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Environmental Management System

West Cliff Area 5
Longwalls 34 - 36
Georges River Management Plan

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External Affairs

ENVIRONMENTAL MANAGEMENT SYSTEM

West Cliff Area 5

Longwalls 34-36

Georges River Management Plan

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ENVIRONMENTAL MANAGEMENT SYSTEM

West Cliff Area 5

Longwalls 34-36

Georges River Management Plan

Revision 1

February 2013

Revision	*Date*	*Description*	*Authorised*
1	***13/02/2013***	*BSOP Development Consent Performance Measures added.* *Georges River Closure Monitoring Lines and monitoring frequency added.* *Response to feedback from I&I 06/02/13, 11/02/12 and 12/02/13.*	***John Brannon (Head of External Affairs)***

Table of Contents

1.0 Background

BHP Billiton Illawarra Coal (BHPBIC) was granted approval for the West Cliff Area 5 Longwalls 34 to 36 Subsidence Management Plan (SMP) Application on 14 May 2009. Longwalls 34 to 36 are located immediately west of the Georges River. The location of the Georges River in respect to West Cliff Area 5, Longwalls 34-36 is shown in Figure 1.

In September 2009, BHPBIC submitted an Environmental Assessment (EA) for its Bulli Seam Operations Project (BSOP) to the NSW Department of Planning and Infrastructure (DoPI) for the continuation of existing underground mining operations for both Appin and West Cliff Mines. The BSOP was approved 22 December 2011 by the NSW Planning Assessment Commission (PAC) under delegation of the NSW Minister for Planning under Part 3A of the NSW Environmental Planning and Assessment Act (EP&A Act).

BHPBIC made the decision to shorten Longwall 34 in light of Level 2 TARP impacts identified in the Georges River for Longwall 33. The Longwall 34 EoP Report concludes there is no flow diversion, and only one occurrence of iron staining. BHPBIC has proposed modification to the Longwall 35 finish line to provide similar environmental outcomes to Longwall 34.

This management plan has been developed to address the requirements of the SMP Approval and BSOP Approval with regards to the management of the Georges River. The contents of this plan replace the Georges River monitoring program aspects of which were submitted in Revision 1, November 2009 Subsidence Management Plan.

2.0 Legislative Requirements

Condition 13 of the SMP Approval, as varied by the Department of Industry and Investment 23/12/09, requires the following:

13 The Leaseholder must not operate otherwise than in accordance with the management plan titled "West Cliff Colliery Area 5 Longwalls 34 to 36 – Subsidence Management Plan January 2008 – Revision 1, November 2009 – Incorporating the Georges River Management Plan" and the Environmental Management Plan identified in condition 13.1.

13.1 The Leaseholder must not carry out longwall operations between the Georges River Trigger Point and the Georges River until an Environmental Management Plan (EMP) has been developed and approved (*the Georges River Trigger Point is defined as the projected lateral distance of 400m west of the western edge of the Georges River*).

The EMP must be prepared in consultation with relevant landholders and government agencies and address:

i.) surface and groundwater (quality and quantity);
ii.) clifflines

The EMP must identify the extent of predicted conventional and non-conventional subsidence and the likely impacts of this subsidence and develop a response strategy for each of the above to include:

a) trigger levels for subsidence impacts that require actions and responses;
b) the procedures that would be followed in the event that the monitoring indicates an exceedance of trigger levels;
c) a protocol for the notification of identified exceedances of the trigger levels;
d) measures to mitigate, remediate and/or compensate any identified impacts; and
e) a contingency plan to ensure impacts are within approved levels.

Performance measures stipulated under Condition 1, Schedule 3 (Table 1) of the BSOP Approval state the following:

1. The Proponent shall ensure that the project does not cause any exceedances of the performance measures in Table 1, to the satisfaction of the Director-General.

Table 1: Subsidence Impact Performance Measures

Watercourses	
Nepean River	Negligible environmental consequences including: • *negligible* diversion of flows or changes in the natural drainage behaviour of pools; • *negligible* gas releases and iron staining; and • *negligible* increase in water cloudiness.
Georges River	Negligible environmental consequences including: • *negligible* diversion of flows or changes in the natural drainage behaviour of pools; • *negligible gas releases and iron staining; and* • *negligible increase in water cloudiness* over at least 80% of the stream length subject to vertical subsidence >20 mm. No subsidence impact or environmental consequence greater than minor.
Other watercourses	No greater subsidence impact or environmental consequences than predicted in the EA and PPR.

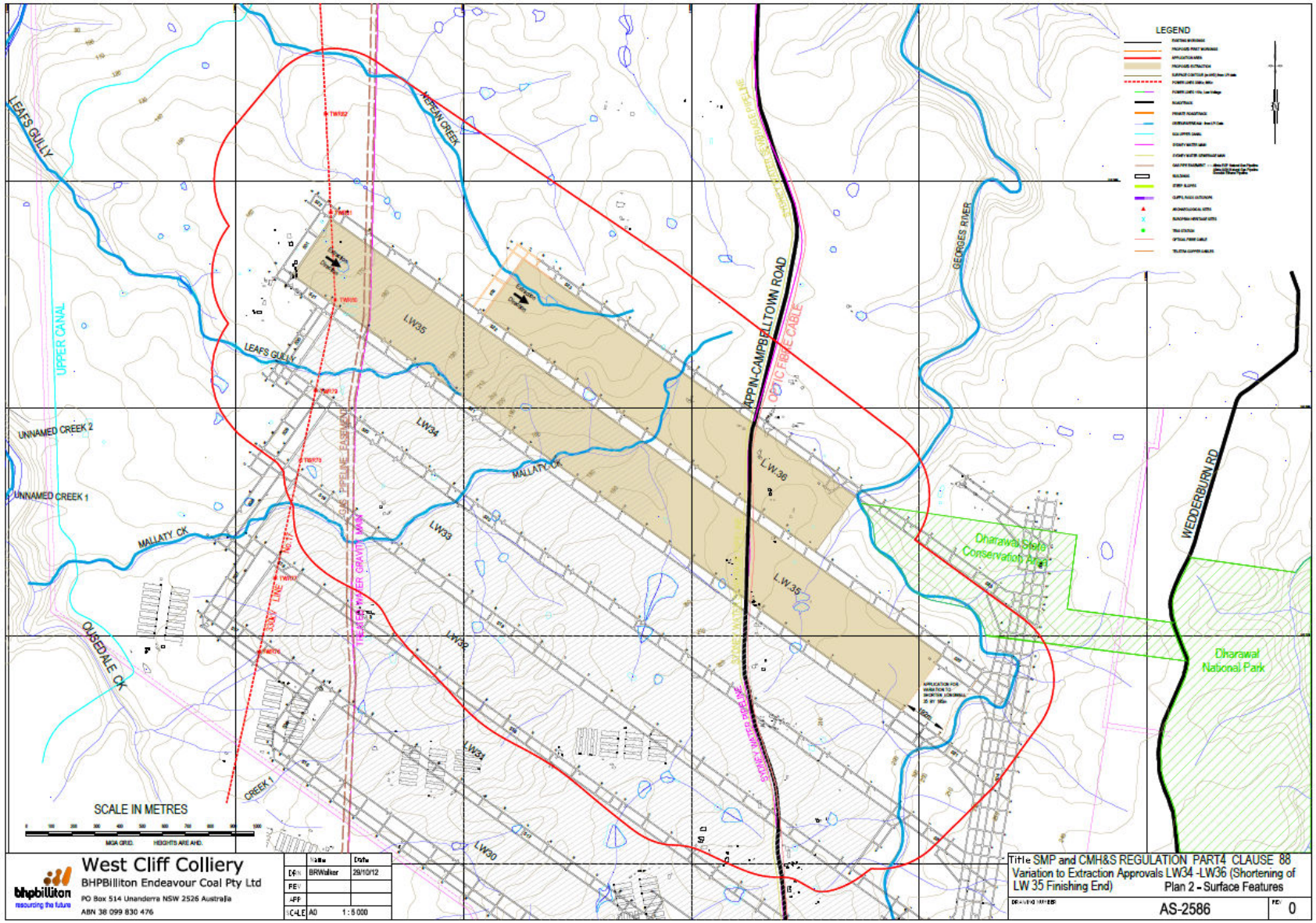


Figure 1. West Cliff Longwall 34-36 Layout (AS-2586, 29/10/2012).

3.0 Modifications to the Longwall Layouts

3.1 Commencing End of Longwall 34 and Longwall 35

On 18/5/2009 BHPBIC submitted an application to shorten Longwall 34 by 897m from the commencing end. This modification was required due to difficulties associated with gas drainage. The new layout was approved 26/5/09. On the 11/03/2011 BHPBIC sought approval to reduce the length of Longwall 35 by 750m at the western end. This reduction was also due to operational issues associated with the effectiveness of gas drainage.

Both variations had no bearing on the Georges River Management Plan as it is at the opposite end of the longwalls and well outside the Georges River Trigger Point referred to in Condition 13 of the SMP Approval.

3.2 Variation to Finishing End of Longwall 34

A variation to the finishing end of Longwall 34 was sought by BHPBIC on the 26/02/2010, and approved by the Director General 6/08/2010. This variation reduced the length of Longwall 34 by 125m at the eastern end of the longwall adjacent to the Georges River. The decision to shorten the longwall was made in accordance with BHPBIC's commitment to review the location of the finish line of each longwall, in light of impacts identified in the Georges River for the previous longwall. In this instance, BHPBIC observed and reported Level 2 impacts in the Georges River that occurred as a result of mining Longwall 33.

3.3 Proposed Variation to Finishing End of Longwall 35

BHPBIC has sought approval to reduce the length of Longwall 35 by 192m at the eastern end, adjacent to the Georges River (on the 14/11/2012). This variation is proposed to reduce the mining related impacts to the George River.

The modified layout reduces the predicted incremental subsidence, upsidence and closure. Although the assessed levels of impacts reduce as a result of the shortened finishing end of Longwall 35 the proposed management strategies are proposed to remain the same.

4.0 Georges River Impact Assessment

4.1 Subsidence Predictions

Subsidence predictions and impact assessments for the proposed Longwalls 34 to 36 were provided in MSEC326, Rev C in December 2007, which supported the SMP Application for these longwalls. BHPBIC has since modified the longwall layout several times to minimise the potential for impacts on the Georges River (refer to

Section 4). The most recent modification being the reduction in Longwall 35 void length from the finishing (eastern) end. The supporting MSEC Report (MSEC598) provides the most up to date subsidence predictions for the proposed longwalls.

