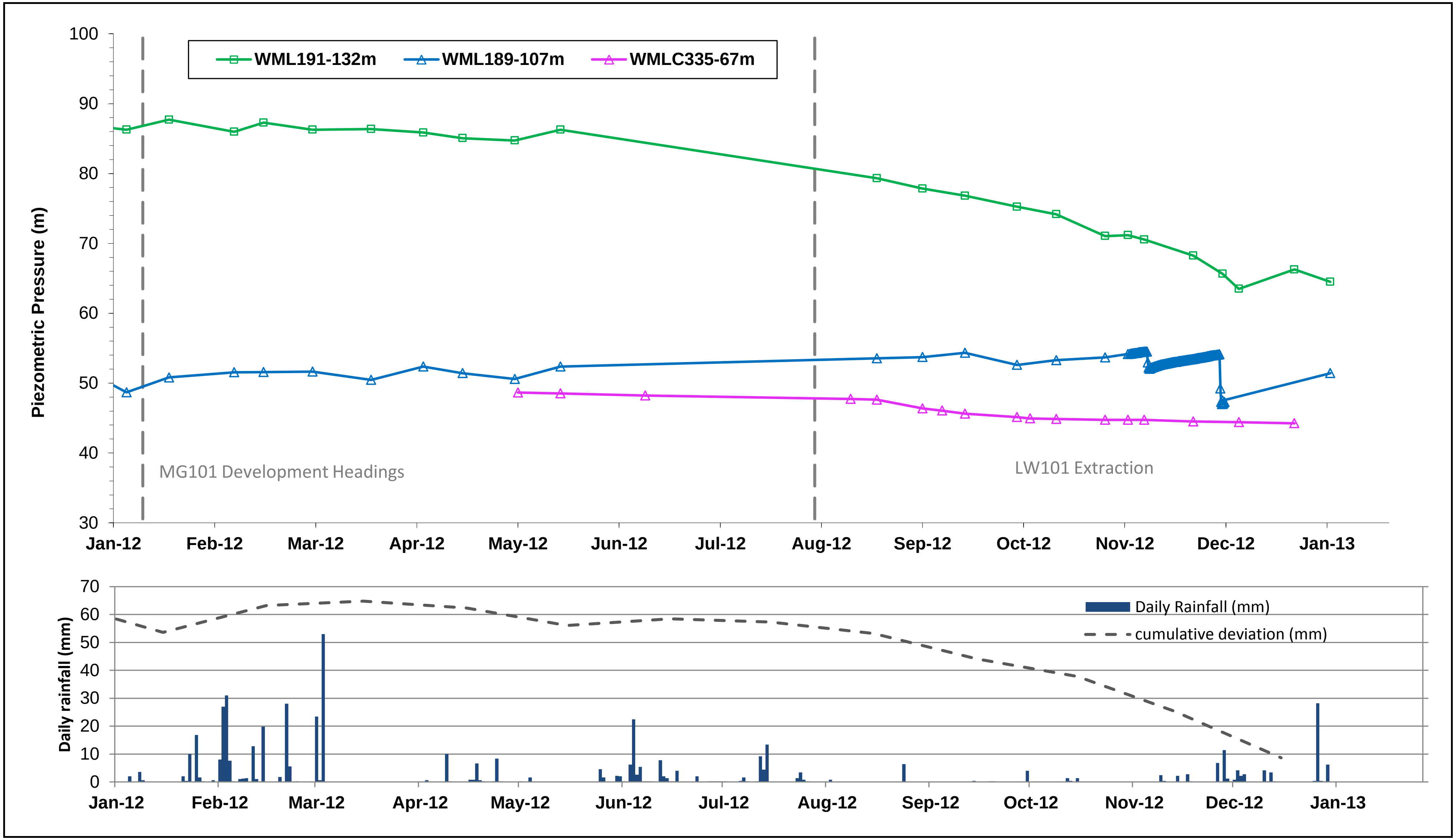


RPS Aquaterra

HYDROGRAPHS: LEMINGTON SEAM 15 FIGURE 11

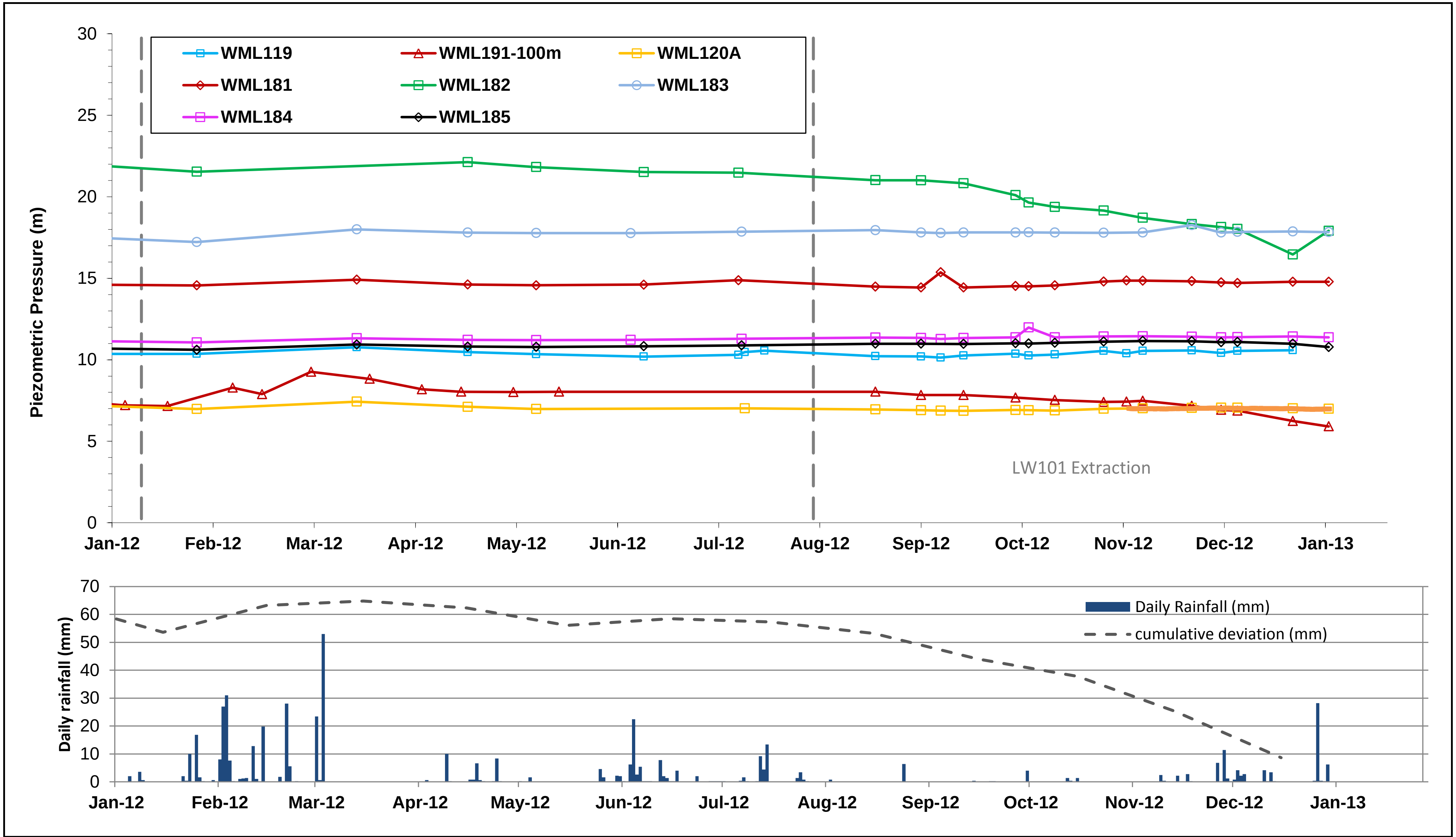


HYDROGRAPHS: LEMINGTON SEAMS 17 AND 19 FIGURE 12



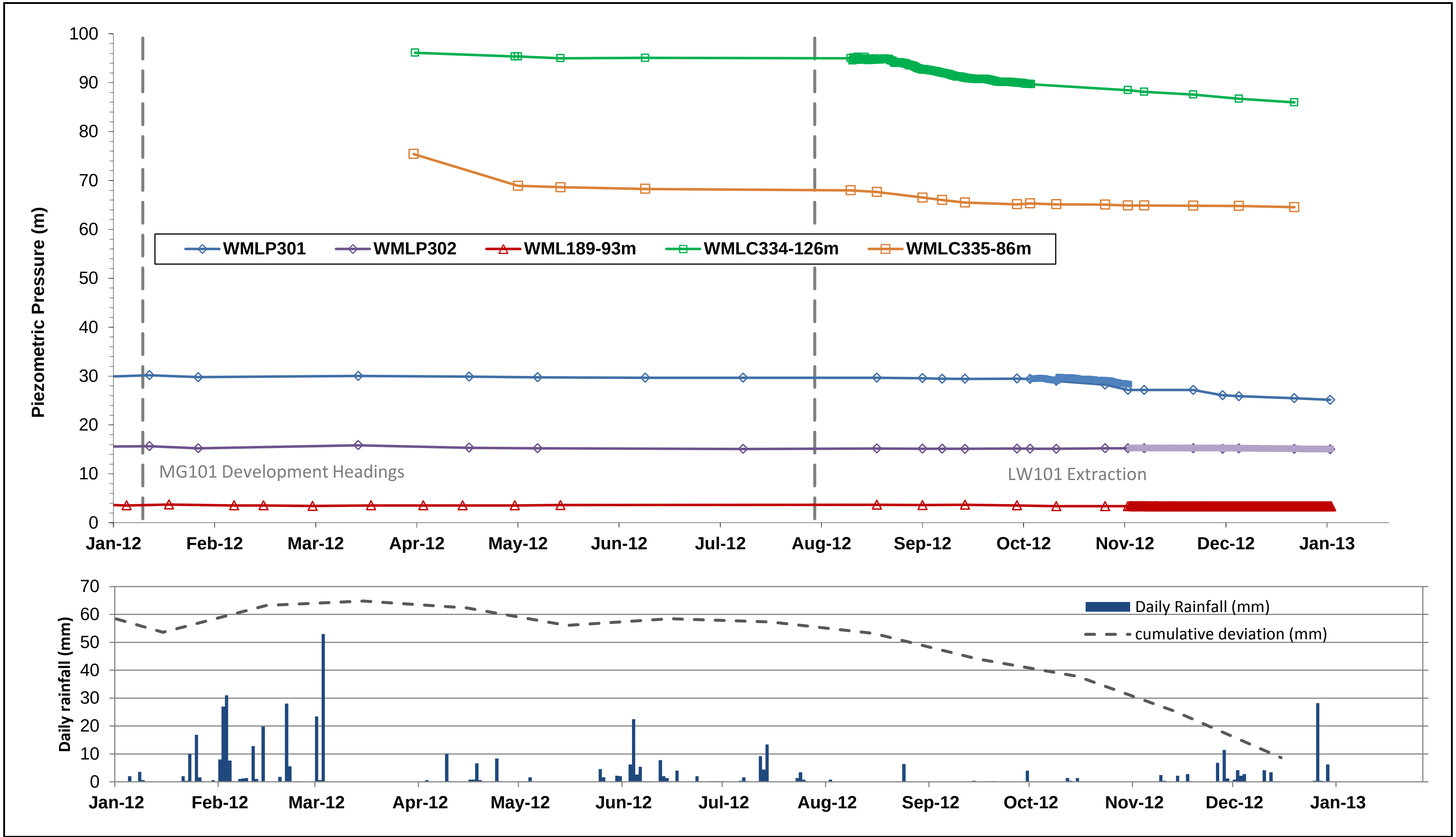
RPS Aquaterra

HYDROGRAPHS: PIKES GULLY SEAM FIGURE 13

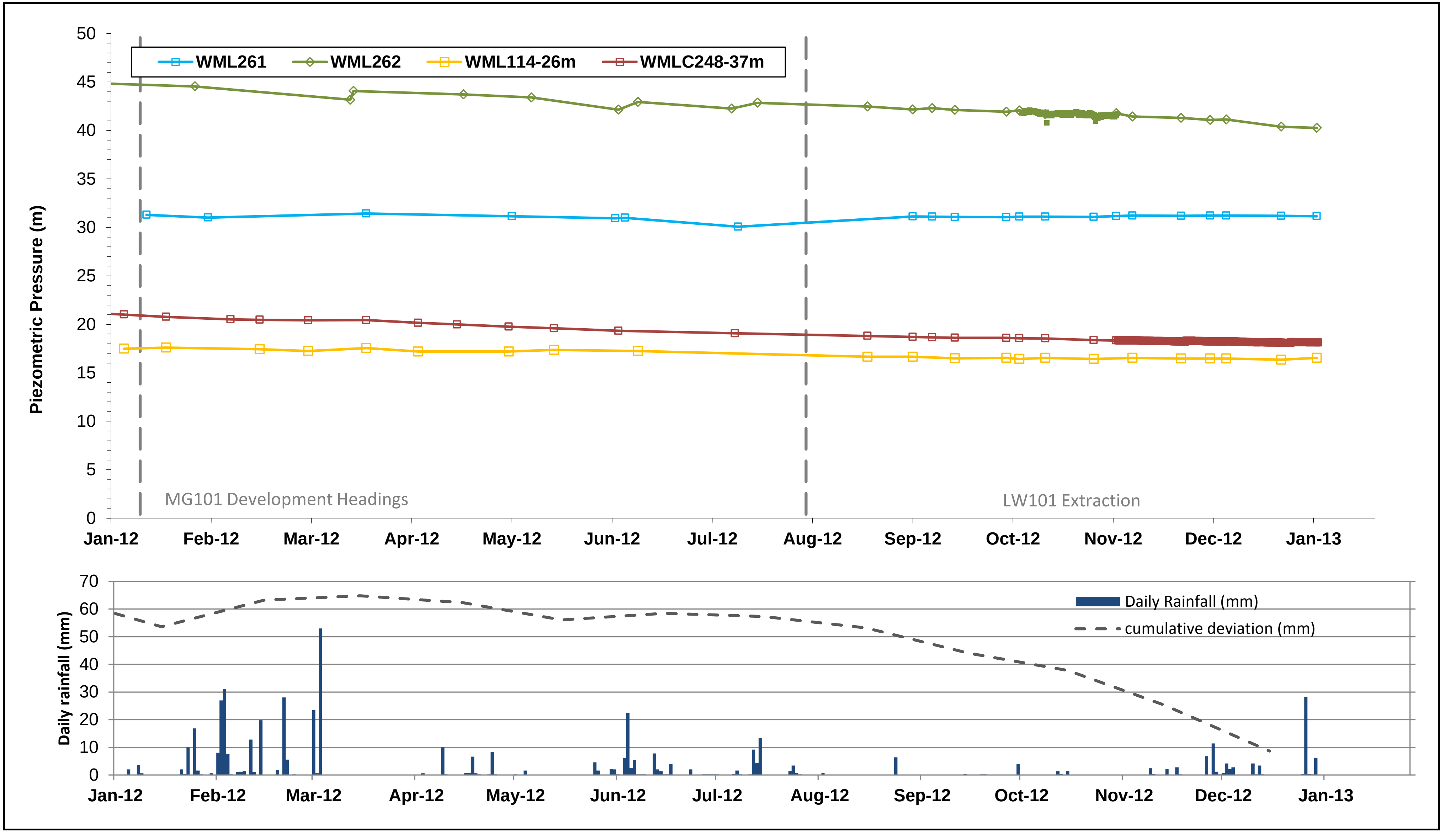


RPS Aquaterra

