End of Panel Report

December 2011

Illawarra Coal Environmental Field Team

West Cliff Mine Longwall 34

Contents

1. Introduction

Monitoring has been carried out by the Illawarra Coal (IC) Environmental Field Team to record any impacts from the extraction of Longwall 34 in accordance with the West Cliff Longwalls 34 to 36 Subsidence Management Plan (SMP) and Georges River Management Plan. Extraction of Longwall 34 commenced on 6 February 2010 and was completed 14 September 2011. This report summarises the monitoring of surface features above West Cliff Longwall 34 undertaken by the IC Environmental Field Team.

1.1. Overview of Monitoring Program

Monitoring of the surface above Longwall 34 is undertaken in accordance with SMP requirements for West Cliff Longwalls 34 to 36. This monitoring includes regular inspections of the Georges River, Mallaty Creek, Leafs Gully, Nepean River and Nepean Creek (Figure 1).

The program includes monitoring of pool water levels, flows and water quality. Photographic and observational monitoring is undertaken to identify any mining-induced fractures, strata gas releases, iron staining, or rock falls from outcrops and steep slopes. Detailed analysis and reporting of water quality data is undertaken by EcoEngineers Pty Ltd.

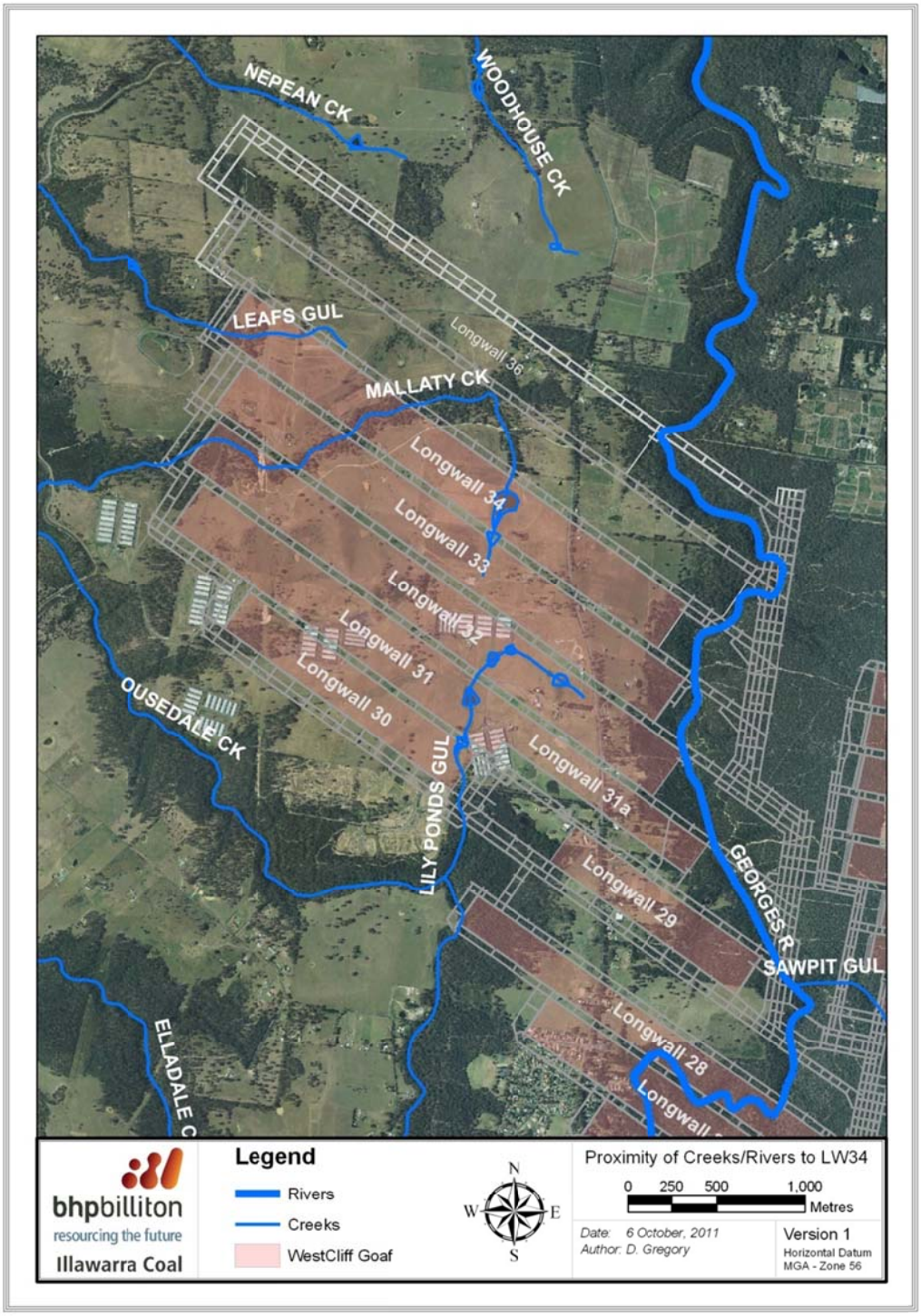

Figure 1: River and Creek locations in relation to Longwall 34.

1.2. Georges River Monitoring Program

Monitoring of the Georges River is undertaken in accordance with SMP requirements for Longwalls 34 to 36 and the Georges River Management Plan (once extraction is within 400m of the Georges River). The Georges River Management Plan has been developed to meet the requirements of SMP Condition 13 and supersede the Georges River program described in the West Cliff Subsidence Management Plan (Revision 1) dated November 2009.