4.1.1 Subsidence, Upsidence and Closure

The profiles of predicted incremental and total subsidence, upsidence and closure along the George River are shown in Figure 2. A summary of the maximum predicted total subsidence, upsidence and closure along the Georges River, resulting from the extraction of Longwalls 29 to 36, is provided in Table 1.

Table 1: Maximum Predicted Total Subsidence, Upsidence and Closure along the Georges River Resulting from the Extraction of Longwall 29 to 36 (MSEC598, Table 3.2)

Layout	Maximum Predicted Total Subsidence (mm)	Maximum Predicted Total Upsidence (mm)	Maximum Predicted Total Closure (mm)
Approved Layout[1]	75	175	200
Modified Layout[2]	60	155	190

[1] *refers to the approved modifications to the finishing end of Longwall 34 and the commencing end of Longwall 35*
[2] *refers to the additional proposed modification to the finishing end of Longwall 35*

4.1.2 Predicted Strain

Strain is affected by many factors, including ground curvature and horizontal movement, as well as local variations in the near surface geology, the locations of pre-existing natural joints at bedrock and the depth of bedrock (MSEC598). This makes the prediction of strain less precise than some other subsidence movements.

Using monitoring data from previously extracted longwalls in the Southern Coalfield, where overburden geology and mining geometry are similar to Longwalls 34 to 36, an indication for the range of potential strains has been determined. This has specifically been undertaken for the application to modify Longwall 35 (refer MSEC598).

4.1.3 Maximum Predicted Valley Related Movements

The predicted valley related movements along the watercourses at West Cliff Colliery have been determined using the methods outlined in ACARP Research Project No. C9067, which were published in the handbook entitled “Management Information Handbook on the Undermining of Cliffs, Gorges and River Systems”, issued in September 2002. Details on the ACARP Method are provided in the background report entitled “General Discussion on Mine Subsidence Ground Movements” which can be obtained from www.minesubsidence.com .

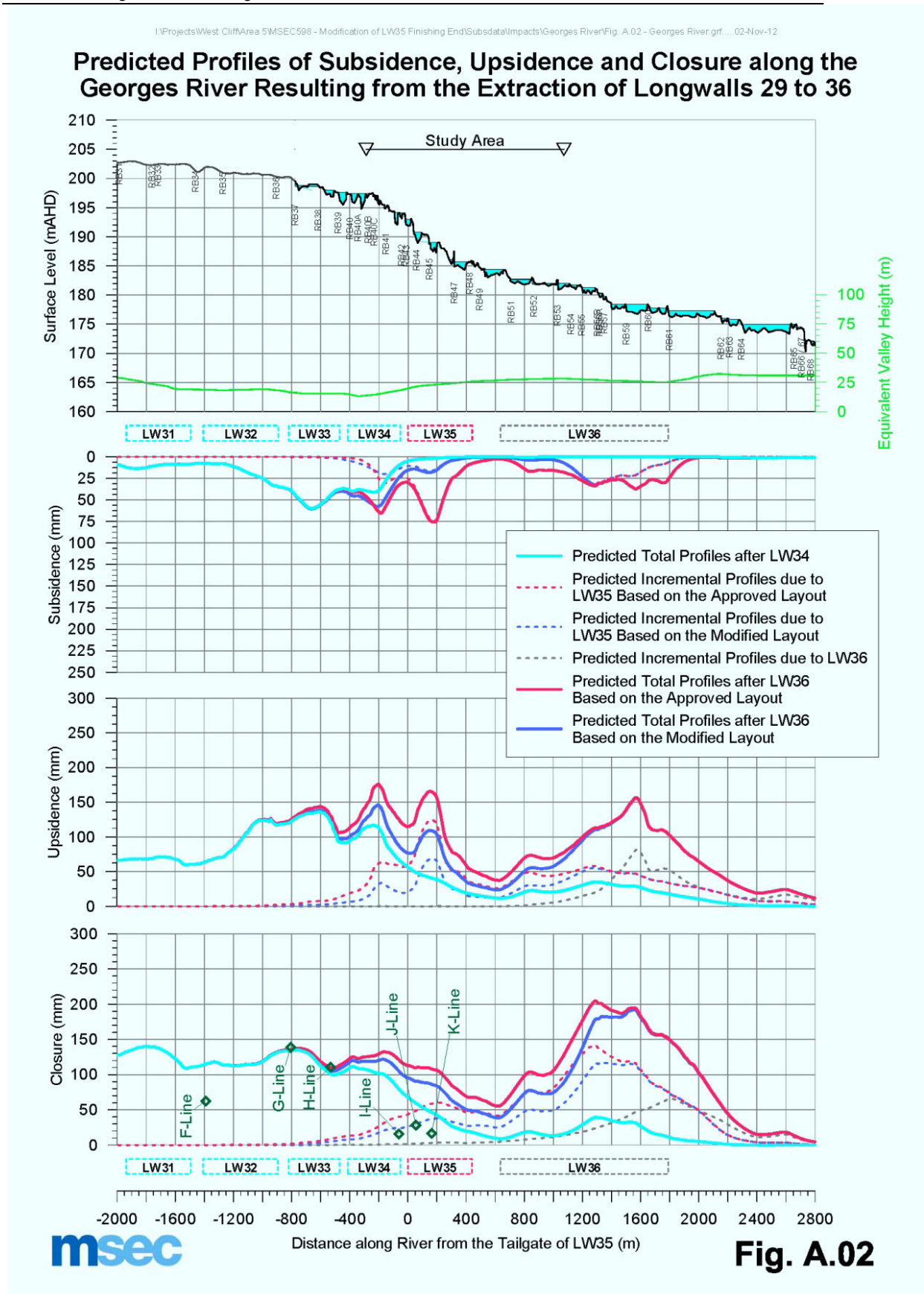


Figure 2. Predicted Profiles of Subsidence, Upsidence and Closure along the Georges River Resulting from the Extraction of Longwalls 29 to 36 (MSEC598).

The predicted upsidence and closure movements along the watercourses have been determined from the empirical database based on their lateral and longitudinal distances from the extracted longwalls, the depths of the valleys and the maximum predicted incremental subsidence resulting from the extraction of each longwall (MSEC598).

4.2 Potential Impacts for the Georges River

The assessment of impacts for the Georges River are based on the predicted systematic and valley related movements. The information in the following sections should be read in conjunction with the other relevant technical reports attached to the SMP Application and later relevant reports.

4.2.1 The Potential for Increased Levels of Ponding, Flooding and Scouring

The Georges River is a permanent stream where surface water flows are derived from the catchment areas as well as from the Licensed Discharges from Appin and West Cliff Collieries. The larger pools in the river are permanent and naturally develop upstream of the rock bars, riffles and boulder fields, these are shown in Figure 3, as well as at the sediment and debris accumulations.

Mining can potentially result in increased levels of ponding and some minor flooding of the adjacent riparian areas in locations where the mining induced tilts oppose and are greater than the natural river gradients. Mining can also potentially result in an increased likelihood of scouring of the river banks in the locations where the mining induced tilts considerably increase the natural river gradients.

Although the river has a relatively shallow natural gradient within the SMP Area, it is unlikely that there would be any significant increases in the levels of ponding, flooding, or scouring of the river banks, as the maximum predicted changes in grade along the river are very small, being less than 0.1 %. It is possible, however, that there could be some very localised increased levels of ponding or flooding where the predicted maximum tilts coincide with existing pools, steps or cascades along the river, however, any changes are not expected to result in more than minor impacts.

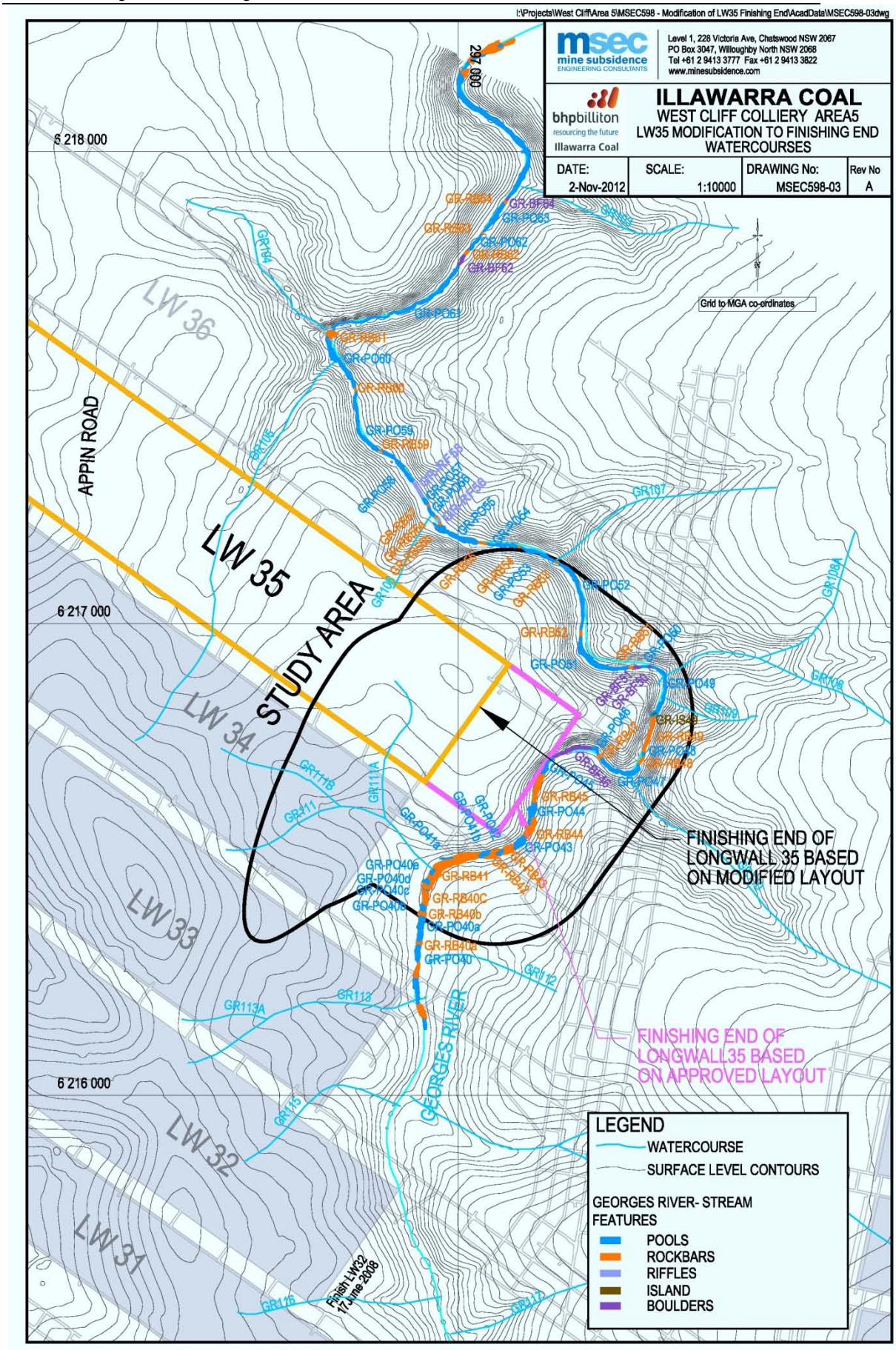


Figure 3. Georges River Pools and Rockbars (Drawing MSEC598-03, LW35 Modification)

4.2.2 The Potential for Changes in Stream Alignment

The potential for changes in stream alignment can occur due to changes in the cross-bed gradients resulting from mining-induced systematic or valley related movements. The potential for mining-induced changes in the stream alignment depends upon the mining-induced ground movements, the natural river cross-bed gradients, as well as the depth, velocity and rate of surface water flows.