HYDROGRAPHS: PIKES GULLY (2) FIGURE 14

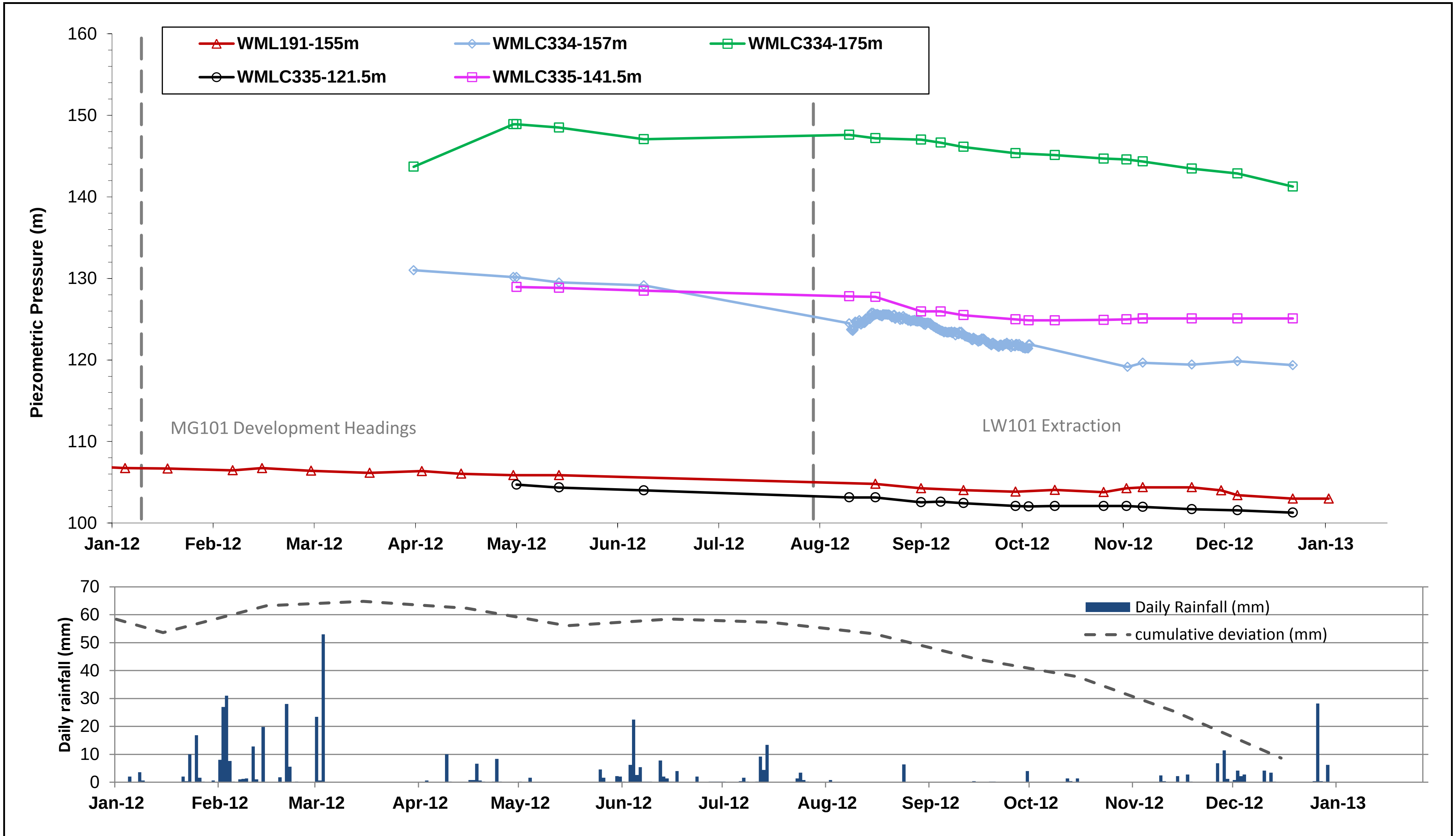


HYDROGRAPH: ARTIES SEAM FIGURE 15



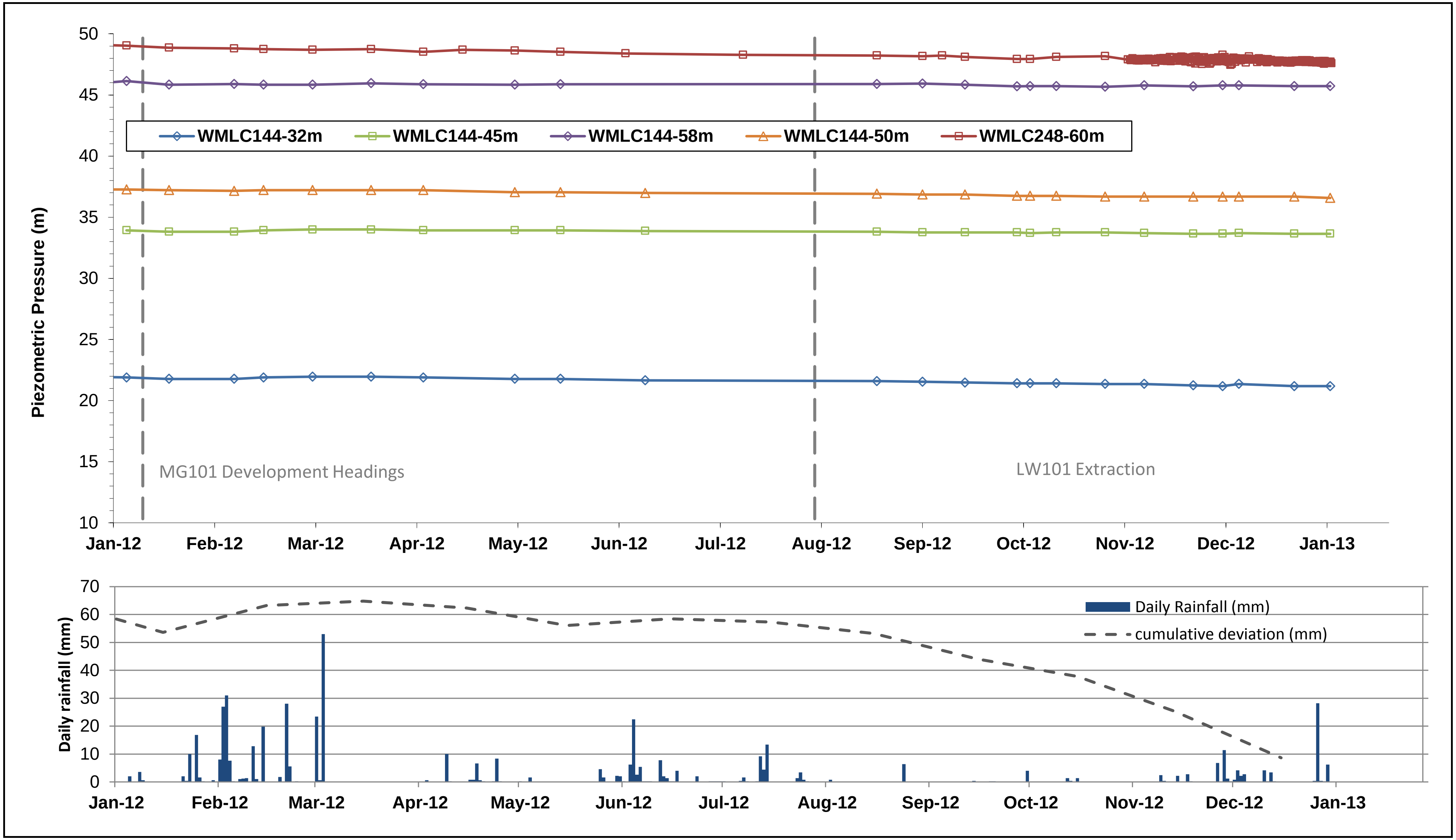
RPS Aquaterra

HYDROGRAPHS: UPPER LIDDELL SEAM FIGURE 16

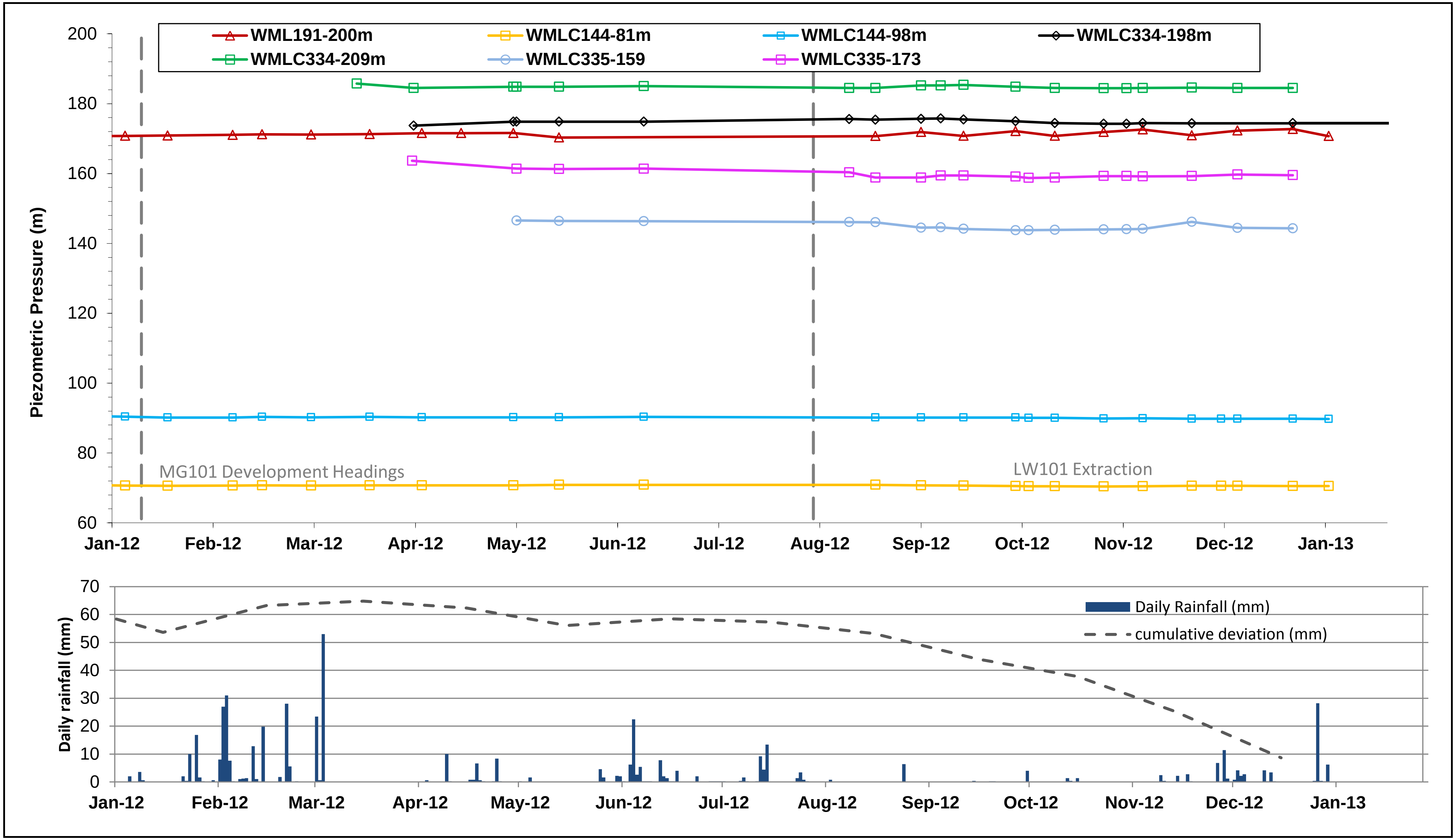


RPS Aquaterra

HYDROGRAPHS: UPPER LIDDELL SEAM (2) FIGURE 17



Piezometric Pressure (m)
50
45
40
35
30
25
20
15
10
WMLC144-32m
WMLC144-45m
WMLC144-58m
WMLC144-50m
WMLC248-60m
MG101 Development Headings
LW101 Extraction
Jan-12
Feb-12
Mar-12
Apr-12
May-12
Jun-12
Jul-12
Aug-12
Sep-12
Oct-12
Nov-12
Dec-12
Jan-13
Daily rainfall (mm)
70
60
50
40
30
20
10
0
Daily Rainfall (mm)
cumulative deviation (mm)
Jan-12
Feb-12
Mar-12
Apr-12
May-12
Jun-12
Jul-12
Aug-12
Sep-12
Oct-12
Nov-12
Dec-12
Jan-13