Monitoring undertaken for Longwall 34 by the IC Environmental Field Team includes field water quality parameters and laboratory parameters (where indicated), flows, water levels as well as observational records at the following sites (from north to south):

- Water quality at sites Pool 64 (lab) Pool 63, Pool 62, Pool 61, GRQ18 (lab), Pool 59, Pool 58, Pool 57, Pool 56, Pool 55, Pool 54 (lab), Pool 53, Pool 52 (lab), Pool 51, Pool 50, Pool 49 (lab), Pool 47 (lab), Hammer Head springs lower (lab), Pool 45, Pool 44, Pool 43 (GRQ17a) (lab), Pool 42, Pool 41, Pool 40 (lab), Pool 39, Pool 38, Pool 37, Pool 36, Pool 35:
    - Monthly baseline monitoring.
    - For lab parameter sites, monthly laboratory parameter tests once mining was within 400m of the Georges River.
    - For lab parameter sites, monthly for 2 months post mining or until parameters are within 2 standard deviations of baseline.
    - For field parameter sites, weekly field parameters testing once mining was within 400m of the Georges River.
    - For field parameter sites, weekly for 2 months post mining, then monthly until parameters are within 2 standard deviations of baseline.

- Water level/flow at sites Rock-bar 64, Rock-bar 53, Rock-bar 43, Rock-bar 40/Airstrip weir and Rock-bar 36. Water level is measured for all water quality sites listed above:
    - Monthly baseline monitoring of flows and pool levels.
    - Weekly manual monitoring of flows (using Pigmy Flow meter, where conditions allow) and pool level during mining within 400m of the Georges River.
    - Ongoing monthly monitoring for 2 months post mining or until flow characteristics are typical of baseline conditions.

- River appearance at all water quality and flow monitoring sites listed above:
    - Monthly baseline monitoring.
    - Weekly monitoring when mining is within 400m of the Georges River.
    - Monthly monitoring for 2 months post mining or until subsidence is complete.

- Visual inspection and photographic records of cliffs, steep slopes, fire trails, and watercourses:
    - Observation in conjunction with water quality and flow monitoring.
- Groundwater levels at Boreholes GR27, GR28 and S2087 (PSP1 – Near Mallaty Creek):
    - Monthly baseline.
    - Weekly monitoring from 200m prior to undermining until 400m past or subsidence is complete. Monthly monitoring post mining for 2 years or as otherwise required. Water samples taken from each site prior to mining.
    - Water samples taken from each site after mining.
    - Borehole S2087 is instrumented with piezometers and data logger.

Figure 2 River and Creek locations in relation to Longwall 34.outlines the locations of these monitoring sites and their proximity to Longwall 34.

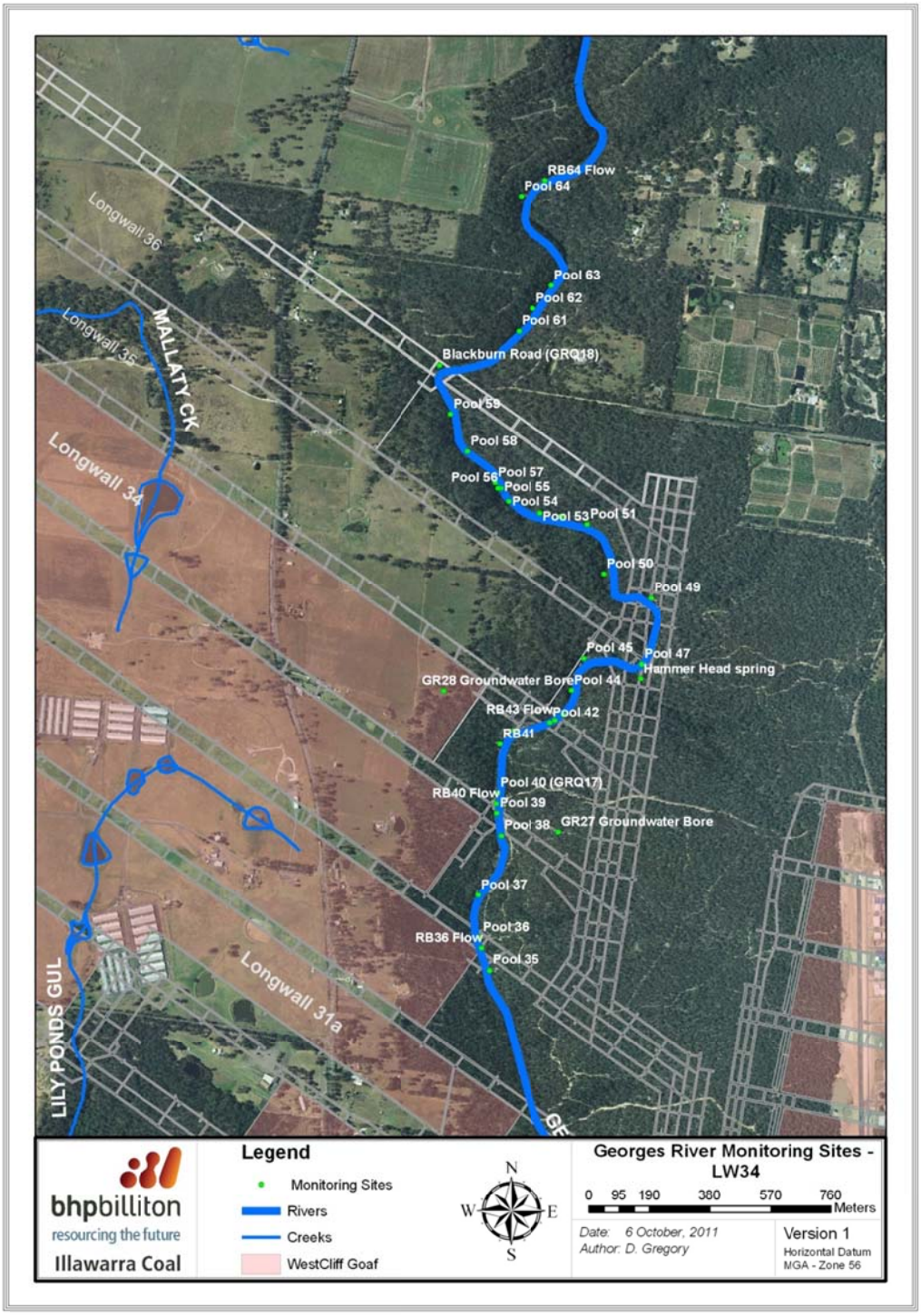

Figure 2: Georges River monitoring sites in relation to Longwall 34.