Changes in stream alignment can potentially impact upon the river if they affect riparian vegetation, or the changes result in additional scouring of the river banks. The potential for changes in stream alignment are generally limited to sections of river where surface flows are confined to shallow streams over a relatively flat river bed.

The predicted changes in the cross-bed gradients are very small and are expected to be an order of magnitude smaller than the natural river cross-bed gradients. The potential impacts associated with changes in the stream alignment, resulting from the extraction of the proposed longwalls are, therefore, not expected to be more than minor.

The potential impacts of the changes in the stream alignment are expected to be minor when compared to the changes in the river depth and width that occur during times of high flow in the river. The potential impacts of scouring are also likely to be less than minor due to the nature of the sandstone river bed.

In the locations where the river bed comprises sediments and deposited debris, rainfall events could also result in changes in the stream alignment. In a significant storm event, rocks and vegetation can be carried downstream. The increased flow velocities in such events are likely to be an order of magnitude greater than those resulting from mining induced changes to bed gradients.

4.2.3 The Potential for Fracturing of Bedrock and Surface Water Flow Diversions

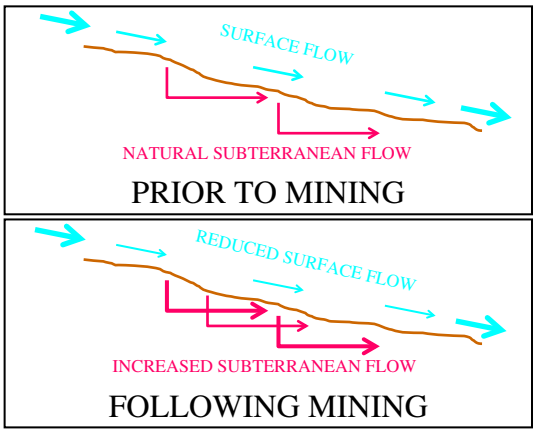
Fractures and joints in bedrock and rock bars occur naturally from erosion and weathering processes and from natural valley bulging movements. Where longwall mining occurs in the vicinity of rivers and creeks, mine subsidence movements can result in additional fracturing or the reactivation of existing joints. The precise causes of these mining-induced fractures are difficult to determine as the mechanisms are complex, although the main mining-related mechanisms are the systematic subsidence and valley related movements.

Diversions of surface water flows also occur naturally from erosion and weathering processes and from natural valley bulging movements. Mining-induced surface water flow diversions into near surface subterranean flows occur where there is an upwards thrust of bedrock, resulting in the redirection of some water flows into the dilated strata beneath the river bed. The water generally reappears further downstream of the fractured zone as the water is only redirected below the river bed where there is a fracture network.

Mining-induced surface water flow diversions due to rock bar leakage occur in a similar manner to the above mechanism, except that the rock bar is elevated above the rest of the river bed and the near surface watertable. The rate of leakage is dependent, among other things, on the extent of horizontal fracturing over the depth of the rock bar and the water level. Rock bars leak at a higher rate when the pool is full, as there is access to all drainage paths and the water head is at its greatest. As the pool level falls, the drainage rate reduces as the water head falls and access is restricted to drainage paths near the base of the rock bar.

The types of surface water flow diversions mentioned above are illustrated in Figure 4.

Diagrammatic Representation of Subterranean Flows



Diagrammatic Representation of Rock Bar Leakage

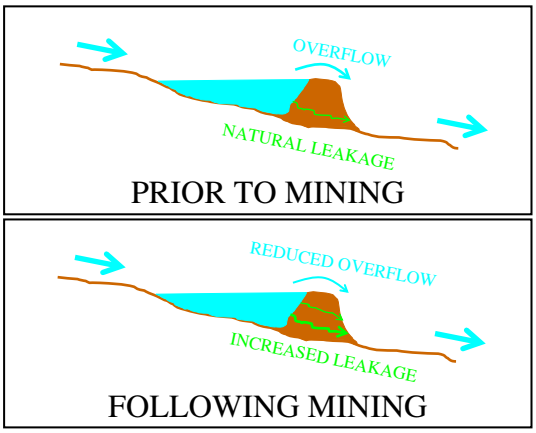


Figure 4. Types of Surface Water Flow Diversions

Interactions between the surface water and groundwater systems have been observed along the Georges River and the river is categorised as a *losing* system for most of the time, where the predominant movement is from the surface water to the groundwater system (IC, 2004a).

In times of extended drought the groundwater table can be lowered considerably. In drought conditions, surface water flows can be naturally diverted through the existing joints into a lower groundwater system and, where mining induced fractures occur, additional surface water diversions can occur into the groundwater system.

Following periods of groundwater recharge rain events, the groundwater levels are expected to return to higher levels, reducing the diversion of surface water flows into the groundwater system.

The surface water which is diverted into the groundwater system is not drawn upon, utilised or lost from the region and, hence, the diverted surface water is not viewed as a loss of water from the system. Over time, the subterranean flow channels and fractures can become blocked with debris and sediment and, therefore, the diversion of surface water into subterranean flows can reduce over time.

The experience gained from previous longwall mining in the Southern Coalfield indicates that mining-induced fracturing in bedrock and rock bars are commonly found in sections of rivers and creeks that are located directly above extracted longwalls. However, minor fracturing has also been observed in locations beyond extracted longwall goaf edges, the majority of which have been within the limit of systematic subsidence. In a few isolated cases, minor fracturing has been observed up to 400 metres outside extracted longwall goaf edges.

Impacts on the Georges River associated with the extraction of Longwall 33 involved minor fracturing with minor localised flow diversions, minor iron spring/staining and minor gas release zones. As discussed in section 3, BHPBIC made the decision to shorten Longwall 34 in light of Level 2 TARP impacts identified in the Georges River for Longwall 33. The Longwall 34 EoP Report concludes there is no flow diversion, and only one occurrence of iron staining. The proposed modification to the Longwall 35 finish line is designed to provide similar environmental outcomes to Longwall 34.

4.3 The Potential for Ground Water Inflows

Although the proposed longwalls do not mine directly beneath the Georges River, it is possible that mining-induced springs could develop following the extraction of the proposed longwalls. The chemical characteristics of groundwater seeps and spring suggest that the water passes through upland Wianamatta Shale and permeates through natural or mining-induced fractures in the Hawkesbury Sandstone before emerging in the Georges River.

Vertical dilation between the Wianamatta Shale and Hawkesbury Sandstone is possible along the tributaries to the Georges River, particularly if the thickness of the Shale is less than 10 to 15 metres, as field studies suggest that the vertical dilation in creeks and rivers extend, as a maximum, to these depths (Mills and Huuskes, 2004). Where these tributaries flow into the Georges River, however, the vertical dilation is expected to be small as they are located at the ends of the proposed longwalls.

There are a number of minor groundwater seeps identified within the SMP Area. No springs developed along the Georges River during the extraction of Longwalls 29 and 31, which did not mine directly beneath the river. A zone of iron staining was identified in Pool 40d (near Rockbar 41) as a result of Longwall 34 extraction. This staining was restricted to the edge of the pool and not visible downstream, no significant water quality impacts were measured or observed in the Georges River. All zones of iron staining observed during mining are no longer visible.

Further discussion on the likely impacts of springs is provided in a report by Ecoengineers (2007).

4.4 The Potential Impacts on Water Quality

Mine subsidence can potentially impact on the quality of water in the river due to leaching of minerals from freshly fractured bedrock and from increased inputs from groundwater to surface water flow. Such impacts tend to be temporary, localised and associated with low flow conditions. An investigation into the potential impacts of mine subsidence on water quality has been undertaken and described in the report by Ecoengineers (2007). Water quality impacts are also discussed in the End of Panel (EoP) Reports for each longwall. No significant water quality impacts were observed or measured in the Georges River during the extraction of Longwall 34.

4.5 The Potential Impacts on Flora and Fauna

Mine subsidence can potentially impact on flora and fauna within rivers. Flora could be adversely affected by the emission of gas through the soil profile and habitats can be affected by the fracturing of bedrock and the cracking of soils. The potential impact of mine subsidence on flora and fauna are provided in the reports by The Ecology Lab (2008) and by Biosis (2007a).

5.0 Response Strategy

Condition 13, as varied by the Department of Industry and Investment 23/12/09, of the SMP Approval for West Cliff Longwalls 34-36 requires that a response strategy be developed for surface and ground water, and cliff lines that are within the Georges River Trigger Point (a projected lateral distance 400m west from the western edge of the Georges River) as shown in Figure 5. Condition 22 of the SMP Approval requires that a cliff line and steep slope management plan be developed to the satisfaction of the District Inspector of Coal Mines.

The response strategy outlined below has been developed to meet the requirements of Condition 13 and Condition 22 of the SMP Approval, as well as address the performance criteria outlined in the BSOP Approval (Condition 1, Schedule 3).