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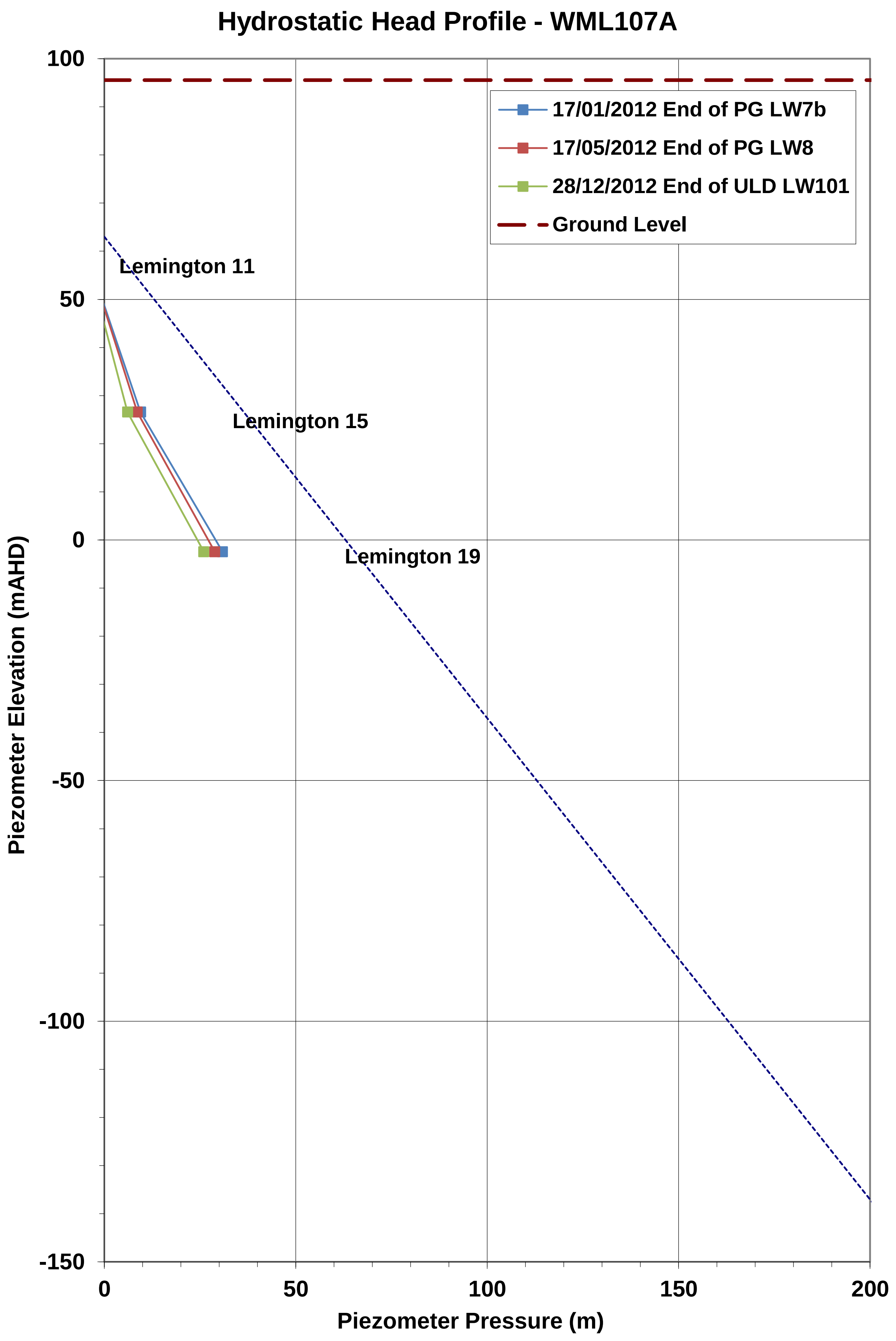
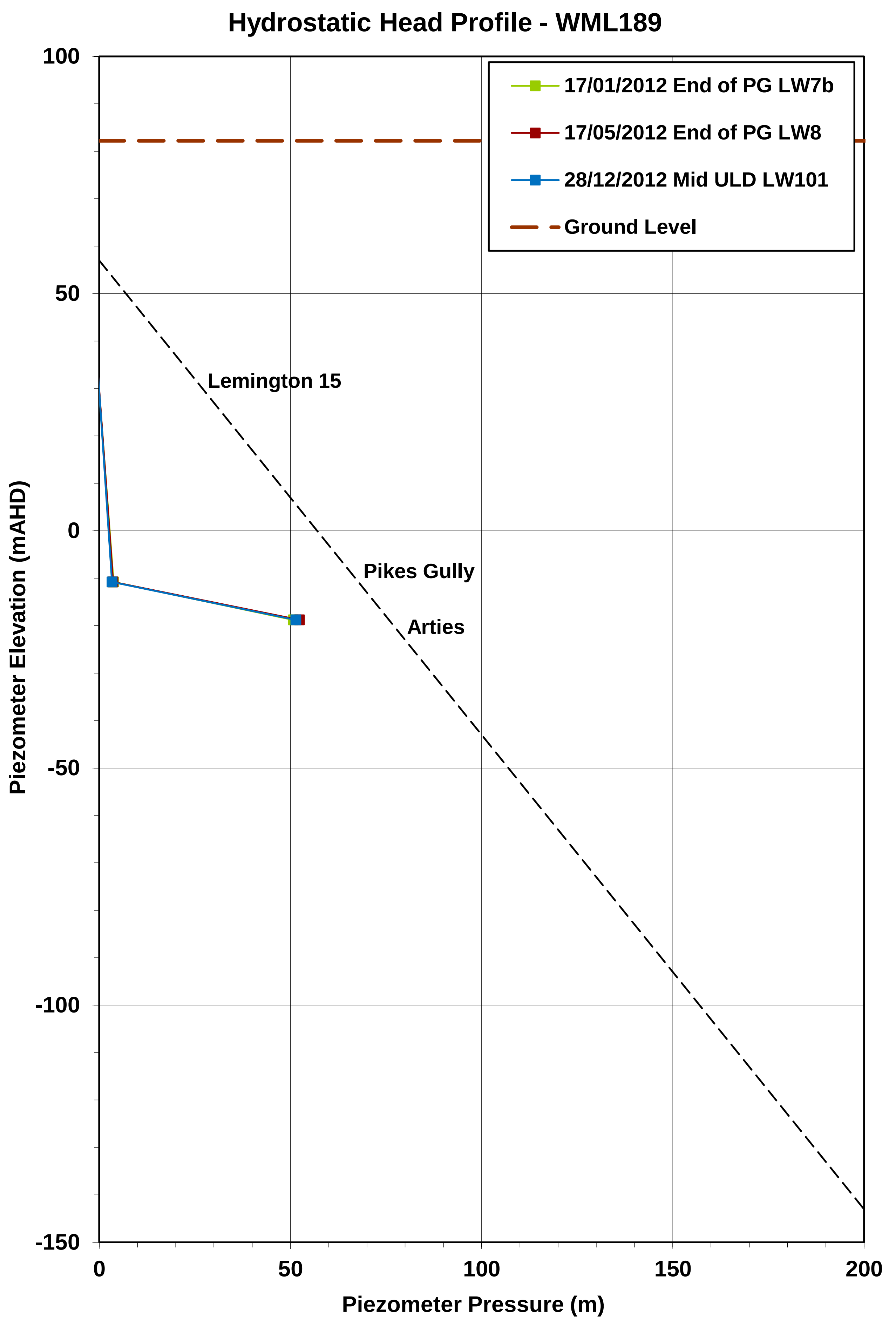
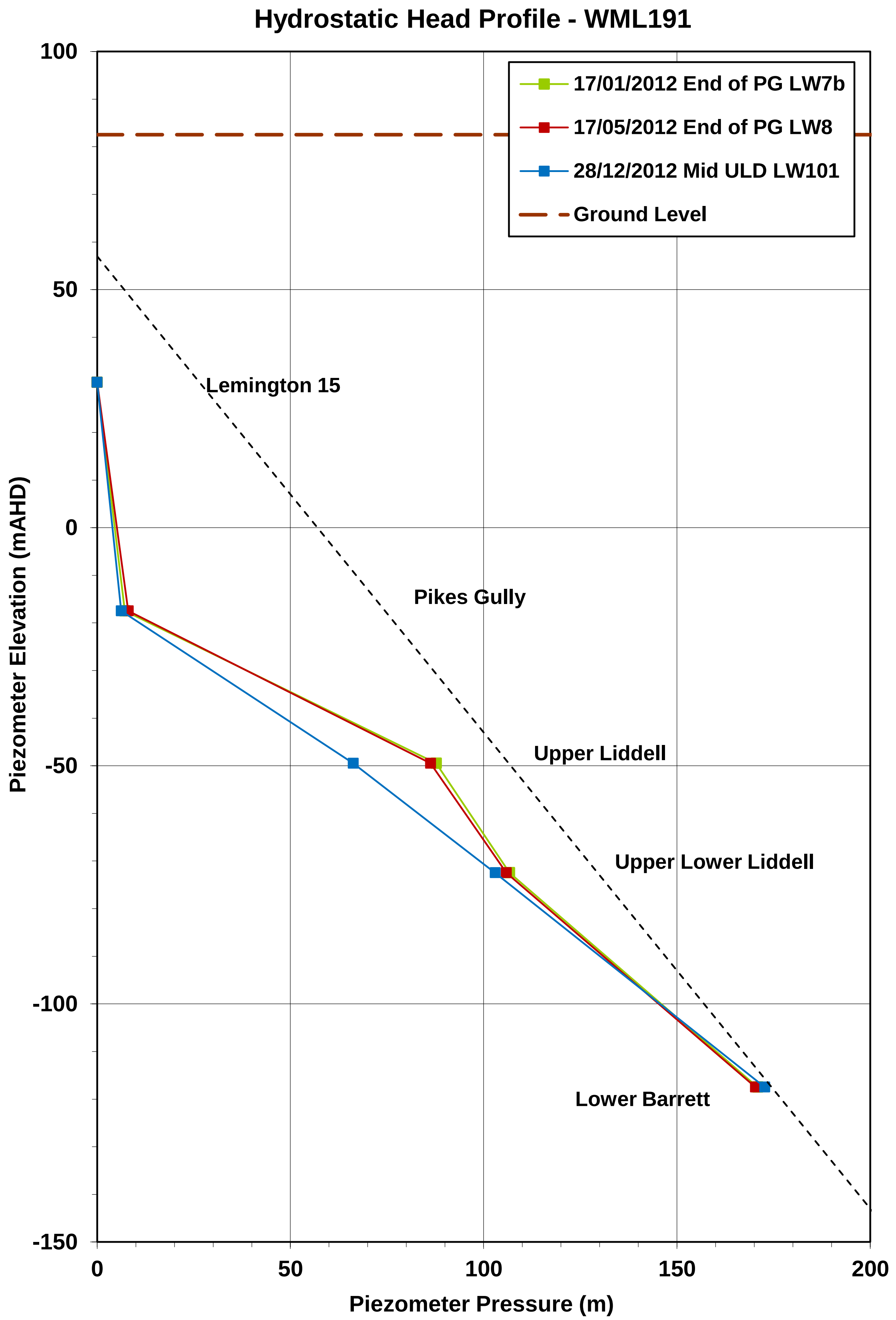
HYDROGRAPHS: UPPER AND LOWER BARRETT SEAMS FIGURE 19