1.3. Ephemeral Creek Monitoring Program

Mallaty Creek, Leafs Gully and Nepean Creek are ephemeral creeks and typically flow during and for a short time following a rain event. They are located within the central and western parts of the SMP Area and drain to the Nepean River. Monitoring and management of these streams takes into account their ephemeral nature. Where these creeks are influenced by Longwall 34 they are not deeply incised and therefore there are no cliffs associated with the eastern section of the SMP Area.

Monitoring undertaken by the IC Environmental Field Team in relation to Longwall 34 includes field water quality parameters and laboratory parameters (where indicated), water levels as well as observational records at the following sites (Figure 3):

- Mallaty Creek (from east to west)**:**
    - MC 100 (lab parameters)**,** MC 110 (lab parameters), MC 120 (lab parameters)**,** MC 130 (lab parameters), MC 140 (lab parameters), MC 05 (lab parameters), MC 20, MC 30 (lab parameters) MC 40, MC 50**,** MC 60, MC 70 (lab parameters)**,** MC 80 and MC 90.

- Nepean creek:
    - NC 10 (lab parameters).

- Leafs Gully (east to west):
    - LG 10, LG 20, LG 30 (lab parameters).

- Nepean River (north to south):
    - NR 50 (lab parameters), NR 40 (lab parameters), NR 30 (lab parameters), NR 20 (lab parameters), NR 11 (lab parameters), NR 10 (lab parameters).

Consisting of:

- Monthly baseline monitoring.
- For lab parameter sites, monthly manual laboratory parameter tests during active subsidence.
- For field parameter sites, monthly field parameters testing during active subsidence.
- Monthly monitoring for 2 months post mining or until subsidence is complete.

Ephemeral stream appearance is monitored at the sites listed above and includes general observations in conjunction with water quality monitoring.

Visual inspection and photographic records of cliffs, steep slopes, fire trails, and water courses is undertaken at sites listed above and is monitored in conjunction with water quality monitoring.

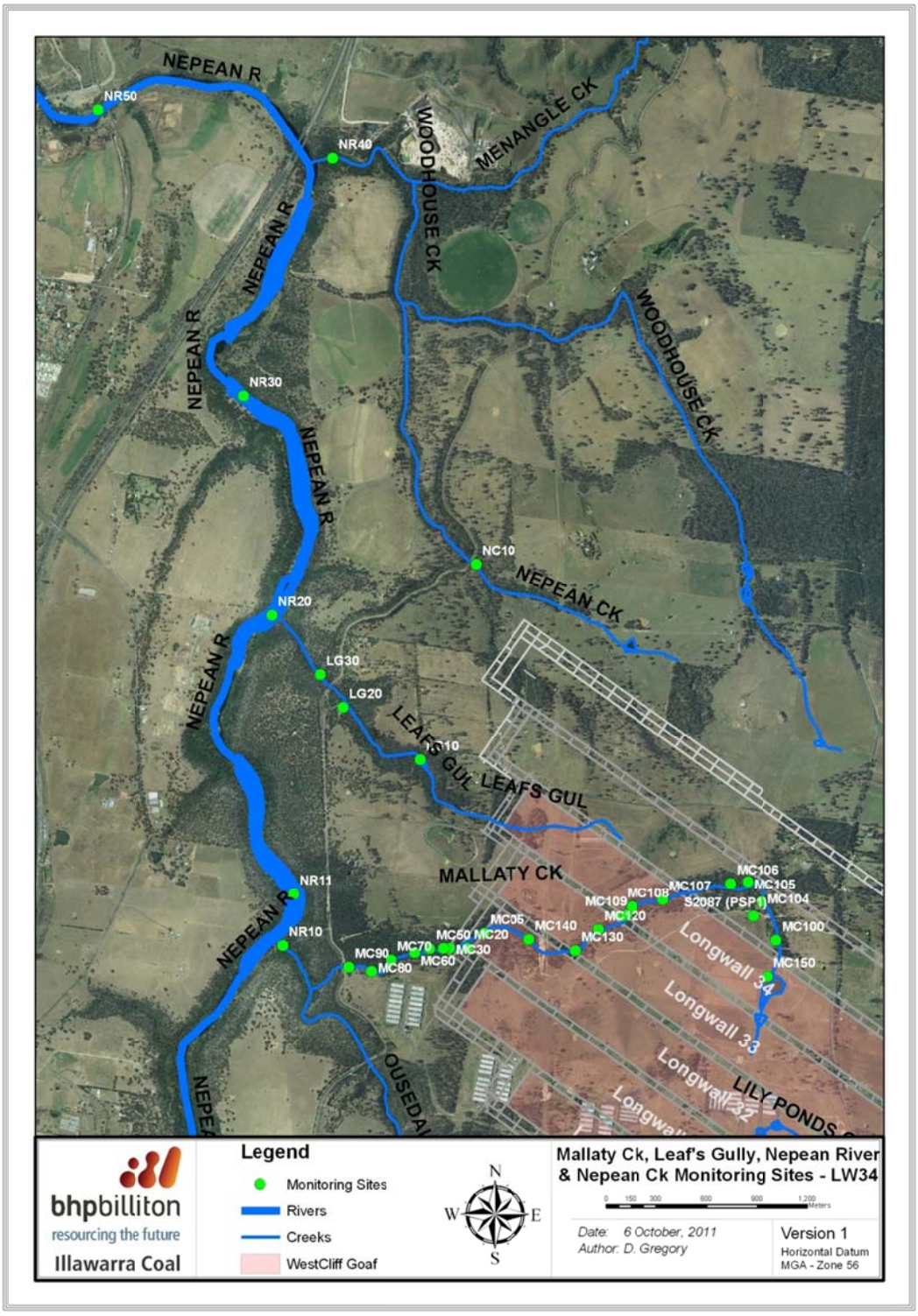

Figure 3: Mallaty Creek, Leaf's Gully, Nepean River and Nepean Creek Monitoring Sites in relation to Longwall 34.