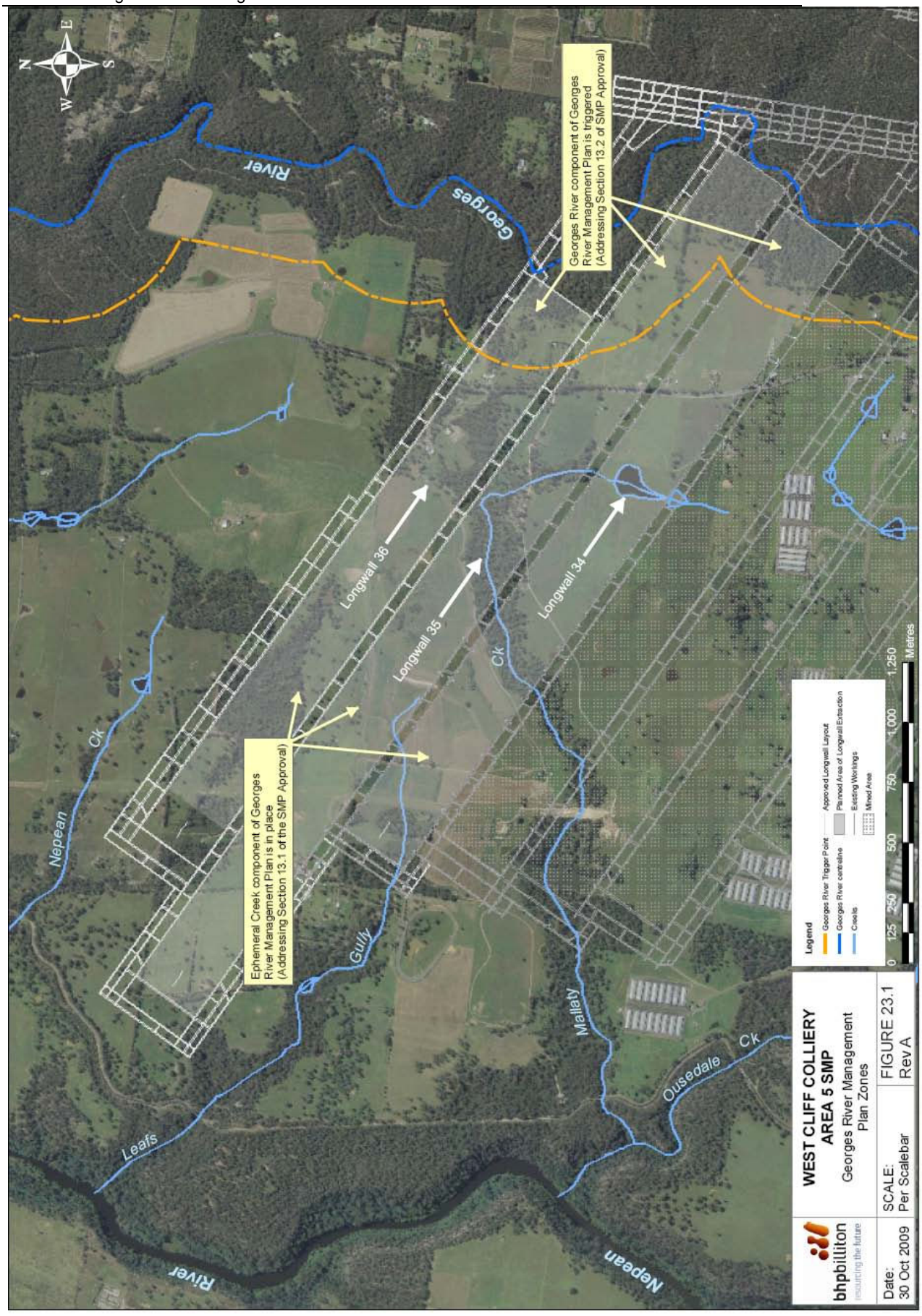


Figure 5. Georges River Management Plan showing location of Georges River Trigger Point relative to Longwalls 34-36.

The West Cliff Area 5 Longwalls 34 to 36 Cliff and Steep Slopes Management Plan (September 2009) should be read in conjunction with this section of the Georges River Management Plan.

5.1 Georges River Trigger Action Response Plan

The Georges River has been identified as a significant environmental feature within the SMP Area for Longwalls 34-36. Associated with the Georges River section of the SMP are a number of aspects including water quality, water level/flow, appearance, aquatic ecology and threatened species, terrestrial flora and habitat, landscape features, as well as European and Aboriginal heritage.

This Georges River Trigger Action Response Plan (GRTARP) is active from the 'Georges River Trigger Point', which is defined in the SMP Approval Condition 13 as a projected lateral distance of 400m west of the cliff lines associated with the western edge of the Georges River. The GRTARP is shown in **Table 2**.

The mine plan layout has been designed so that only 'minor' level impacts are predicted to occur at the Georges River. Triggers and actions associated with 'minor' impacts have been highlighted green, yellow and orange in the following table to identify the expected management actions that will occur during predicted subsidence movements associated with the Georges River.

As one component of the GRTARP, water quality parameters aligned with the identification of mining impacts have had trigger values defined. These trigger values are determined by statistical standard deviations calculated from baseline data and with consideration of environmental impacts. The applicable parameters are pH, dissolved oxygen, sulphate, total iron, total manganese dissolved nickel and dissolved zinc. **Table 3** provides a summary of the water quality trigger levels and **Appendix A** contains a series of graphs demonstrating how they were verified for Pool 40 (GRQ17) and how they will be applied to Longwalls 34-36. Analysis against the triggers will consider baseline results, upstream/downstream results, environmental conditions and/or other potential influences if such exist.

Should impacts exceed predictions then contingency management actions (CMAs) will be considered as per the red highlighted field. Considerations would include adaptive management, such as adjusting the dimensions of future longwall to manage ongoing impacts at the Georges River.

5.1.1 Subsidence Monitoring

Nine subsidence monitoring lines have been established over key rock bars in the Georges River (known as Cross Lines E, F, G, H, I, J, K, L and M Lines). Prior to Longwall 35 coming within 1500m of the Georges River two additional subsidence monitoring lines (N and O Line) were added downstream of the current northern line (M Line).

The monitoring proposal for Longwall 35 is to monitor the crosslines G to O on a fortnightly basis once mining is within 400m of the River.

The monitoring frequency on Lines I - O shall increase too weekly when the closure resulting from Longwall 35 (on any line) exceeds 100mm. The monitoring frequency on Lines O – M shall increase to weekly when the closure resulting from Longwall 35 and 36 (on any line) exceeds 100mm. The increased monitoring frequency will ensure that the approach to 200mm closure and/or impacts is identified as early as possible. For any crossline which exceeds 200mm of closure monitoring results and an interpretation of closure and strain movements will be provided to the Department within three working days of data collection.

Table 2: Georges River Trigger Action Response Plan

Georges River	Characteristics of level	Actions	Action by	Notification
Normal	• No observable mining induced fractures in rockbars or base of Georges River • No reduction in water level of mapped pools under similar flows comparing pre-mining and post-mining – pools generally full • Where no discharge from BCD occurs, Georges River becomes ephemeral - some pools drain naturally at pre-mining rate • Survey Cross Lines: <100mm closure measured	• No remedial action necessary • Monthly review meeting • Continue monitoring program	Manager Approvals	None necessary Notify agencies for information only if BCD discharges reduce/cease and pool water levels drop due to natural causes
Level 1 **(Within Predicted Impact Criteria)**	• Fracturing in rockbar or bed of the Georges River which does not cause reduction of water level in mapped pools, when comparing pre-mining baseline and post mining • Iron staining greater than pre-mining levels • Gas releases • Water chemistry parameters do not exceed first trigger point when comparing against upstream/downstream and/or pre-mining and post-mining results • Survey Cross Lines: >100mm closure measured as a result of LW35 - 36	• No remedial action necessary • Monthly review meeting • Continue monitoring program • Increase Survey Monitoring Programme to weekly for all Georges River Cross Lines	Manager Approvals Manager Survey	Notify agencies of Level 1 impacts in monthly subsidence report
Level 2 **(Within Predicted Impact Criteria)**	• More than negligible diversion of flows or changes in the natural drainage behaviour of pools for less than 20% of the stream length subject to vertical subsidence >20mm e.g. fracturing in rockbar or bed of the Georges River which	• Increase monitoring/inspection frequency of key sites to twice weekly • Increase discharge from BCD to maintain pool water levels for ecosystem protection • Develop and following	Manager Approvals	Notify agencies of Level 2 impacts within 24 hours of confirmation Notify agencies of gas release, iron staining and/or minor water quality changes in monthly report

Georges River	Characteristics of level	Actions	Action by	Notification
	causes reduction of water level in mapped pools, which are unable to be maintained with intervention • More than negligible iron staining or gas releases for less than 20% of the stream length subject to vertical subsidence >20mm e.g. iron staining or gas releases resulting in a measurable ecological impact • More than negligible increase in water cloudiness for less than 20% of the stream length subject to vertical subsidence >20mm e.g. water cloudiness resulting in a measurable ecological impact • Survey Cross Lines: >200mm closure measured as a result of LW35 - 36	appropriate approvals implement remedial action such as manual crack filling with local materials e.g. sand and debris to reduce rockbar bypass flow • Review management options, including implementation of; measures to reduce the level of observed impacts and mine plan changes to ensure Level 3 impacts are not induced by future longwall(s) • Within three months of the completion of the longwall, assess the magnitude of pool water level reduction. If ongoing mining induced pool water level reduction is occurring, develop remedial works to restore pool water level. Implement remedial works as soon as subsidence movements within Area 5 that may affect the rehabilitation works are complete and appropriate approvals are in place • Develop and implement monitoring program to ensure effectiveness of remedial works if they are required		Confirm implementation of action(s) with agencies Notify relevant technical specialists Update progress in monthly subsidence report
Level 3 **(Exceeding Predicted Impact Criteria)**	Exceed Subsidence Impact Performance Measures as specified in the Bulli Seam Operations Project Approval (see Section 2 above), including: • More than negligible diversion of flows or changes in the natural drainage behaviour of pools for more than 20% of the stream length subject to vertical	• Increase monitoring/inspection frequency of key sites to twice weekly • Increase discharge from BCD or Appin East Main Dam to provide a minimum refuge water level in pools for minimum ecosystem protection • Implement remedial	Manager – Approvals	Notify agencies of Level 3 impacts within 24 hours of confirmation Confirm implementation of action(s) with agencies Notify relevant technical specialists

Georges River	Characteristics of level	Actions	Action by	Notification
	subsidence >20mm e.g. fracturing in rockbar or bed of the Georges River which causes reduction of water levels in mapped pools, which are unable to be maintained with intervention • More than negligible iron staining or gas releases for more than 20% of the stream length subject to vertical subsidence >20mm e.g. iron staining or gas releases resulting in a measurable ecological impact • More than negligible increase in water cloudiness for more than 20% of the stream length subject to vertical subsidence >20mm e.g. water cloudiness resulting in a measurable ecological impact	action such as manual crack filling with sand or hand mortaring to reduce rockbar bypass flow • Review management options, including implementation of additional mitigation and contingencies measures to reduce the level of observed impacts (e.g. maintenance watering of aquatic plants and relocation of aquatic fauna) and mine plan changes to ensure further Level 3 impacts in other parts of the Georges River are not induced by future longwall (s) • Within three months of the completion of the longwall, assess the magnitude of pool water level reduction. If ongoing mining induced pool water level reduction is occurring, develop remedial works to restore pool water level. Implement remedial works as soon as subsidence movements within Area 5 that may affect the rehabilitation works are complete and appropriate approvals are in place • Develop and implement monitoring program to ensure effectiveness of remedial works		Update progress in monthly subsidence report Provide completion report that demonstrates successful rehabilitation outcomes

Table 3: Water quality trigger values as are outlined in the Georges River Management Plan TARP (Pool 40 data used in below analysis).