Hydrostatic Head Profile - WML107A
17/01/2012 End of PG LW7b
17/05/2012 End of PG LW8
28/12/2012 End of ULD LW101
Ground Level
Lemington 11
Lemington 15
Lemington 19
100
50
0
-50
-100
-150
0
50
100
150
200
Piezometer Elevation (mAHD)
Piezometer Pressure (m)


Hydrostatic Head Profile - WML189
100
50
0
-50
-100
-150
Piezometer Elevation (mAHD)
0
50
100
150
200
Piezometer Pressure (m)
17/01/2012 End of PG LW7b
17/05/2012 End of PG LW8
28/12/2012 Mid ULD LW101
Ground Level
Lemington 15
Pikes Gully
Arties



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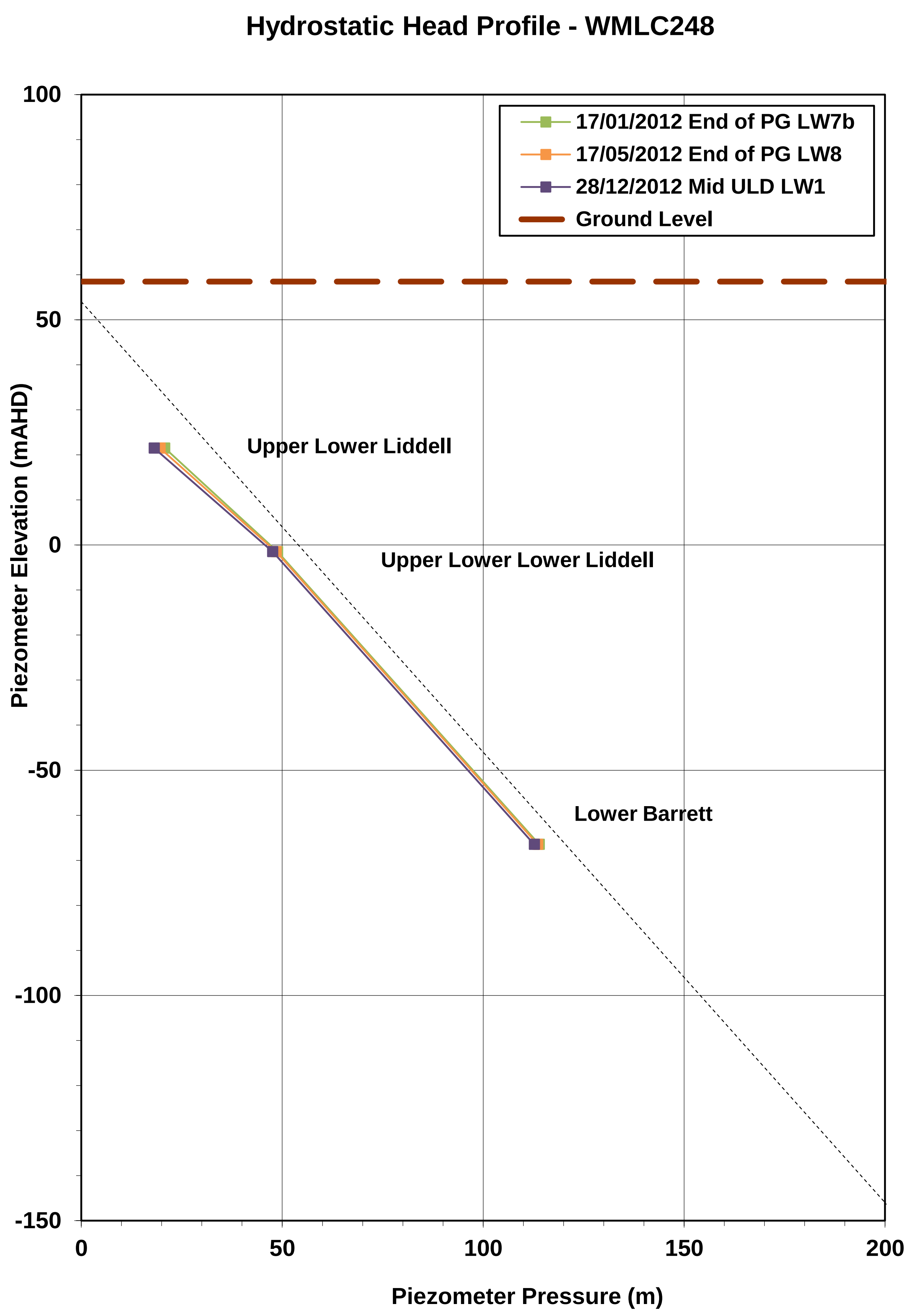
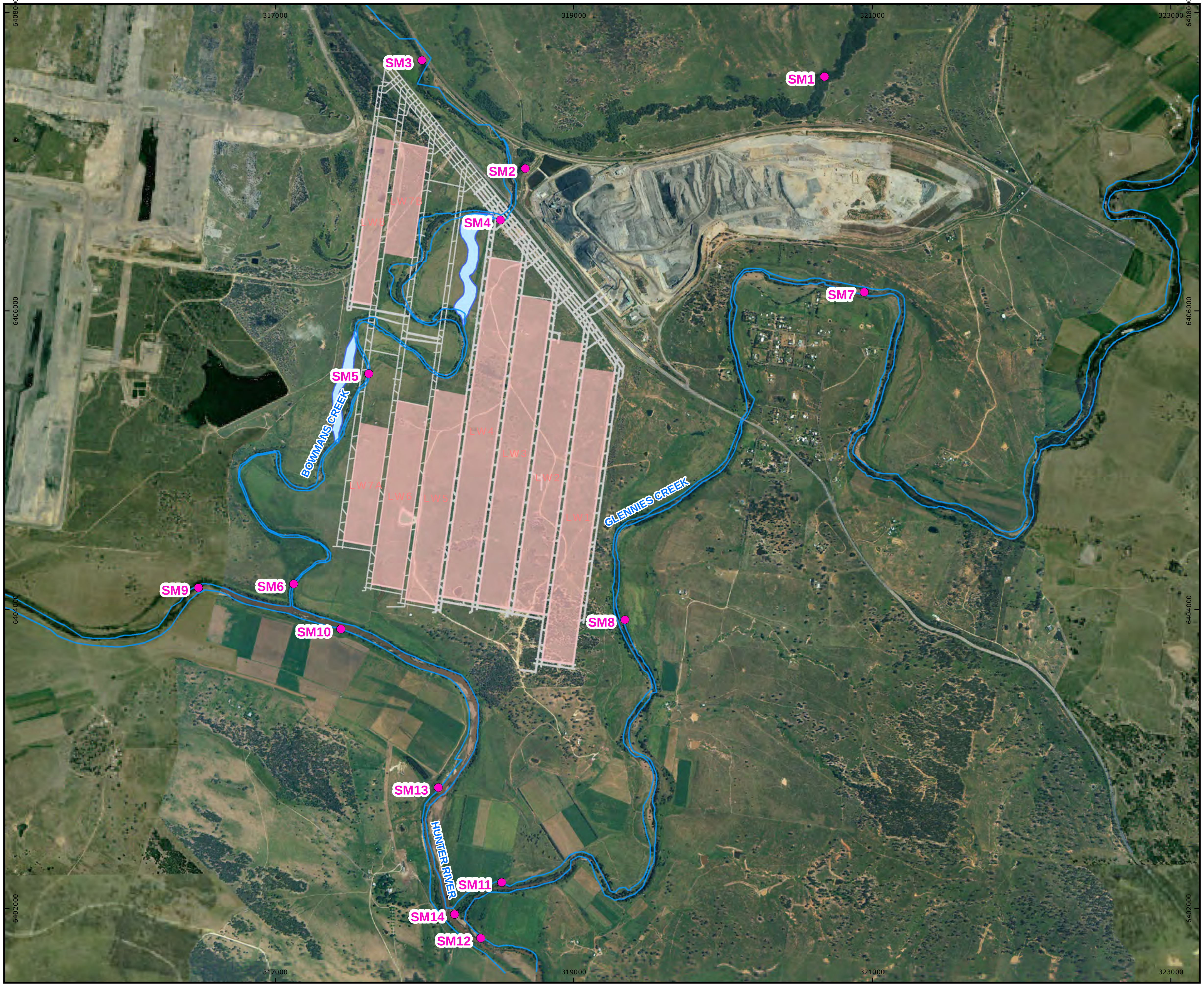
HYDROSTATIC PRESSURE HEAD PROFILE: WML191 FIGURE 22