2. Results from Monitoring Program

Four impacts were identified by the IC Environmental Field Team as a result of Longwall 34 extraction. All impacts are within predicted levels as per the Monitoring and Management Table (Table 23-1) of the SMP for Longwalls 34 to 36. A detailed description of these impacts is provided in following sections of this report. A summary of the observed and predicted impacts for Longwall 34 is provided in the table below.

Aspect	Feature	Predicted Impacts	Observed Impacts	Action for LW34
The Georges River	Water Quality	Water chemistry parameters not predicted to exceed second trigger point (ie. between 2 and 3 standard deviations) when comparing upstream/downstream and/or pre-mining and post-mining results (see Georges River TARP for details)	No significant impacts identified. No Level 2 water quality parameters (ie. between 2 and 3 standard deviations) were recorded when mining was within 400 m of the Georges River (and the Georges River Management Plan and TARP were triggered) Note: parameters outside this range occurring before the Georges River TARP was triggered are not considered to be related to the mining of Longwall 34	N/A
	Water Levels/Flow	Temporary reduction in pool water level in any of the pools being monitored (<20% decline in any pools monitored at similar flows by comparing pre-mining data with postmining data).	No impacts observed.	N/A
	River Appearance	Small crack/s (no observable loss of surface water flow or pool water level). Slight increase in turbidity, iron staining, algal growth, or other visible water quality parameters determined by comparing baseline photos with photos during the mining period.	Zone of fracturing on the western margin of Rockbar 41. Zone of iron staining identified in Pool 40d situated on Rockbar 41.The staining is localised to the western margin of the pool. No staining is visible downstream in Pool 40b.	Continue monitoring program. Capture photographic record. Summarise all actions and monitoring in Subsidence Management Status and impact reports, End of Panel Reports and AEMRs.
	Cliffs, steep slopes, fire trails, and water courses	Rock fall from a cliff which is left mostly intact, resulting in insignificant ground disturbance. Minor surface movement with negligible soil surface exposed.	No impacts observed.	N/A

		Small crack or increased ponding in a watercourse which is not observed to result in surface water loss, be causing erosion, or impeding flow. Small crack in an unsealed road which does not appear to be causing erosion or impeding access. Insignificant erosion at any location localised to a small area and should naturally stabilise in the future. Small areas (<100m2) of impacted vegetation (by rockfalls, soil slippage) that would commence natural regeneration within 6 months. Minor gas emissions with no vegetation die off.		
	Shallow Groundwater	Temporary reduction in groundwater levels (i.e. effect not persisting after significant groundwater recharge rainfall events after mining) in any of the boreholes compared to the variability determined in baseline monitoring.	Temporary reduction in water level in Borehole 28. 6 deep water piezometers in Borhole S2087 not operational as a result of shear.	Reported in regular reporting IC specialists notified
Ephemeral Creeks	Water Quality	Temporary reduction in water quality (< 2 standard deviation reduction in water quality apparent at downstream monitoring site when comparing pre-mining to baseline data and/or upstream samples) observed for less than 2 months at any site when comparing baseline period to mining period and/or upstream samples	No significant impacts to ephemeral streams identified as no evidence of long term or short term changes to water quality parameters from baseline levels. The majority of water quality parameters were within 2 standard deviations of the mean. This is considered to be within the normal range of variation.	
	Stream Appearance	Crack/s (no or small observable loss of surface water flow or pool water level). Slight increase in	Minor compression fracturing and surface flow diversion observed within Mallaty Creek at monitoring site Pool MC 109. Impact resulting in localised	Continue monitoring program. Capture photographic record.

		turbidity, iron staining, algal growth, or other visible water quality parameters determined by comparing baseline photos with photos during the mining period.	reduction in pool water level.	Summarise all actions and monitoring in Subsidence Management Status and impact reports, End of Panel Reports and AEMRs.
	Cliffs, steep slopes, fire trails, and water courses	Minor surface movement with negligible soil surface exposed. Crack or increased ponding in a watercourse which is not observed to result in complete surface water loss be causing erosion or impeding flow. Small crack in an unsealed road which does not appear to be causing erosion or impeding access. Insignificant erosion at any location localised to a small area and should naturally stabilise in the future. Small areas (<100m2) of impacted vegetation (by rockfalls, soil slippage) that would commence natural regeneration within 6 months. Minor gas emissions with no vegetation die off.	No impacts observed.	N/A

2.1. Impacts to Georges River – Rockbar Fractures and Iron Staining

A zone of fracturing was identified on the western margin of Rockbar 41. The fractured zone extends over an area of approximately 2m^2 and consists of multiple small fractures and uplift of 1cm along the fractured zone (Figure 4 and Figure 5). The fractured zone is situated on the edge of the dominant flow path and will be under water during periods of moderate to high flow in the River. No flow diversion was observed during the inspection. The water level in Pool 41, immediately upstream of the fractured rockbar is consistent with baseline levels.

Iron staining was identified in Pool 40d situated on Rockbar 41 (Figure 6). The staining is localised to the western margin of the pool and no iron staining is visible downstream in Pool 40b.

Figure 4: Zone of fracturing and iron staining.

Figure 5: Rock fracture and uplift.

Figure 6: Iron staining.

2.2. Impacts to Ephemeral Stream Appearance – Pool Water Level

Minor compression fracturing and surface flow diversion was observed within Mallaty Creek at monitoring site Pool MC 109. This has resulted in localised reduction in pool water level (Figure 4, Figure 5 & Figure 6). A small number of minor compression fractures were observed in pool MC109 with a maximum width of 3mm and up to 220mm in length. The immediate upstream and downstream monitoring pools, MC108 and MC110 respectively, continue to retain water. Pool MC109 water levels continue to respond to recharge rainfall events.