Parameter	Normal or Level 1*[>] (within impact criteria)	Level 2[>] (within impact criteria)	Level 3[>] (exceeding impact criteria)
pH	<-2SDs <7.81	Between -2 and -3SDs 7.81 – 7.46	>-3SDs >7.46
DO (%)	<-2SDs <54.5	Between -2 and -3SDs 54.5 – 29.5	>-3SDs >29.5
SO4 (mg/l)	<+2SDs <43.52	Between +2 and +3SDs 43.5 – 53.15	>+3SDs >53.15
Total Fe (mg/l)	<+2SDs <2.41	Between +2 and +3SDs 2.41 – 3.08	>+3SDs >3.08
Total Mn (mg/l)	<+2SDs <0.165	Between +2 and +3SDs 0.165 – 0.222	>+3SDs >0.222
Dissolved Ni (mg/l)	<+2SDs <0.168	Between +2 and +3SDs 0.168 – 0.210	>+3SDs >0.210
Dissolved Zn (mg/l)	<+2SDs <0.053	Between +2 and +3SDs 0.053 – 0.068	>+3SDs >0.068

Note that the GRTARP (Table 5) also requires comparison with baseline data and upstream/downstream pools to determine if there are any other influences acting on the system.

*** Level 1 impacts commence when physical changes are observed in rockbars, pool height, iron staining, gas etc. See GRTARP (Table 5) for more detail on physical triggers.**

[>] Water parameter values for Level 1 – 3 impacts are graphed and displayed in Appendix A.

5.2 Groundwater

Groundwater in the SMP Area is not significantly utilised as a resource and there are no licensed boreholes in the area. Groundwater is not potable or suitable for irrigation but may be suitable for stock watering. Landowners are reliant on surface dam captured waters.

The Groundwater TARP shown in Table 4 will be implemented for operations to the east of the Georges River Trigger Point (i.e. when longwall extraction goes beyond

the GRTP). The majority of monitoring boreholes are located adjacent to the Georges River

Table 4: Groundwater TARP

Groundwater	Characteristics of level	Actions	Action by	Notification
Normal	• No observable mining induced groundwater level variability • No mining induced change in water quality in groundwater	• No action required • Monthly review meeting • Continue monitoring program	Manager Approvals	None necessary
Level 1 (Within Predicted Impact Criteria)	• 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.	• No remedial action necessary • Monthly review meeting • Continue monitoring program	Manager Approvals	• Notify agencies of Level 1 impacts in monthly subsidence report
Level 2 (Within Predicted Impact Criteria)	• Permanent reduction in groundwater levels (i.e. effect persisting after significant groundwater recharge rainfall events after mining) in some of the boreholes compared to the variability determined in baseline monitoring.	• Monthly review meeting • Continue monitoring program • Provide alternative supply to any groundwater users who are adversely affected • Reinstate bores in consultation with owner	Manager Approvals	• Notify agencies of Level 2 impacts within 24 hours of confirmation • Confirm implementation of action(s) with agencies • Notify relevant technical specialists • Update progress in monthly subsidence report
Level 3 (Exceeding Predicted Impact Criteria)	• Permanent reduction in groundwater levels (i.e. effect persisting after significant groundwater recharge rainfall events after mining) in all of the boreholes compared to the variability determined in baseline monitoring.	• Monthly review meeting • Continue monitoring program • Provide alternative supply to any groundwater users who are adversely affected • Reinstate bores in consultation with owner	Manager Approvals	• Notify agencies of Level 3 impacts within 24 hours of confirmation • Confirm implementation of action(s) with agencies • Notify relevant technical specialists • Update progress in monthly subsidence report • Provide completion report that demonstrates successful rehabilitation outcomes

6.0 Response to the Georges River TARP

The "Trigger- Action- Response Plans (TARPs) relate to identifying, assessing and responding to the range of conditions related to subsidence impacts for the Georges River.

The following is a list of actions that will be considered in response to triggers:

- Variance of natural pool water levels will represent triggers for increased investigation, mitigation and rehabilitation;
- All key stakeholders will be informed of the variance and proposed investigation, mitigation and rehabilitation, where required;
- Illawarra Coal and its consultants and contractors are responsible for acting on alerts;
- Investigative, mitigation and rehabilitation actions will be taken in response to alerts after consultation with key stakeholders and appropriate approvals are in place;
- Water quality effects of remediation measures will be taken into account when designing and implementing any program. These issues will be addressed during any approval process;
- The effectiveness of remediation will be further discussed with approval agencies for each program but will be based on returning the area to as similar to pre-mining conditions as is practicable or as otherwise negotiated with relevant stakeholders.
- Observed impacts on the Georges River from the current longwall will be considered before subsequent longwalls approach the Georges River. If impacts exceed 'predicted' levels, then an 'adaptive management' approach will be considered for future longwalls to prevent further instances of exceedance of predicted impacts. Adaptive management may include, but not be limited to, relocating the finishing line of the longwall away from the Georges River.

Illawarra Coal has developed a strategy that sets out the history, objectives, key technical constraints and opportunities, and options available to manage subsidence impacts to natural features (BHP Billiton 2005). This section of the GRMP draws on this strategy and would be used to assess the need for specific preventative or mitigative measures. The implementation of remedial or adaptive management measures would be assessed through the results of the monitoring programs outlined in the SMP and additional detailed assessments as required. The focus of the SMP is on the natural environment and the subsequent sections deal primarily with these aspects. Mitigation and management of the built environment is briefly discussed below and considered in more detail in specific Infrastructure plans.

A number of remedial measures and rehabilitation options are available to address impacts to the environmental values of the SMP Area. Some of these are implemented prior to disturbance to reduce a known effect of subsidence while others are implemented following subsidence to repair impacts. Rehabilitation of impacts can be actively undertaken or occur through natural processes. In some circumstances, a combination of natural, active, pre-mining and post-mining rehabilitation may be required.

This section outlines some of the techniques and processes that can be used for mitigation and rehabilitation. However, it is important to note that based on the predicted subsidence levels and subsidence effects, it is envisaged that potential impacts would not require substantial rehabilitation works, nor would adaptive management measures such as changes to the mine plan for subsequent longwalls be required. Notwithstanding this, Illawarra Coal recognises that the mitigation, rehabilitation and monitoring measures proposed in this SMP are an integral part of the proposed mining activity.

6.1 Preventative Options

Most of the management actions listed in Table would be implemented after the subsidence impact has been identified. Some measures, such as grouting, would be implemented following the completion of most subsidence movements. Other preventative options are discussed in the Illawarra Coal Natural Features Subsidence Management Strategy (BHPBIC, 2005).

6.1.1 Mine Planning

The most applicable pre-emptive measure for reduction of impact is through the reduction of subsidence. At this stage, the most appropriate method of reducing subsidence is by leaving barriers of coal to support the surface. This is achieved through modifications to the mine layout.

The mine layouts at West Cliff Area 5 have been modified to reduce the potential for impacts to surface features, particularly the Georges River. The proposed longwalls do not mine directly beneath the Georges River such that impacts greater than minor, such as fracturing causing draining of pools would occur. Longwalls 34 to 36 have been shortened to avoid mining under the Georges River.

BHPBIC submitted a variation to the Director General to shorten Longwall 34 so that it finished at least 135m from the Georges River. This variation was approved by the Director General 6 August 2010. The impacts from Longwall 34 on the Georges River included two zones of minor fracturing at Rockbar 40 and Rockbar 43 and an associated zone of minor iron staining identified in Pool 40d, above Rockbar 41. No

flow diversion was identified in these areas and water levels in the pools are consistent with baseline levels. These impacts are consistent with less than minor environmental consequences as described in the Bulli Seam Operations Development Consent.

BHPBIC submitted a variation to the Director General 14 November 2012 to shorten Longwall 35 at the finishing end next to the Georges River by 192m. This reduction in length results in Longwall 35 mining no closer than 160m from the Georges River.

With the implementation of this adaptive management approach of reviewing and seeking variations for subsequent longwalls it is likely that the Bulli Seam Operations Subsidence Impact Performance Measures of 'negligible environmental consequences over at least 80% of the stream length subject to vertical subsidence >20mm and no subsidence impacts or environmental consequences greater than minor' would be met.

Should impacts observed on the Georges River exceed predicted levels, adaptive management techniques will be considered, such as seeking variations to adjustment the length of longwalls.

This process adopts the hierarchy of avoid/minimise/mitigate as requested by the I&I, DoPI and OEH during consultation with BHPBIC.

6.1.2 Active Flow Management

During no low rainfall periods the flow in the Georges River is largely determined by the volume of water discharged via Licensed Discharge Point 10 from Brennans Creek Dam and from Appin East. If the Level 2 trigger for minor cracking leading to a reduction in pool water level is observed, then additional flow can be released from Brennans Creek Dam and/or Appin Colliery to ensure pool water levels are maintained.

6.2 Rehabilitation

6.2.1 Natural remediation

Cracking due to subsidence will tend to seal as the natural processes of erosion and deposition act on them. The characteristics of the surface materials and the dynamics of a specific area will determine the rate of self-healing.

Cracks that occur in drainage paths are more likely to have the erosion and deposition processes acting to facilitate natural sealing. It is also possible that the erosion deposition equilibrium is disrupted and one process could dominate leading to additional surface impacts. Where a stream or water channel is ephemeral, it is

important to note that the potential for natural sealing and or additional impacts may be temporally offset to the initial impact as infilling processes are largely limited to when there is flow in the stream.

While sealing of surface fractures will occur naturally in some instances and over time, it is recognised that this may not provide sufficient mitigation in some situations and that active sealing of the streams may be required in some locations.

6.2.2 Hand Mortaring

Where water transfer is observed through well-defined joints or fractures, the joints and fractures will be sealed using a variety of products, some of which can be applied in wet conditions and under water. These materials are normally applied using small held-held equipment and in localised situations.

Should large fractures occur in the base of the pools they will be sealed over with hand placed cement grout and natural oxides.