Hydrostatic Head Profile - WMLC248
17/01/2012 End of PG LW7b
17/05/2012 End of PG LW8
28/12/2012 Mid ULD LW1
Ground Level
Upper Lower Liddell
Upper Lower Lower Liddell
Lower Barrett
100
50
0
-50
-100
-150
0
50
100
150
200
Piezometer Elevation (mAHD)
Piezometer Pressure (m)



LEGEND

- Surface Water Monitoring Location
- Pikes Gully Seam Extraction
- Bowmans Creek Diversion
- Creeks or River
- Mine Plan (Pikes Gully)

N

200 0 200 400
Metres

APPROX SCALE 1:24,826 @ A3

GDA 1994 MGA Zone 56

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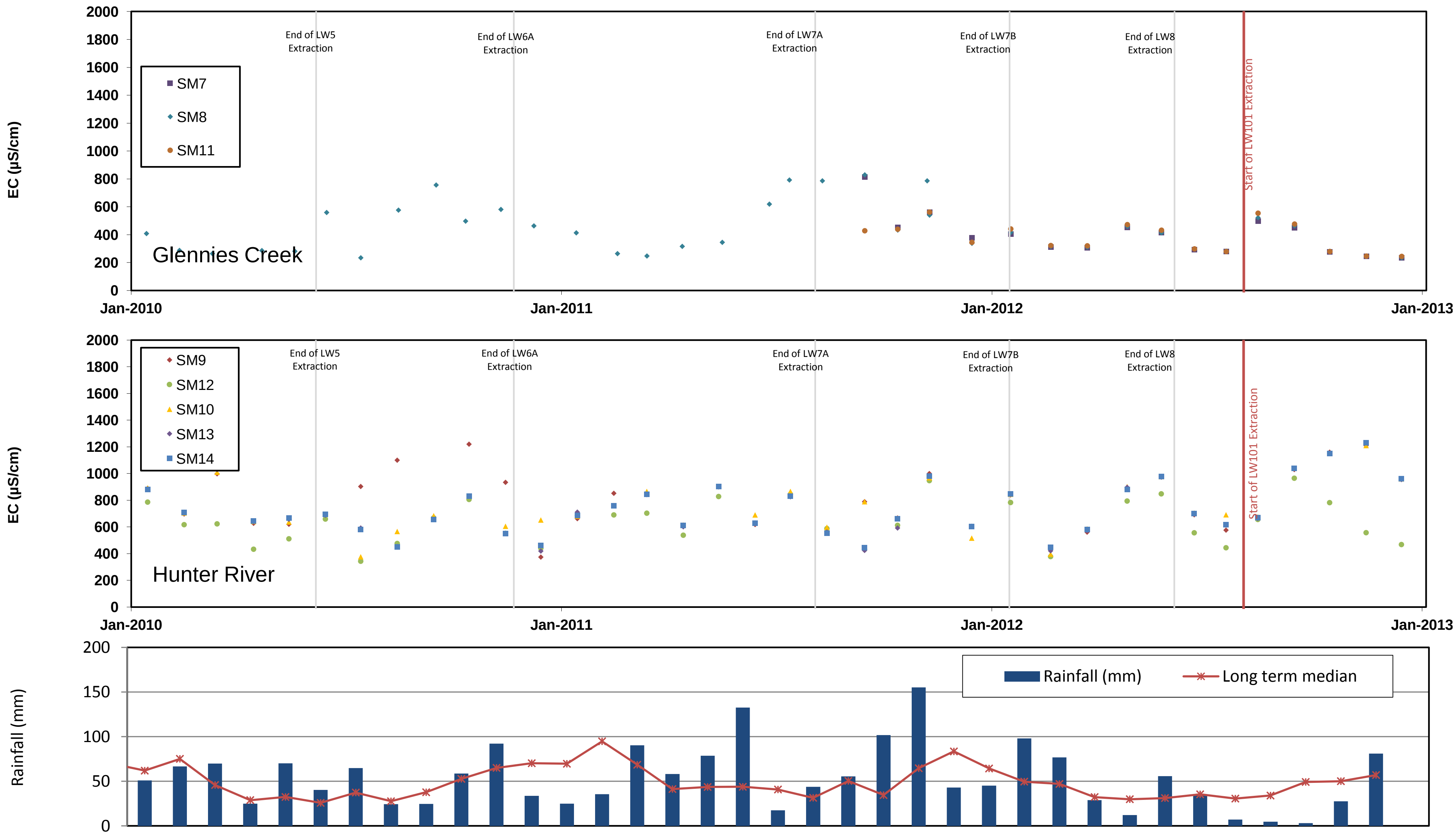
FIGURE 24