The impacted section of Mallaty Creek is ephemeral with riparian and aquatic ecology adapted to periods with no surface water. No direct impact on aquatic flora, fauna or fish has been identified during monitoring.

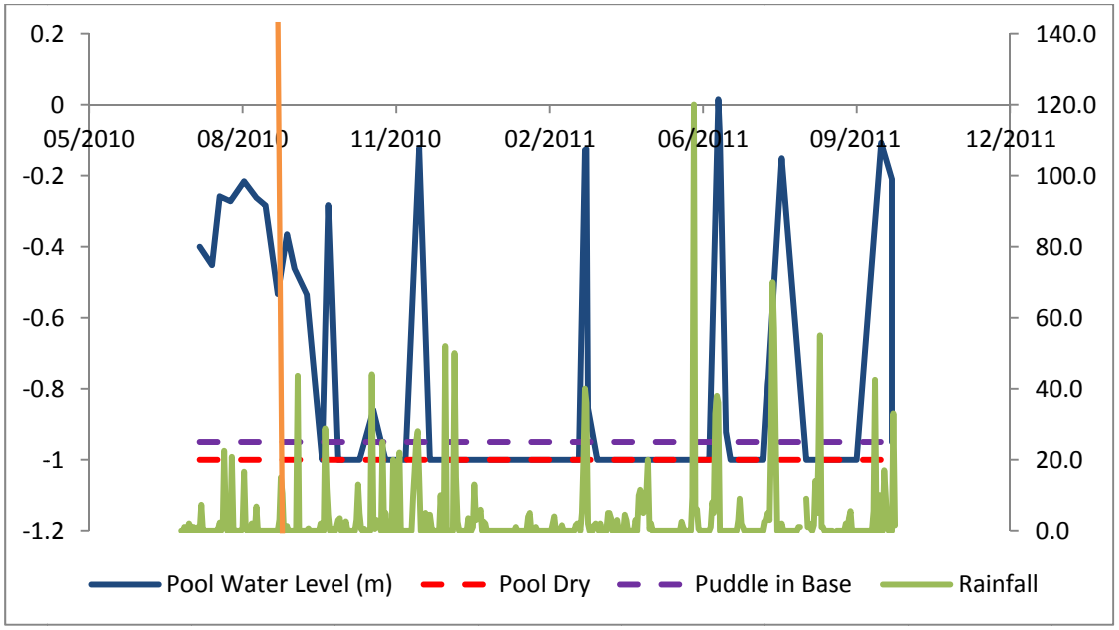

Figure 7: Pool water level – MC109. MC109 was undermined on the 4 September 2010 (indicated by the orange line). Rainfall data collected from West Cliff Mine.

Figure 8: MC109 prior to mining impact

Figure 9: MC109 with reduced pool water level

2.3. Impacts to Groundwater

Boreholes GR27, GR28 and S2087 (PSP1) were monitored during the extraction of Longwall 34 as required by the SMP. The location of these boreholes is displayed in Figure 10. The boreholes are screened in a section of strata equivalent to the base of the river in that location. Previous longwall extraction in West Cliff Area 5 has indicated that groundwater levels directly over or adjacent to goaf areas can reduce as a result of extraction.

Borehole GR27 water levels have remained relatively stable with no water level reduction associated with Longwall 34 extraction (**Error! Reference source not found.**). Borehole GR28 recorded a temporary decrease in water level toward the end of Longwall 34 extraction. Since the initial reduction in water levels in GR28 the water level has responded to recharge rainfall events. Water level rises were recorded after rain events on 25 and 26 September 2011 and 3 October 2011 (**Error! Reference source not found.**).