6.2.3 Injection Grouting

Where creeks are fractured as a result of subsidence and there is limited ability for them to naturally seal it would be necessary to carry out remedial measures. Such remedial measures have been implemented at other locations in the Illawarra region. These measures usually include grouting to return ground water to the surface or reduce pool water loss. Grout can be delivered by small handheld equipment or truck-mounted equipment for deeper holes. Angled and horizontal drilling techniques can be utilised to position grout remotely from the site. The engineering techniques on which this type of rehabilitation is based are well established and used in the mining and construction industries and can be applied in these circumstances.

A number of grouts are available for use in such situations including cement, pulverised ash and chemical grouts, with or without fillers. The fillers can include sand and gravel or vegetable fibres. The choice of grout will be determined based on the nature and extent of the fracturing, the surface/ground water interaction and the objectives of the rehabilitation program.

These rehabilitation operations have the potential to cause adverse environmental impacts through the materials used and the disturbance associated with access and will be carefully planned to avoid contamination of watercourses. Bunds will be used to contain any spillage at mixing points. The materials used in these processes are non-toxic, environmentally inert and do not significantly impact upon the natural habitats of aquatic species.

6.2.4 Permeation Grouting

This involves the introduction of grouting and filling materials into an individual pool or a stream flow, in such a manner that the material will be drawn into cracks and thereby seals the voids in the bed of the creek.

6.2.5 Impermeable Blankets or Linings

This involves the installation of a waterproof lining to a pool to prevent loss of water into the voids below. A variety of materials are available with the choice dependent on site-specific circumstances.

6.2.6 Joint Sealing

Where water is leaking from a creek or riverbed through well-defined joints or fractures, the joints and fractures can be sealed using a variety of products, some of which can be applied in wet conditions and under water.

6.2.7 Surface Treatment

Surface impacts may display as cracks of varying depths and widths, erosion scares or deposition areas. The treatment of these areas will be planned taking into account specific site conditions and impacts.

Where cracking develops in significant areas and natural sealing is not progressing, the cracks may require forking over and compacting to prevent subsequent erosion. Larger cracks may require more work to repair them, for example, mulch or other protection to prevent the development of erosion channels. Surface protection will remain in place until revegetation covers the disturbed area. In some cases, if the cracks are wider they may require gravel or sand filling up to surface level and revegetation using local native plants. Such rehabilitation measures have the potential to cause impact through the materials used and the disturbance associated with access. Considerable care and relevant approvals will be obtained to ensure the protection of the environment as such works are implemented.

6.2.8 Gas Release

A typical driver of gas release at the surface is fracturing of the rock mass and associated release with groundwater flows to the surface. Grouting techniques discussed above can reduce these associated gas flows. In all identified circumstances in the Southern Coalfields the gas releases have diminished over a number of months but it can take a number of years. Where vegetation is impacted by gas releases the areas affected will be revegetated once monitoring determines

the gas releases have ceased or reduced to an extent that vegetation is no longer affected.

7.0 Reporting Procedures

Reporting will be undertaken as per Table 5.

Table 5: Reporting undertaken which is applicable to the Georges River Management Plan

Reporting Means	Frequency	Reported By	Reported To
Phone Call, Email, Report	Within 24 hours if Level 2 trigger is reached (Cond 16 SMP Approval)	Manager Approvals	I&I*, OEH, NOW, DoPI, govt agency with regulatory role if requested
Subsidence Management Status Report	Monthly (Cond 17 SMP Approval)	Mining Approvals Coordinator	I&I*, OEH, NOW, DoPI, govt agency with regulatory role if requested
Impact Reports	When a Level 2 or greater impact is observed	Manager Approvals	I&I*, OEH, NOW, DoPI, govt agency with regulatory role if requested
Annual Environmental Management Reports	Annually	West Cliff Site	I&I*, OEH, NOW, DoPI, govt agency with regulatory role if requested, Wollondilly Shire Council
End of Panel Reports	End of each Longwall within 34-36 (Cond 18 SMP Approval).	Manager Approvals	I&I*, OEH, NOW, DoPI, govt agency with regulatory role if requested

*Note: * includes Department of I&I Environment and Subsidence Branches.*

Where applicable, reporting of results will include the following information:

- Date of monitoring.
- Location including easting and northing positions.
- Distance the longwall has travelled from the face starting position and/or distance from the Georges River.

The monitoring report will be collated and assessed against the results of the Georges River Monitoring and presented at the monthly Subsidence Management

Meeting. If however, the findings of a particular inspection or monitoring result are deemed to warrant an immediate response the Manager Approvals will call a special assessment meeting at the earliest opportunity. Responses will be determined and/or confirmed at this meeting. The Manager Approvals shall be responsible for the implementation of the response. All actions taken will be reported to I&I and other stakeholders.

Monitoring delays may be caused, in some cases, by adverse weather conditions, flooding of the river and non-availability of satellites for GPS work. Every effort will be made to conduct surveys and inspections according to the schedules and any deviation and the reasons therefore will be recorded and advised to key stakeholders.

8.0 Training

All field surveying work and analysis of results will be carried out by or under the immediate supervision of a suitably qualified professional e.g. Surveyor. It shall be the responsibility of the Manager Approvals to ensure that all persons and organisations having responsibilities under this Plan are trained and understand their responsibilities.

The person(s) performing regular inspections of the cliff faces and edges shall be under the supervision of the Environment Field Team Coordinator and be trained in observation and reporting. The Environment Field Team Coordinator shall be satisfied that the person(s) performing the inspections is capable of meeting and maintaining this standard.

9.0 Resources Required

The Head of External Affairs provides resources sufficient to support this Plan.

Equipment will be needed for the Control and Response provisions of this Plan. Where this equipment is of a specialised nature, it will be provided by the supplier of the relevant service. All equipment is to be appropriately maintained, calibrated and serviced as required in operation manuals.

Equipment required for this Plan includes, but is not limited to:

- Signs and signposts.
- Photographic equipment.
- Survey equipment.

It shall be the responsibility of the Manager Approvals to ensure that personnel and equipment are provided as required to allow the provisions of this Plan to be implemented.

10.0 Roles and Responsibilities

The overall responsibility for the successful implementation of this Plan resides with the Manager Approvals who shall be the Plan's authorising officer. The responsibility for co-ordination of this Plan resides with the Manager Approvals, as does the responsibility for its implementation in the field.

Head of External Affairs

- Ensure that the requisite personnel and equipment are provided to enable this Plan to be implemented effectively.

Manager Approvals

- Authorise the Plan and any proposed amendments thereto.
- Delegate, to an appropriately qualified person, the responsibility to document any changes to the Plan, recognising the potential for those changes to affect other aspects of the Plan.
- Ensure regular inspections are conducted (including photographing) of areas considered to be at risk of impacts. Determine the standards by which such inspections are to be conducted and recorded.
- Ensure surveys required by this Plan are conducted and record details of instances where circumstances prevent these from taking place.
- Organise and participate in assessment meetings called to review mining impacts on cliffs or steep slopes. The Environment Field Team Coordinator and the Survey Manager would also normally attend such meetings.
- Prepare a report of all actions determined as being necessary in accordance with the Response Action Plan and distribute to stakeholders should any 'trigger' level be reached that requires a response other than increasing frequencies of surveying and/or inspections. Maintain a record of meetings.
- Within 24 hours, respond to any queries or complaints made by members of the public in relation to mining effects.
- Organise audits and reviews and participate in the Plan Review following any audit or other milestone event.
- Address any identified non-conformances, assess improvement ideas submitted and implement if considered appropriate.

- Ensure all data, records and reports arising from the provisions of this Plan are kept for a period of at least 12 months following the completion of Longwalls 34-36.
- Arrange implementation of any agreed remedial measures to protect persons from potential falls. This would include liaison with landowners if required.

Environment Field Team Coordinator

- Instruct suitable person(s) in the required standards for inspection, recording and reporting and be satisfied that these standards are maintained.
- Investigate significant falls of ground or rock.
- Identify and report any non-conformances with Plan provisions.
- Participate in any other assessment meetings called to review the behaviour of the river valley area affected by mining.

Manager Survey

- Collate survey data and present in an acceptable form for review at assessment meetings.
- Bring to the attention of the Manager Approvals any findings indicating an immediate response may be warranted.
- Bring to the attention of the Manager Approvals any non-conformances identified with the Plan provisions or ideas aimed at improving the Plan.

Technical Experts

- Conduct the roles assigned to them in a competent and timely manner to the satisfaction of the Manager Approvals and formally provide expert opinion as requested.

Environmental Field Officers

- Formally bring to the attention of the Environment Field Team Coordinator any non-conformances identified with the Plan, or ideas aimed at improving the Plan.
- Conduct inspections of the monitoring sites identified by the Environmental Field Team Coordinator in a safe manner.

11.0 Plan Monitoring and Corrective Action

The ongoing effectiveness of the Management Plan requires personnel to be able to highlight non-conformances with Plan provisions and make recommendations to improve the Plan. The corrective action requirements of this Plan facilitate the continual monitoring and improvement of Plan provisions.

12.0 Communications

The Manager Approvals shall institute subsidence management meetings during the extraction of Longwalls 34-36 for the purpose of maintaining communications necessary for the effective operation of this Plan.

Should any trigger level of ground movement be attained other than an increase in the frequency of surveying and/or inspection, the Manager Approvals shall immediately convene a meeting of all affected parties to formulate an agreed and appropriate response. The Manager Approvals shall be responsible for implementation of the agreed actions and for communication to affected Landowners.

13.0 Record Keeping and Control

The processes defined within this Management Plan can be demonstrated as being effective in the control of hazards over the mining period. It specifically addresses hazards associated with cliff face and edge deterioration resulting from ground movement.

The following information is collected, reported and maintained to improve the understanding of the effect of subsidence on cliffs and steep slopes:

- Surveys conducted.
- Regular review of subsidence movement monitoring and inspections.
- Interpretation and assessment of the data derived from surveys and observations.
- Assessment of any response actions implemented.

14.0 Document Control

This Management Plan shall be controlled as part of the BHPBIC Document Control System. The Manager Approvals will be responsible for maintaining document control standards for the Plan.

The monitoring, actions and adequacy of this Plan will be reviewed when compiling the End of Panel Report for each Longwall. The Manager Approvals shall approve all proposed modifications and amendments to the Plan or associated documentation for submission to I&I.

15.0 Contacts

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16.0 References

BHP Billiton – *West Cliff Colliery Area 5 Longwalls 34 to 36 Subsidence Management Plan Application*, January 2008.

BHP Billiton, *West Cliff Colliery Longwall 34 End of Panel Report*, January 2012

BHP Billiton, *West Cliff Colliery Longwall 33 End of Panel Report*, March 2010

Biosis (2007a) *West Cliff Colliery Area 5 Longwalls 34-36 Impacts of Subsidence on Terrestrial Flora and Fauna*.