Ashton Coal
Surface Water Monitoring Network



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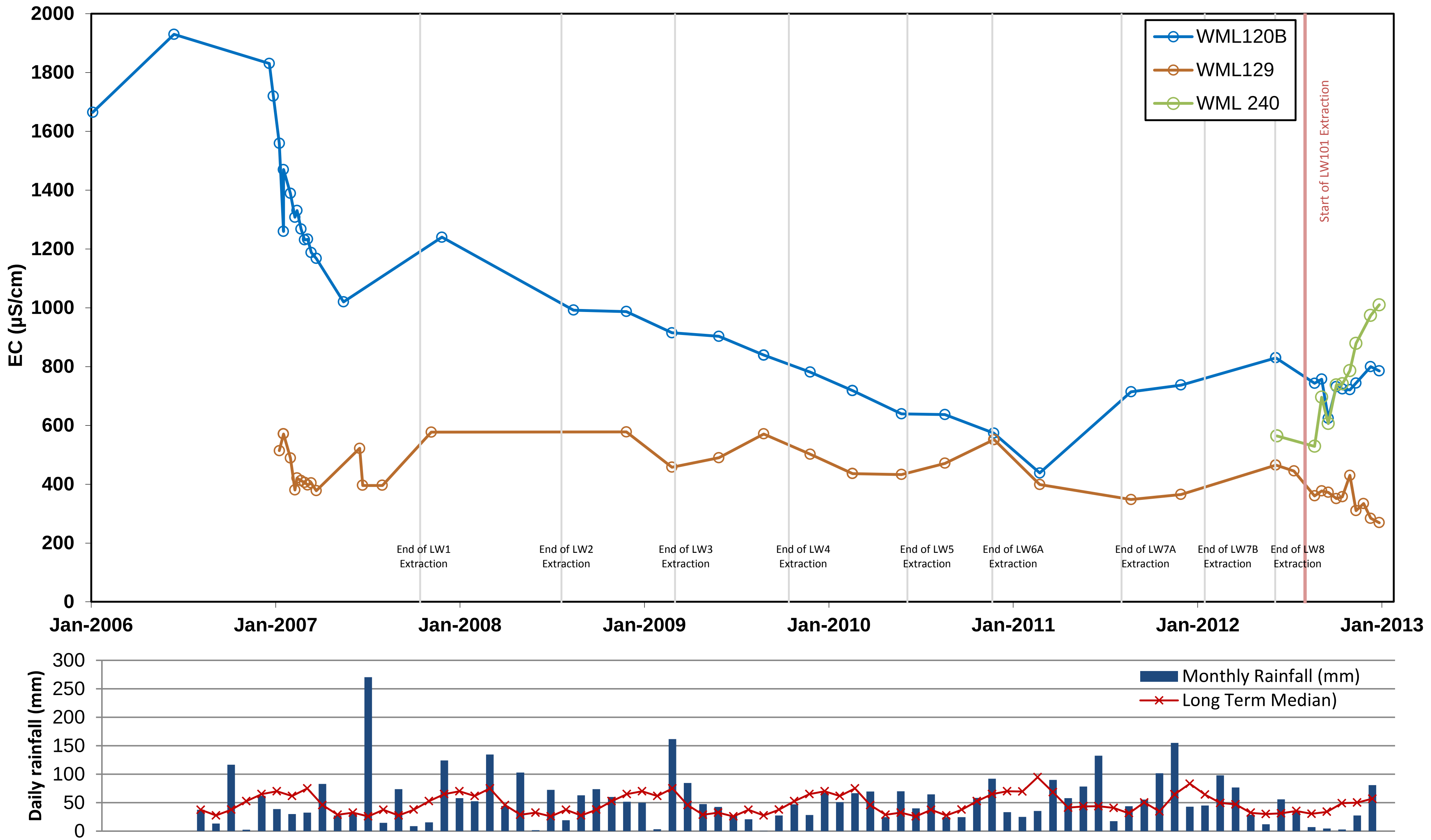
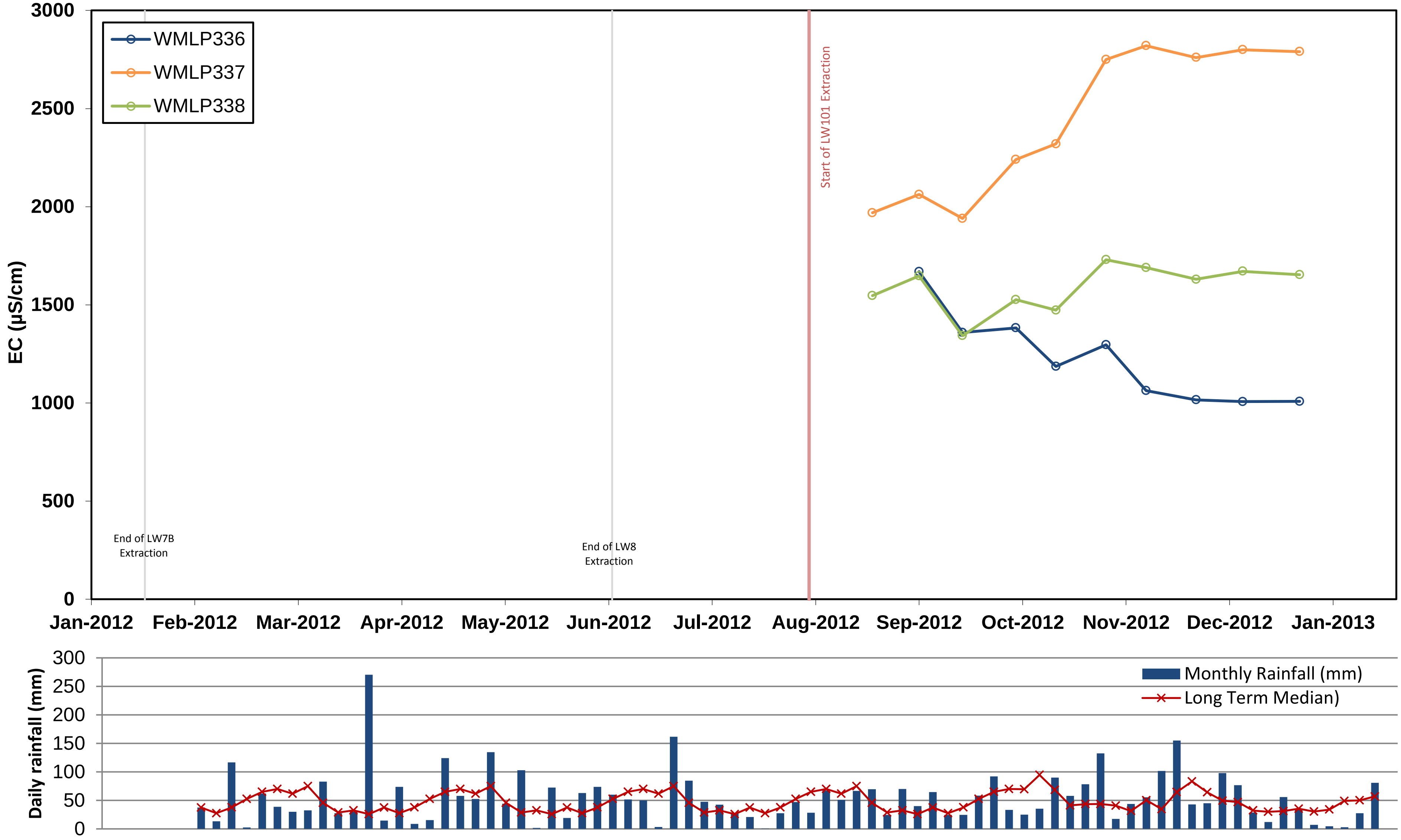
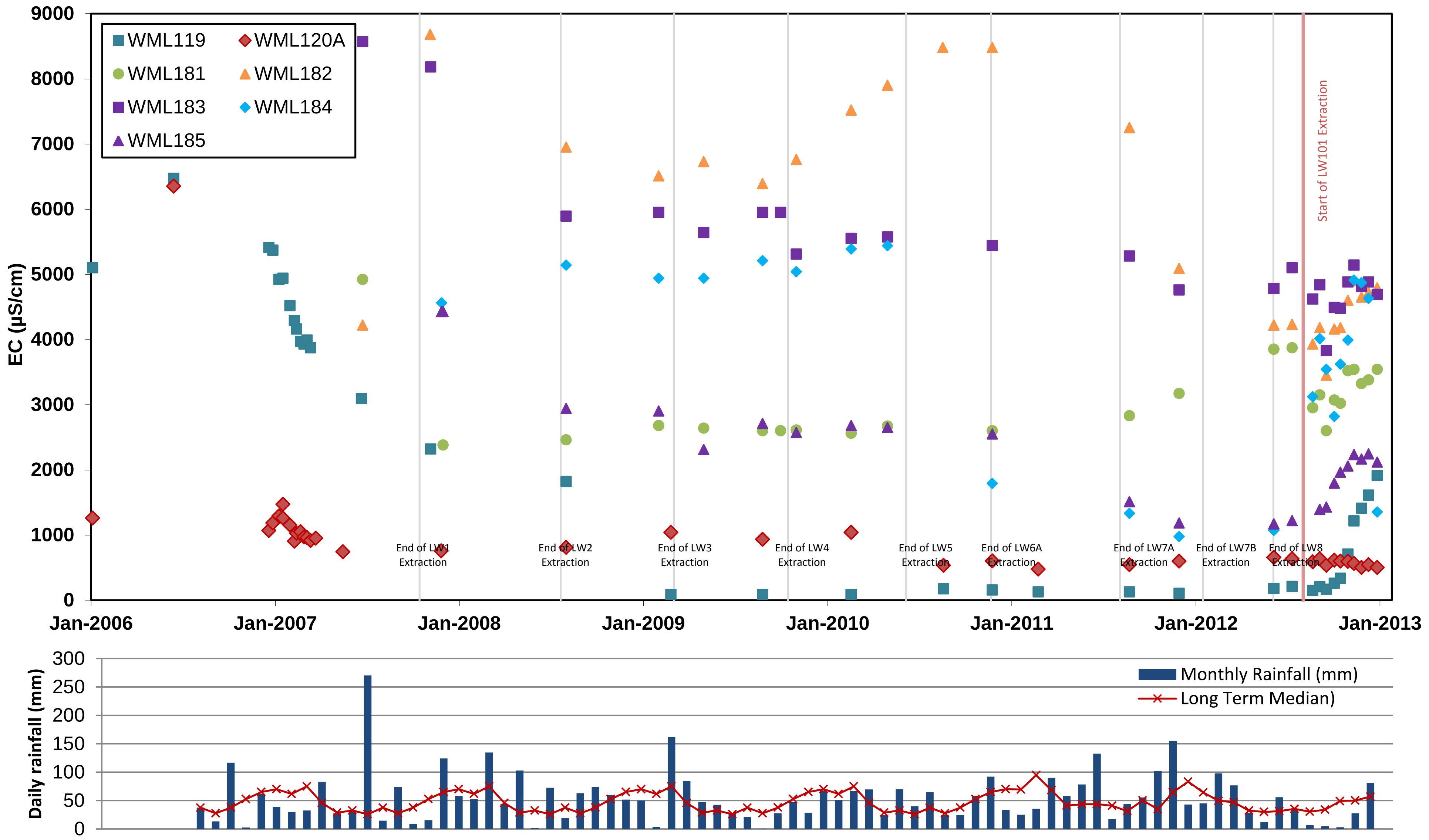
Ashton Coal Operations Pty Ltd
SURFACE WATER SALINITY Figure 25

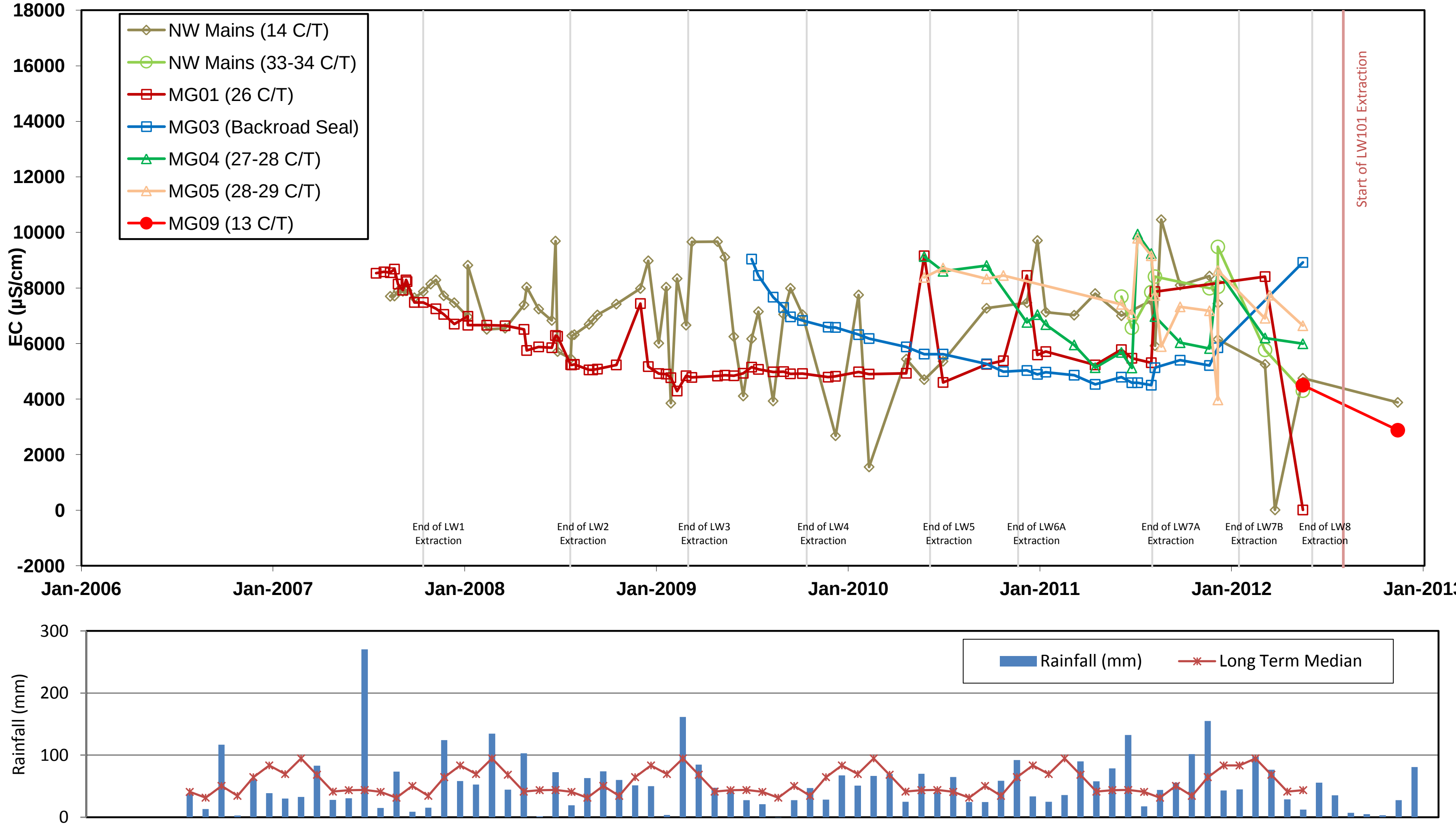


EC (µS/cm)
2000
1800
1600
1400
1200
1000
800
600
400
200
0
Jan-2006
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
WML120B
WML129
WML 240
Start of LW101 Extraction
End of LW1 Extraction
End of LW2 Extraction
End of LW3 Extraction
End of LW4 Extraction
End of LW5 Extraction
End of LW6A Extraction
End of LW7A Extraction
End of LW7B Extraction
End of LW8 Extraction
Daily rainfall (mm)
300
250
200
150
100
50
0
Monthly Rainfall (mm)
Long Term Median)