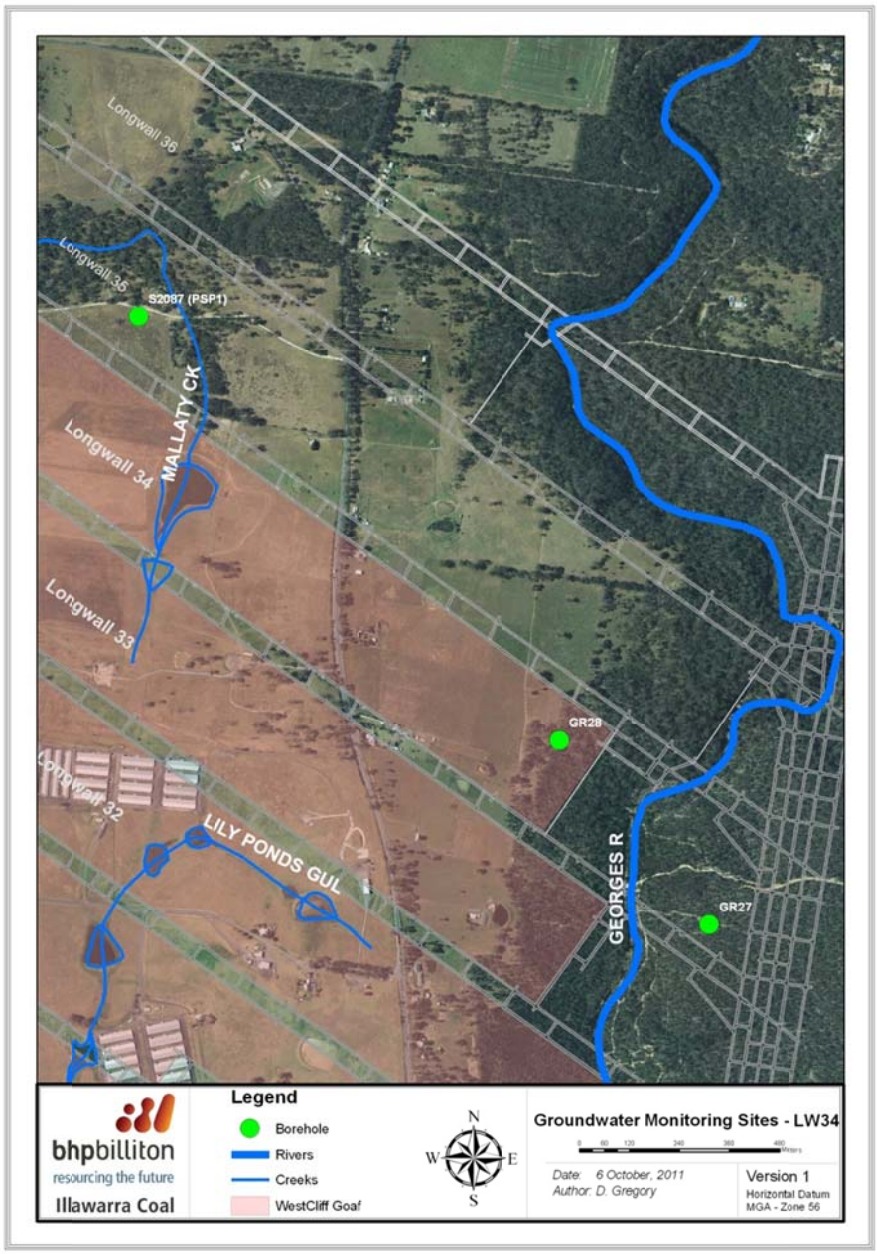

Figure 10: Locations of Boreholes GR27, GR28 and S2087 (PSP1) in relation to Longwall 34.

Figure 11 shows the correlation between water levels in boreholes GR27 and GR28 and rainfall. Water samples were taken from both boreholes on two occasions - 27 May 2010 and the 27 Sept 2011. This resulted in minor decreases in water level as shown in the figure below.

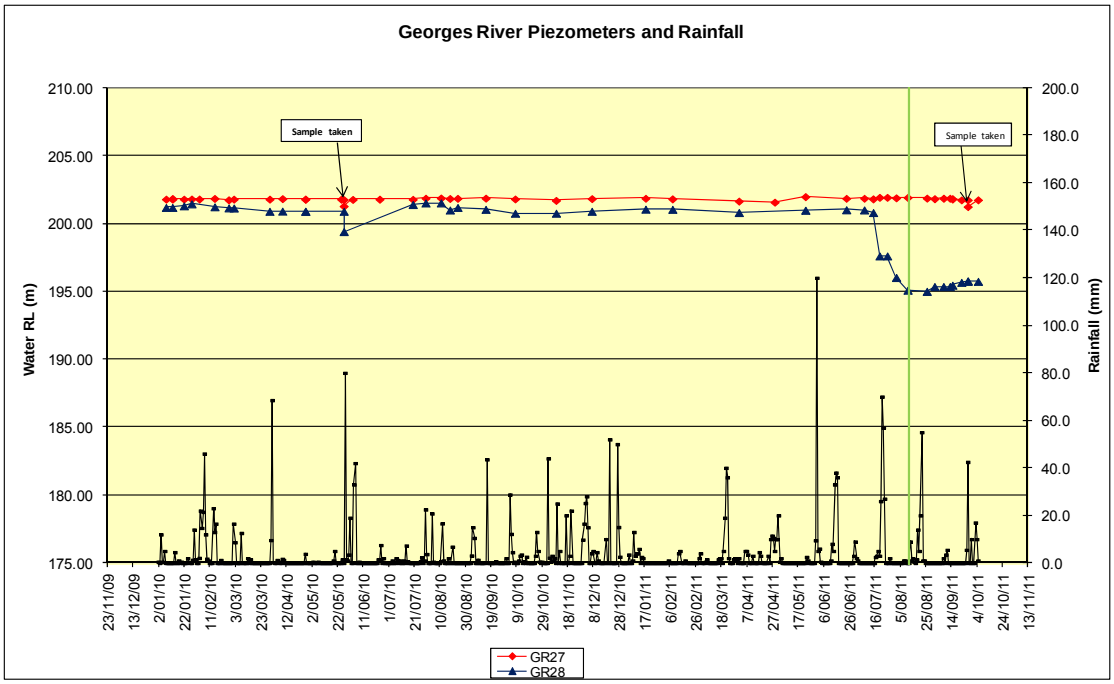

Figure 11: Water Level in Georges River Groundwater Boreholes and Rainfall.

GR28 was undermined on the 12 August 2011 (indicated by the green line). Rainfall data is from West Cliff Mine.

Eight piezometers were installed in bore S2087 (PSP1) on 5 July 2010 as tabulated below.

Depth (m)	Stratum
55	Hawkesbury Sandstone
95	Hawkesbury Sandstone
185	Hawkesbury Sandstone
238	Bulgo Sandstone
313.5	Bulgo Sandstone
394	Bulgo Sandstone
419	Scarborough Sandstone
440	Scarborough Sandstone

All piezometers were grouted in place. Monitoring from that time was conducted at 60 minute intervals.

Longwall 34 passed close to the location of this bore on 7 December 2010. All except the two uppermost piezometers failed in a seven week period subsequent to 7 December 2010 (Figure 12). This was probably as a result of strata shear from mine subsidence movements. This was an expected outcome based on the location of the bore in relation to the longwall.