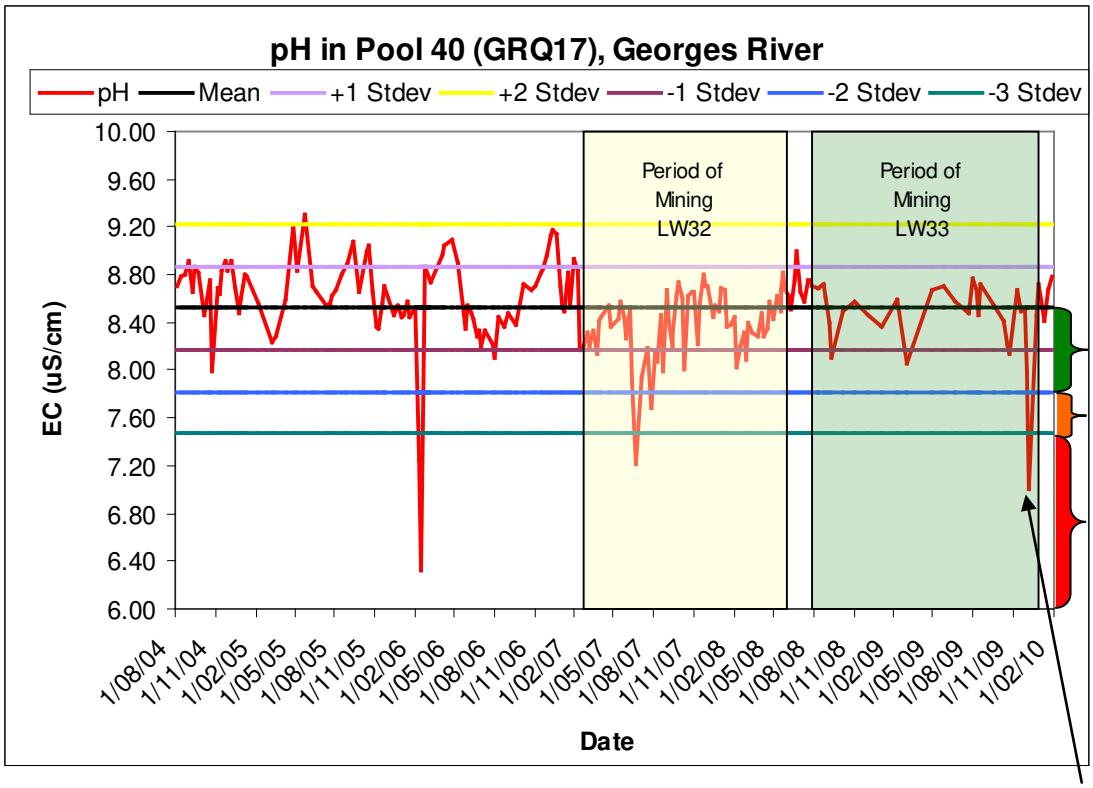
Ecoengineers (2007) *Assessment of Water Effects West Cliff Colliery Longwalls 34 to 36*.

Ecology Lab (2008) *West Cliff Area 5 Longwalls 34-36 Assessment of Mine Subsidence Impacts on Aquatic Habitat and Biota*.

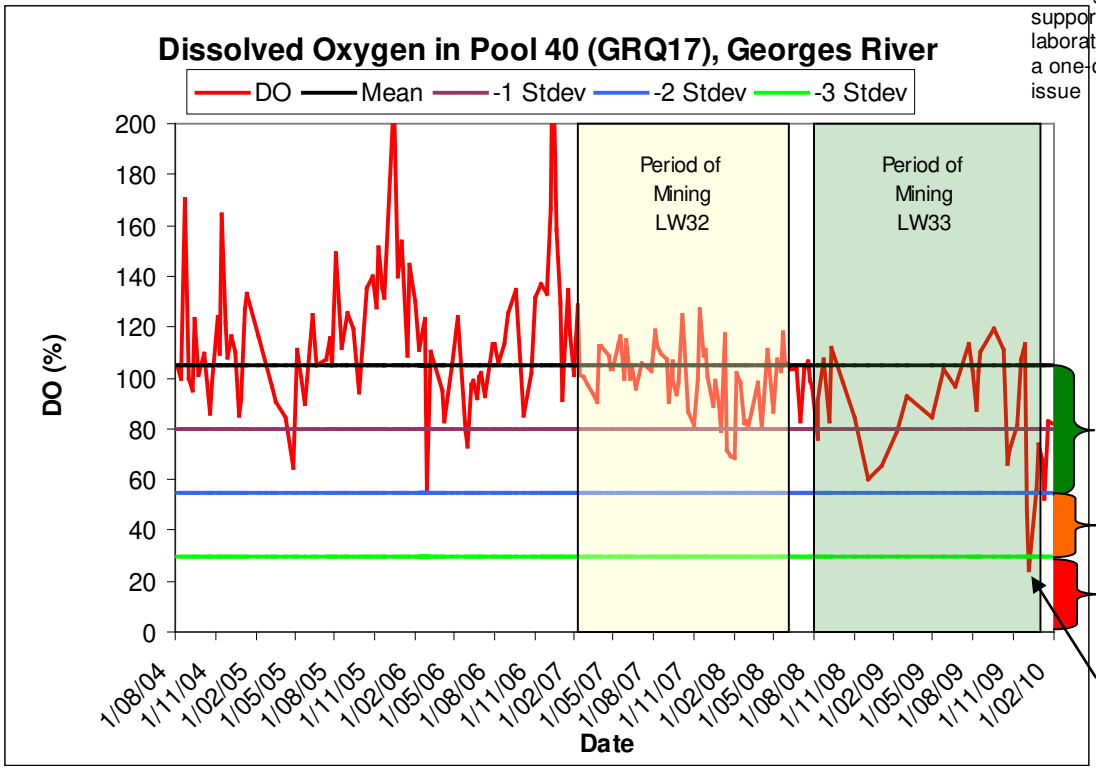
MSEC598 – *The Effects of the Proposed Modified Finishing End of Longwall 35 on Previous Subsidence Predictions and Impact Assessments*, November 2012.

MSEC326 – *The prediction of subsidence parameters and the assessment of mine subsidence impacts on natural features and surface infrastructure resulting from the extraction of proposed Longwalls 34 to 36 in Area 5 at West Cliff Colliery in support of the SMP Application*, December 2007.

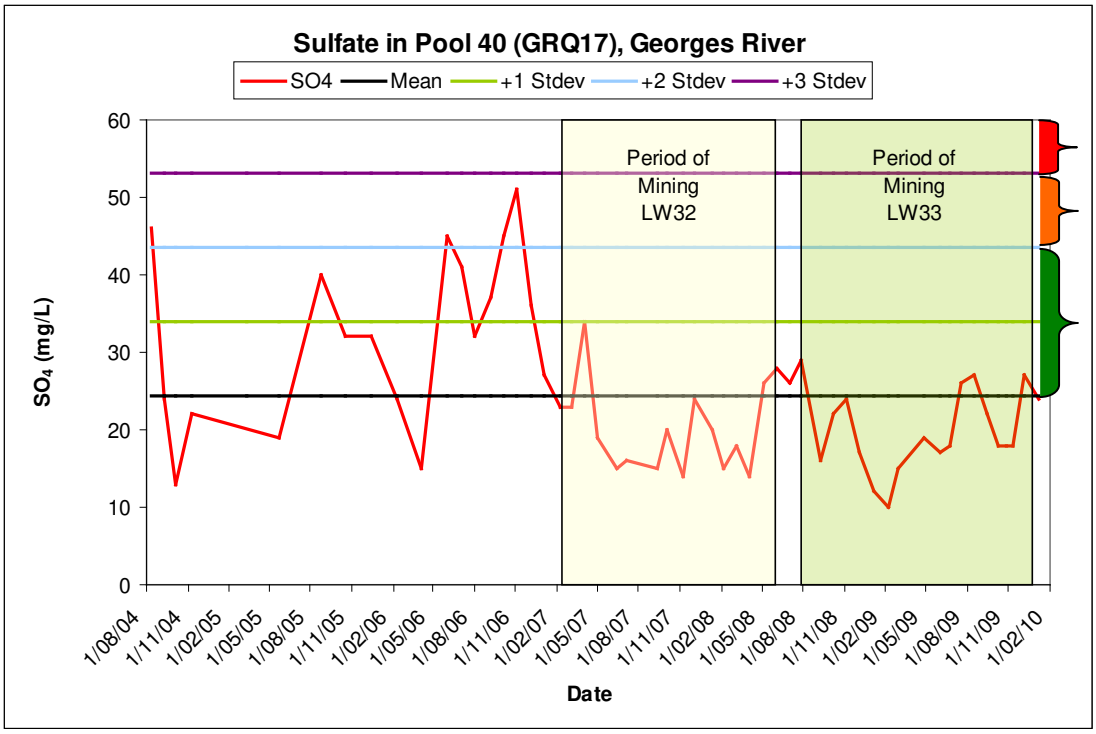
17.0 Appendix A – Graphs Showing Use of Standard Deviations for Water Quality TARP Triggers