3000
2500
2000
1500
1000
500
0
EC (µS/cm)
WMLP336
WMLP337
WMLP338
Start of LW101 Extraction
End of LW7B Extraction
End of LW8 Extraction
Jan-2012
Feb-2012
Mar-2012
Apr-2012
May-2012
Jun-2012
Jul-2012
Aug-2012
Sep-2012
Oct-2012
Nov-2012
Dec-2012
Jan-2013
300
250
200
150
100
50
0
Daily rainfall (mm)
Monthly Rainfall (mm)
Long Term Median)



9000
8000
7000
6000
5000
4000
3000
2000
1000
0
EC (µS/cm)
WML119
WML120A
WML181
WML182
WML183
WML184
WML185
End of LW1 Extraction
End of LW2 Extraction
End of LW3 Extraction
End of LW4 Extraction
End of LW5 Extraction
End of LW6A Extraction
End of LW7A Extraction
End of LW7B Extraction
End of LW8 Extraction
Start of LW101 Extraction
Jan-2006
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
300
250
200
150
100
50
0
Daily rainfall (mm)
Monthly Rainfall (mm)
Long Term Median)


NW Mains (14 C/T)
NW Mains (33-34 C/T)
MG01 (26 C/T)
MG03 (Backroad Seal)
MG04 (27-28 C/T)
MG05 (28-29 C/T)
MG09 (13 C/T)
EC (µS/cm)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
End of LW1 Extraction
End of LW2 Extraction
End of LW3 Extraction
End of LW4 Extraction
End of LW5 Extraction
End of LW6A Extraction
End of LW7A Extraction
End of LW7B Extraction
End of LW8 Extraction
Start of LW101 Extraction
Jan-2006
Jan-2007
Jan-2008
Jan-2009
Jan-2010
Jan-2011
Jan-2012
Jan-2013
Rainfall (mm)
300
200
100
0
Rainfall (mm)
Long Term Median

APPENDIX A:
CURRENT GROUNDWATER MONITORING NETWORK

Table 1: 2001 Environmental Impact Statement Piezometers

Piezometer	Location	Aquifer
RM02	Located within maingate chain pillars of LW5	Colluvium/CM
RM05	Located south-west corner LW8	CM Overburden
RM07	Located in oxbow between LW6A and LW6B	BC Alluvium/CM
RSGM1	Located within LW8	Bayswater Seam

Table 2: 2008 Test Piezometers

Piezometer	Location	Screened Aquifer
T2-A	Located within LW7A, close to the northern end of extraction	BC Alluvium
T2-P		CM Overburden
T3-A	Located within southern part of LW7A, 65m from LW6A goaf edge	BC Alluvium
T3-P		CM Overburden
T4-A	Located within the southern part of LW6A, about 155m from the start line	BC Alluvium
T4-P		CM Overburden
T5	Located within tailgate chain pillars of LW7B	BC Alluvium
T6		
T7	Located within maingate chain pillars of LW8	BC Alluvium
T10	Located within chain pillar between LW6A and LW7A	BC Alluvium

Table 3: 2008 Bowmans Creek Alluvium Investigation Piezometers

Piezometer	Location	Screened Aquifer
RA10	Located above maingate chain pillar of LW7A	BC Alluvium
RA12	Located mid-panel within LW5	Colluvium
RA14	Located inside LW7A	BC Alluvium
RA15	Located west of LW7A	BC Alluvium
RA16	Located within maingate chain pillars of LW5	Colluvium
RA18	Located just outside northern end of LW6A	BC Alluvium
RA27	Located to the south of LW5-LW7A, along the bank of Hunter River.	HR Alluvium
RA30	Located within LW7B	BC Alluvium

Table 4: General Underground Monitoring Network

Piezometer	Location	Screened Aquifer	Installation date
WML107B	Located outside southern end of LW2	Lem8-9	Sep-06
WML108B			
WML110C	Located inside southern end above LW6A	BC Colluvium	
WML111B	Located inside southern end of LW6A	CM Overburden	May-06
WML112C	Located near LW7A maingate	BC Alluvium	Jul-06
WML112B		Bayswater 1-2	
WML113C	Located just west of southern end of LW7A	BC Alluvium	May-06
WML113B		Bayswater 1	
WML115B	Located in eastern chan pillars of LW7B	CMOB & Lem3-4	-
WML115C		BC Alluvium	
WMLP316	Located adjacent to the west diversion	BC Alluvium	Feb-11
WMLP320			
WMLP308	Located adjacent to the eastern creek diversion	BC Alluvium	Feb-11
WMLP311			
WMLP323			
WMLP324		CM Overburden	
WMLP325			
WMLP326	Located southwest of LW6A	BC Alluvium	Feb-11
WMLP327		CM Overburden	
WML275	Located within/close to southern end of LW6A	BC Alluvium	-
WML276			
WML277	Located to the south of LW5-LW7A, along the bank of Hunter River.	HR Alluvium	-
WML278			
WML279			
WML280			
WML119	Located to the east of LW1 and west of Glennies Creek	Pikes Gully	Jun-06
WML120A			
WML120B		GC Alluvium	Jun-06
WML129			-
WML181		Pikes Gully	Mar-07
WML182			
WML183			
WML184			
WML185			
WML186			
WML187			
WMLP301		Arties	Jul-10
WMLP302			
WML261		Upper Liddell	Oct-09

Piezometer	Location	Screened Aquifer	Installation date
WML262		Upper Liddell	Oct-09
WMLP336	Located south of LW1	HR Alluvium	Jul-12
WMLP337	Located south of LW3		
WMLP338	Located south of LW2		

Table 5: Multi-level Vibrating Wire Piezometers

Piezometer	Location	Aquifer	Installation Date
WML106-32*	Located outside southern end of LW1	Lem15	Jul-06
WML106-68*		Lem19	
WML106-84*		PG	
WML107A -38	Located outside southern end of LW2	Lem11	May-06
WML107A -69		Lem15	
WML107A -69		Lem15	
WML107A -98		Lem19	
WML108A-53	Located outside southern end of LW3	Lem11-12	Apr-06
WML108A-80		Lem15	
WML113A-40	Located just west of southern end of LW7A	Bayswater 2	May-06
WML113A-65		Lem9	
WML113A-95		Lem10-12	
WML113A-124		Lem15	
WML189-49	Located in chain pillars between LW1 and LW2	Lem15	-
WML189-93		Arties	
WML189-101		Pikes Gully	
WML191-52	Located in chain pillars between LW1 and LW2	Lem15	-
WML191-100		Pikes Gully	
WML191-132		Upper Liddell	
WML191-155		Upper Lower Liddell	
WML191-200		Lower Barrett	
WML213-48	Located southwest of LW7A	Bayswater	-
WML213-110.5		Lem8-9	
WML213-169.5		Lem15	
WML213-185.5		Lem19	
WML213-205		Pikes Gully	
WML213-247		Upper Liddell	
WML213-276		Upper Lower Liddell	
WML213-300		Lower Barrett	
WML269-24	Located in maingate chain pillars close to LW5 start line	Lem5	-
WML269-56		Lem7	
WML269-64		Lem8-9	

Piezometer	Location	Aquifer	Installation Date
WML269-92		Lem11-12	
WML269-122		Lem15	
WML269-142		Lem19	
WMLC333-124m	Located to the south of LW4	Lem15B	Feb-12
WMLC333-144m		Lem17A	
WMLC333-178m		Arties	
WMLC333-212m		Upper Liddell	
WMLC333-232m		Upper Lower Liddell	
WMLC333-251m		Upper Barrett	
WMLC333-264m		Lower Barrett	
WMLC334-29.5m	Located to the south of LW1 and LW2	Lem10	Apr-12
WMLC334-63m		Lem15	
WMLC334-91m		Lem19	
WMLC334-126m		Arties	
WMLC334-157m		Upper Liddell	
WMLC334-175m		Upper Lower Liddell	
WMLC334-209m		Lower Barrett	
WMLC334-198m		Upper Barrett	
WMLC335-23m	Located to the south of LW1 and LW2	Lem15A	Apr-12
WMLC335-29.5m		Lem17	
WMLC335-67m		PG-U	
WMLC335-86m		Arties	
WMLC335-121.5m		Upper Liddell	
WMLC335-141.5m		Upper Lower Liddell	
WMLC335-159m		Upper Barrett	
WMLC335-173m		Lower Barrett	

* Piezometer destroyed by longwall extraction in September 2012