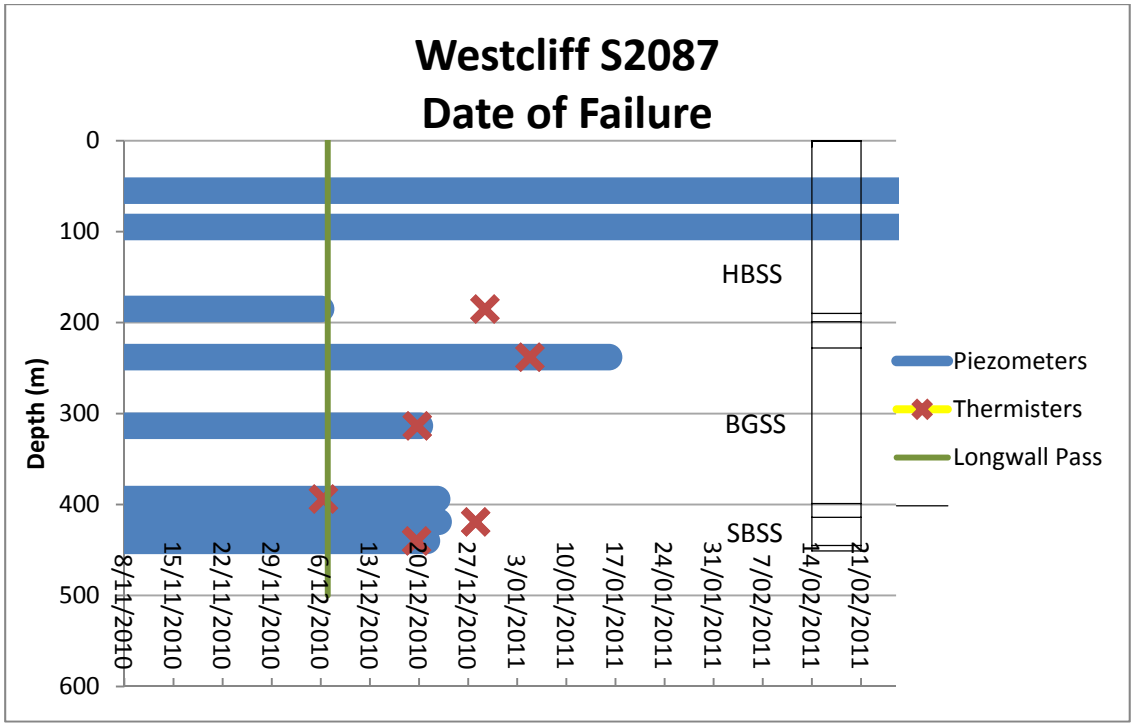

Figure 12: Failure dates of the six deep groundwater piezometers located within Borehole S2087.

Quality of the piezometric data acquired over the recording period was poor to good. The deeper piezometers were affected by electronic noise which did respond to site adjustments but was not completely eliminated. The data shows a period of two months of stabilisation extending to September 2010. After September 2010 the Narrabeen piezometers show a slow fall in piezometric head until December when the piezometer at 238m shows a marked drop in piezometric head until its failure about ten days after the passing of the longwall. The remaining five piezometers that failed in the Narrabeen and basal Hawkesbury Sandstone did not show any significant fall in piezometric head prior to their failure shortly after the passing of Longwall 34.

Two piezometers at 55 and 95m in the Hawkesbury Sandstone remain operational into 2011. The relative head level of each of these piezometers is greater than the six lower piezometers which commonly showed a relative level of the order of 100m to 115m (Figure 13). The two upper piezometers are more variable in their head with time but do not appear to show more than a coincidental relationship with the passing of Longwall 34. The variation in heads in both these piezometers would appear to be influenced by seasonal rain levels and intensity.

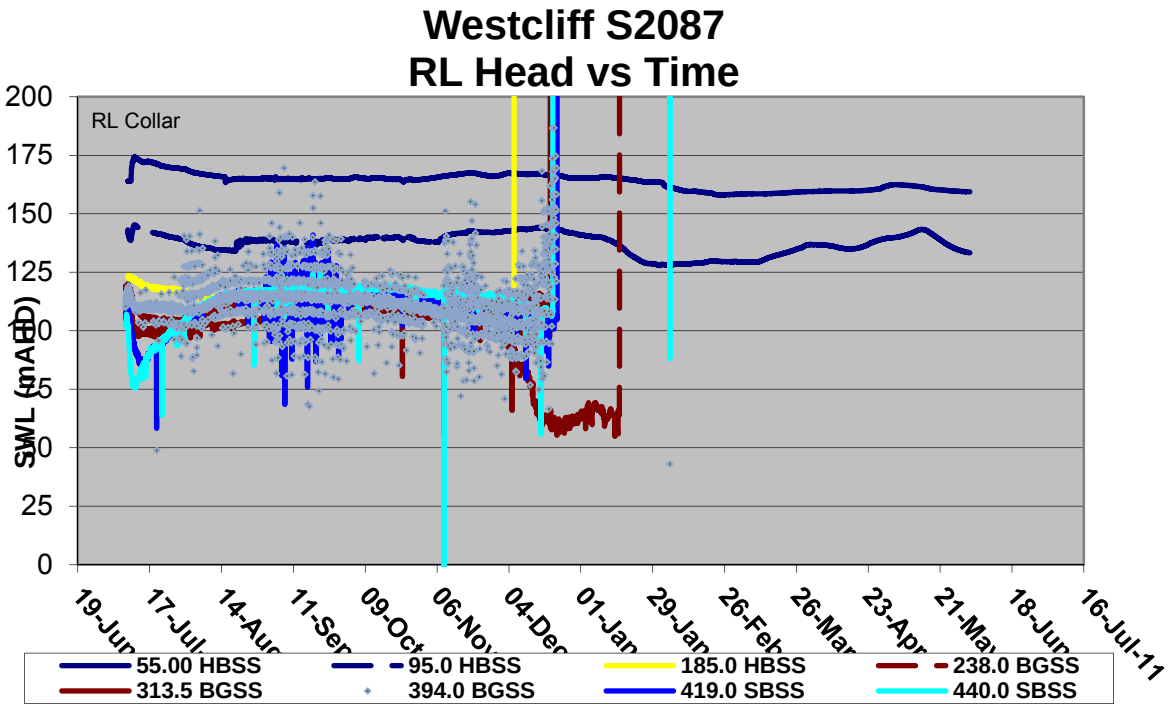

Figure 13: Deep and shallow groundwater level data from piezometers located within Borehole S2087.