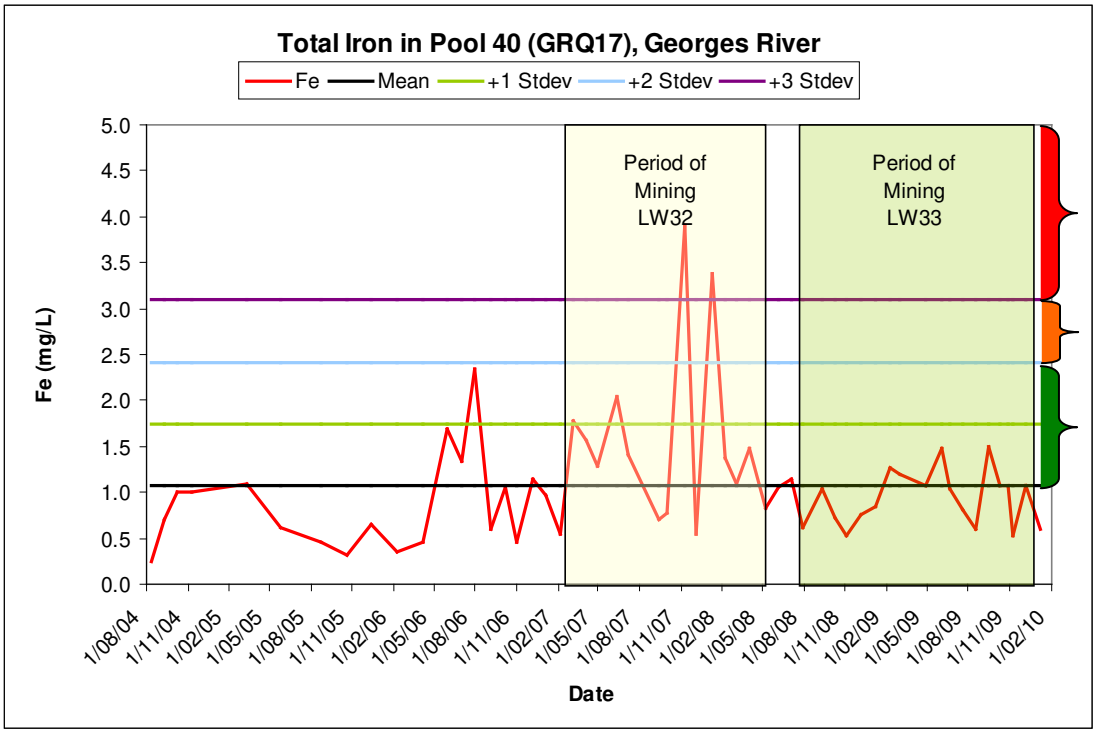


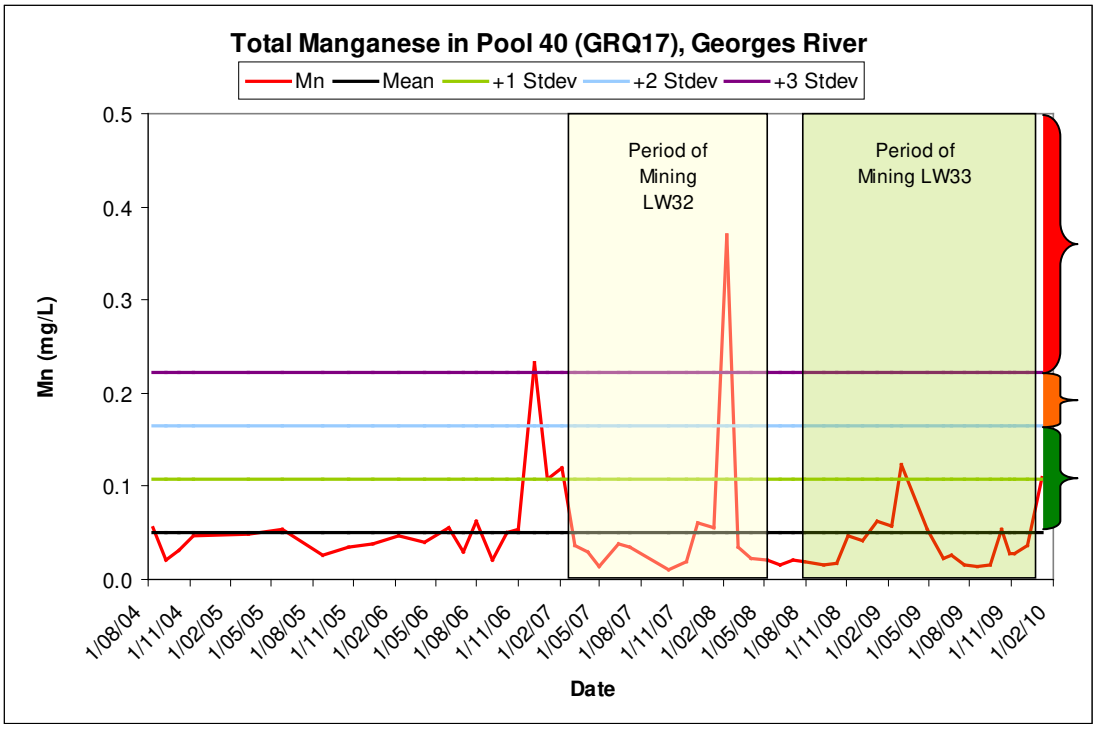
Investigations, supported by laboratory result, show a one-off calibration issue



Result not persistent downstream, recovered in subsequent monitoring. Not considered a mining impact


Sulfate in Pool 40 (GRQ17), Georges River
SO4
Mean
+1 Stdev
+2 Stdev
+3 Stdev
Period of Mining LW32
Period of Mining LW33
SO4 (mg/L)
Date
Level 3
Level 2
Normal / Level 1


Total Iron in Pool 40 (GRQ17), Georges River
Fe
Mean
+1 Stdev
+2 Stdev
+3 Stdev
Period of Mining LW32
Period of Mining LW33
Fe (mg/L)
Date
Level 3
Level 2
Normal / Level 1


Total Manganese in Pool 40 (GRQ17), Georges River
Mn
Mean
+1 Stdev
+2 Stdev
+3 Stdev
Mn (mg/L)
0.5
0.4
0.3
0.2
0.1
0.0
Period of Mining LW32
Period of Mining LW33
Level 3
Level 2
Normal / Level 1
1/08/04
1/11/04
1/02/05
1/05/05
1/08/05
1/11/05
1/02/06
1/05/06
1/08/06
1/11/06
1/02/07
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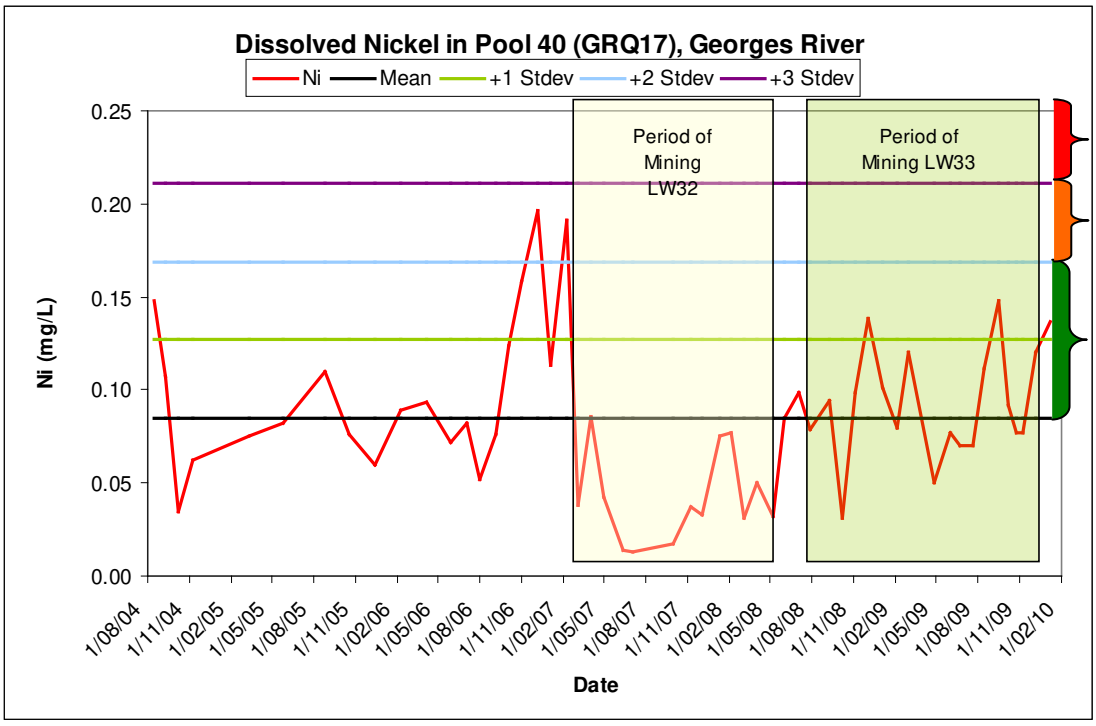
Dissolved Nickel in Pool 40 (GRQ17), Georges River
Ni
Mean
+1 Stdev
+2 Stdev
+3 Stdev
Ni (mg/L)
0.25
0.20
0.15
0.10
0.05
0.00
Period of Mining LW32
Period of Mining LW33
Level 3
Level 2
Normal / Level 1
1/08/04
1/11/04
1/02/05
1/05/05
1/08/05
1/11/05
1/02/06
1/05/06
1/08/06
1/11/06
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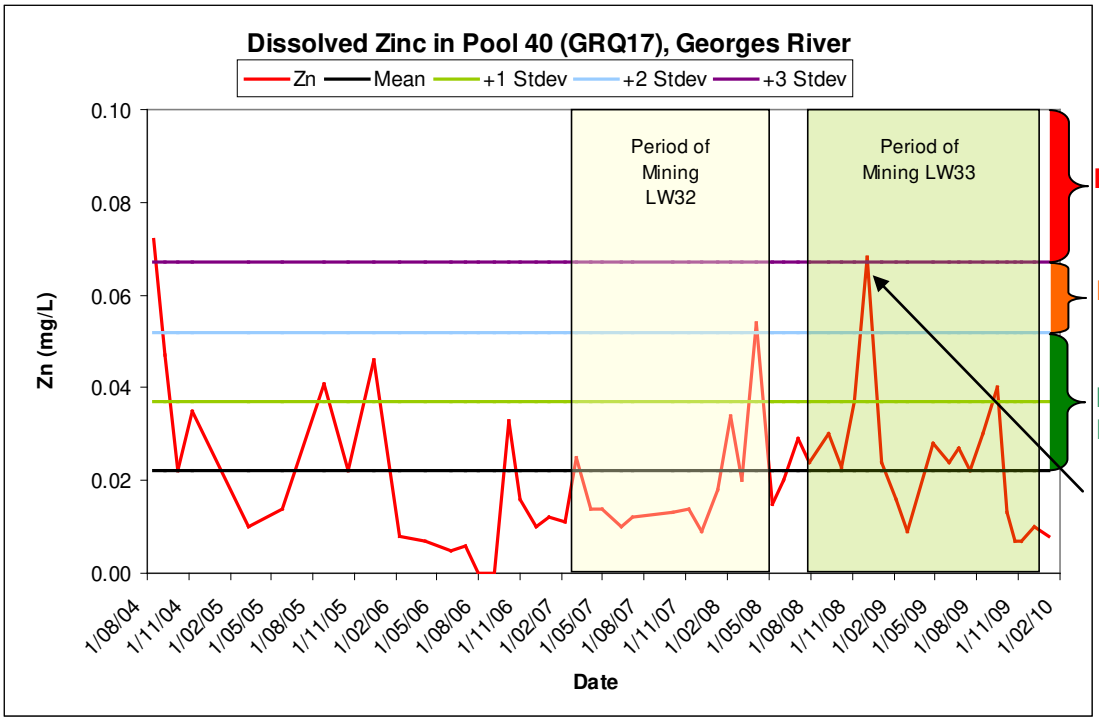
Date



All sites show a peak in dissolved Zn, not just those adjacent to current mining. Therefore not considered a mining impact