3. LW34 Monitoring and Future Monitoring for West Cliff Area 5

Aspect	Feature	Monitoring Commitments Longwalls 34-36 SMP	Monitoring to Date assoc. with Longwall 34	Proposed Future Monitoring
Georges River	Water Quality	Monthly Baseline monitoring 1 year prior to mining. For lab parameter sites Monthly manual laboratory parameter tests once mining is within 400m of the Georges River. For lab parameter sites monthly for 2 months post mining or until parameters are within 2 standard deviations of baseline. For field parameter sites. Weekly field parameters testing once mining is within 400m of the Georges River. For field parameter sites weekly for 2 months post mining, then monthly until parameters are within 2 standard deviations of baseline.	Monthly (weekly once LW within 400m from the river) at sites (From north to south): Pool 63 (lab Parameters), Pool 62, Pool 61, GRQ18 (lab Parameters), Pool 59, Pool 58, Pool 57, Pool 56, Pool 55 (lab Parameters), Pool 54, Pool 53, Pool 52 (lab Parameters), Pool 51, Pool 50, Pool 49 (lab Parameters), Pool 47 (lab Parameters), Hammer head springs lower (lab Parameters), Pool 45, Pool 44, Pool 43 (GRQ17a) (lab Parameters), Pool 42, Pool 41, Pool 40 (lab Parameters), Pool 39, Pool 38, Pool 37, Pool 36, Pool 35.	No change.
	Water Level/Flow	Monthly Baseline monitoring of flows and pool nail levels. Weekly manual monitoring of flows (using Pigmy Flowmeter, where conditions allow) and pool level nails during mining within 400m of the Georges River. Ongoing monthly monitoring for 2 months post mining or until flow characteristics are typical of baseline conditions.	Monthly (weekly once LW within 400m from the river) at sites RB 64, RB43, RB40/Airstrip weir and RB36 where conditions have allowed.	Monthly (weekly once LW within 400m from the river) at sites RB 64, RB43, RB40/Airstrip weir and RB36 (where conditions have allowed) - Removal of site RB53 from monitoring program as RB 53 has been altered by flooding and is no longer a suitable site for flow monitoring. No alternative site exists downstream of RB 53 (until RB64).
	River Appearance	Monthly Baseline monitoring. Weekly monitoring when mining is	Monthly (weekly once LW within 400m from the river)	No change.

		within 400m of the Georges River. Monthly monitoring for 2 months post mining or until subsidence is complete.		
	Landscape Features - cliffs, steep slopes, fire trails and water courses.	Two 6 monthly baseline monitoring campaigns one year prior to mining. Monthly within 400m of the Georges River. Two post mining monitoring campaigns one year after mining.	Observation in conjunction with weekly/monthly water quality and flow monitoring.	No change.
	Shallow Groundwater	Monthly baseline 1 year prior to mining. Weekly monitoring from 200m prior to undermining until 400m past or subsidence is complete. Monthly monitoring post mining for 2 years or as otherwise required. Water samples taken from each site prior to mining. Water samples taken from each site after mining.	Shallow groundwater levels before, during & after mining in Boreholes: - GR27 and GR28 monthly (weekly once LW within 400m from the river). - S2087 (PSP1) near Mallaty Ck (instrumented BH).	GR27 and GR28 monthly (weekly once LW within 400m from the river) and S2087 (PSP1) near Mallaty Ck (instrumented BH).
Ephemeral Streams	Water Quality	Monthly Baseline monitoring. For lab parameter sites, monthly manual laboratory parameter tests during active subsidence. For field parameter sites, monthly field parameters testing during active subsidence. Monthly monitoring for 2 months post mining or until subsidence is complete.	Monthly lab & field parameters as required at sites (where conditions have allowed): Mallaty creek (From East to West)**:** MC 100 (lab Parameters)**,** MC 110 (lab Parameters), MC 120 (lab Parameters)**,** MC 130 (lab Parameters), MC 140 (lab Parameters), MC 05 (lab Parameters), MC 20 MC 30, (lab Parameters) MC 40 MC 50**,** MC 60, MC 70 (lab Parameters)**,** MC 80**,** MC 90. Nepean creek: NC 10 (lab Parameters).	Monthly lab & field parameters at sites: Mallaty creek (From East to West)**:** MC 100 (lab Parameters)**,** MC 110 (lab Parameters), MC 120 (lab Parameters)**,** MC 130 (lab Parameters), MC 140 (lab Parameters), MC 05 (lab Parameters), MC90 (lab parameters), MC107, MC108, MC109, & MC150. *Recommend removal* of MC 20 MC 30, MC 40, MC 50**,** MC 60, MC 70 (lab Parameters) and MC 80. Nepean creek:

			Leafs Gully (East to west): LG 10, LG 20, LG 30 (lab Parameters). Nepean River (North to south): NR 50 (lab Parameters), NR 40 (lab Parameters), NR 30 (lab Parameters), NR 20 (lab Parameters), NR 11 (lab Parameters), NR 10 (lab Parameters).	NC 10 (lab Parameters). Leafs Gully (East to west): LG 10, LG 20, LG 30 (lab Parameters).
	Ephemeral Streams Appearance	Monthly Baseline monitoring 1 year prior to mining. Monthly monitoring during active subsidence. Monthly monitoring for 2 months post mining or until subsidence is complete.	Observation in conjunction with monthly water quality monitoring.	No change.
	Landscape Features - cliffs, steep slopes, fire trails and watercourses.	Two 6 monthly baseline monitoring campaigns 1 year prior to mining. Monthly within 400m of the ephemeral waterway. Two post mining monitoring campaigns one year after mining.	Observation in conjunction with monthly water quality monitoring.	No change.

Table 1: Summary of monitoring associated with Longwall 34 and proposed monitoring for Longwall 35.